

Module 12: Institutional Issues

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Purpose

Agencies often overlook the institutional issues they may encounter in deploying and maintaining intelligent transportation systems (ITS) technologies, yet these issues can be as complex and challenging as the technological challenges. Agencies frequently encounter political and organizational challenges with funding, system ownership, and legal requirements, among others. Institutional arrangements need to be implemented during the planning stages of an ITS project to ensure success. This module looks at the various kinds of institutional issues that can arise, and provides guidance on addressing them.

Objectives

The learning objectives of this module are the following:

- Gain an understanding of the kinds of institutional challenges that agencies can encounter in planning, deploying, and maintaining ITS technologies.
- Gain an understanding of successful methods agencies can use to address these challenges.
- Provide information on valuable resources that can be helpful in addressing these institutional challenges.

Introduction

Institutional challenges have plagued ITS projects since their advent. Numerous papers and reports document lessons learned from ITS projects that encountered institutional issues over the past two decades. A 2006 University of California, Berkeley, study explored the factors that prevent ITS from being a mainstream transportation planning activity. The study revealed that most agencies believed that the ITS projects that were not proceeding well were the ones that suffered from institutional problems.¹ Though agencies will still encounter new challenges in deploying ITS technologies, much can be learned from previous experiences. This module presents institutional issues commonly encountered in deploying and maintaining ITS, provides examples of how agencies have successfully overcome these challenges, and provides resources where the readers can find additional information on this topic.

The remainder of this module is organized as follows:

- *Making the Business Case for ITS* – This section discusses the challenges that State and local agencies face in choosing to invest in technology over pavement, bridges,

and potholes, essentially the “ITS versus operations and maintenance” question. It also discusses how agencies can work to mainstream ITS in their programs.

- *Organizational Capabilities for ITS* – This section discusses resources available to agencies regarding their organizations’ capability or readiness to implement an ITS program.
- *Funding and Financing ITS* – This section discusses methods for funding and financing ITS projects and includes information about the Federal Aid Program.
- *Data Privacy Issues* – This section discusses current and emerging issues with data privacy, because an increasing number of ITS technologies could encounter challenges with regard to personally identifiable data.
- *Standards and Open Source* – This section covers topics such as data sharing and licensing, which are becoming increasingly common challenges as the number of public-private partnerships increase. This section also discusses recent advances in this area that pose new challenges, such as agencies making nontraditional data available for public use.
- *Operating and Maintaining ITS* – This section discusses the fact that maintenance is an often overlooked aspect of deploying ITS. This aspect is particularly important for multiagency projects, where it is critical to formally establish responsibilities upfront for both the financial and the staffing resources that will be required for ongoing maintenance activities.
- *Interjurisdictional Cooperation* – This section discusses issues involved with interjurisdictional cooperation, including clear establishment of roles and responsibilities for deployment as well as operations and maintenance.
- *Workforce Issues* – This section discusses workforce needs related to deploying and maintaining ITS, including staffing requirements for overseeing the work of consultants and contractors as well as for conducting work in-house. It discusses the common challenges many agencies face regarding new skill sets their staff must have in order to address changing needs, and it provides professional capacity-building and workforce development resources.

Making the Business Case for ITS

State and local agencies frequently face challenges in getting ITS on their agendas because choosing to invest in technology instead of repairs to pavement, bridges, and potholes can be politically difficult. This section of the module discusses how agencies can work to mainstream ITS within their agencies and State.

Incorporating ITS into the Planning Stage

To get ITS on the agenda, agencies should begin at the planning stage. If ITS projects are not properly represented in the planning process, they may not get to the point of facing institutional issues at the deployment or operating phases. As a result, metropolitan planning organizations (MPOs) and other planning organizations play a key role in relaying the need for ITS investments. The U.S. Department of Transportation (USDOT) has a wide range of resources available to planners and operations staff who are interested in incorporating ITS into the planning process through an initiative called Planning for Operations.² The Planning for Operations initiative is a joint effort between the Federal Highway Administration (FHWA) Office of Operations and the FHWA and Federal Transit Administration (FTA) Offices of Planning. The initiative was developed to promote multimodal planning practices that support 21st-century transportation system management and operations. To link operational services (e.g., ITS) into the transportation planning and programming process, transportation planners and operators need to have a common understanding of the mobility, safety, and efficiency benefits. Planning for operations includes three important aspects:

- Collaboration and coordination activity of regional transportation operations that facilitates regional transportation systems management and operations (RTSM&O)
- Management and operations considerations within the context of the ongoing regional transportation planning and investment process
- The opportunities for linkage between regional operations collaboration and regional planning

Linking planning and operations is vital to improving transportation decision making and the overall effectiveness of transportation systems. Coordination between planners and operators helps ensure that regional transportation investment decisions reflect full consideration of all available strategies and approaches to meet regional goals and objectives.

Linking ITS to Current Issues

Getting ITS on the agenda is easier if it is linked to a current issue, whether that be emergency preparedness, job growth, or congestion mitigation. ITS can solve a multitude of problems given the appropriate application of technologies. For example, the Florida Department of Transportation (FDOT) successfully linked its ITS strategy to hurricane preparedness in developing an integrated statewide operations system for traffic monitoring, incident data capture, weather information, and traveler information in the iFlorida project.³

USDOT's *ITS Knowledge Resources* website⁴ provides information on specific projects and on specific benefits that have been developed from these projects, allowing users to identify ITS strategies appropriate for their agency or their region's needs.

Educating Policymakers

In some instances, institutional issues associated with ITS technologies can arise in the planning process because they lack adequate representation in policy discussions or are not fully understood by policymakers, or both. Some public officials and staff members responsible for transportation plans and programs are still only vaguely familiar with ITS technologies, and

many of the important back-office technologies are not apparent to the public, making them a tougher sell with politicians whose constituents are not requesting the technologies. Some public officials associate the term ITS with fully automated guideways and vehicles (driverless cars), leading them to conclude that these technologies are too far in the future to be worth considering for near-term plans. One strategy that can be quite effective at educating policymakers is to establish a coalition or group focused solely on transportation issues. One example of this is the Central Maryland Transportation Alliance, which is a coalition of Baltimore area business, civic, and nonprofit groups intent on improving travel within central Maryland, consisting of the city of Baltimore as well as five surrounding counties. Establishment of a group such as this provides a mechanism for explaining the need for specific transportation investments and technologies in advance of seeking funds.

Educating the Public

A study reported at the 2013 meeting of the Transportation Research Board demonstrated that funding for ITS, which comes largely from the government, is driven by the transportation consumer, in that people set governmental priorities and need to place value on ITS technology and services to justify the funding. In the study, the authors suggest that ITS concepts and benefits should be topics of messaging to the general public, who may not be aware of the many challenges faced by the transportation system.⁵ As shown through lessons learned documented through a variety of managed lanes projects,⁶ educating the public can include conducting preproject education, marketing a specific project, and providing ongoing public education.

Educating Decision makers on the Costs and Benefits of ITS

In many cases, agencies simply need better and more current information on the benefits and costs of ITS. In the 2006 UC Berkeley study previously cited, respondents reported that lack of information on the benefits and costs of ITS was hindering them in fitting ITS projects into mainstream transportation planning processes,¹ and some agencies still do not know where to turn for information. There are a number of Federal resources that agencies can turn to for information, including the following: USDOT's *ITS Knowledge Resources* website; USDOT's *ITS Benefits, Costs, Deployment, and Lessons Learned Desk Reference: 2011 Update*;⁷ and USDOT's *Operations Benefit/Cost Analysis Desk Reference*.⁸ (Also see "Additional Resources" at the end of this module.)

Organizational Capabilities for ITS

Many State departments of transportation as well as many transit agencies have a deeply ingrained engineering culture that is well suited for managing construction and infrastructure maintenance projects. This culture, however, is not particularly well suited for ITS projects. As a result, many agencies are currently experiencing an adjustment period to accommodate the evolving industry and the new technical skills the industry requires. The American Association of State Highway and Transportation Officials (AASHTO) recently undertook an effort to address this gap head-on, creating resources for the industry on how to successfully adjust their culture in terms of agency mission, new technical knowledge, organizational capacity, and relationships.

