

Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

DETAILS

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 70

**Guidebook for Implementing
Intelligent Transportation
Systems Elements to
Improve Airport Traveler
Access Information**

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AIRPORT COOPERATIVE RESEARCH PROGRAM

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FOREWORD

By Lawrence D. Goldstein

Staff Officer

Transportation Research Board

ACRP Report 70 includes a guidebook with an accompanying interactive CD-ROM that provides descriptions, component details, and examples of how airport ground access information can be disseminated using various intelligent transportation systems (ITS) technologies. The guidebook contains tables to help airport operators determine the applicability of certain ITS strategies based on airport operational needs and airport size. ITS needs of airports not only must address the size of the airport, but also must consider the nature of traveler demographics, levels of congestion on the surrounding roadway network, as well as other defining characteristics. The interactive CD that accompanies the guidebook helps the user to explore and evaluate the information needs of various airport traveler market segments and to identify ITS technologies that best meet the needs of the airport user. The CD also contains a decision support tool that allows users to identify appropriate methods of delivering airport traveler information based on airport traveler market segment. At the same time, the decision support tool helps airport management and staff recognize technologies and efforts they already use to disseminate traveler information so that constructive next steps can be suggested.

This guidebook and accompanying CD were developed for a broad spectrum of users, including airport personnel (management, planning, information technology, operations, and public information staff) and project planners and designers who have responsibility for collecting and providing ground access information to airport travelers.

Many airports have developed and applied sophisticated programs that provide travelers with ground access information; but, historically, there is little guidance or common format for presenting this information to the public, either on airport websites or via other electronic media. In addition, although many metropolitan areas have or are developing advanced traveler information systems, few of these systems are integrated with airports or address ground access requirements specific to airport travelers. The information provided in this guidebook and CD is intended to serve as a resource to help airport personnel assess their current situation and identify customer as well as operational needs that may be addressed through the provision of advanced traveler information technologies. This guidebook will also help airport personnel to evaluate and select ITS technologies to meet specific identified needs, and then develop an implementation strategy that is feasible from funding, coordination, and operational and maintenance perspectives.

Based on the information and data collected throughout the course of this research, it is evident that a significant opportunity exists to enhance the efficiency, safety, and convenience of airport traveler access information through increased use of ITS technologies. Availability of data is not necessarily a significant hurdle in providing a comprehensive view of ground

access information to the traveler. In fact, in many cases, the data exists; however, other considerations often stand in the path of integrating and sharing that information. These external considerations include security and institutional coordination issues, availability of time and money to build the systems, as well as a lack of understanding of how the system will benefit airport operations and its customers.

Integration of both static and real-time information critical to an airport traveler is an emerging goal of every commercial airport. The need for this information can encompass a traveler's entire trip, both as a departing and as an arriving passenger. Presenting information on access and egress road conditions and travel times, roadway incidents, parking location and availability, public transit options and schedule status, alternative mode options, and security and flight information in a consistent and coordinated format will ultimately improve the ground access experience for airport travelers. Recognizing the nature of technology change, airports will also need to be prepared to monitor the fast-paced evolution of applications to determine how best to adjust their ITS traveler information systems to avoid rapid obsolescence.

Confirmed by survey, there is already a substantial portion of air travelers who subscribe to airline emails and text alerts as well as those who consult online and mobile-web sources for information regarding travel to and from the airport; however, it is also apparent that there are significant gaps and variability in the type and extent of ITS applications presently available. The research team, led by Gresham, Smith and Partners, examined opportunities for expanding ITS applications through an extensive data collection process that encompassed a variety of methods targeted at a variety of audiences: surveys, phone interviews, focus groups, as well as website and document reviews.

The increased desire of travelers to be able to access real-time information or for technology applications to "push" them the information they need is indicative of the increasing sophistication of both the traveler and the technologies they are using. Fast-paced technology shifts are significantly expanding the demand for traveler information services, and the increasing demand for services is demanding increased information technology. As a result, the fundamental trend is that travelers want more information, available across a wider range of applications and devices, which includes rich content such as video and graphics. This guidebook examines those needs, explores options, and presents an effective alternatives evaluation strategy.



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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

Based on the research and data collected throughout the course of the project, it became evident that there is significant opportunity to enhance the efficiency, safety, and convenience of airport traveler access information through the increased use of intelligent transportation systems (ITS) technologies. In the broadest sense, ITS applications encompass a range of wireless and wired communications-based information and electronics technologies such as websites, handheld devices, detection devices and sensors, closed circuit television cameras, kiosks, and dynamic message signs.

Airport travelers, both resident and non-resident, often need real-time information about the various segments of their ground access trip. Many airport travelers have become accustomed to obtaining necessary travel information using a variety of advanced technologies and often need real-time information on parking availability, access delays, and alternative travel modes. Currently, there is considerable diversity within the airport industry in the type, amount, integration, and method of dissemination of ground access travel information made available to customers. While most airports' primary method of communicating this information to the traveler typically occurs through a website, there are many other sources and methods of information currently in use at airports across the United States and internationally. Optimally, the traveler who has become accustomed to the method of attaining ground access information in one US airport would quickly and efficiently be able to access similar information (e.g., roadway conditions, security wait times, parking availability, etc.) at an airport with which he/she was not familiar.

The increased desire of travelers to access real-time information or for technology applications to “push” them all of the information that they need is indicative of the increasing sophistication of the technologies that travelers are using. These and other fast-paced technology shifts are significantly expanding the market for traveler information services. The fundamental trend is that travelers want more information, available across a wider range of applications and devices. Presenting information on road conditions and travel times, roadway incidents, parking location and availability, public transit options and schedule status, alternative mode options, security, and flight details in a consistent and coordinated format will greatly improve the ground access experience for airport travelers and should be the goal of every commercial airport. Airports will also need to be prepared to monitor the fast-paced evolution of technology applications and determine how best to evolve their ITS to prevent obsolescence over time.

The information provided in the guidebook and accompanying interactive CD-ROM is intended to provide uniform guidance to airport operators so that they can simply, efficiently, and interactively evaluate options for providing both pre-trip and real-time ground access information to travelers with the ultimate goal of enhancing the customer experience.



CHAPTER 1

Overview of the Guidebook

The Need for Advanced Traveler Information Systems

Without question, airports are important to local and national economic growth. While their primary function is within the air transportation system, airport users and operations interface with a broader and often multimodal transportation system. Airport users come from every walk of life and have both domestic and international origins. Providing effective and accessible ground transportation information and guidance to, from, and within an airport is a critical component of the airport's total service to its customers.

Information dissemination systems for airport ground access travelers vary greatly from airport to airport, and even among different ground access modes for any given airport or region. The information, standards, methodologies, presentation forms, and interoperability of these systems are often substantially different from airport to airport. This situation is not necessarily unexpected in that airports are independently developed entities and their transportation systems and surrounding local conditions vary widely. However, even with these differences, there is a basic foundation of the types of ground access information that are generally available to airport travelers regardless of airport facility.

At most airports, and especially those in larger metropolitan areas, research has shown that there is significant opportunity to enhance the efficiency, safety, and convenience of traveler ground access information through the increased use of intelligent transportation systems (ITS) applications. In the broadest sense, ITS applications encompass a range of wireless and wired communications-based information and electronics technologies such as websites, hand-held devices, detection devices and sensors, closed circuit television (CCTV) cameras, kiosks, and dynamic message signs (DMS). There are several instances where airports have developed advanced tools and techniques for providing travelers with ground transportation information specific to their region. However, there is no common national or international format for presenting this information to the airport traveler, either on airport websites or via many ITS technologies that are commercially available today.

As airports consider making new or expanded capital investments to improve traveler access and the customer experience, there is increasing interest to create a consistent format for quickly and effectively presenting information on viable ground access travel options and their status, particularly through the use of ITS technology. *ACRP Report 4: Ground Access to Major Airports by Public Transportation* specifically recommended that a study be undertaken to create a standard approach to presenting ground access information on airport websites. As the ground access information important to airport travelers is often obtained from several sources, no single agency is typically responsible for the facilities and systems used in the entire airport traveler ground transportation trip. Therefore, obtaining comprehensive, coordinated, and real-time traveler information is often a difficult task involving multiple agencies and organizations.

For safety, efficiency, and customer service reasons, integration of both static and real-time information critical to an airport traveler should be a goal of every commercial airport. These information needs exist across the traveler's entire trip, both as a departing and arriving passenger. Presenting information on road conditions and travel times, roadway incidents, parking location and availability, public transit options and schedule status, alternative mode options, security, and flight details into a consistent and coordinated format will greatly improve the ground access experience for airport travelers. As with any technology-dependent deployment, airports should be prepared to monitor the fast-paced evolution of technology applications and determine how best to evolve their ITS to prevent obsolescence over time.

Background

As noted, the research team for *ACRP Report 4: Ground Access to Major Airports by Public Transportation*, recommended that a study be undertaken to create a standard approach to presenting ground access information on airport websites. They concluded that while many US airports have developed major programs for providing ground access services, there is no common format for presenting these services to the public on airport websites and other electronic media such as ITS. The Airports Council International–North America has also identified a need for airports to work together to create a common set of procedures for presenting ground access information.

ACRP Report 4 also noted that while many US airports have made, or are considering making, major capital investments to improve public mode access, no consistent format has been created for quickly and effectively presenting viable ground access travel options to the traveler. In addition, many metropolitan areas have or are developing advanced traveler information systems, but few of those systems have incorporated travel modes that are specific to the users of the airports. Optimally, the traveler who has become accustomed to the method of attaining ground access information in one US airport would quickly and efficiently be able to access similar information (e.g., roadway conditions, security wait times, parking availability, etc.) at an airport with which he/she was not familiar.

An objective of *ACRP Report 4*'s proposed future research was to help the airport community develop a common web-based format for presenting all ground transportation options to the traveling public, particularly to the non-resident market. The research team concluded that if many of the large airports adopted a common format, the process of presenting ground transportation services to new travelers at an airport could become more efficient, and faster for the traveler. The team also felt that the adoption of a common framework for information presentation may reduce or eliminate the need for many airports to separately undertake the same market research and software development. The team's recommended final product was a set of guidelines for presenting ground access services, and a working web-based prototype of such a system for possible adaptation for use at specific US airports.

Finally, the *ACRP Report 4* research team's recommended approach was not to create any form of mandatory "standard" for the individual airports to adopt; rather it was to establish a common logic of information presentation that could be used as each individual airport updates its existing websites.

Purpose of the Guidebook

Travelers to and from airports, both resident and non-resident, need real-time information about the many segments of their ground access trip. Many airport travelers have already become accustomed to attaining useful travel information using advanced technology. The purpose of

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this guidebook is to inform airport operators of available ITS technologies and to provide them with useful guidance on how to evaluate, select, and effectively disseminate ground access information via ITS technologies that will best meet the needs of the airport user.

The information provided in the guidebook is intended to serve as a resource to help airport operators assess their current situation and identify customer and/or operational needs regarding the provision of traveler information; evaluate and select ITS technologies to meet the identified needs; and then develop an implementation strategy that is feasible from a funding, coordination, and operational and maintenance perspective. Consistency in the format and approach of the dissemination of advanced traveler information in individual airports and across the airport industry will improve the airport traveler customer service experience.

Many airports have developed advanced and highly sophisticated programs for providing travelers with ground access information, but there is little guidance or common format for presenting this information to the public, either on airport websites or via other electronic media. Although many metropolitan areas are developing advanced traveler information systems, few of these systems address ground access requirements specific to airport travelers. As airports consider making new or expanding existing capital investments to improve the public access experience, there is increasing interest in the potential for creating a consistent format for quickly and effectively presenting information on viable ground access travel options and their real-time status using ITS technology.

This guidebook accomplishes the following key objectives:

- It establishes the current state-of-the-practice in the delivery of airport ground access information to travelers by airports as well as by information providers external to the airport.
- It provides guidance to airport operators for developing and implementing ITS solutions specific to their local/regional environment and operational needs. This guidance includes utilization of existing and emerging technologies for presenting useful information on all forms of ground transportation available to travelers to and from the airport.
- It describes opportunities for airports to use the latest ITS technology to help travelers simply, efficiently, and interactively evaluate their airport ground transportation options.
- It provides a complementary tool, in the form of a CD-ROM, that allows users to explore the information needs of various airport traveler market segments and the different technologies that can be used to provide that information.

Methodology

The research supporting the development of this guidebook consisted of gaining an understanding of the current knowledge and practice pertaining to airport traveler characteristics and needs, ITS technologies available to airport travelers today, and the vision for future traveler information capabilities. Figure 1 provides an overview of the methodology, including the key work efforts associated with each phase of the guidebook development.

In particular, the research performed under this project was scoped by the following questions:

- What ground access traveler information is desired?
- What systems are currently in use to provide that information?
- What systems are planned for the future, both by airports and other agencies?
- What is the state-of-the-practice in providing ground access information?
- What is considered state-of-the-art, or the vision of the future, for ground access traveler information, and how can airports get there?
- Is cost and benefit information available for providing ground access traveler information?

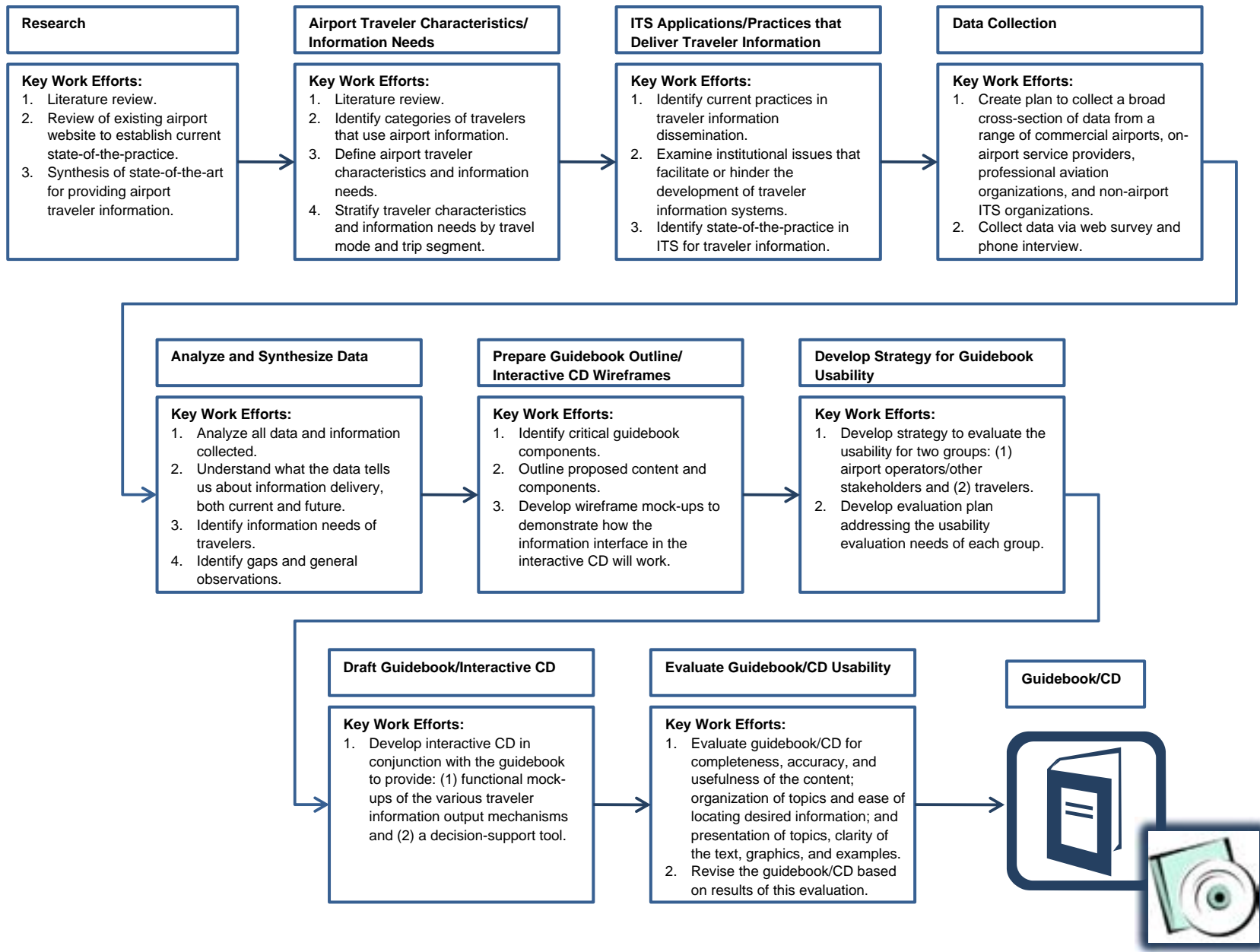


Figure 1. Project methodology.

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The research included a comprehensive literature review, a review of existing operator practices to establish the current state-of-the-practice on airport websites, and the development of a synthesized list of ground access components that are considered state-of-the-art for providing airport traveler information.

Telephone interviews with airport landside operators, on-airport service providers, professional aviation organizations, and non-airport ITS organizations were then used for the following purposes:

- To validate the data collected in the literature and review of airport websites;
- To determine if there were gaps in the research;
- To determine future plans for expanding or enhancing traveler information;
- To determine the anticipated implementation path that will be needed to deploy future ITS applications;
- To identify desired components to be included in this guidebook; and lastly,
- To validate that the guidebook and interactive CD as the selected information delivery method are appropriate and usable.

This research effort formed the basis on which this guidebook was written and documented the following:

- Current knowledge and practice related to delivery of ground access information to airport travelers;
- Airport traveler characteristics and their information needs;
- ITS technologies available to facilitate traveler information delivery;
- Institutional issues that facilitate—or hinder—the development of effective traveler information systems;
- Feedback from surveys of airport operators and others involved in airport planning, design, and operations; and
- The difference between the state-of-the-practice and the state-of-the-art for providing ground access information.

Organization of the Guidebook

The chapters of this guidebook are organized in a manner that presents a number of logical, sequential steps to guide airport operators through an assessment of their traveler information needs and the determination of which ITS technologies and strategies will best enhance traveler information at their facility in a beneficial and cost-effective way.

As identified in the Figure 2 flowchart, these steps guide the assessment process from the beginning overview of state-of-the-practice for traveler information dissemination in the airport industry, to the implementation of a traveler information system that best meets the needs of that particular airport. A series of intermediate steps are identified which guide the airport in assessing their own traveler information needs, followed by guidance in determining the ITS strategies and applications that best meet those needs. Once the desired technologies have been selected, the guidebook provides a framework for the necessary project planning, functional design, implementation, and operation and maintenance steps that are required for any successful ITS project.

Additionally, Figure 2 provides a flexible format for navigating through the contents of the guidebook. The figure allows the reader to interactively select specific chapters or subsections that meet their immediate needs or allows them to proceed through the entire guidebook chapter by chapter to obtain comprehensive knowledge on the subject. The main chapter headings are located down the center of Figure 2, with interactive subsections listed to the right and left of the major chapters.

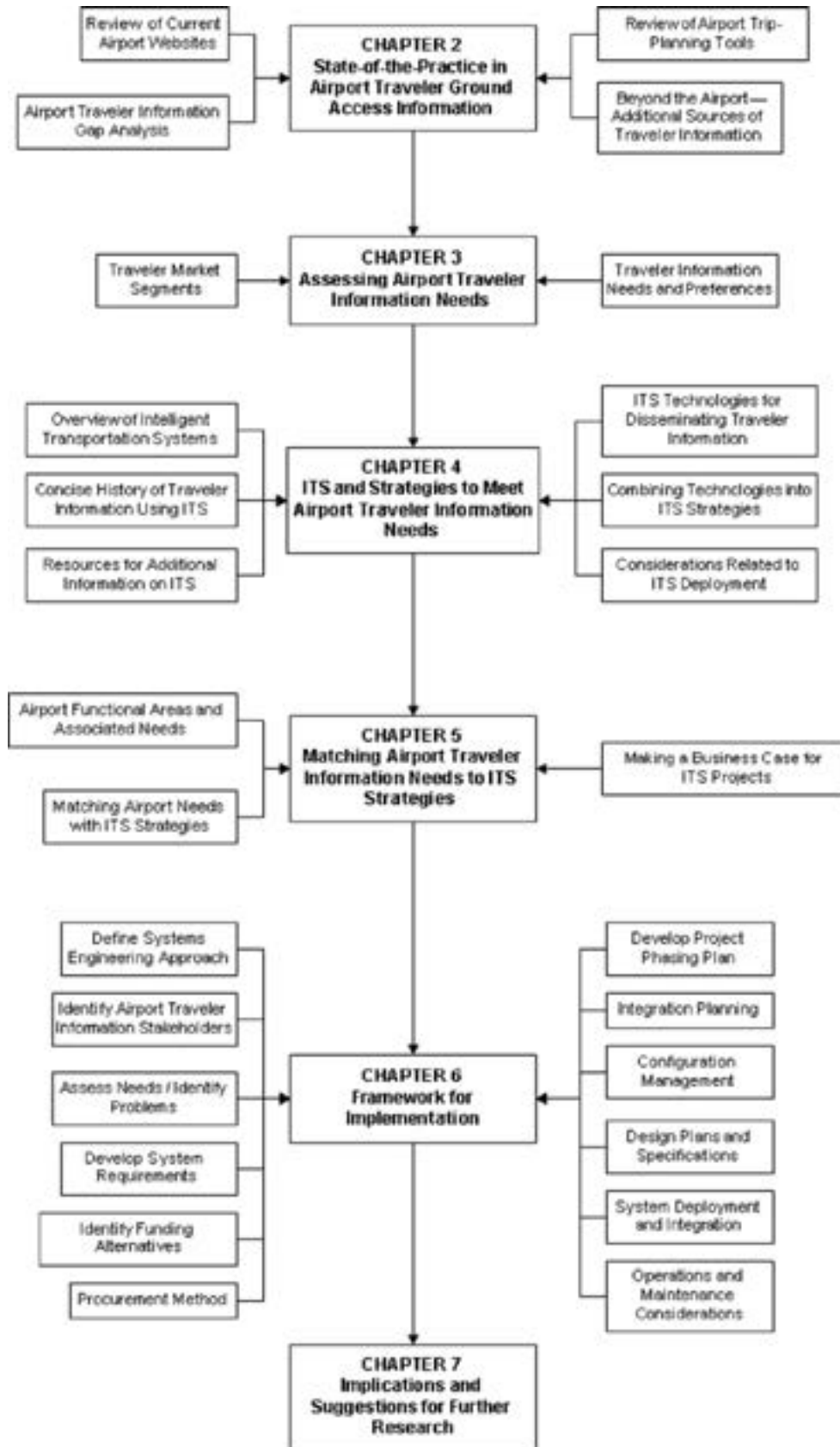


Figure 2. ITS traveler information project implementation guidance.

Relationship of Interactive CD to the Guidebook

The interactive CD-ROM was developed to serve as a complementary tool to the guidebook. It is included in Appendix D and is available for download from TRB's website (www.trb.org) on the *ACRP Report 70* summary web page. The purpose of the CD is to allow users to explore the information needs of various airport traveler market segments and the different technologies that can be used to provide that information. The CD contains a user-friendly and interactive menu interface that allows the user to select one of two primary sections: Technologies Overview or Decision Support Tool. Both sections employ a browser interface, which allows users to make choices and navigate through items on the CD. For convenience, references to the guidebook are included where additional information and details on various items can be found.

The Technologies Overview portion of the CD provides descriptions, details, and examples of how airport traveler information can be disseminated through various technologies. For some technologies it is relatively easy to provide basic traveler information and this is noted as “minimum” suggested information. In many cases for the same technology, it may be desirable to advance the tools in order to meet the “preferred” and “ultimate” information needs of the traveler. While standards and specifications are not provided on this CD, the source of the required data and any security considerations associated with the data are presented. Finally, a reference is provided to the guidebook chapter where more detail can be found for a particular technology.

The Decision Support Tool allows users to identify appropriate methods of delivering airport traveler information based on the four market segments of airport users. At the same time, the Decision Support Tool allows airports to recognize technologies and efforts they already use to disseminate traveler information so that the next steps can be suggested. Links are then offered that allow airports to explore the appropriate technologies and data considerations that will provide the desired traveler information. The Decision Support Tool functions by asking a user which market segment they are interested in marketing to, presenting characteristics of that market, then allowing users to select what is currently being provided for traveler information dissemination in those specific areas. The Decision Support Tool then presents opportunities to increase or enhance the traveler information capabilities in a particular category, such as parking information.

The research team is aware that an airport's use of information technology, particularly items such as websites, are proprietary features used to support a number of airport-specific programs above and beyond traveler information, such as marketing. The visualizations on the CD are not intended as a design specification for traveler information displays or technologies. They are meant solely as an illustration of how various information components can be presented, utilized, and potentially, combined.

The symbol of a CD and case, as shown here, has been placed throughout the guidebook informing the reader that the subject section closely aligns with examples and content contained on the interactive CD.



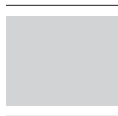
Who Should Use This Guidebook and Interactive CD

This guidebook was developed for use by a broad spectrum of users including airport personnel (management, planning, information technology, operations, and public information staff) and project planners and designers who have responsibility for collecting and/or providing ground access information to airport travelers. An airport career background is assumed for the guidebook user, and therefore certain topics regarding airport design, operations, and ground access are covered only at a general level.

Other ACRP Reports

The ACRP serves as one of the primary applied research programs that aids the airport industry in developing solutions to practically meet the demands placed on it. The ACRP produces a series of research reports, similar to this guidebook, for use by airport operators, airport consultants, local agencies, the Federal Aviation Administration (FAA), and other interested parties to disseminate findings on important needs and issues within the industry. Specific ACRP research reports and projects that are associated with the topics covered in this guidebook include:

- *ACRP Report 4: Ground Access to Major Airports by Public Transportation;*
- *ACRP Report 10: Innovations for Airport Terminal Facilities;*
- *ACRP Report 21: A Guidebook for Selecting Airport Capital Project Delivery Methods;*
- *ACRP Report 24: Guidebook for Evaluating Airport Parking Strategies and Supporting Technologies;*
- *ACRP Report 25: Airport Passenger Terminal Planning and Design, Volume 1: Guidebook;*
- *ACRP Report 40: Airport Curbside and Terminal Area Roadway Operations;* and
- *ACRP Synthesis of Airport Practice 10: Airport Sustainability Practices.*



CHAPTER 2

State-of-the-Practice in Airport Traveler Ground Access Information

Introduction

The research has shown that there is considerable diversity within the industry in the type, amount, integration, and method of dissemination of ground access travel information made available to airport customers. While most airports' primary method of communicating this information to the traveler typically occurs through a website, there are many other sources and methods of information currently in use at airports across the United States and internationally.

In general, the type of ground access traveler information disseminated by airports includes both static and real-time data and addresses many types of information, including:

- Maps and driving directions to the airport (both static and real time);
- Real-time area traffic conditions;
- Transit access and schedules to the airport;
- Real-time transit status;
- Bicycle access guidance to the airport;
- Multimodal trip-planning assistance;
- Parking locations, rates, and status;
- Ground transportation options and status;
- Cell phone lot location and status;
- Rental car locations;
- Security wait status; and
- Flight status information.

Technologies and devices in use to provide this information to the airport traveler include:

- Airport websites,
- Other area traffic and public transportation websites,
- Email/text alerts,
- Smartphone applications,
- Multi-user flight information display systems (MUFIDs),
- Kiosks,
- Roadway DMS,
- 511 Systems, and
- Radio (including highway advisory radio [HAR]).

Understanding the state-of-the-practice in ground access traveler information dissemination was accomplished by (1) reviewing current airport websites to determine the information that is currently delivered and (2) performing a gap analysis to determine where gaps in traveler information exist. Additionally, sources of traveler information outside the airport were reviewed to identify other sources and types of information that may be available.

Review of Current Airport Websites

An extensive review of current airport websites provided a solid basis for understanding the state-of-the-practice in the delivery of the types of airport traveler information to the website user and whether each type of information presented was static or if it was routinely updated (i.e., dynamic). A review was performed of the websites of the 30 largest airports in each of the FAA-designated categories (large, medium, small, and non-hub). In addition, the 30 largest international airports were also examined. FAA enplanement data from 2007 was the basis for determining the largest airports in each category.

The review looked for the presence of the traveler information items shown on the airport website, not at the airport itself. This distinction is important to understand. As an example, consider the case of a typical cell phone lot. Most facilities of this type have dynamic information on flight arrivals presented in the parking area. However, information on the airport website will most likely be static in nature, reflecting the existence of the airport cell phone lot and possibly providing information about its use and directions to the facility. The dynamic information is not also presented on the website, as it may be of little value to the user as pre-trip traveler information. A classification of static information does not mean that the cell phone lot does not contain dynamic information. It simply means that in the context of this review methodology, which did not utilize site visits, the traveler information presented on the airport website was not dynamic.

The following pieces of ground transportation information were examined for each airport included in the review:

- Directions to the airport,
- Airport roads information,
- Airport access route congestion,
- Links to regional traffic information,
- Passenger drop-off/pick-up information,
- Cell phone lot information,
- Parking information,
- Terminal information,
- Weather conditions,
- Flight/gate status information,
- Rental car information,
- Cargo information,
- Shuttle/bus information,
- Mass transit information, and
- Information presented in multiple languages.

A detailed analysis of each of the above traveler information categories is provided in Appendix C.

By considering the findings obtained through the telephone interviews of airport operators, the research team determined that gaps in traveler information at airports are not caused by lack of data. Often, data either already exists within other systems at the airport or can be gathered relatively easily. Generally, the gaps are due to other reasons, such as:

- Difficulty in turning existing data into useful information for travelers,
- Difficulties in identifying adequate ways of disseminating the information,
- Institutional issues relating to data/information sharing,
- System/technology incompatibilities, and
- Funding constraints.

Although airport traveler information gaps do exist, the most commonly stated reason these gaps are not being filled is the cost to develop and deploy the required systems.

Airport Traveler Information Gap Analysis

To determine the difference between the levels of information currently provided to travelers and what is perceived as the desired levels, a “gap” analysis was performed. Gap analysis is a technique which looks at the difference between “where are we?” and “where do we want to be?” In this case, the gap analysis specifically examines the airport travelers’ information needs discussed earlier in this section and what traveler information is currently being provided.

Table 1 provides the results of the analysis, by showing columns of how the traveler information is currently being provided on airport websites compared to how the airport traveler desires the information to be provided. The table makes reference to the future mode of information being dynamic and integrated. This is the largest obvious gap in information. While many aspects of

Table 1. Information gap analysis for airport traveler information needs.

Information Area	State-of-the-Practice	Future/Desired
Airport directions	Predominantly static	Dynamic – Integrated with a trip-planning tool to provide turn-by-turn directions.
Airport road information	Predominantly static	Dynamic – Present real-time travel conditions on airport access roadways and curbsides.
Airport access route congestion	Not readily available	Dynamic – Integrated with local and regional traveler information systems.
Regional traffic information	Link to dynamic site	Dynamic – Integrated with local and regional traveler information systems.
Passenger pick-up information	Static on website, dynamic on property	Dynamic – Pick-up locations may vary based on curbside congestion.
Location/wait time for baggage claim	Location announced on plane, MUFIDS	Dynamic – Information “pushed” to travelers via text message or email.
Flight/gate status	Dynamic	Dynamic.
Cellphone lot information	Static on website, dynamic on property	Dynamic flight/gate status displayed in lot.
Real-time arrival information to airports (by mode)	Links to other modes of travel	Dynamic information on airport arrival times displayed within transit vehicles or pushed to users via text message/email.
Parking information	Static on website, dynamic on property	Dynamic – Real-time parking facility status and space availability displayed on website and pushed to travelers via text message/email.
Terminal information	Static	Integrated – Terminal location/shuttle information integrated with information on travel time to the airport.
Check-in/security wait times	Not readily available	Dynamic/Integrated – Real-time wait times displayed on website and pushed to travelers via text message/email and integrated with trip-planning tools.
Weather	Dynamic	Dynamic.
Rental car information	Static	Integrated – Rental car return location/shuttle information integrated with information on travel time to the airport.
Taxi/car service/shared van related information	Static	Integrated with trip-planning tool to display rates and travel times by mode.
Public transit information	Static links	Dynamic/Integrated – Real-time arrival/departure times of public transit vehicles displayed on website and integrated with trip-planning tool to display rates and travel times by mode.

traveler information are currently available in a dynamic aspect, an integrated presentation of information across all aspects of the trip is currently lacking. For the purpose of this guidebook, integrated presentation refers to the compilation of information from different, and often disparate, sources into one system that displays the information in a coordinated fashion.

It is not always necessary that data is shared among agencies; at the most elementary level, a link may be provided to another agency's website that provides the desired information. However, it should be noted that with increasing numbers of travelers accessing information from mobile websites, "linking" to external websites is not the most desirable solution. It is very easy for a user to get lost while attempting to follow external website links and oftentimes they cannot easily navigate back to the original website.

Being able to access fully integrated trip information would be highly useful to various users during many phases of a trip, including (1) during pre-trip planning, (2) during the travel as a departing passenger, (3) during the travel as an arriving passenger, and (4) before and after the trip as a person picking up or dropping off a traveler. While not all aspects of the integrated information would need to be available during each of the previous phases, a fully integrated application would serve multiple traveler segments.

It should be remembered that much of the information on state-of-the-practice identified in Table 1 came from the review of airport operator websites. As mentioned previously, there were no site surveys of airports; therefore, the current status information predominantly reflects what is available on the airport website. It is recognized that some information may be available on the airport property in a dynamic fashion, such as within a cell phone lot.

After gaps have been identified, a plan can be created for addressing them. Some gaps may be addressed by simple process changes. For example, a missing piece of data can be collected and entered into an existing system. Other gaps may require some attention during the integration process, such as resolving conflicting business rules when two systems are integrated. Larger gaps may even require additional systems to be built or acquired.

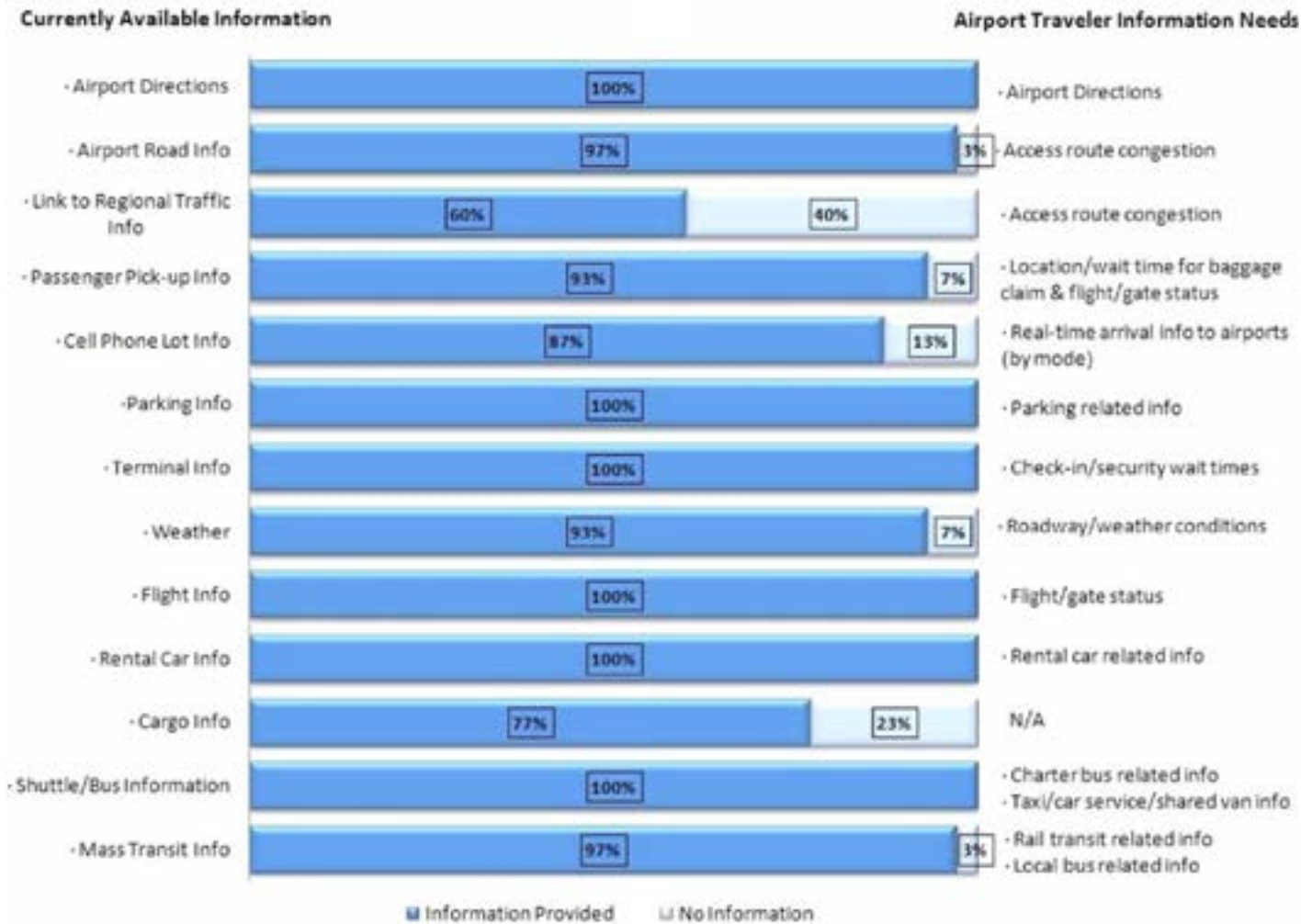
In addition to the high-level comparison shown in Table 1, the information gap analysis can be extended to examine the provision of traveler information in terms of the size and/or classification of the airport:

- Domestic large-hub airports,
- Domestic medium-hub airports,
- Domestic small-hub airports,
- Domestic non-hub airports, and
- International airports.

Tables 2 through 6 highlight the traveler information gaps by the size or classification of the airport. The gaps are indicated by the lighter colored portion of the bars, which generally increase in size as the airport size decreases. As expected, large airports, in general, are meeting traveler information needs the best. This is most likely attributable to one or more of the following reasons:

1. **Funding:** Large airports have greater revenues and sources of revenues than their smaller counterparts. This permits large airports to make more substantial investments in systems to provide traveler information.
2. **Environment complexities:** Large airports provide service from more airlines, occupy a greater land size, use a system of multiple terminals and concourses, may have more transportation options for arriving at and departing from the airport, etc. These attributes require large airports to provide more traveler information to address such complexities and attempt to overcome confusion or intimidation of their environment.

Table 2. Information gap analysis for domestic large-hub airports.



