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.

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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

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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.*

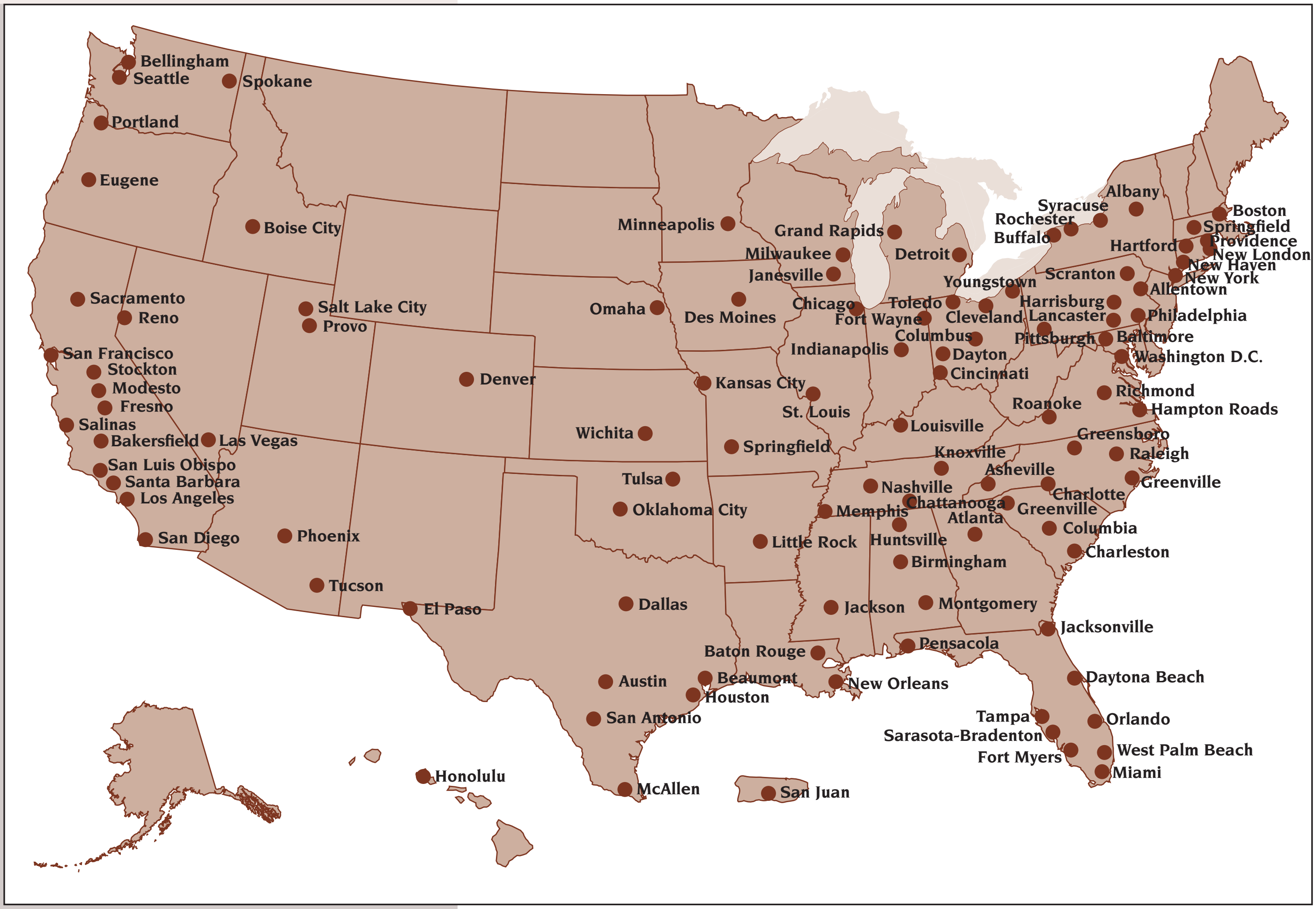

Figure 1 – Metropolitan Areas Surveyed Through the ITS Deployment Tracking Project

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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