Systems operations and management (SO&M) is a term that refers to programs, projects, and strategies intended to get the most efficient use out of existing transportation infrastructure, as described in the 2010 AASHTO guidance on SO&M.⁹

The logic for aggressive pursuit of SO&M is compelling. SO&M strategies are typically extremely cost effective (and low cost) with relatively short lead times. However, the rate of strategy deployment by many transportation agencies has been modest—despite the constraints on improving levels of service through the construction of new capacity. Transportation agencies have a long tradition, engineering culture and well developed program for capacity construction and maintenance that is not altogether supportive of SO&M. In some cases, the legacy culture must be adjusted in terms of agency mission, new technical knowledge, processes, organizational capacity, and relationships.

The AASHTO guidance and the [One-Minute Guidance](#) Evaluation helps agencies to evaluate capabilities in key areas of process and institutional arrangements and to prepare a formal action plan. The guidance was derived from the capability maturity model (CMM). It is presented according to six dimensions that represent features of transportation agencies and their activities that are critical to effective system operation and maintenance. Each of the six dimensions is further divided into three or four sub dimensions, reflecting agencies' varying levels of maturity and providing guidance appropriate for achieving the next level. The six dimensions are presented below. Not all of these dimensions relate to institutional issues associated with ITS deployment, but some do, and they are discussed in other sections of this module, as noted below:

- **Business Processes** – Includes formal scoping, planning, programming, and budgeting.
- **Systems and Technology** – Includes systems architecture, standards, interoperability, and standardization and documentation. Many aspects of systems and technology are covered in Module 2, “Systems Engineering.” Institutional issues related to data standards are discussed in this module in the section “Standards and Open Source.”
- **Performance Measurement** – Includes the definition of measures, data acquisition, data analysis, and use of data.

- **Culture** – Includes technical understanding, leadership, policy commitment, outreach, and program authority.
- **Organization and Workforce** – Includes organizational structure, staff capacity, development, and retention. Institutional issues related to organization and workforce are covered in this module under “Workforce Issues.”
- **Collaboration** – Includes relationships with public safety agencies, local governments, MPOs, and the private sector. Institutional issues related to collaboration are discussed in this module in the section “Interjurisdictional Cooperation.”

Funding and Financing ITS

Past funding of ITS research and deployment has resulted in significant progress toward a unified vision of integrated and sustainable smart transportation described in the previous modules of this *ITS ePrimer*. This vision supports the goals of mitigating traffic congestion, promoting mobility, ensuring safety and security, and protecting the environment and reducing greenhouse gas emissions.¹⁰ The need for sufficient funds is still a practical consideration and touches many aspects of ITS, including system design and engineering, field demonstration and user testing, data management, ongoing deployments, site management and coordination, and operations and maintenance. Funding for ITS projects is obtained in various ways. The following sections describe potential funding opportunities for ITS projects as well as some of the challenges associated with obtaining funding.

Federal Sources of Funding for ITS Projects

On July 6, 2012, President Obama signed into law P.L. 112-141, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MAP-21 provides needed funds to sustain the Highway Trust Fund and provide States and communities with funding to build needed roads, bridges, and transit systems during FY2013–2014.¹¹ MAP-21 authorizes the Federal ITS program at a \$100M annual budget level and encourages ITS deployment incentives and grant funding. The law makes various sources of Federal aid available, which are outlined in USDOT’s *Guide to Federal-Aid Programs and Projects* and its website www.fhwa.dot.gov/federalaid/guide/guide_current.cfm.

Certain projects may be eligible for funding through the following MAP-21 programs:

- **The FTA grant program** – A potential source of capital funds for transit ITS projects is the FTA grant program as authorized by MAP-21, which includes Section 5307 for public transportation in urbanized systems, 5310 for systems serving seniors and people with disabilities, and 5311 for public transportation in rural areas.¹²
- **The Congestion Mitigation and Air Quality Improvement (CMAQ) Program** – The CMAQ program provides funds to support surface transportation projects and other related efforts that contribute air quality improvements and provide congestion relief. MAP-21 provides just over \$2.2 billion in CMAQ funding each year in 2013 and 2014.¹³

- **The Surface Transportation Program (STP)** – STP provides flexible funding that may be used by States and localities for projects to preserve and improve the conditions and performance on any Federal-aid highway, bridge, and tunnel projects on any public road, pedestrian and bicycle infrastructure, and transit capital projects, including intercity bus terminals. MAP-21 provides approximately \$10 billion each year for 2013 and 2014.¹⁴

Public-Private Partnerships

One approach to funding may be to foster coordination between public and private entities in development and implementation of new concepts and technologies. Third parties sometimes have more resources available to refine technological solutions.¹⁵ Working with the private sector also has the potential to promote economic growth.

Related to this, Shaheen et al. considered that, “industries benefiting from a functional transportation system, such as the freight industry, could buy out sections of the transportation system. The privatization of U.S. roadways could prove favorable for ITS, as government fiscal barriers could be circumvented and hasten implementation. However, this would necessitate that ITS devices and vehicles be compatible to ensure a seamless U.S. transportation infrastructure across operators. This compatibility issue would require a policy to establish an industry standard, which could pose a legal barrier due to intellectual property rights.”¹⁵

In an increasing number of examples, private sector entities are constructing needed roadway facilities in exchange for the right to collect tolls for a number of years to recoup their investment and generate profits. There are also emerging examples of State and local agencies obtaining data from private sector enterprises for use in their traffic management and traveler information initiatives, whereas they might traditionally have installed their own infrastructure to gather this information.

Despite the benefits of public-private partnerships (PPPs), public agencies should take into account several potential risks when considering a PPP, including possible financial disadvantages. PPPs can incur higher costs of capital, “because interest on PPP debt is taxable while interest on municipal bonds, used by public agencies to pay for infrastructure projects, is tax exempt.”¹⁶ In addition, the private sector must pay Federal, State, and local taxes on certain assets and net revenues that the public sector generally does not, which increases project costs.¹⁶ Though not common, there is also a risk that the private partner involved in a PPP will go bankrupt or default on the debt, leading to the possibility that the public agency will have to take temporary control of the project or that publicly funded debt will not be repaid.¹⁷

Another factor increasing the cost of PPP-financed projects involves concession projects, in which private companies hold management and construction responsibilities for infrastructure for a certain period of time and then transfer rights back to the government. This is a popular form of PPP, because government officials will retain ownership while limiting initial financial and construction risks. However, when engaging in a concession project, public agencies “must accept that transferring *all* associated project risk—including inflation and exchange rate risk to financing—to private firms will increase the total cost of the project.”¹⁸

In addition to the potential cost-related drawbacks of PPPs, there are logistical limitations: currently only 23 States and Puerto Rico allow the use of PPPs for transportation projects, and some States do not give their transit and transportation agencies the authority to contract out their services.¹⁷ Many transportation stakeholders are wary that PPPs will lead to fewer job opportunities for the public sector labor force and to loss of public control over the transportation system, especially with long-term concession projects. Because private organizations are profit driven, some feel that they do not have the public's best interest in mind and that they may "skimp on maintenance and repairs to boost profits," for example.¹⁹ Loss of public control is also an issue in PPP contracts that include noncompete clauses that "prohibit, limit and/or elicit compensation for highways or other transportation facilities"¹⁹ that compete with those leased by the private organization, thereby limiting the public agency's ability to deliver needed infrastructure if it violates the noncompete agreement. This issue can be mitigated either by prohibiting noncompete clauses (which several States do) or by making sure that contract language protects the public interest even while limiting "predominant financial risks from competing facilities."¹⁹

Overcoming Funding Challenges

Agencies can face a variety of challenges when it comes to obtaining funding for projects, whether it be capital costs or operations and maintenance costs. One challenge is that different States have different approaches to categorizing and managing ITS projects compared to more traditional transportation work. A 2004 paper described funding sources in different States and discussed some of the unique challenges States face.¹⁵ For example, it discussed the fact that ITS projects in the State of Texas have a difficult time competing with more traditional transportation system improvements (e.g., pavement overlays or rehabilitation, additional capacity, bridge rehabilitation or replacement), as there is no distinct category for ITS-type projects, and they are presumably combined in the categories highlighted previously. As such, a more proactive approach to conveying ITS benefits and costs may be necessary for future ITS deployment to compete for State funds. A number of resources are available on the costs and benefits of ITS technologies, as cited throughout this module.