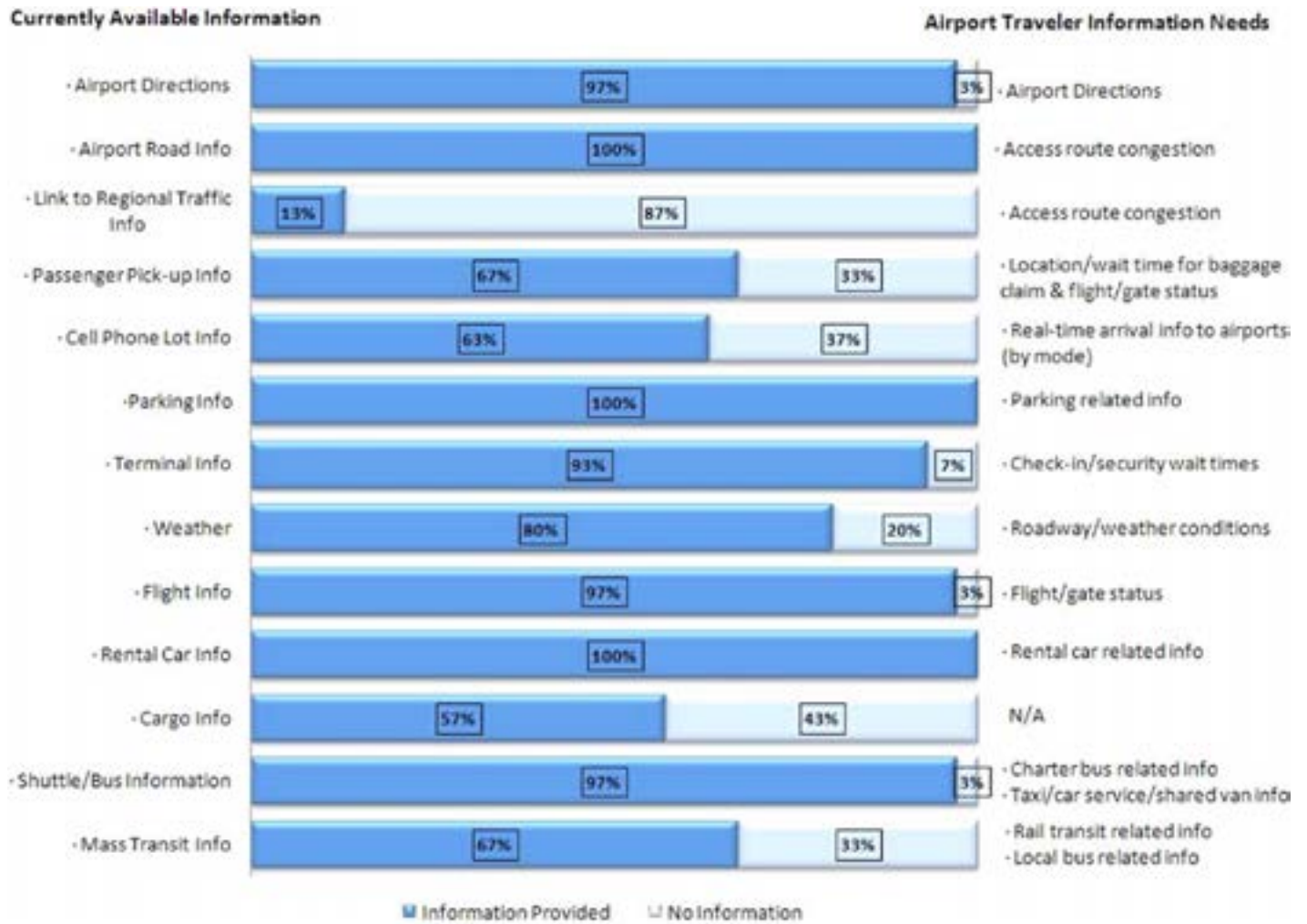
3. **Expectations:** Air travelers are savvy as to what technologies can be used to deliver information. Travelers expect large, urban airports to provide information using these technologies and to remain current with technology trends. Large airports are aware of these expectations and want to satisfy their customers as best they can.

While large airports appear to be satisfying a greater number of traveler information needs, this does not imply the smaller airports are failing to be proactive. In most cases, airports of all sizes provide basic information such as parking options, directions to airport, etc., and various levels of information and technology sophistication occur at all airport sizes. Additionally, the “failure” of an airport to provide transit information may be because the airport is not served by transit. As pointed out earlier, however, the true gap in this area is not necessarily the provision of the information, but rather the provision of the information in a single, unified, organized view or application.

Review of Airport Trip-Planning Tools

During the review of airport websites, several examples of integrated traveler information were identified in the form of trip- or journey-planning tools. These tools allow users to input origin and destination information and subsequently obtain detailed route and itinerary information

Table 3. Information gap analysis for domestic medium-hub airports.



for multiple travel modes. This allows users to select the mode that best meets their needs in terms of price, arrival and departure times, and overall travel time. Although several examples of airport ground access planning tools are provided in this section, this type of integrated information was not found to be a common provision among airport websites. The following examples of airport trip-planning tools are provided in this section:

- BWI (Baltimore/Washington International Airport) Ground Access Information System (Baltimore, Maryland)
- Schiphol Journey Planner (Amsterdam, the Netherlands)
- Heathrow Route Planner (London, England)
- Narita Airport Access Planner (Tokyo, Japan)

BWI Ground Access Information System (Baltimore, Maryland)

Users can access the BWI Ground Access Information System directly from the airport website. The trip-planning tool allows users to plan a trip either to or from BWI and provides detailed route and itinerary information for a number of travel modes, including real-time traffic information. The real-time traffic information is provided by INRIX, which aggregates data from millions of mobile devices and sensors in order to provide real-time and predictive traffic conditions.

Table 4. Information gap analysis for domestic small-hub airports.

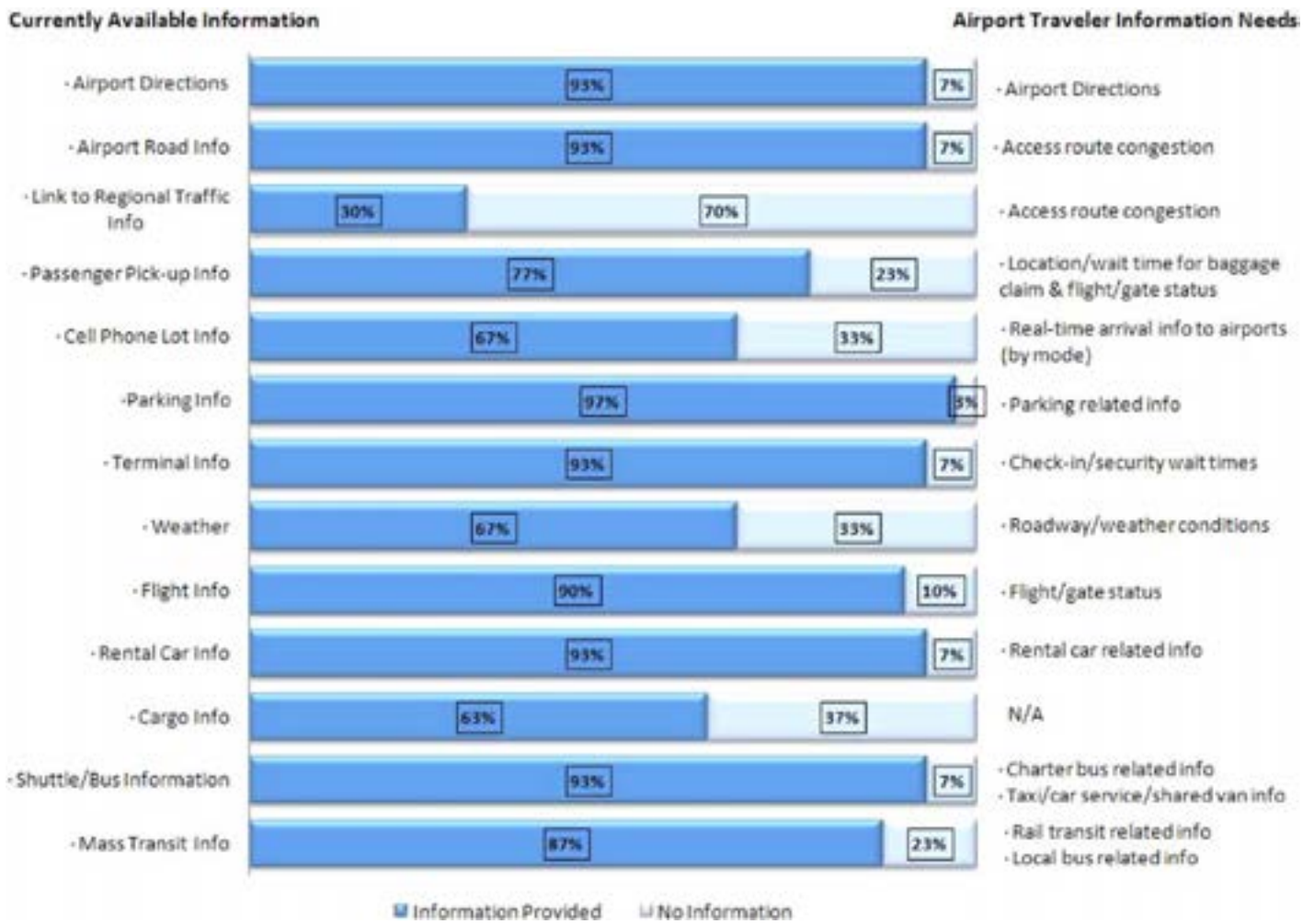


Table 5. Information gap analysis for domestic non-hub airports.

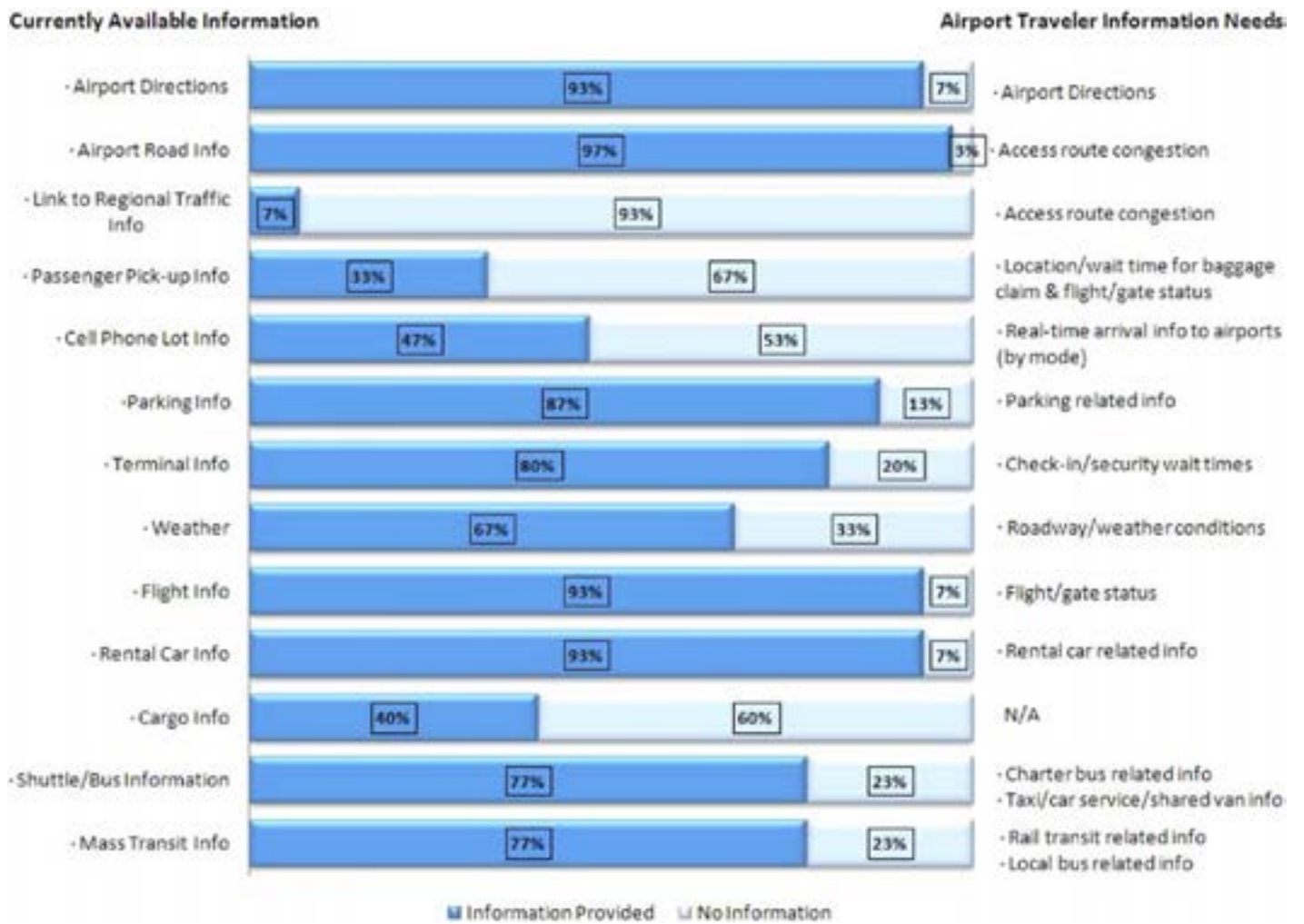
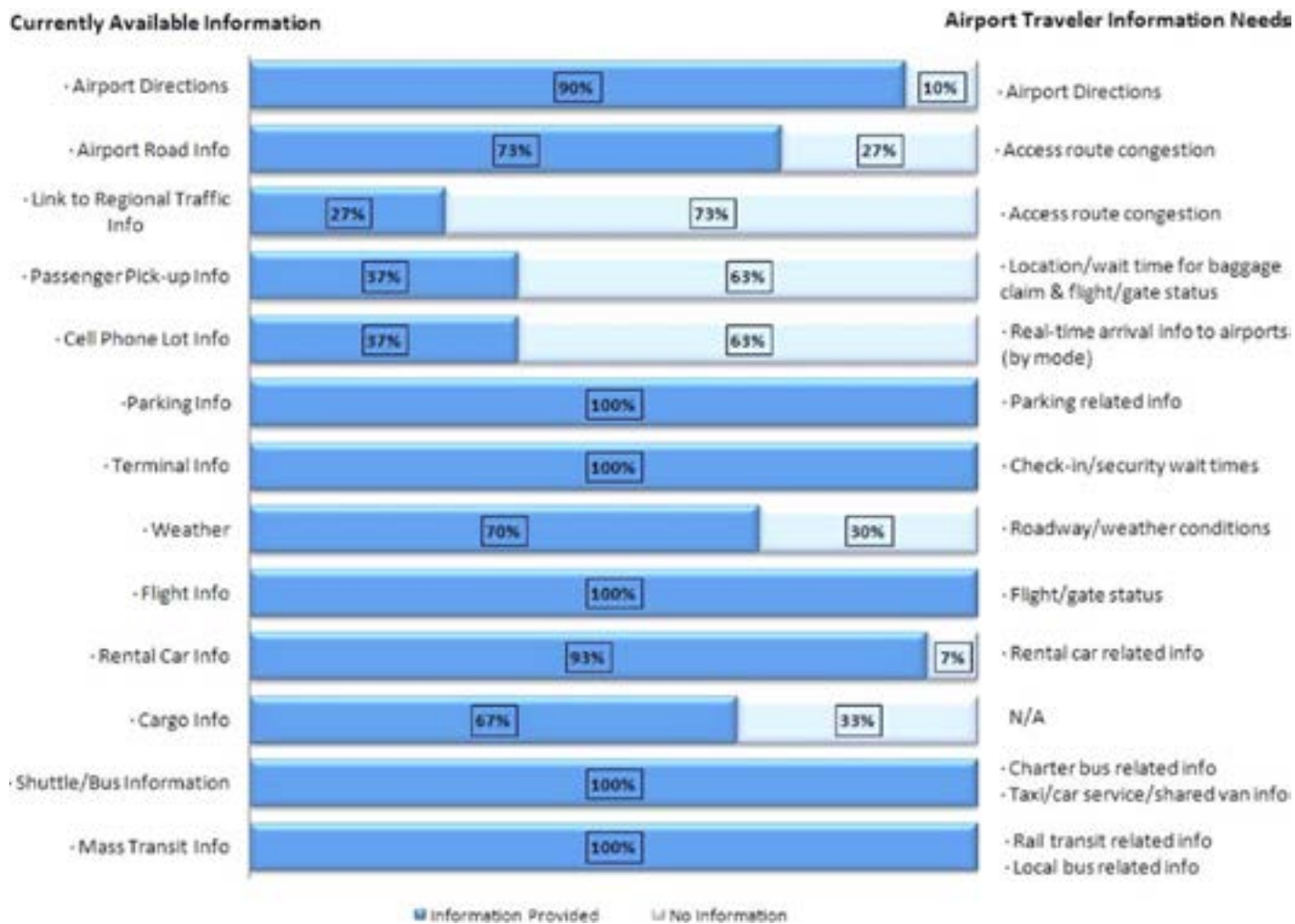


Table 6. Information gap analysis for international airports.



To plan a trip using the system, users can enter an address, select a rail station, or simply click on the interactive map to identify the location from which to begin or end their trip. Map-based graphics provided by Google have the ability to display rail stations and real-time traffic conditions as well as the selected route. The home page for the BWI Ground Access Information System is shown in Figure 3.

As a test of the system, a sample trip was entered: depart from BWI and arrive at DuPont Circle in Washington, DC. As shown in Figure 4, the following information was retrieved:

- Distance to destination;
- Taxi pricing information;
- Shared-ride van details and pricing information (links to shuttle providers' websites);
- Driving details, including step-by-step directions and estimated travel time and delay. These details can also be accessed directly by selecting the "Driving" tab from the menu to the left of the map;
- Rail details, including rail line, travel time, and pricing information. These details can also be accessed directly by selecting the "Rail" tab from the menu to the left of the map; and
- Travel time delays in minutes by Interstate. These details can also be accessed directly by selecting the "Travel Delay" tab from the menu to the left of the map.

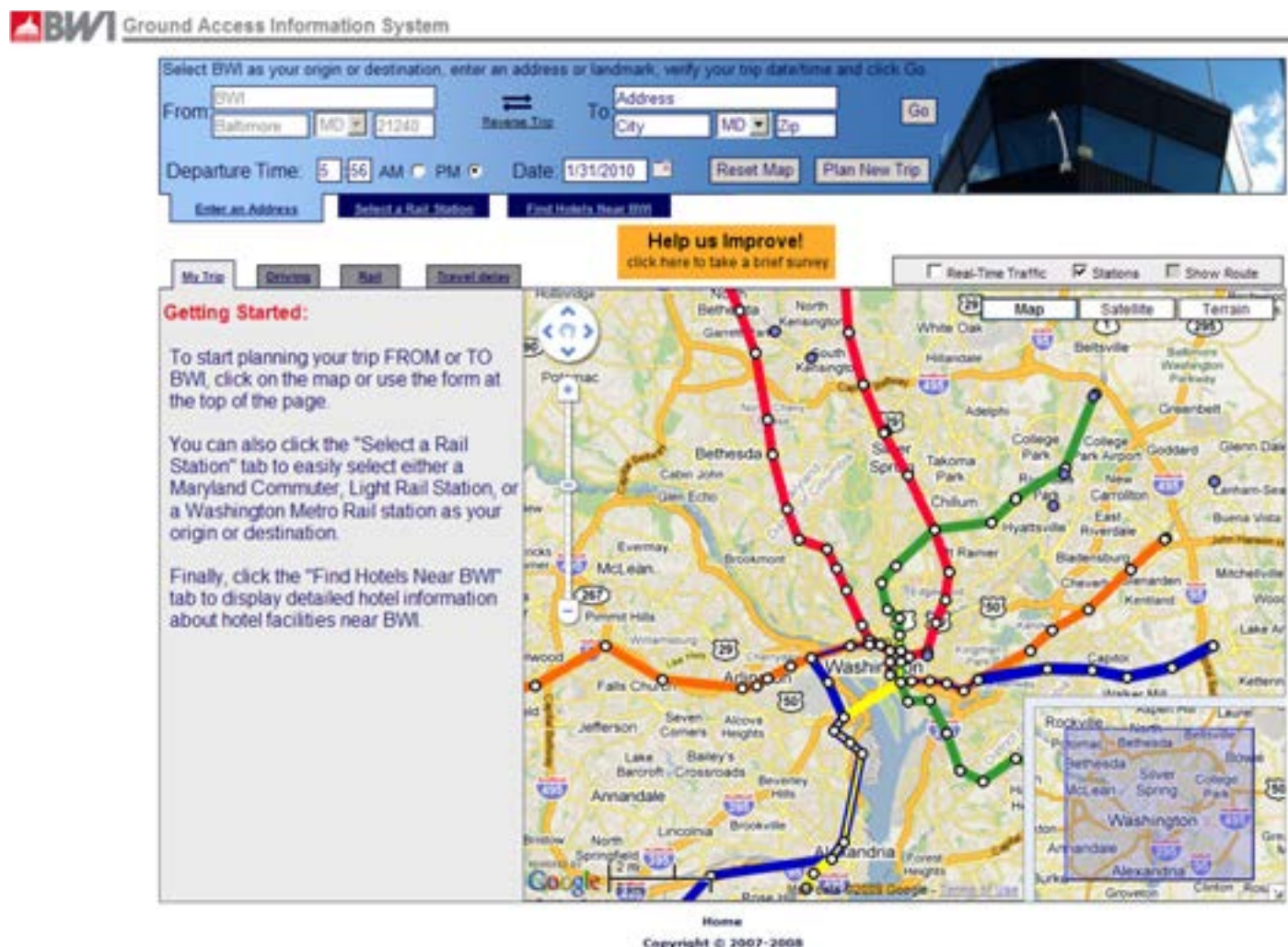


Figure 3. BWI Ground Access Information System: Home page.

Schiphol Journey Planner (Amsterdam, the Netherlands)

Similar to the BWI Ground Access Information System, the Schiphol Journey Planner for Schiphol Airport in Amsterdam, the Netherlands, provides users with the ability to enter an origin and subsequently select a travel mode that best meets their travel needs. As shown in Figure 5, after an origin is entered, a list of transportation modal options are displayed with associated fares and travel times to the airport.

Heathrow Route Planner (London, England)

London Heathrow Airport provides travelers with a route planner that is facilitated by Transport Direct, which is a non-profit consortium, led by Atos—an international information technology (IT) firm. Similar to the BWI and Schiphol trip-planning tools, the Heathrow Route Planner allows users to input origin information and then displays travel options by mode.

Narita Airport Access Planner (Tokyo, Japan)

As shown in Figure 6 and similar to the other examples provided in this section, the Narita Airport Access Planner provides information linked to flight information, travel routes, and times and fares by mode choice. It is interesting to note that two options are offered for transfer

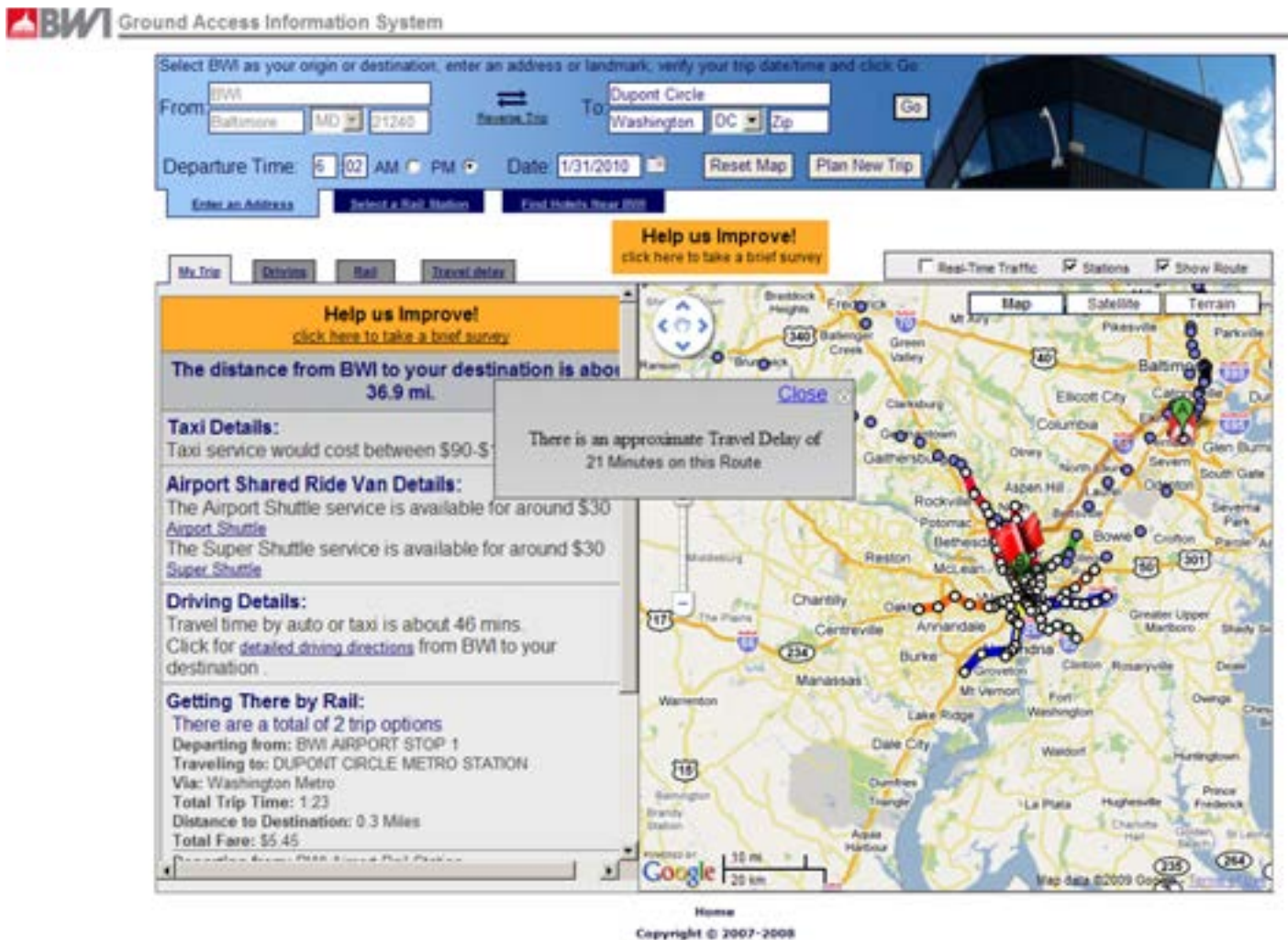


Figure 4. BWI Ground Access Information System: Results page.

times and connections. A user can choose between “Regular” and “Long.” “Regular” is the approximate time that a man in his thirties would take to make the transfer, walking at a normal pace. “Long” refers to 1.4 times the regular time. It is recommended that passengers with large or many pieces of luggage select the “Long” transfer time. It should also be noted that if the transfer involves the use of steps, escalators, or elevators, then the time shown for the transfer includes use of these. A user can select the originating station of the bus or a landmark based on the area of Tokyo, whether an airport access bus will be needed, the amount of time desired at the airport prior to departure (i.e., for shopping, eating, etc.), how to sort the results (i.e., by travel time, lowest fare, or number of transfers), and finally, the time needed for transfer (i.e., regular or long).

Beyond the Airport—Additional Sources of Traveler Information

A review of the status of worldwide mobile communications as well as additional external sources of traveler information services was performed to identify the potential sources and types of information that are currently available to the airport traveler. This review shows

The screenshot displays the Schiphol Journey Planner interface. At the top, the Schiphol logo is visible along with navigation links for Travellers, B2B, Vacancies, and Schiphol Group. A search bar is present in the top right. The main navigation bar includes Home, Flight information, To & from Schiphol, At Schiphol, Shop & relax, and Travel agency Schiphol.nl. The current page is titled 'Journey planner' and shows a 'Your personal itinerary to Schiphol' section. This section is divided into two steps: 1. Enter your portal code, Enter your address, Enter time, and Enter the date. The address entered is 'SATURNUSSTRAAT' and 'haarlem', with a time of 22 H and 12 M, and a date of 22/09/11. A 'Calculate times' button is visible. Below this, a note advises arriving earlier. Step 2, 'Choose your mode of transport', offers two options: Car (22:49**) and Public Transport (21:12**). The car option is 22.1 km (about 23 mins) and the public transport option is 46 minutes with 2 transfers. A 'Select' button is provided for each option. A disclaimer at the bottom states that times are approximations and do not include parking time. A weather widget for Schiphol is also visible on the right side.

Figure 5. Schiphol Journey Planner: Results page.

significant diversity and growth in the amount, format, and dissemination methods currently in use—all of which are increasing an airport’s ability to better communicate with their customers.

Status of Worldwide Mobile Communications

Mobile Cellular

According to the International Telecommunications Union (ITU), the leading agency of the United Nations for information and communications technology issues, by the end of 2010 there will be approximately 5.3 billion mobile cellular subscriptions worldwide. Of those subscriptions, 940 million will have access to 3G service. Although not everyone has access to a mobile phone with data capacities, access to mobile networks is available to 90 percent of the world population. Between 2007 and 2010 the number of countries that were offering 3G broadband services increased by 50 percent from 95 to 143 (International Telecommunications Union, 2010). Currently, a number of countries are moving to 4G broadband services, including Sweden, Norway, Ukraine, and the United States.

The screenshot shows the 'e-Airport' website interface. The top navigation bar includes the 'e-Airport' logo and 'e-information' with language options for 'English' and 'Japanese'. The left sidebar contains several menu items: 'Route Guidance' (with sub-options for flight departure, arrival, meeting passengers, and time), 'Timetable' (for Narita Airport Terminal), 'Ground Transportation' (for Rail, Buses, and Road Maps & Parking), and 'to use the Service' (with links for What is Airport Access Planner, Conditions of use, and Mobile Phone Site). The main content area is titled 'Search results' and shows a 'Preferences' section with details for flight CO78/NEWARK, Terminal 1, and a scheduled departure time of 20.01.12 17:45. Below this, it indicates 'Airport access bus: Yes' and 'Time at airport: 2h'. A 'Moddy Trip' button is visible. A table lists the route details: 'Route1: Departing The Ritz-Carlton Tokyo at 12:35 - Arriving Narita-Airport at 14:45'. The table has columns for 'Transfers', 'Travel time', and 'Fare'. The first row shows '0 Times' for transfers, '2h10m' for travel time, and '3,000 Yen' for fare. The route is broken down into segments: 'The Ritz-Carlton Tokyo' (departing at 12:35), 'Airport bus routes' (arriving at 14:45), and 'Narita-Airport'. A 'Send search results via e-mail' button is also present.

Figure 6. Narita Airport Access Planner: Results page.

Furthermore, as indicated in Figure 7, in 2010 there were 114.2 mobile cellular subscriptions per 100 inhabitants in developed regions. This fact is likely attributable to users having a mobile phone in addition to a tablet PC, both of which may require a cellular subscription.

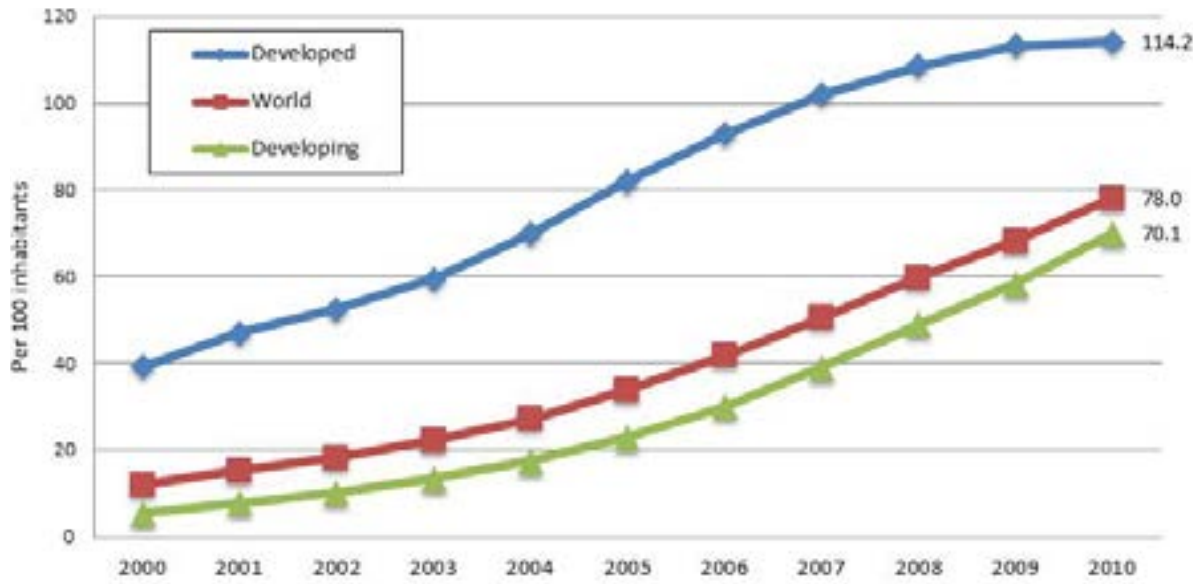
Short Message Service Text Messaging

In addition to the increasing saturation of the mobile phone market, another interesting statistic to note is the dramatic increase in the number of short message service (SMS) text messages sent. Globally, the number of text messages sent tripled between 2007 and 2010, from an estimated 1.8 trillion to 6.1 trillion. The Philippines and the United States made up 35 percent of all text messages sent in 2009 (International Telecommunications Union, 2010).

Internet

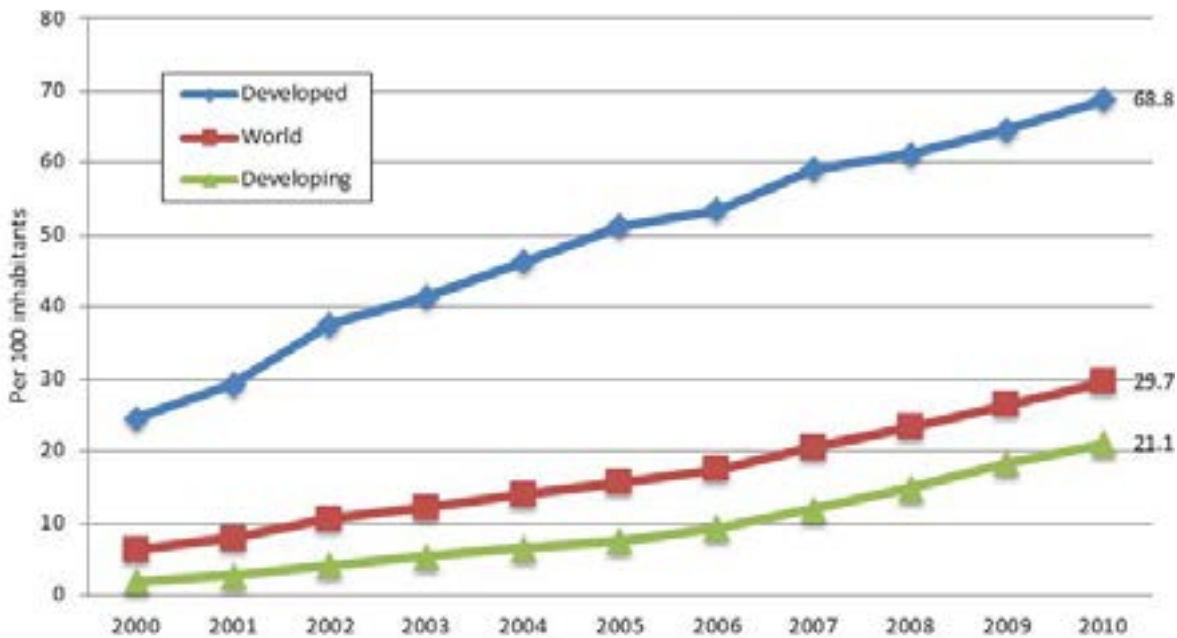
Between 2005 and 2010, the number of internet users worldwide doubled to almost 2 billion in 2010. China, with more than 420 million internet users, is the largest internet market in the world. While mobile phone technology is penetrating rural and developing countries, only 21 percent of the population of developing countries has access to the internet (International Telecommunications Union, 2010).

As indicated in Figure 8, in 2010 there were 68.8 internet users per 100 inhabitants in developed regions. With the increasing prevalence of smartphone use, and the fact that the difference between mobile web and internet is diminishing, it seems reasonable that the



The developed/developing country classifications are based on the UN M49, see: <http://www.itu.int/ITU-D/ict/definitions/regions/index.html>
 Source: ITU World Telecommunication /ICT Indicators database

Figure 7. Mobile cellular subscriptions per 100 inhabitants, 2000–2010.



The developed/developing country classifications are based on the UN M49, see: <http://www.itu.int/ITU-D/ict/definitions/regions/index.html>
 Source: ITU World Telecommunication /ICT Indicators database

Figure 8. Internet users per 100 inhabitants, 2000–2010.

number of internet users will continue on a steady path upwards toward full penetration, especially for developed regions.

Near Field Communication

Near field communication (NFC) technology has been around for some time; however, it is increasingly being referred to as the next big development that will occur in the evolution of the mobile phone market. The premise of NFC technology is that a mobile phone could serve as a contactless device providing users with the capability to make electronic payments, check in for flights, use it as a transit pass, obtain special offers or coupons, as well as others.

Traffic Information

There are several web pages that offer information on traffic conditions for roadways in all metropolitan regions, such as Google maps, Traffic.com, Yahoo maps, and regional traffic management centers, such as Houston TranStar (serving the Houston, Texas, region) and Georgia NaviGator (serving the Atlanta, Georgia, region).

Regional traffic management web pages typically display the following information on a map-based background:

- Incident locations;
- Construction locations;
- Closed circuit television (CCTV) camera locations and streaming feeds;
- Traffic flow status (congestion level, average speed);
- Dynamic message sign locations and messages displayed; and
- Road weather condition information.

Some traffic management sites provide functionality that allows users to input their trip origin and destination, view the traffic conditions in the surrounding area, and then select the best route. Speeds on the surrounding roadways are color coded and lane closures or incidents are indicated by an icon. Users can select specific incidents and read a short description and determine the exact location of the problem, and then make adjustments to their trip as necessary. This feature is especially useful when determining the quickest route to and from airports.

Email is a mechanism that is often employed to get traveler information. Many people sign up to get special alerts or notifications and some traffic sites allow a user to customize those emails to a particular route and/or time of day. A shorter form of email, commonly known as text messaging, is also widely used to disseminate information, such as travel alerts.

In recent years, third-party data collection and information service providers, such as INRIX and Google, have rapidly advanced in their ability to provide high-quality, real-time traffic information due to their ability to aggregate data from millions of global positioning system (GPS) enabled vehicles and mobile phones. Additionally, INRIX and Google provide the ability for users to view traffic forecasts up to 8 hours in advance, which is based on past conditions. A screenshot showing real-time Google traffic information for an area of Los Angeles, California, is displayed in Figure 9.

Weather Information

Numerous web pages and smartphone applications display weather forecasts, such as The Weather Channel (www.weather.com) and Weather Underground (www.wunderground.com). On these pages, users input the zip code or city/state to view the daily, hour-by-hour, weekend,



Figure 9. Screenshot from Google Traffic, Los Angeles.

and/or 10-day weather forecast for that area. Users can also view interactive radar maps that show the specified location with weather conditions over a 30-minute block of time. Using the internet to check weather conditions is useful on a day-to-day basis for local conditions, but also useful when traveling or flying.

Parking Information

Aside from airport websites, there are a number of sites that provide drivers with information on parking availability and pricing that allows them to find available spaces and compare pricing and locations on an interactive map-based display on their computer or mobile phone. Two examples of sites that provide this type of information are Parkopedia (<http://en.parkopedia.com>) and Parking Spotter (www.parkingspotter.com).