BROOKINGS

TUESDAY AUGUST 17, 2010

An Intelligent Transportation Policy

Transportation, Cities, Community Development, Cities, Technology

Robert Puentes, Senior Fellow, Metropolitan Policy Program

The Brookings Institution

WINTER 2001 — (An edited version of this article appears in the Winter 2001 Edition of the Brookings Review)

The United States has invested hundreds of billions of dollars in building and maintaining roads to accommodate auto and truck travel. Yet, no matter how much more money we spend, congestion and delays seem to get worse and political obstacles often put alternative strategies out of reach. Can the advanced technologies that in recent years have transformed American life solve our intractable traffic problems? A new universe of smarter vehicles and highways may be able to do what miles and miles of concrete and asphalt can't.

Simply, Intelligent Transportation Systems, or "ITS", refers to the integrated application of modern technologies and management strategies in our surface transportation systems. To put it more concretely (pardon the pun), ITS includes many different technical augmentations to otherwise familiar equipment: traffic signals that are centrally controlled by computer; electronic toll collection tags that enable drivers to pay without stopping at toll booths; changeable message signs that provide information concerning the next bus or train or about rough traffic conditions ahead; talking navigation systems that provide turn-by-turn directions through satellite technology for drivers while en-route. Contraptions that until very recently were thought of as "electronic gizmos" or "gee-whiz technology" are now nearly as common as the computer on your desk.

Traffic control centers now operate in dozens of locations across the U.S. In many ways, these centers are the embodiment of ITS and represent the latest in public sector transportation system management.

Montgomery County, MD's Transportation Management Center

Visit Their Website to Learn More About ITS

Resembling mission control for NASA, workers in these centers keep an eye on traffic by monitoring dozens of often wall-size video images from cameras connected by miles and miles of high tech cable. From there, these multi-agency centers are able to dispatch emergency vehicles as needed, adjust signal timing to reflect current conditions and relay important information to motorists about those conditions. Measured benefits include air quality improvements, reductions in fuel consumption, accident mitigation and more efficient use of emergency services. Naturally, traffic control centers' costs vary depending on many factors such as their location and complexity. The TranStar Center in Houston was built for $13.5 million. Project costs for the Regional Traffic Management Center in Minneapolis' Twin Cities was $23.5 million. Indianapolis' TrafficWise system will cost a total of $25-$30 million.

Private sector ITS focuses on devices installed in the vehicle to help drivers find directions, avoid accidents, receive information and enhance perceptions of personal safety. Talking navigation systems provide turn-by-turn directions for drivers while en-route. These devices know the location of a vehicle through the military's global positioning satellite (GPS) technology and use computerized maps to calculate directions. These devices are especially attractive to those renting cars (Hertz is installing about 50,000 in its fleet), while consumer demand for individual purchases is steady but slow - partly because the devices remain relatively expensive (averaging about $2,000 each.) Also popular is General Motors' wireless OnStar system with over 100,000 subscribers. OnStar uses cell phone technology to connect drivers with human operators for directions, concierge services and emergency assistance.

Key Intelligent Transportation Elements:

- Central traffic signal control
- Freeway management
- Transit & fleet management
- Electronic toll collection & fare payment
- Advanced emergency response
- Regional multi-modal traveler information
- Satellite-based navigation systems
- Driver assistance devices

Independent market research for these and other types of consumer products indicates that the private sector market for ITS in this country is expected to exceed $300 billion over the next 15 years. Public sector infrastructure over the same period is estimated at about $75 billion. More than half a million jobs are expected to be created in the ITS industry over the next two decades.[1]

The key for all this intelligence is the coalescence of the public infrastructure and the private devices. The next generation of navigation systems, for example, will "talk" with transportation management centers to obtain current traffic information and provide directions to the traveler based on that information to help them avoid delays. Another example of this nexus is related to payment systems. Electronic toll collection systems are employed on about 100 facilities throughout the U.S. and boast more than 5 million subscribers. Electronic fare cars have become standard ways to pay for transit trips worldwide.