Two ongoing issues related to funding are generating public support for projects and dealing with policy issues regarding ownership and governance.

Public Support

Shaheen et al. (2013) report that funding for ITS, which comes largely from the government, is driven by the transportation consumer, in that people set governmental priorities and need to place value on ITS technology and services to justify the funding. In their study, they suggest that ITS concepts and benefits should be topics of messaging to the general public, who may not be aware of the many challenges faced by the transportation system.

Policy Regarding Ownership and Governance

The USDOT's ITS Strategic Plan calls for certain objectives between 2010 and 2014, and some of these are related to policy questions that could affect how agencies and the Federal Government collaborate with partners. Among the questions to be asked are "What entities will potentially fund, own, and govern connected vehicle systems, components, and data?" and "What level of items within a device or what interfaces need to be certified, and how would you accomplish the certification?" It is envisioned that government and industry will share responsibility for this area of work. However, government will have a primary role in funding developments prior to a user market emerging for certified products. Government will serve as an enabler and coordinator of this function."¹⁰

Data Privacy Issues

Information is the core component of ITS. To be effective, ITS applications need to be able to collect, integrate, store, and disseminate data and information on the state of various aspects of the transportation network. Depending on the application, information could be required about travelers, vehicles, or cargo, potentially raising significant privacy concerns around the collection, retention, analysis, use, or disclosure of any personal information collected.

Data protection issues arise for any ITS application that involves collection of personal information, whether through traffic cameras, license plate identification, or some other mechanism. Advanced transportation systems that collect personal information include electronic toll collection (ETC) systems, speed cameras and cameras for red light running, and border crossing technologies, all of which typically identify the vehicle and, subsequently, the individual to whom the vehicle is registered.

Historically many ITS applications did not require information about specific travelers, but as transportation technologies become more sophisticated, they are increasingly turning toward requiring data from individual vehicles. Examples of technologies not previously mentioned that require detailed data include sophisticated travel time applications and road pricing schemes that charge by the mile, by location, or by roadway type. Furthermore, many safety applications of connected vehicles require detailed data on vehicles because they must be able to track the position, speed, and heading of vehicles so that warnings can be issued to neighboring vehicles if a potential for a conflict exists. Although these advanced safety systems do not require data on the vehicle or driver, privacy concerns could still arise due to the detail of the data that is being captured.

With the future turning toward connected vehicles, endless possibilities are opened up in terms of data that can be used to plan and operate transportation facilities. A 2011 report developed by the AASHTO Connected Vehicle Working Group, with support from USDOT, highlights the following areas of known interest:²¹

- Traffic and transportation management performance measures
- Vehicle-classification-based traffic studies
- Origin-destination studies
- Intersection turning movement analysis
- Traffic model baselining
- Predictive traffic studies

Over time, the public will interact with ITS on an increasingly frequent basis so data privacy will, by necessity, become an area of increased focus for the transportation industry.

Federal Guidance on Data Privacy

The Federal Privacy Act of 1974 provides a standard definition of *personally identifiable information*: “Any item, collection, or grouping of information about an individual ... that contains his name, or the identifying number, symbol, or other identifying particular assigned to the individual, such as a finger or voice print or a photograph” (5 U.S.C. § 552(a) (2005)). In contrast, anonymous information or information that has been summarized to the extent that it cannot be linked to an individual is not personal information.

Over the years, as ITS has evolved into requiring richer data, various Federal programs have explored data privacy. For example, a major Federal ITS initiative in 2007 was Vehicle Infrastructure Integration (VII), the precursor to the connected vehicle program,

under which the VII Coalition prepared a document laying out a possible framework for privacy policies.²⁰ The principles laid out in this document were adapted from the privacy principles published in guidelines adopted by the Organization for Economic Cooperation and Development, as well as the National Information Infrastructure Privacy Principles, and are ultimately based on fair information practices (FIPs) that are widely used in both the public and private sectors. Many of the policies laid out in this document are still applicable to the industry five years later. In 2011, representatives of the VII Coalition reported that public privacy remains a significant issue that must be resolved. The group called for a review and reaffirmation of the privacy principles originally developed in 2007.

In 2001, ITS America developed a document titled “Fair Information and Privacy Principles,”²² in recognition of the importance of upholding individual privacy in implementing ITS technologies. The principles were designed to be advisory, with the goal of educating and guiding transportation professionals, policymakers, companies, organizations, and the public as they develop fair information and privacy guidelines for specific ITS projects.

With the understanding that privacy and data protection policies are essential components of any connected vehicle system, USDOT is actively addressing privacy and security safeguards through current connected vehicle research. In 2010, USDOT prepared a policy road map for vehicle-to-vehicle and vehicle-to-infrastructure safety, which specifies some aspects of handling data privacy, including the following:²³

- **Device and Equipment Certification** – This certification provides a process to ensure that all devices and equipment in the connected vehicle system meet specific criteria relating to security, performance, and privacy. State and local agencies need to understand these criteria and how to specify, within their procurements, the appropriately certified devices and equipment.
- **Certificate Authority, Privacy, and Security** – A certificate authority is an entity that issues digital certificates that validate that the person, vehicle, organization, or other entity looking to access the system is a legitimate user. Certificates need to be incorporated onto vehicles and into nomadic devices, and they also may be needed as part of roadside equipment.

Furthermore, in the 2012 “Report to Congress on ITS Program Advisory Committee Recommendations,” USDOT speaks supportively of opt-in systems. In those systems, if safety applications were made mandatory, the data needed to support them would not be mandatory, and drivers would be given the choice to opt in to allow their data to be shared as required by the services they seek.²⁴

In recognizing that additional protections are necessary to preserve consumer trust in the wake of increasing technological advances that drive the digital economy, the White House released a document in February 2012 providing a framework for protecting privacy while promoting innovation.²⁵ The framework includes a Consumer Privacy Bill of Rights, which lays out the

following seven guiding principles that can guide deploying agencies that are facing potential privacy concerns:

- **Individual control** – Consumers have a right to exercise control over what personal data companies collect from them and how they use it.
- **Transparency** – Consumers have a right to easily understandable and accessible information about privacy and security practices.
- **Respect for context** – Consumers have a right to expect that companies will collect, use, and disclose personal data in ways that are consistent with the context in which consumers provide the data.
- **Security** – Consumers have a right to secure and responsible handling of personal data.
- **Access and accuracy** – Consumers have a right to access and to correct personal data in usable formats, in a manner that is appropriate to the sensitivity of the data and the risk of adverse consequences to consumers if the data is inaccurate.
- **Focused collection** – Consumers have a right to reasonable limits on the personal data that companies collect and retain.
- **Accountability** – Consumers have a right to have personal data handled by companies with appropriate measures in place to ensure that they adhere to the Consumer Privacy Bill of Rights.

Strategies for Mitigating Privacy Issues

The operating agency ultimately has control over how the system data is protected and used. Where multiple jurisdictions are involved or where there are both public and private sector partners, privacy issues become even more important. Some key considerations for agencies include the following:^{22,26,27}

- **Prepare formal data sharing agreements if data will be shared between multiple agencies or organizations.** Data sharing within a region may be necessary to take advantage of opportunities to share data. If this is the case, it is important to formally document the procedures for data sharing, including what data will be shared, how it will be shared, how the various organizations will use the data, and how they will keep the data secure.
- **Create a formal written data policy that includes procedures for disclosure of information.** The data policy should address data collection, access, protection, and use, and disclosure of the data in question. It should specify that all individuals who have access to the data should receive training about appropriate data handling procedures before being provided access to the data. It is also important to establish

protocols for release of information. Any information that is not specifically marked as protected from public disclosure is releasable to the public upon request under the Freedom of Information Act (FOIA).²⁸ Agencies should determine in advance what types of information they are willing to release and publish rules and conditions for release of this information. In particular, the policy should address handling responses to law enforcement requests for data. Providing law enforcement agencies access to data is likely to decrease public support for the system, and ITS America's "Fair Information and Privacy Principles"²² specify that information identifying individuals should not be disclosed to law enforcement absent consent or appropriate legal processes, but that aggregate data may be provided to law enforcement. As an example, some toll authorities prohibit the use of toll data for speed enforcement, and limit law enforcement's access to the data, except where required by subpoena or warrant.