Parking at airports by time-constrained travelers is often a hectic and stressful experience, especially during peak travel times when parking facilities may be reaching capacity and the process to locate an available space becomes more time consuming. Websites have been developed that aim to ease travelers' stress by allowing them to locate, select, and reserve a parking space in advance. An example of a site that provides this service is Airport Parking Reservations (www.airportparkingreservations.com).

The screenshot shows the Airport Parking Reservations website interface. At the top, there is a navigation bar with the logo and links for 'Airports', 'Airlines', 'Customer Service', 'Stop & Fly Hotel', 'Blog', and 'Login or Register'. Below this is a prominent orange banner that reads 'GET A FREE AIRPORT PARKING QUOTE'. A search form is located below the banner, with fields for 'Departure Airport' (Phoenix (PHX)), 'Destination Airport' (Optional), 'Parking Arrival' (10/20/2011, 02:00 PM), and 'Parking Return' (10/23/2011, 12:00 PM). A green 'Check Rates' button is positioned to the right of the form.

The main content area displays search results for 'Phoenix Sky Harbor International Airport (PHX)'. A filter bar allows users to sort results by 'Price', 'Parking Type', 'Company Name', 'Star Rating', and 'Distance'. The results are listed in a table-like format:

Company Name	Rating	Distance from Airport	Daily Rate
QuikParkPHX (Crown Plaza Hotel) - Covered	5 stars	3.5 miles	\$6.00
Sky Harbor Airport Parking - Self	5 stars	3.8 miles	\$6.48
Blue Sky Airport Parking - Self	5 stars	2 miles	\$7.00
The Parking Spot 2 (formerly FASTTRACK Economy) - Self	5 stars	4.5 miles	\$7.20
PreFlight Airport Parking - Self	5 stars	4.5 miles	\$7.50
Sky Harbor Airport Parking - Covered	5 stars	3.8 miles	\$7.86
FASTTRACK Washington St. Lot - Self	5 stars	-	\$8.00

On the right side of the page, there are several promotional banners: '10 YEARS OF SERVICE 2002 - 2011', 'Live Help' with a chat icon, 'Reserve by phone 1.800.PARKING (1.800.727.5454)', and a 'McAfee SECURE' badge.

Figure 10. Screenshot from Airport Parking Reservations website.

A sample query was input into the system for Phoenix Sky Harbor International Airport. Eight results were found, which included both on- and off-airport parking facilities. Users have the ability to sort the results by price, parking facility type (self, valet, covered), customer ratings, or company. Once a user has completed a reservation, a receipt is provided that includes a travel itinerary with directions to the parking lot as well as other trip information. A screenshot from the website is displayed in Figure 10.

Flight Tracking/Status

Multiple websites and mobile phone applications, such as FlightView Elite (www.flightview.com) as shown in Figure 11, provide syndicated flight status information that allows travelers to track the real-time status of flights as well as airport delays. Typically, a user inputs the flight number or departure and arrival cities to obtain information related to a particular flight. Some sites allow a user to view all flight activity at a certain airport. While this information is not specifically ground access information, real-time flight status may influence an airport traveler's choice of access mode, route, parking option, and other critical trip elements.



Figure 11. iPhone screenshots from FlightView Elite.

Trip Itinerary Planning

Itinerary planning sites, such as TripIt, allow travelers to organize all of their travel plans in one spot and receive alerts concerning travel delays, cancellations, and gate changes. TripIt will build an itinerary based on flight, hotel, and rental car confirmation emails that you forward to the designated email address.

Really Simple Syndication (RSS) Feeds

RSS (Wikipedia, 2010c) feeds, such as blog entries, news headlines, audio, and video, can be read using software called an “RSS reader,” “feed reader,” or “aggregator,” which can be web based, desktop based, or mobile device based. Web feeds benefit publishers by letting them syndicate content automatically. They benefit readers who want to subscribe to timely updates from favored websites or to aggregate feeds from many sites into one place. The RSS reader checks the user’s subscribed feeds regularly for new work, downloads any updates that it finds, and provides a user interface to monitor and read the feeds. Examples of information that airport travelers may access using RSS feeds are general airport conditions, delays by destination, and general departure and arrival delays.

Social Media and Networking

Social media and networking tools use web-based and mobile applications to facilitate information dissemination and social interaction among individuals, groups of people, businesses, and organizations through the creation, sharing, and exchange of user-generated content. The two most common social networking formats used by airports to disseminate and exchange information with users are Facebook and Twitter. YouTube is the most common social media tool that provides the airport with an outlet to broadcast information to users. These tools should be consistently monitored and managed by the airport to refine and improve usage, format, and content.

Facebook

Facebook is a social networking service and website that has achieved a phenomenal number of users. As of January 2011, Facebook was estimated to have more than 600 million active users worldwide (Business Insider, 2011). Users of the service typically create a personal profile, add other users as friends, join common interest user groups, and exchange messages.

Facebook is used by many airports as a way to communicate and share news items, air travel delays, status of parking facilities (i.e., open/full), and photos of airport construction projects; advertise airport products such as parking or the location of a particular airport vendor; and announce new airlines and flights servicing the airport; among other activities.

Twitter

Twitter is a social networking service and website that allows users to send and read text-based posts of up to 140 characters called “tweets.” Users may subscribe to other users’ tweets, known as “following,” which are then automatically added to the user’s Twitter feed page. Airports should consider using Twitter for disseminating traveler information that changes on a regular basis. The following types of information would be useful for airport travelers to receive via Twitter:

- Security wait times,
- Access route congestion (including curbsides),
- Parking lot/garage status,
- Flight status and gate changes, and
- System-wide delays.

YouTube

YouTube is a social media website that allows users to view, upload, and share videos. Airports may create their own YouTube “channel” where videos can be uploaded for sharing with users. YouTube is not typically used for providing users with real-time information like Facebook and Twitter, but used primarily as a repository for informational and newsworthy video clips. For example, the Denver International Airport uses its YouTube channel to provide videos of tours of the airport, how to find lost items, how the airport keeps the airfield clean, sustainability initiatives, and public art features among others.

Future—Connected Vehicle Technology

The US Department of Transportation (USDOT) and ITS organizations around the world are promoting research in the area of connected vehicles with the goal of developing applications that will improve safety, reduce emissions, and lower transportation system operating costs through more efficient operations. The end result will essentially be a fully integrated transportation system. Specifically, the Dynamic Mobility Applications initiative (USDOT ITS Joint Program Office) is focusing on the development of applications that take advantage of vehicle-to-vehicle and vehicle-to-infrastructure connectivity through the use of data from probe vehicles, dedicated short-range communications (DSRC), and other wireless communications methods. Data on travel conditions and congestion could conceivably be obtained in real-time by travelers while en route. This information could then be used to help airport travelers make decisions with respect to mode choice, vehicle routing, and travel times.

According to a 2010 ITS America-sponsored survey of ITS industry professionals, the application identified as the best candidate for early commercial deployment (i.e., 1 to 4 years) of the connected vehicles initiative was traveler information. However, a number of risks and hurdles were also identified, including uncertainty in initial and ongoing operations and maintenance funding, concerns of low DSRC penetration, as well as low maturity of standards, technology, and products (Berg, Khijniak, & Rausch, 2010).

There is still a considerable amount of technical research to be accomplished related to connected vehicles in the coming years. Key focus areas include harmonization of international standards and architecture around the vehicle platform to ensure interoperability, human factors research to examine the risks involved in providing additional information to drivers, connected vehicle certification, as well as results from the vehicle-to-vehicle and vehicle-to-technology test bed (Test Bed 2.0).

It is acknowledged that in addition to the USDOT's connected vehicles initiative, there are a number of similar and related programs such as the European webinos initiative. Webinos is driven by a consortium of 22 partners with members ranging from mobile phone manufacturers, telecommunications operators, and car manufacturers to universities and research institutions. The goal of webinos is to deliver an open source platform that will enable web applications and services to be used and shared over a wide variety of connected devices such as mobile phone, PC, home media (TV), and in-vehicle units.



CHAPTER 3

Assessing Airport Traveler Information Needs

Traveler Market Segments

Each airport has unique characteristics and therefore unique traveler information needs. This chapter identifies the airport traveler market segments that exist at every airport and discusses their characteristics and information needs. An airport needs to understand the characteristics of its traveler market segments to best understand what information and information dissemination methods best serve their travel customers.

For the purpose of this discussion, the term *airport traveler* will be used to describe any air traveler who travels to or from an airport by a mode other than air. The airport traveler market is regularly classified by both the trip purpose and residential status of the traveler. As shown in Figure 12, these two variables, when combined, result in four airport traveler market segments: resident business, resident non-business, non-resident business, non-resident non-business.

Each market segment has a variety of characteristics that influence its choice of travel mode and associated ground access information needs. The following list provides some of the characteristics for each market segment (Leigh Fisher Associates, Coogan, M., and MarketSense Consulting, 2000):

- Resident Business Trip
 - Most frequent users of the airport;
 - Developed pattern of access behavior based on repeated trips;



Figure 12. Airport traveler market segments.

- Know the most efficient way of accessing the airport;
- Trips are generally short in duration (0 to 3 nights);
- Carry little luggage compared to non-business travelers;
- Sensitive to access time reliability (even minor delays);
- More likely to travel during peak arrival/departure times;
- Transit may be used if convenient and reliable; and
- More likely to use convenient and expensive airport parking.
- Resident Non-Business Trip
 - Almost certain to be leaving from home to access the airport;
 - Generally travel in larger travel parties than business travelers;
 - May be elderly or traveling with small children;
 - Generally have more luggage than business travelers;
 - Generally have longer length of stay than business travelers;
 - More sensitive to access costs (due to travel party size);
 - More likely to need assistance with baggage handling;
 - Have some information about access to the airport;
 - May have a preferable method to access the airport;
 - More likely to travel during off-peak times;
 - Likely to be dropped off/picked up by friends, relatives, etc.;
 - May rely on airport-based shared-ride shuttle services;
 - May park at airport but in reduced-rate facilities; and
 - Candidates for transit if access location is convenient.
- Non-Resident Business Trip
 - Destined for a place of business or hotel (begin trip same way);
 - Origins/destinations in city centers/near highways/airport;
 - Trips are generally short in duration (0 to 3 nights);
 - Carry little luggage compared to non-business travelers;
 - May require the flexibility of rental car/taxi;
 - Likely use the most efficient means of transport disregarding cost; and
 - May use transit if convenient, reliable, and expedient (no transfers).
- Non-Resident Non-Business Trip
 - Least informed and unfamiliar with access options to the airport;
 - Generally travel in larger travel parties than business travelers;
 - May be elderly or traveling with small children;
 - Generally have more luggage than business travelers;
 - Generally have longer length of stay than business travelers;
 - More sensitive to access costs (due to travel party size);
 - More likely to need assistance with baggage handling;
 - More likely to travel during off-peak times;
 - Not likely to use the destination airport repeatedly;
 - Likely to stay in hotel or place of residence;
 - Use most readily available access option (taxi/shared van);
 - May be dropped off/picked up by friends, relatives, etc.; and
 - Less likely to use transit due to unfamiliarity with the region.

Traveler Information Needs and Preferences

To identify traveler information needs, a matrix was created where each traveler market segment was stratified by potential mode choice, trip segment (i.e., pre-trip, at trip commencement/conclusion, and en route), and type of trip (i.e., arrival vs. departure).

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The following travel modes were included in the matrix:

- Automobile drop-off/pick-up,
- Automobile self-park,
- Rental car,
- Taxi,
- Private car service,
- Shared van (shuttle),
- Local bus,
- Charter bus, and
- Rail transit.

Although much of the information technology is the same for constructing traveler information systems specifically for airports, the information may be required at different points in the trip or to different travel segments. The airport traveler trip was broken down into four segments, as shown in Figure 13, in order to identify information needs and the technology applications that make sense to disseminate the information for each segment. These segments exist for both arriving and departing travelers.

Chapter 2 identified various technologies or applications that can be used to provide airport traveler information. Table 7 summarizes the most applicable technology applications segmented by identified information need and trip segment. Additional evaluation factors such as geographic location, density of traveler trip ends, socioeconomics of the region, accessibility of an airport to different modal systems, climate, pricing, ability to use ITS technologies and the need to access real-time updates during travel were also considered and are described later in this chapter.

Traveler Expectations

A number of studies have been conducted to determine the expectations of drivers who use traveler information systems. While these studies have not focused on the airport traveler specifically, the study results can be reasonably applied to the airport traveler market. Traveler expectations of these systems typically include the following (Athey Creek Consultants, 2009):

- Accuracy,
- Timeliness,
- Reliability,
- Convenience (ease of access and speed in obtaining information), and
- Safety (of operation).

However, drivers are not the only users of traveler information systems. Information must also be disseminated to users of alternative travel modes. It has been found that travelers increasingly like information systems that have the ability to “push” information to the user via email or text message, and due to this, these types of information dissemination methods are becoming more prevalent.



Figure 13. Airport traveler trip segments.

Table 7. Summary of airport traveler information needs and applicable technology applications.

AIRPORT TRAVELER INFORMATION NEEDS	TECHNOLOGY APPLICATIONS										
	Website	Email/ Text Alerts/ Social Media	Telephone	Radio/Television	511	Kiosk	Highway Advisory Radio	In-vehicle Systems	Dynamic Message Signs (Freeway)	Dynamic Message Signs (Airport)	Airport Information Displays (Terminal)
Flight/gate status	P	P,E	P								C
Access route congestion	P, E, C	P, E, C		P,E	P, E	P	E	E	E	E	
Roadway/weather conditions	P, E, C	P, E, C		P,E			E		E	E	
Check-in/security wait times	P, E, C	P, E, C		P,E						E	C
Real-time arrival info to airport (by mode)		P, E, C					E				
Location/wait time for baggage claim											C
Parking related info	P, E, C	P, E, C	P, E, C	P,E		C			E	E	
Rental car related info	P, E, C	P, E, C	P, E, C			C				E	
Taxi/car service/shared van related info	P, E, C	P, E, C	P, E, C			C		E			
Local bus related info	P, E, C	P, E, C	P, E, C		P, E	P,C		E			
Charter bus related info	P, E, C		P, E, C			C		E			
Rail transit related info	P, E, C	P, E, C	P, E, C		P, E	P,C					

Trip Segment
P = Pre-trip
E = En route
C = Trip commencement/conclusion

Additional Considerations

Geographic Location

According to *ACRP Report 4: Ground Access to Major Airports by Public Transportation*, characteristics related to the geographic location of an airport that have an impact on mode choice and associated information needs are how densely clustered the airport market trip origins are (i.e., a downtown market that can be served by fixed route and schedule services), how dispersed the trip origins are (i.e., an exurban market that facilitates the formation of gathering locations for shared-ride services), or whether the airport location is more of a “middle market” (i.e., where clustering of trip origins is not dense enough to support the classic forms of fixed route or schedule service, where shorter trips are not conducive to long-headway park-and-ride solutions, and where shared-ride door-to-door services can succeed in attaining high levels of vehicle occupancy) (Coogan, M., MarketSense Consulting, and Jacobs Consultancy, 2008).

Additionally, the geographic size of the airport’s market and proximity to competing airports, the location of and the densities of trip origins/destination, the efficiency of the regional transportation network, and the strength of the business market all have an impact on the type of ground access services that are best suited to an airport.

Density of Traveler Trip Ends

The measure of trip-end density is the combination of the number of ground access trips and their geographic location. Based on data collected in *ACRP Report 4: Ground Access to Major Airports by Public Transportation*, approximately 60 to 80 percent of air traveler trip ends are generated from an area equaling not more than 10 percent of the total area associated with ground transportation trips to an airport. This observation suggests that a large proportion of all ground transportation trips to an airport are generated from a relatively small physical area (Coogan, M., MarketSense Consulting, and Jacobs Consultancy, 2008). There is existing data regarding the trip-end densities that are supportive of various forms of airport ground access services. Although it may be most desirable to provide fixed route and/or schedule services, they require a certain density of traveler trip ends to operate at reasonable headways. Similarly, if it is recognized that the majority of travelers access the airport via certain roadways, it may make sense, at a minimum, to provide real-time information on travel conditions for those roadways.

Socioeconomics of the Region

The socioeconomic factors that affect mode choice and associated information needs within a region include income levels, auto ownership, and English-speaking ability. In previous studies, high population density has been related to low daily vehicle travel, but it is not clear whether the low vehicle travel is due to density as opposed to other factors such as traffic congestion or poverty or transit availability. The mode choice decisions of airport travelers are somewhat different from those of typical residents or commuters within a single region. Additionally, the characteristics of any single travel mode vary by location (i.e., pricing, accessibility of mode, number of transfers, schedule, travel time reliability, etc.).

According to a study on the disparity in IT access and use between natives and immigrants to the United States, immigrants are systematically excluded from access to and use of computers and the Internet (Hiroshi and Zavodny, 2006). Furthermore, immigrants from English-speaking regions are more likely than immigrants from non-English-speaking regions to have access and use IT, and likewise, a higher English ability is strongly correlated with higher internet access and usage rates.

Accessibility of Traveler Information for Persons with Disabilities

Section 508 of the Rehabilitation Act of 1973 requires that individuals with disabilities, who are seeking information from a federal agency via electronic means or from information technology, have access to the information equal to that of users without disabilities. Section 508 applies in all circumstances unless an undue burden would be placed upon the agency to provide the information in an accessible manner. *NCHRP Synthesis of Highway Practice 399: Real-Time Traveler Information Systems* describes many of the challenges associated with the accessibility of traveler information for persons with permanent or temporary disabilities. The most common types of disabilities that prevent travelers from accessing information are:

- Visual impairments,
- Hearing or speech impairments, and
- Language barriers.

Visual impairments create many challenges for traveler information websites. It has become customary that travel information websites use maps with colored segments and symbols to display roadway travel conditions. To make these sites accessible for visually impaired users, an all-text option should be provided that allows for the information to be announced by a screen reader to the user. Hearing and/or speech impairments make the use of traveler information telephone systems challenging due to the use of automated systems. These systems typically do not work well with teletypewriter or text telephone (TTY) due to the interpretation that a delay in response is a hang-up or failure to select a menu option. To avoid this challenge, systems should provide a menu option at initiation of the call that allows users to indicate that they are using a TTY device. Additionally, language barriers may prevent users from using both websites and traveler information telephone systems.

Furthermore, with the dramatic increase in smartphone use, the accessibility of mobile apps should also be considered. Although most apps are covered under the Web-based Intranet and Internet Information and Applications technical provisions of the Section 508 guidance, due to the small size of mobile devices, additional accessibility concerns may exist that are not covered under existing technical provisions. Many resources and tools regarding Section 508 are available on the US Government's website: www.section508.gov. Additionally, a blog hosted by the US General Services Administration provides a forum for discussion about Section 508 and its application. The blog can be accessed at the following web address: <http://buyaccessible.net/blog/>.

Accessibility of the Airport to Different Modal Systems

The accessibility of the airport to different modal systems can be related to a wide variety of factors, including the size of the airport, the surrounding population and population density, geographic location of the facility, and its distance or orientation from the central business district. Additionally, the employees of the airport as a market for public transportation systems may be a driving factor, as well as competition from other transportation services.

Climate

Precipitation is by far the most relevant weather variable when a traveler is selecting a mode by which to travel to/from the airport. Precipitation has an effect on the level of congestion of the roadway network and makes waiting for a transit vehicle less enjoyable (if a shelter is not provided), although it does not have much of an impact on rail transit time reliability. Climate conditions can also affect ground operations that can have significant impacts on delays.

Distracted Driving Legislation

Many types of air travel information are most beneficial if received in real-time (e.g., flight/gate status, access route congestion, check-in/security wait times, parking availability, real-time arrival information for transit modes, etc.). With the prevalence of data-enabled mobile phones, this information is readily accessible in real time by the average traveler via websites or real-time text message alerts. However, as of March 2011, 30 states, the District of Columbia (DC), and Guam ban texting while driving, and 8 states, DC, and the Virgin Islands require the use of hands-free devices by motorists talking on phones (Governors Highway Safety Association). It seems that moving forward, any real-time alerts should have the ability to be sent via voice as well as text. It is yet to be determined how the USDOT's Connected Vehicle Initiative and its associated research on human factors will affect the way that travelers access real-time information while en route.



CHAPTER 4

ITS and Strategies to Meet Airport Traveler Information Needs

Overview of Intelligent Transportation Systems

In the broadest sense, ITS applications encompass a diverse and rapidly changing range of wireless and wired communications-based information and electronics technologies. Although many metropolitan areas have developed and continue to develop and expand local and regional roadway and transit traveler information systems using ITS technology, few existing systems address ground access requirements specific to airport travelers or are coordinated effectively with current airport traveler information systems.

Sometime in the 1980s it became evident that the United States would not be able to continue to “build” its way out of congestion. Simply adding lanes to an overburdened freeway was no longer an option in many parts of the country due to environmental and socioeconomic concerns. Subsequently, in 1989 the United States took a more unified approach to advancing technology to improve transportation systems when the notion of Intelligent Vehicle/Highway Systems (IVHS) was defined. Initially, IVHS was divided into four categories: advanced transportation management systems, advanced traveler information systems, advanced rural transportation systems, and commercial vehicle operations. Soon afterward, with the passage of the Intermodal Surface Transportation Efficiency Act, IVHS became an integral part of US transportation policy at the federal level. In 1994, two other categories were defined—advanced public transportation systems and advanced vehicle control systems—and IVHS was rebranded as ITS to better reflect the needs of all modes of transportation, not just roadway vehicles.

The USDOT is charged with supporting the overall development of ITS through major initiatives, exploratory studies, and deployment. Today, ITS encompasses far more than the six original categories. The USDOT currently breaks ITS into two primary categories: intelligent infrastructure and intelligent vehicles. These two categories are further broken down into 16 ITS application areas as shown in Figure 14. Subsequently each of these 16 application areas is composed of numerous categories.

Intelligent Infrastructure	Intelligent Vehicles
1. Arterial Management	1. Collision Avoidance
2. Freeway Management	2. Driver Assistance
3. Crash Prevention and Safety	3. Collision Notification
4. Road Weather Management	
5. Roadway Operations and Maintenance	
6. Transit Management	
7. Traffic Incident Management	
8. Emergency Management	
9. Electronic Payment and Pricing	
10. Traveler Information	
11. Information Management	
12. Commercial Vehicle Operations	
13. Intermodal Freight	

Figure 14. Application areas of ITS.



Figure 15.
Interconnectivity
between ITS system
components.

ITS should also be looked at from a systems perspective. The scope of ITS includes transportation centers, vehicles, field devices, users, and the various communication systems between them. At an airport, there are other information technology systems with which traditional ITS applications may need to be integrated, such as ground transportation, parking, and security systems. As illustrated in Figure 15, all of these systems should be addressed collectively and are defined in the National ITS Architecture. The compatibility of system components is being greatly improved through the use of ITS standards, which will make implementations by airports simpler and less expensive in the future. Standards define how ITS systems and components interconnect and exchange information with each other. Consistent and widespread use of ITS standards will permit data and information sharing among public agencies and private organizations (USDOT, Iteris, 2009).

A typical *intelligent transportation system* involves the following components:

- **Transportation centers:** A transportation center is essentially any combination of personnel and computers that is charged with monitoring and/or managing some aspect of a transportation system. A center can be as basic as a computer in an operations center, or as complex as a full-service transportation operations center that employs dozens of people responsible for monitoring a regional highway and transit network. Other examples of centers are toll administration, transit management, fleet and freight management, and emergency management, to name just a few.
- **Vehicles:** Different vehicle classes have different needs for technology to address. Much of the USDOT's focus on vehicles is performed through the Connected Vehicles Research Program. Connected vehicles research combines the most recent advancements in wireless communication, on-board sensors, computer processing, navigation, and infrastructure to enable vehicles to identify and respond to threats on the vehicle roadway.
- **Field devices:** A wide range of field devices can be used to reduce congestion and improve safety and efficiency in a transportation system. Devices are found on streets (such as traffic signal controllers), on highways (dynamic message signs, video cameras), on toll ways (electronic toll collectors), in parking facilities (parking guidance and count systems), and at vehicle check-points (weigh-in-motion systems).
- **Travelers:** Any person that uses the roadway system can be considered a traveler. And just as each center has a different need for data, so do users of the system. A daily commuter on his or her way to work does not require the same information as a shuttle bus driver on a fixed route. Likewise, a fire truck driver doesn't need the same information that a delivery truck driver needs.
- **Communication systems:** So much of ITS involve communication. Communication is the link between the other four aspects of ITS. Data or information can be transmitted over high-speed or low-speed networks. It can be transmitted over wires or wirelessly. It can be short range or long range. It can be between fixed points or moving points. In other words, there is not one single communication technology approach for ITS projects. Rather, the technology must match the needs and requirements of the system.

As the concept of ITS continues to mature, it becomes more and more evident that ITS have become an integral part of all transportation systems regardless of whether they are older facilities in need of reconstruction or brand new, state-of-the-art facilities. This is not a singular trend in the United States, but rather is being seen via deployments across many countries. Many European nations, likewise faced with space limitations and other constraints, have moved rapidly into all aspects of ITS. In several areas, Europeans are leading the world in ITS applications and developments.

The immediate future of ITS development and deployment will continue to be greatly influenced by federal legislation. The previous authorization bill (SAFETEA-LU) expired in 2009. Presently, funding is being maintained by authorization of interim expenditures.

Concise History of Traveler Information Using ITS

For as long as there have been vehicles on the roadway, a critical component of protecting the safety of both the system and the users has been communicating information to the driver. In the early days of the automobile, especially in the city, this communication generally consisted of supplying regulatory information via means such as manned intersections and traffic signals. As the decades passed and the transportation system continued to increase in size and complexity, methods such as dynamic message signs, highway advisory radios, radio broadcasts, newspapers, or TV were often used to communicate information, such as weather alerts, construction activity or a road closure (Athey Creek Consultants, 2009). These early attempts at providing additional information were an ideal supplement to the maps that most drivers carried in their glove compartments and which they used to plan any lengthy trips. The problem with these initial solutions is they were not very dynamic and had a hard time staying up to date with the latest activity on the roadway. Additionally, drivers had limited access to many of these means, such as TV or newspapers, while they were actually on the road.

As time and technology progressed, attempts to provide additional information to travelers became more sophisticated. Through advances in technology and programs such as ITS, the dynamic message signs were tied into sensor systems and were able to report current information, such as weather, speeds, the location of incidents, detour routes, and even travel times. Using the unforeseen and rapid growth of the internet, transportation agencies launched traveler information websites. In the early stages, these websites reported current conditions, but each iteration of advances provided additional capability, such as pre-trip planning for the best routes, predicted travel times, camera snapshots or live streaming video, and more. The internet allowed agencies to develop websites that contained travel information relevant to the region or state.

The combination of the growth in personal communications such as cell phones and the internet enabled this reach to be extended into the vehicle and allow drivers to get personalized information en route. Some websites even offered subscription-based text alerts to drivers on certain routes, to inform them of up-to-the-minute changes in conditions such as an incident or increasing delays. At the impetus of the federal government, most state agencies have also developed 511 systems, a free public telephone number to call to obtain the latest traveler information. Although specific implementations and available information differ, more than 33 states and metropolitan areas now offer 511 systems, covering over 50 percent of the US population (Athey Creek Consultants, 2009).

Additionally, the increase in available information and technology gave birth to a new industry: the third-party information provider for traveler information. These services started with the use of GPS and static maps that provided in-vehicle directions and routing, based on the historical best path or shortest route. Many of these companies now have supplemented the historical information with real-time traffic information sent to their devices and subscribers, so routing recommendations are now based on current travel conditions. Many cell phones are now equipped with some form of GPS as a standard capability and private enterprises are utilizing these signals (stripped of identifying information) to greatly increase the number of data points that are covering the transportation system. As an example, Google adds real-time traffic conditions in additional locations almost weekly and has recently added incidents and road closures to the available data stream—all available (currently) for free. These private enterprise websites often have a larger, even national, focus on their traveler information. Google has also developed a data format,

known as the General Transit Feed Service (GTFS) for the exchange of transit information to provide real-time updates, which is currently utilized by more than 100 transit agencies.

A critical concern, however, is that the growing abundance of information that can be accessed while in the vehicle actually distracts the driver and may lead to an increase in incidents and dangerous situations. The USDOT has recently launched a major initiative aimed at combating the distracted driving problem. Recent actions include a ban on texting while driving for commercial truck drivers (USDOT|NHTSA, 2009). This problem and actions to thwart it could have a significant impact on the future delivery mechanisms for traveler information, both for the highway user and the ground access airport traveler.

Taken together, these services are known as advanced traveler information systems (ATIS), one component of the 16 application areas of ITS services as illustrated in Figure 14. ATIS has arguably become not only one of the most visible aspects of ITS, but also one of the most used aspects and is therefore a critical concern for continued improvement. Drivers report that they consult ATIS for four primary reasons (Lappin, 2000):

- Saving time,
- Avoiding congestion,
- Reducing stress, and
- Avoiding unsafe conditions.

Resources for Additional Information on ITS

There are many valuable internet resources where readers can obtain more detailed information on ITS and associated technology applications, including the following:

- USDOT ITS Joint Program Office: <http://www.its.dot.gov/>
- USDOT Knowledge Resource Portal, Benefits and Costs Database: <http://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/krhomepage>
- National ITS Architecture: <http://www.iteris.com/itsarch/index.htm>
- Systems Engineering Guidebook for ITS: <http://www.fhwa.dot.gov/cadiv/segb/>
- ITS America: <http://www.itsa.org/>
- ITS Europe (ERTICO): <http://www.ertico.com/>
- Sustainable Aviation Guidance Alliance: <http://www.airportsustainability.org/>

ITS Technologies for Disseminating Traveler Information

This section provides an overview of the most readily deployed ITS strategies and their supporting technologies. Supporting technologies include the information systems that are needed, which essentially provide the interface and interaction between the data and the users of the data. Supporting technologies may include communications infrastructure, ITS field equipment, and the airport network equipment and management.

Traveler information for highway users is typically divided into two categories: pre-trip information and en route information. The method of disseminating information depends on the category or part of the trip in which the traveler is involved. These methods include several tools to deliver the information, such as:

- Airport websites,
- Kiosks,
- DMSs,
- MUFIDs,

- Smartphones,
- Email/text alerts,
- 511 systems, and
- Radio (including HAR).

A technology summary is provided at the end of this chapter for each of the dissemination methods in the previous list. The summaries include the following components:

- **Technology description**—The description contains a brief overview of the technology’s typical uses and components.
- **Primary uses**—The primary uses are listed for each technology as it relates to the dissemination of airport traveler information.
- **Functional requirements**—Every technology-based system has certain “business needs” that it must satisfy, which are the mission-oriented objectives of the organization for which the system is built. The functional requirements define the functions that the system must have in order to satisfy the business needs (i.e., *what* must be done but not *how* it should be implemented). The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems and is an excellent resource for obtaining information on the functionality and inputs and outputs for a particular ITS technology.
- **Institutional/integration issues**—Working as a regional team versus independent agencies is important for ITS because agencies can benefit from a collaborative effort to achieve their respective goals and objectives. Some common institutional issues associated with ITS projects are as follows (Volpe National Transportation Systems Center, 1994):
 - Financial risk/cost sharing among agencies or departments;
 - Acceptance of investment in ITS;
 - Funding for deployment as well as ongoing operations and maintenance (O&M);
 - Insufficient communication and coordination among stakeholders;
 - Resistance to change;
 - Insufficient resources (human, financial, technical, etc.);
 - Information sharing and security concerns; and
 - User perception and acceptance.
- **Data sharing/security considerations**—Connecting with other regional information sources and distribution systems is a key component of ITS. Information sharing allows agencies to identify needed resources, provide the public with information upon which to base their travel choices, and enhance interagency coordination in a region to improve travel conditions (Birenbaum, 2009). Sharing transportation information occurs between agencies within a single jurisdiction and also across jurisdictions and is a common strategy that operators use to improve their transportation management capabilities (Bauer, Smith, & Armstrong, 2007).

Like any information technology system, ITS are subject to security threats, tampering, and unauthorized use. The National ITS Architecture contains a variety of information on security areas and potential threats that may affect or threaten ITS. The documentation provided by the Architecture applies general security concepts to the specific functions and information flows of ITS technologies and applications. The Architecture breaks ITS security into four categories:

 - Information security,
 - ITS personnel security,
 - Operational security, and
 - Security management.
- **Benefits**—The deployment of many ITS applications has proven to provide measurable benefits in terms of congestion reduction, decreased emissions, increases in transit ridership, safety, and economic productivity. However, there are a number of ITS applications whose benefits are difficult to measure quantitatively; namely, the effectiveness of delivering traveler information. Qualitative benefits are listed for each technology.

Table 8. Unit cost breakdown for DMS installation.

Item Description	Unit	Quantity	Unit Price	Total Cost
Electrical service connection	each	3	\$20,000.00	\$60,000.00
Concrete footing	each	6	\$2,000.00	\$12,000.00
Dynamic message sign (full matrix)	each	3	\$120,000.00	\$360,000.00
Communications equipment and integration	LS	1	–	\$160,000.00
Erosion control/seeding	LS	1	–	\$3,500.00
Engineering design services (12%)	LS	1	–	\$71,460.00
Mobilization (5%)	LS	1	–	\$29,775.00
Traffic control (10%)				\$59,550.00
Other construction items (15%)				\$89,325.00

Estimated Total Project Cost = \$845,610.00

LS = lumpsum

- **Unit costs**—Unit construction/implementation cost ranges are provided for each technology. The following percentage breakdown can be expected for other project-related costs:
 - Engineering design—10 to 15 percent of construction cost,
 - System integration—20 to 35 percent of construction/implementation cost,
 - Construction engineering and inspection—15 to 20 percent of construction cost,
 - Contractor mobilization—5 to 7 percent of construction cost,
 - Traffic control—5 to 10 percent of construction cost, and
 - Other construction items—15 percent of construction cost.

The cost for system integration may vary widely depending on the existing IT infrastructure and project-specific parameters. Also, traffic control will apply only if construction work is being accomplished adjacent to a roadway and lanes will need to be closed periodically to accommodate the installation.

Table 8 illustrates how these percentages would be applied to a project involving the field installation of three dynamic message signs on airport circulation roadways.



Keep in mind, the interactive CD that accompanies this guidebook also provides valuable visualizations and information specific to each technology type. It is acknowledged that an airport's use of information technology, particularly items such as websites, are proprietary features used to support a number of airport-specific programs above and beyond traveler information, such as marketing. The visualizations on the CD are not intended as a design specification for traveler information displays or technologies. They are meant solely as an illustration of how various information components can be presented, utilized, and potentially combined.



Technology Summary 1: Airport Website

Description

Most airports, regardless of size, have a website. The information across airport websites varies based on a number of factors, including airport size, geographic location, and access by transit modes, among others. The internet is a useful tool for airports to deliver key information regarding departures, arrivals, terminal/gate information, and airline/flight status. Most international airports allow users to search for information for a particular flight via the airport's website using the flight number, the carrier, the arrival city, and/or the departure city. Once a flight has been selected, the scheduled and estimated arrival time, the gate number, the baggage claim area, and additional flight comments are displayed. Several airports, such as Brisbane Airport in Queensland, Australia (<http://www.bne.com.au/to-from-airport>), have information of this type available.

Primary Uses

The primary types of ground access traveler information disseminated by airport websites include:

- Directions to the airport;
- Airport roads information;
- Access route conditions and delays;
- Regional traffic information;
- Ground transportation providers and services;
- Parking information, including location, availability, rates by type, and shuttle bus access information;
- Flight/gate information;
- Cell phone lot information;
- Security wait time;
- Passenger pick-up information; and
- Location/wait time for baggage claim.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for an airport website:

1. The website shall provide a user interface that intuitively guides users to the information they seek.
2. The website shall have a hierarchical menu.
3. The website shall provide a map-based user interface for the provision of real-time (or near real-time) information on access route conditions (including construction, incidents, congestion, travel speeds, delays, and roadway weather conditions) and/or a link to the local transportation agencies' traveler information website.
4. The website shall provide real-time information on transit modes and/or provide a link to the transit provider's website.
5. The website shall provide real-time information on parking facility status and availability.
6. The website shall provide real-time information on security wait times.
7. The website shall provide real-time information on flight and gate status.
8. The website shall provide static information on parking facility location and rates.
9. The website shall provide static information on cell phone lot location and amenities.
10. The website shall provide static information on the location of passenger pick-up and drop-off.
11. The website shall provide personalized services that push information to the user based on a pre-determined user profile. Information shall be pushed to the user via email, text, and voice alerts.
12. The website shall provide the capability to translate the information in multiple languages based on the user-selected preference.
13. The website shall be compliant with the Americans with Disabilities Act and be accessible by users with visual and hearing disabilities.
14. The website shall be scalable to allow for expansion/changes to meet future traveler information needs.

Data Sharing/Security Considerations

Data Sharing. Agreements must be in place between organizations that share real-time data with the airport. The Institute of Transportation Engineers (ITE) is one of a number of standards development organizations involved in the development of ITS standards. ITE has

Table 9. Costs for deployment of a traveler information website.

System Components	Capital Unit Cost	Annual O&M Cost
Web/database server	\$8-12K	\$2-5K
Web page design	\$25-50K	\$1-5K
Initial configuration and testing	\$10-15K	
Software licenses	\$20-50K	\$15-25K
Operation of website		\$10-15K

developed Traffic Management Data Dictionary (TMDD) standards to support center-to-center communications as part of the regional deployment of ITS in order for centers to cooperate in the management of a corridor, arterial, incident mitigation, etc. The TMDD provides the dialogs, message sets, data frames, and data elements to manage the shared use of devices and the regional sharing of data. The TMDD standards often reference elements of the National Transportation Communications for ITS Protocol (NTCIP) standards.

Data Management and Integration. Data needs to be shared in a standard format. Conflicting data among various sources needs to be identified in order to provide consistent information to the user.

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications.

System Availability. The system should protect critical services in order to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.
- Improves customer service.

Costs

Capital costs for deployment of a traveler information website are listed in Table 9. These costs may vary dramatically depending on existing resources, infrastructure, and personnel capabilities. These costs are for adding a traveler information component to an existing airport website and do not provide for a complete redesign of a complex website.



Technology Summary 2: Kiosks

Description

A kiosk that disseminates real-time travel information typically consists of a computer terminal located within a small booth or on a newspaper stand-type structure. Kiosks can have information on multiple travel modes and often include information on local points of interest, since historically a majority of the users of travel information kiosks are non-residents/tourists.