ITS "works" for the same reason electronic cash registers work: because automated technologies reduce operator error, allow similar devices to be tied together enabling them to function as a system, and provides instant feedback on the system's performance from a central location. Until just a few years ago, surface transportation could be thought of as the old push-button dinosaurs cashiers labored over. ITS represents the new gleaming supermarket that speeds customers through check-out lines, enables them to pay electronically, dispenses important information to enable customers to make better decisions, and responds to a clean-up in Aisle 6 (or Highway 6, as the case may be).

However, ITS is not a magic bullet that is going to solve all transportation problems. In fact, a credible criticism is that these technologies make the time drivers spend in their vehicles more comfortable and convenient and cause trips to be more predictable. Therefore, ITS can actually exacerbate congestion by facilitating the longer daily commutes associated with sprawling suburban development. A growing body of research is demonstrating that the problem of traffic congestion is best tackled by addressing the connection between transportation and land use. And unfortunately, linkages between intelligent transportation and land use are spotty at best.

A History of Federal Investments

What we do know is how advanced technologies are fundamentally redefining surface transportation and the role the federal investment has in supporting that effort. Since 1990, federal investment has totaled more than $1.3 billion with another $900 million obligated through 2002. This should not be too surprising as the federal government has always played a key role in the development and redevelopment of the surface transportation system. In 1956, the Federal Highway Act created today's Interstate System and the Highway Trust Fund dollars that paid for it - using federally imposed gas taxes. There were a few reauthorizations to the highway program over the years, but none more revolutionary than the Intermodal Surface Transportation Efficiency Act of 1991, commonly known by its less cumbersome name, ISTEA ("Ice Tea"). Among its landmark provisions, ISTEA formally created the federal ITS program.

Although in many ways ITS is basically the natural evolution of venerable transportation technologies such as traffic signals and roadway sensors, in many others the world of ITS harkened some back to Norman Bel Geddes' "Futurama" exhibit at the General Motors pavilion at the 1939 World's Fair. GM dazzled patrons with visions of an advanced highway system that would zip drivers effortlessly along uncongested roadways. Fifty years later the vision resurfaced with the high profile field test of the Automated Highway System. A public-private partnership led by GM, Lockheed Martin, Raytheon and U.S. DOT, the automated highway proposed a solution to solving traffic congestion by allowing drivers to cruise hands-free while reading the newspaper, sleeping or a variety of other sundry activities. These vehicles would move automatically through the use of advanced technologies such as automatic cruise control that senses vehicles and objects and automatically applies the brakes before letting it get too close.

Of course, the automated highway never came to fruition but some of its elements have endured due to their proven and unique capability in reducing the number, rate, and severity of motor vehicle crashes - the key focus of U.S. DOT's National Highway Traffic Safety Administration (NHTSA). According to NHTSA, 90% of the deaths on our nation's roadways (which occur every 13 minutes) are due to driver error. U.S. DOT estimates that more than 50,000 annual crashes could be prevented through the integration of intelligent lane keeping and collision-avoidance technologies. Understanding consumers' high regard for their own personal safety, car companies have begun hawking such devices during nighttime news programs. Leveraging this private sector investment, U.S. Transportation Secretary Rodney Slater recently urged U.S. auto manufacturers to develop such devices in order to achieve a national goal of reducing crash fatalities by 20 percent over the next 10 years. More intriguing is Slater's challenge to metropolitan areas to deploy the infrastructure portion -

recognizing that all this advanced gadgetry on the vehicle is no good unless it can communicate with the roadway.

A System of Systems - Benefits and Costs

Probably the most important element of this policy discussion is that intelligent transportation technologies are not stand-alone, but are designed to work within the existing transportation system. High-tech components by themselves will not go a long way in reducing congestion, pollution or operating costs - rather, it is the integration of devices, systems and agencies that make the difference. The investments made by the federal government as well as those made by the states have certainly been significant. And many studies have shown that when properly integrated, ITS does reduce the need for new roadway construction and comes out positive in benefit/costs analyses:

- Maryland's statewide highway monitoring program finds very high benefits in its incident response program over the program's costs. The benefits of reductions in delay, fuel consumption, and ancillary accidents is estimated to total $30.5 million, about seven times the $4 million cost of the initial capital investment and annual maintenance and operations. [2]