- **Collect only the personal information needed for the application of interest, use the least-sensitive form of information necessary, and set clear and reasonable limits on the retention of the data.** Data should be collected anonymously whenever the application permits. Information that must be collected in individual units but that is later used in aggregate form should be aggregated as early as possible in the data collection process. In many cases, the system can be designed to maximize data protection. As an example, in the recently completed Minnesota Road Fee Test, the Minnesota Department of Transportation designed a system to assess mileage-based user fees that was able to assess miles driven within different fee categories without having access to details of when and where study participants drove. This was accomplished by designing a system whereby all fee calculations are conducted on the individual's device, and the only information that is required to be sent up to the central server is the total number of miles driven within each fee category over a given time period.
- **If personally identifiable data is required of the system, ensure that this is transparent to the public, and provide a mechanism for repudiation. Disclose all collection and uses of individual data.** ITS America's privacy principles advise that individuals should know what information is collected about them, how it is collected, what its uses are, and how it will be distributed. It is necessary to ensure that individuals consent to the collection, use, and disclosure of personal information, and have the opportunity to choose the least invasive technology for the intended purpose. The data policy established for the system should be made publicly available, with the exception of details about information security processes.
- **Consider an opt-in solution where possible to provide users choices.** The level of privacy concerns varies by individual, and people like to feel in control of their data. Under the recent USDOT recommendations, in some cases opt-in systems can be established, in which users provide data only if they are interested in services that require use of that data.

Standards and Open Source

This section of the module discusses institutional issues related to standards and open source transportation data. As transportation agencies continue to deploy ITS infrastructure and collect transportation data, the need for data sharing and public dissemination is becoming more significant. In addition, various private sector entities have begun providing transportation data. USDOT's Integrated Corridor Management (ICM) initiative highlights the need for data sharing across modes and jurisdictions.²⁹ By sharing data, agencies can leverage information collected in nearby jurisdictions, not only to plan in their jurisdiction but to plan for the entire region. Further, as more data becomes available in finer granularity and in real time, stakeholders can better refine their planning and operations procedures to improve efficiencies within the agency as well as improve the safety, mobility, and environmental impacts on their roadways. The increasing involvement of external stakeholders interested in transportation data can generate challenges related to the ownership and licensing of the data. The topics covered in this section include institutional issues related to ITS data: standards, licensing, access, and users.

Standards

As transportation agencies across the country continue to deploy ITS equipment to improve the safety, mobility, and environment of their roadways, these ITS assets are providing practitioners with a growing number of data sources. Data generally falls into one of the following four categories: traveler, vehicle, center, or infrastructure. Traveler information is data regarding the actual traveler, including routing, mode choice, transit fare information, or tourism information. Vehicle data describes data transmitted from the vehicle, and could include location, speed, or fuel consumption information. Center data describes interfaces between transportation management centers (TMCs) and vehicles, infrastructure, or travelers, and includes incident data, road construction data, and other data related to traffic management. Finally, infrastructure data is generally data collected by roadside infrastructure and describes the performance of the roadway that is being monitored, for example, traffic volume or density data.³⁰ ITS data standards are used to assist in organizing the numerous types of data and data sources.

The application of data standards is critical in maintaining interoperability of data by different users. The need for robust data standards has been identified by USDOT as critical in moving forward the development and use of ITS data. Without well-defined data standards, it is difficult to communicate effectively between organizations, use equipment from different vendors, or obtain data from other sources and integrate it with an existing system. In an attempt to develop an overarching set of standards, the USDOT ITS Standards Program has been leading the development of ITS standards, with nearly 100 standards and supporting documentation developed since 1991. ITS standards are divided into two primary categories: ITS cooperative system standards and ITS infrastructure standards.³¹

Both ITS cooperative system standards and ITS infrastructure standards are typically developed by standards development organizations (SDOs) with oversight by USDOT. These standards are consensus based, open, and voluntary. The SDOs function as public-private partnerships with USDOT.

ITS cooperative system standards often discuss information or data transmitted wirelessly to either equipped vehicles or roadside equipment. Essentially, these standards address communication when at least one of the sources is moving (e.g., vehicle-to-vehicle or vehicle-to-infrastructure communication). These standards allow establishment of a wireless link for vehicle-to-vehicle and vehicle-to-infrastructure communications, establish procedures for information exchange, and define message content. ITS infrastructure standards are those standards that guide information or data transmitted between infrastructure components, generally the communication between two fixed-point sources such as between a traffic signal controller and a traffic management center.³²

Although these standards are increasing practitioners' ability to effectively communicate their transportation data among agencies, a current challenge across many transportation agencies in the United States is that data is captured and stored as a single source from a single mode.³³ In this fashion, each type of data is collected and stored independently of other data sources (e.g., freeway loop data is stored independently of periodic floating car travel time runs). There are several reasons for collecting and storing single-source data, but often the reason for this type of collection and storage is a knowledge gap between stakeholders where one is not aware of the data's use to another. For example, law enforcement officers actively capture and record vehicle crash information, but the methods by which the data is stored can significantly affect how useful the information can be to a State or local transportation agency. If crash data is collected on paper copies of crash reports that are eventually filed electronically in a dataset available only internally to the law enforcement agency, transportation practitioners likely will find little use for it because they would have to invest significant time and effort to collect, organize, and analyze the information. However, if this information is stored electronically and made readily available to external stakeholders, transportation practitioners can more easily access and analyze the crash information to plan safety countermeasures. Although in both cases the crash data is stored as a single source (e.g., law enforcement crash report file database), an online electronic database allows practitioners to use the data to generate a multisource dataset when combining it with their roadway information.

Similarly, organizing and making data available by a single mode hampers multimodal analysis, which is often needed when considering transit trips or freight movements. A challenge often observed with freight-related data involves the various stakeholders involved in the supply chain of a product from origin to destination. An item produced in China for delivery in the United States may be transported by different private carriers via water, rail, and finally highway before arriving at its final destination. Furthermore, many private carriers consider information about their product delivery strategies to be proprietary information, thus adding additional challenges for transportation practitioners attempting to obtain and consolidate these various single sources into a comprehensive multimodal dataset.

Data warehousing and storage also must be considered when discussing data sharing.²² Data can be collected and stored locally on transportation agency systems, but if sharing is to be considered, agencies will need a method to transfer the information. Furthermore, if the data is

intended to be archived, sufficient storage space will need to be identified. A strategy used for the USDOT's Next Generation Simulation (NGSIM) is the use of a community of different storage locations to mirror the data and store it at various backup locations.³⁴ The benefit of mirroring data across various locations is that if one location becomes unavailable, the data is still available at other locations. Another strategy is the use of a centralized storage location where data is uploaded from various sources and the compiled dataset can be accessed as needed by various practitioners, as demonstrated by USDOT's Highway Performance Monitoring System (HPMS).³⁵ A third example would involve having a central location to store various databases, such as Data.gov. With any method chosen for distribution, users must be careful to avoid any potential issues related to version control. For example, if there is a revision to a copy of the dataset, and that dataset is housed in multiple locations, practitioners must ensure that all locations are updated to avoid potential version control problems.

An additional challenge of data sharing practices is the ability to properly identify, protect, and describe the dataset in a way that other practitioners can obtain the data and properly apply the data to their scenario.³⁶ Common ways to describe data are through the use of metadata, or data about data.³⁰ Metadata provides users with context for the dataset, including high-level descriptions of the data, what data types it contains, and under what conditions the data was collected. Having standards for how metadata is written will help practitioners understand more quickly how to apply a dataset to their analysis. Well-defined metadata also allows for system-to-system access of data that is secure and helps form the basis for interagency trust.