Primary Uses

A kiosk can be used to provide specific information to travelers at a specific location. The kiosk must be located so that it can be reached by the target audience to provide both static and real-time information. Types of information provided may include traffic information, road conditions,



Source: RSL Group of Coventry, UK



Source: RSL Group of Coventry, UK

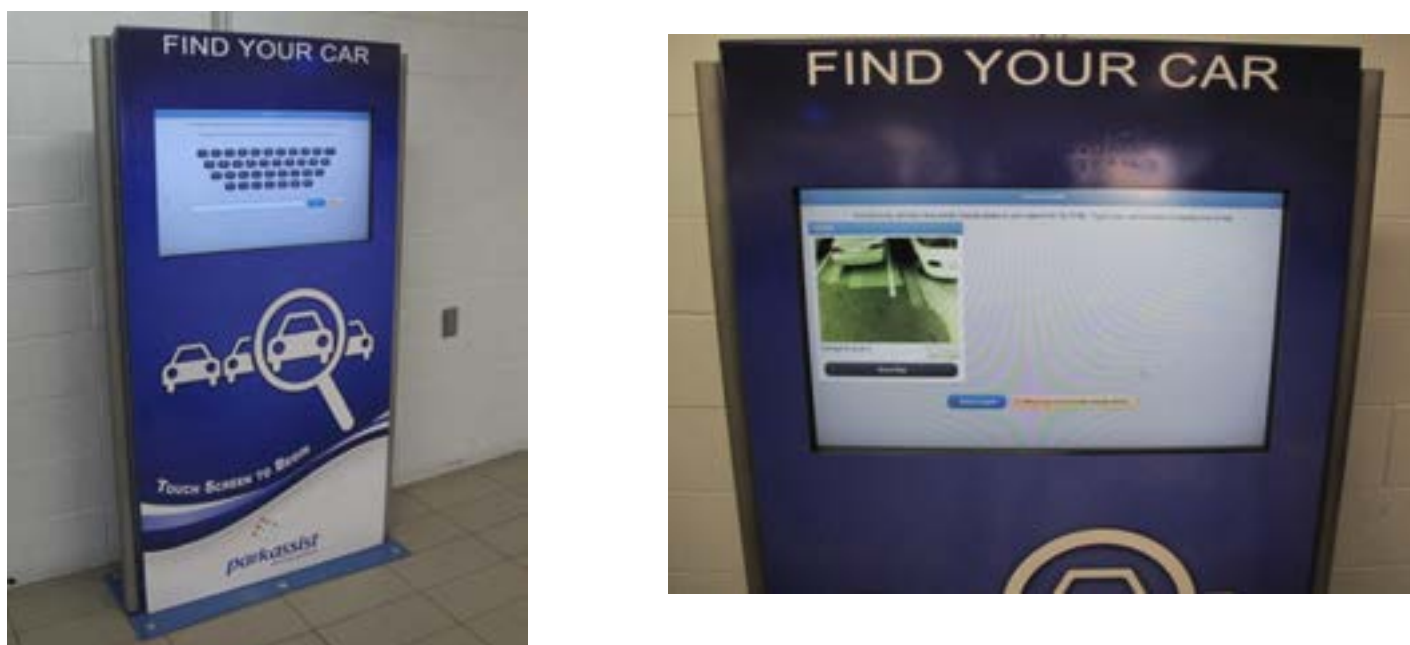
transit information, parking information such as location of parked car, traveler services or special event information, and other information tailored to a traveler’s request or profile.

They should be located where large numbers of people congregate or gather. The goal should be to reach a broad cross section of people. Kiosks may be used by people with varying levels of education, computer literacy, disabilities, and English-speaking ability.

As shown in Figure 16, the Park Assist kiosk allows users to find the location of their parked car by entering in the license plate number. The kiosk then displays a map of the parking facility level and pinpoints the location of the parked car.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is



Source: Park Assist

Figure 16. Park Assist kiosks.

a list of functional requirements for a kiosk, compiled using the National ITS Architecture as a guide:

1. The public interface for travelers shall receive traffic information from a center and present it to the traveler upon request.
2. The public interface for travelers shall receive transit information from a center and present it to the traveler upon request.
3. The public interface for travelers shall receive Yellow Pages information (such as lodging, restaurants, theaters, bicycle facilities, and other tourist activities) from a center and present it to the traveler upon request.
4. The public interface for travelers shall receive event information from a center and present it to the traveler upon request.
5. The public interface for travelers shall receive evacuation information from a center and present it to the traveler.
6. The public interface for travelers shall receive wide-area alerts and present it to the traveler.
7. The public interface for travelers shall accept reservations for confirmed trip plans.
8. The public interface for travelers shall support payment for services, such as confirmed trip plans, confirmed Yellow Pages services, tolls, transit fares, parking lot charges, and advanced payment for tolls.
9. The public interface for travelers shall provide an interface through which credit identities and stored credit values may be collected from tags, traveler cards, or payment instruments used by travelers.
10. The public interface for travelers shall base requests from the traveler on the traveler's current location or a specific location identified by the traveler, and filter the provided information accordingly.
11. The public interface for travelers shall provide digitized map data to act as the background to the information presented to the traveler.
12. The public interface for travelers shall support traveler input in audio or manual form.
13. The public interface for travelers shall present information to the traveler in audible or visual forms consistent with a kiosk, including those that are suitable for travelers with hearing or vision physical disabilities.
14. The public interface for travelers shall be able to store frequently requested data.

Data Sharing/Security Considerations

Data Sharing. Real-time traffic and transit information should be supplied through an automated process. If digitized map data is used as a background for the traveler information display, the system should obtain data updates as soon as they are available. Additionally, the kiosk should provide a secure payment interface through which credit card information can be entered and collected. Payments obtained from the kiosk may be used for parking facilities, transit fares as well as other traveler-related services. Kiosks would typically be part of an airport's digital dynamic signage system and may be managed directly by the airport or by a contracted provider. Likewise, the system may operate over a dedicated network or may operate over the airport's local area network.

General Security Risks. Kiosks may become target areas for criminals trying to rob or harm unsuspecting travelers. Because of this security threat, the kiosk should include appropriate physical security measures including placement in well-lit areas and video and audio surveillance to secure the use of the equipment.

System Confidentiality. The system should prevent the unauthorized disclosure of sensitive information (i.e., personal and financial data that may be input into the system). Transactions requiring sensitive information should be secured.

Table 10. Costs for kiosks and related equipment.

Kiosk System Components	Capital Unit Cost	Annual O&M Cost
Kiosk (indoor)	\$10-15K	\$7-10K
Kiosk (outdoor)	\$15-20K	\$7-10K
Installation/start-up	\$2-5K	
Software	\$3.5-60K	\$2-5K
Operations monitoring		\$45-60K

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications.

System Availability. The system should protect critical services in order to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Benefits

- Reduces customer uncertainty and anxiety.
- Provides access to real-time information to travelers with disabilities or without mobile access to the internet.
- Improves customer service.

Costs

Capital costs for kiosks and related equipment are listed in Table 10. These costs may vary depending on the specific installation parameters. Costs for the communications infrastructure, electrical service connection, and external security measures are not included in the costs listed.

Technology Summary 3: Dynamic Message Signs

Description

A dynamic message sign (DMS) is a sign that is capable of displaying more than one message (one of which might be a “blank” display) and can be changed manually, by remote control, or by automatic control. These signs are also frequently referred to as changeable message signs (CMS) or variable message signs (VMS).

Primary Uses

The primary function of a DMS is to alert and inform motorists of changing or temporary conditions along their travel path. Dynamic signs on major roads should be used only to convey messages that *change* on an hourly, daily, or weekly basis, such as:

- Traffic conditions, roadway delays, and estimated travel times;
- Construction or maintenance lane closures, detours, or speed reductions; and
- Public service messages such as Amber alerts.

In the airport ground access environment, DMSs may be used for:

- Parking availability,
- Parking fee schedules,
- Lane status control at parking entry/exit plazas,
- Alternative parking locations and routing,
- Cell phone lot displays,
- Security alerts,





Source for all photos: Daktronics, Inc.

- Construction messages,
- Terminal curbside conditions, and
- Highlighting changes in roadway configurations or airport destinations.

The roadway version of the DMS is merely a larger version of the same sign and technology utilized for pedestrian wayfinding within airport terminals and concourses. The signs can be dynamically changed from a remote location. The method for getting the message data to the actual sign can be via direct connection with a laptop or any number of methods via a remote computer [i.e., fiber optic cable, radio frequency (RF) link, and cellular transmission]. DMSs are capable of displaying single-color or full-color (red/green/blue) text and graphics.

In some instances a majority of the information on a sign remains static, while only a portion of it is dynamic. This type of hybrid installation may be appropriate for airports that wish to display parking lot status or pricing information.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for DMS, compiled using the National ITS Architecture as a guide:

1. The field element shall include, under center control, DMSs for dissemination of traffic and other information to drivers; the DMSs may either display variable text messages or have fixed format display(s) (e.g., vehicle restrictions or lane open/close).
2. The field element shall provide operational status for the DMS to the operations center.
3. The field element shall provide fault data for the DMS to the operations center for repair.
4. The operations center shall remotely control DMSs for dissemination of traffic and other information to drivers.
5. The operations center shall collect operational status for the DMS.
6. The operations center shall collect fault data for the DMS for repair.
7. The operations center shall distribute traffic data to maintenance and construction centers, transit centers, emergency management centers, and traveler information providers (if applicable).
8. The operations center shall distribute traffic data to the media; the capability to provide the information in both data stream and graphical display shall be supported (if applicable).
9. The operations center shall provide the capability for center personnel to control the nature of the data that is available to non-traffic operations centers and the media (if applicable).

Integration Issues

ITS Standards. Compatibility between ITS and components across public and private applications in roadway and transit transportation systems should be ensured. For the ITS technologies implemented at airports to interoperate seamlessly with the ITS for freeway, arterial or transit management, the use of ITS standards should be adopted. Use of ITS standards ensures that components from different manufacturers will work together, without removing the incentive for designers and manufacturers to compete to provide products that are more efficient or offer more features. The NTCIP family of standards should be used for all DMS deployments.

Systems Engineering. The systems engineering process focuses on defining user needs and required functionality early in the project development cycle and validates that those needs have been met through the design, implementation, testing, and operations and maintenance phases of the project life cycle. The systems engineering process should be used for all DMS deployments.

Table 11. Costs for dynamic message signs.

DMS Type	Capital Cost	Annual O&M Cost
Full matrix walk-in DMS for roadway installations	\$100-250K	\$3-7K
Small, lane status DMS (open/closed)	\$2-5K	\$0.5K
Parking Status Display (by structure level—per sign)	\$10-15K	\$0.5K

Existing Device Inventory. The airport should have a list of all equipment that is owned, operated, and maintained by the airport. To ensure that existing equipment will work with the new equipment, the following information is needed about the existing system:

- Manufacturer/make/model,
- Communications protocols,
- Installation and test dates,
- Warranty periods,
- Spare parts inventory,
- Operating system type/database language,
- Software version, and
- NTCIP compliance.

Burn-In Period. A burn-in period should be provided prior to final acceptance of the device(s). It is during this period that the equipment is most likely to experience failures, which can then be corrected prior to final acceptance of the device(s).

Security Considerations

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications, which could affect the operation of the transportation system. For example, a Texas Department of Transportation portable DMS was hacked into by pranksters and the message “ZOMBIES AHEAD” was displayed.

System Availability. The system should protect critical services in order to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.

Costs

Capital costs for dynamic message signs are listed in Table 11. These costs may vary depending on the specific installation parameters. Costs for the communications infrastructure and electrical service connection are not included in the costs listed because they may vary significantly depending on site-specific conditions.

Technology Summary 4: Multi-user Flight Information Displays

Description

A multi-user flight information display (MUFID) system is a method of visually displaying flight information to travelers in real time. The flight information displayed usually includes the airline name, city of origin or destination, expected arrival/departure time, gate



AIRLINE	FLT	CITY	TERM	STATUS
America West	6443	Memphis	4	Ready for Pickup
Midwest Exec	11200	Milwaukee	3	Enroute
SouthWest	11200	Ontario	4	Ready for Pickup
SouthWest	3277	Providence	4	Enroute
America West	396	Puerto Vallarta	4	Enroute
SouthWest	3511	Sacramento	4	Enroute
Delta	3093	Salt Lake City	3	Enroute
SouthWest	3301	San Diego	4	Enroute
America West	151	Seattle	4	Enroute
Alaska Air	714	Seattle	3	Enroute
America West	660	St. Louis - Lam	4	Ready for Pickup
SouthWest	394	Tampa	4	Enroute

Source: Daktronics, Inc.

number, and status of the flight (i.e., boarding, departed, delayed, etc.). MUFIDs are typically placed throughout the airport terminal but may also be placed in cell phone lots, parking garages and lots, as well as transit stations and rental car facilities.

Primary Uses

The primary function of a MUFID is to provide real-time flight information to departing and arriving passengers as well as people picking up arriving passengers. Dynamic message signs are used for outdoor displays, while LCD or plasma displays are typically used inside the terminal. MUFIDs are typically used in

these areas for the following reasons:

- **In and around the terminal**—display real-time flight information throughout the terminal to provide departing and arriving passenger with flight and gate information.
- **Baggage claim**—display flight and baggage pick-up location and status.
- **Cell phone lot**—display flight arrival status so that drivers picking up arriving passengers know when to leave the cell phone lot to pick them up. Provision of this information in the cell phone lot reduces the occurrence of vehicles congregating at the passenger pick-up curbside as well as undue congestion on the airport circulation roadways.
- **Parking facilities**—display flight information at shuttle stops in parking lots and garages.
- **Rental car return**—display flight information at shuttle stop for rental car return.
- **Transit station**—display flight information for travelers exiting transit mode and proceeding to airport.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for MUFIDs:

1. The MUFID shall provide operational status to the operations center.
2. The MUFID shall provide fault data to the operations center for repair.
3. The operations center shall remotely control the MUFIDs for posting of emergency messages.
4. The operations center shall collect operational status for the MUFID.
5. The operations center shall collect fault data for the MUFID for repair.
6. The MUFID shall display flight information specific to an airport, including the airline name, city of origin or destination, expected arrival/departure time, gate number, status of the flight, and baggage claim carousel information.

Security Considerations

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications, which could affect the operation of the transportation system.

System Availability. The system should protect critical services to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Benefits

- Reduces customer uncertainty and anxiety.

Table 12. Costs for multi-user flight information displays.

MUFID	Capital Cost	Annual O&M Cost
LCD or plasma display—indoor (2.5' x 4')	\$2-5K	\$0.5-1K
MUFID for cell phone lot (10' x 20')	\$250K	\$6K

Costs

Capital costs for MUFIDs are listed in Table 12. These costs may vary depending on the specific installation parameters. Costs for the communications infrastructure and electrical service connection are not included in the costs listed.

Technology Summary 5: Smartphone

Description

A smartphone is a cellular telephone that runs operating system software, which allows the user to install and run advanced applications that mobile telephones cannot. Smartphones provide the user with some level of computing ability as well as access to the internet. The applications that smartphones run are commonly referred to as “apps.” According to Gartner, a leader in information technology research and market share analysis, smartphones will become increasingly more affordable in the future due to providers offering tiered data plans to users, which will drive the total cost of ownership down. (Gartner Inc., 2010)

Primary Uses

Below is a list of the primary types of travel information accessed via a smartphone:

- Flight/gate status,
- Trip itinerary,
- RSS feeds,
- Access route conditions,
- Weather information,
- Check-in and security wait times,
- Parking information, and
- Transit information and status.

Figure 17 presents screenshots of flight/gate status, trip itinerary, and directions to the airport as shown in the flight tracking application, FlightView.

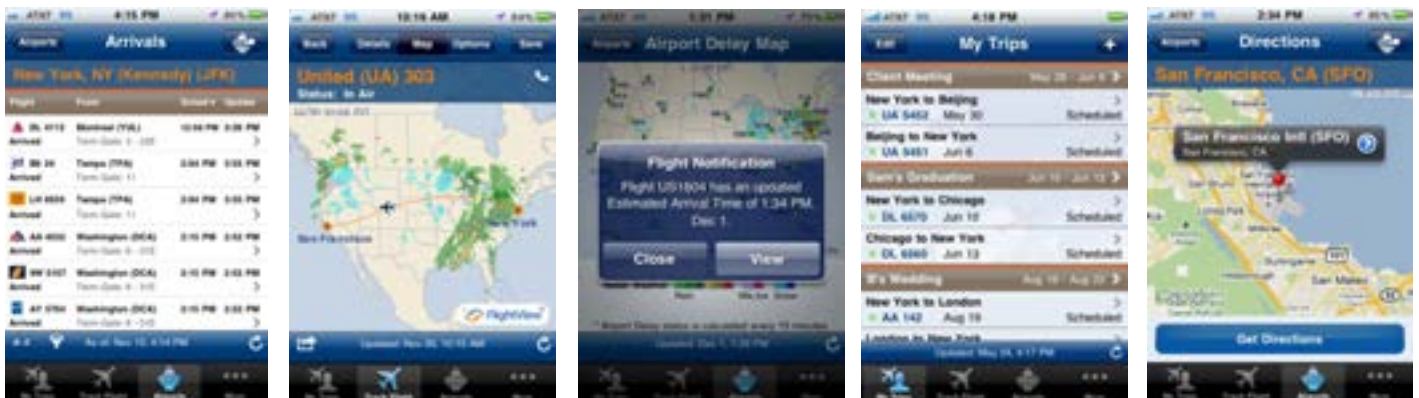


Figure 17. Screenshots from FlightView.



Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for providing travelers with information via a smartphone application, compiled using the National ITS Architecture as a guide:

1. The smartphone application shall receive traffic information from a center and present it to the traveler upon request.
2. The smartphone application shall receive transit information from a center and present it to the traveler upon request.
3. The smartphone application shall receive Yellow Pages information (such as lodging, restaurants, theaters, bicycle facilities, and other tourist activities) from a center and present it to the traveler upon request.
4. The smartphone application shall receive event information from a center and present it to the traveler upon request.
5. The smartphone application shall receive evacuation information from a center and present it to the traveler.
6. The smartphone application shall receive wide-area alerts and present it to the traveler.
7. The smartphone application shall accept reservations for confirmed trip plans.
8. The smartphone application shall support payment for services, such as confirmed trip plans, tolls, transit fares, parking lot charges, map updates, and advanced payment for tolls.
9. The smartphone application shall provide an interface through which credit identity, stored credit value, or traveler information may be collected from a traveler card being used by a traveler with a personal device.
10. The smartphone application shall base requests from the traveler on the traveler's current location or a specific location identified by the traveler, and filter the provided information accordingly.
11. The smartphone application shall provide digitized map data to act as the background to the information presented to the traveler.
12. The smartphone application shall support traveler input via audio, keypad, or touch screen entry.
13. The smartphone application shall present information to the traveler in audible or visual forms consistent with a personal device and suitable for travelers with hearing and vision physical disabilities.
14. The smartphone application shall be able to store frequently requested or used data, including the traveler's identity, home and work locations, etc.
15. The smartphone application shall receive travel alerts and present them to the traveler. Relevant alerts are provided based on pre-supplied trip characteristics and preferences.
16. The smartphone application shall accept personal preferences, recurring trip characteristics, and traveler alert subscription information from the traveler and send this information to a center to support customized traveler information services.

Data Sharing/Security Considerations

Data Sharing. Real-time traffic, transit, and other information should be supplied through an automated process. Formal policies and data sharing agreements should be developed and executed.

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications.

System Availability. The system should protect critical services to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Table 13. Costs associated with a smartphone app.

Smartphone App	Capital Unit Cost	Annual O&M Cost
App development cost	\$30-75K	\$5-7K
Data cost (i.e., flight data feeds, INRIX traffic data)	–	\$15.5-31K

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.
- Provides user-friendly access to transportation information.

Costs

The airport may want to consider the development of a smartphone application as a requirement provided by one of the DMS project integration participants (e.g., an app could be developed in conjunction with a DMS project, with the intent that the app has some potential revenue generation through advertising by those groups shown as part of available services).

Capital costs for development of a smartphone app are shown in Table 13; however, the real costs to the airport will be providing the data in a format that can be viewed by users. It should be noted that the cost may vary widely depending on the specific project parameters. For example, the cost for INRIX traffic data depends on the number of miles of roadway from which data is desired. For a typical urban area served by an airport, the annual data cost could be expected to be in the range of \$15,000 to \$25,000. Similarly, but far less expensive, FlightStats provides syndicated flight status information to airports based on either a term of service or transaction limit (i.e., the number of queries). The cost of the service is \$500 for 365 days or 100,000 queries, whichever occurs first. There are also more customizable options available through contractual agreements.

Technology Summary 6: Email/Text Alerts

Description

Electronic mail is a mechanism that is often employed to receive traveler information (see Figure 18). Many people sign up to get special alerts or notifications, and some traffic sites allow a user to customize those emails to a particular route and/or time of day. A shorter form of electronic mail, commonly known as text messaging or SMS, is also widely used to disseminate

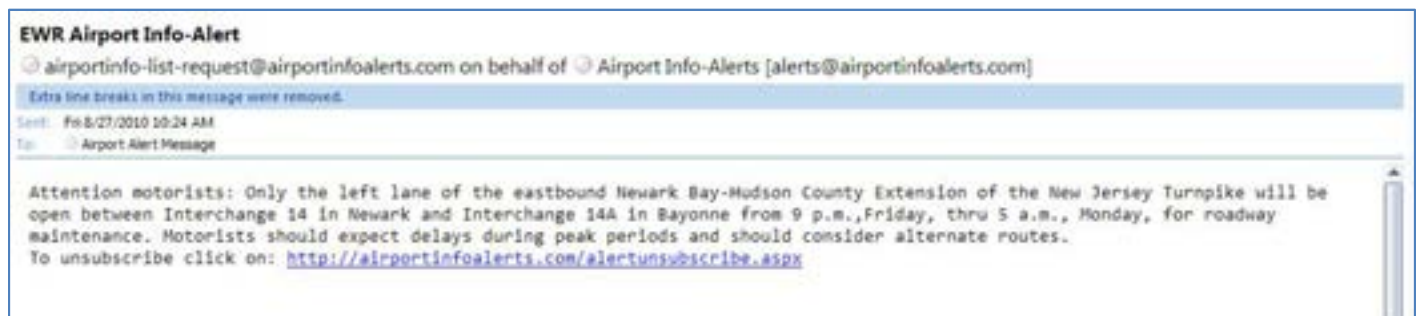


Figure 18. Sample email alert from Newark Liberty International Airport.

information, such as travel alerts. In the latest surveys of mobile phone use, only about 25 percent of all cell phone subscribers in the United States have smartphones, so SMS has the ability to reach a much larger audience than email alerts.

Primary Uses

The primary types of information disseminated by email/text alert include:

- Flight/gate status and delays;
- Access route conditions and delays;
- Bridge/tunnel status and delays;
- Transit status and delays;
- Weather delays (exceeding a minimum threshold; e.g., 120 minutes);
- Check-in/security wait times; and
- Parking lot/garage status (i.e., full).

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for traveler information alerts, compiled using the National ITS Architecture as a guide:

1. The center shall accept traveler profiles that establish recurring trip characteristics including route, mode, and timeframe information.
2. The center shall accept traveler profiles that define alert thresholds that establish the severity and types of alerts that are provided to each traveler.
3. The center shall disseminate personalized traffic alerts reporting congestion, incidents, delays, detours, and road closures that may affect a current or planned trip.
4. The center shall disseminate personalized transit alerts reporting transit delays and service interruptions.
5. The center shall disseminate personalized parking alerts reporting parking availability and closures.
6. The center shall disseminate personalized road weather alerts reporting adverse road and weather conditions.
7. The center shall disseminate personalized multimodal transportation service alerts including ferry and air travel delays, port closures, and service interruptions.
8. The center shall disseminate personalized event alerts reporting special event impacts on the transportation system and provide information on alternative mode options.
9. The center shall provide an operator interface that supports monitoring and management of subscribers and the content and format of alert messages.

Data Sharing/Security Considerations

Data Sharing. Real-time and batch data sources will have different data sharing requirements. Some examples of real-time data sources include FAA information feeds as well as direct airport and airline data feeds. Batch data sources include Transportation Security Administration (TSA) security wait times, security, health, and consular information.

System Integrity and Compliance. The system should ensure that information is protected from unauthorized intentional or unintentional modifications. The system should also ensure any message sent is in compliance with the Controlling the Assault of Non-Solicited Pornography and Marketing (CAN-SPAM) Act of 2003. In the context of airport email alerts, the CAN-SPAM Act applies to routing information (i.e., the email may not contain false or misleading routing information).

Table 14. Costs for providing text message/email alert services.

System Components	Capital Unit Cost	Annual O&M Cost
Automated notification service	\$15-20K	\$40-50K

System Availability. The system should protect critical services to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Distractions Driving. There is currently a global effort to end distracted driving, which has led to legislation banning texting and handheld cell phone use in many areas. Simultaneously, email and text alerts have gained popularity as a method of distributing real-time information on travel conditions to travelers. While these alerts will still be a viable method of disseminating information to non-drivers, alternatives need to be explored for communicating real-time travel information to drivers without compromising their safety. One such method would be to communicate messages to travelers via an automated voice message service.

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.
- Improves customer service.

Costs

Capital costs for providing text message/email alert services vary significantly depending on whether the service is housed internal to the airport communications system or whether the service is provided by a third party. These costs may vary depending on availability of existing personnel to facilitate the service or whether a new position is created. The costs listed in Table 14 include the hardware and software needed to facilitate the service as well as an operator to develop and disseminate the alerts.

Technology Summary 7: 511 Systems

Description

511 is a three-digit travel information telephone number designated by the Federal Communications Commission that is available to states and local jurisdictions in the United States. The information contained in 511 systems is also posted on websites (e.g., www.511.org—San Francisco Bay Area). 511 systems typically provide information on traffic conditions and ground and public transportation in metropolitan areas and major airports. Traffic conditions may also include parking availability and rates, as well as detours, roadway conditions, and lane closures. Systems should be updated every few minutes, although not all systems provide updates in such a timely manner.

511 systems are currently deployed in a majority of the U.S. states and major metropolitan areas but have not been deployed in at least 12 states as of December 10, 2010.

Primary Uses

The primary use of 511 systems is to obtain the following information:

- Traffic conditions for a specific route,
- Regional traffic conditions,
- Transit information and status,



- Parking information, and
- Trip planning.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for providing travelers with information via 511 systems, compiled using the National ITS Architecture as a guide:

1. The 511 system shall provide the capability to process voice-formatted requests for traveler information from a traveler telephone information system and to return the information in the requested format.
2. The 511 system shall provide the capability to process dual-tone multi-frequency-based requests (touch-tone) for traveler information from a traveler telephone information system.
3. The 511 system shall provide the capability to process traveler information requests from a traveler telephone information system.
4. The 511 system shall provide information on traffic conditions in the requested voice format and for the requested location.
5. The 511 system shall provide work zone and roadway maintenance information in the requested voice format and for the requested location.
6. The 511 system shall provide roadway environment conditions information in the requested voice format and for the requested location.
7. The 511 system shall provide weather and event information in the requested voice format and for the requested location.
8. The 511 system shall provide transit service information in the requested voice format and for the requested location.
9. The 511 system shall provide Yellow Pages services information in the requested voice format and for the requested location.
10. The 511 system shall provide current ferry and rail schedule and airport status information in the requested voice format and for the requested location.
11. The 511 system shall provide the capability to support both specific caller requests as well as bulk upload of regional traveler information.
12. The 511 system shall receive and forward region-specific wide-area alert and advisory information to the traveler telephone information system, including major emergencies such as a natural or man-made disaster, civil emergency, child abductions, severe weather watches and warnings, military activities, and law enforcement warnings.

Data Sharing/Security Considerations

Data Sharing. Real-time traffic, transit, and other information should be supplied to the system through an automated process.

System Integrity. The system should ensure that information is protected from unauthorized intentional or unintentional modifications.

System Availability. The system should protect critical services in order to prevent degradation or denial of service to users. Single points of failure should be avoided through the use of redundant communications paths.

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.
- Provides user-friendly access to transportation information.

Table 15. Costs for a 511 system.

511 System Components	Capital Unit Cost	Annual O&M Cost
511 system for an airport	\$200-500K	Varies based on call volume

Costs

Airport travel information could be integrated into an existing regional 511 system with little cost to the airport aside from costs associated with formatting and sharing data. The cost range listed in Table 15 is for a scenario where an airport would develop its own 511 system that would provide airport travel information for a single metropolitan area.

Technology Summary 8: Radio (Including Highway Advisory Radio)

Description

Many FM and AM radio stations in larger urban and metropolitan areas provide some form of traffic information during the morning and afternoon/evening peak travel periods. These traffic updates often center on informing people of new and clearing incidents and their effect on travel conditions. Some radio stations will also announce the current average speed on sections of roadways or average travel times between two points based on current travel conditions. A few also provide alternative route recommendations when non-recurring congestion is encountered.

When inclement weather affects traffic, radio stations always attempt to provide the status of roadway surface conditions. Advisories to avoid certain areas due to ice, flooding, low visibility, etc., may be issued.

The growth of satellite radio, a paid service, also increases the options for dissemination of traveler information. More than 20 US cities are covered by current systems and additional ones are forthcoming. Europe is also developing satellite radio systems.

Primary Uses

The primary use of radio/HAR is to obtain the following traveler information:

- Traffic conditions for a specific route,
- Location of incidents and expected delays,
- Travel speeds and travel times,
- Roadway weather conditions,
- Regional traffic conditions,
- Curbside conditions,
- Optimal locations for passenger pick-up/drop-off,
- Parking availability, and
- Cell phone lot location and space availability.

Functional Requirements

The functional requirements define the functions that the system must have and perform in order to satisfy the business needs of the organization implementing it. The following is a list of functional requirements for providing travelers with information via radio/HAR systems, compiled using the National ITS Architecture as a guide:

1. The center shall disseminate traffic and highway condition information to travelers, including incident information, detours and road closures, event information, recommended routes, and current speeds on specific routes.



Table 16. Costs for highway advisory radio systems.

HAR System Components	Capital Unit Cost	Annual O&M Cost
Highway advisory radio system	\$50-60K	\$1.5-3K per HAR
Highway advisory sign w/flashing beacons	\$15-25K	\$0.2-0.5 per sign

2. The center shall disseminate maintenance and construction information to travelers, including scheduled maintenance and construction work activities and work zone activities.
3. The center shall disseminate transit routes and schedules, transit transfer options, transit fares, and real-time schedule adherence information to travelers.
4. The center shall disseminate parking information to travelers, including location, availability, and fees.
5. The center shall disseminate toll fee information to travelers.
6. The center shall disseminate weather information to travelers.
7. The center shall disseminate event information to travelers.
8. The center shall disseminate air quality information to travelers.
9. The center shall provide the capability to support requests from the media for traffic and incident data.
10. The center shall provide the capability for a system operator to control the type and update frequency of broadcast traveler information.

Benefits

- Increases transportation system efficiency and capacity.
- Reduces energy consumption and environmental costs.
- Reduces customer uncertainty and anxiety.
- Provides user-friendly access to transportation information.

Costs

HAR costs are shown in Table 16.

Combining Technologies into ITS Strategies

In the airport environment for disseminating traveler information, strategies made up of a combination of ITS technologies and applications often work together to provide a desired service. The combination of multiple technologies allows for scalable systems and phased implementations. For example, an advanced parking management system (APMS) comprises multiple technologies, including dynamic message signs, space occupancy detectors, vehicle counters, space occupancy indicators, website displays, MUFIDS, email/text alerts, and operating software.

At the most elementary level, an APMS may indicate parking facility status (e.g., open or full) but nothing else. Although the status provides drivers with information as to whether to pull into the lot or garage and hunt for a space or to continue to an alternative parking facility, it does not solve the problem of drivers circulating around the garage or lot in search of available spaces. More advanced systems provide drivers with directional guidance that allows them to efficiently access an available space, which saves them the time and frustration often associated with locating an available parking space.

Similarly, a cell phone lot may provide real-time flight arrival information to meet/greeters through the use of MUFIDS located in a designated parking facility. Due to their ability to reduce traffic congestion and the potential for vehicle-pedestrian conflicts on terminal curbsides, some

airports are offering additional amenities within the cell phone lot in order to entice drivers to remain in the lot until their party is ready for pick-up.

Transportation management centers exist in almost every major metropolitan area for the purpose of freeway and arterial management. These operations centers are typically run by state and local transportation agencies and include the capability to collect and process data and images related to the prevailing travel conditions via a network of CCTV cameras and sensors. These centers are most frequently used for incident management and coordination and for dissemination of traffic conditions to the media, other agencies, and the public.

This section provides descriptions for three of the more large-scale ITS strategies applicable to the airport environment, including APMSs, cell phone lots, and traveler information and incident management services. However, it should be noted that a range of ITS applications may be implemented that have the ability to improve safety and efficiency and achieve the airport's customer service objectives related to the provision of ground access information.

Advanced Parking Management System

One area of considerable focus for airport operators is the dissemination of real-time parking information. This information is typically provided through the use of dynamic signage and guidance systems within parking facilities to assist drivers in finding available parking spaces. The basic concept is that a series of sensors count vehicles as they enter and exit specified areas of a parking facility. These in/out counts are compared against the known number of parking spaces within each area whereby the number of vehicles parked in each zone can be calculated. As areas become full, this information is conveyed to drivers via dynamic signs and in-pavement markers so that they can bypass the full areas and proceed to areas with available parking. The areas can be defined at the macro level (i.e., the entire parking facility) or at the micro level (i.e., individual parking spaces) (Croft, 2001).

In the 2009 Airport Sign Managers Survey (Gresham, Smith and Partners and Texas Transportation Institute, 2009), 55 percent of airports responding indicate they use some form of electronic car counting. Some airports display this information to the public, while other airports use the car count information internally to make operational decisions such as to place cones or barricades to block off areas of a parking facility.

Figure 19 shows a roadway sign providing information as to the availability of parking in each parking facility at O.R. Tambo International Airport in South Africa. The information is provided prior to the decision point where the driver must commit to a specific parking facility.

Figures 20 through 22 show the progression of signs used to guide drivers to an available parking space. Figures 20 and 21 show that a series of dynamic signs are used to indicate which levels and zones have available parking. Sensors located above each parking space, shown in Figure 22, use red and green indicator lights to inform drivers if a particular space is occupied or not.

Advanced parking management systems are gaining popularity at airports; collective guidance has been provided by the Federal Highway Administration (FHWA) regarding the strategy and is included in a publication entitled *Advanced Parking Management Systems: A Cross-Cutting Study—Taking the Stress Out of Parking* (FHWA, 2007). This document is informative in the topics of describing the state-of-the-practice, recommendations for planning APMS, and other implementation items. The guidebook generally discusses signage but does not provide specific details regarding sign content, form, or placement. In fact, specifics and recommendations on signage associated with APMS are often suggested by vendors providing the APMS.



Source: Intelligent Devices, Inc.

Figure 19. Parking availability by facility type, O.R. Tambo International Airport.



Source: Intelligent Devices, Inc.

Figure 20. Parking availability by level, O.R. Tambo International Airport.



Source: Intelligent Devices, Inc.

Figure 21. Parking availability by zone, O.R. Tambo International Airport.



Source: Intelligent Devices, Inc.

Figure 22. Sensor status of parking spaces, O.R. Tambo International Airport.

The primary function of an APMS is to provide parkers with real-time parking availability information, so that they can find an available space in a timely manner. This leads to better space utilization, less circulation in parking facilities, and better overall customer service.

The primary information components of an APMS are:

- Parking facility status (e.g., open/closed),
- Parking availability by level or row (number of spaces),
- Guidance to the location of available spaces, and
- Finding the location of the parked vehicle.

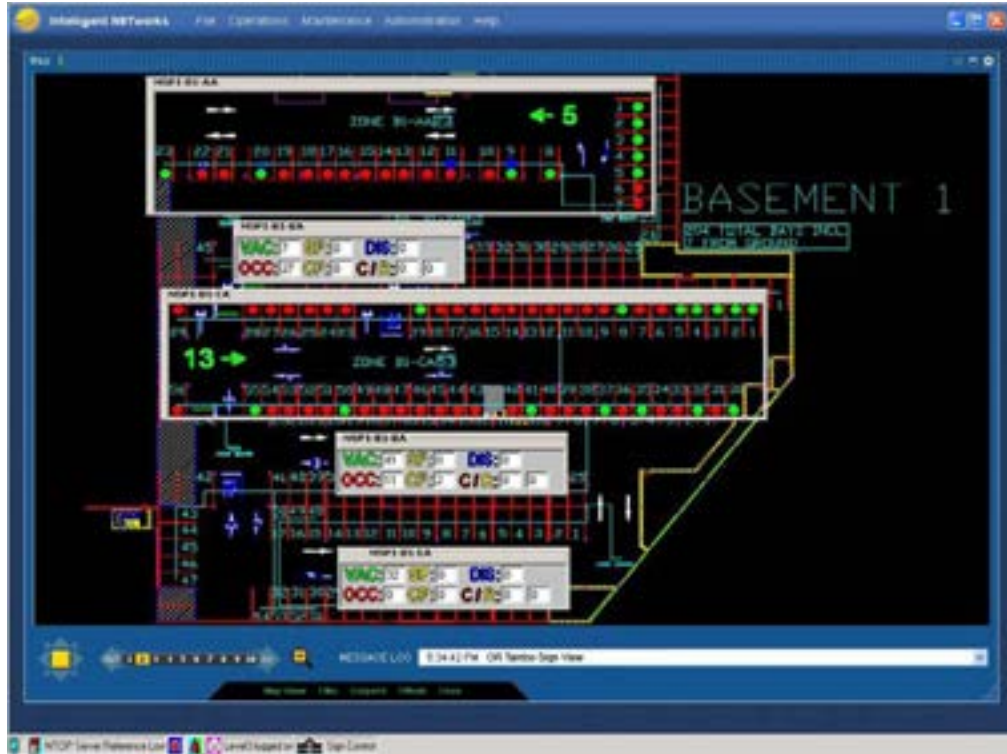
As with the individual ITS technologies, there are system integration and security concerns associated with an APMS, especially for systems that collect personal and financial data through payment processing. And, although these systems are typically not mission critical, system integrity and availability are important. System malfunction or degradation of service may cause undue stress and frustration for parkers and ultimately leads to customer dissatisfaction.

Several screenshots from sample APMS operating software, provided by Intelligent Devices, Inc., are shown in Figures 23 through 25. The figures illustrate the capability for parking operators to remotely monitor the status of individual parking spaces, messages that are displayed on dynamic signage, and statistics related to parking usage during a specific time period as well as operational status of the equipment (i.e., good, communications failure, sensor failure).

As an example, BWI airport currently has approximately 13,000 spaces under control of an APMS. A 2003 customer satisfaction survey indicated that 81 percent of the BWI travelers surveyed thought that *parking was easier* at BWI compared to other airports they frequent and 68 percent agreed that *parking was faster*. Advanced parking management systems have been proven to reduce circulation in parking facilities, increase space occupancy and associated revenue, reduce energy consumption and environmental costs, as well as reduce customer uncertainty and anxiety.