- In Atlanta, the benefit/cost ratio for the freeway and incident management system was 21/2 to 1. This is based on total benefits of $44 million in reduced delay time calculated as the decrease in the duration of incidents coupled with savings generated by enabling traffic to move at full capacity. Hardware, system and operating costs are estimated to be just under $20 million per year.[3]

- Efficiently linking traffic signals through leased telephone lines to a central control room in the Tysons Corner area of Fairfax County, Virginia was found to save motorists nearly $20 million per year based mainly on reductions in delay ($18 million) but also fuel savings and emissions reductions.[4]

Overall, ITS infrastructure will generate a benefit-cost ratio of 8.8 to 1 for the nation's 75 largest most congested areas for reasons not unlike those expressed above. But again, unless these high tech elements are deployed in an integrated, coordinated, cooperative manner, these ratios are not likely to be realized. Recognizing this, the U.S. DOT was charged by Congress with ensuring that ITS projects that are funded with Highway Trust Fund dollars conform to a national system of architecture and standards.

Driven to Distraction

While there is general agreement that advanced technologies have direct benefits to transportation ? there is quite a bit of debate over the best and safest ways to deploy such devices in the vehicles.

Earlier this year, the Federal Communications Commission approved the U.S. DOT's petition to assign one of the few remaining "N11" numbers for advanced traveler information services. This significant announcement enables drivers to access current traveler, traffic and transit information by dialing 511 from any telephone (similar to 411 for information or 911 for emergencies) as opposed to a seven digit number that always changes from one jurisdiction to the next. This is important because about 45 metropolitan areas and over 100 transit agencies operate some type of telephone-based traveler information system. A motorist driving up the I-95 corridor between Washington, DC and New York City is presented with 11 such services, all with different telephone numbers. To address the next challenge of deciding who fields the incoming telephone call (private companies often operate such fee-based services) Vice President Gore proposed a new program that would provide start-up funds for assistance.

However, at the same time the FCC granted the petition, one of the U.S.DOT?s agencies, NHTSA was studying the growing issue of driver distraction. According to NHTSA, 44% of drivers have telephones in their vehicles or carry them when they drive; 7% have access to email and 3% have fax capabilities. NHTSA researchers estimate that 25% of all fatal crashes are caused by driver distraction. The Network of Employers for Traffic Safety estimates that driver inattention is a factor in 25 to 50 percent of all highway collisions. And a 1997 study in the New England Journal of Medicine found that talking on a phone while driving quadrupled the risk of a crash and was almost as dangerous as driving while drunk.

Using cell phones while driving has already been banned in cities and counties throughout the U.S. and support of such restrictions is growing. Experts say that the in-vehicle navigation systems that exist in over a million vehicles provide the greatest distraction.

Big Brother and Smart Transportation

Perhaps one of the most contentious issues surrounding ITS deployment is related to the issue of automated enforcement technologies. As the name suggests, such systems snap photographs of vehicles in the act of a specific traffic violation. Photographs are usually taken of the rear license plate and matched against a state?s Department of Motor Vehicle database. The registered owner of the vehicle is then mailed a ticket or other notification that an infraction has occurred.

Such technologies have all the essential elements of ITS products and services: they use advanced electronic equipment, combined with computers and telecommunications to address a transportation-related problem. However, when the national ITS program was being developed several years ago automated enforcement technologies were conspicuously absent. Such was the fear of a hostile response from the general public over privacy and civil liberty concerns.

At least in some respects, these worries were unfounded. Despite this oversight by the transportation community, certain automated enforcement technologies began to proliferate - particularly red light cameras. Local decision-makers and public safety officials all across the U.S. see these cameras as key tools in their never-ending quest for safer roads. In fact, at least 21 states have passed enabling legislation to support red light cameras and U.S. DOT has offered grants to study the technology in five others.