Licensing

Data licensing describes who can use a given dataset and how that dataset can be used. For example, some licensing agreements with private providers of traffic data do not allow transportation agencies to post the traffic data to their website or to their dynamic message signs for public dissemination. Licensing is also important for clearly and articulately answering questions regarding ownership of the data (intellectual property). One example of a licensing agreement that affected the end use of data is FHWA's Transportation Technology Innovation and Demonstration (TTID) Program, which funded a program to collect travel times in various locations around the United States. The initial agreement of this effort established that the vendor, not FHWA, had ownership of all data collected through the effort. Because of this agreement, FHWA's ability to reuse the data was limited.³⁷ Licensing challenges can be overcome by using concise language at the beginning stages of any data collection effort. These agreements can be further strengthened through the use of memorandums of understandings (MOUs), as demonstrated by the I-95 Corridor Coalition through their vehicle probe project. In this case, the MOU served as a solid foundation for the project because it specified how data would be handled in the project. The I-95 Corridor Coalition's vehicle probe project was a collaborative effort among the I-95 Corridor Coalition, University of Maryland, and INRIX. The coalition's request for proposal clearly stated rules for data ownership and licensing, guaranteeing that the coalition would have full right of data ownership and use. In addition, the coalition had an MOU with the University of Maryland stating that the coalition would have the right to use all traffic data procured by the university for the project for its own purposes as well as public dissemination. The language in this agreement also protected INRIX from unfair duplication of its data by competing private sector service providers.³⁸

Another strategy to mitigate issues with intellectual property (IP) ownership of data is the use of an open data policy. Maintaining an open data policy allows the data to be freely available to another agency or entity without copyright issues. For example, the city of Madison has created a [data portal](#) that is open to the public and that includes a wide variety of data. The goal of the portal is to make the operation of city government more transparent, effective, and accountable to the public. It should be noted that privacy issues can arise with open data, and these issues are covered in the “Data Privacy Issues” section of this module. To mitigate some of the privacy concerns, transportation practitioners must decide at what level data will be open and available to what users. Additional information on open data is discussed in the presentation [Open Data for Transportation Agencies](#).

In regard to funding and financing ITS infrastructure deployments, increasing numbers of examples can be found in which private sector entities construct needed roadway facilities in exchange for the right to collect tolls for a number of years to recoup their investment and generate profits. There are also emerging examples of State and local agencies obtaining the data used in their traffic management and traveler information initiatives from private sector enterprises, whereas they traditionally might have installed their own infrastructure to gather this information. In these instances, the provider is able to use the data in their commercial products to generate revenue. If this type of approach is used, agencies must ensure that appropriate levels of access and data sharing are granted prior to completing any agreements with private sector partners.

Access

Collecting and storing ITS data without allowing practitioners access to the data would limit its usefulness. However, who should be able to access the data and what data should be available to which stakeholders? Although these questions may be answered through the license agreements put in place before the data is collected, potential problems can emerge with the provision of access to different stakeholders. Many agencies provide generic traveler information, such as route speed or travel time for major corridors, through different applications such as dynamic message signs. Other agencies are providing more detailed information through devices such as user-customizable dashboards or interactive applications by which users can view transportation data specifically tailored to their needs. For example, the Nevada Department of Transportation provides public access to their Performance Monitoring and Measurement System Dashboard (available at <http://bugatti.nvfast.org/>), which allows users to view interactive maps with traffic overlays, information on daily a.m. and p.m. peak speeds on various routes, access to roadside closed-circuit televisions with real-time images, and weather information.³⁹ Other agencies, such as the Washington Metropolitan Area Transit Authority, offer real-time transit bus location to help riders arrive in time to board the bus with minimum wait time (www.wmata.com/rider_tools/nextbus/arrivals.cfm).⁴⁰

Providing access to real-time data versus archived data can pose additional challenges because of concerns about allowing access without first performing a quality assurance check on the data. Although many State DOTs offer aggregate real-time datasets (e.g., speed data

collected through loop detectors) for public dissemination to enable travelers to make informed route choices, few offer access to disaggregate real-time datasets.

FHWA is doing a great deal to establish a baseline real-time program that will unify and promote interoperability across State DOTs using the Real-Time System Management Information Program.⁴¹ This program states that all DOTs must deliver consistent data prior to November 8, 2014, on the following activities:

- **Construction activities** – The timeliness for the availability of information about full construction activities that close or reopen roadways or lanes will be 20 minutes or less from the time of the closure for highways outside of metropolitan areas and 10 minutes or less from the time of the closure or reopening for roadways within metropolitan areas. Short-term or intermittent lane closures of limited duration that are less than the required reporting times are not included as a minimum requirement under this section.
- **Roadway or lane blocking incidents** – The timeliness for the availability of information related to roadway or lane blocking traffic incidents will be 20 minutes or less from the time that the incident is verified for highways outside of metropolitan areas and 10 minutes or less for roadways within metropolitan areas.
- **Roadway weather observations** – The timeliness for the availability of information about hazardous driving conditions and roadway or lane closures or blockages because of adverse weather conditions will be 20 minutes or less from the time the hazardous conditions, blockage, or closure is observed.
- **Travel time information** – The timeliness for the availability of travel time information along limited access roadway segments within metropolitan areas will be 10 minutes or less from the time that the travel time calculation is completed.
- **Information accuracy** – The designed accuracy for a real-time information program shall be 85 percent accurate at a minimum, or have a maximum error rate of 15 percent.
- **Information availability** – The designed availability for a real-time information program shall be 90 percent available at a minimum.

Users

Traditionally, the majority of the users of ITS data have been the transportation organizations collecting the data. For example, an agency collecting speeds or travel times could use this information internally to better plan future infrastructure improvements. However, the combination of the maturation of these data sources and an increase in data sharing has enabled other users, such as academic researchers or private sector partners, to experiment with available transportation data.

Fewer challenges are seen in sharing data in the academic setting, as the data generally will be used for research rather than for application. However, it is important that the data used for research be available after completion so that research findings can be confirmed. The use of open source datasets, such as with data from NGSIM, is often a way to overcome such challenges regarding validation of completed research.

Often ITS data collection and archiving by transportation agencies is conducted on an ad hoc basis where the processes, data structure, and other considerations vary from agency to agency. A challenge with this type of data collection is that although the data may be available to be shared with other practitioners, the data may not easily integrate into their system. A challenge for practitioners with disjointed datasets is that in order to integrate this shared data into their planning and operations, they need to understand the data and understand how it can be incorporated into their current datasets. An improper understanding can cause practitioners to introduce error. One method to assist with a clear and concise understanding is to develop metadata to describe all data collected. Further, in recent years USDOT's Research and Innovative Technology Administration's Real-Time Data Capture and Management Program has been conducting research and providing guidance in an effort to develop interoperable data environments that can be shared among various transportation practitioners.⁴²

Data shared with transportation agencies could be used more effectively to improve transportation operation at a wider scale. For example, sharing real-time traffic signal timing can assist agencies in collaborating and optimizing signals on a corridor that traverses both jurisdictions. Sharing data that can potentially be used to increase safety or mobility for the public must have a level of quality assurance to minimize any potential liabilities. These challenges can be overcome by ensuring that proper quality assurance steps are taken prior to distributing data as well as making these quality assurance techniques transparent.

In times of budget constraints, a challenge continually faced by State and local DOTs is doing more with less. One way some DOTs have traditionally collected and analyzed transportation data is through consultants. As ITS deployments and data sharing practices continue to become more common throughout the United States, transportation agencies could potentially collect vastly more data and different data than they have in the past without the use of outside consultants. Given this increased amount of potentially new data, the transportation agency will require trained staff to process and apply this data to improve operations at the agency.

Private sector partners may also be interested in obtaining data from ITS infrastructure. Numerous industries can use transportation data to strengthen their products. For example, mapping and navigation providers often include real-time traffic information as a way for their users to determine alternate routes in the case of congestion. A potential issue with this type of dissemination is that users may follow the guidance of these applications or devices blindly. An example of this could be a GPS navigation device instructing a commercial vehicle to an alternate route, but the system might not have data available about height or weight restrictions on that route and could cause the vehicle to damage a bridge with low clearance.

Operating and Maintaining ITS

This section of the module discusses some of the key aspects related to maintaining ITS, such as funding ongoing maintenance costs and defining roles and responsibilities for system ownership.