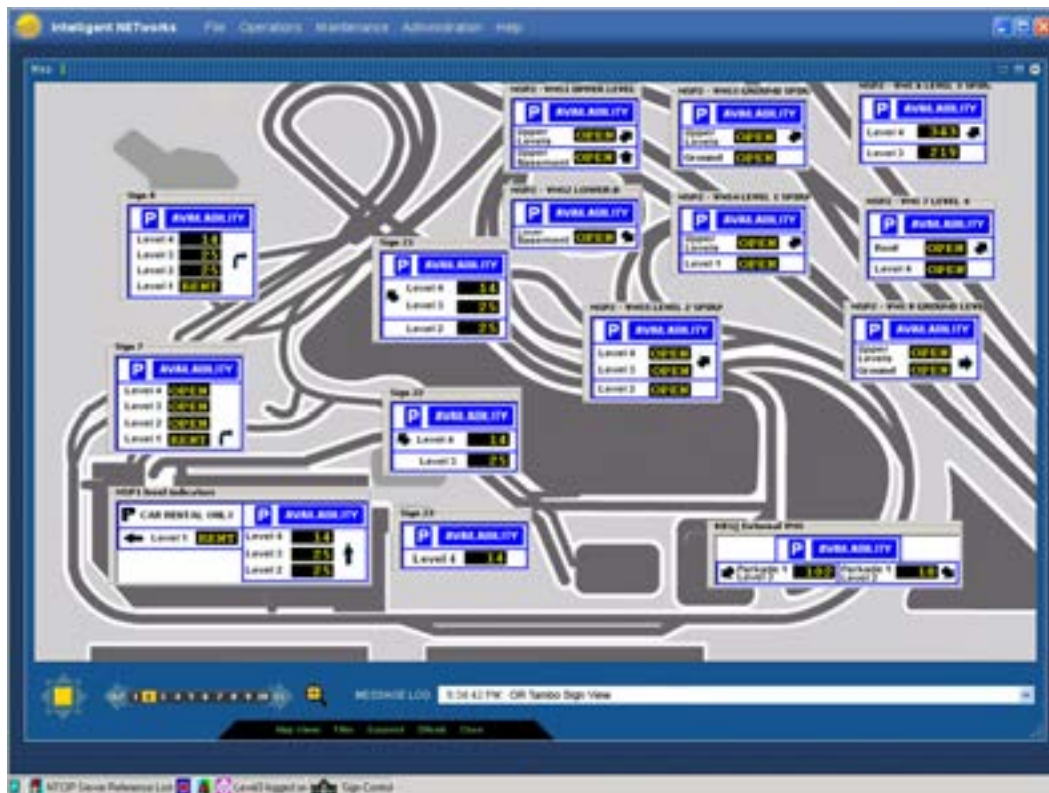
Advanced parking management systems vary significantly in cost depending on a number of deployment variables:

- Type and level of accuracy of the information provided,
- Degree of complexity in installation of the sensors,
- Integration and operating software,



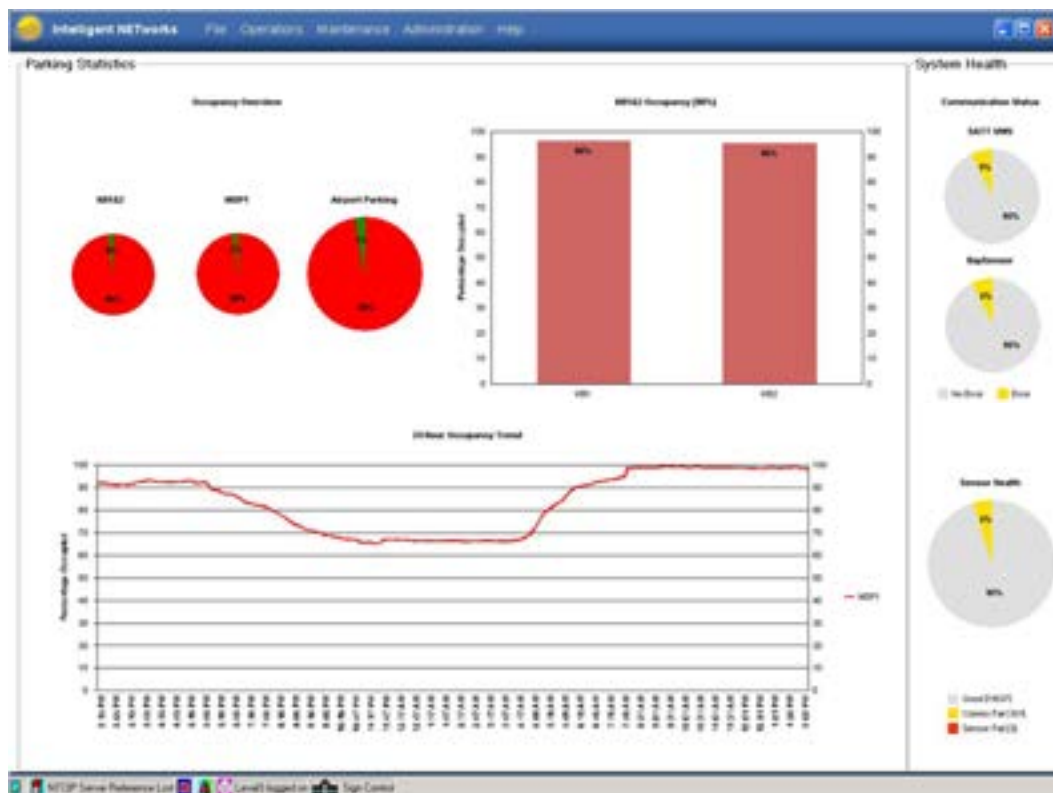
Source: Intelligent Devices, Inc.

Figure 23. Screenshot showing space occupancy status, O.R. Tambo International Airport.



Source: Intelligent Devices, Inc.

Figure 24. Screenshot showing dynamic message sign status, O.R. Tambo International Airport.



Source: Intelligent Devices, Inc.

Figure 25. Screenshot showing APMS statistics, O.R. Tambo International Airport.

- Availability of communications infrastructure,
- Availability of electrical service connections, and
- Amount of new wayfinding and dynamic signage required to convey the information.

A range of capital cost per parking space for a parking and guidance system that leads a driver to an available space is listed in Table 17. The costs vary significantly depending on the specific services provided and site-specific installation parameters.

ACRP Report 24: Guidebook for Evaluating Airport Parking Strategies and Supporting Technologies provides detailed cost information in Appendix A for the various elements involved in the deployment of an APMS.

Cell Phone Lots

With the proliferation of mobile phones over the past decade, the concept of just-in-time delivery has progressed to just-in-time passenger pick-up at airports. Now that people are able to receive real-time information on a flight’s arrival status, the need to guess when a flight might land and to find a parking place to wait until it does arrive is dissipating. Airports have developed special areas for people to wait short periods of time in their vehicles until

Table 17. Costs for an advanced parking management system.

Advanced Parking Management System	Capital Cost	Annual O&M Cost
Installation and O&M cost per parking space	\$250-850	\$100-300



Source: Daktronics, Inc.

Figure 26. MUFID in cell phone lot, St. Louis International.

their family, friends, or business associates contact them via cell phone to pick them up at the terminal curbside. In the 2009 survey (Gresham, Smith and Partners and Texas Transportation Institute, 2009), more than 74 percent of the airports indicated they provide some form of cell phone parking lots.

Because of their popularity and ability to decongest terminal curbsides, some airports are providing dedicated information and amenities within the cell phone waiting areas. Flight information display boards, free wireless internet, vending machines, and restrooms are the more common items. Figure 26 is an example of a MUFID in the cell phone lot at St. Louis International Airport, which provided real-time information to patrons. This encourages people to stay in the cell phone lot and not circle the airport or congest terminal curbsides. Additional information that is not displayed in Figure 26 but would be useful to people picking up passengers is whether the plane is taxiing or has reached the gate as well as baggage claim wait times.

Cell phone lots can vary significantly in cost depending on a number of deployment variables:

- Size of lot;
- Amount of demolition, earthwork, and grading needed to convert land to parking lot;
- Amenities provided (Wi-Fi, refreshments, restrooms, etc.);
- Number and size of MUFIDs installed;
- Availability of communications infrastructure;
- Availability of electrical service connections; and
- Additional personnel required to monitor the lot.

A capital cost range for a cell phone lot is listed in Table 18. The costs vary depending on the specific installation parameters listed earlier.

Table 18. Costs for a cell phone lot.

Cell Phone Lot	Capital Cost	Annual O&M Cost
Installation cost of lot per parking space	\$7-12K	TBD
MUFID (20' x 10' display)	\$250K	\$6K

Traveler Information and Incident Management

Although travelers can commonly access information regarding congestion and delays for the freeway portion of their trip and sometimes the arterial network, they are often uncertain as to how long activities will take once on airport property such as parking, returning a rental car, riding a shuttle to the terminal, checking bags, and getting through security—all in time to catch a flight. The same uncertainties also exist for a traveler arriving at an airport and needing information to plan their departing trip to off-airport destinations. All of these areas for uncertainty provide opportunities for airports to provide valuable information to travelers.

As a major destination and commerce hub, airports have a role as a critical part of regional surface transportation networks. Just as many municipalities have done to address their traffic management needs, airports could essentially establish what is known as a “transportation management center” (TMC) to observe and actively address traffic issues on airport roadways and terminal curbsides. Through a series of sensors, cameras, radio advisories, dynamic message signs, and other traveler information outlets, airports could efficiently identify and mitigate incidents that may cause travel delays for air travelers arriving and departing the airport. In addition, a TMC could provide a means to observe the overall impact of traffic detours, construction closures, and temporary maintenance operations that occur on a frequent basis at airports.

DMS located along the airport roadways/curbside could inform motorists of parking rates and availability, alternative parking locations and routing, security alerts, check-in or security wait times, construction messages, and terminal curbside conditions. Additionally, a HAR system could be used to disseminate similar information via a radio broadcast.

It is possible that airport traffic management centers and municipal/regional traffic control centers could share the data and information gathered at their respective locations. This concept would provide an integrated, all-encompassing source of traffic information so that the traveler is not forced to identify the “boundaries” between traffic control centers and then attempt to switch to the appropriate provider. Theoretically, the concept is straightforward. The execution of such an arrangement is made difficult by several institutional issues that are discussed later in this report. Figure 27 shows the monitoring capabilities of the regional traffic management center located in Memphis, Tennessee.

A capital cost range for traveler information and incident management equipment is listed in Table 19. The costs vary depending on the specific installation parameters.



Source: Gresham, Smith and Partners

Figure 27. *Traffic management center, Memphis, TN.*

Table 19. Costs for traveler information and incident management equipment.

Traffic Management Center	Capital Cost	Annual O&M Cost
Video wall (similar to Figure 27)	\$1.2M	\$30-40K
Video wall (4 cubes/operating software)	\$30-40K	\$30-40K
CCTV camera	\$8-15K	\$1-2K
Video sharing equipment	\$5-15K	\$1-2K
Radar detector	\$2-5K	\$0.5-1K
TMC central software	\$50-250K	TBD
Full matrix DMS (roadway)	\$50-150K	\$2-5K

Considerations Related to ITS Deployment

In addition to identifying and selecting ITS technologies that meet airport traveler needs (including the needs of disabled travelers), airports should also consider deploying technologies that meet current ITS standards to ensure interoperability of devices across partnering organizations and phased deployments. A formal data sharing policy should also be developed that addresses sharing airport ITS data with both public and private entities. Benefits and costs should also be considered, specifically the ongoing operations and maintenance costs associated with deploying technology-based systems.

Information Technology Accessibility

It is important that individuals with disabilities have equal access to airport services. Individuals with disabilities may have impairments that limit their ability to use information technology or ITS and/or components. These impairments may include low or limited vision, blindness, hearing loss or deafness, and/or limited or no ability to reach, touch, or manipulate devices.

There are a number of existing accessibility regulations in the United States—such as the Americans with Disabilities Act (ADA) and the Air Carrier Access Act (ACAA)—as well as state regulations related to information technology use, including the Illinois Information Technology Accessibility Act (IITAA). The purpose of the IITAA is to ensure that information and electronic technology developed, purchased, or provided by the State of Illinois is accessible to individuals with disabilities. The applicable types of equipment and technology include software applications; electronic information; equipment used to create, store, display, or manipulate data, video, and multimedia; kiosks; and telecommunications devices; as well as copiers, printers, and computers.

Furthermore, on September 19, 2011, in an ongoing effort to implement the ACAA, the USDOT announced a proposed regulation that would require airlines to make their websites and airport kiosks accessible to travelers with disabilities. Within a 2-year period, airline websites would be obligated to meet the requirements of the Website Content Accessibility Guidelines. Existing airport kiosks would not be required to meet the rule; however, any kiosks ordered 60 days after the rule takes effect would be required to meet the accessibility requirements contained in the ADA.

ITS Standards

The USDOT has facilitated significant progress in ITS standards that are fundamental to the establishment of an open ITS environment. Standards facilitate deployment of interoper-

able systems at local, regional, and national levels without impeding innovation as technology advances and new approaches evolve (USDOT, 2009b). Through the ITS Standards Program (<http://www.standards.its.dot.gov/>), the USDOT has facilitated significant progress in compatibility between ITS and components across public and private applications in roadway and transit transportation systems. This level of compatibility has not yet been achieved across airport traveler information systems.

In order for the ITS technologies implemented on airports to interoperate seamlessly with the ITS for freeway, arterial, or transit management, the use of established ITS standards should be adopted. The use of ITS standards gives airport and transportation agencies confidence that components from different manufacturers will work together, without removing the incentive for designers and manufacturers to compete to provide products that are more efficient or offer more features. Although stand-alone ITS applications can create benefits, the integration of ITS devices and center-based systems results in the greatest efficiencies and improves mobility and safety, especially in area-wide or regional traveler information systems. ITS standards are an important element in the integration of advanced technologies and facilitate interoperability between systems, allowing for the efficient exchange of data as well as accommodating future equipment replacement, systems upgrades, and expansions (USDOT|RITA, 2010).

The NTCIP family of standards defines protocols and profiles that are open, consensus-based data communications standards. Like all ITS standards, interoperability and interchangeability are two goals of the NTCIP standards. NTCIP provides communications standards for two categories of ITS communications: center to field (C2F) and center to center (C2C). C2F communications occur between a center system and control of multiple field devices that are managed by the center (e.g., a traffic management system that controls CCTV cameras, DMS, and HAR transmitters on roadways). On the other hand, C2C communications involve messages sent between two or more systems or computers (e.g., a transit system that reports schedule adherence exceptions to a transit customer information system and to a regional traveler information system in real time). C2C communications can occur between computers in the same room, by adjacent agencies, or in different jurisdictions or states (AASHTO, ITE, NEMA, 2009). The following list provides examples of C2F and C2C applications:

- **C2F Applications**

- Dynamic message signs;
- Traffic signals;
- Field masters (closed loop systems);
- Data collection and monitoring devices such as traffic counter, traffic classifiers, and weigh-in-motion stations;
- On-board sensors and controllers;
- Environmental sensors;
- Ramp meters;
- Vehicle detectors;
- CCTV cameras (camera control only); and
- Video switches.

- **C2C Applications**

- Traffic management (freeway/surface street, urban/rural);
- Transit management;
- Incident management;
- Emergency management;
- Parking management;
- Traveler information (all modes);

- Commercial vehicle operations regulation; and
- Any mix of these.

Data/Resource Sharing

Connecting with other regional information sources and distribution systems is a key component of ITS. Information sharing allows agencies to identify needed resources, provide the public with information upon which to base their travel choices, and enhance interagency coordination in a region to improve travel conditions (Birenbaum, 2009). Information sharing is critical for an appropriate response to problems because the efforts can have direct correlations to public safety and mobility.

The primary issue involved with data integration is the diversity of database formats that lead to inconsistencies, inaccuracies, and duplication. Security and accessibility issues are also often a concern. Data quality standards must be established to ensure accuracy, consistency of reporting data, terminology used, and completeness and to accommodate the differences inherent among various data sets. Means of data exchange among these disparate data sources must also be established to assure usability, accuracy, and security of the data. Issues associated with the administration of the database should be addressed at the beginning of the project to ensure adequate mechanisms and resources are available for administrative tasks following development of the database.

Data ownership is a term used to describe both the possession of and responsibility for information. Several issues that must be considered when making decisions regarding data ownership include paradigm of ownership, data hoarding, data ownership policies, balance of obligations, and technology. Paradigm of ownership refers to the complexity of ownership issues by identifying the range of possible examples used to claim data ownership. There are several parties that may lay claim to ownership of data, such as the creator, the consumer, the compiler, the funder, or the purchaser/licenser. Data ownership policies should be set in place in order to preserve the integrity of the data and should be used in many scenarios, including agreements between an academic institution and industry (public/private sector), agreements between an academic institution and researcher staff, collaboration between research colleagues, and agreements between authors and journals (Office of Research Integrity, 2010).

The USDOT's ITS Joint Program Office routinely develops a report, *Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned*, that presents information on deployed ITS with the goal of supporting informed decision making with regards to the deployment of ITS. One of the key lessons learned from a policy and planning perspective from the most recent report update (2008) is to develop a formal data sharing policy for ITS data.

Items to be included in a data sharing policy may include but certainly not be limited to the following (USDOT|RITA, 2008):

- Type of data to be shared;
- Fees or costs borne by the private sector associated with access or dissemination of the shared data;
- Sharing of third-party (privately generated) data with the airport and protection of its value;
- Control over video images;
- Requirements that third-party entities use the airport ITS data to provide information to travelers;
- Acknowledgment of the airport as the source of the data;
- Technical requirements for access (e.g., communication system);
- Allowable advertising;
- In-kind services provided by third-party entities who obtain data from the airport;

- Training on use of the data;
- Intellectual property rights;
- Standardization of data format;
- Monitoring usage of traveler information services;
- Liability for data quality and availability; and
- Sharing of third-party entity revenue with airport in exchange for data.

Typically, data and/or resource sharing agreements between agencies are in the form of a Memorandum of Agreement (MOA). A MOA describes the specific roles and responsibilities of each party involved in order for their mutual goals to be accomplished. Oftentimes, the resources shared and/or data exchanged between agencies involve benefits that may not be equal to both parties. However, since valuable benefits are provided to the end user of the system, agencies may accept that the benefits they gain are not equal to the partnering agency.

The following list provides examples of the type of information that may be included in an MOA for data and resources shared between agencies. The list is neither comprehensive nor all-encompassing of the items to be included in the legal agreement but simply serves to provide a starting point from which airports can then have a MOA developed specific to their situation.

- **C2C connectivity**—A C2C network typically facilitates data sharing between agencies. The agencies will be connected via some sort of communications infrastructure (e.g., fiber optic cable, wireless communications, leased lines, etc.). In this section of the MOA, it should be stated that each agency is responsible for operating the equipment in its ownership in order to maintain the C2C connection. C2C connectivity may require additional communications equipment in the control center of each agency, so adequate room should be available in the respective equipment rooms to accommodate the necessary equipment.
- **ITS field equipment (e.g., DMS, CCTV cameras)**—Video images may be shared between agencies for the purpose of incident management or providing traveler information. The owning agency may allow another agency that is party to the MOA to have operational control of the CCTV cameras (i.e., use the pan, tilt, and zoom capabilities). The owning agency will maintain an override capability should their needs necessitate operational control. Similarly, agencies may agree to share DMS for the purpose of displaying messages for traffic conditions, incident information, and safety information that may be beneficial to both parties. The owning agency should provide an approved message library so that only approved messages are displayed on the signs. Priority levels may be assigned to messages so it is clear which agency should be allowed to post a message if both wish to post on the same sign.
- **ITS resources**—The MOA should document the specific details related to the equipment to be shared (i.e., type, number, and location).
- **Compensation**—Since the premise of the agreement is for the sharing of data and/or resources, both parties typically agree that neither will charge the other for the use of the resources/data contained in the agreement.
- Additional sections in the MOA may include, but shall not be limited to, revocation, guarantees, maintenance and limitation of damages, sovereign immunity, term and termination, assignment, copyright, third-party beneficiary, and liability.

Benefits of ITS Applications

The deployment of many ITS applications has proven to provide measurable benefits in terms of congestion reduction, increases in transit ridership, safety, and economic productivity. However, there are a number of ITS applications whose benefits are difficult to measure quantitatively; namely, the effectiveness of delivering traveler information.

The value that an airport will receive by investing in the deployment of ITS technologies for the purpose of meeting airport travelers' information needs, reducing their stress associated with getting to and from the airport in a timely manner, and ultimately reaching their gate more efficiently/faster is not something that can be easily measured. Generally speaking, the only way to measure customer satisfaction is through surveys.

As a starting point, an effective traveler information system should have the following characteristics (Mitretek Systems and TransCore, 1998):

- Provide information that is timely, accurate, reliable, relevant to making travel decisions, and marketable;
- Provide information for the entire region. This requires the participation of public agencies across jurisdictional boundaries;
- Operate with efficient, well-trained staffs;
- Be integrated easily with other ITS—emergency management, freeway management, traffic signal control, and transit management—to obtain adequate traveler information;
- Be easy to use and easy to access by the traveling public;
- Be easy to maintain (with in-house or contract resources) and not require excessive costs and time to operate. Ideally, traveler information components need to be interoperable between different manufacturers and vendors. This reduces maintenance costs and provides added flexibility in repairing equipment faults and malfunctions, finding spare parts, and developing system upgrade paths; and
- Provide services that are affordable to end users.

The USDOT's ITS Joint Program Office develops a report, *Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned*, that presents information on deployed ITS with the goal of supporting informed decision making with regards to the deployment of ITS. The ITS technologies for disseminating traveler information included in the report are a critical component of the USDOT's Congestion Initiative, as outlined in the May 2006 document *National Strategy to Reduce Congestion on America's Transportation Network*. The initiative stresses the importance of implementing operational and technological improvements to traveler information in order to reduce congestion.

Based on a 6-year long survey of the 78 largest metropolitan areas in the United States, the most popular medium for distributing traveler information is the internet with email as the second most popular. Benefits of traveler information systems have been identified to include the following (USDOT|RITA, 2008):

- Drivers who use route-specific travel time information as opposed to area-wide traffic advisories can improve on-time performance by 5 to 13 percent;
- Travel information services are in very high demand during severe weather events, emergencies, or other special events;
- Customer satisfaction with regional 511 telephone system deployments range from 68 to 92 percent; and
- Network traffic distribution is enhanced, which improves effective capacity and reduces fuel consumption and emissions.

Travel Time Reliability

The goal of providing travelers with advanced information either pre-trip or en route is to improve travel time reliability (i.e., reduce the variation in travel times on an hour-to-hour or day-to-day basis). Traffic congestion caused by weather events, incidents, or other factors greatly affect delay that travelers incur, but how can travelers estimate the impacts of such delays, especially the unexpected ones? The FHWA has sponsored extensive research that indicates that commuters plan their trip based on the worst travel days, not the average day.

As an example, a commuter route in Seattle, Washington, has a travel time of 12 minutes with no congestion on the route, a travel time of 18 minutes on a typical weekday, and a travel time of about 25 minutes with a combination of weather and incident delays. If commuters were to plan their routes based on the average travel time, they would be early half the time and late half the time (Cambridge Systematics, 2005). The importance of having accurate travel time estimates is even more pronounced when travelers have extremely time-sensitive trips (e.g., to catch a flight).

The Washington State Department of Transportation (WSDOT) is leading the effort of collecting and using archived travel time data to provide travel time reliability information to travelers. The WSDOT website provides travelers with a “95% Reliable Travel Times Commute Calculator.” The calculator provides travelers with 95th percentile travel times for user-selected routes, which means that the times should be reliable 95 percent of the time. While providing 95 percent reliability sounds good, this often results in over-estimation of travel time, because the user is essentially receiving travel time data for the “worst case” travel time scenario. Further research is needed to determine an airport traveler’s threshold for delay.

Sustainability

Airport sustainability, as with any sustainable practice of the global transportation system, encompasses a variety of applications ranging from planning and design to buildings and operating facilities. According to an FAA Memorandum dated May 27, 2010, there are three core principles:

- Protecting the environment;
- Maintaining high and stable levels of economic growth; and
- Social progress that recognizes all stakeholders’ needs.

In 2009 the FAA established a Pilot Sustainability Planning Program. Requirements of the program include the development of either a stand-alone Sustainable Management Plan or incorporation of sustainability initiatives into the Airport Master Plan. The goal of the program is to help the FAA develop guidance in the area of sustainability.

ACRP Synthesis of Airport Practice 10: Airport Sustainability Practices contains useful information to airports with regards to sustainable initiatives that will meet the needs of all stakeholders, including passengers, employees, airlines, and residents of neighboring areas. In the area of air quality, there are increasingly stringent federal regulations for industrial air pollution sources, including vehicular emissions. More specifically, more than 25 percent of US commercial airports are located in air quality non-attainment areas. To meet federal regulations, airports must show that their growth conforms to air quality initiatives for the region and that programs will be established to offset increases in air pollution (Berry, Gillhespy, & Rogers, 2008).

The deployment of ITS technologies and applications are a viable and proven approach to reduce vehicular congestion and associated emissions and should be included in an airport’s sustainability master planning. Examples of applications that should be included are cell phone lots, advanced parking management systems, and other methods of providing advanced traveler information such as roadway DMSs, which in the end will result in less congestion on airport roadways and parking garages and will have a significant impact on reduction of airport emissions.

Benefits Estimation

For an airport to justify an investment in ITS technologies, the benefits associated with the implementation should be quantifiable. The FAA Investment Planning and Analysis Office

provides documentation on estimating benefits to support FAA investment decisions in *FAA Guidelines for Benefits Estimation*. The FAA benefits estimation has the following guiding principles (FAA, 2010b):

1. There must be a documentable cause and effect (temporal) relationship between the investment and the benefits.
2. Economic benefits must be achievable in monetary terms by specific entities.
3. The implementation must be checked for potential “negative benefits” (costs, performance degradation, etc.) that might result from the investment. For example, a project that increases terminal capacity also may have the potential of increasing the likelihood of a collision, particularly if it involves some technical risk.
4. Benefits involving integration between multiple programs must be considered.
5. Any impact caused by dependency on other programs must be considered.
6. The documentation should include a complete description of the benefit estimation methodologies, the computations, and the data used.
7. Documentation, data bases, and models should be retained for future use. Electronic versions should be archived so they don’t disappear with departing staff or contractors.
8. Plans for post-implementation assessment of the actual benefits should be included in the assessment and should be implemented after the project is operational.

Table 20 provides a list of potential benefits that can be attributed to the ITS application areas of advanced traveler information, cell phone lots, and advanced parking management systems. Associated performance measures are also provided to guide the airport in determining how each benefit may be quantified. As part of an ITS implementation, the airport should ensure that the performance of the “before” situation is well documented. For example, before a cell phone lot is constructed, the airport should perform traffic volume counts on airport circulation roadways in order to document the reduced number of vehicles circling during peak passenger pick-up times. These counts are performed by temporarily installing a tube counter across the roadway, which counts each vehicle that passes a point within a 24-hour period. The typical data collection cost for a 24-hour tube count is \$500–600 per count location.

It will be more difficult to quantify the benefits accrued through greater customer satisfaction. These benefits are generally documented through customer satisfaction surveys or in the reduced number and/or type of complaints that the airport is receiving.

More information on the benefits and costs of ITS implementations can be found on the USDOT’s ITS Joint Program Office website: <http://www.benefitcost.its.dot.gov/its/itsbcllwebpage.nsf/krhomepage>.

Table 20. ITS benefits and performance measures.

ITS Application Area	Benefit	Performance Measures
Advanced Traveler Information	Increase transportation system efficiency and capacity	Traffic flows/volumes Volume-to-capacity ratio Vehicle hours of delay Queue lengths Average vehicle occupancy Use of transit and high-occupancy vehicle (HOV) modes Intermodal transfer time Infrastructure operating costs Vehicle operating costs
	Enhance mobility	Number of trips taken Individual travel time Travel time variability Travel cost Vehicle miles traveled Exposure to crashes and incidents
	Reduce energy consumption and environmental costs	Emissions Fuel consumption Vehicle fuel efficiency
	Improve safety	Number of crashes Number of incidents Number of injuries/fatalities Incident response times Medical/insurance costs
	Increase economic productivity	Travel time savings Operating cost savings Manpower savings Vehicle maintenance/depreciation Information-gathering costs Integration of transportation systems
Cell Phone Lot	Increase transportation system efficiency and capacity	Traffic flows/volumes Volume-to-capacity ratio Vehicle hours of delay Queue lengths Infrastructure operating costs Vehicle operating costs
	Reduce energy consumption and environmental costs	Emissions Fuel consumption
	Improve safety	Number of illegally parked vehicles Congestion at curbside
	Improve customer service	Fuel consumption Customer anxiety/stress
Advanced Parking Management System	Reduce circulation in lots and garages	Traffic flows/volumes Infrastructure operating costs Vehicle operating costs
	Reduce energy consumption and environmental costs	Emissions Fuel consumption
	Increase space occupancy and revenue	Vacancy rate Revenue
	Improve customer service	Average time to find parking spot Customer frustration/stress

Source: Kristof, Lowry, & Rutherford (2005)



CHAPTER 5

Matching Airport Traveler Information to ITS Strategies

Airport Functional Areas and Associated Needs

Traveler information as well as airport operational needs vary based on the different functional areas of the airport. The ground access travel environment for an airport traveler can be broken down into the following functional areas:

- Access roadways,
- Circulation roadways,
- Terminal curbside,
- Parking facilities,
- Cell phone lot,
- Rental car facilities, and
- Transit stations.

Table 21 identifies operational and traveler information needs that may be associated with the different functional areas of the airport. The identified needs are mapped to appropriate ITS information dissemination strategies in the next section of this guidebook.

Matching Airport Needs with ITS Strategies

This section of the guidebook provides information in a tabular format that will allow airport operators to identify appropriate information dissemination methods for each grouping of airport operational and traveler information needs. Tables 22 through 27 match information dissemination methods with traveler information needs and also stratify the general applicability of a particular method by airport size. It should be understood by the airport operator that certain strategies may be applicable to other airport sizes although a checkmark is not placed in the box. For example, a small airport in a heavily congested urban area may have substantially different operational and traveler information needs than a small airport in a sparsely populated area. The applicability of an ITS strategy to a particular airport size is based on general characteristics of the size category.

Although most of the identified information dissemination methods are applicable for implementation on the airport proper, there are some methods that may be supplemented by the efforts of other agencies or third-party developers. When this is the case, a checkmark was placed in the “Non-Airport Provider” column of the table. For example, dynamic message signs may be used by state or municipal transportation agencies for the purpose of displaying travel, congestion, and roadway conditions on the access routes leading to the airport. And, they may similarly be used on airport circulation roadways for the purpose of displaying roadway conditions, construction information, parking information, and others.

Table 21. Airport functional areas and associated needs table.

Airport Functional Area	Operational Needs	Traveler Information Needs
<p>Access Roadways</p> <p><i>(Refer to Table 22 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Efficient and reliable routes to the airport - Roadway signage to airport from all major interstates and roadways - Increase operational efficiency - Viable alternative routes to airport in case of accidents, construction, or congestion - Maximize capacity of existing roadway - Data sharing with local transportation agencies - Reduce energy consumption - Decrease reliance on vehicular travel mode - Increase overall customer satisfaction 	<ul style="list-style-type: none"> - Location of the airport - Turn-by-turn directions to/from the airport - Real-time traffic conditions/delay/travel times - Roadway weather conditions - Alternative route options - Alternative mode options
<p>Circulation Roadways</p> <p><i>(Refer to Table 22 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Reduce driver confusion and circulation - Minimize congestion at major decision points - Maximize capacity of existing roadway - Reduce congestion during peak times - Reduce energy consumption - Increase overall customer satisfaction 	<ul style="list-style-type: none"> - Location of airport destinations (e.g., passenger pick-up, cell phone lot, rental car facilities, etc.) - Terminal/airline location information - Advance warning of decision points - Parking-related information (e.g., products, lot/garage status—open/full, space availability, rates, etc.)
<p>Terminal Curbside</p> <p><i>(Refer to Table 23 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Minimize congestion during peak times - Increase efficiency of through movement - Maximize capacity of existing roadway - Minimize dwell times for vehicles waiting for arriving passengers - Multiple modes sharing the same area - Interaction between pedestrians and vehicles - Increase overall customer satisfaction 	<ul style="list-style-type: none"> - Location of passenger pick-up, drop-off, baggage claim - Terminal/airline information - Flight arrival status
<p>Parking Facilities</p> <p><i>(Refer to Table 24 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Reduce operating costs - Decrease circulation in lot/garage - Decrease underutilization of spaces - Ability to adjust parking rates on temporary basis - Ability to disseminate parking lot status to travelers - Reduce occurrence of illegally parked vehicles - Efficient shuttle service to/from terminal - Reduce customer frustration - Reduce customer delay - Provide adequate payment options and efficient processing - Maximize customer safety - Collect data - Increase overall customer satisfaction 	<ul style="list-style-type: none"> - Parking product options (e.g., short term, long term, economy, satellite, etc.) - Proximity of parking products to terminal - Pricing/payment information - Parking availability by product - Location of available parking spaces - Distance of parking facility to terminal - Location of terminal/shuttle stops - Shuttle schedules - Real-time arrival information for shuttle - Location of parked car (at trip conclusion)
<p>Cell Phone Lot</p> <p><i>(Refer to Table 25 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Decrease circulation on airport roadways - Reduce occurrence of illegally parked vehicles - Reduce customer frustration - Maximize customer safety - Increase overall customer satisfaction 	<ul style="list-style-type: none"> - Location of the cell phone lot - Flight arrival status with terminal/gate information - Baggage claim location/wait time

(continued on next page)

Table 21. (Continued).

Airport Functional Area	Operational Needs	Traveler Information Needs
<p>Rental Car Facilities</p> <p><i>(Refer to Table 26 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Reduce operating costs - Efficient shuttle service to/from terminal - Reduce congestion on airport roads - Increase customer satisfaction 	<ul style="list-style-type: none"> - Location of rental car shuttle or vehicle pick-up/drop-off area - Shuttle schedules - Real-time arrival information for shuttle - Location of vehicle drop-off areas - Time/distance of rental car facility to terminal
<p>Transit Stations</p> <p><i>(Refer to Table 27 for ITS technologies to meet the listed needs)</i></p>	<ul style="list-style-type: none"> - Increase transit usage - Improve schedule reliability - Minimize long walking distances - Minimize difficulty of vertical transitions - Provide adequate parking spaces (if park-and-ride services offered) - Maximize safety and security - Reduce delays at transfer points - Increase customer satisfaction 	<ul style="list-style-type: none"> - Location of transit station/boarding location - Fare/payment information - Transit destinations and departure times - Real-time arrival information - Next stop identification on vehicle - Elevator locations - Park-and-ride lot location and location of parking spaces

Making a Business Case for ITS Projects

Although the FAA business case development procedure is similar in many ways to the systems engineering project development process recommended by the FHWA for the deployment of all ITS projects, it is mentioned in this guidebook because many airport operators may be familiar with it and can compare its procedures with the systems engineering process described in Chapter 6.

The FAA has documented a business case development rationale and procedure, which is available on its website in a document titled *Business Case Analysis Guidelines, January 6, 2010*. This document contains information on developing cost, benefit, risk, schedule, and economic analyses for a proposed project. The business case analysis is used to justify the resources and capital investment necessary to deploy a certain project, which is intended to ensure that the FAA receives the maximum value for the resources expended. The level of analysis required for the business case is based on FAA Acquisition Category (ACAT) levels. The more complex and costly a project is, the more detailed and complex analysis it will require. Essentially, the business case should be developed at a level that is commensurate with the scope of the proposed project and the risks involved.

Most, if not all, deployments of the ITS strategies included in this guidebook would be considered small in scope, falling into ACAT level 5, and it is possible that the business case requirement would be waived by the FAA Acquisition Director. Airports should discuss with their FAA representatives whether the application of the business case analysis is necessary for a particular ITS project.

Although a business case may not necessarily be required for all ITS deployments, a discussion of the business case requirements and a sample business case for an APMS is provided to *(text continued on page 79)*

Table 22. Airport Need Grouping 1—Airport access/circulation roadways.

Airport Operational Need Grouping 1—Airport Access/Circulation Roadways						
<ul style="list-style-type: none"> • Increase operational efficiency/maximize capacity of access and circulation roadways • Reduce energy consumption • Reduce driver anxiety and uncertainty • Increase customer satisfaction 			<ul style="list-style-type: none"> • Reduce occurrence of illegally parked vehicles • Reduce number of vehicles waiting at curbside for arriving passengers • Maximize customer safety 			
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Dynamic message signs	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Location of airport destinations - Parking availability/pricing - Baggage claim status/wait time - Flight arrival status 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Kiosks	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Airport website	<ul style="list-style-type: none"> - Location of the airport - Turn-by-turn directions to/from the airport - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Location of airport destinations - Parking availability/pricing - Terminal/airline location information - Flight/gate status - Security wait time 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Traffic-monitoring websites	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Alternative route options - Alternative mode options 					<input checked="" type="checkbox"/>
Email/text alerts	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Parking availability - Flight/gate status - Security wait time 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Radio/TV	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Alternative route options - Alternative mode options 					<input checked="" type="checkbox"/>
511 systems	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Alternative route options - Alternative mode options - Airport parking availability/pricing 					<input checked="" type="checkbox"/>

Table 23. Airport Need Grouping 2—Terminal curbside.

Airport Need Grouping 2—Terminal Curbside <ul style="list-style-type: none"> Minimize congestion during peak times Increase efficiency of through movement Maximize capacity of existing roadway Minimize dwell times for vehicles waiting for arriving passengers <ul style="list-style-type: none"> Multiple modes sharing the same area Interaction between pedestrians and vehicles Increase overall customer satisfaction 						
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Airport website	<ul style="list-style-type: none"> - Location of passenger pick-up, drop-off baggage claim - Terminal/airline information - Flight/gate status 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Dynamic message signs	<ul style="list-style-type: none"> - Flight arrival status - Baggage claim wait time 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Airport MUFID	<ul style="list-style-type: none"> - Terminal/airline location information - Flight/gate status 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		

Table 24. Airport Need Grouping 3—Parking facilities.

Airport Need Grouping 3—Parking Facilities <ul style="list-style-type: none"> Decrease underutilization of parking spaces Decrease circulation in parking facilities Disseminate parking facility status/rates Reduce energy consumption Reduce driver anxiety, uncertainty, and delay <ul style="list-style-type: none"> Increase customer satisfaction Reduce operating costs Maximize customer safety Collect data 						
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Airport website	<ul style="list-style-type: none"> - Parking product options (e.g., short term, long term, economy, etc.) - Location of parking products - Distance to terminal - Parking product status (e.g., open, full) - Rates (\$/hour, \$/day) 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Dynamic message signs	<ul style="list-style-type: none"> - Parking product status (e.g., open, full) - Parking availability by product - Location of available spaces - Rates (\$/hour, \$/day) - Shuttle stops/real-time shuttle arrival info - Location of parked car - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Airport MUFID	<ul style="list-style-type: none"> - Terminal/airline location information - Flight/gate status 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Kiosks	<ul style="list-style-type: none"> - Location of parked vehicle - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
511 systems	<ul style="list-style-type: none"> - Real-time traffic conditions, delay, travel times, etc. - Roadway weather conditions - Alternative route options - Alternative mode options 					<input checked="" type="checkbox"/>

Table 25. Airport Need Grouping 4—Cell phone lot.