As it turns out, the American public strongly supports their use. Surveys of large metro area residents sponsored by the Insurance Research Council reveal that 83% of respondents favor the use of red light cameras. However, not all enforcement technologies enjoy such support. The Insurance Institute for Highway Safety found that only 57% of respondents support the use of photo radar, a similar technology that nabs speeders. Likewise, automated emissions technology that detects gross polluters from the roadside has not exactly garnered a lot of support from the general public. What is clear is that the public (correctly) perceives red light running as a serious traffic threat and condones innovative methods to alleviate the problem. On the other hand, speeding and aggressive driving violations are another matter entirely and "Big Brother" references always seem to accompany this argument. Clearly, outreach and education is needed.

Preparing for the Future

The Federal Highway Administration (FHWA) has stated openly that the Interstate Highway System is essentially complete (that word "essentially" is important). In doing so, they will be relying on advanced technologies, connected systems and improved communications between agencies, businesses and travelers to provide and improve transportation services.

So does this mean that the FHWA will disband? Far from it. Like others, FHWA has initiated a program to prepare for the next round of federal transportation legislation. ISTEA was reauthorized as the Transportation Efficiency Act for the 21st Century (TEA-21), which in turn expires in 2003. FHWA recognizes that the challenge for the future is in the maintenance and operation of the existing transportation system. A national dialogue has been initiated on the federal level, which indicates that the focus has shifted from the stovepipe implementation of individual projects (high tech and otherwise) to continuous, seamless performance of the entire network. No longer exclusively focused on laying down ribbons of asphalt, FHWA appears ready to include management and operations as equal partners, along with planning, design and construction.

It is, of course, naïve to think that road construction will halt entirely. The federal government will continue to build roads, as will the states. However, there are some signs that transportation policy on a statewide level is changing, too. This past summer, the New Jersey legislature passed a bill signed by the Governor that emphasizes a "fix-it-first" transportation policy. Specific provisions require the state DOT to focus on the rehabilitation and technical augmentation of existing transportation facilities with new highway construction to come only after explicit approval of the legislature. Other elements of the bill include efforts to study highway congestion mitigation through smart transportation technologies. Make no mistake; this is a radical departure from traditional transportation policy.

Unfortunately, the uncontrolled Congressional earmarking of federal transportation dollars continues to hamper U.S. DOT policies. As has been the case in past years, the House and Senate continue to earmark almost all of the available ITS funds for specific projects back home. The trough for the ITS earmarks was the Deployment Incentives Program which was designed to seed projects that contribute to the U.S.DOT goals of integration and connectivity. Although both the Senate and House included report language emphasizing these goals, the list of earmarks were included in the bill as statutory language and therefore has the force and effect as law (as opposed to report language which is viewed only as recommendations to the responsible executive branch agency). Since projects in the bill are identified only by geographic location (e.g., "North Central Pennsylvania" or "State of North Carolina") it is often impossible to know exactly how the money is to be spent and whether or not the policy goals and objectives of the U.S. DOT are to be properly considered. More stringent evaluation and assessment under uniform, discretionary criteria is needed. Our nation has too many diverse needs to earmark an entire pool of funds and bypassing debate and discussion on these issues.

A responsible federal policy would be one that is, of course, unified among the branches. But also that gives priority to those projects that adhere to a fix-it-first mentality and clearly contribute to integration, cooperation and interoperability. More than smart cars, smart highways and smart buses - new transportation policies seek to "build" a smarter intermodal transportation system with smarter travelers. But despite such advances, our nation's roadways are still very dangerous, congestion continues to escalate, and quality of life suffers the consequences. The challenge is to make sure transportation policy and investment serves the needs of people and the region, not just the needs of vehicles and facilities.

Photo Credits:

1. Montgomery County, Maryland's Transportation Management Center
2. Insurance Institute for Highway Safety

Work Cited:

1. The Market for Emerging Technology Applications in Transportation, Hagler Bailly, 1998.

2. Chesapeake Highway Advisories Routing Traffic (CHART) Incident Response Evaluation, COMSIS Corporation, May 1996.

3. Calculating Benefits for Georgia's Intelligent Transportation System, Georgia Department of Transportation and Federal Highway Administration, September 23, 1998.

4. SMART Traffic Signal System, Virginia Department of Transportation Engineering Group, March 2000.