Funding for Operation and Maintenance Costs

Deployment of ITS projects very often is achieved using Federal funds, whereas State and local funds must be used for operations and maintenance costs. This share can be a significant challenge for agencies because ITS projects typically incur a greater proportion of their costs in the years after deployment to operate and maintain the system, compared with more traditional transportation improvements. Operations and maintenance costs for an ITS project can be high, as they include all continuing costs necessary to keep all elements of the system performing as planned, including power, communications, labor, and routing maintenance. Although operations and maintenance costs are a critical component of the total cost of any technology project, these costs are an often overlooked aspect of deploying ITS, or funds for operations and maintenance simply are not available. Too often, getting capital costs is easier than getting funds for ongoing operations and maintenance costs. Too many policymakers and decision makers still view ITS projects as a build-it-and-leave-it investment.

When considering necessary funds for ITS projects, it is critical to consider the long-term operations and maintenance costs for all aspects of the project. How the system is designed, what project components are selected and where the components are installed, and how the system is used can add substantial staff responsibilities as well as recurring operations and maintenance costs. For example, the Chicago Regional Transportation Authority elected to use solar batteries to power a remotely located variable message sign as part of an advanced parking management system, since there was no electrical line available at the sign location. At the time of design, running an electrical line to the sign appeared to be more costly than using a battery. In retrospect, however, they found that the batteries needed to be replaced frequently and that the installation of a new electrical line would have been more cost-effective in the long run.⁴³

Where possible, State agencies should plan some level of funding for operations and maintenance in the project budget at the outset to avoid having to procure funding after the fact. To accommodate these elements in planning budgets, it is important to identify all operations and maintenance requirements up front (including both equipment and resource needs), and to determine which agencies (if there are multiple agencies involved) will be responsible for which costs. In their project to expand CommuterLink, Utah's real-time transportation information system, the Utah Department of Transportation found that identifying all operations and maintenance requirements and needs up front was necessary to enable all participating agencies to plan for and request budget funds and technical resources to support the project.⁴⁴

Information Technology

For many public agencies, the selection, setup, and operation of computer and communication equipment for an ITS project is considered to be a data processing function rather than an

engineering function and therefore falls under the purview of information technology (IT) rather than under the purview of the division that is deploying or operating the system. Because of that designation, the project staff are required to work with IT staff to ensure that the job gets done. IT staff do not always recognize that they should be providing a customer service, so they often do not do exactly what is requested by the project staff.

Roles and Responsibilities for System Ownership

System ownership post deployment is often an overlooked aspect of ITS deployment. The following are some key aspects to consider⁴⁵ First, agencies should establish roles and responsibilities for maintenance activities at the outset of the project and involve those who will be responsible during the design process. In the iFlorida Model Deployment, responsibilities for equipment maintenance were not established up front. The district leading the effort anticipated that the districts in which the statewide monitoring equipment was located would take over responsibility for maintaining the equipment upon completion of the project. However, only districts that had an active ITS program were willing to take over this responsibility. At the time, some districts had little or no ITS equipment deployed and no staff or maintenance contracts for maintaining ITS equipment. Furthermore, they had not been involved in the design of the system and therefore had not had the opportunity to verify that the new equipment was compatible with any existing equipment. If formal maintenance procedures are not established up front, in most cases the system will end up being maintained either by the agency that led the deployment or by the agency that interacts most frequently with the system.

The second aspect of planning is to establish a well-defined process for monitoring and maintaining field equipment before beginning a significant expansion. The existing monitoring and maintenance process should be examined and streamlined before expanding the base of field equipment. A simple system that works well for a small amount of equipment may be less effective as the amount of equipment increases. The iFlorida Model Deployment significantly increased the number, types, and geographic distribution of field equipment that FDOT District 5 was required to maintain. Over a three-year period, the number of traffic monitoring stations increased from 240 to 650. This rapid increase in maintenance responsibility resulted in some problems with equipment maintenance. One challenge FDOT faced was that the contracts for deploying the field devices did not include requirements related to how the equipment would be monitored. This meant that FDOT had to rely on manual methods for monitoring whether field devices were operational, which placed a higher demand on staff and contractor time.

Federal Resources

In recognizing the importance of ongoing maintenance efforts, the FTA recently launched the State of Good Repair (SGR) initiative. The understanding of the initiative is that maintaining the nation's bus and rail systems in a state of good repair is essential if public transportation systems are to provide safe and reliable service to millions of daily riders. The initiative involves agencies in sharing ideas on recapitalization and maintenance, asset management practices, and innovative financing strategies. It also includes issues related to measuring the condition of transit capital assets, prioritizing local transit reinvestment decisions, and implementing preventive maintenance practices.⁴⁶

Interjurisdictional Cooperation

Many ITS projects require the involvement of multiple agencies, and for these efforts, institutional integration is the key to success. It can be difficult to bring agencies and other stakeholders together, and it can be even more difficult to sustain these relationships over of

the life of the project, from deployment to operation. This section of the module discusses strategies that can aid with interjurisdictional cooperation, including clear establishment of roles and responsibilities for deployment, operations, and maintenance.

Addressing Political Hurdles

Some of the biggest hurdles for ITS projects to overcome are the political aspects. Challenges with local and State governments can prevent an ITS project or program from being implemented. USDOT's Integrated Corridor Management (ICM) program experienced significant political hurdles (examples outlined below as identified at the planning stages for the Dallas project), but the projects eventually overcame these challenges, and the San Diego project went on to be a finalist for ITS America's 2013 Best of ITS Award.^{47,48}

- Several of the agencies had policies against diverting traffic from freeways to arterial streets, and several of the agencies had policies against specifying specific detour routes. Without some changes to current policies, full corridor optimization could not be achieved.
- Many of the city agencies had limited operating hours due to funding issues. As a result, it was known that response to some of the corridor scenarios would have to be limited during off hours.
- Some agencies would not allow modification or control of their assets by others. As a result, it was known that responses to some scenarios would require more coordination and possibly increased response time.

Building Institutional Relationships

Some key actions that can foster stakeholder cooperation when building institutional relationships for an ITS project include the following:⁴⁹

- **Involve a wide range of participants.** Developing a coalition of involved organizations can be a significant help in a multijurisdictional project. The more these participating organizations cooperate, communicate, share ideas and information, and solve problems together, the greater the success for ITS integration. In addition, civic leaders, lobbyists, and advocates can help bridge institutional gaps. They can educate and inform others, promote ITS programs in their region, seek funding, and help obtain additional resources. They are often regional authorities such as a county commissioner, a congressman, the director of a metropolitan planning organization, or a nationally recognized expert who is a local resident. They typically become experts themselves on ITS topics, but they are just as often supported by dedicated staff that provide background and factual information.
- **Keep the stakeholder groups connected.** Regular information sharing with the broad stakeholder group is critical because it helps maintain an atmosphere of cooperation and agreement. Those actively involved in the process must keep those less involved informed. It is critical to cultivate understanding and interest in ITS at all levels of the

participating agencies early in ITS development. Operations staff members need to understand how the coordination of systems and information flows can improve their operational responsibilities; planning staff members need to understand their role in ITS planning and the roles and the responsibilities of operations staff. Establishing these working relationships can not only facilitate successful day-to-day operations, but also help form a foundation from which to develop future ITS initiatives.

- **Think regionally.** Successful deployments can be the best way to convince decision makers of the benefits of participating in an ITS development process. The E-ZPass program in the Northeast gave solid evidence to decision makers and the public throughout the region of the advantages of both ITS and interagency coordination. Although each participating agency to the E-ZPass system was primarily motivated by its own operational needs and concerns, bringing these organizations together early in the process and establishing new relationships cultivated a greater interest in regional transportation issues and regional ITS solutions.
- **Establish roles and responsibilities for all partners early in the process.** As discussed under the section “Operating and Maintaining ITS,” having clearly defined roles and responsibilities is critical to a project’s deployment as well as for operations and maintenance of the system post deployment.

Another key aspect of interjurisdictional coordination is the need to formally establish roles and responsibilities for all parts of the project, including future operations and management. At the outset, system planners need to (a) identify which agency, and which staff position within that agency, will be responsible for monitoring and maintaining the system, (b) identify what activities they should perform, and (c) ensure that they are trained to use the equipment. A successful model for interagency cooperation and coordination is the [I-95 Corridor Coalition](#), established in the early 1990s. The coalition’s success is apparent in the fact that its members span a broad region and include transportation authorities; transit and rail agencies; port authorities; motor vehicle agencies; State and local police, law enforcement, and public safety officials; USDOT; Canadian Provincial DOTs; intercity passenger and freight transportation providers; and transportation industry associates.

Workforce Issues

Transportation organizations face a multitude of challenges when it comes to having staff with the necessary skill sets to effectively manage ITS projects. This section of the module discusses workforce issues related to planning, deploying, and maintaining ITS, including both staffing requirements for overseeing the work of consultants and contractors, and staffing requirements for conducting work in-house. It discusses common challenges that many agencies face related to the new skill sets their staff will need to effectively manage ITS projects in an ever-changing environment, and discusses associated professional capacity building and workforce development considerations. Finally, it provides available resources for workforce development and training.

The Multifaceted Challenge

A variety of challenges face the transportation industry with regard to its workforce, including an aging workforce, competition for skilled workers, retention, and changing skill sets required of the industry.

An Increasingly Competitive Workforce

In 2010, USDOT and the Council of University Transportation Centers (CUTC) prepared a road map for handling workforce challenges in the transportation industry, titled *A National Transportation Workforce Development Strategy: A Roadmap to the Future*.⁵⁰ The document highlights various aspects of the challenges the industry faces, including the impending retirement of the baby boomer generation, the fact that fewer people are entering transportation-related fields, and the increasing competition with other industries for workers. The roadmap describes the challenges as follows:

...public and private transportation organizations face an ever-increasing challenge finding qualified staff and managers. As the baby boom generation retires, there will be an exodus of experienced employees: up to fifty percent of the current transportation workforce could leave in the next ten years. With fewer people entering transportation-related fields, increasing competition for workers from other industries and difficulties in reaching women and minorities, replacing those retirees will be challenging.

A National Cooperative Highway Research Program (NCHRP) report also cites retirement of the baby boomers as one of four critical issues affecting transportation workforce recruitment, training, and retention: "The loss of these highly skilled personnel is likely to result in significant loss of specialized knowledge and historical perspective critical to the efficient operation of transportation organizations."⁵¹

The University of Minnesota has created a [video](#) promoting careers in ITS. Promotional information such as this can go a long way toward generating interest in the profession and building a stronger workforce.

Workforce Retention

The CUTC's *Framework for Action*, a report from the 2012 National Transportation Workforce Summit, defines workforce retention as vital to industry productivity and efficiency and highlights the fact that many sectors of the transportation industry face significant attrition challenges as employees choose to switch positions within a company or mode or to leave the transportation field entirely. In an opening session at the summit, Patrick Natale, of the American Society of Civil Engineers (ASCE), substantiated this view, remarking that nearly 50 percent of engineering graduates leave the engineering fields at some point in their career.⁵²

Changing Skill Sets Required of the ITS Workforce

At the same time that the industry faces challenges in staffing the workforce, the needs of the workforce are changing, requiring skills that go far beyond traditional engineering disciplines. As described in the USDOT/CUTC roadmap:⁵²

[D]elivering and managing transportation systems and services will require greater skills in areas such as financing, project management, sustainability, livable communities, and greater public engagement. These skills go beyond traditional engineering disciplines, which are themselves expanding to reflect new materials and technologies. As a result, the skills and abilities of the next generation of the transportation workforce will need to be substantially different from today's.

NCHRP Report 693 also cites the increased focus on maintaining and operating systems more efficiently, rather than focusing primarily on new construction, as the key driver that is requiring the workforce to be capable of addressing a wider variety of technical and nontechnical experience.⁵¹

Effective Workforce Development Strategies

To address the challenge of accommodating an aging and multigenerational transportation workforce, the *Framework for Action* identified a number of strategies and action items:⁵²

- Create a collaborative culture of cross-generational mentoring, and build mentorship responsibility into job descriptions, performance, and duties.
- Increase technical and technological training and design training exchange programs. A good resource on teaching and training is the presentation [Teaching ITS to a Web 2.0 Generation](#).
- Examine retirement projections to identify needs and implement succession planning.
- Create opportunities for ongoing professional capacity building and workforce development, keeping in mind that a single approach to training is not sufficient because the transportation workforce requires a range of skills and abilities. For example, change management, interpersonal, and collaboration skills are a higher priority for workers in supervisory roles, whereas specific technical training is necessary for specialty occupations. Hands-on training should be part of on-the-job training to enable workers to continue to build the skills necessary to meet changing conditions and address new challenges.

Outsourcing

Outsourcing is the process by which organizations use external providers to manage or maintain certain aspects of their businesses when agency resources or skills are insufficient. Outsourcing can range from completely privatizing the deployment, management, and operation of a system, to simply supplementing staff to cover specific needs.

In the event that an agency elects to outsource any element of the deployment or operations and maintenance of ITS technologies, there are key elements to consider. Lessons learned from a cross-section of State departments of transportation in selecting telecommunications options provide a good list of items to consider when outsourcing:¹

- **Design a request for proposal (RFP) that is both complete and specific.** The RFP should specify all of the services desired, under what conditions they must be performed, and the resources that are required. The RFP should consider operations and maintenance as well as any additional services that may be needed for network modifications or expansions.
- **Specify a structure for the bidder's pricing or rates.** The nature and complexity of the work should dictate the contracting mechanism, whether it is cost plus fixed fee, time and materials, or fixed price.
- **Determine the criteria for selection.** The agency needs to carefully consider on what bases the selection decision will be made. A reliance on price as the sole determinant may not be adequate, given the technical complexity often involved with ITS applications. Rather, agencies should consider a range of factors, such as qualifications, experience, key personnel, and price. One process of selection is best value, in which the final selection criteria include subjective considerations and not just a low bid price.
- **Consider the impact of the length of the contract.** The length of the contract is a significant determinant of price and level of satisfaction. Contractors tend to offer more aggressive pricing for longer contracts. A commonly used contract structure is to have a base period with multiple option years. In addition, agencies should be able to terminate the contract at key points for poor service.
- **Recognize that the type of contract affects the level of risk sharing.** With a fixed-price contract, the financial risk rests primarily with the contractor, but this type of contract is recommended only if the project is well defined, since contractors will include a higher risk penalty in their prices for work involving significant unknowns. Agencies obtain maximum flexibility from a cost-plus type of contract, where it is possible to specify the types and levels of service on a reasonable real-time basis.

¹www.itslessons.its.dot.gov/ITS/benecost.nsf/ID/15D0B0AEDC4439358525728A007602AD?OpenDocument&Query=Home

Performance-based contracting can also be appropriate in some cases. Performance-based contracting is a contracting approach in which the contractor's performance is assessed against the desired outcome rather than the level of effort performed. Performance-based contracting can be an effective approach for contracts involving operations and maintenance of ITS equipment, such as operating a transportation management center. Some advantages of performance-based contracting can include potential reduction in costs, improved level of service, reduction in risk (risk is transferred to the contractor), more innovation, more integrated services, enhanced asset management, the ability to reap the benefits of partnering, and achievement of economies of scale. Disadvantages can include a more costly procurement process, a longer procurement process, a reduction in competition, uncertainty associated with long-term contracting relationships, challenges in mobilizing, and loss of agency control and flexibility, for example, to reallocate funds when there are large long-term commitments.⁵³ All of this should be considered in selecting a contracting approach.

Professional Capacity-Building and Workforce Development Resources

A number of training resources are available to practitioners, including the following:

- **USDOT's ITS Joint Program Office (JPO) Professional Capacity Building (PCB) Program** – The ITS PCB program offers free online ITS standards training, an 18-module series aimed at practitioners in State and local highway agencies and transit agencies who seek the skills needed to procure, implement, and operate ITS standards-based devices and equipment. Modules are free and can be viewed anytime on the ITS PCB website (www.pcb.its.dot.gov/standardstraining/). USDOT also offers training courses and workshops related to the National ITS Architecture, the Turbo Architecture software, and systems engineering. Information about these courses is available at www.iteris.com/itsarch/html/training/training.htm.
- **The Institute of Transportation Engineers (ITE)** – ITE offers a variety of online courses. Offerings vary over time and are listed at the ITE website: www.ite.org/education/onlinelearning.asp.
- **The American Public Transportation Association (APTA)** – APTA offers a variety of webinars and webcasts throughout the year on topics relevant and vital to the public transportation industry, focusing specifically on today's transit needs. Offerings are listed at APTA's website: www.apta.com/resources/profdev/webinars/Pages/default.aspx.
- **The Transportation Research Board (TRB)** – The TRB holds periodic webinars on a variety of topics. Federal and State employees and other stakeholders may participate free of charge, including individuals who are chairs of TRB standing committees, sections, or groups. Offerings are listed at www.trb.org/ElectronicSessions/ConferenceRecordings.aspx.

- **The National Highway Institute (NHI) and National Transit Institute (NTI)** – NHI and NTI offer a variety of in-person and Web-based courses, with course offerings listed at USDOT's ITS PCB website: www.pcb.its.dot.gov/courses.aspx#nhi.
- **The FHWA Resource Center** –Specialists at the FHWA Resource Center offer ITS-related courses, seminars, and workshops. Course offerings are listed at www.fhwa.dot.gov/resourcecenter/misc/training.cfm.
- **The Consortium for ITS Training and Education (CITE)** – CITE offers a variety of Web-based courses; certificate programs including ITS Project Management, Traffic Engineering, and Operations and ITS Systems; and two graduate-level, full semester programs of study, both of which are offered for continuing education units (Fundamentals of ITS and Traffic Management and ITS Applications and Management). Course offerings are listed at the ITS PCB website: www.pcb.its.dot.gov/courses.aspx#nhi.
- **State and Regional Resources** – A variety of States offer courses locally. An example includes the Southern California Regional Transit Training Consortium (SCR TTC). SCR TTC comprises transit systems, community colleges, and other affiliates and is a training resource network focused on the development and employment of the transit industry's workforce. SCR TTC provides courses to ensure that new and incumbent workers are proficient in the standards, practices, and procedures of the transit industry. The organization is funded through membership fees, Federal grant funding, and private industry partnerships. More information is available at www.scrttc.com/.

Other Federal resources include the following:

- **USDOT's ITS Peer-to-Peer (P2P) Program** – The ITS P2P program provides short-term technical assistance to agencies facing ITS planning, procurement, deployment, and operational challenges. A broad range of organizations are eligible for P2P assistance, including State, county, and city transportation and public works offices; transit agencies; turnpike and tollway authorities; metropolitan and statewide planning organizations; emergency and public safety organizations; and motor carrier offices. Practitioners are matched with a peer from among over 120 ITS peer experts of public and private sector transportation professionals who are active in the planning, design, procurement, and implementation of ITS. Pending available funding, the P2P program attempts to cover all costs associated with the assistance efforts, including travel, accommodations, meals, incidental expenses, and similar costs associated with onsite and offsite assistance. Information is available at www.pcb.its.dot.gov/p2p.aspx.
- **USDOT's Knowledge Resources Databases** –USDOT's Knowledge Resources databases present information on the benefits, costs, deployment levels, and lessons learned regarding ITS deployment and operations. The databases were developed by USDOT's ITS JPO evaluation program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The Knowledge

Resources databases contain over 15 years of summaries of the benefits, costs, lessons learned, and deployment status of specific ITS implementations, drawn primarily from written sources such as ITS evaluation studies, research syntheses, handbooks, journal articles, and conference papers. The databases are available at www.itsknowledgeresources.its.dot.gov/.

The lessons learned database provides a wealth of information on overcoming the institutional challenges that transportation professionals face in the planning, deployment, and operations of ITS. Lessons in the database are organized by nine lesson categories, including management and operations, policy and planning, design and deployment, leadership and partnerships, funding, technical integration, procurement, legal issues, and human resources. The lessons learned database is available at www.itslessons.its.dot.gov/.

- **USDOT’s Talking Technology and Transportation (T3) Webinars** –USDOT offers free 90-minute, interactive online meetings that offer knowledge sharing on topics related to ITS planning, design, procurement, deployment, and operations. The goal of the T3 Webinar Program is to increase the planning and technical capabilities of the ITS workforce, leading to a greater number of integrated, strategic, and effectively deployed ITS systems. Webinar offerings are listed at the ITS PCB website (www.pcb.its.dot.gov/t3_webinars.aspx), and past events are stored in an archive along with audio and video playback.
- **The National Transportation Operations Coalition (NTOC)** – NTOC offers a Web conference series titled Talking Operations, which sometimes includes ITS topics. Current offerings are available at the NTOC website at www.ntoctralks.com/web_casts.php.
- **USDOT’s ITS Help Line** – Practitioners can receive technical support by e-mail or telephone at its_help@dot.gov, or 866-367-7487.

Federal grants also exist for workforce development. In 2013, USDOT and the FTA will award \$7 million in workforce development grants to 17 organizations in 12 States through the Innovative Transit Workforce Development Program. MAP-21 continues programs to foster the training and development of surface transportation–related workforces and to support disadvantaged business enterprises. Subject to project approval by the secretary, a State may use apportioned funds (except metro planning) for surface transportation workforce development, training, and education. Eligible activities include the following:⁵⁴

- Tuition and direct educational expenses (other than salaries) in connection with the education and training of employees of State and local transportation agencies
- Employee professional development
- Student internships
- University or community college support

- Education activities, including outreach, to develop interest and promote participation in surface transportation careers
- NHI course participation
- Local technical assistance programs (LTAP)

Summary

The institutional issues encountered in deploying and maintaining ITS technologies are often as complex and challenging as the technological issues. Agencies will continue to face institutional challenges moving forward, and much can be learned from the past experiences of others. This module has looked at the various kinds of institutional issues that can arise in ITS deployments and has provided guidance on addressing these issues. The module has discussed a range of institutional topics, including how agencies can make the business case for ITS; what methods exist for funding and financing ITS projects, including information about Federal ITS funding under MAP-21; current issues in data privacy; the numerous institutional challenges revolving around the collection, storage, and use of transportation data, and examples of various data licensing and storage strategies that can be used to overcome some of these issues; institutional challenges in maintaining ITS, including funding challenges; strategies for successful interjurisdictional coordination; and finally, workforce issues that can be encountered as well as resources that are available for professional capacity building and workforce development.

As ITS technologies continue to evolve, so will institutional issues and challenges. The continued leadership from USDOT in the development of standards, open source data policies, and data environments will be critical in facilitating efficient collection and sharing of data while ensuring data privacy. Workforce development will be a key focus in coming years, again supported by resources available from USDOT.

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List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AERIS	Applications for the Environment: Real-Time Information Synthesis
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
CMM	Capability Maturity Model
CMAQ	Congestion Mitigation and Air Quality
CITE	Consortium for ITS Training and Education
CUTC	Council of University Transportation Centers
CVISN	Commercial Vehicle Information Systems and Networks
FIP	Fair Information Practices
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FIPPs	Federal Fair Information Practices Principles
FMCSA	Federal Motor Carrier Safety Administration
FOIA	Freedom of Information Act
FTA	Federal Transit Administration
HPMS	Highway Performance Monitoring System
ICM	Integrated Corridor Management
IEEE	Institute of Electrical and Electronics Engineers
IP	Intellectual Property
IT	Information Technology
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITS JPO	Intelligent Transportation Systems Joint Program Office
MAP-21	Moving Ahead for Progress in the 21st Century Act
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NCSIM	Next Generation Simulation
NHI	National Highway Institute
NTI	National Transit Institute
NTOC	National Transportation Operations Coalition
O&M	Operations and Maintenance
P2P	Peer-to-Peer

PCB	Professional Capacity Building
PPP	Public-Private Partnership
RFP	Request for Proposal
RTAP	Rural Transit Assistance Program
RTSM&O	Regional Transportation Systems Management and Operations
SDO	Standards Development Organization
SGR	State of Good Repair
SO&M	Systems Operations and Management
SCR TTC	Southern California Regional Transit Training Consortium
STP	Surface Transportation Program
TRB	Transportation Research Board
TTID	Transportation Technology Innovation and Demonstration
USDOT	United States Department of Transportation
V2V	Vehicle-to-Vehicle
V2I	Vehicle-to-Infrastructure
VIIC	Vehicle Infrastructure Integration Consortium