Airport Need Grouping 4—Cell Phone Lot <ul style="list-style-type: none"> Decrease circulation on airport roadways Reduce occurrence of illegally parked vehicles Reduce customer frustration Maximize customer safety Increase overall customer satisfaction 						
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Airport website	<ul style="list-style-type: none"> Location of the cell phone lot Maximum allowable wait time in lot Distance to terminal 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Airport MUFID	<ul style="list-style-type: none"> Flight arrival status with terminal/gate information Baggage claim location/wait time 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>

demonstrate how such an analysis may be developed. Generally speaking, the business case should document all of the relevant facts of a project and include the following information:

- Why is the project needed (issues and opportunities)?
- What is the recommended solution(s)?
- What are the risks, advantages, and disadvantages of the existing and proposed alternatives?
- What will happen if the effort is not undertaken (the “do nothing” scenario)?
- When will the solution be deployed?
- How does the solution address the issues or opportunities (benefits)?
- How much money, people, and time will be needed to deliver the solution and realize the benefits?

Table 26. Airport Need Grouping 5—Rental car facilities.

Airport Need Grouping 5—Rental Car Facilities <ul style="list-style-type: none"> Increase customer satisfaction Reduce driver anxiety, uncertainty, and delay Efficient shuttle service to/from terminal 						
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Airport website	<ul style="list-style-type: none"> Distance to terminal Terminal/airline location information Flight/gate status Terminal/gate info Real-time traffic conditions on regional roadway network Roadway weather conditions 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Dynamic message signs • At rental car facility	<ul style="list-style-type: none"> Wait time for shuttle 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Airport MUFID • At rental car facility • On-board shuttle bus	<ul style="list-style-type: none"> Terminal/airline location information Flight/gate status 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>
Kiosks • At rental car facility	<ul style="list-style-type: none"> Real-time traffic conditions, delay, travel times, etc. Roadway weather conditions 	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>

Table 27. Airport Need Grouping 6—Transit stations.

Airport Need Grouping 6—Transit Stations <ul style="list-style-type: none"> Link the airport with the region it serves Increase transit usage Improve schedule reliability Minimize walking distances Minimize difficulty of vertical transitions <ul style="list-style-type: none"> Provide adequate parking spaces (if park-and-ride services offered) Maximize safety and security Reduce delays at transfer points Increase customer satisfaction 						
Information Dissemination Method	Traveler Information Needs	Applicability by FAA Category Designation				Non-Airport Provider
		Large	Medium	Small	Non-Hub	
Airport website	<ul style="list-style-type: none"> - Real-time traffic conditions on regional roadway network - Roadway weather conditions - Travel mode options - Location of transit station/boarding location - Location of park-and-ride lot and available parking spaces - Distance from transit station to airport terminal - Fare/payment information - Transit destinations and departure times 	☑	☑	☑	☑	
Dynamic message signs <ul style="list-style-type: none"> On-board transit vehicle At transit stations 	<ul style="list-style-type: none"> - Next stop identification on vehicle - Real-time arrival information - Wait time for shuttle (if needed to access airport terminal) 	☑	☑			☑
Airport MUFID <ul style="list-style-type: none"> On-board transit vehicle At transit stations 	<ul style="list-style-type: none"> - Terminal/airline location information - Flight/gate status 	☑	☑			☑
Kiosks	<ul style="list-style-type: none"> - Fare/payment information - Transit destinations and departure times 	☑	☑			☑

Table 28 provides an example of the section headings and type of information that may be included in a business case analysis for the deployment of an APMS at an airport. Note that, depending on airport-specific conditions, more detail may be warranted in some sections than is provided in Table 28.

Table 28. Sample business case for advanced parking management system.

Business Case Section	Sample Analysis
<p>Executive Summary</p> <p><i>Executive-level staff may read only the Executive Summary. It is important to clearly demonstrate the existing problem, the benefits that will be achieved, and the estimated cost for the project.</i></p>	<p>This proposed investment is for an advanced parking management system (APMS) for Sample Airport located in Any City, USA. These systems have been proven to increase the space utilization and efficiency of the parking facility, reduce congestion and vehicle emissions, improve customer satisfaction, and increase revenue.</p> <p>In an increasingly tech-savvy world, technology is and should be available as a tool for the airport traveler’s ground access trip. In addition to deployment of the traditional components of an APMS (e.g., vehicular sensors, dynamic message signs, etc.), functionality to “push” the real-time status and availability of the parking facilities to travelers via email alert, text message, and posts to airport-managed social media feeds will also be implemented. This information will be updated every 10 minutes during off-peak parking periods and every minute during peak periods.</p> <p>The system will initially be implemented in the Long Term Parking Garage (9,500 spaces) which will be accomplished in a 1-year period, with 6 months of design and 6 months of construction implementation. The total cost is estimated to be \$4,705,000.</p>
<p>Problem Statement</p>	<p>Since parking is one of the largest revenue streams for the airport, the ease of parking facility use, availability of parking spaces, efficient space utilization, and ultimately customer satisfaction is of utmost importance.</p> <p>Problems with the current situation include:</p> <ul style="list-style-type: none"> - An increase in passenger volumes has directly translated into an increased demand for the fixed number of garage parking spaces; - Inefficient space utilization; - Varying demand for parking spaces depending on seasonal trends and other variations; - Customers spend an excessive amount of time searching for a space; - Illegally parked vehicles; - Excessive vehicular circulation in garage; - Customer frustration and anxiety; and - Increasing number of off-airport parking options as well as mobile applications that make locating and reserving a space easier for travelers.
<p>Assumptions/ Constraints/ Conditions</p>	<p>The following constraints and/or conditions currently exist at the airport:</p> <ul style="list-style-type: none"> - Fixed number of garage parking spaces; - Limited available land on which to add additional parking capacity; - No communications infrastructure in existing garage, however a communications trunk line runs close to the garage; and - Need to implement NTCIP-compliant devices to ensure interoperability with future ITS devices.

(continued on next page)

Table 28. (Continued).

Business Case Section	Sample Analysis
<p>Current State Description “As Is”</p>	<p>During peak periods of parking demand, travelers may spend an unnecessarily long amount of time searching for a parking space (some customer complaints have indicated they have searched for up to 8 minutes for a space). This leads to circulation and traffic congestion in parking facilities, increased vehicular emissions, increased potential for vehicular and pedestrian conflicts, and customer frustration and anxiety.</p> <p>Travelers are increasingly relying on updates obtained from mobile applications and websites in order to more efficiently use transportation systems (i.e., transit, freeway/surface street, parking, etc.). The dissemination of real-time parking availability information by third-party providers is becoming more prevalent, and if airports do not provide this same level of customer service, then customers may be lost to off-airport parking facilities. If a traveler knows that he can quickly and efficiently access and use an off-airport facility and even reserve a space in advance but is unsure of the availability of on-airport parking, he may choose to use the option with the least number of uncertainties (i.e., the off-airport parking option).</p> <p>Savvy travelers know where to look in advance for the most economical, convenient, and reliable parking facility. The airport will continue to lose customers to off-airport facilities unless they upgrade the services that they provide to travelers.</p>
<p>Future State Description “To Be”</p>	<p>Travelers sign up to receive real-time parking status (i.e., open/full and/or number of available spaces) information in advance on the airport website or they download the mobile application. Parking status updates are pushed to travelers on a routine basis. Alternatively, travelers may access real-time parking status updates on the airport-managed social media feed pre-trip or en route to the airport.</p> <p>Armed with the proper information, travelers are able to decide where to park in advance of arriving on the airport property, thus reducing unnecessary circulation on airport roadways and in parking facilities. At the entrance to the parking facility, travelers read a dynamic message sign, which tells them which levels of the parking facility are open; once they arrive on the appropriate level, a series of dynamic message signs lead them to the aisle with available spaces. The driver then looks down the aisle and sees either a red or a green indication above each parking space. He locates a green indication, which indicates a vacant space, parks the car, and proceeds to the airport terminal for check-in.</p>
<p>Alternatives Analysis/Metrics</p>	<p>The primary alternative is to increase the capacity of the existing garage facility. The typical construction cost per garage parking space ranges from \$14,000 to \$20,000. So, a new garage or expansion that contains 1,000 spaces will cost somewhere between \$14 million and \$20 million.</p> <p>However, simply increasing the number of parking spaces will not solve the problem with vehicles unnecessarily circulating the facilities to find a vacant space. Furthermore, the spaces will not be utilized in a more efficient manner just because there are more of them.</p>
<p>Life Cycle Cost</p> <p><i>Life cycle costing is important since the cost of operations and maintenance will vary through the life of the implementation.</i></p>	<p>The major cost elements in the APMS are:</p> <ul style="list-style-type: none"> - Ultrasonic sensors above each parking space; - Integration and operating software; - Dynamic signage; - Electronic payment systems; and - Electrical and communications service points. <p>Equipment Cost = \$3,325,000.</p> <p>Design and Engineering = \$500,000.</p> <p>Construction Administration Services = \$500,000.</p> <p>Annual O&M Cost = \$380,000.</p>

Table 28. (Continued).

Business Case Section	Sample Analysis
<p>Benefits (quantitative/qualitative)</p> <p><i>Often with traveler information it is difficult to quantify benefits because no supporting historical data or analysis has been performed. Additionally, there may be cases where the measure of the net benefits to the provider may be less than the net benefits to the public.</i></p>	<p>Efficient access to the airport and its facilities is an important service that should be provided to travelers. APMS will reduce landside delay for travelers, meeter/greeters, and others using the airport parking facility.</p> <p>The following benefits were achieved at O.R. Tambo International Airport in South Africa after implementing an APMS:</p> <ul style="list-style-type: none"> - Less time spent searching for a parking space (average time reduced from 8 to 2.5 minutes); - Reduced frustration and anxiety about missing a flight; - Lower vehicular emissions (70 percent reduction); - Improved safety due to fewer vehicles circulating parking facilities, resulting in fewer vehicular-pedestrian conflicts; - Lower operating costs, due to fewer employees monitoring the status of the parking facilities; - Increased space occupancy and associated increase in revenue—return on investment in 2 years due to 5-6 percent increase in revenue; - Fewer illegally parked vehicles; and - Improved user efficiency—fewer user delays.
<p>Schedule</p>	<p>Design—6 months</p> <p>Construction—6 months</p>
<p>Risk and Sensitivity</p>	<p>There are a number of minor risks associated with this proposed project. They include the following:</p> <ul style="list-style-type: none"> - Inability to meet design and construction schedule; - Cost overruns; - Communication failures; - System malfunctions; - Non-standard maintenance risk, including DMS and sensor maintenance; and - Ongoing operations responsibility for transmitting info to customers—may be automated process but staff will be required to oversee and monitor as well as solve customer service-related issues.
<p>Budget Impact</p>	<p>The project requires an investment of \$4,705,000. This will be funded through the existing airport capital budget.</p>



CHAPTER 6

Framework for Implementation

This chapter provides a basic framework for the implementation of ITS strategies and associated technologies by airports for airport ground access travelers. This framework is the link between the planning-level tasks such as the identification of ITS technologies that match the airport and user needs and the design tasks, which include the identification of project-specific details. The following key topics involved in project planning, design, and implementation are addressed in this chapter:

- Systems engineering approach,
- Identification of airport traveler information stakeholders,
- Needs assessment and problem identification,
- Incorporation of ITS into the Airport Master Plan,
- System requirements,
- Funding alternatives,
- Procurement method,
- Project phasing plan,
- Integration planning,
- Configuration management,
- Design plans and specifications, and
- Deployment and integration.

Define Systems Engineering Approach

Although ITS projects come in all sizes and have varying levels of complexity, they all use technology and frequently include the exchange of information, either within a system or between systems. Typically, the goals of ITS project managers include (1) meeting the user's needs and (2) staying within the estimated cost and schedule. The systems engineering process focuses on defining customer needs and required functionality early in the project development cycle and validates that those needs have been met through the design, implementation, testing, and operations and maintenance phases of the project life cycle. Key systems engineering principles are:

1. Reach consensus with stakeholders up front on what the project should accomplish and how success will be measured.
2. Engage stakeholders in a systematic way through all stages of the project.
3. Clearly define the problem before implementing the solution.
4. Delay technology choices due to the rapid pace of technological innovation.
5. Manage the complexity of large systems by breaking them down into manageable subsystems.
6. Manage changes so that every change and its relationship to other items is tracked (this is commonly referred to as traceability).

Many studies performed by the International Council of Systems Engineering have demonstrated that the use of the systems engineering process for project development helps ITS project managers reduce the risk of schedule and cost overruns and increase the likelihood that the implemented project will meet the user's needs. Furthermore, the following associated benefits have been attributed to the use of systems engineering (FHWA and Caltrans, 2009):

- Improved stakeholder participation,
- More adaptable, resilient systems,
- Verified functionality and fewer system defects,
- Higher level of reuse from one project to the next, and
- Better project documentation.

The USDOT recognized the potential benefit of the systems engineering approach for ITS projects and thus requires a systems engineering analysis be performed for all ITS projects that use funds from the Highway Trust Fund, including the Mass Transit Account. This requirement was promulgated by the FHWA Federal Regulation 23 CFR 940.11. The *Systems Engineering Guidebook for ITS* (<http://www.fhwa.dot.gov/cadiv/segb/index.htm>) is an online tool that ITS practitioners can use to access information that will aid in applying systems engineering processes intelligently to ITS projects. The guidebook was co-sponsored by the FHWA and the California Department of Transportation (Caltrans).

Identify Airport Traveler Information Stakeholders

Stakeholders are those agencies or organizations who will own, operate, maintain, use, interface with, benefit from, or otherwise be affected by the project and/or implemented system. Although stakeholders will vary from airport to airport and based on the project to be implemented, Table 29 provides a list of generic ITS and airport stakeholders and should serve as a starting point for the identification of specific stakeholders relevant to an airport's ground access transportation system.

Stakeholders are typically identified and included in the project development process through outreach activities that may include meetings, workshops, interviews, and surveys. Coordination with regional transportation agencies and information service providers is important for successful ITS implementations because greater benefits can be achieved from a collaborative effort and information/data sharing.

According to the *Systems Engineering Guidebook for ITS*, the following questions should be used as a checklist to ensure that the appropriate stakeholders have been represented and that ultimately the prioritized needs are clearly documented and agreed upon (FHWA and Caltrans, 2009).

- Have all relevant stakeholders been represented?
- Have all appropriate resources been utilized to elicit needs?
- Have all collected needs and conclusions been reviewed with the stakeholders?
- Is there an objective and justifiable approach for prioritizing needs?
- Are conclusions and rationale well documented?
- Have all stakeholders agreed that their needs are clearly and fairly represented?

The larger the number of agencies or airport departments involved, the more risk there is for conflicting needs and incompatible operations. Consequently, the level of effort expended on needs assessment and prioritization typically grows as the number of agencies/departments involved increases. On the other hand, a single agency/department project based on well-defined and limited needs may not need extensive prioritizing of user needs.

Table 29. Potential airport stakeholders for an ITS project.

Stakeholder Group	Description
Passengers (Arriving, Departing)	Airport passengers, both arriving and departing, have a variety of characteristics based on trip purpose, residential status, and mode choice that influence their need for reliable and timely ground access information.
Meeters and Greeters	Meeters and greeters are typically individuals who go to the airport for the purpose of assisting arriving or departing passengers with parking, check-in, baggage handling, or other requested services.
Airport Employees	Airport employees are users of the airport ground access system and support a myriad of services inside the airport. Some examples include airport operations and management, sky caps, baggage handlers, ticket agents, concession workers, security agents, pilots, and flight attendants, among others.
Airport Management and Staff	Airport management typically comprises the following major departments: operations (airside, landside, terminal), security, emergency services, IT, planning and design, maintenance, marketing, etc.
Investors and Bondholders	Airport investors or bondholders have an interest in the financial stability of the airport. Airport revenue bonds are used to construct or expand an airport. Typically, the bonds are secured by airport revenue generated from landing fees, fuel fees, and lease payments.
Local, Regional, and Federal Government	Surface transportation agencies such as the Federal Highway Administration, Federal Transit Administration, state department of transportation, metropolitan planning organization, and regional planning commission all play a role in ensuring that the access roadway network meets the needs of airport travelers.
Public Transportation Service Providers	Public transportation service providers range from municipal or regional transit agencies to demand-response operators that provide curb-to-curb transportation service to a variety of destinations, including airports. Transit agencies are generally independently managed non-profit public utilities that receive both federal and state funding.
Private Transportation Service Providers	Shared-ride vans, taxis, and limousines are privately owned, for-profit entities and all use the airport ground access transportation system.
Information Service Providers	Information service providers typically collect transportation data from a variety of sources, integrate the data, and disseminate the data through many types of distribution channels (i.e., internet, personal data assistants, kiosks, radio, and television).
Parking Operators	Airport parking operators may be either publicly or privately owned operations. Both on-airport and off-airport parking operators typically offer free shuttle service to the airport if the location of the parking facility is not within walking distance of the terminal.
Rental Car Operators	Rental car agencies typically have operations on airport property. If not located at the terminal in a consolidated facility, rental car operators offer shuttle service to and from the terminal.
Public Safety Agencies	Public safety agencies receive emergency calls and respond to incidents within their jurisdictional area.
Emergency Management Agencies	Emergency management agencies typically promote emergency preparedness and assist with the coordination of disaster response and recovery operations, during and after a disaster or major emergency.
Local Television/Radio/Media	Local media publicly broadcast information pertaining to travel conditions, incidents, special events, and other transportation-related news services to the traveling public.

Assess Needs/Identify Problems

To ensure that the deployed system will meet the needs of the project's stakeholders, a needs assessment should be performed early on in the project development process and be re-visited throughout. The goal of involving all key stakeholders early on in the project planning is to elicit needs as well as constraints from a diverse range of sources. For example, a constraint may be that the type of DMS operating software currently in use can only control a certain model of DMS or a certain number of signs. It would be undesirable to run multiple operating software packages for control of a group of DMS that essentially serve the same purpose (i.e., provide parking status or overflow condition information). This constraint should be identified up front so that a plan can be developed for upgrading all signs to run off the same operating software. All airport departments with operational capabilities for dynamic signage should be involved in future projects to ensure that the additional signs are compatible with the existing sign control software and meet the needs of all users.

During the needs assessment process is the time to document agreement on the direction of the project in order to prevent future contention among stakeholder groups (FHWA and Caltrans, 2009). Key questions to ask during the needs assessment phase:

- What is wrong with the current situation?
- What needs does the ITS project fill?
- What existing infrastructure can be leveraged in the ITS project?
- Have we clearly articulated the need?
- Do all ITS project stakeholders have a common understanding of its goals and objectives?

The needs and problems identified with the current situation should be thoroughly documented in the business case analysis. Refer to Table 28 for a sample business case analysis for an advanced parking management system.

Incorporate ITS into the Airport Master Plan

The long-range vision for ITS deployment for an airport should guide the investment in and implementation of ITS strategies over a multi-year planning horizon and should be based on user needs and operator goals for the system. The development of a long-range vision is important because it defines the purpose and expected outcomes for implementing ITS strategies and ensures continuity in the event of staff or leadership changes within the organization.

In developing a long-range vision of ITS to incorporate into the Airport Master Plan, airports should consider implementing ITS technologies and strategies that will:

- Align with airport sustainability initiatives for emissions reduction,
- Improve management and operations of the ground access system,
- Improve efficiency of airport personnel and equipment,
- Improve airport traveler's efficiency in accessing the airport,
- Enhance airport traveler safety,
- Be easily maintained and expanded,
- Be interoperable with other ITS projects in the city/region/state,
- Ensure a high level of customer service related to an airport traveler's ground access needs, and
- Ensure that airport traveler's access to relevant ground access information remains timely and reliable for all modes of travel.

Develop System Requirements

System requirements must define the functions, performance, and environment of the system under development to a level that can then be built by a contractor.

In addition to assisting in the identification and engagement of stakeholders, the airport project manager should also be involved in validating the requirements to ensure that the correct requirements are developed. The airport “owner” of the ITS should ensure that the following tasks are performed as part of the requirements development process:

- Identify the specific functions that the ITS project will perform,
- Define each function in detail,
- Identify all system interfaces,
- Define all system interfaces,
- Assess ADA and accessibility requirements,
- Define the required system performance in quantifiable terms,
- Review all requirements with stakeholders,
- Consider system availability requirements,
- Assess reliability and maintainability requirements,
- Identify which requirements must be validated with the customer(s), and
- Consider the security needs of the system.

Identify Funding Alternatives

There are several federal programs that airports may consider when identifying a funding source for an ITS project. In addition to the sources described in this section, others may exist that should be evaluated, such as non-aviation agencies and programs, as well as private funding and partnerships. Consideration should certainly not be limited to the sources listed in this guidebook.

Airport Improvement Program

The current Airport Improvement Program (AIP) was originally developed shortly after the end of World War II and known as the Federal-Aid Airport Program, authorized by the Federal Airport Act of 1946. The goal of the program was to ensure that a system of airports was developed that would meet the nation’s needs. With the passage of the Airport and Airway Development Act of 1970, grants for airport planning and development were issued from two separate programs and funded through the Airport and Airway Trust Fund, which expired in September of 1981. The Airport and Airway Improvement Act of 1982 authorized the current program, which has most recently been amended with the passage of the Century of Aviation Reauthorization Act (Vision 100), which draws funds from the Airport and Airway Trust Fund (FAA, 2010a).

The eligibility of airport ground access projects to be funded through the AIP often depends on the specifics of the project but guidance can be found in FAA Order 5100.38C, AIP Handbook, Paragraph 620.a. Additional guidance is included in the Federal Register Notice of February 10, 2004. It should be noted that longstanding FAA guidance on funding eligibility prohibits AIP (or Passenger Facility Charge) funding of ground access projects that are not located on airport property or on right-of-way owned or controlled by the airport or that are intended for the use of both airport and non-airport passengers, regardless of the benefit to the airport (FAA, 2004).

Passenger Facility Charge Program

The Passenger Facility Charge (PFC) Program allows the collection of PFC fees up to \$4.50 for every enplaned passenger at commercial airports controlled by public agencies. Airports use these fees to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition (FAA, 2010c).

Guidance included in the Federal Register Notice of February 10, 2004, on page 6369 states that typically the following objectives must be met by an airport ground access transportation project:

Typically, public agencies propose that an airport ground access transportation project meets the objective of preservation or enhancement of capacity of the national air transportation system, in that airport passengers or air cargo customers may be afforded faster and/or more reliable access times to airports, thus reducing total trip times. The FAA uses reduced trip time as a rough gauge of capacity benefits as it means that the national air transportation system can accommodate the same number of people or amount of air cargo with less average delay, or alternatively, a larger number of people or a larger amount of air cargo at the same level of average delay (FAA, 2004).

ITS projects have been proven to increase capacity without adding lanes to the transportation system. Although there is no evidence that airports have used this justification for installing ITS applications, it seems logical that one could make this argument supported by analysis of benefits achieved by similar ITS projects.

Airport Revenue

For airports that have received federal assistance, revenues generated by the airport may be used only for the capital or operating costs of (1) the airport; (2) the local airport system; or (3) other local facilities owned or operated by the airport owner or operator, and directly and substantially related to the air transportation of passengers or property (49 USC §47107(b), §47133).

Guidance for the use of airport revenues on airport ground access transportation projects is provided in “Policies and Procedures Concerning the Use of Airport Revenue,” Section V.A.9 (64 FR, 7718-7719, February 16, 1999). The FAA’s final policy on use of airport revenue, issued in February 1999, affirms that airport revenue may be used for capital and operating costs of transit system and ground access facilities owned or operated by the airport and directly and substantially related to the air transportation of passengers or property.

Determine Procurement Method

NCHRP Report 560: Guide to Contracting ITS Projects provides guidance on the selection of appropriate contracting options for the design and implementation of an ITS project. Selecting the appropriate option depends on many variables, including the following:

- Type and complexity of the required products, systems, and services;
- Interdependence of project components and subsystems;
- Inclusion of ITS components with roadway construction projects;
- Use of varied and rapidly changing advanced technologies;
- Need to pre-qualify consultants and/or contractors;
- Constrained deployment schedule;
- Magnitude of construction impacts on road users; and
- Risk management factors associated with capital investments.

ITS procurements often entail sophisticated combinations of hardware and software that are challenging to specify because they are tailored to the unique requirements of the procuring

agency and use components embodying technology that may have advanced substantially in the time between the development of the project concept and the project implementation. Because of these complexities and uncertainties, the low-bid contracting process that transportation agencies traditionally use to purchase capital improvements often is not the best approach for ITS procurements (Marshall & Tarnoff, 2006). If low bid is required due to the use of federal funds, consideration should be given to prequalifying the contractors prior to the low-bid process.

The complexity of a project can have a significant impact on the selection of a procurement strategy. ITS projects can range in complexity from those that are relatively straightforward—as in adding field devices (e.g., CCTV, DMS, etc.) to an existing traffic management system—to those that are complex—such as the implementation of a new transportation management system including custom software applications. The procurement strategy for these two undertakings would be significantly different. Additionally, operations and maintenance planning need to be considered in many ITS projects prior to executing the final procurement plan. The four components of the procurement process—work distribution, method of award, form of the contract, and the contract type—are illustrated in Figure 28.

Experience has shown that the ITS procurement method can have substantial influence on the ultimate success of the ITS installation. The procurement method determines how responsibilities are distributed and decisions are made, the qualifications of the contractor, the systems engineering process, and the controls available to the contracting agency. The procurement method, ideally selected to suit the characteristics of the procuring agency as well as those of the project, can make or break a project.

The following guidelines may be helpful in selecting a procurement package based on project-specific characteristics (Marshall & Tarnoff, 2006):

- Systems manager is preferred to design-build when a significant amount of new software development is required;
- Design-build is preferred over systems manager only for major projects when significant amounts of field construction are involved and there is a desire to reduce implementation delays associated with having to administer multiple procurement contracts;
- If a project includes both new software and field construction, consider splitting it into multiple contracts;
- Low-bid contracting should be used only in the unlikely event that it is required by agency policy or if projects are limited to field construction and supply off-the-shelf equipment; and
- Commodity procurement is applicable if an existing ITS package is available that does not require any modification to meet agency’s requirements.

ACRP Report 21: A Guidebook for Selecting Airport Capital Project Delivery Methods discusses the pertinent factors and issues to consider when an airport is selecting a project delivery method

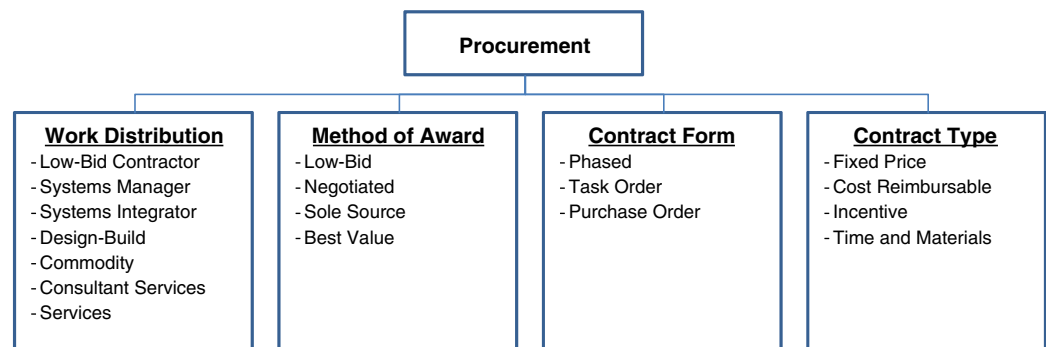


Figure 28. Four components of procurement.

Table 30. Procurement types for ITS projects.

Procurement Type	Method of Award	Contract Form	Contract Type	Comments
Commodity Supplier	Low-bid selection of pre-qualified packages	Single phase or purchase order	Fixed price	Used for commercial-off-the-shelf (COTS) procurements
Low-Bid Contractor with Design Consultant	Low bid for contractor	Phased or task order	Fixed price for contractor Incentives optional	Consultant performs 100% of design. May provide additional services during implementation Use should be restricted to well-defined systems Contractors should be pre-qualified prior to bidding
Systems Manager	Quality-based selection (negotiated procurement)	Phased or task order	Fixed price, cost plus or time & materials Incentives optional	Additional contracting burden placed on agency Field equipment procured by agency using low-bid process
Design-Build Contractor with Design Consultant	Best-value selection (based on consideration of price and quality)	Phased	Usually fixed price, cost plus or time & materials Incentives optional	Consultant provides 30% design Most applicable to systems with time constraints and requirement for continuity between the design and implementation
Consultant	Negotiated	Phased or task order	Fixed price, cost plus or time & materials Incentives optional	Used for system design and many other consultant services
Outsourcing Agency Activity	Low bid may be based on rates	Usually single phase	Fixed price or time & materials Incentives optional	Typical activities include maintenance, operations, signal timing, etc.
Outsourcing Agency Function	Best value or low bid	Single phase	Fixed price, cost plus or time & material contracts Incentives optional	Typical functions include traveler information and toll collection. May be public-private partnership Difficult to define measures and outcomes

Source: Marshall & Tarnoff (2006)

and should be referred to in combination with *NCHRP Report 560* for more detailed information. Generally speaking, the factors that affect the selection of the appropriate project delivery method include the wide range in size, scope, and cost of airport projects; security issues; the need for the airport to remain in operation during construction; the complexity of airport systems; stakeholders; and types of funding.

Table 30 lists options for procurement for ITS projects and includes comments as to when a particular procurement type may be the most appropriate.

Develop Project Phasing Plan

ITS projects by their very nature are meant to be integrated because of their complex mix of technology components; therefore, a phased implementation approach is typical. Project phasing should be guided by the criticality of the needs that will be met, the level of benefits to be

achieved through project implementation, available resources and funding, as well as necessary institutional and jurisdictional support. Furthermore, the scope of deployment of any phase of a project may be limited based on a lack of any one of these criteria. The following list presents the pros and cons of a phased implementation approach:

- **Pros**
 - Makes early positive impact on system to benefit users,
 - Aids in public acceptance of the new system by demonstrating benefits over remaining existing systems,
 - Provides lessons learned for future phases,
 - More manageable from a financial and personnel perspective, and
 - Allows for customer feedback before future phases are deployed.
- **Cons**
 - Limitations of the existing system,
 - Inconsistency in services provided between new and existing systems,
 - Rapid changes in technology,
 - Training must be provided multiple times,
 - Duration of design and construction process is longer with multiple phases, and
 - Implementation phasing may be unclear to users.

To develop a phased implementation approach, a planning horizon consisting of a range of time is used. The planning horizon can consist of any range of time but is likely to be 10 to 20 years, which is then segmented into multiple implementation phases. The controlling factor when determining project phasing is typically funding. For example, projects that are implemented in the first phase are those that have the least risk, will provide tangible benefits, and already have funding secured.

A project phasing plan should answer the following questions for each phase:

- What will be deployed?
- Where will it be deployed?
- What operational capabilities will result?
- What is the estimated deployment cost and schedule?
- What agreements are needed?
- Is funding available for design, construction, and operations and maintenance?

Plan Integration

This section describes the integration planning process. Integration is the process of combining hardware and software components and systems into one complete and functioning system. Systems integration is essential to the deployment success of ITS projects due to the large number of disparate elements with numerous data flows, communications protocols, and methods of physical connectivity.

Integration planning should be initiated when the project is first defined and is driven by the system requirements, system interfaces, and any external interfaces to legacy systems with the end product being an integration plan. Airports will have multiple legacy systems administered by various agencies that must be evaluated and prioritized for integration into the ITS. “Legacy system” is a term used to describe an existing system that continues to function for the user’s needs, even though it is outdated and newer technology or more efficient methods are now available. Information from these legacy systems will most likely come in different electronic formats, and integration into the system will require some data manipulation and fusion. It is important to identify the source, owner, protocol, interface, size, bandwidth, version, and anything else available.

Custom software may be developed to ease the data integration effort, but it is expensive and time consuming to specify, develop, and monitor and will remain proprietary for the life of the system.

Institutional integration involves cooperation and coordination between various agencies and jurisdictions to achieve seamless operations and interoperability. Information sharing and exchanges between systems require knowledge of the transmission protocol and data formats to ensure compatibility. Coordinating field device operations owned by different agencies requires defined procedures for submitting data requests and rules governing when such requests can be honored. While all interfaces involve good working relationships between agencies for data compatibility, agreements for procedure, operation, maintenance, and training may also be critical elements to optimizing the benefits of the architecture. Table 31 contains planning considerations related to ITS integration.

Communications infrastructure makes data sharing, agency coordination, and system integration possible. This type of infrastructure includes telephone networks (landline and mobile), cable television networks, internet (including high-speed data cables, routers, servers, and software used for these products), communication satellites, undersea cables, networks used for internal

Table 31. ITS integration planning considerations.

ITS Integration Planning Considerations	
Identify Existing Hardware	<ul style="list-style-type: none"> - Who owns the hardware? - What is the current use? - Can it meet a functional requirement? - What are its constraints? - How does it communicate? - Where is it located? - Does it need to be integrated with the new system?
Identify Existing Software	<ul style="list-style-type: none"> - Who owns the software? - What is the current use? - Can it meet a functional requirement? - What are its constraints? - How does it communicate? - Does it need to be integrated with the new system?
Identify New Hardware	<ul style="list-style-type: none"> - Is the hardware replacement necessary? - Has the old hardware reached its end of life cycle? - Is the old hardware still supportable? - Is the new hardware backwards compatible with your system? - Do all units need to be replaced at the same time? - Is a maintenance capability available? - Will it add functionality? - Will it require new or additional software? - Is training available? - Can replacement be funded?
Identify New Software	<ul style="list-style-type: none"> - Is the software replacement necessary? - Has the old software reached its end of life cycle? - Is the old software still supportable? - Is the new software backwards compatible with your system? - Do all units need to be replaced at the same time? - Is support capability available? - Will it add functionality? - Will it require new or additional hardware? - Is training available? - Can replacement be funded?

communication and monitoring, pneumatic tube mail distribution networks, GPS, and air traffic control centers.

Safety and Security of the System

This section describes the ongoing safety and security issues that airports must manage related to the integration and sharing of information between technology systems. The security of the system relates to the safety of the system in that any attempt to deny service, manipulate data, masquerade and gain access, or replay or repudiate actions or messages could result in harm to the system or users of the system.

The physical security of the field devices located along airport roadways, in parking facilities, and at any other location needs to be addressed during the design of the system. Most traditional ITS have been deployed in less sensitive and tightly controlled areas such as freeways and urban roadways. Communications cables and wireless signals will pass from relatively uncontrolled areas to highly secure areas, presenting unique challenges in both design and maintenance. Decisions regarding equipment placement should consider security and ease of access for maintenance personnel. If the system is planned to be maintained by a permanent airport staff, then the location of equipment in controlled access areas may not be a problem. However, if contract maintenance is used, the need to escort and monitor maintenance personnel into controlled areas could be costly and cause delayed recovery of failed systems.

The constant state of construction and deployment of upgrades at most airports must be considered in the design and maintenance of airport ITS. Communications systems must remain operable during construction. Designing a system with redundant communications paths may be one solution to limit the potential loss of communications to field elements caused by construction. Temporary or permanent wireless systems should be considered for additional restoration.

Monitoring systems that include intrusion alarms, video monitoring, and access control should be part of any system deployed. Existing security systems should be evaluated to determine if they can accommodate the additional elements that are part of the ITS. Close coordination will be essential during the design phase to eliminate conflicts and disputes between airport departments. While the overall objective of any ITS is to provide and share information, airport systems are highly vulnerable to malicious attack. Basic network protection is necessary in any system and will include firewalls, passwords, and routing. The airport electronic security must go further and include encryption of electronic messages sent over wireless and wired communications channels. The level of security should match the perceived threat. Command and control software that automates notification of alarm system activity among various elements of the system should be a high priority during the identification of the functional requirements. This should occur in both the systems engineering and design process.

Plan Configuration Management

This section describes the philosophy behind and the importance of configuration management in any ITS. Simply stated, configuration management is the process by which changes, repairs, and upgrades to the system are handled and documented. It is extremely important that the system/component documentation is complete to the extent that the system's owner can use another qualified development team to upgrade and maintain the system independent of the initial development team.

The purpose of configuration management is to keep the physical implementation of a system consistent with the design intent. Configuration management ensures that project documentation

accurately describes and controls the functional and physical characteristics of the end product being developed, thereby establishing system integrity. It is extremely important that the system/component documentation is complete to the extent that the system's owner can use another qualified team to upgrade and maintain the system independent of the initial development team.

The path to good configuration management starts with a configuration management plan, which establishes guidelines and a formal procedure for submitting configuration changes for approval. Some agencies appoint a single person who approves or rejects all proposed changes to the system. It is important to understand that configuration management is a process that is active throughout the entire life of the project, is scalable, and has many parts and pieces. Hardware, software, documentation, cable routing, IP address schemes, switch and router programming, serial addresses, and more need to be managed in detail.

The equipment used in technology projects is constantly changing. During and after the initial deployment of a system, it is necessary to keep an up-to-date and accurate inventory of all devices. This includes hardware and firmware versions, serial numbers, model numbers, and documentation. It is not unusual for a manufacturer to make firmware or software changes that affect the operation of equipment or how it interfaces with central software systems. For example, video encoders at two CCTV locations can look the same and have the same model numbers but be significantly different due to firmware changes. The central software may need to know the firmware of the encoder at the CCTV location to be able to communicate and process the video. If a maintenance technician replaces an encoder with different firmware, then the system will not work, even though the device the technician installed does not have operational issues.

Managing changes to system configurations is essential to minimize cost and schedule overruns on ITS projects. The following checklist, excerpted from *A Guide to Configuration Management for Intelligent Transportation Systems* (Mitretek Systems, 2002b), can be used as a guide in developing a configuration management plan:

- Is there a documented configuration management process for this project?
- Is the configuration management process integrated with the project plan and an integral part of the culture?
- What classes of information does your project control?
- What items are under control?
- How is the decision to control them made?
- Are all versions controlled?
- Are configuration control tools used for status accounting and configuration identification tracking?
- Are periodic reviews and audits in place to assess the effectiveness of the configuration management process?
- Are all pieces of information shared by two or more organizations placed under configuration management?
- Who on the project is responsible for change control of baseline and non-baseline items?
- Do you have a configuration control board? If so, who are its members?
- Do you have a process for controlling non-product software that is shared?
- How does the developer make releases to the acquirer?
- How does the acquirer take delivery of items from the developer?

Develop Design Plans and Specifications

For systems that require the implementation of equipment in the field, the development of engineering design plans and specifications is a critical final step in ensuring that the airport receives the system that it desires and that meets its needs. In general, the design plans should

show the location of and type of equipment to be installed, its interface with existing systems, construction notes, and an estimate of the quantity and type of material to be installed. The technical specifications are developed to further define the materials and equipment to be installed.

Although an airport will have a Master Spec containing various commonly used materials specifications, it is likely that any project involving ITS applications and technologies will require a custom-developed set of technical specifications. As with any materials specification, the ITS equipment spec should include, but not be limited to, the following sections:

- Description,
- Materials,
- Manufacturer qualifications,
- Construction requirements,
- Acceptance testing,
- Warranty,
- Maintenance and support (if applicable),
- Method of measurement, and
- Basis of payment.

In addition to design plans and specifications, projects may require systems integration services that include physical, logical, and operational network infrastructure design. These services may involve network integration plans for multiple software packages, network design and specification development, implementation plans to address the impact of the new system on existing operations, and documentation on how the system will be tested prior to being put into service.

Deploy and Integrate System

Perform Integration Activities

Integration is an iterative process, which typically includes taking hardware and software components and forming them into complete subsystem elements, and then combining the subsystem elements into larger combined subsystems, and ultimately combining all of the subsystems into a final system. Typically for ITS, this process involves communications system integration, field element integration, operations center integration, and subsequently full system integration, as illustrated in Figure 29.

The following activities should be performed as part of the integration process:

- Provide necessary training for personnel to execute the integration activities;
- Provide appropriate documentation on each subsystem to be integrated;
- Place components to be integrated under configuration control;
- Prepare audit or review reports;

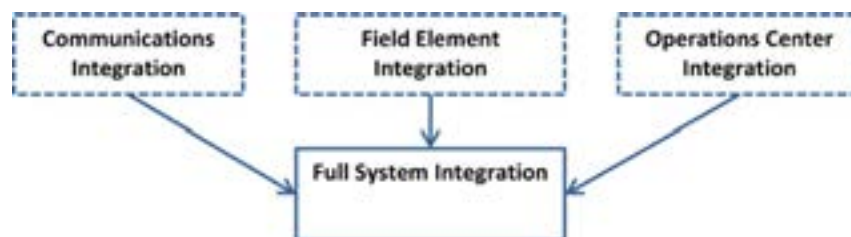


Figure 29. System integration.

- Establish integration testing procedures, which should include the following, at a minimum:
 - Verify data integrity,
 - Verify diagnostic messages,
 - Introduce potential failures and threats,
 - Evaluate performance under degraded conditions,
 - Verify diagnostic messages, and
 - Perform normal transaction tests;
- Conduct subsystem integration testing; and
- Integrate subsystems into final system.

Verify System

This section describes the system verification process, which is used to accept the system from the development/deployment team. This process may be performed by the airport or by a consultant hired to monitor and manage the installation under a Construction Engineering and Inspection contract. Having an engineering team experienced with ITS deployments and integration will free airport staff from this requirement and ensure the process is executed appropriately.

Verification ensures that the system meets its functional requirements and matches the design and technical specifications. In this step, the system components are assembled into a working system to ensure that it fulfills all of its requirements. Assembling a puzzle is a nice, simple analogy for this step, but the challenge in an ITS project “puzzle” is that not all of the pieces are available at the same time; some will not fit together particularly well at first; and there will be pressure to change some of the pieces after they have already been assembled. The systems engineering approach provides a systematic process for integration and verification that addresses the challenges and complexity of assembling ITS.

Integration and verification are iterative processes in which the software and hardware components that make up the system are progressively combined into subsystems and verified against the requirements. This process continues until the entire system is integrated and verified against all of its requirements.

Validate System

This section describes the validation process, which ensures that the operational system meets the users’ needs and its intended purpose. For example, in the validation step, the owner may collect data for the purpose of a “before and after” study (if this is the case, data would also need to be collected prior to deployment). In an airport ITS deployment, the validation process tends to be more complex than a typical roadway system. This is the natural result of having multiple agencies relying on the effective performance of any system. For example, a parking system must meet the needs of the inbound and outbound traveler, shuttle services, airlines, maintenance units, fee collection units, and possibly others.

In systems engineering a distinction is made between verification and validation. Verification confirms that a product meets its specified requirements. Validation confirms that the product fulfills its intended use. The majority of system verification can be performed before the system is deployed. Validation really cannot be completed until the system is in its operational environment and is being used by the real users. For example, validation of a parking management system cannot be fully completed until the new system is in place and it can be determined how effectively it controls circulation and saves users time in locating a vacant parking space.

The last thing that an owner wants to discover is that the wrong system was built just as it is becoming operational. This is why the systems engineering approach seeks to validate the products that lead up to the final operational system to maximize the chances of a successful system validation at the end of the project. Since validation activities are performed throughout the project development process, there should be few surprises during the final system validation.

Provide Public Outreach/Education

The following outline provides ideas for various information sharing/education activities for the purpose of making the public aware of new ITS and/or improved functionality of an existing system. In order to maximize the benefits achieved, the public needs to understand how the system works and how to use it. The airport may do any combination of public outreach activities, including the following:

- Hold a press conference (likely reserved for implementation of larger scale projects)
 - Invite representatives from local print, radio, and television outlets;
- Develop a media kit (distribute media kit to all local print, radio and television outlets)
 - Press release,
 - Project fact sheet,
 - FAQs,
 - High-resolution images, and
 - Contact information for questions/follow-up;
- Add content to the airport website (create dedicated section or add to appropriate existing section of website)
 - Project fact sheet,
 - FAQs,
 - Podcasts—utilize video to demonstrate new systems/processes,
 - Image gallery, and
 - Contact information;
- Utilize existing digital network/distribute information via digital channels such as:
 - Email contact database,
 - Airport’s dedicated Facebook page,
 - Airport’s dedicated Twitter feed, and
 - Airport’s YouTube channel.

Operations and Maintenance Considerations

An often overlooked or underestimated item in planning for technology-based projects is the cost to operate and maintain the system after it is installed. Many airports likely have in-house IT, communications, and maintenance staff with the capability to maintain the new components installed as part of the ITS; however, resources need to be allocated appropriately so that existing staff can accommodate the new system in addition to their existing workload. If it is determined that the existing staff mix and technical skills represented is not adequate to handle the additional components installed, then a plan needs to be developed to acquire the necessary resources or identify adequate budget for contract support and maintenance services. The following should be considered when planning for the operations and maintenance of ITS:

- Identify funding and policies supporting ongoing operations and maintenance;
- Identify the aspects of the system needing operations or maintenance support;
- Identify the manuals (user, administrator, and maintenance), configuration records, and procedures that are to be used in operation and maintenance;
- Identify the personnel who will be responsible for operations and maintenance;

- Identify initial and ongoing personnel training procedures, special skills, tools, and other resources;
- Identify operations- and maintenance-related data to be collected and how it is to be processed and reported; and
- Identify methods to be used to monitor the effectiveness of operations and maintenance.

The level of operations and maintenance support the airport administration will need to provide will vary based on the maintenance method selected, the size of the system, and the normal operating hours of the airport. Compared to more traditional infrastructure improvement such as roadway projects, ITS improvements typically incur a greater proportion of their costs as continuing management, maintenance, and operations costs rather than up-front capital costs. ITS equipment also typically has a shorter anticipated useful life than many traditional infrastructure improvements, and it must be replaced as it reaches obsolescence. Further complicating the operations and maintenance of ITS is the sharing of ITS equipment and resources across different departments and possibly multiple agencies.

The airport administration should assess its capabilities and current staffing to arrive at a maintenance and operations concept that fits its situation. This assessment should be initiated during the project development process and finalized during system validation. Personnel resources needed for the operation of the system will depend on the design and level of automation included in the system. Information such as flight arrival and departure times are typically fully automated and received from other sources, but monitoring an advanced parking management system and cell phone lot will require active participation by a staff of operators.

Following are some examples of how state and municipal transportation agencies have handled operations and maintenance responsibilities for their ITS:

- The Tennessee Department of Transportation uses contract maintenance for its systems with a separate contracted consultant hired to monitor the maintenance contractor. The workload to administer the two contracts utilized existing staff.
- The Mississippi Department of Transportation (MDOT) established an in-house maintenance capability with some positions filled by contract labor and others by MDOT staff. This method required the purchase and maintenance of additional resources such as vehicles, test equipment, tools, safety gear, etc.
- Some municipalities have added the ITS maintenance duties to existing traffic signal maintenance groups. Typically, traffic signal maintenance shops have some of the equipment needed to support the operations and maintenance effort of ITS, such as bucket trucks and basic communications test equipment. Airports will also have support and test equipment in established maintenance functions.

The ITS components that require routine and ongoing maintenance fall into one of three categories: central control, field elements, and communications. Table 32 contains a list of components and should be used as a planning guide for determining the level of additional maintenance expertise that will be needed for ITS. The FHWA maintains a database with the projected average life expectancy for many types of ITS devices, which can be referred to for more information.

Performance Measures

Whether the maintenance activities are conducted by in-house personnel or contracted out, there are several measures of performance that can be used to determine the effectiveness of ITS maintenance. These performance measures include:

- **Mean time between failures**—the average time between device failures, usually expressed in hours;
- **Mean time to repair**—the average time to repair (or replace) a device, typically this includes the response time, expressed in hours;

Table 32. ITS maintenance components.

Maintenance Category	Sample ITS Components
Central Control	<ul style="list-style-type: none"> - Power supply, generators, batteries, and related equipment - Video displays - Internal communication networks - Computer hardware - Computer software - Control systems - Other COTS products - Media connections - Website
Field Elements	<ul style="list-style-type: none"> - Dynamic message signs - CCTV cameras - Vehicle detectors - Access control gates
Communications	<ul style="list-style-type: none"> - Fiber optic cable - Wireless infrastructure - Copper twisted pair - Coaxial cable - Ethernet switches - Terminal servers - Modems - Test equipment (optical time domain reflectometer, power meters)

- **System availability**—the time that the system provides its designed functionality, expressed in hours. Typically, this excludes scheduled downtime due to maintenance or system administration activities; and
- **System reliability**—similar to system availability but expressed as the probability that the system will be available to perform as intended.

Maintenance Staffing

There are no established or accepted guidelines that agencies can utilize to specifically determine maintenance staffing levels by classification for the number and type of ITS devices that it owns and operates. The national examples indicate that, in general, one maintenance staff person can typically maintain anywhere from 100 to 200 ITS devices. Choice of technology can affect the size of the required maintenance staff. Agencies that end up with a variety of different technologies will complicate their maintenance activities. Developing an airport specification can mitigate this type of problem. Technology choices themselves can also reduce the overall need for maintenance activities. For example, some technologies have built-in diagnostic functions that can aid in troubleshooting.

Another option that an airport may want to consider involves contracting with one or more firms for unit-price, open-ended maintenance support services. In this situation, an experienced contractor would be selected to be on call to the airport for emergency and peak needs when airport staff is unavailable or under-staffed for a particular project. The contract would establish fixed unit prices for labor, equipment, and materials, and it could have all-inclusive prices for performing standard maintenance activities such as control center hardware/software updates, bulb or LED replacements, replacing cameras and detectors, or even installing device poles and foundations. Regardless of the approach taken, the airport should consider bidding a “maintenance period” alternate in their major ITS projects that would provide for routine and/or

emergency response maintenance by contract forces. The type and level of maintenance activities, along with length of maintenance period, could be varied to provide options for the airport based on available funding.

Funding for Ongoing Operations and Maintenance

To ensure that the deployed ITS will continue to operate as intended and meet the needs of travelers on a continual basis, the airport must identify funding sources for day-to-day operations and maintenance of the system. Although most agencies would like to reduce O&M expenditures with the implementation of new systems, ITS and other technology-based systems often have high ongoing costs associated with them. The benefits of ITS deployments are only achieved through efficient operation of the systems, which must be identified when justifying funding for the O&M costs.

The first year of operation of the ITS will not be a good indicator for what annual O&M costs will be due to product warranties. Over time, the O&M costs will tend to increase as equipment ages and/or more devices are added to an existing system. A range of O&M costs were presented in Chapter 4 associated with each ITS technology application. Since O&M costs can vary significantly depending on the specific installation parameters, a more detailed assessment should be made in the planning stages of the ITS project. This will allow airport planners to more appropriately determine the impact of the O&M for the ITS project on existing budgets.



CHAPTER 7

Implications and Suggestions for Further Research

Implications

Based on the research and data collected throughout the course of this project, it is evident that there is significant opportunity to enhance the efficiency, safety, and convenience of the airport traveler access information through the increased use of ITS technologies. The availability of data is not a significant hurdle in the vision of a unified view of traveler information dissemination. In fact, in many cases, the data exists, but other considerations stand in the path of integrating and disseminating the information such as security, institutional coordination issues, time and money to build the systems, as well as a lack of understanding of how the system will benefit airport operations and its customers.

Integration of both static and real-time information critical to an airport traveler should be a goal of every commercial airport. These information needs exist across the traveler's entire trip, both as a departing and arriving passenger. Presenting information on road conditions and travel times, roadway incidents, parking location and availability, public transit options and schedule status, alternative mode options, and security and flight information into a consistent and coordinated format will greatly improve the ground access experience for airport travelers. Airports will also need to be prepared to monitor the fast-paced evolution of technology applications and determine how best to adjust their ITS to prevent obsolescence.

Confirmed by the survey of travelers, there is already a substantial portion of air travelers who subscribe to airline emails and/or text alerts and who consult online and mobile web sources for information regarding travel to and from the airport. The increased desire of travelers to access real-time information or for technology applications to “push” them all of the information that they need is indicative of the increasing sophistication of the technologies that travelers are using. These and other fast-paced technology shifts are significantly expanding the market for traveler information services. The fundamental trend is that travelers want more information, available across a wider range of applications and devices, which include rich content such as video and graphics.

The vision for the future of airport ground access traveler information includes the following key elements:

- The use of traditional methods for disseminating traveler information (dynamic message signs, radio, etc.) will remain relevant to a large portion of the population who lack the resources/skills necessary to access the latest technologies.
- Use of ITS technologies will increase to effectively present ground access traveler information in a consistent format to airport travelers, regardless of airport size.
- Airport websites will provide interactive trip-planning capabilities, including mode choice, pricing information, estimated travel time, and anticipated delay based on time of day. In more

advanced systems, the trip-planning tool may be linked to real-time flight and ground access conditions.

- More traveler information will be pushed to the user via simplified and personalized voice/email/text message alerts.
- Increased implementation of advanced parking management and guidance systems will provide travelers with the location and availability of parking spaces and communicate this information to users via the airport website and/or voice/email/text alerts.
- Increased coordination with area 511 systems will provide ground access traveler information to airport travelers that is integrated with the freeway/arterial ITS.
- Integration of airport systems with department of transportation systems will increase, providing center-to-center communications for the exchange of traveler information between the two agencies.
- There will be greater third-party participation and innovation in data collection, aggregation, and dissemination.

Suggestions for Further Research

The following questions may be used to scope future research to provide airport operators with additional data on the benefits of deploying ITS technologies in the airport environment:

- How does an airport traveler's threshold for delay differ from other travelers using the same multimodal transportation system?
- What are the real-world benefits and associated challenges of integrating airport traveler information with traditional highway traveler information systems? This research would involve development of case studies.
- Is it feasible for airports to adopt use of ITS standards? Explore the use of communications and device interoperability standards for the airport environment that would allow for seamless integration with highway ITS.
- How is distracted driving legislation ultimately going to affect the way that real-time information is disseminated to travelers?
- How will connected vehicle technology, and more specifically, dynamic mobility applications that will take advantage of vehicle-to-vehicle and vehicle-to-infrastructure connectivity, impact the way that travelers access information on mode choice, vehicle routing, and travel times?

Bibliography

- 511 Deployment Coalition. (2010). *What is 511*. Retrieved January 25, 2010, from Deploy 511 Travel Information: <http://www.deploy511.org/whatis511.html>
- 511 Deployment Coalition. (2005). *America's Travel Information Number*. Retrieved February 7, 2010, from <http://www.deploy511.org/docs/511%20Guidelines%20Version%203.0.pdf>
- AASHTO, ITE, NEMA. (2009, July). *NTCIP 9001 v04*. Retrieved from National Transportation Communications for ITS Protocol: <http://www.ntcip.org/library/standards/default.asp?standard=9001>
- Aero Tech Consulting and Amadeus Consulting. (2009). *ACRP Report 13: Integrating Airport Information Systems*. Washington, DC: Transportation Research Board.
- Aero Tech Consulting and Amadeus Consulting. (2008). *ACRP Web-Only Document 1: Analysis and Recommendations for Developing Integrated Airport Information Systems*. Washington, DC: Transportation Research Board.
- Airport Consultants Council. (2008, June). *Airport Information Technology & Systems (IT&S): Best Practice Guidelines*. Retrieved January 12, 2010, from Airport Consultants Council: <http://www.acconline.org/Content/NavigationMenu/Resources/ACCLibrary/default.htm>
- Answers.com (Email). (2010). *Definitions from Answers.com: Email*. Retrieved January 25, 2010, from Answers.com: <http://www.answers.com/topic/e-mail>
- Answers.com (Web Site). (2010). *Definitions from Answers.com: Web Site*. Retrieved January 25, 2010, from Answers.com: <http://www.answers.com/topic/website>
- Athey Creek Consultants. (2009). *NCHRP Synthesis of Highway Practice 399: Real-Time Traveler Information Systems*. Washington, DC: Transportation Research Board.
- Aviation System Consulting, Inc. (2008). *ACRP Synthesis of Airport Practice 5: Airport Ground Access Mode Choice Models*. Washington, DC: Transportation Research Board.
- Baker. (2009, November). *What is a Project Charter*. Retrieved January 5, 2010, from Bright Hub: <http://www.brighthub.com/office/project-management/articles/5161.aspx>
- Barich, Inc. (2008). *ACRP Synthesis of Airport Practice 8: Common Use Facilities and Equipment at Airports*. Washington, DC: Transportation Research Board.
- Battelle Memorial Institute and Multisystems, Inc. (2003). *Customer Preferences for Transit ATIS: Research Report*. Washington, DC: US Department of Transportation, Federal Highway Administration.
- Bauer, J., Smith, M., & Armstrong, A. (2007). *The Collaborative Advantage: Realizing the Tangible Benefits of Regional Transportation Operations Collaboration*. Washington, DC: US Department of Transportation, FHWA.
- Berg, R., Khijniak, D., & Rausch, B. (2010, December 8). *ITSA Connected Vehicle Task Force Survey*. Retrieved September 20, 2011, from ITS America Website: <http://connectedvehicle.itsa.wikispaces.net/Task+Force+Member+Survey+2011+-+Connected+Vehicle>
- Berry, F., Gillhespy, S., & Rogers, J. (2008). *ACRP Synthesis of Airport Practice 10: Airport Sustainability Practices*. Washington, DC: Transportation Research Board.
- Birenbaum. (2009). *Information Sharing for Traffic Incident Management*. Washington, DC: US Department of Transportation, Federal Highway Administration.
- Burdette, D., & Hickman, M. (2001). Investigation of Information Needs of Departing Air Passengers. *Transportation Research Record 1744*, 72–81.
- Business Insider. (2011, January 5). Retrieved March 18, 2011, from Business Insider Website: <http://www.businessinsider.com/facebook-has-more-than-600-million-users-goldman-tells-clients-2011-1>
- Cambridge Systematics. (2007). *Real-Time Traveler Information Services Business Models: State of the Practice Review*. Washington, DC: FHWA.
- Cambridge Systematics. (2005). *Traffic Congestion and Reliability: Making It There On Time, All The Time*. Washington, DC: FHWA.

A-2 Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

- Charles River Associates. (1997). *User Acceptance of ATIS Products and Services: A Report of Qualitative Research*. Washington, DC: United States Department of Transportation, Intelligent Transportation Systems Joint Program Office.
- Coogan, M., MarketSense Consulting, and Jacobs Consultancy. (2008). *ACRP Report 4: Ground Access to Major Airports by Public Transportation*. Airport Cooperative Research Program. Washington, DC: Transportation Research Board.
- Croft. (2001). Streamlined Parking System Headlines BWI Upgrades. *Aviation Week & Space Technology*.
- Dresner, M. (2006). Leisure versus business passengers: Similarities, differences, and implications. *Journal of Air Transport Management*, 12 (1), 28–32.
- FAA. (2010a). *Federal Aviation Administration: AIP Overview*. Retrieved December 2010, from Federal Aviation Administration: <http://www.faa.gov/airports/aip/overview/>
- FAA. (2010b). *FAA Guidelines for Benefits Estimation*. Washington, DC: FAA.
- FAA. (2010c). *Federal Aviation Administration: PFC Funding*. Retrieved from Federal Aviation Administration: <http://www.faa.gov/airports/pfc/>
- FAA. (2009). *FAA Aerospace Forecast Fiscal Years 2009–2025*. Retrieved February 11, 2010, from Federal Aviation Administration: http://www.faa.gov/data_research/aviation/aerospace_forecasts/2009-2025/media/FAA%20Aerospace%20Forecasts%20FY%202009-2025.pdf
- FAA. (2006). *Bulletin 1: Best Practices—Surface Access to Airports*. Retrieved December 2010, from Federal Aviation Administration: http://www.faa.gov/airports/resources/publications/reports/media/bulletin_1_surface_access_best_practices.pdf
- FAA. (2004, February 10). Notice of Policy Regarding the Eligibility of Airport Ground Access Transportation Projects for Funding Under the Passenger Facility Charge Program. *Federal Register*, 69 (27), pp. 6366–6371.
- FHWA. (2007). *Advanced Parking Management Systems: A Cross-Cutting Study—Taking the Stress Out of Parking*. Washington, DC: US Department of Transportation.
- FHWA. (2005). *Managing Demand Through Travel Information Services*. Retrieved February 7, 2010, from http://ops.fhwa.dot.gov/publications/manag_demand_tis/travelinfo.htm
- FHWA and Caltrans. (2009). *Systems Engineering Guidebook for ITS*. Retrieved December 2010, from Systems Engineering Guidebook for ITS website: <http://www.fhwa.dot.gov/cadiv/segb/index.htm>
- Florida DOT. (2010). *Displaying Message on Dynamic Message Signs*. Retrieved January 25, 2010, from My Florida.com: Policies and Procedures: <http://www2.dot.state.fl.us/proceduraldocuments/procedures/bin/000750015.pdf>
- Florida DOT. (2007). *2006 Annual Report SMART SunGuide Transportation Management Center (TMC)*. Retrieved February 7, 2010, from <http://www.smartsunguide.com/PDF/Annual%20Report%20-%20screenV2.pdf>
- Gartner Inc. (2010). *Gartner Says Worldwide Mobile Device Sales Grew 13.8 Percent in Second Quarter of 2010, But Competition Drove Prices Down*. Retrieved from Gartner Newsroom: <http://www.gartner.com/it/page.jsp?id=1421013>
- Gosling, G. (2008). *ACRP Synthesis of Airport Practice 5: Airport Ground Access Mode Choice Models*. Washington, DC: Transportation Research Board.
- Goswam, A. K., Miller, J. S., & Hoel, L. A. (2007). Measuring Pre-Flight Travel Time in the Air Journey. *Proceedings of the 29th International Air Transport Conference* (pp. 78–89). Irvine, Tx: America Society of Civil Engineers.
- Governors Highway Safety Association. (n.d.). Retrieved March 18, 2011, from Governors Highway Safety Association Website: http://www.ghsa.org/html/stateinfo/laws/cellphone_laws.html
- Gresham, Smith and Partners and Texas Transportation Institute. (2009). *Wayfinding and Signing Guidelines for Airport Terminals and Landside. Synthesis Report*. ACRP Project 07-06. Washington, DC: Gresham, Smith and Partners.
- Hiroshi and Zavodny. (2006). Immigrants, English Ability and Information Technology Use. *Annual Meeting of the American Sociological Association*. Montreal, Quebec: American Sociological Association.
- Intelligent Transportation Society of America. (2000). *Closing the Data Gap: Guidelines for Quality Advanced Traveler Information Systems (ATIS) Data*. Washington, DC: ITS America.
- International Telecommunications Union. (2010). *The World in 2010*. Retrieved February 2011, from International Telecommunications Union Website: www.itu.int/ITU-D/ict/
- Jacobs Consultancy, Walker Parking Consultants, Mannix Group, & DMR Consulting. (2010). *ACRP Report 24: Guidebook for Evaluating Airport Parking Strategies and Supporting Technologies*. Washington, DC: Transportation Research Board.
- Jenkins, L. (2007, November 16). *Can't remember where you parked at the airport?* Retrieved October 12, 2009, from Mail Online: <http://www.dailymail.co.uk/sciencetech/article-492859/Cant-remember-parked-airport-Meet-gadget-car-you.html>
- Jenner, G. (2008). Airport IT Trends 2008. *Airline Business*, 24 (10), 94–97.

- Kimley-Horn and Associates, Inc. (2007). *Real-Time Information Services Business Models: State of the Practice Review*. Washington, DC: Federal Highway Administration.
- Kristof, T., Lowry, M., & Rutherford, G. S. (2005). *Assessing the Benefits of Traveler and Transportation Information Systems*. Olympia: Washington State Department of Transportation.
- Landrum and Brown. (2001). *Ground Access to Airport Study: Executive Summary*. Sacramento, CA: California Department of Transportation.
- Lappin, J. (2000). *Chapter 4. What have we learned about advanced traveler information systems and customer satisfaction?* Washington, DC: United States Department of Transportation Research and Special Programs Administration.
- Lappin, J., & Bottom, J. (2001). *Understanding and Predicting Traveler Response to Information: A Literature Review*. Washington, DC: United States Department of Transportation Research and Special Programs Administration and John A. Volpe National Transportation Center.
- Leigh Fisher Associates, Coogan, M., and MarketSense Consulting. (2002). *TCRP Report 83: Strategies for Improving Public Transportation Access to Large Airports*. Washington, DC: Transportation Research Board.
- Leigh Fisher Associates, Coogan, M., and MarketSense Consulting. (2000). *TCRP Report 62: Improving Public Transportation Access to Large Airports*. Washington, DC: Transportation Research Board.
- Maccubbin, Staples, Kabir, Lowrance, Mercer, Philips and Gordon. (2008). *Intelligent Transportation System Benefits, Costs, Deployment, and Lessons Learned: 2008 Update*. Washington, DC: USDOT/RITA.
- Mahmassani, H., Chebli, H., Slaughter, K., & Ludders, F. (2002). *Assessment of Intermodal Strategies for Airport Access*. Austin, TX: Federal Highway Administration.
- Marshall, K. R., & Tarnoff, P. J. (2006). *NCHRP Report 560: Guide to Contracting ITS Projects*. Washington, DC: Transportation Research Board.
- Mitretek Systems. (2002a). *Developing Functional Requirements for ITS Projects*. Washington, DC: ITS Joint Program Office, US DOT.
- Mitretek Systems. (2002b). *Guide to Configuration Management for ITS Systems*. Washington, DC: FHWA.
- Mitretek Systems and TransCore. (1998). *Developing Traveler Information Systems Using the National ITS Architecture*. Washington, D.C: FHWA Joint Program Office.
- Narita International Airport. (2009). http://naa.ivcreation.com/pc_us/. Retrieved January 23, 2010, from eAirport Narita: http://naa.ivcreation.com/pc_us/
- Noblis, Inc. (2010). *Technology and Innovation Scan (Unpublished)—Effectiveness of Different Approaches to Disseminating Traveler Information on Travel Time Reliability*. Washington, DC: Strategic Highway Research Program.
- Office of Research Integrity. (2010). *Responsible Conduct in Data Management: Data Ownership*. Retrieved December 3, 2009, from US Department of Health and Human Services: http://ori.dhhs.gov/education/products/n_illinois_u/datamanagement/dotopic.html
- Paniata. (2003). *Use of Changeable Message Sign (CMS) for Emergency Security Messages*. Retrieved July 31, 2009, from Federal Highway Administration: <http://www.fhwa.dot.gov/legsregs/directives/policy/securmemo.htm>
- Rupert, B., Wright, J., Pretorius, P., Cook, G., Hutchinson, K., Kell, W., et al. (2003). *Traveler Information Systems in Europe*. Washington, DC: FHWA.
- SAIC. (2000). *Seattle Metropolitan Model Deployment Evaluation Report*. Washington, DC: FHWA.
- Shapiro, P., & Katzman, M. (1998). Relationships Between Airport Activity and Ground Transportation Needs. *Transportation Research Record: Journal of the Transportation Research Board*, 1622, 8–12.
- Stocking, C., DeLong, J., Braunagel, V., Healy, T., & Loper, S. (2009). *ACRP Report 13: Integrating Airport Information Systems*. Washington, DC: Transportation Research Board.
- Sydney Airport Corporation Limited. (2006). *Sydney Airport: 2006 Airport Ground Travel Plan*. Sydney, Australia.
- TRB Airport Terminal and Ground Access Committee. (2006). *TRB A1J04 Home Page*. Retrieved February 11, 2010, from TRB Airport Terminal and Ground Access Committee: <http://www.leighfisher.com/trb/>
- US Government Accounting Office. (2005). *Intermodal Transportation. Potential Strategies Would Redefine Federal Role in Developing Airport Intermodal Capabilities*. Washington, DC.
- USDOT. (2009a). *ATIS02—Interactive Traveler Information*. Retrieved December 2010, from National ITS Architecture Version 6.1 web site: <http://www.iteris.com/itsarch/html/mp/mpatis02.htm>
- USDOT. (2009b, January 7). *ITS Standards*. Retrieved December 2010, from National ITS Architecture Version 6.1: <http://www.iteris.com/itsarch/html/standard/standard.htm>
- USDOT. (2009c). *Securing ITS*. Retrieved December 2010, from National ITS Architecture Version 6.1: <http://www.iteris.com/itsarch/html/security/securityhome.htm>
- USDOT. (1996). *Airport Ground Access Planning Guide*. Retrieved December 14, 2009, from RITA National Transportation Library: <http://ntl.bts.gov/DOCS/AGAPP.html>
- USDOT, Iteris. (2009). *National ITS Architecture Version 6.1*. Retrieved October 10, 2010, from <http://www.iteris.com/itsarch/index.htm>

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- USDOT|BTS. (2009). *RITA|BTS|Air Carrier Traffic Statistics*. Retrieved January 26, 2010, from Bureau of Transportation Statistics: http://www.bts.gov/xml/air_traffic/src/index.xml#CustomizeTable
- USDOT|NHTSA. (2009). *Distracted Driving|National Highway Traffic Safety Administration*. Retrieved January 14, 2010, from Distraction.gov: <http://www.distraction.gov/>
- USDOT|RITA. (2010). *USDOT|RITA*. Retrieved February 6, 2010, from Benefits Database: <http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ByInfo/WhatIsBCClassifications>
- USDOT|RITA. (2009). *RITA|ITS|Frequently Asked Questions*. Retrieved December 10, 2009, from Research and Innovative Technology Administration: <http://www.its.dot.gov/faqs.htm>
- USDOT|RITA. (2008). *Intelligent Transportation Systems Benefits, Costs, Deployment, and Lessons Learned*. Washington, DC: USDOT.
- Volpe National Transportation Systems Center. (1994). *IVHS Institutional Issues and Case Studies: ADVANCE Case Study*. Washington, DC: U.S. Department of Transportation.
- Wikipedia. (2010a). *Highway Advisory Radio*. Retrieved January 25, 2010, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Highway_advisory_radio
- Wikipedia. (2010b). *IVR: Interactive Voice Response*. Retrieved June 2, 2010, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Interactive_voice_response
- Wikipedia. (2010c). *RSS: Really Simple Syndication*. Retrieved January 7, 2010, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/RSS_Feeds
- Wikipedia. (2010d). *Social Media Marketing*. Retrieved January 25, 2010, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Social_media_marketing
- Wikipedia. (2009). *Legacy System*. Retrieved December 22, 2009, from Wikipedia, the free encyclopedia: http://en.wikipedia.org/wiki/Legacy_system
- Wikipedia. (2007). *Global Positioning System*. Retrieved January 23, 2010, from Wikipedia, the free encyclopedia: <http://en.wikipedia.org/wiki/GPS>
- WSDOT. (2010). *WSDOT: Best Time To Leave*. Retrieved December 2010, from Washington State Department of Transportation: <http://www.wsdot.wa.gov/Traffic/Seattle/TravelTimes/reliability/>
- Zimmerman, C., Raman, M., Mallett, W., & Roberts, C. (2002). *Sharing Data for Traveler Information: Practices and Policies for Public Agencies. Securing our future: ITS America 12th Annual Meeting and Exposition*. Washington, DC: ITS America.


 APPENDIX B

List of Acronyms

ACAT	Acquisition Category
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
AIP	Airport Improvement Program
APMS	Advanced Parking Management System
ATIS	Advanced Traveler Information Systems
BWI	Baltimore/Washington International Airport
C2C	Center to Center
C2F	Center to Field
CCTV	Closed Circuit Television
CFR	Code of Federal Regulations
COTS	Commercial-off-the-Shelf
DMS	Dynamic Message Sign
DSRC	Dedicated Short-Range Communications
FAA	Federal Aviation Administration
FAQ	Frequently Asked Questions
FHWA	Federal Highway Administration
GPS	Global Positioning System
GTFS	General Transit Feed Service
HAR	Highway Advisory Radio
IITAA	Illinois Information Technology Accessibility Act
IT	Information Technology
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITU	International Telecommunications Union
IVHS	Intelligent Vehicle Highway System
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MDOT	Mississippi Department of Transportation
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MUFID	Multi-user Flight Information Display
NCHRP	National Cooperative Highway Research Program
NFC	Near Field Communication
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
PFC	Passenger Facility Charge

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RF	Radio Frequency
RITA	Research and Innovative Technology Administration
RSS	Really Simple Syndication
SMS	Short Message Service
STIP	State Transportation Improvement Program
TIP	Transportation Improvement Program
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TSA	Transportation Security Administration
TTY	Text Telephone
USDOT	United States Department of Transportation
WSDOT	Washington State Department of Transportation



APPENDIX C

Airport Website Traveler Information Review

The following elements of ground transportation information were examined for each airport included in the survey, and an overview is provided in the following pages of this appendix:

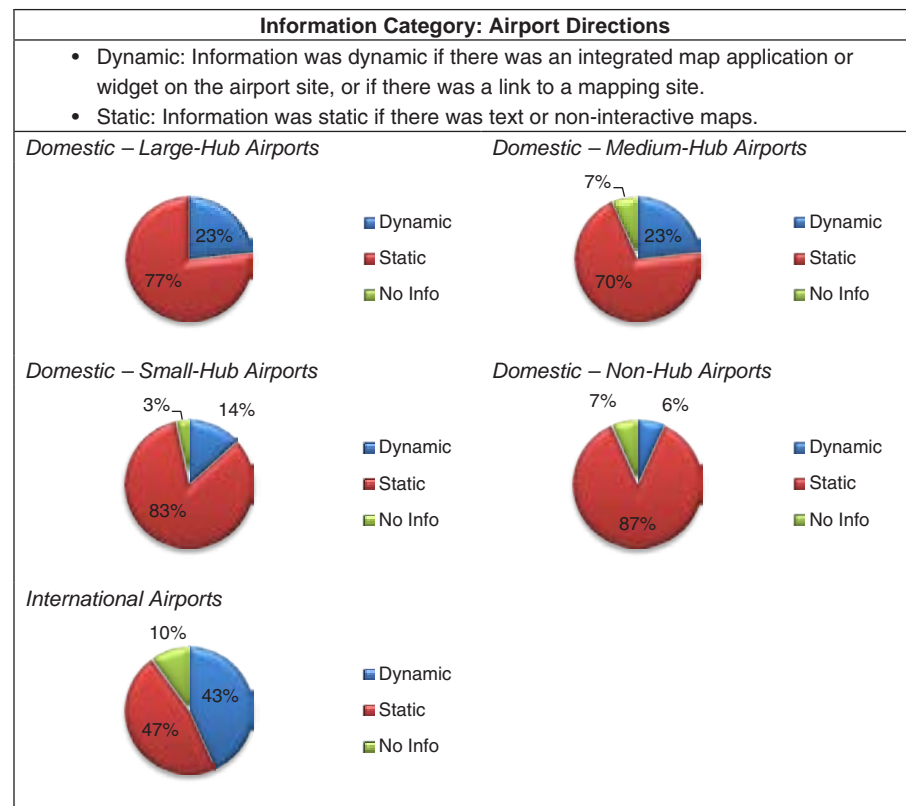
- Directions to the airport,
- Airport roads information,
- Airport access route congestion,
- Links to other regional sources of traffic information,
- Passenger drop-off/pick-up information,
- Cell phone lot information,
- Parking information,
- Terminal information,
- Weather conditions,
- Flight/gate status information,
- Rental car information,
- Cargo information,
- Shuttle/bus information,
- Mass transit information, and
- Information in multiple languages.

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Directions to the Airport

Directions to the airport are a basic information source that travelers need, especially if they are not frequent travelers. As shown in Table C-1, while nearly all airports in the sample cross section provided directional information, the vast majority of domestic airports provide it in a static manner. However, the international airport review showed a much larger percentage providing dynamic directional information with approximately 43 percent providing directions dynamically. With little additional technical effort, the provision of an integrated mapping application window or link to a mapping website would allow travelers to obtain personalized, turn-by-turn directions to the airport, a resource that could be highly useful for the occasional traveler, either business or personal.

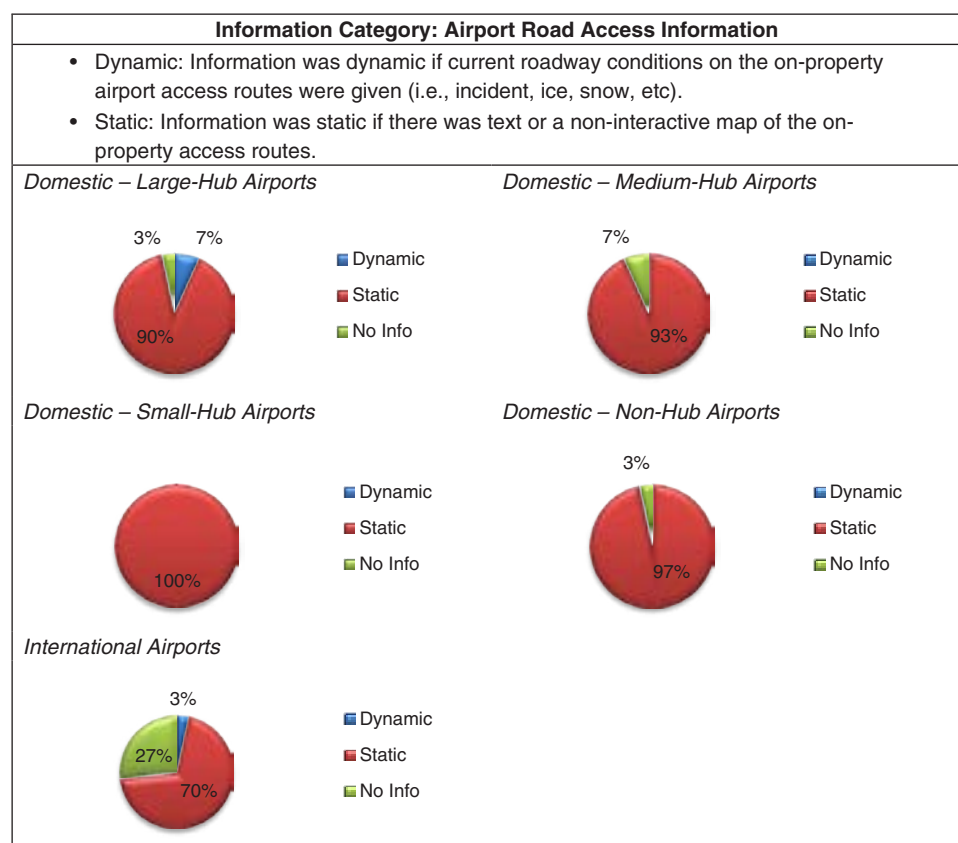
Table C-1. Airport website information analysis: Airport directions.



Airport Roads Information

In most situations, the final portion of any trip to the airport occurs on roads controlled and maintained by the airport. This review category encompassed two components of information. The first was directions or a map of the on-property roads, while the second was status information on these roadways. While almost all domestic airports in the sample cross section provide some static information, airport websites that provide this level of information in a dynamic fashion to travelers are rare. Table C-2 shows the results of the review for this category. In contrast to the findings from the review of airport directions, slightly more than 25 percent of international airports provide no information pertaining to on-property access information.

Table C-2. Airport website information analysis: Airport road access information.

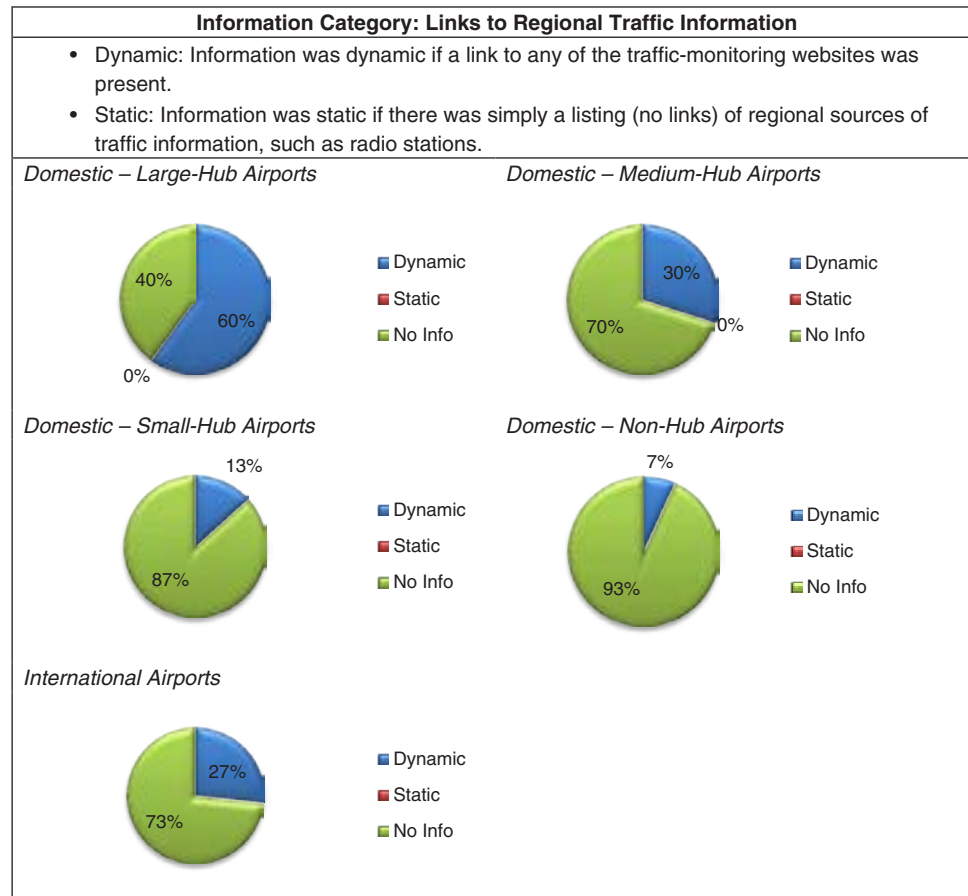


C-4 Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

Links to Other Regional Sources of Traffic Information

The results of examining airport websites for links to regional traffic information resulted in a trend based on airport size, with a decreasing amount of linkages as the airport size decreases. This is likely due to the lack of a regional traffic information website, as most smaller communities do not have this type of information or the ITS infrastructure to provide it. However, all of the regions served by the largest airports should have a regional traffic conditions website, and providing a link to, or an integrated view of, the information is a simple technical process. Table C-3 shows the results of the review in this category.

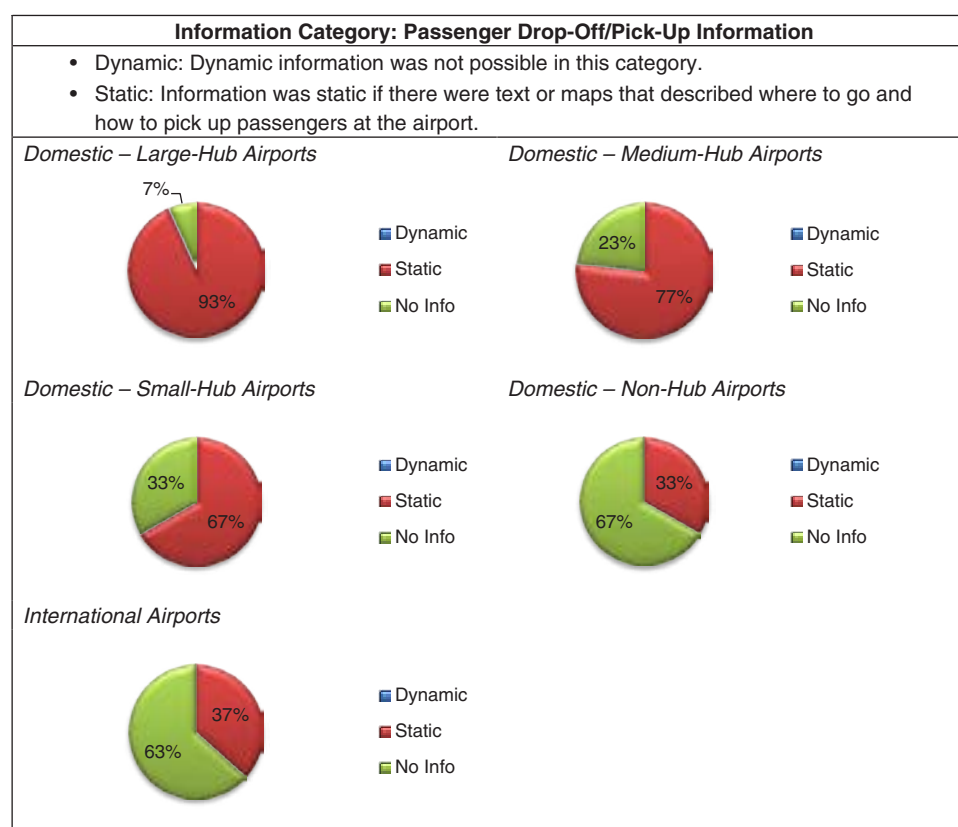
Table C-3. Airport website information analysis: Links to regional traffic information.



Passenger Drop-Off/Pick-Up Information

The provision of information for passenger drop-off or pick-up would be difficult, if not impossible, to provide in a dynamic fashion. The information would be most applicable to vehicles entering the property and proceeding to a terminal. Any dynamic aspect would likely be very short-lived and apart from a DMS or in-vehicle device detailing the time to the terminal, difficult to communicate to drivers. Other aspects of passenger drop-off or pick-up information such as transit or parking or cell phone lots were covered in other categories of the website review process. Table C-4 shows the results of the review in this information category.

Table C-4. Airport website information analysis: Passenger drop-off/pick-up information.

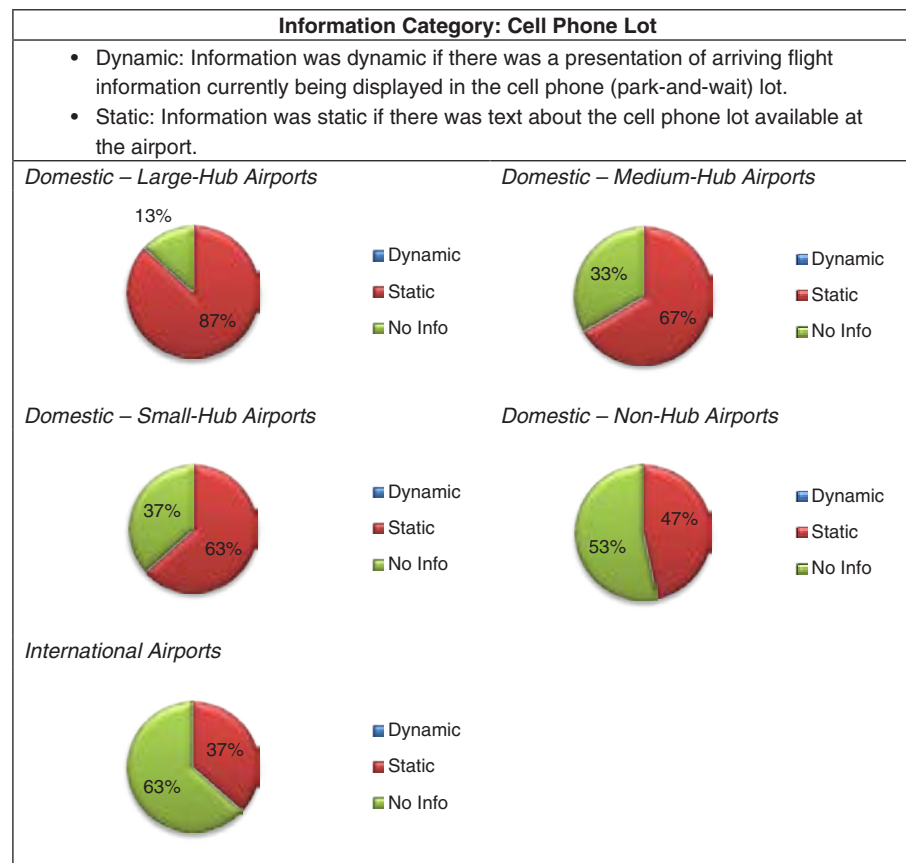


C-6 Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

Cell Phone Lot and Information

Cell phone lots, also called park-and-wait facilities, devote a parking facility for vehicles to wait to pick up travelers, generally for free, effectively removing those vehicles from the traffic flow at the curbside and on airport circulation roadways. For dynamic aspects, a large information display will show patrons of the lot the status of incoming flights so expectations as to meeting times between parties can be managed. Note that not all airports have this type of facility, so a finding of no information may also reflect not having the facility. Additionally, it is not possible to tell from all airport websites if there is an information display in the lot, so without site visits, a determination was provided of static instead of dynamic. Table C-5 shows the findings from this aspect of the analysis.

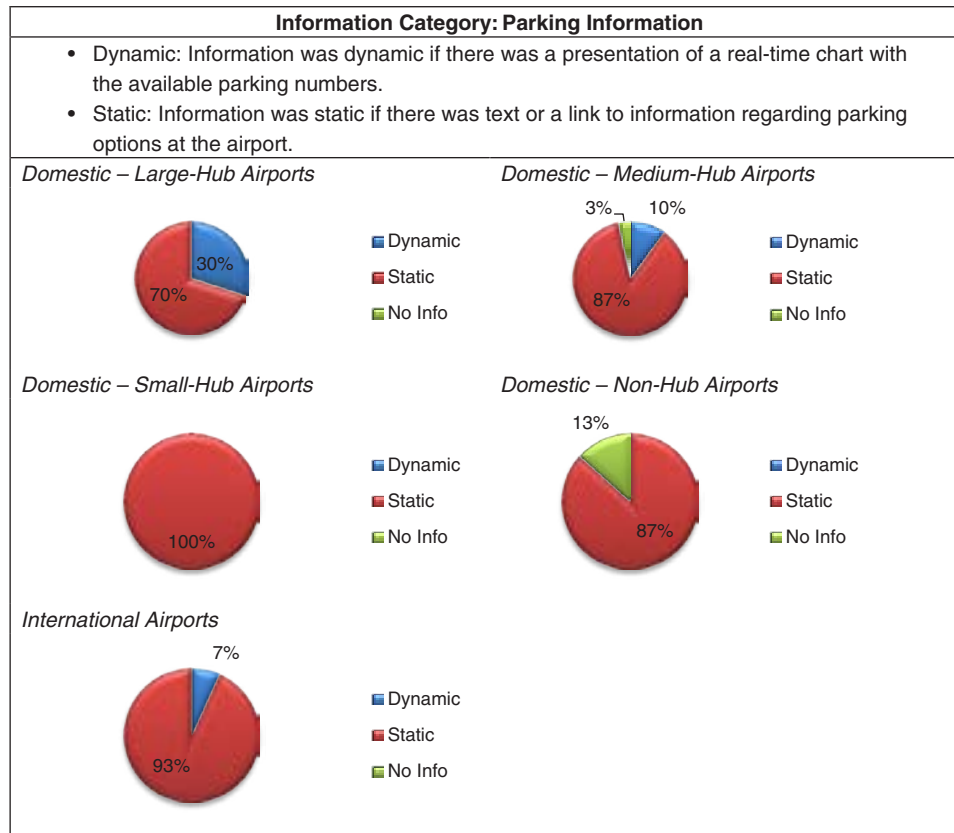
Table C-5. Airport website information analysis: Park-and-wait facility.



Parking Information

The operation and advantages of parking management systems were detailed earlier in this synthesis. Table C-6 shows the results of the airport website review for this category of information. It should be noted that this is an imperfect method of determining the availability of these systems. While some airports with this technology in use tout it on their website as an innovation, it is possible that the lots operate in a dynamic fashion on site, but the website is either not linked in to the information or makes no mention of it. A trend that is obvious, however, is that an increasing number of airports are implementing these systems and that they appear to be spreading beyond only the largest airports. Only at the smallest airports were there any findings that showed a total lack of parking information, speaking to its relative importance to the airport traveler.

Table C-6. Airport website information analysis: Parking information.

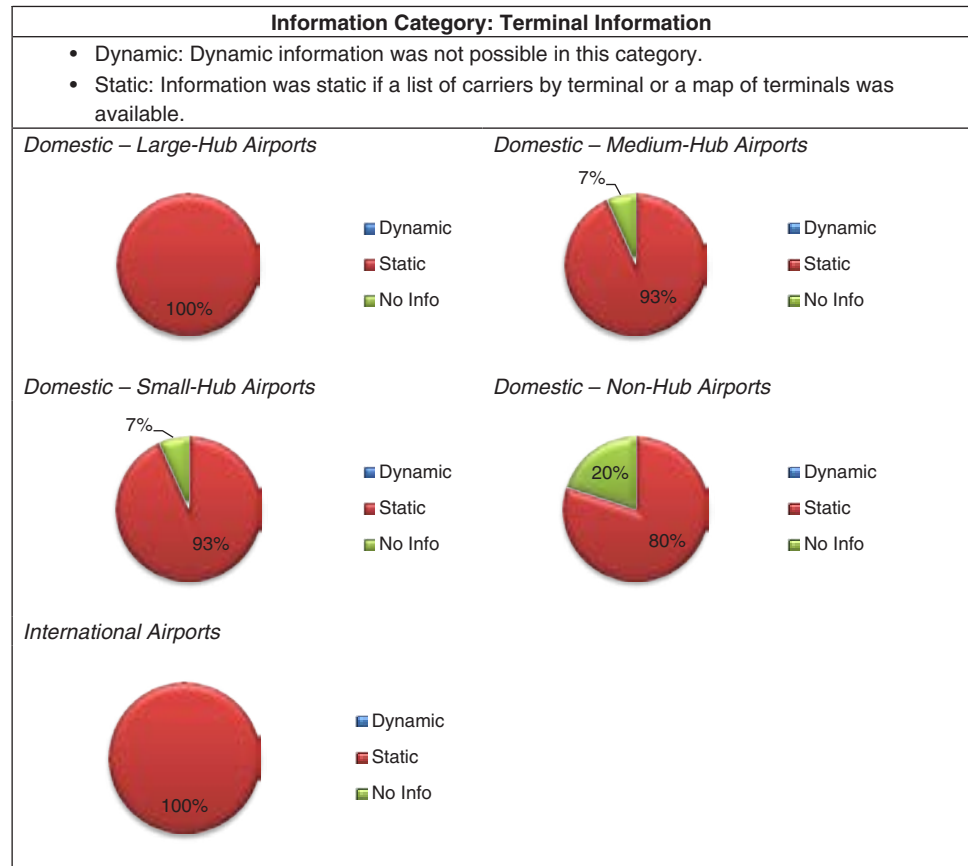


C-8 Guidebook for Implementing Intelligent Transportation Systems Elements to Improve Airport Traveler Access Information

Terminal Information

The provision of information pertaining to terminals in a dynamic fashion was judged to be impossible. Table C-7 shows that the vast majority of airports provide terminal information in a static fashion, generally a map or a list of which carriers are located in which terminal. It is known that many airports also provide this information on the on-property airport access roads; however, it is also static in nature at those points.

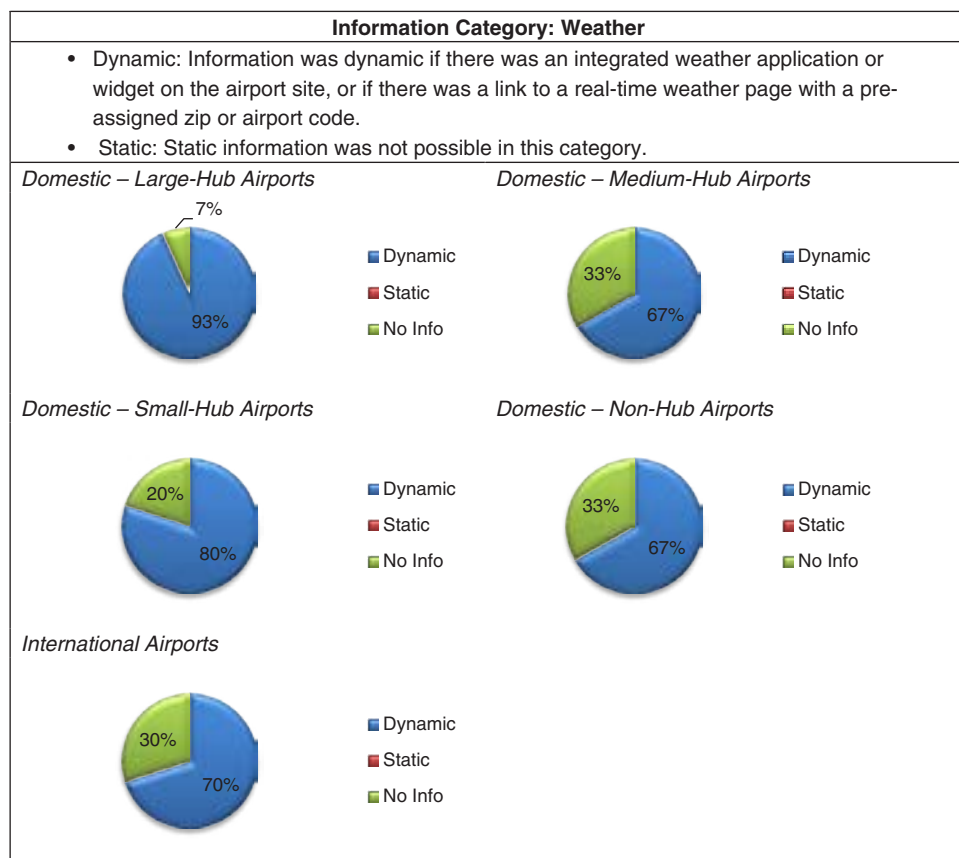
Table C-7. Airport website information analysis: Terminal information.



Weather Conditions

Although not identified in the findings of desired traveler information for highway users, weather information is an information component that can be decidedly more critical to air travelers. Even at a base level, many air travelers are interested in weather at their destination in order to know how to dress on the day of travel. Table C-8 shows that a vast majority of airport websites provide weather information in a dynamic fashion using an integrated weather widget or a link to a real-time weather page. While the review did not focus on the impact of weather on ground operations at the airport and therefore potential flight delays, this is a potentially important concept or linkage to carry forward for the concept of truly integrated information.

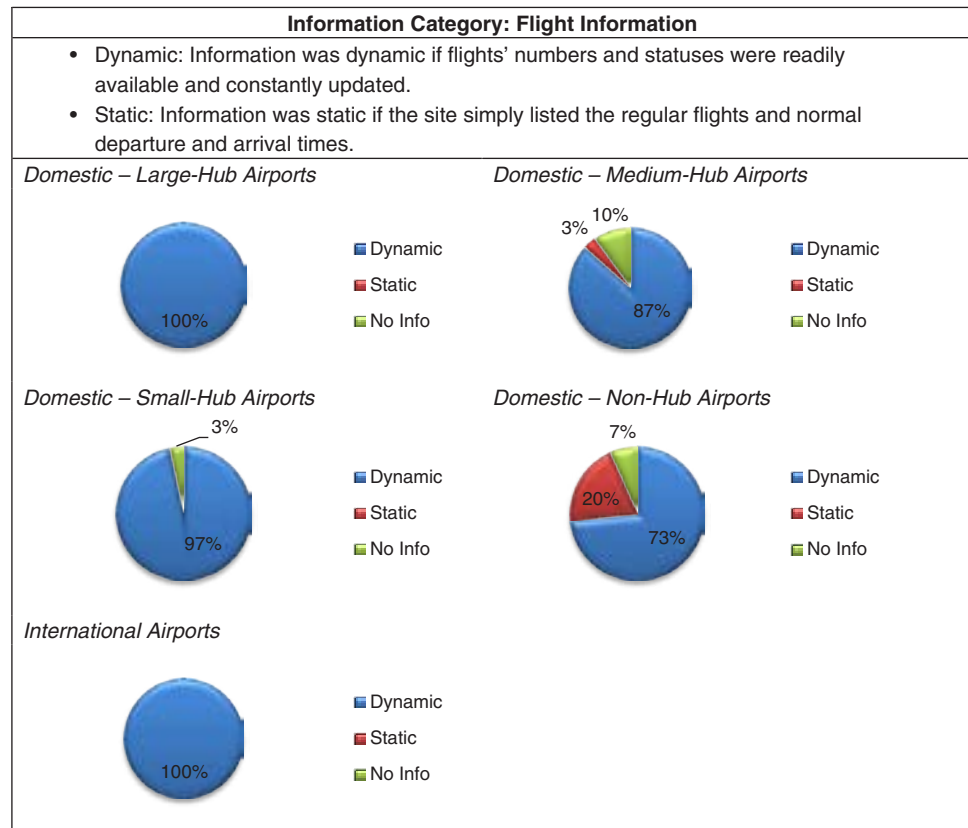
Table C-8. Airport website information analysis: Weather.



Flight/Gate Status Information

Virtually all but the smallest airports provide flight information in a dynamic fashion. At the very smallest airports, the scarcity and regularity of flights typically lead to a static list of carriers, gates, and expected arrival and departure times, as this information rarely changes. Table C-9 shows that all of the FAA-designated large airports and all of the international airports provide flight information in a dynamic fashion and dynamic means is the predominant method of providing this information across all sizes of airports.

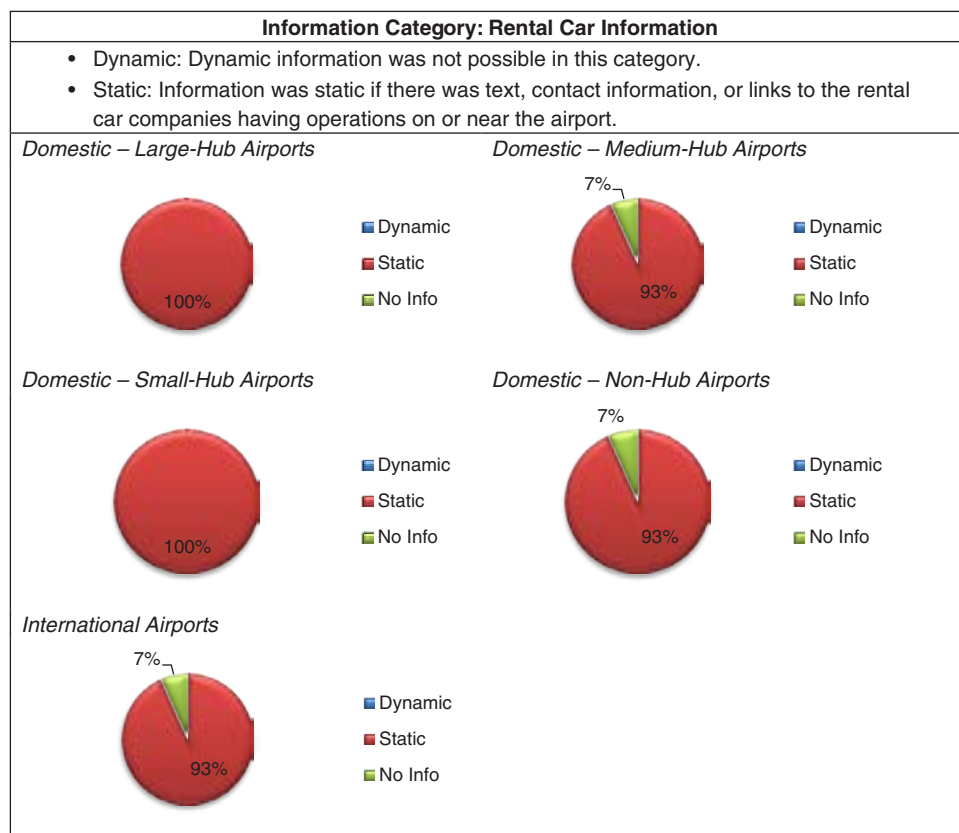
Table C-9. Airport website information analysis: Flight information.



Rental Car Information

Table C-10 shows the results of the information analysis for rental car information. It is not surprising that there were no findings of dynamic information in this category, as it is not envisioned how rental car information could be dynamic, short of stating the number or availability of rental vehicles. Presenting this information in a dynamic fashion would not generally be useful to most traveler segments as reservations for a rental car are typically made ahead of time. It would also be a significant technical hurdle to integrate the status information of multiple rental car companies to an airport information technology infrastructure, for very little perceived benefit.

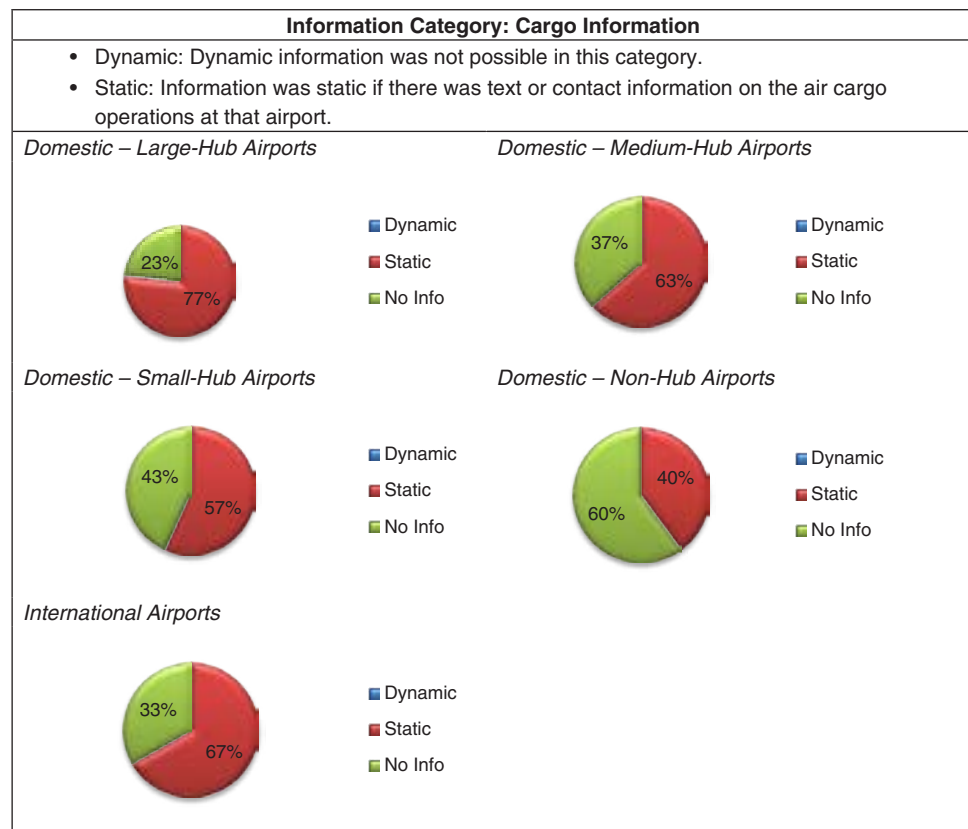
Table C-10. Airport website information analysis: Rental car information.



Cargo Information

As with some of the other categories of information in the website review, dynamic information pertaining to cargo was judged to not be possible. However, as Table C-11 shows, nearly a quarter of all domestic large airports do not even address cargo on their websites. A similar finding resulted from international airport websites, with nearly a third not addressing cargo. This may be due to the experience and familiarity that delivery and shipping companies will already have with airport operations. Presumably, new employees will obtain the required information from their places of employment and not from the airport website. There is very little applicability of cargo information to the predominant airport traveler, although it is a significant aspect of many airport operations.

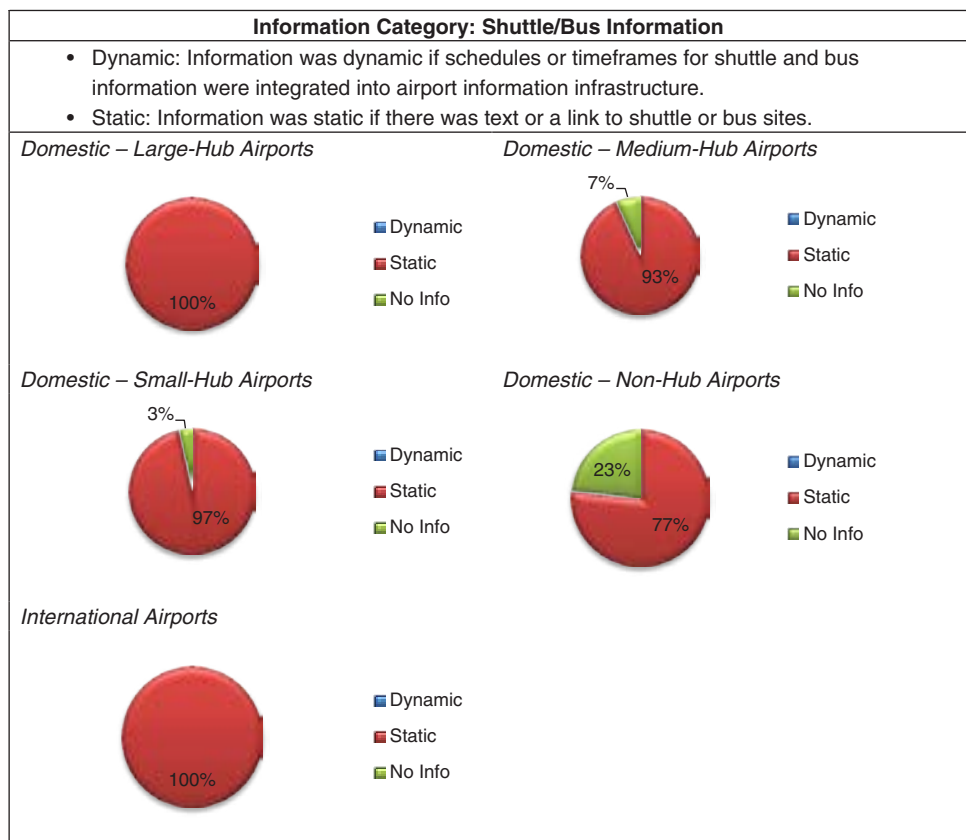
Table C-11. Airport website information analysis: Cargo information.



Shuttle/Bus Information

Dynamic information for shuttles or buses would take the form of schedules or next bus arrival information. Primarily this information would be most applicable to passengers arriving on flights and would have a delivery system of kiosks or message boards internal to the airport. It is therefore not surprising that airport websites do not showcase this information in a dynamic fashion. As shown in Table C-12, the vast majority of airports do provide shuttle or bus information, but in a static fashion. The results also show that nearly a quarter of the smallest airports in the review do not provide any information in this category. This may be because the airport is not served by any shuttle or bus agencies, as a result of the size of the facility and the number of enplanements.

Table C-12. Airport website information analysis: Shuttle/bus information.

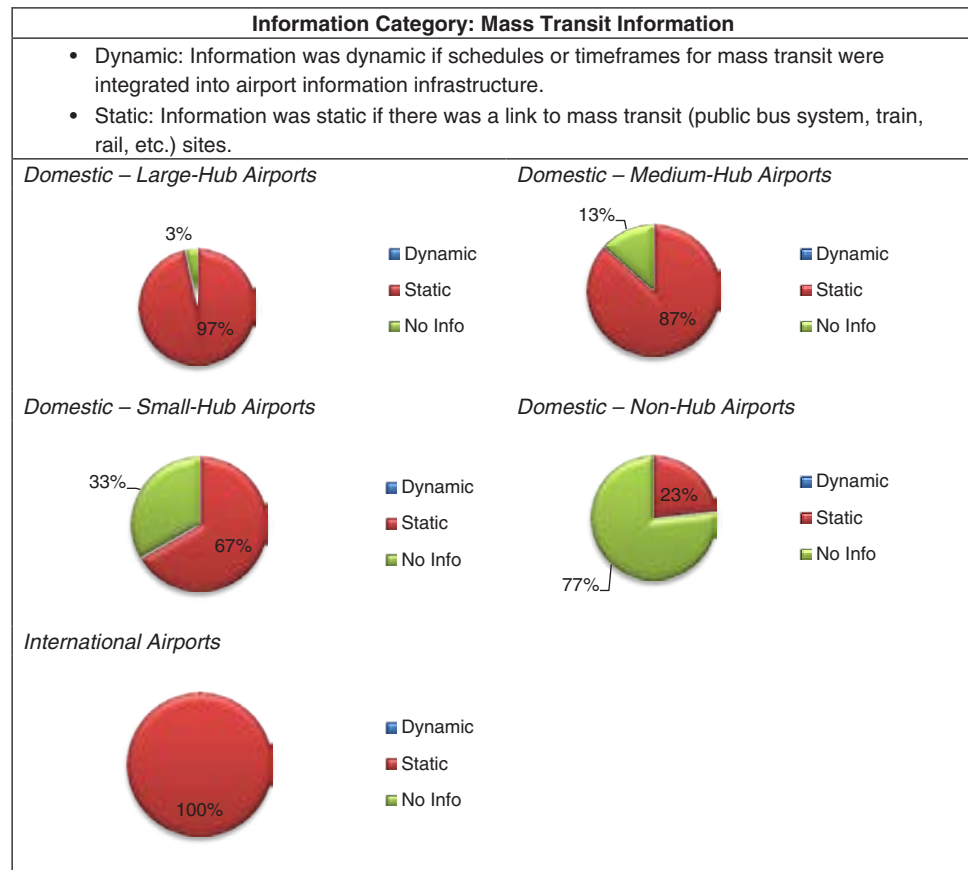


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Mass Transit Information

The provision of mass transit information is analogous to the previous category, the provision of shuttle and bus information. As shown in Table C-13 however, across domestic categories, less information is provided about mass transit options. In general, technology is not the issue. A more complete picture as to the lack of information availability becomes apparent when one considers aspects such as availability of transit to the airport, intermodal cooperation, lack of public awareness of transit options, or policies that do not promote alternative arrival modes.

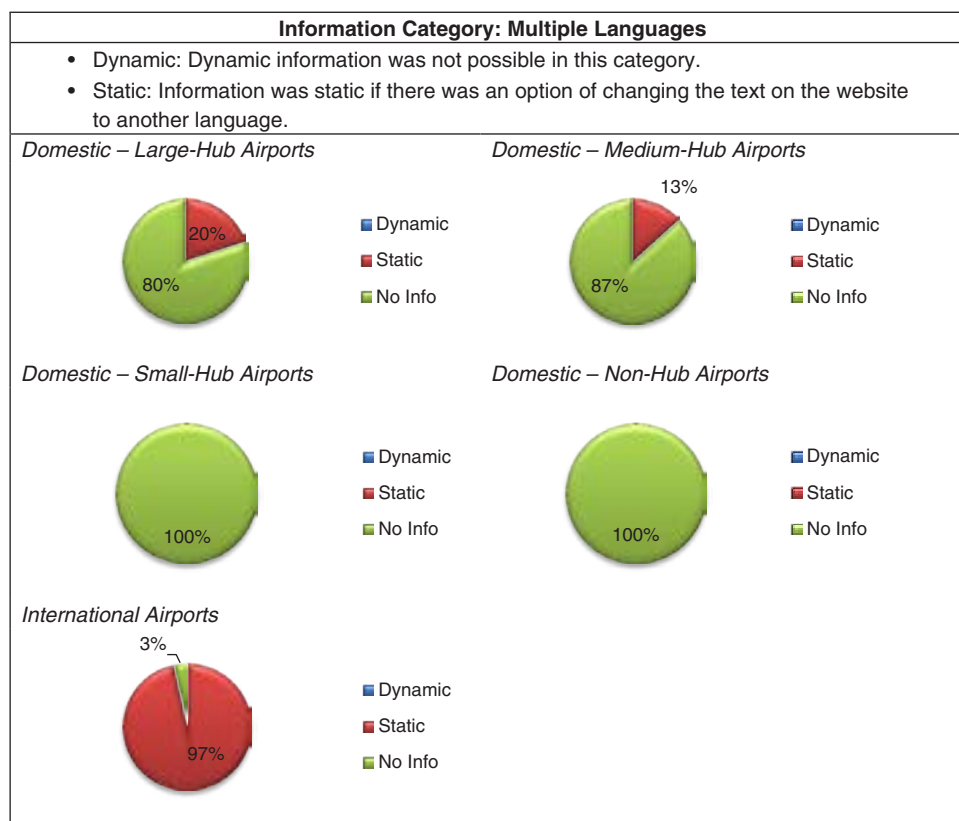
Table C-13. Airport website information analysis: Mass transit information.



Information in Multiple Languages

The final information category reviewed across the airport websites was the provision of information in multiple languages. Domestically, some of the larger airports do provide information in languages other than English. It is of course understood that providing this information in a dynamic fashion is not possible from the aspect of the airport website. There are web browser add-ins that dynamically translate pages as they are viewed, but this was not addressed in the website review. Internationally, virtually all of the airport websites provide pages in other languages, reflecting the use of English as the international language and the official language associated with air travel. Table C-14 shows the results from this category of review.

Table C-14. Airport website information analysis: Multiple languages.





APPENDIX D

Interactive CD

The interactive CD was developed to serve as a complementary tool to the guidebook. The CD contains information on various technologies in use for providing traveler information as well as a decision support tool that allows users to input characteristics about their airport and subsequently display a list of opportunities for improving their traveler information system through the use of ITS applications.

The CD initially asks the user to select either “Technologies Overview” or “Decision Support Tool.” If “Technologies Overview” is selected, a variety of technologies in use for traveler information systems is presented. The user is then asked to select the type of trip, either arriving or departing. The term “ARRIVING” refers to a person getting off the plane and leaving the airport, while the term “DEPARTING” refers to a person going to the airport to board a plane for another destination. When these choices are made, visualizations and information specific to the technology and trip type are displayed. If “Decision Support Tool” is selected on the home screen, the user is then asked to select an airport traveler market segment. Once a market segment is selected, the characteristics of that segment are displayed. The user then has the ability to select types of information that they would like to provide with ITS applications. Ultimately, a list of opportunities for providing information and the associated dissemination methods is displayed. This will allow users to identify opportunities for improving their traveler information system through the use of ITS technologies.

The research team is aware that an airport’s information technology, particularly items such as websites, consists of proprietary features used to support a number of airport-specific programs above and beyond traveler information, such as marketing. The visualizations on the CD are not intended as a design specification for traveler information displays or technologies. They are meant solely as an illustration of how various information components can be presented, utilized, and potentially combined.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation