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National Evaluation Strategy

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7. Authors V. Alexiadis (CSI), M. Carter (SAIC), A. DeBlasio (Volpe National Lab), V. Inman (SAIC), B. Perez (SAIC), C. St-Onge (SAIC), M. Van Aerde (Virginia Tech)		**8. Performing Organization Report No.**
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16. Abstract

This document describes the strategy used to evaluate the Intelligent Transportation Systems (ITS) Joint Program Office's Metropolitan Model Deployment Initiative (MMDI). The MMDI is an aggressive deployment of ITS at four urban sites: New York/New Jersey/Connecticut, Phoenix, San Antonio, and Seattle. These sites were chosen because of their high level of pre-existing ITS, and the promise of evaluating the integration of these legacy ITS components together with new ITS components.

The evaluation strategy itself consists, first, of classifying all MMDI projects as one of nine ITS components or their integration. These nine ITS components are traffic signal control, freeway management, incident management, electronic toll collection, emergency management, transit management, electronic fare payment, railroad grade crossing, and traveler information systems. One section of the document is devoted to defining these components as well as integration, and also show what projects within MMDI fall into each category. The MMDI projects and their integration are then evaluated through six different study areas. These study areas are safety, energy and emissions, operational efficiency, benefit-cost, customer satisfaction, and institutional benefits. A further section of the report is devoted to the presentation of the approach to be used in each study area. The importance of the evaluation of integration is stressed throughout the strategy.

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EXECUTIVE SUMMARY

OBJECTIVES OF THE MMDI

The United States Department of Transportation (U.S. DOT) Intelligent Transportation System (ITS) program was established as part of the Intermodal Surface Transportation Efficiency Act in 1991. Since late 1994, the U.S. DOT's ITS Joint Program Office (JPO) has been gathering information on the effect of ITS projects on surface transportation networks in the US. The Metropolitan Model Deployment Initiative (MMDI) is an important part of this work. The history leading up to this program can be found in Appendix A.

The MMDI consists of aggressive deployment of ITS projects at four selected metropolitan sites: Seattle, New York/New Jersey/Connecticut (NY/NJ/CT), Phoenix, and San Antonio. These sites were chosen for their pre-existing ITS infrastructure, and for the evaluation potential of proposed future ITS deployments. They were also chosen in order to answer the main evaluation hypothesis regarding ITS: that integration of ITS infrastructure components, one with the other, will result in a synergy of benefits. This can be otherwise stated as: "The whole is greater than the sum of the parts." Other objectives of the MMDI include:

- Documenting the institutional benefits that enabled these sites to be selected, and methods for successfully addressing new issues during the model deployment development and implementation process.
- Determining the incremental effects of increasing ITS deployment levels, especially traveler information systems, on some key transportation system attributes. These attributes include customer satisfaction, traffic flow, travel demand, and safety.
- Conducting an economic analysis of costs versus benefits of ITS deployment.

DEPLOYMENT OF ITS AT THE FOUR SITES

In 1995, the U.S. DOT and ITS America jointly identified a set of nine metropolitan area ITS infrastructure components. These components would share a common architecture that would allow consistent market evolution of ITS technologies. The nine ITS components are:

- Traffic Signal Control
- Freeway Management
- Incident Management
- Transit Management
- Regional Multimodal Traveler Information Systems
- Electronic Fare Payment
- Electronic Toll Collection
- Highway-Rail Intersection
- Emergency Management Services.

Together these components are expected to deliver safety, congestion reduction, and productivity benefits. It is further hypothesized that use of a common architecture will allow easier transfer and control of information between ITS components. This inter- and intra-component integration is expected to yield benefits in excess of those that would be realized by the individual components operating in isolation. This hypothesis, that the whole is greater than the sum of the parts, is the expectation driving the MMDI evaluation.

Sixty-four projects were defined and considered for evaluation as part of the MMDI. Descriptions of these projects, as well as local hypotheses or expected outcomes, can be found in Appendix B. Table 1 shows the distribution of these projects by ITS component and by site. Of these 64 projects, almost half are in Seattle, and 45% are traveler information projects. To ensure a full coverage of all nine ITS components, some non-MMDI funded projects are also being considered for evaluation. For example, there are no Electronic Toll Collection or Electronic Fare Payment projects being funded by MMDI, and only one MMDI funded Highway-Rail Intersection project.

Table 1. ITS Components Deployed at MMDI Sites

ELEMENT	*Abbr.*	*San Antonio*	*Phoenix*	*Seattle*	*NY/NJ/CT*	*TOTAL*	
Traffic Signal Control Systems	TS	1	3	6	0	10	16%
Freeway Management Systems	FM	1	1	3	0	5	8%
Incident Management	IM	0	1	2	0	3	5%
Electronic Toll Collection	ETC	0	0	0	1	1	1%
Emergency Management	EMS	1	1	3	0	5	8%
Transit Management	TM	2	3	3	0	8	13%
Electronic Fare Payment	EFP	0	1	0	0	1	1%
Railroad Grade Crossing	RRX	1	0	0	1	2	3%
Traveler Information Systems	ATIS	4	8	12	5	29	45%
Total		10	18	29	7	64	
		16%	28%	45%	11%		

Integration of components takes place through the transfer of information between components, and the use of transferred data by components. Thirty-two information exchanges are possible between ITS components, some between and some within components.

Figure 1 shows the possible data exchanges among the nine ITS components. The intra-component exchanges occur within the Traffic Signal Control, Electronic Toll Collection, and Electronic Fare Payment components. Within a Traffic Signal Control system, for example, data can be exchanged between traffic signals across multiple local jurisdictions within the same metropolitan area; therefore making better arterial signal coordination possible. A common electronic tag can also be used at toll collection points owned and operated by different toll authorities, making integration within an Electronic Toll Collection system possible.

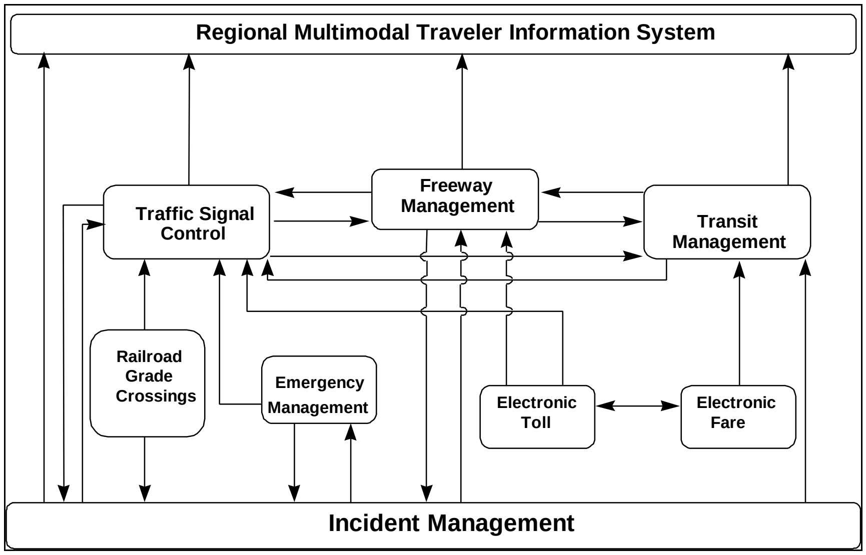

Figure 1. Possible Information Flows Between ITS Components

EVALUATION OF THE MMDI

The evaluation of the MMDI deployments is designed to furnish information to the U.S. DOT, Congress, States, Metropolitan Planning Organizations (MPOs), industry, public interest groups, and others regarding the desirability of investment in ITS. The evaluation will facilitate comparisons of alternative investments within the U.S. DOT's ITS program, and between ITS and non-ITS programs. Goals and objectives for ITS deployment are listed in the *National ITS Program*. These goals and objectives are to:

- Improve the safety of the Nation's surface transportation system
- Increase the operational efficiency of the surface transportation system
- Increase the capacity of the transportation system
- Reduce energy and environmental costs associated with traffic congestion
- Enhance present and future productivity
- Enhance mobility, convenience and comfort on the surface transportation system
- Create an environment where the development and deployment of ITS can flourish.

All of these goals are considered important by the ITS JPO. In addition, the JPO has developed a set of measures of effectiveness to be considered explicitly in the MMDI evaluation. These measures of effectiveness, also referred to as the few good measures (FGMs), are listed here:

- Crashes
- Fatalities
- Throughput
- Delay Reduction
- Cost
- Customer Satisfaction.

The ITS JPO and FHWA's Office of Environment and Planning are also committed to working with the Environmental Protection Agency in the development of measurement methods for ascertaining energy and environmental impacts of ITS deployments.

Taking the goals of the *National ITS Program*, the U.S. DOT's FGMs, and the three MMDI objectives listed earlier into consideration, the MMDI evaluation has been grouped into six studies. Expected outcomes of MMDI projects postulated by the local partners will also be tested as part of these studies. The studies are interconnected, and not completely independent. For example, results from most of the studies will be needed as inputs for the benefit-cost study. The impact of integration of components will be addressed in all appropriate study areas. The six study areas are:

- Safety Study
- Operational Efficiency Study
- Customer Satisfaction Study
- Benefit-Cost Study
- Energy and Emissions Study
- Institutional Benefits Study.

Figure 2 presents the national and local evaluation reporting strategy. Planning, analysis, and reporting will be conducted at the national level. The focus of the national evaluation is to provide a comprehensive picture of the benefits associated with the nine ITS components across the four sites. The focus at the local level is to plan, conduct, and report results that address both the national study area hypotheses and the expected outcomes of the local partners. The result of this process will be a national evaluation report and local evaluation reports for each of the MMDI sites.

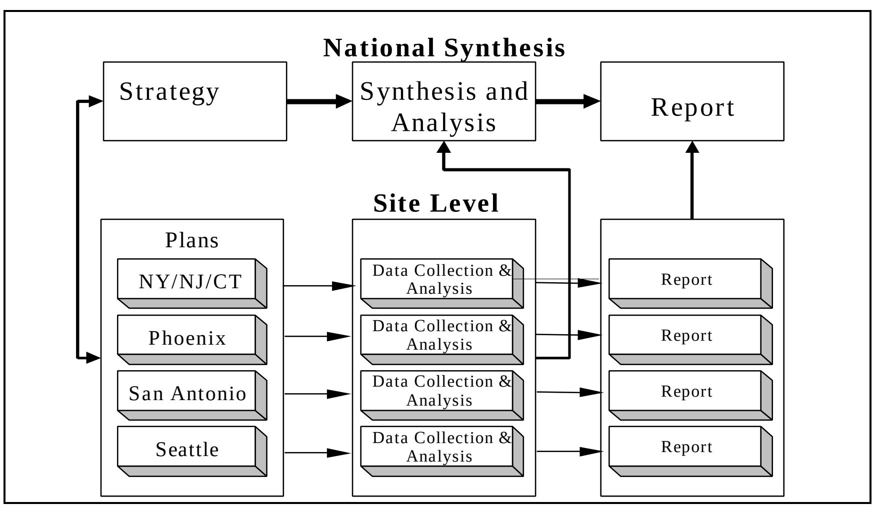

Figure 2. Local and National Evaluation and Reporting Framework

Figure 3 shows the national approach to evaluation of MMDI deployments. Data collection will provide both direct measurement of the "with-ITS" and, if needed, the "without-ITS" conditions. It will also provide data needed for any necessary modeling efforts. Modeling may be necessary to separate benefits due to individual components, or to integration, from total observed benefits. Modeling may also prove necessary to estimate ITS effects on energy consumption, emissions, and safety. These measures can be very difficult and costly to obtain, and in some cases difficult to attribute to a specific ITS deployment.

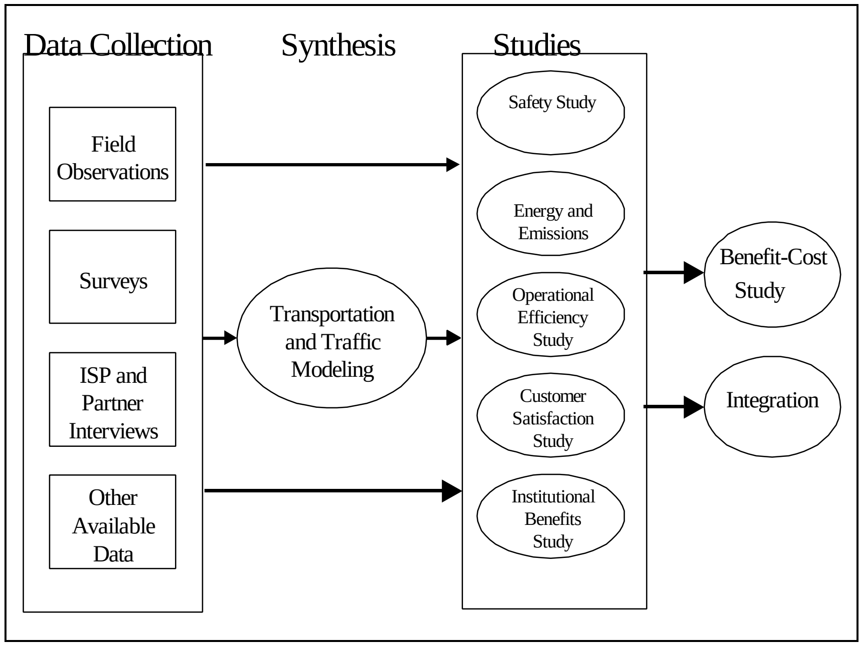

Figure 3. Connections between Data Collection, Synthesis, and Results

PROGRAM RESPONSIBILITIES

The overall philosophy behind the MMDI evaluation approach emphasizes the fact that evaluation is a process that parallels design, development, and implementation of the deployments. According to this philosophy, each site has a Lead Test Site Engineer (LTSE) who works closely with the partners to ensure the evaluation captures the central vision behind the projects, the partners' objectives, and expected outcomes. The evaluation must then identify pertinent measures of effectiveness to see how well expectations are met. Test plans are then developed to orchestrate how, when, and where the data will be collected. Data analysis and report writing culminate the evaluation activity. Throughout the process, feedback from the partners is solicited to ensure a fair evaluation at the end. Objectivity of results is ensured, as much as possible, through separate reporting of the on-site and off-site evaluators directly to the ITS Joint Program Office.

The overall responsibility for conducting the MMDI evaluation rests with Dr. Joseph Peters of the ITS JPO. The JPO is being assisted by staff at the Volpe National Transportation Systems Center and Mitretek Systems, Inc. Teams from Science Applications International Corporation (SAIC) and Battelle are serving as ITS Program Assessment Support contractors. The SAIC team leads the development of the MMDI evaluation strategy, and is responsible for the final report. The Battelle and SAIC teams share responsibility for development of site test plans, site data collection, and preparation of site final reports. The Battelle team is responsible for the Phoenix and NY/NJ/CT MMDI sites, while SAIC is responsible for Seattle and San Antonio MMDI sites. Key members of the Battelle and SAIC teams are shown in Table 2.

Table 2. Key Contractor Personnel

Position	*Name*	*Organization*
Program Manager	David Norstrom	Battelle Team
Phoenix LTSE	Jeff Jenq	
NY/NJ/CT LTSE	Buck Marks	
Customer Satisfaction	Chris Cluett	
IPAS Program Manager	William Perez	SAIC Team
MMDI Coordinator/Manager	Mark Carter	
Principal Investigator	Michel Van Aerde	
Seattle LTSE	Robert Sanchez	
San Antonio LTSE	Charles St-Onge	
Safety	Charles St-Onge	
Energy and Emissions	Michel Van Aerde	
Operational Efficiency	Michel Van Aerde	
Cost Data Collection	Mark Carter	

In addition to these teams, experts in the six study areas have been selected to assist in the MMDI evaluation. These experts are shown in Table 3.

Table 3. U.S. DOT Study Area Experts

Study Area	*Name*	*Organization*
Safety	Larry Brown	FHWA
Energy and Emissions	Cecilia Ho	FHWA
Operational Efficiency	Karl Wunderlich	Mitretek Systems, Inc.
Benefit-Cost	Doug Lee	USDOT, Volpe Center
Customer Satisfaction	Jane Lappin	EG&G/Volpe Center
Institutional Benefits	Allan DeBlasio	USDOT, Volpe Center

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1. INTRODUCTION

This document provides the national strategy for the evaluation of the Metropolitan Model Deployment Initiative (MMDI). This section begins with an overview of the Intelligent Transportation Systems (ITS) Program, and the role of the MMDI within that program. The purpose for evaluating the MMDI is presented. Evaluation goals are summarized, as are the measures planned for assessing goal achievement. Finally the evaluation study areas, and the strategy for executing the evaluation are discussed.

Following this introduction, the components that comprise metropolitan ITS are defined in Section 2. The measurement of ITS integration is discussed, and Section 2 also provides an overview of the components being considered for evaluation at each of the sites. Section 3 presents a more detailed discussion of measurement issues and summarizes the strategy for conducting the separate, but integrated, evaluation studies that will comprise the overall evaluation. For those readers who are new to the Intelligent Transportation Systems program, Appendix A provides a brief history of significant events leading up to the MMDI. Appendix A presents a summary of the ITS projects originally planned to be deployed. Because of the number of projects, these summaries provide only a hint of the technologies that are being deployed, and of the challenge that lies ahead in evaluating the benefits of those technologies. Each project description also includes the hypotheses or expected outcomes prepared by the local partners.

1.1 METROPOLITAN MODEL DEPLOYMENT PROGRAM

The MMDI is a highly visible endeavor, with an aggressive schedule, of great importance to the United States Department of Transportation (U.S. DOT) and the overall ITS program. Initially, the U.S. DOT received 23 applications from metropolitan regions and agencies in response to a notice published in the February 26, 1996 *Federal Register*. The notice sought offers from public and private sectors to form partnerships and participate in the ITS model deployment initiative. The applications were evaluated based on criteria such as commitment to full ITS infrastructure deployment, a regional approach, degree of institutional cooperation, private sector involvement, consistency with the national ITS system architecture, commitment toward evaluation, and a long-term financing commitment. Available federal funding limited selection to four sites. In each case, non-federal partners fund 50 % or more of the total cost of the project.

Selection of the model sites was a key step toward achieving the goals of the U.S. DOT's Operation Time-Saver initiative. The U.S. DOT allocated approximately $38.7 million for the four selected deployment projects, which included: Seattle ($13.7 million), the New York, New Jersey, and Connecticut metropolitan area ($10.4 million), San Antonio, Texas ($7.1. million) and Phoenix, Arizona ($7.5 million).

The purpose of the MMDI is to foster public-private partnerships that showcase fully integrated metropolitan-area ITS infrastructure. The model deployments are intended to demonstrate measurable benefits that result from the application of integrated, region-wide approaches to transportation management, and the provision of advanced traveler information services. The model deployments are also expected to provide improved transportation management and increased levels of service to the traveling public through the integration of traditional functions of traffic signal control; transit management; freeway management; incident management; emergency services management; and regional, multimodal traveler information services. In addition to introducing the public to the benefits of ITS products and services, the model deployments also serve to illustrate the benefits of ITS to key local decision makers across the US. The model deployment sites also provide a setting for the conduct of rigorous evaluations of the benefits of integrated metropolitan area ITS transportation management systems.

1.2 MMDI EVALUATION PURPOSE

ITS technology has been evolving over the past ten years. Some of it has been deployed in field tests, in pilot applications, and in components of state and local transportation management systems. The MMDI is intended to show the value of integration across ITS components and across jurisdictions. The four MMDI sites were selected based upon their already having achieved a certain level of ITS deployment, but needing additional resources to achieve integration or higher levels of integration. They represent unique opportunities to determine the impact not only of new ITS components, but also the integration of new and existing ITS components. In addition, at most MMDI sites, field operational tests, current and ongoing, will be available to provide evaluation data and findings for the MMDI evaluation.

The overriding goal of the MMDI evaluation is to test the hypothesis that "the whole is greater than the sum of the parts." This synergy hypothesis states that integration of deployed ITS infrastructure will result in greater total benefits than if the different parts of the infrastructure acted independently. Other corollary objectives include:

- Documenting institutional benefits that enabled these sites to be selected.
- Determining the incremental effects of increasing the levels of ITS deployment, especially Traveler Information Systems, on some key transportation system attributes, such as customer satisfaction, traffic flow, travel demand, and safety.
- Conducting an economic analysis of costs versus benefits of ITS deployment.

Some of the questions that evaluation of the MMDI will address are:

- Which ITS elements or packages produce the greatest payoff relative to the resources expended?
- Will safety benefits, such as reducing the number of crashes, be realized through the use of ITS?
- How does the previous level of ITS deployment affect the benefit-cost performance of additional ITS elements or packages?
- How do ITS approaches compare with traditional approaches to transportation and air quality problems, such as adding expressway lanes or imposing emissions standards?
- Assuming ITS will not be deployed everywhere immediately, under what conditions and in what locations are ITS alternatives most effective?
- Will ITS deployments have significant effects on air quality, energy consumption, traffic and travel volumes, and the efficiency of the transportation system, and if so, in what direction (better or worse) and by how much?
- Are ITS alternatives a way to increase the throughput of the transportation system without adding a lot of physical capacity, and is ITS cheaper than adding capacity to achieve the same throughput?
- Are the benefits from integrating ITS components greater than if no integration occurred?
- Do users and taxpayers have favorable views of ITS activities?

The evaluation is intended to furnish information to U.S. DOT, Congress, States, MPOs, industries, public interest groups, and others regarding the effectiveness of ITS investments and corresponding enhancements to national, state, regional and local transportation programs. The study will facilitate comparisons among alternative investments within the U.S. DOT's ITS program, and between ITS and non-ITS programs.

The proposed approach to conducting the MMDI evaluations will maximize the potential for obtaining scientifically substantiated findings in four main areas of investigation:

- The estimation of the relevant incremental impacts of each increase in ITS deployment at each MMDI site, where these impacts consist of both changes in traffic flow and travel demand related attributes, as well as changes in transportation-related attributes such as throughput, safety, customer satisfaction, energy consumption, and the environment.
- A monetary valuation of these relevant incremental impacts for each increase in ITS deployment at each site, in such a manner that these valuations can also be directly matched against the corresponding incremental monetary cost responsible for these impacts.
- A synthesis, across all sites and by ITS service, of the relevant incremental effects of the various increases in ITS deployment that were observed at each MMDI site.
- A synthesis, across all sites and by ITS service, of the valuations of the relevant changes in ITS impacts, in such a manner that it can be compared to a similar synthesis of the corresponding incremental ITS deployment costs.

The evaluation plan outlines how the overall MMDI evaluation will provide coverage of all of the 9 ITS services, including their integration. In addition, the evaluation strategy suggests, at a high level, how all relevant measures will be estimated for each ITS component. The evaluation strategy also provides recommendations with respect to standardized evaluation methods and surveys, such that results can be consolidated across sites.

Site-specific test plans will be developed at each of the four sites. These test plans will detail the scope and methods for the evaluations at the sites. The national evaluation team will provide a structure for these test plans, and the test plans in turn may reference the specific evaluation and survey techniques identified within the overall strategy.

1.3 NATIONAL ITS PROGRAM GOALS AND PRIMARY MEASURES

Per the *National ITS Program*, the goals and objectives of the ITS Program are:

- Improve the safety of the Nation's surface transportation system
    - Reduce the frequency of crashes
    - Reduce the severity of crashes
- Increase the operational efficiency of the surface transportation system
- Increase the capacity of the transportation system
    - Reduce congestion due to incidents
    - Improve transportation customer service

- Reduce energy and environmental costs associated with traffic congestion
  - Reduce harmful emissions per unit of travel
  - Reduce energy consumption per unit of travel
  - Reduce new transportation right-of-way requirements
- Enhance present and future productivity
  - Reduce costs of fleet operators, operating agencies, and individuals
  - Reduce travel time
  - Improve transportation system management and planning
- Enhance the personal mobility and the convenience and comfort of the surface transportation system
  - Enhance traveler security
  - Reduce travel stress
  - Improve access to transportation
- Create an environment in which the development and deployment of ITS can flourish.

The goals and objectives are measured in terms of outcomes to be achieved with ITS programs. Outcomes are measures that relate directly to the goals and objectives of the ITS program. In defining the outcomes or measures, U.S. DOT has developed a set of primary indicators used in the MMDI evaluation strategy. These measures are:

- Crashes
- Fatalities
- Throughput
- Delay reduction
- Cost
- Customer Satisfaction

These "few good measures" (FGMs) are not meant to be the exclusive evaluation indicators. They are meant to complement the *National ITS Program* goals, and assist in testing the JPO's hypothesis that "the whole is greater than the sum of the parts." How all of these goals and indicators will be combined into an evaluation strategy is discussed following the discussion of infrastructure integration.

1.4 MEASURING DEPLOYMENT OF INTEGRATED ITS INFRASTRUCTURE

A proposed goal of MMDI is to encourage integration of ITS components. Each test site was to have already made considerable investment in ITS infrastructure and obtained agreements for institutional cooperation. In other words, the premise of the model deployment awards is that the whole is more than the sum of the parts, and the model deployment initiative offers the opportunity to showcase the benefits of integration.

The evaluation will rely on work in the area of ITS deployment tracking. The U.S. DOT has an on-going project aimed at tracking the deployment of the ITS Infrastructure components and their integration across 75 of the largest metropolitan areas in the U.S. The four MMDI sites are on the top of the priority list for collecting and summarizing data with respect to deployment tracking.

A survey has been developed for assessing the level of deployment of the 9 ITS infrastructure components and their integration. The survey assesses the amount of data flowing between components and the degree to which data are used to support control or decision making. The measurement of ITS components, and their integration, is discussed in Section 2 of this report.

1.5 EVALUATION STUDY AREAS

Six study areas have been defined to combine the JPO's synergy hypothesis, the *National ITS Program* goals, and the JPO's FGMs into an overall evaluation strategy. These six evaluation studies are:

- Safety
- Operational Efficiency
- Customer Satisfaction
- Benefit-Cost
- Energy and Emissions
- Institutional Benefits.

The FGMs are evaluated as part of the Safety, Operational Efficiency, Customer Satisfaction, and Benefit-Cost. Other goals such as evaluating emissions and assessing institutional benefits are covered by the last two studies. The synergy hypothesis will be evaluated both within each study and by integrating results across studies. Section 3 describes the evaluation strategy for each of these studies.

1.6 BENEFITS TO PROJECTS AT THE LOCAL SITES

The evaluation strategy is intended to provide benefits in the planning, conduct, and analysis of evaluations at each of the MMDI sites. The benefits of the strategy to the local sites are expected to derive from five actions:

- Suggest priorities
- Ensure sufficient data are collected
- Provide a common set of data collection tools
- Provide a common set of inference tools
- Provide economies of scale

Suggest priorities. For each site, ITS components that represent evaluation priorities will be identified. This does not mean that other ITS components at this site are not important, or should not be evaluated. However, it does mean that the evaluation of high priority ITS components will receive particular attention to ensure that benefit and cost assessments are performed in a manner that supports the evaluation requirements.

Ensure sufficient data are collected. The evaluation team will help to ensure that sufficient before and after, or with and without, data are collected to ensure the evaluations are technically sound and statistically valid. The national evaluation team will strive to ensure that the local evaluations track outcome measures that might reasonably be expected to have measurable impacts. Special emphasis will be given to ensuring that the measurable benefits of integration of ITS components are tracked.

Provide a common set of data collection tools. Where appropriate, the use of common data collection and survey instruments will be encouraged. The purpose of encouraging use of common instruments is to ensure comparable results across sites. Common instruments may represent but a subset of the total measurements at each site: common instruments will be supplemented with additional material to address unique local issues and concerns.

Provide a common set of inference tools. The evaluation team will strive to provide a core set of standardized inference tools. Many of the outcome measures, such as safety, throughput, and mobile emissions, will not be measured directly in the field. Instead, they may be inferred using inference tools such as planning models, traffic models, and emission models. The evaluation team will recommend tools to perform inferential analysis, and offer to perform certain analyses for the sites.

Provide economies of scale. By providing prioritization of unique and redundant projects among the sites, ensuring sufficient inferential power, and providing common data collection and analysis instruments, the synthesis approach offers economies of scale that avoid unnecessary duplication of efforts and ensures that important opportunities are not inadvertently overlooked.

1.7 EVALUATION STRATEGY

The evaluation of the MMDI sites represents a departure from previous ITS evaluation efforts. In the past, Field Operational Tests (FOTs) have been conducted to evaluate the deployment of single or relatively few ITS components in a single metropolitan area. Furthermore, for the conduct of ITS FOTs, no a priori attempts were made to develop a unifying strategy for conducting evaluations across FOTs. Rather, evaluation guidelines were developed and distributed, and general guidance and support was provided by U.S. DOT to the specific FOT sites. At a general level, to conduct a field evaluation one needs to define what is to be evaluated and how it will be evaluated. The evaluation strategy principally addresses the what of evaluation.

The what for evaluation includes the MMDI sites, the projects at the sites (related to ITS components), and the integration of ITS components at the sites. Appendix B of this strategy document presents the current listing of projects that are candidates for evaluation. The project descriptions also include a listing of local partner hypotheses or expected outcomes.

The strategy also presents the types of analyses to be conducted and the measures of effectiveness (e.g., few good measures) that will be employed. The strategy is responsive to the requirements of the MMDI evaluation: to address the few good measures; to address the issue of benefits and costs, and to consider the effect of MMDI on both energy use and emission production. Sections are presented in this strategy that address the overall approach for satisfying these analysis requirements. The analyses will employ data collected from the MMDI sites, and data or results from other sources (e.g., results from previous field operational tests).

This document represents a framework or national strategy within which to conduct the evaluations, and is presented as a work in progress. The evaluation strategy will evolve as details are worked at the local level (MMDI sites) and the feasibility and pay-off associated with alternative evaluation methods and techniques are more clearly defined.

Figure 1-1 presents an overview of the national approach from a planning framework. Planning, analysis, and reporting will be conducted at the national level with the primary aim to present a comprehensive picture of the benefits associated with the deployment of ITS. The focus at the local level is to plan, conduct, and report results that are responsive and comprehensive with respect to the goals of the local partners and what was actually deployed at the sites.

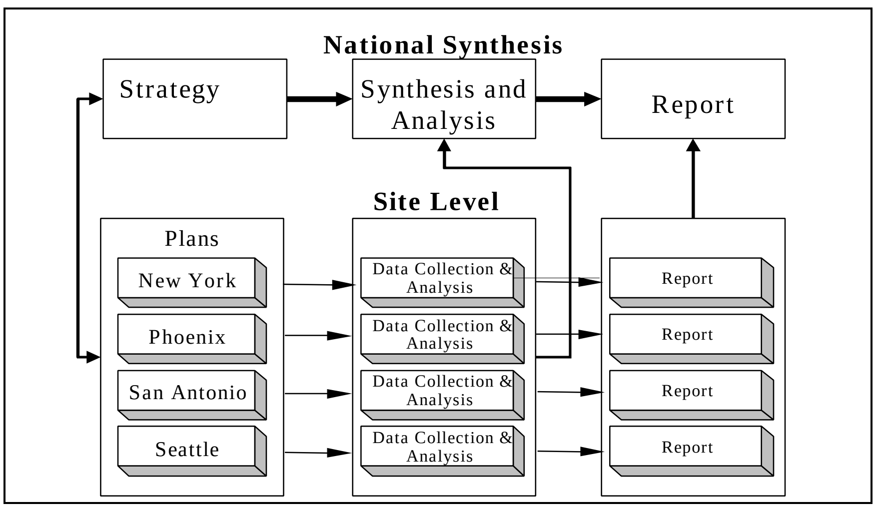


Figure 1-1. Local and National Evaluation and Reporting Framework

The strategy also focuses on the evaluation of hypotheses or expected outcomes for each of the MMDI projects, a consistent analysis framework across all sites, and the use of benefit-cost analysis techniques for reporting overall results. The evaluation strategy consists of three major steps, which are presented in the following three paragraphs.

The first step will be the collection of direct data, whether through surveys, automatic data collection, traffic counts, or other means. Anecdotal reports and "success stories" will also be collected to document some of the noteworthy achievements of the MMDI. Interim reports on these data will be released as they become available. While these preliminary reports may be superficial, or simply report raw numbers collected from surveys or traffic counts, they will serve to establish a basis for the further analysis steps.

The second evaluation step will be to use these interim results in more complex statistical analyses or modeling. Models will use field data to draw further and broader conclusions, especially in the area of energy and emissions. They will also play a key role in separating the benefits of the individual deployments from the benefits due to integration with other projects. More in-depth study of survey results will lead to better insight into satisfaction and behavioral issues, that may in turn point to areas where further research may be warranted. Further interim reports will be released detailing some of the observations and early conclusions drawn from modeling and further analysis.

As a last step, modeled and analyzed data will be used to perform benefit-cost analyses of the MMDI evaluation projects. This step will involve comparison of costs of deployment with the benefits achieved in order to draw conclusions on the economic benefits of the MMDI deployments. This step will lead into the preparation of both site reports and a national synthesis report, which will add further detail to the previously released interim reports, and will include the benefit-cost analyses, lessons learned, and success stories from the sites.

1.8 PROGRAM RESPONSIBILITIES

The overall philosophy behind the MMDI evaluation approach emphasizes the fact that evaluation is a process that parallels design, development, and implementation of the deployments. According to this philosophy, each site has a Lead Test Site Evaluation Engineer (LTSE) who works closely with the partners to ensure the evaluation captures the central vision behind the projects, the partners' objectives, and expected outcomes. The evaluation must then identify pertinent measures of effectiveness to see how well expectations are met. Test plans are then developed to orchestrate how, when, and where the data will be collected. Data analysis and report writing culminate the evaluation activity. Throughout the process, feedback from the partners is solicited to ensure a fair evaluation at the end. Objectivity of results is ensured, as much as possible, through separate reporting of the on-site and off-site evaluators directly to the ITS JPO.

The overall responsibility for conducting the MMDI evaluation rests with Dr. Joseph Peters of the ITS JPO. The JPO is being assisted by staff at the Volpe National Transportation Systems Center, and Mitretek Systems, Inc. Teams from Science Applications International Corporation (SAIC) and Battelle are serving as ITS Program Assessment Support contractors. The SAIC team leads the development of the MMDI evaluation strategy, and is responsible for the final report. The Battelle and SAIC teams share responsibility for development of site test plans, site data collection, and preparation of site final reports. The Battelle team is responsible for the Phoenix and NY/NJ/CT MMDI sites, while SAIC is responsible for Seattle and San Antonio MMDI sites. Key members of the Battelle and SAIC teams are shown in Table 1-1.

Table 1-1. Key Contractor Personnel

Position	*Name*	*Organization*
Program Manager	David Norstrom	Battelle Team
Phoenix LTSE	Jeff Jenq	
NY/NJ/CT LTSE	Buck Marks	
Customer Satisfaction	Chris Cluett	
IPAS Program Manager	William Perez	SAIC Team
MMDI Coordinator/Manager	Mark Carter	
Principal Investigator	Michel Van Aerde	
Seattle LTSE	Robert Sanchez	
San Antonio LTSE	Charles St-Onge	
Safety	Charles St-Onge	
Energy and Emissions	Michel Van Aerde	
Operational Efficiency	Michel Van Aerde	
Cost Data Collection	Mark Carter	

In addition to these teams, experts in the six study areas have been selected to assist in the MMDI evaluation. These experts are shown in Table 1-2.

Table 1-2. U.S. DOT Study Area Experts

Study Area	*Name*	*Organization*
Safety	Larry Brown	FHWA
Energy and Emissions	Cecilia Ho	FHWA
Operational Efficiency	Karl Wunderlich	Mitretek Systems, Inc.
Benefit-Cost	Doug Lee	USDOT, Volpe Center
Customer Satisfaction	Jane Lappin	EG&G/Volpe Center
Institutional Benefits	Allan DeBlasio	USDOT, Volpe Center

2. ITS COMPONENTS

There are nine ITS components to be assessed by MMDI evaluation. Of particular importance, in addition to the infrastructure required for the components themselves, is their integration. This section describes each of the components in turn. It also explains what, for evaluation purposes, is meant by integration. Following the description of each component is a short paragraph that identifies where the components are being deployed, and under which projects. Detailed descriptions of each of the MMDI projects are provided in Appendix B.

2.1 INTRODUCTION

This section introduces the concepts used to measure the extent of ITS technologies in use at the MMDI sites. ITS deployments are broken out into categories: (1) individual ITS components and (2) integration of ITS components. The measurement of the deployment of an individual component is based on measurement of the technologies commonly used to implement that component. For example, common Freeway Management technologies include electronic traffic surveillance, ramp metering, lane control, variable message signs (VMS), and highway advisory radio (HAR).

There are currently 64 projects being considered for evaluation as part of the national MMDI. The distribution of these projects by ITS component and site is shown in Table 2-1. The deployment of most of these projects is being funded through the U.S. DOT model deployment initiative. For some ITS components, such as Electronic Fare Payment, no MMDI-funded deployments are planned. In this and other such cases, non-MMDI funded projects are being considered for evaluation to give more coverage to all nine ITS components. It should be noted that projects will change in characteristic and numbers. Over time, the numbers in Table 2-1 will change slightly.

Table 2-1. ITS Component Deployments by Site

ELEMENT	*Abbr.*	*San Antonio*	*Phoenix*	*Seattle*	*NY/NJ/CT*	*TOTAL*	
Traffic Signal Control Systems	TS	1	3	6	0	10	16%
Freeway Management Systems	FM	1	1	3	0	5	8%
Incident Management	IM	0	1	2	0	3	5%
Electronic Toll Collection	ETC	0	0	0	1	1	1%
Emergency Management	EMS	1	1	3	0	5	8%
Transit Management	TM	2	3	3	0	8	13%
Electronic Fare Payment	EFP	0	1	0	0	1	1%
Railroad Grade Crossing	RRX	1	0	0	1	2	3%
Traveler Information Systems	ATIS	4	8	12	5	29	45%
Total		10	18	29	7	64	
		16%	28%	45%	11%		

2.2 NON MMDI EVALUATION PROJECTS

The following five, non-MMDI funded projects have been included in Table 2-1. These projects have been included to provide information on ITS components about which little evaluation data is known.

- Long Island Railroad NY/NJ/CT Railroad Grade Crossing
- BusCard Phoenix Transit Management
- TransGuide Expansion San Antonio Freeway Management
- EZPass NY/NJ/CT Electronic Toll Collection
- TRASMIT NY/NJ/CT Traveler Information

2.3 FREEWAY MANAGEMENT

2.3.1 Definition and Characteristics

The primary functions of Freeway Management systems are to:

- Monitor traffic conditions on the freeway system.
- Identify recurring and non-recurring flow impediments so that short-term and long-term actions can be taken to alleviate congestion.
- Implement various control and management strategies (such as ramp metering, lane control, or traffic diversion).
- Provide traveler information to travelers through infrastructure-based dissemination methods such as variable message signs (VMS), highway advisory radio (HAR), and in-vehicle signing.

Freeway Management often includes a Freeway Management Center (or multiple centers where responsibility for the freeway system is shared by more than one operating entity in a metropolitan area) and links to other ITS components in the metropolitan area. From these centers, personnel electronically monitor traffic conditions, activate response strategies, and initiate coordination with intra-agency and inter-agency resources, including emergency response and incident management providers.

Closed-circuit television and an array of sensors (e.g., inductive loops, magnetometers, microwave radar, ultrasonic, infrared, video image processing, automatic vehicle identification, and passive acoustic devices) may be used to electronically monitor freeway conditions in real-time. Other sources of information concerning real-time freeway conditions include communications received from police and maintenance personnel as well as cellular telephone reports called in from drivers. Automatic Vehicle Identification (AVI) readers may also be used to acquire probe vehicle data.

Traffic condition data are analyzed to identify the cause of a flow impediment and to formulate an appropriate response in real-time. Traffic control devices, such as ramp meters or lane control devices, may be proactively applied to provide a better balance between freeway travel demand and capacity. Information may be provided to travelers through roadside traveler information devices such as variable message signs, highway advisory radio, and in-vehicle signing. Emergency response and incident management providers may be notified to respond to non-recurring incident events.

2.3.2 Freeway Management Integration

Figure 2-2 shows how the following information may be transferred from other components to the Freeway Management component, as well as from the Freeway Management component to other components.

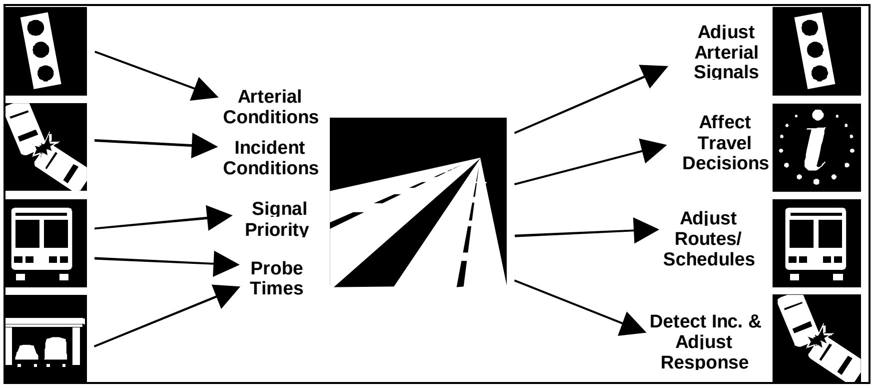
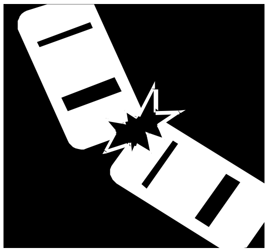


Figure 2-2. Freeway Management Integration

2.3.3 MMDI Deployment of Freeway Management

There are four MMDI Freeway Management projects and one non-MMDI Freeway Management project among the 64 MMDI deployments. Three MMDI deployments are located in Seattle, and the fourth is in Phoenix. The non-MMDI project is in San Antonio. San Antonio is implementing an additional 27 miles of "smart" freeway, monitored by cameras, loop detectors, and fitted with lane control signals (LCS) and variable message signs (VMS). This project is included as it may play a part in evaluating the deployment of AVI tags and tag readers on other freeways and arterials in San Antonio. Seattle is creating one new regional traffic systems management center for the Olympic Region, and updating the Northwest region's center. These centers collect management information from freeway loop detectors and cameras. This information will be integrated more fully with traveler information and traffic signal control systems. Further integration of the freeway video system with the traveler information and other systems is also being done as part of the Regional Video System project. Integration is part of all of these projects. More complete descriptions of these projects can be found in Appendix B.

2.4 INCIDENT MANAGEMENT



2.4.1 Definition and Characteristics

The primary functions of Incident Management systems are to:

- Coordinate incident identification, response, and clearance activities across regional boundaries.
- Use traffic management capabilities to improve response times.
- Reduce traveler delays due to incidents.

Incident management provides an organized and functioning system for quickly identifying and clearing crashes, disabled vehicles, debris, and other non-recurring flow impediments from area freeways and major arterials. Roadways are cleared and flow restored as rapidly as possible, minimizing frustration and delay to travelers while at the same time meeting the requirements and responsibilities of the agencies involved. The various jurisdictions and agencies responsible for operations and enforcement have worked together to develop a policy and operations agreement that defines specific responsibilities of incident management. Such an agreement includes detection, verification, response, clearance, scene management, and traffic management and operation.

This multi-jurisdictional operating agreement ensures cooperation, coordination, and communication among all agencies including law enforcement, fire, ambulance, highway traffic control, and maintenance, as well as environmental and other public agencies. Interagency cooperation also reduces duplication of effort in coordinating incident management activities. In addition, private sector businesses that do towing and recovery may be involved in incident clearance.

Incident Management is often fully integrated with Freeway Management to utilize the surveillance, traffic control strategies, and traveler information resources provided by the Freeway Management. In addition, Incident Management maintains communications with Emergency Management Services to respond to incidents, manage incident sites, and restore traffic flow conditions. Finally, Incident Management may be integrated with Traffic Signal Control to effect coordinated traffic signal timing to accommodate traffic diversion during incident response.

Monitoring of freeway conditions for the purpose of incident management is usually integrated with Freeway Management, with notification of the presence of an incident provided to the Incident Management component. The Incident Management component is then responsible for developing an appropriate response strategy and for clearance of the incident. An appropriate response strategy is put into action and responsible agencies are notified to manage the incident site and clear impediments as quickly and safely as possible.

2.4.2 Incident Management Integration

Figure 2-3 shows how the following information may be transferred from other components to the Incident Management component, and also from the Incident Management component to other ITS components.

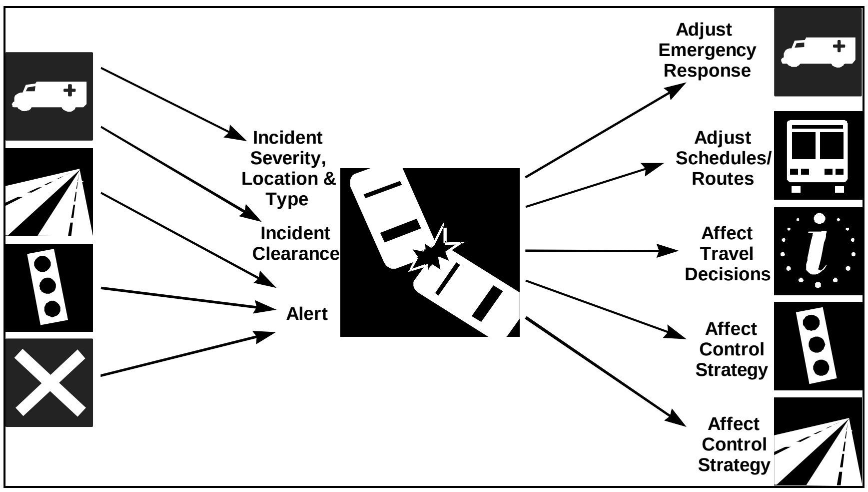
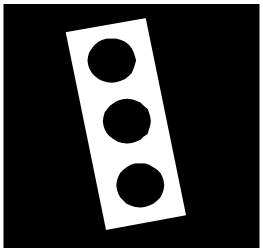


Figure 2-3. Incident Management Integration

2.4.3 MMDI Deployment of Incident Management

Two Incident Management systems are being deployed in Seattle, and one is to be deployed in Phoenix. Phoenix has an Incident Management project that consists of computer-aided incident investigation. Seattle has two projects, consisting of incident video capturing and processing systems. Integration is an important part of both of these Seattle projects. Descriptions of these three Incident Management systems can be found in Appendix B.

2.5 TRAFFIC SIGNAL CONTROL



2.5.1 Definition and Characteristics

The primary functions of Traffic Signal Control systems are to:

- Monitor traffic conditions on arterials.
- Coordinate traffic signal timing patterns across metropolitan arterials and networks.
- Implement traffic signal timing patterns that are responsive to traffic conditions.
- Implement traffic signal timing patterns that are responsive to transit and emergency vehicles.

Traffic Signal Control is responsible for the coordinated control of traffic signals along metropolitan arterials and networks. Traffic Signal Control provides the capability to adjust the amount of green time for each street and coordinate operation between and among signals in response to changes in demand patterns. Traffic signal timing patterns may be executed in response to pre-established "time of day" or "special event" plans, based on historical traffic conditions, or may be executed in response to real-time traffic conditions using "traffic adaptive" algorithms. Coordination can be implemented through a number of techniques including time-based and hardwired interconnection methods. Coordination of traffic signals across agencies requires the development of data sharing and traffic signal control agreements. Therefore, a critical institutional component of Traffic Signal Control is the establishment of formal or informal arrangements to share traffic control information as well as actual control of traffic signal operations across jurisdictions.

Unlike traditional traffic signal control, the Traffic Signal Control component of the ITS infrastructure employs cooperative institutional arrangements; advanced surveillance, control, and information technologies to improve travel times and overall transportation network efficiency. ITS features include: closed circuit TV surveillance; motorist information and/or traveler information components; a data base management system to support analysis and development of management strategies; and, data exchange with other traffic management systems including freeway management and incident management. Simulation may be included to project near-term traffic trends for selection of signal timing strategies to optimize throughput.

2.5.2 Traffic Signal Control Integration

Figure 2-4 shows how the following information may be transferred from other components to the Traffic Signal Control component for the purpose of adjusting signal timing or preemption. It also shows how information gathered from Traffic Signal Control systems can be shared with other ITS components:

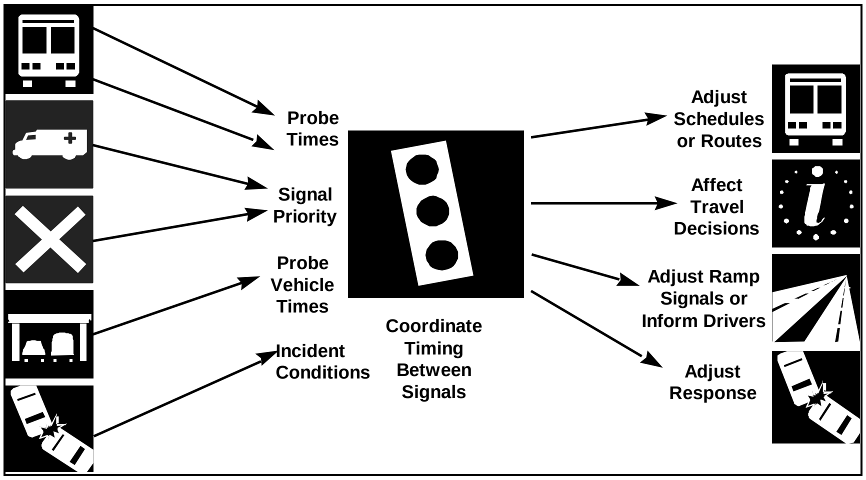
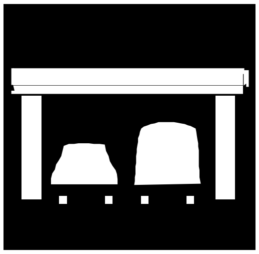


Figure 2-4. Traffic Signal Control Integration

2.5.3 MMDI Deployment of Traffic Signal Control

There are ten Traffic Signal Control projects proposed at three MMDI sites. Phoenix is developing cross-jurisdictional integration of arterial signals in three corridors. Seattle's six projects consist almost entirely of integration of six advanced traffic management subsystems with other ITS components. San Antonio's MMDI Corridor project consists of implementing better signal timings and integrating of information on a stretch of arterial roadway in the city's medical district. More detailed descriptions of these ten projects can be found in Appendix B.

2.6 ELECTRONIC TOLL COLLECTION



2.6.1 Definition and Characteristics

The primary functions of Electronic Toll Collection systems are to:

- Implement electronic financial transaction processing to reduce delay at toll collection plazas.
- Reduce the need for travelers and public agencies to handle money.
- Coordinate between agencies to establish a common payment medium.
- Reduce toll agency costs.

Electronic Toll Collection (ETC) provides for automated collection of toll revenue through the application of in-vehicle, roadside, and communication technologies to process toll payment transactions. Participating patrons (vehicles) are identified by the use of roadside hardware and software and an identifier or "tag." In areas with more than a single toll collection authority, compatible tag technologies should be used to enhance convenience to the patron and to promote seamless transaction processing.

Communications between the roadside equipment and the identifier occur as the vehicle approaches or passes the toll collection point. When the communication is complete, the roadside equipment utilizes the identification information contained on the "tag" to initiate the in-lane processing function. The in-lane processing involves some level of validation of identification information and vehicle classification information from the patron or vehicle. Validation may include verification that a particular "tag" was issued by the particular toll authority as well as validation of the account status. To assure customers that correct transactions have occurred, confirmation of toll charges are provided through roadside message signs or in-vehicle devices. After the passage of the vehicle, the in-vehicle processing ends with creation of a transaction record that is forwarded to the central processing function to consolidate the transactions for each tag and collect the appropriate toll revenue from the patron. Additional data, such as an image or images of the vehicle and/or license plate, may be collected during in-lane processing to detect and enforce violations.

2.6.2 Electronic Toll Collection Integration

Figure 2-5 shows how the following information may be transferred from other components to the Electronic Toll Collection component for the purpose of providing a common fare medium: credit identification from the Electronic Fare Payment component.

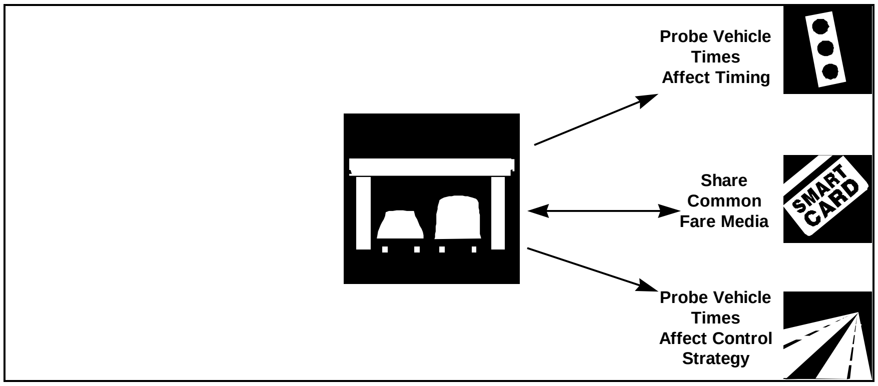
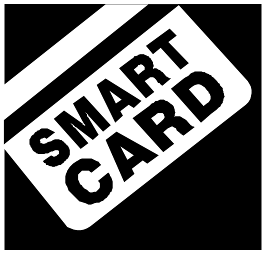


Figure 2-5. Electronic Toll Collection Integration

2.6.3 MMDI Deployment of Electronic Toll Collection

No MMDI Electronic Toll Collection projects are planned. In order to fill this gap in the MMDI evaluation, one non-MMDI project, the installation of more EZPass electronic toll collectors at toll plazas around the NY/NJ/CT area, is being considered for evaluation.

2.7 ELECTRONIC FARE PAYMENT



2.7.1 Definition and Characteristics

The primary functions of Electronic Fare Payment are to:

- Provide a single fare medium for paying travel-related fares and parking fees.
- Reduce the need for travelers and public agencies to handle money.

Electronic Fare Payment provides electronic communication, data processing, and data storage technologies to collect travel-related fares (such as public transit fares) and parking fees. Electronic Fare Payment provides transportation agencies with the ability to automate their accounting and financial settlement processes, and provides travelers with a convenient way to pay for transportation services.

Payment cards can take a variety of forms including debit, credit, and stored value cards. The payment card technologies range from a cardboard or plastic “swipe” card with limited data storage capability to a “smart” card containing a high level of storage and data processing capacity. Cards may be encoded with a variety of electronic data that are used to initiate a fare payment transaction, process the transaction, and enforce violations of fare payment policy. In areas with more than a single transit operator, a common fare medium should be used to enhance traveler convenience and promote coordinated financial transaction processing.

Payment processing is initiated by the card reader either through direct contact with the payment card or, in the case of more advanced technologies, scanning of a card located in close proximity to the reader. The data contained on the card are interrogated by the card reader to establish fare pricing for a requested trip or parking service and to validate the patron or card account status. In the case of a debit card, the appropriate fare is immediately deducted from the payment card and a new credit level is established. In the case of a credit card, the patron account will be billed the appropriate amount. A transaction record is prepared and forwarded to the central processing function.

2.7.2 Electronic Fare Payment Integration

Figure 2-6 shows how credit identification information obtained through the Electronic Toll Collection component may also be transferred to the Electronic Fare Payment component for the purpose of enabling a common fare medium.

Credit identification information may be transferred from the Electronic Fare Payment component to Electronic Toll Collection component for the purpose of enabling a common fare media. Transit ridership details obtained coincident with fare payment may also be transferred from the Electronic Fare Payment component to the Transit Management component for use in service planning. The same fare card could also be used for transit park and ride lot fees and other costs associated with transit use.

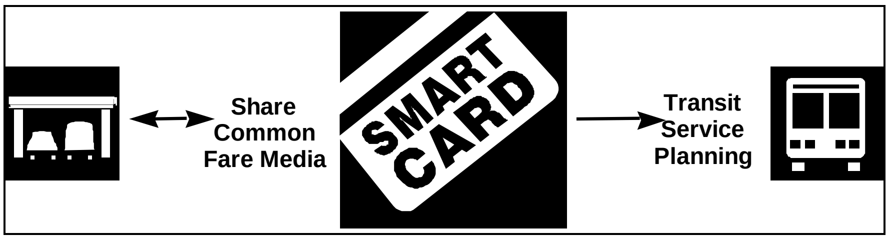
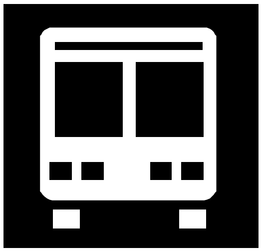


Figure 2-6. Electronic Fare Payment Integration

2.7.3 MMDI Deployment of Electronic Fare Payment

One non-MMDI Electronic Fare Payment project is being considered for evaluation. As in the case of Electronic Toll Collection, it is being considered to provide full coverage of all nine ITS components. The non-MMDI Transit Electronic Fare Payment project in Phoenix is already in place. Integration with other components is not a part of this project. A description of the project may be found in Appendix B.

2.8 TRANSIT MANAGEMENT



2.8.1 Definition and Characteristics

The primary functions of Transit Management systems are to:

- Monitor the location of transit vehicles to support schedule management and emergency response.
- Monitor maintenance status of the transit vehicle fleet.
- Provide demand responsive flexible routing and scheduling of transit vehicles.
- Provide real-time, accurate, transit information to travelers.

Transit Management supports management of the transit fleet by electronically monitoring vehicle locations in real time. Transit vehicles equipped with automatic vehicle location (AVL) technology provide the basis for vehicle tracking. Information on the current location of a transit vehicle is transmitted to a centralized dispatcher who then compares the actual location with the scheduled location. Depending on the variance between the actual and scheduled locations, actions may be taken to improve schedule adherence and to transfer information to travelers. This also supports emergency response by providing real time information on vehicle locations in emergency situations.

Transit management includes the electronic monitoring of vehicle performance parameters using in-vehicle sensors. This involves monitoring of usage statistics such as mileage and status of routine scheduled maintenance. In addition, this permits automatic monitoring of vehicle condition, including key parameters such as oil and fuel levels and tire pressure.

The use of AVL also supports advanced demand-responsive computer-aided routing and scheduling, especially useful to paratransit operators. Transit dispatchers can combine real-time information on vehicle location and status with advanced computer aided dispatching systems to provide optimal vehicle assignment and routing to meet non-recurring public transportation demand. Some additional advantages of transit management projects could include increased security, quick and accurate location of transit vehicles for apprehending criminals, and providing a deterrent to criminal activity.

Schedule information can be disseminated in near real-time to travelers through a variety of methods directly controlled by the transit management agencies, such as information kiosks, radio and television, and the World Wide Web.

2.8.2 Transit Management Integration

Figure 2-7 shows how Transit Management can receive information on freeway travel conditions from Freeway Management and arterial conditions from Traffic Signal Control, as well as incident location and severity from Incident Management, and adjust vehicle routing or scheduling as a result. Transit Management may also receive information on the origins and destinations of transit riders from Electronic Fare Payment.

Information links from Transit Management to Traffic Signal Control can provide for signal priority treatment of transit vehicles to improve on-time performance. Links with Freeway Management can support ramp metering priority for transit vehicles. Transit Management can also provide Freeway Management and Traffic Signal Control with probe information for highway travel time determination. Transit location and schedule data as well as data on real-time schedule adherence can be transferred to the Regional Multimodal Traveler Information system to distribute traveler information concerning transit service performance.

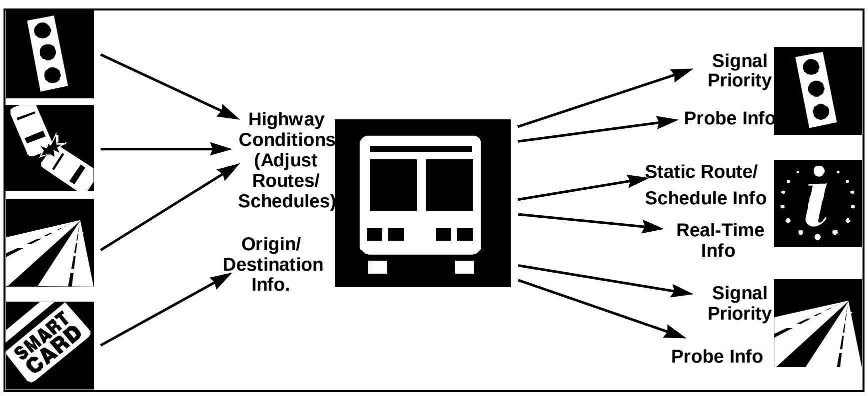
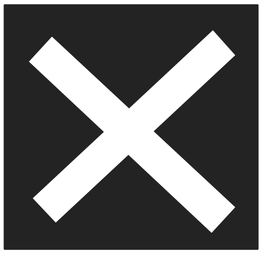


Figure 2-7. Transit Management Integration

2.8.3 MMDI Deployment of Transit Management

Eight Transit Management deployments at three sites are currently being considered for evaluation. Three Transit Management projects are planned for Phoenix, two for San Antonio, and three for Seattle. Of the three projects in Phoenix, only one is an MMDI funded project. This is a Transit Vehicle Dispatch project, consisting of the placement of mobile data terminals and AVI tags on select buses in the Phoenix area. One other non-MMDI funded project will involve deployment of AVI tags on paratransit buses to facilitate vehicle dispatch and routing. The last project, also non-MMDI funded, will include installation of mobile data terminals and AVL on Phoenix transit service vehicles. One of San Antonio’s transit projects will include the installation of driver-activated video surveillance on buses. The second will involve the installation of IVN units in paratransit vehicles. Seattle’s three projects consist of automatic vehicle location for buses in the region to provide real-time schedule information, a bus signal priority system for two corridors, and a ride matching web page. Integration will play an important role in some of the Seattle projects. More detailed descriptions of these projects can be found in Appendix B.

2.9 RAILROAD GRADE CROSSINGS



2.9.1 Definition and Characteristics

The primary functions of Railroad Grade Crossing systems are to:

- Coordinate traffic signals with rail movements.
- Provide travelers with advanced warning of crossing closures.
- Improve and automate warnings at railroad grade crossings.

Railroad grade crossings are a special form of a roadway intersection where a roadway and one or more railroad tracks intersect. At a crossing, the right-of-way is shared between railroad vehicles and roadway vehicles, with railroad vehicles typically being given preference. Railroad trains, which travel at high speeds and can take up to a mile or more to stop, pose special challenges. As a result, automated systems are now becoming available that allow the deployment of safety systems to adequately warn drivers of crossing hazards.

The Railroad Grade Crossing component involves electronic surveillance of grade crossings to detect and identify vehicles within the crossing area, either through video or other means such as loop detectors. This component may eventually support real-time information on train position and estimated time of arrival at a crossing and interactive coordination between roadway traffic control centers and train control centers.

2.9.2 Railroad Grade Crossing Integration

Figure 2-8 shows the integration possibilities of Railroad Grade Crossing systems. Integration of this component with other elements of the ITS infrastructure generally involves transfer of information concerning the status of train arrival at intersections. This information concerning crossing status may be transferred to Traffic Signal Control to be used to modify signal timing to ensure vehicles are not forced onto the train tracks. This capability may be limited to one crossing, or could involve one or more crossings in a regional traffic signal control system. In addition, information on the time, location, and expected duration of train crossing status may be passed to Incident Management, which may, in turn, transmit this information to a Traveler Information system.

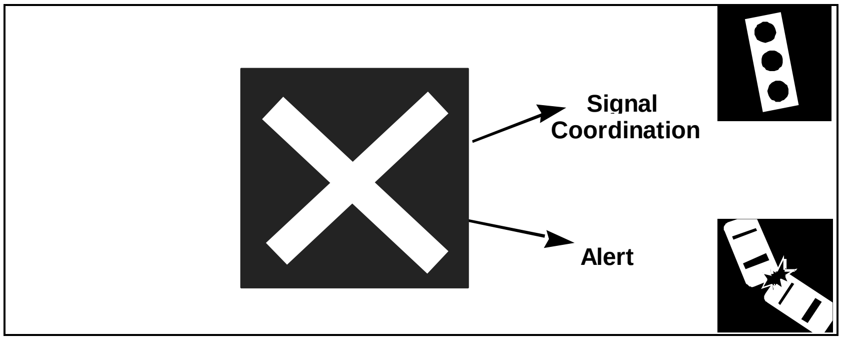


Figure 2-8. Railroad Grade Crossing Integration

2.9.3 MMDI Deployment of Rail Grade Crossings

Only one MMDI funded, and one possible non-MMDI funded, rail grade crossing project are being considered for evaluation. The MMDI-funded AWARD project in San Antonio consists of advance warning detectors being placed close to a railway right-of-way in advance of grade crossings. Information on intersections blocked by trains will be transmitted to in-vehicle navigation devices installed in public works service vehicles, as well as to highway VMSs. A non-MMDI project involving advance warning of train crossings on the Long Island railroad in New York may also be evaluated to supplement the AWARD project. More detailed information on the AWARD project can be found in Appendix B.

2.10 EMERGENCY MANAGEMENT SERVICES

2.10.1 Definition and Characteristics

The primary functions of Emergency Management Service systems are to:

- Employ advanced demand responsive dispatching capabilities to improve response times.
- Employ advanced vehicle guidance capabilities to improve response times.

The purpose of Emergency Management Services is to improve the response time of emergency services providers thereby saving lives and reducing property damage. Reducing the time it takes to notify the emergency services providers and the time it takes for the emergency services providers to arrive at the scene should reduce overall response time. Emergency notification can be accomplished through cellular telephones, roadside call boxes, and mayday devices.

Emergency vehicle management is oriented to reducing the time from receipt of notification of an incident to the arrival of the emergency vehicle on the scene. The three major components of emergency vehicle management are emergency vehicle fleet management and route guidance. Emergency vehicle fleet management utilizes automatic vehicle location (AVL) equipment to provide computer-aided dispatching of vehicles. Through the use of real-time information on vehicle location and status, emergency service dispatchers can make optimal assignment of vehicles to incidents. The installation of route guidance equipment in emergency service vehicles provides improved directional information for drivers and improves responsiveness of emergency services.

2.10.2 Emergency Management Services Integration

Emergency Management provides information to Incident Management concerning the severity, location, and type of incidents. In addition, on-scene Emergency Response personnel (e.g., police, fire, or emergency medical personnel) transfer information on progress toward clearing of incidents to Incident Management. Emergency Management transfers routing information to Traffic Signal Control to obtain priority signal control for emergency response vehicles, either through timing changes or through individual signal priority. Emergency Management receives information from Incident Management concerning incident location, severity, and type. Figure 2-9 shows these integration possibilities.

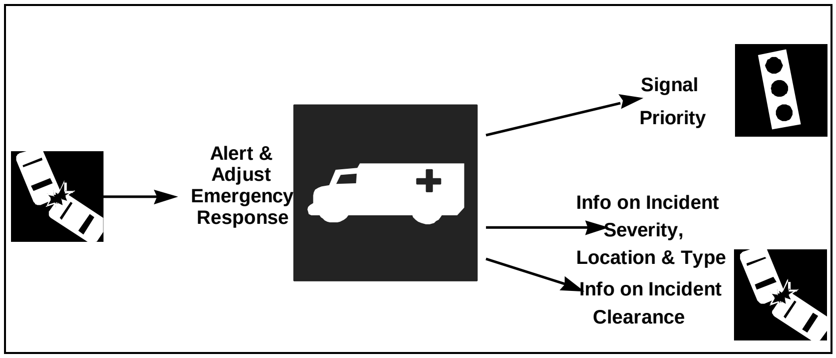


Figure 2-9. Emergency Management Services Integration

2.10.3 MMDI Deployment of Emergency Services

Five Emergency Management projects, all MMDI-funded, are proposed for evaluation. One is in San Antonio, one is in Phoenix, and three in Seattle. The Phoenix project consists of integration of emergency information from traffic signal control centers, transit management, and emergency services. The San Antonio project, LifeLink, will involve transmission of patient vital signs, video and audio information, between ambulances at crash sites and local hospital emergency rooms. One of Seattle's projects consists of further integration of emergency operation center functions with other ITS components. The other involve the deployment of two "mayday" services. Details of these projects can be found in Appendix B.

2.11 ADVANCED TRAVELER INFORMATION SYSTEMS

2.11.1 Definition and Characteristics

The primary functions of Advanced Traveler Information systems are to:

- Collect current, comprehensive, and accurate roadway and transit performance data for the metropolitan area.
- Provide multimodal information to support traveler decision-making (e.g., selection of mode, route, departure time, etc.)
- Provide traveler information to the public via a range of communication techniques (e.g., broadcast radio, FM subcarrier, the Internet, cable TV) for presentation on a range of devices (e.g., home/office computers, television, pagers, personal digital assistants, kiosks, radio).

The Advanced Traveler Information component provides the ability to collect and disseminate information about various modes of travel over the regional transportation network. Providing timely traveler information will enable the public to make informed pre-trip and en-route choices regarding whether or not to travel as well as travel decisions such as mode selection, route selection, travel-time scheduling, and decisions to work at home or at remote sites. Not only is the customer, the traveling public, served directly, but the infrastructure is served by potentially reducing demand in areas, times, and modes that are at or over capacity.

Advanced Traveler Information consists of three elements or subsystems: the Information Service Provider (ISP) element; the Remote Traveler Support (RTS) element; and the Personal Information Access System (PIAS). Traffic and transit data are input, processed, and stored by the ISP. The ISP may either be centralized (i.e., housed and managed in one facility) or distributed (i.e., housed and managed in separate facilities). The other two elements, RTS and PIAS, request information from the ISP and provide it to the traveler.

The ISP receives roadway and transit system surveillance and detection data from a variety of sources provided by both public and private sector entities. The ISP has the capability to combine data from different sources, package the data into various formats, and provide the information to a variety of distribution channels.

The RTS element disseminates the information at fixed sites, such as transit stops, kiosks, shopping malls, and other public places. The PIAS element disseminates traveler information in the home, vehicle, or place of business using personal portable devices and other electronic media.

2.11.2 Advanced Traveler Information Integration

Integration is essential to the deployment of an effective Advanced Traveler Information system. It is the aggregation of data from many disparate sources, and the presentation of these data integrated in a common, easily assimilated format, that makes Advanced Traveler Information Systems functional. Regional multimodal traveler information relies upon other ITS components to provide current travel conditions in a metropolitan area. It receives incident, traffic, and transit data from other ITS components. Figure 2-10 illustrates the integration possibilities.

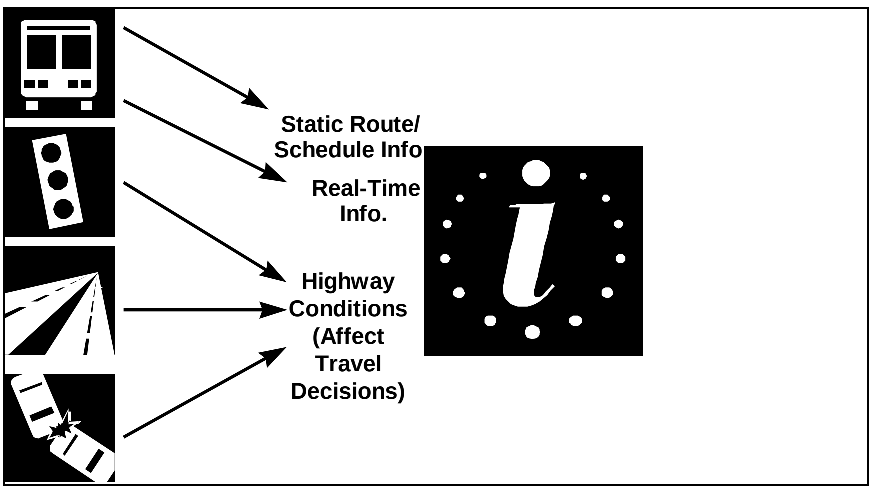


Figure 2-10. Regional Multimodal Traveler Information Integration

2.11.3 MMDI Deployment of Traveler Information

Traveler information ITS components make up almost half of all MMDI site deployments. Five projects may be evaluated in NY/NJ/CT, eight in Phoenix, four in San Antonio, and eleven in Seattle. Detailed descriptions of each of these projects can be found in Appendix B. However, it is possible to sub-divide most of these deployments into a few general types of information systems.

Web Pages. The use of the Internet to disseminate traveler information is proposed for all four sites. Seattle has four projects that consist almost entirely of web pages, either accessed privately by subscription or available to the public. Phoenix and San Antonio are both planning to develop web pages on which travel times and incident information will be available.

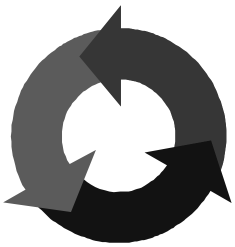
Portable Devices. Seattle and Phoenix are both participating in projects where information on travel will be delivered to users in some portable format. This may be through a computer, a watch, or some dedicated-use device.

Media. Seattle and Phoenix are both planning projects that will involve more technologically advanced use of media such as television and radio for traveler information dissemination. NY/NJ/CT and Seattle are also planning to develop telephone information systems, both static and interactive.

In-Vehicle. All the sites except NY/NJ/CT had planned to implement in-vehicle navigation to some degree. San Antonio's project will be limited to public works service vehicles. Although Seattle and Phoenix had hoped to encourage more general usage of this technology by the traveling public, the initially proposed projects were dropped.

Kiosks. All four sites are planning to implement kiosks, or permanent information dissemination devices, to some extent. These kiosks for the most part will be located in airports, shopping malls, and transit centers, and will be able to provide traveler information and in some cases trip planning.

2.12 INTEGRATION



2.12.1 Definition and Characteristics

Integration of ITS components is one of the foremost reasons for the MMDI. Sites were selected that already had some measure of ITS components in place, where the MMDI would consist primarily of connecting these existing systems together. New ITS components added as part of the MMDI would also build on, and enhance, the functionality of legacy ITS systems. "Integration" is the term used to describe these types of enhancements occurring at MMDI sites.

ITS components (e.g., freeway management, traffic signal control) are often developed independently by a variety of agencies within a metropolitan area. However, the movement of goods and people occurs on the total transportation system within an area. The testing of JPO's synergy hypothesis, that "the whole is greater than the sum of the parts," depends on the integration of ITS components throughout an urban area. Integration of ITS components can occur in three, not necessarily mutually exclusive, ways:

Institutional Integration: Many urban areas consist of a number of distinct municipal and county agencies. These agencies often maintain and operate their own separate transportation systems and networks. Additionally, other agencies such as fire departments, police departments, transit agencies, and emergency services also use these networks and systems. Insuring that information from one agency is available for use by another agency is called "institutional integration". An example of this form of integration would be the sharing of traffic information with fire and police departments responding to emergencies.

Infrastructure Integration: Systems which make ITS possible, including fiber-optic cables, data servers, and computer networks, can be shared by more than one ITS component. This sharing of communications networks and data storage facilities is called "infrastructure integration". For example, a fiber-optic cable system installed along a freeway could be used both to control variable message signs along the freeway and to transmit crash scene information from an ambulance to a hospital. Another example of infrastructure integration is the shared use of a travel speed data server by a web page, traveler information kiosks, and in-vehicle navigation units.

Integration of Control: The first two types of integration involved both the exchange of information and the shared use of equipment. This third type of integration, sometimes called shared control, takes integration a step further and involves the control of one ITS component by another, or coordinated control of components. For example, traffic signals near freeways and meters on freeway ramps may be controlled by a state agency, while traffic signals along perpendicular and parallel arterials are operated by one or two municipal agencies. If all of these components are integrated together so that one agency can control the arterial signals, the freeway ramp signals, and the meters, integration of control has been achieved.

The case of coordination of traffic signals between jurisdictions is an interesting case for integration, in that it could be one, two, or all three forms of integration. If jurisdictions come together and choose common signal timing plans, but implement these plans on distinct signal timing equipment, only institutional integration has occurred. If a signal timing server is shared by municipalities, and a common signal timing plan is implemented, but any new timing plan must be approved by all municipalities, institutional and infrastructure integration have occurred. If a common server is used, and a single real-time signal timing system is installed for all jurisdictions, then all forms of integration including integration of control have been put in place.

Figure 2-11 shows the external data exchanges between components that are used to describe component "integration" for deployment tracking purposes. These exchanges, however, do not describe whether the exchanges are institutional, infrastructure, involve shared control. Twenty-eight one-way data exchanges can occur between ITS components. In addition, three components (Traffic Signal Control, Electronic Toll Collection, and Electronic Fare Payment) have internal information exchanges to represent integration within each component (e.g., separate toll agencies that use a common toll tag technology). The 31 information exchanges are not intended to represent physical interconnections. Rather, they represent general data transfer between functional areas.

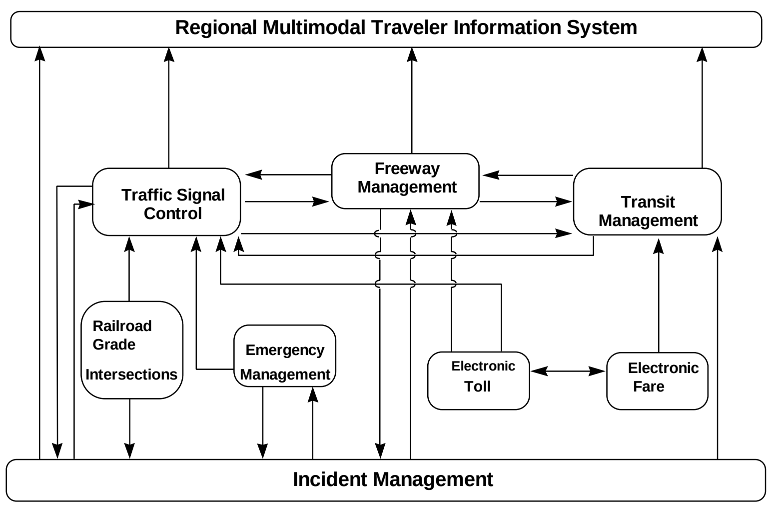


Figure 2-11. Possible Information Flows Between ITS Components

Several key forms of integration present in the MMDI will be evaluated. These evaluations will be presented as case studies, and will involve each of the six studies presented in Section 3, as appropriate. A case study approach has been chosen to best represent the unique nature of each form of integration. Some types of integration that will be evaluated as part of the MMDI include inter-jurisdictional signal coordination (institutional), traffic signal and freeway management (institutional), and freeway management and emergency management (infrastructure).

3. MEASURE OF PERFORMANCE STUDIES

3.1 INTRODUCTION

The ultimate goal of evaluating the efficacy of the ITS component deployments is to satisfy the goals set out in the *National ITS Program.*[1] These goals include:

- Improve the safety of the Nation's surface transportation system
- Increase the operational efficiency of the surface transportation system
- Increase the capacity of the transportation system
- Reduce energy and environmental costs associated with traffic congestion
- Enhance present and future productivity
- Enhance mobility, convenience, and comfort on the surface transportation system
- Create an environment where the development and deployment of ITS can flourish.

The ITS JPO of the FHWA has identified a set of measures, known as the Few Good Measures (FGMs), to which special attention will be paid in the MMDI evaluation. These FGMs are:

- **Crashes**. Deployment of ITS components is hoped, in many cases, to reduce the number of crashes on the surface transportation system.
- **Fatalities**. Reducing the number of fatalities resulting from crashes on the surface transportation system is another safety measure of interest to the JPO.
- **Throughput**. Throughput can be defined loosely as the capacity of the surface transportation system. It is hoped that ITS deployments and their integration will increase throughput, thereby mitigating the need for construction of costly new facilities.
- **Delay reduction**. Reduction in travel time and delay is a major goal of most ITS deployments. This can be accomplished by increasing throughput, reducing delay due to incidents, improving the efficiency of transit through better fleet management, and other means.
- **Cost**. The costs of deployments, both acquisition and life cycle costs, are of interest to all parties involved, especially as the cost relates to benefits to the system.
- **Customer Satisfaction**. Customer satisfaction indicates the degree to which transportation consumers perceive ITS as being beneficial. Reductions in stress and uncertainty, and satisfaction with increased information levels would be some expected benefits associated with this measure.

Taking into account these performance indicators and the *National ITS Program* goals, the following six study areas have been developed. Input from each study area for each project will be required to drive the benefit-cost study. However, the depth of the analysis will vary by project. The expected outcomes of the local partners, the FGMs, and the synergy hypothesis will determine the projects that receive more in-depth study in each area. The six study areas are:

- **Operational Efficiency**. The operational efficiency study will evaluate two of the JPO's FGMs: throughput and travel time. It will also addresses the *National ITS Program*'s capacity and efficiency related goals. The changes in these indicators attributable to ITS component deployment or integration will be assessed at some level for all projects.

- **Benefit-Cost**. This study will use the benefits determined from the other five studies, as well as the cost of the component, to carry out a benefit-cost analysis.

- **Safety**. The safety study is one part of the safety evaluation required for any construction or deployment project, ITS or otherwise. The MMDI evaluators are specifically interested in the benefits of the MMDI to safety, but will also gather data needed for assessing the safety of the ITS infrastructure. Crashes and fatalities are the two FGMs identified by the U.S. DOT as safety indicators.

- **Customer Satisfaction**. This study will evaluate the satisfaction of travelers, elected officials, traffic management system operators, and business community leaders with ITS deployment. This study will address the JPO's customer satisfaction FGM and the goals of improving convenience and comfort contained in the *National ITS Program*.

- **Energy and Emissions**. Whereas the U.S. DOT has not listed decreases in fuel consumed or changes in travel-related pollution among its primary indicators, these goals are part of the *National ITS Program*. Therefore this study will address the effect of ITS deployments on energy and emissions changes caused by projects and their integration.

- **Institutional Benefits**. The study of institutional benefits will address both the public sector and private sector involvement in the MMDI. It will identify and evaluate public sector institutional structures associated with the deployment and integration of ITS products and services at the MMDI sites. The study will also track institutional changes made over time to address non-technical impediments, identify lessons learned from addressing these impediments, and document the benefits and costs of addressing them.

The MMDI sites serve as data sources for the six planned studies. The Operational Efficiency, Safety, Energy and Environment, Cost-Benefit, and Customer Satisfaction studies are highly interconnected. These interconnections are both in terms of the effects that are expected due to the implementation of ITS, and the analysis of the results. For example, the type of facility that one drives on and the level of congestion experienced will have an effect on safety, as well as on emissions and energy consumed, and efficiency of the facility. From an analytical perspective these studies need to be considered in an integrated manner. Data collected to assess the effects of ITS in terms of delay reduction will also be employed in analysis of the effects on energy, emissions, and safety.

3.2 OPERATIONAL EFFICIENCY STUDY

3.2.1 Introduction

The *National ITS Program* lists a number of benefits to the surface transportation system expected from investments in ITS. A number of these relate to the efficiency and capacity of the surface transportation system. These include "increasing the operational efficiency of the surface transportation system," "increasing the capacity of the transportation system," and "enhance present and future productivity." Objectives associated with these goals include, "reducing travel time and reducing right-of-way requirements by increasing capacity." The U.S. DOT has two Few Good Measures (FGMs) that relate to these goals: throughput and travel time. Throughput measures how much work is produced by the system. Travel time measures how efficiently the system works.

Throughput and travel time will also be used as input in other MMDI evaluation studies including the Energy and Emissions, Safety, Customer Satisfaction, and Benefit-Cost studies. For example, the measurement of emissions is based on number of trips, the speed of travel for these trips, and the operating mode distribution of this speed (acceleration, deceleration, idle, and cruise speed). These variables can also be used as input for the Operational Efficiency study.

Throughput is the name given to the amount of people and goods that a system can move over time. Throughput is generally measured through two proxies: travel demand and travel time. Typically, the measurements for these two proxies are:

Travel Demand

- Person-miles of travel (PMT)
- Vehicle-miles of travel (VMT)
- Person-trips
- Vehicle-trips
- Person-volumes at individual links and screenlines
- Vehicle-volume at individual links and screenlines
- Trip origin, destination, and path

Travel Time

- Person-hours of travel (PHT)
- Vehicle-hours of travel (VHT)
- Person-hours of delay

- Vehicle-hours of delay
- Vehicle speed
- Vehicle operating mode (acceleration, deceleration, idle, cruise)
- Variation in observed travel time (reliability and variability of travel time).

3.2.2 Technical Approach for the Operational Efficiency Study

The deployment of ITS has varying effects on travel time and throughput across different facility types and different modes of transportation. Spatial diversion, time diversion and mode shift are typical responses of travelers to the deployment of ITS. Less typical responses include destination changes and induced/foregone travel. Thus, the evaluation of throughput and travel time impacts of ITS requires taking into account several dimensions of travel corresponding to these traveler responses, including:

- **Facility type** This includes freeway (mixed-flow and high occupancy vehicle - HOV) lanes, arterials, ramps, local streets, corridors, network-wide system and multimodal system. Here, data should be collected and analyzed for facility segments that are homogeneous in terms of their travel demand and supply characteristics.
- **Time of day** This includes AM versus PM travel, peak versus off-peak travel, and individual time-slice within the peak period.
- **Transportation mode** For example, single occupant auto, high occupancy vehicle with two passengers (HOV2), high occupancy vehicle with three or more passengers (HOV3+), bus, light rail transit, heavy rail, commuter rail, ferry, truck, motorcycle;
- **Travel market segment** This includes various trip maker segments (based on income levels, household size, vehicle ownership, etc.), various trip purposes (work trips, shopping trips, school trips, visitor trips, etc.), area type (urban, suburban, rural), and various system cost elements (parking costs, gasoline costs, transit fares, etc.)

The following sections deal with the steps required for performing the operational efficiency evaluation.

3.2.3 Guidelines for the Development of Site-specific Evaluation Plans

The first step is to provide guidelines for the development of site-specific evaluation plans and individual test plans. In the case of travel time and throughput data, these guidelines include hypotheses and anticipated outcomes, measures of effectiveness, measurement methods, analysis methods, data requirements, and relationship to other studies.

3.2.4 Assemble/Collect Evaluation Data

The second step is to acquire available evaluation data on a baseline time period before implementation of the MMDI, during deployment, and after implementation. This step also includes collection of new baseline data. Data collection methodologies generally include direct observations and travel surveys.

Table 3-1. Measurement and Evaluation Tools for the Operational Efficiency Study

Component	Measurement Method	Analysis Tool
Traffic Signal Control	• Floating car runs on arterials, adjacent streets • AVL-instrumented vehicle runs on arterials and adjacent local streets • A combination of transponder-equipped vehicles and roadside readers • License plate recognition systems • Travel surveys • Traffic counts at arterials, parallel facilities, and intersecting facilities	• Traffic simulation modeling • Travel demand modeling • Statistical analysis of data • Discrete choice analysis
Freeway Management	• Floating car runs at freeways, parallel arterials • AVL-instrumented vehicle runs at freeways, parallel arterials • A combination of transponder-equipped vehicles and roadside readers • License plate recognition systems • Travel surveys • Traffic counts at freeways, parallel arterials and ramps • Traveler surveys to identify route diversion, mode shift, temporal diversion, destination changes and induced/foregone demand	• Travel demand modeling • Traffic simulation modeling • Statistical analysis of data • Discrete choice analysis
Transit Management	• Agency records • On-board observations • AVL-instrumented buses • Surveys, interviews and focus groups of users, employees, dispatchers, drivers, and administrators at transit systems to identify perceived and actual travel and wait time and throughput benefits. User surveys will also identify impact on route diversion, mode shift and temporal diversion.	• Travel demand modeling • Traffic simulation modeling • Statistical analysis of data • Discrete choice analysis
Incident Management	• Floating car runs on freeways, parallel arterials, and ramps during incident(s) • AVL- instrumented vehicle runs at freeways, parallel arterials and ramps during incident(s) • Traffic counts at freeways, parallel arterials and ramps during incident(s) • Traveler surveys to identify route diversion, mode shift, temporal diversion, destination changes and induced/foregone demand	• Travel demand modeling • Traffic simulation modeling • Statistical analysis of data • Discrete choice analysis
Emergency Management Services	• Improvement in incident response, recovery time • Surveys, interviews, focus groups with first responder agencies including employees, dispatchers, drivers, and administrators to identify perceived and actual travel time and throughput benefits. Surveys will also identify impact on route diversion, and temporal diversion. • AVL-instrumented vehicle runs	• Traffic simulation modeling • Statistical analysis of data • Discrete choice analysis
Advanced Traveler Information Systems	Surveys of households / travelers at each of the four sites. Surveys used to identify route diversion, mode shift, temporal diversion, destination changes, induced/foregone demand • Interviews and focus groups with system users • Floating car runs on freeways, parallel arterials • Instrumented vehicle runs on freeways and parallel arterials • Traffic counts on freeways, parallel arterials	• Travel demand modeling • Traffic simulation modeling • Statistical analysis of data • Discrete choice analysis
Railroad Grade Crossings	• Floating car runs at railroad crossing and its vicinity • Traffic counts at crossing and its vicinity	• Traffic simulation modeling • Statistical analysis of data

Typically, direct observations (such as floating car runs or traffic counts) are more cost-effective in measuring/analyzing impacts in spatially-limited environments such as freeways, arterials, toll plazas, etc.

However, these methods become less cost-effective when the analysis needs to cover a corridor, network, or multimodal system. In these environments, a more macro-level measurement method (such as a survey or focus group) would be more cost-effective.

3.2.5 Analyze Data and Validate Results

The third step includes the analysis of data and the validation of results. Data analysis methodologies include statistical analysis, as well as use of traffic simulation modeling and regional travel demand modeling. Data collected in the previous step will be used to validate, calibrate, and enhance these models.

Typically, traffic simulation models are more cost-effective in measuring/analyzing impacts in spatially-limited environments such as freeways, arterials, toll plazas, etc. However, these tools become less cost-effective when the analysis needs to cover a corridor, network, or multimodal system. In these environments, a more macro-level measurement analysis tool (such as a regional travel demand model) would be more cost-effective. Also, regional models are more cost-effective than simulation models in measuring the amount of trip-making and throughput. However, regional models are not as accurate in producing estimates of speed and travel time. Simulation models are more cost-effective in producing travel time estimates.

This step will also include the identification of net benefits for ITS versus non-ITS approaches. This step will also define travel time and throughput benefits in terms that are meaningful to constituents.

3.2.6 Report Results

The fourth step includes reporting on each individual test and on each site-specific evaluation. This step will also include the analysis and development of nation-wide conclusions on the effectiveness of the deployment of ITI technologies in different settings.

3.3 BENEFIT-COST STUDY

3.3.1 Introduction

Of concern to partners involved in the deployment of ITS is the cost of the deployments vis-a-vis the expected benefits. Of particular interest is the “integration” hypothesis, which is that the whole is greater than the sum of the parts. If this hypothesis can be demonstrated, then it can be expected that the benefits of ITS will continue to accrue as more components are integrated with each other. In order to better assess the relationship between benefits and cost for each of the ITS components deployed, a benefit-cost study will be conducted. This study will address several questions, including:

- Which ITS components produce the greatest payoff from resources expended?
- How does the previous level of ITS deployment affect the benefit-cost performance of particular ITS elements or packages?
- Do the benefits of ITS come especially from integrating an array of ITS components within a single metropolitan area, or from isolated deployment of single elements?

For a benefit-cost analysis two sets of conditions need to be compared. These are the “without” or base case alternative and the with, or project alternative. If a certain level of ITS deployment is already present, it is assumed to be part of the base case. The expected impacts, or benefits, due to the project alternative then need to be measured. Finally, dollar values need to be associated with these benefits. The framework for these steps is presented in the next section.

3.3.2 Benefit-Cost Framework

The basic premise behind benefit-cost framework is that ITS will improve travel supply through improvements in speed, throughput, and accident reduction. Thus, ITS will generate greater customer value and satisfaction and result in more efficient travel choices and patterns. To satisfactorily address concerns and priorities of the local MMDI partners as well as the JPO, the benefit-cost approach needs to include two major components studies:

- Benefit-cost assessment studies for each of the four sites
- A roll-up B-C study addressing impacts and implications of ITS costs and benefits for other sites and deployment levels and for national aggregates

There are three essential steps of BCA:

1. **Description of Alternatives** At least two alternatives must be specified. The description of the “project” represented the investment in ITS improvements and related actions, while the corresponding base case or “counterfactual” describes the conditions that would have resulted at the specific site had the ITS intervention not occurred.

2. **Impacts of the Project Alternative(s)** The differences between what occurred under the project alternative relative to the base case are measured or estimated. All costs and benefits are measured

as differences between what actually occurred at the site and what would have occurred in the no-additional-ITS alternative.

3. **Evaluation of Differences** Impacts are then valued in dollar units, such as the unit opportunity cost of delay reduction, the consumer surplus from additional travel, and the benefit of increased reliability. The time streams of costs and benefits are discounted and summarized as net benefits, in either present worth or annualized form.

Benefits, it is noted, consist of all impacts that make society better or worse off, other than those items already counted as costs. Typically, costs are the initial investment and startup costs (capital and labor), usually embodied in an expenditure or resources, and all other gains and losses to society as a whole - whether positive or negative - are benefits.

A sample listing of the potential benefits (or disbenefits) of an ITS project is given in Table 3-2. The benefits are in the form they most directly take as benefits to society. The ITS project may alter the quantity and quality of travel in various ways, but the net benefits cannot be assessed until the outcomes are translated into categories in the table. Benefits may, in turn, be passed on to other persons or economic activities, in the form of, say, additional retail sales, higher salaries, or increased land values, but such indirect effects are not included in benefits because they are already counted in direct benefits; to add them in additionally would be double counting.

Table 3-2. Summary Benefit-Cost Table for an ITS Project

BENEFITS	*VALUE*
Accident Savings (user, private, public)	$
Travel Delay reduction	$
User Operating Cost Savings (personal, commercial)	$
Agency O&M Cost Savings	$
Consumer Satisfaction (Consumer Surplus, Option Demand)	$
Reductions in Externalities (Emissions)	$
COSTS	
Capital Costs of the ITI Improvement	$
Operating Costs of ITI	$
	$
NET BENEFITS	

3.3.2.1 Benefits

Benefit-cost analysis, as proposed, will focus on the categories of benefits listed below. The data for the benefit-cost analysis will be generated by the other evaluation studies presented in this paper.

- **User Crash and Safety Savings** Savings in crash costs are comprised of the monetary value of reducing the fatalities, personal injuries, and property damage. Improvements in safety and cost reductions may also result from reduced crime, as well as reductions in unsafe outcomes other than crashes and crime.

- **User Travel Delay reduction**. At the aggregate level it is possible to estimate travel delay reduction to users by applying an average value of time to the number of hours of travel time avoided. However, under many circumstances it is desirable to break travel delay reduction down according to different types of travel time saved, because individuals value different types of travel time differently. Accounting of savings in travel time might be broken down by: in-vehicle travel-time; out-of-vehicle travel time; and variance of travel time. Out-of-vehicle travel time, in the case of mass transit, might further be divided into access time by type of mode (auto, walk, bike), in-vehicle time, and transfer time. Analysis of user travel delay reduction should give particular attention to delay reduction and related benefits accruing to commercial users. Freight and other commercial users typically value delay reduction at a much higher rate than personal travelers. The commercial drivers (and other workers) in such vehicles are "on the clock" and the operators also take into account the "time value" of the goods carried or service being provided. The reliability of travel time (variance) is all the more important to commercial users. Travel time variance is expected to become even more important in the future as firms increase their reliance on "just in time" deliveries.

- **User Operating Cost Savings** Savings in vehicle operating costs will depend upon the types of vehicles involved and will include avoided depreciation, fuel, wear and tear on tires, insurance, tolls and parking costs. In typical highway user benefit analyses, savings in vehicle operating costs are calculated for autos, pickups, and commercial vehicles. In the MMDI evaluations avoidable user operating costs will include avoidable out-of-pocket costs such as fares, tolls, gas and parking. Care in identification of all operating and out of pocket costs is particularly important when comparisons involve choice among options such as personal vehicles and transit.

- **Agency O&M Cost Savings**. Avoided repair, operating and maintenance costs will accrue to the governments and the private sector. If government or private sector cost savings are passed onto users in terms of reduced fares, tolls, etc., then the cost savings to government and/or the private sector should not be counted to ensure against double counting (i.e., under user and agency costs). ITS also might result in lower capital costs for the governments and the private sector. Both long- and short- term savings will be considered. Whereas in the short term (one or two years) one does not expect these cost savings (e.g., reduced parking space needs if some solo drivers shift to HOV modes and/or some peak travelers shifted to off-peak travel) to show up explicitly, such savings will show up over time in many situations.

- **Customer Satisfaction**. ITS is expected to increase the value of travel services available to customers — both through reductions in the generalized travel price faced by individuals (i.e., price of travel in terms of all relevant costs perceived by the traveler) and by making newer and better products available. New and better products may increase the willingness to pay, thus fulfilling the desire for making additional travel or simply providing a new option. In such situations, the difference between what people are willing to pay and what they actually pay (in terms of generalized cost) increases. This increase is called *consumer surplus* and is a measure of benefits accruing to users because of reduction in travel costs and increase in willingness to pay. The benefits of *option demand* (willingness to pay for additional choices) will also be captured via the customer satisfaction study.

- **Reductions in Externalities**. An important source of external costs is air pollution. External costs are defined as those costs users impose on non-users. Avoided external congestion costs — the congestion delay cost an individual automobile driver imposes on other road users upon entering a stream of traffic — are picked up in the benefits category as travel delay reduction.

3.3.2.2 Costs

There are two types of costs associated with the cost component of this study:

- **Capital Costs of the ITS Infrastructure Improvement**. Capital Costs are incurred by the public and private sectors.

- **Operating Cost of ITS Infrastructure**. These are costs of operating the public and private infrastructure.

Allocating project costs among observed benefits will be a particular challenge of this study. For example: if information from advance vehicle identification (AVI) tags is used by more than one component, how are the one-time costs of the AVI tags allocated between projects? This is especially important when analyzing the effect of component integration.

The benefit-cost analysis will account for all public and private costs for each of the MMDI elements. Enumeration of costs is made difficult by the fact that the private sector is often reluctant to share proprietary cost data with analysts. However, the literature can provide some assistance in this regard. Allocations of joint costs across different ITS elements will be carried out where such sharing occurs and any resulting savings will be attributed to benefits of integration of ITS elements.

3.3.2.3 Benefits Versus Costs

The overall benefit-cost measure will be:

- Net benefits = Δ Benefits - Δ Costs

This measure tells whether the particular project is worth doing in economic terms (i.e., if net benefit is positive). This accounting framework strives on the one hand for a complete accounting and on the other hand avoids double counting. Where the cost accounting framework falls short of a complete accounting because benefits, or where costs are too difficult to measure, a qualitative description of these benefits and costs will be provided. In this framework, net benefits are the difference between benefits and costs. All of benefits and costs are measured in annualized, discounted constant dollars.

3.3.3 Benefit-Cost Analysis

To facilitate the benefit-cost calculations, a spreadsheet will be developed for each MMDI project. The spreadsheets will serve a number of purposes. First, they provide an efficient and effective means to apply the benefit-cost methodology to specific projects. Spreadsheets will be tailored to individual projects. Calculation procedures will be evaluated and refined so that results are quickly obtained once data have been collected and parameter values established. Moreover, the spreadsheets will facilitate sensitivity analysis and enable numerous similar calculations. The spreadsheets will also be used to acclimate evaluation team members and local partners to economic analysis methodology.

It is currently envisioned that a generic spreadsheet will first be developed for each ITS component. In some cases, such as traveler information, spreadsheets for sub-components such as kiosks or in-vehicle navigators will be developed. Then more specific spreadsheets will be developed for each deployment project. Furthermore, the spreadsheets will provide a basis for extrapolation of local analysis of benefits and costs to the national level. Spreadsheet calculations from the site evaluations will be appended to model calculations used in the national evaluation.

The spreadsheets will exhibit a number of features consistent with the benefit-cost methodology described above:

- Provide a means to examine the difference between the "with" and "without" cases for each MMDI project
- Apply standard incremental benefit-cost analysis
- Address trend variables including market penetration
- Account for different market segments
- Address behavioral changes
- Provide linkages between different types of data.

Figure 3.2 shows a schematic diagram of a generic benefit-cost analysis. Most of the benefit data will be made available from the five other study areas: safety, customer satisfaction, operational efficiency, Institutional Benefits, and energy and emissions.

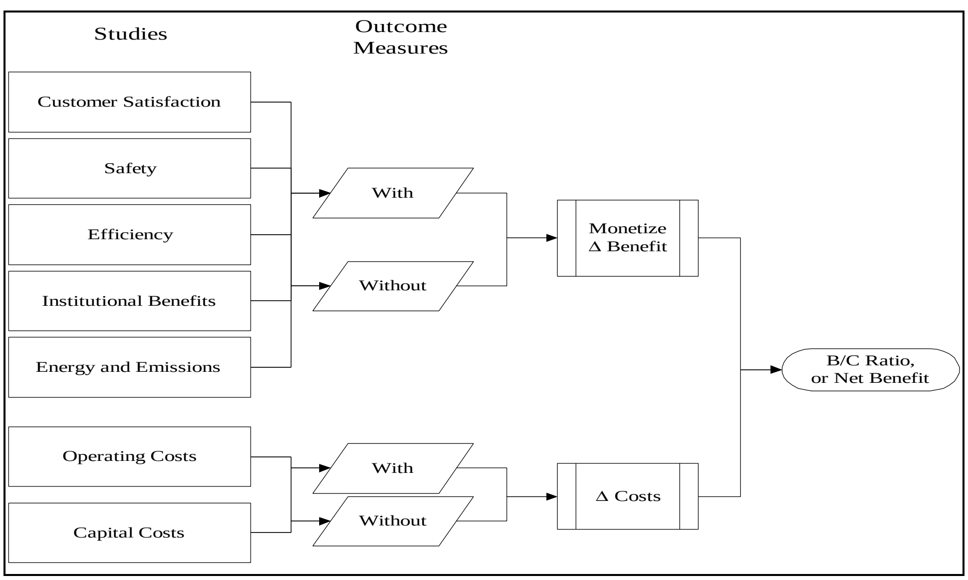


Figure 3-1. Generic Benefit-Cost Analysis

3.4 SAFETY STUDY

3.4.1 Introduction

Safety, as it applies to ITS deployments, can refer to both the safety benefits of deployment as well as the inherent safety evaluation of the deployments themselves. In the case of the later, the U.S. DOT requires that safety must be evaluated at every step of an ITS project, from the planning stages through deployment. The specific safety study of the MMDI evaluation is part of this much larger safety evaluation in which all MMDI partners play a part. It is understood by the MMDI evaluation team that ITS components that are part of MMDI will have been through an initial safety evaluation before deployment. This initial evaluation is assumed to include certification by the manufacturers of any devices or hardware being used by agency employees or the public, as well as some form of safety review or initial audit by all partners involved in an MMDI deployment.

In the case of the safety benefits of ITS, the *National ITS Program* has identified “improved safety” as one of the expected impacts of ITS implementation. The U.S. DOT is not only interested in deploying a safe infrastructure, but also in having that infrastructure play a role in increasing safety. Specifically, the U.S. DOT expects ITS to “improve the safety of the Nation’s surface transportation” through the reduction of crash frequency, and the reduction of crash severity. The U.S. DOT has identified two FGMs for MMDI evaluation pertaining to safety: the number of crashes and the number of fatalities. It is the role of evaluating these specific safety impacts that the MMDI evaluation plays. The safety study of the MMDI evaluation will concern itself primarily with assessing whether the MMDI does in fact have a positive effect on crashes and fatalities. Conversely, it may also catch disbenefits that may have been missed in the safety evaluations leading to this point in the process. The following section addresses the overall strategy of the safety evaluations to be conducted at each MMDI site.

3.4.2 Evaluation of U.S. DOT Multi-Modal Projects

The MMDI involves, directly and indirectly, a number of agencies within the U.S. DOT. Transit Management projects involve to some extent the Federal Transit Administration; devices within, and users of, vehicles are of particular interest to the National Highway Traffic Safety Administration (NHTSA), and highway and infrastructure projects are of interest to the FHWA. All of these agencies have their own not dissimilar processes and measures of effectiveness (MOEs) for evaluating the safety of hardware, infrastructure, and devices within their areas of responsibility. It is important that different MMDI deployment projects are evaluated with safety procedures and MOEs appropriate for their particular character and functionality. However, since the two safety FGMs identified were crashes and fatalities, the process used for any of the MMDI safety evaluations will consider foremost a deployment’s effect on those two MOEs.

Different approaches can be taken for the safety evaluation of MMDI projects. The preferred method is that of direct evaluation, that will be used for all projects where sufficient data is available and where present methodologies make it possible. Another methodology possible where direct measurement is not feasible is indirect evaluation. This method uses surrogates measures, such as erratic maneuvers, for evaluation and assessment of safety. Surveys may be another form of indirect evaluation, although less quantitative than surrogate assessment. In some cases, anecdotal data may also be useful. Anecdotal data may include comments from a school principal regarding changes in the safety of a school crossing because of the construction of a overpass. Lastly, although not itself a methodology, provision should be made for the collection of data that may be used in a future evaluation effort.

3.4.2.1 Direct Evaluation through Crash Data

The primary and preferred method of safety analysis is the collection of actual incident and crash data. Incidents include car breakdowns, flat tires, and other roadway blockages. Crashes refer specifically to incidents involving damage to vehicles or their occupants. This is commonly referred to as a “crash-based analysis.” Incident and crash data may be from the local law enforcement authorities, from freeway or traffic management centers, or some other sources. A crash-based consists of statistical comparison of trends “before” or “without” ITS, and “after” or “with” trends.

Collection of sufficient quantities of incident data for a valid analysis may prove difficult owing to the short data-collection time frame (one year). However, where possible, this data should still be collected so that it may be used with other or later evaluations. Even if sufficient quantities of data are available from which to draw conclusions, it may prove too difficult to attribute crashes and fatalities to one or another of the many integrated ITS components at the MMDI sites. For example, many forms of traveler information, such as web pages or kiosks, have effects on traveler behavior that may in turn have safety impacts. In these cases, the second methodology may need to be used.

3.4.2.2 Indirect Evaluation through Surrogates for Crashes

Should the data for a direct evaluation of safety impacts through crashes prove too sparse, or too difficult to attribute to a specific deployment, a second method may be pursued. This method would require that surrogates for safety be determined and linked to other safety MOEs, as well as the two FGMs. These surrogates could be values measured in the fields, or values calculated through use of a simulation model. This methodology would require surrogate links, such as crash risk rates by facility and congestion level (macroscopic), or probability of crash given car-following and lane-changing behavior (microscopic). See Figure 3-2 for a diagram of this type of evaluation.

Past research has shown the difficulty in defining standard safety surrogates that provide valid safety conclusions. The FHWA’s 1981 version of the Highway Safety Evaluation procedural guide states that “non-Accident measures are not intended to be a substitute for the ultimate safety measure (accident and severity reduction), since definitive quantitative relationships between accident experience and many non-accident measures have not been developed.” Note that, although this 1981 guide uses the word “accidents”, the word incident or its subset “crash” is now preferable.

Two other forms of indirect evaluation are surveys and anecdotal evidence. Surveys may ask respondents whether they feel safer now that a safety device such as a camera has been installed. Anecdotal evidence may consist of observations that pedestrians are using safer paths for walking, or are finding it easier to cross busy roadways.

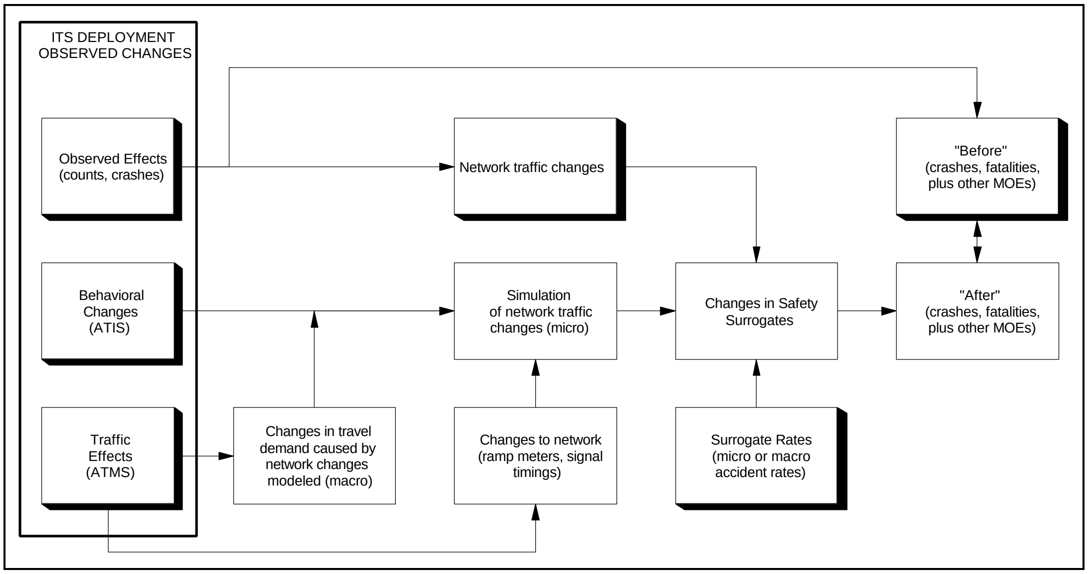


Figure 3-2. Using Surrogate Measures to Evaluate Safety

3.4.2.3 Future Evaluation Efforts

Both direct and indirect evaluation may, in some cases, prove to be either technically or financially inappropriate. This may be for reasons of feasibility, validity, or practicability, as determined by the U.S. DOT in consultation with the evaluation team. In those situations, new unique methodologies may need to be developed beyond the scope or the MMDI evaluation, or beyond current state-of-the-art safety evaluation techniques. In these cases every effort will be made to collect data that may allow an evaluation in the future. Safety evaluation results would need to be reported as inconclusive in these cases.

3.4.3 Four ITS Deployment Types for Safety Analysis

Given the above, it will most likely be necessary to break down all MMDI deployments into four categories for safety evaluation purposes. These groups of ITS deployments are mentioned because a common evaluation methodology, whether direct, indirect, or a combination of these, should be applicable to all members of that group.

These types are: (note: ATIS stands for Advanced Traveler Information Systems).

- Portable ATIS (IVN, pagers, watches)
  - Used In-vehicle
  - Used for Pre-trip planning
- Non-portable en-route ATIS (VMS, radio)
- Non-portable pre-trip ATIS (web pages, kiosks, radio)
- System Management (FM, traffic control centers, emergency response)

- Security (Ambulance-Hospital Links, Bus Surveillance)

The first type of ATIS can effect travel behavior both before trips and during trips. Depending of whether its use is pre-trip or en-route, use of this type of ATIS could have different safety impacts that may need to be considered separately. The second group consists of ATIS devices that are only used en-route. These devices will only effect the behavior of travelers already underway, possibly through diversion to other facilities. The third type of ATIS can only be used for making pre-trip decisions, and should be evaluated in a fashion similar to portable ATIS used before travel. The last type of ITS deployment does not affect travel behavior, but rather can have direct impacts on traffic flow. Examples of these direct impacts may include ramp meters, re-timed signals in response to incidents, and incident management.

3.5 CUSTOMER SATISFACTION STUDY

3.5.1 Introduction

The *National ITS Program* identifies "enhancing the personal mobility and the convenience and comfort of the surface transportation system" as an important goal. The U.S. DOT has identified "customer satisfaction" as one of its FGM primary performance indicators for MMDI. In order to evaluate how the MMDI deployments measure up to these goals, a customer satisfaction study will be part of the MMDI National Evaluation Strategy.

According to a report prepared for the US Department of Transportation Intelligent Transportation Systems Joint Program Office, current estimates of anticipated spending on ITS in the United States over the next twenty years assume that about 80 percent of the estimated $200 billion total will be private investment.[(3)] If large private investments in ITS are to materialize, individual consumers (customers) will need to discover real value, and positive return on their ITS investments. Therefore, we evaluate customer satisfaction in order attain the information we need to ensure that ITS benefits are realized, and as a result, the required levels of private investment are attained.

By understanding customer satisfaction with ITS, we can:

- Provide decision makers with information that enables them to direct ITS investments towards those products that achieve the highest levels of customer satisfaction.
- Provide information on travelers' options and preferences regarding mode choice, route choice, and other travel decisions to assist decision makers shaping ITS development and deployment.
- Understand ITS customer perceptions in a way that enables government and private agencies to better address customer desires and thereby increase the likelihood that ITS deployment goals are achieved.
- Recommend approaches for achieving higher levels of product service, dissemination, and adoption.
- Identify areas needing further research towards understanding of customer behavior and perception.

For the purposes of the Metropolitan Model Deployment Initiative evaluation, customer satisfaction subsumes three concepts:

- Customers' revealed preferences for ITS products and services
- Customers' stated preferences for ITS products and services
- Customers' willingness to pay for ITS products and services.

Revealed preferences refer to consumer behavior: When given the opportunity, do consumers purchase and, or, use ITS? Revealed preferences may also include consumption choices such as the decision to make a trip or use a particular facility. *Stated preferences* are what people say they do, or will do, when given the opportunity to purchase and, or, use ITS. Stated preferences also include other measures of consumer perceptions of ITS, such as explanations of why customers perceives products and services as they do. *Willingness to pay* may be assessed via revealed and stated preference techniques, but with a focus on quantification of monetary demand for ITS.

Willingness to pay will be assessed for all ITS services that are evaluated, even for services that are offered for free and for which there is no intention to charge in the future. The difference between what users are willing to pay, and what they are charged, is referred to in the benefit-cost analysis as consumer surplus, and is critical to monitization of the benefits of ITS investments. All three customer satisfaction measures will support the benefit-cost analysis.

ITS customers are broadly defined as those who will be affected by the improvements to the transportation infrastructure, and by the products and services that improved infrastructure will enable. Secondary products and services enabled by ITS improvements may not be observable within the time frame of the evaluation. Therefore, the evaluation of customer satisfaction will focus on first-order customers who are most likely to directly experience the effects of ITS Metropolitan Model Deployment Initiative improvements. A complete list of first order customers of ITS would include:

- General travelers.
  - Work or school related commuters.
  - Non-work related shopping/personal.
  - Recreational/tourist.
- Commercial travelers.
- Taxi, limousine, transit and paratransit drivers, dispatchers, and owners.
- Freight and delivery service drivers dispatchers, and owners.
- Elected and appointed officials.
- Business community (e.g., Chamber of Commerce, Rotary).
- Value added service providers (e.g., commercial distributors of ITS traveler information).
- Traffic management system operators.
- Emergency Management System drivers and operators.

This list of first-order customers is more inclusive than references to customers in other portions of this report. This is because whereas studies in other areas are primarily concerned with capturing narrowly defined changes in travel behavior, the customer satisfaction study is intended to encompass a wider scope.

The Customer Satisfaction Study will collect data and coordinate efforts to evaluate customer satisfaction of travelers, elected officials, traffic and transit management system operators, and business community leaders who are not directly involved in ITS deployments. (e.g., business leaders who would not be surveyed in the institutional benefits study, but who do have an interest in transportation investments).

Satisfaction with ITS will presumably be influenced by the performance of the deployed systems relative to outcome measures of other evaluation studies. Therefore, where feasible, the evaluation will address relationships between customer satisfaction and system performance as assessed by the other outcome measures.

Another important feature of the customer satisfaction study will be to compare and contrast results across the sites. Especially in the area of regional multimodal traveler information, similar projects are being conducted at all four sites. Projects common at two or more sites include:

- Kiosks to provide multimodal travel information.
- Multimodal traveler information pages on the world wide web.
- In-vehicle navigation devices.
- Mayday devices.
- Pagers and personal digital assistants with traveler information.
- Television programs presenting travel information.
- Telephone call-in and call-back services.

None of the nominally similar projects are identical. Often, the business models differ. The types and format of information presented will differ. It is likely that the quality of information will also differ. These and other factors which may differentiate similar efforts between sites provide opportunities for valuable insights into which variants best satisfy consumers. Coordination of evaluation efforts between sites will emphasize measurements that attempt to clarify which differences between similar deployments are important to the observed differences in customer satisfaction.

3.5.2 Approach to Assessment of Customer Satisfaction

Data for the national evaluation will come from the four Metropolitan Model Deployment Initiative sites. Each of the deployments is unique, and will make a unique contribution to evaluation of customer satisfaction. Across all four sites, it is our intent to form as complete picture as possible of satisfaction with the ITS components. To accomplish this intent we will:

1. Identify the customer satisfaction issues that are amenable to evaluation at each site
2. Prioritize these issues at each site based on the assessment of partners at the respective sites

3. Assess the completeness of coverage traveler information services and other ITS components across the four sites, to ensure that important elements are not overlooked

4. Re-evaluate priorities at the sites, based on outcome of step 3

5. Form a consensus between sites and national evaluation based on regional and national priorities and available evaluation resources.

The national evaluation will focus on summarizing the customer satisfaction findings at four sites, as well as on comparing and contrasting findings across the sites to coalesce results. The ultimate goal is to produce a unified picture of:

- Promising business models for traveler information systems
- ITS services that satisfy travelers' information needs and generate desired changes in travel behavior
- Community leaders' impressions of and goals for ITS services
- Travelers' desires for improvements in ITS products and services
- Willingness to pay for ITS services.

Although observed travel behaviors are the preferred measures for drawing customer satisfaction inferences, it is recognized that much of the data will come from various forms of surveys: questionnaires, interviews, and focus groups. Comparisons of results across sites can be most readily interpreted if the content and format of these surveys are similar. Ideally, the only differences between the surveys would be in details necessary to tailor them to differences in what was deployed at the sites. To the extent that surveys differ across sites, differences in finding between sites might properly be attributed to either difference in the ITS deployed at the sites, consumers at the sites, or survey differences. The plausibility of the latter attribution is clearly undesirable. Therefore, the national evaluation team will work with the sites to develop survey instruments that share common questions, formats, and objectives.

3.5.3 Customer Satisfaction Data Requirements

Figure 3-3 provides a conceptual flow diagram that is intended to illustrate some of the important data requirement considerations for the customer satisfaction study. These considerations include:

- conditions at the sites prior to deployment
- describing what was deployed
- determining whether the target users are aware of the ITS services
- assessing whether those who are aware of services use them, and how they use and value them
- assessing how travel behavior changes as a result of using ITS services

- and ultimately determining how changes in user behavior affect the transportation system in terms of relevant output measures and the net benefits-cost for those effects.

Preconditions are shown to acknowledge that, before fielding ITS projects, a unique set of social, environmental, organizational, and infrastructure elements existed at the site. For traveler information projects, it will be important to note:

- What kinds of traveler information were available before the project?
- What were the problems that the project was designed to address?
- What were travelers' attitudes towards these problems before the project?
- What were travelers' actual and perceived options in responding to the problems?

Where available, pre-deployment surveys of customer attitudes will be used to establish a baseline. In Seattle, the Puget Sound Regional Council has been conducting a traveler panel survey for a number of years.[4] This survey samples the same households in each wave of the survey so that Seattle area traveler attitudes can be followed as they change over time. The panel includes a subset of travelers who use transit on a regular or occasional basis. Two waves of the panel survey will be conducted within the time span of the evaluation; one prior to deployment, and one at the end of the deployment period. These two waves will include questions specially formulated to address MMDI evaluation questions. The Puget Sound Regional Council Panel Survey provides a means of assessing trends underlying user satisfaction issues. For instance, it can be used to estimate the number and types of travelers who currently try to obtain pre-trip information with the number who do so after the MMDI traveler information systems are deployed. It can be used to determine which travelers have access to, and awareness, of various means of obtaining traveler information such web sites, traffic TV, and telephone hotline services.

By establishing the pre-deployment conditions in Seattle, the evaluation will be better positioned to frame the applicability of evaluation findings for other sites.

In Seattle, and to some extent at other sites, changes in traffic operations centers (freeway management systems and traffic signal systems) will include increased information availability across management agencies, but may not include implementation of plans that would use that information. Where this is the case, it would not make sense to evaluate changes in throughput or efficiency that might result from full deployment of freeway and arterial traffic management plans. However, it may be useful to survey traffic operations center personnel before and after improvements are made to determine (1) what needs they perceive for sharing data and control across agencies, and (2) any improvements they have perceived as a result of shared information and control. Therefore, the customer satisfaction study will include interviews with TOC operators to assess perceived needs and incremental improvements related to sharing of information and control across centers. Interviews before the ITS improvements in freeway and traffic signal system improvements are made will establish the preconditions for this assessment.

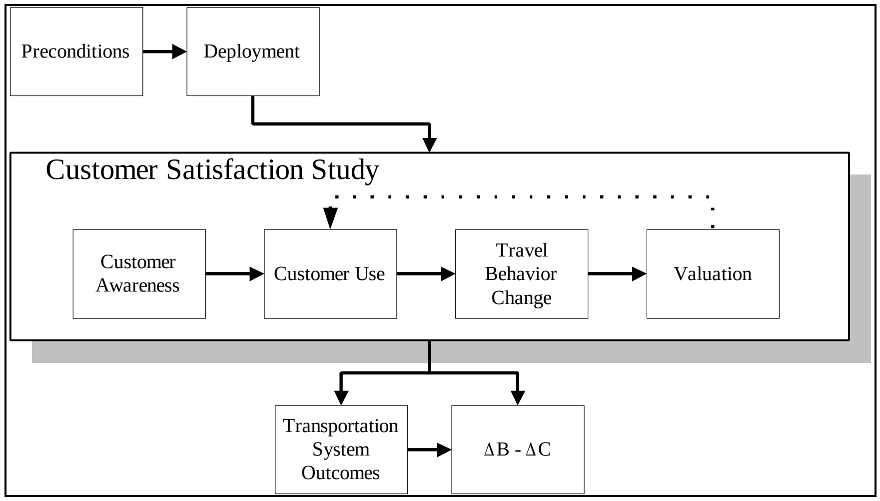


Figure 3-3. Conceptual Data Elements for Customer Satisfaction Study

Deployment of ITS at the MMDI sites will be thoroughly described, and differences between sites for similar projects will be documented such that the behavioral, perceptual, and willingness to pay measures can be properly assessed.

Customer awareness of the ITS services that are deployed is, generally, a precondition for using that service. The customer satisfaction study will assess awareness of ITS projects so that the distinction can be made between level of success attributable to awareness and that attributable to demand or perceived need. For example, a traffic information hotline might fail because other means of distributing traffic information, such as the radio, are deemed sufficient by consumers, or it could fail because consumers are unaware of the service. The customer satisfaction evaluation will strive to ensure we can distinguish between causes for such outcomes. Furthermore, the next step in customer satisfaction will be to determine demographic categories into which customer data will be disaggregated.

Customer use of ITS will be measured by observation whenever feasible. When use cannot be observed by direct means, then questionnaires, focus groups, and, or interviews will be used to obtain statement and perceptions about use of ITS services.

Travel behavior changes can sometimes be observed, as when we observe users diverting in response to variable message signs. However, the predominant means of assessing behavior change will be through inferences about what people tell us they do in response to ITS. As with awareness and customer use, whereas observation is the preferred measurement technique, questionnaires, interviews, and focus groups will often be the method used to assess behavior change. To ensure that comparisons of changes across projects and sites are valid, the national strategy will ensure that the survey instruments are similar across projects and sites. Important areas of similarity include phrasing of questions, scaling of responses, and comparability of choice alternatives.

Travel behavior, as used in Figure 3-3, is intended to encompass much more than behavior during trips. It includes trip planning activities, and even responses to willingness to pay surveys. Willingness to pay will be assessed not only for services that are intended to be sold, but also for services that are offered to consumers for free, or are paid for by advertising revenue. Willingness to pay is an important measure of value, even for "free" service, for several reasons. Among these are: more refined assessment of demand and potential for new markets; computation of "consumer surplus", an important aspect of benefit-cost analysis; and projection of future market penetration given changes in pricing for competing technologies that may not currently be "free".

The national strategy for conduct of the customer satisfaction study is to work closely with the teams conducting the travel efficiency study and benefit-cost studies, as inputs from customer satisfaction measurements will be critical to the success of those efforts. For instance, the travel efficiency study, and through travel efficiency the energy and emissions and safety studies, will derive most of its inputs for travel demand changes from customer satisfaction data. These studies, in turn, will provide input to the benefit-cost study. The customer satisfaction study will also provide willingness to pay and user satisfaction data directly to the benefit-cost study.

3.6 INSTITUTIONAL BENEFITS STUDY

3.6.1 Introduction

The Institutional Benefits study will address in part the last goal of the *ITS National Plan*, that deployment of ITS encourage an environment where ITS development and deployment can flourish.

The study of Institutional Benefits will address both the public sector and private sector involvement in the MMDI. First the study will identify and evaluate public sector institutional structures associated with the deployment and integration of ITS products and services at the MMDI sites. Over a period of time, the study will track institutional changes made to address non-technical impediments, identify lessons that were learned from addressing these impediments, and document the quantitative and qualitative benefits and costs of addressing them.

Second, the study will describe the ATIS business models (or approach) developed by the private sector partners for the development and dissemination of ATIS consumer products and services. The private partners' decisions and the concomitant outcomes will be tracked over the course of the first year of operations as the initial business models are refined and adapted in response to evolving market conditions.

3.6.2 Relative Role of Each Site to Institutional Benefits

In the context of the study of Institutional Benefits, the four MMDI sites will all be assessed equally at the onset. Depending on the preliminary findings based on the review of project documentation, greater emphasis in several of the MMDI sites may be warranted. At this time, each site is anticipated to provide a comparable level of experience and input in the area of Institutional Benefits and business model assessment.

3.6.3 Approach

3.6.3.1 Public Sector Study

The public sector study will focus on four significant areas that represent organizational activities that should be maintained to facilitate the development and deployment of ITS products and services.

- activities within implementing agencies
- activities among implementers
- activities between implementers and customers
- activities with other regional efforts.

Within each area, actions that support these activities have been identified.

Activities within implementing agencies

- developing a project management structure
  - defining internal roles and project leadership
  - developing communications and intra-agency coordination
  - establishing accountability
- identifying human resource requirements
  - implementing staffing levels and work loads
  - identifying required skills
  - identifying training needs
- gaining upper management support
- obtaining staff acceptance
- working within state laws and regulations
- working with agency policies and procedures
- obtaining future support (O&M and staffing)

Activities among MMDI implementers

- defining the project organizational structure
  - establishing the decision-making process
  - defining roles and responsibilities
  - distributing authority
  - establishing accountability
  - determining schedules
  - allocating staff time
  - maintaining communications and meeting logistics
- identifying team expertise

- handling differing agency priorities or agendas
- processing project procurements
  - using non-competitive procurements
  - using innovative methods
- handling procedural and regulatory requirements
  - processing legal agreements and financial documents
  - assigning intellectual property rights
  - addressing liability
- obtaining future support and cooperation
- coordinating proposed and existing systems
  - implementer to implementer

Activities between implementers and users

- coordinating with operating agencies
- gaining support of potential users
- transitioning from deployment to operations

Activities with other regional efforts

- coordinating metropolitan and CVISN MMDIs within an area
- coordinating with the metropolitan transportation planning process
- working with regional coalitions and priority corridors
- drawing support and expertise from non-MMDI agencies

For the purpose of this study, MMMDI implementers comprise four groups:

- state government agencies
- local government agencies

- transit agencies
- public transportation authorities

MMDI users may consist of public sector transportation system managers, emergency service officials, and the general public (not included in this study).

The study team will use five methods to obtain the information required by this study. The first method is a review of project documentation. The second and primary method will be face-to-face interviews with the major MMDI participants. Third, telephone interviews with major MMDI participants will be conducted whenever a face-to-face interview cannot be scheduled. Fourth, questionnaires will be distributed to additional participants when necessary to supplement the interviews. Finally, the evaluation teams' MMDI lead test site engineers and the CVISN points of contact will monitor the on-going activities of the MMDI sites and provide insight that can be applied to the study team's work.

3.6.3.2 Private Sector Study

The private sector study will have two phases. In Phase I, the study team will:

1. Assemble company profiles for each of the private partners to establish the company's current MMDI activities within an overall company strategy
2. Interview each of the private sector partners to identify the particular outcomes they expect to accomplish through their investment in the respective MMDI site(s)
3. Review the partners' initial business plans and identify expected challenges and constraints and
4. Assemble a regional profile of each of the four MMDI regions to include relevant demographic, economic, cultural, and transportation network profiles, as well as the type, amount, and type of interface to the travel data available to the ATIS business.

There will be a report at the conclusion of Phase I summarizing findings and observations.

Phase II will track the adjustments made by the private partners in response to predicted and unforeseen changes in the operating and market environment. At the conclusion of a year of operations, the team will formally revisit the partners to learn about their plans and expectations for the second year. A second report will be produced at the end of phase II comparing and contrasting the different experiences of the private partners in relation to market forces (including the activities of the government partners) in each of the four MMDI regions.

3.6.4 Anticipated Outcomes

3.6.4.1 Public Sector Study

The first objective of the institutional benefits study is to test one hypothesis:

Making institutional changes to address problems that arise in the development, implementation, and integration of ITS facilitates the deployment of ITS.

In order to perform this test, five questions will be addressed:

- What institutional and other non-technical impediments did the public sector MMDI participants encounter while establishing partnerships and deploying an integrated ITS?
- What were the causes of these impediments?
- What institutional changes were made to address these impediments?
- What benefits did the public sector MMDI participants achieve from making these changes?
- What costs were involved?

The second objective of the study is to develop guidelines [rules of thumb] that can be offered to public sector agencies considering deployment of ITS products and services.

Institutional changes, which may be construed as costs, may not directly affect the success of a deployment. An institutional change may be one of many "intervening linkages" that lead to the success or failure of a deployment. Also, the benefits of an institutional change may not be quantifiable. Therefore, anecdotal as well as quantitative benefits will be identified.

The product of this study is a set of guidelines that will aid other areas contemplating the deployment of ITS. The report will identify non-technical issues that occurred within the MMDI sites, the important lessons that have been learned, and the institutional changes made to address the issues. The study team will also provide whatever is required to document the Institutional Benefits Study Area in the reports produced by the evaluation teams.

3.6.4.2 Private Sector Study

The goal of the study is to provide insight into the evolving traveler information market and the resulting implications for both the value-added service provider and the public sector transportation agencies. The study has four objectives:

- Describe the MMDI ATIS business models and the underlying economic rationale.
- Identify broad market factors that are likely to affect the future structure and profitability of ATIS businesses.
- Provide a comparative analysis across MMDI sites, identifying and contrasting differences in context and approach that may affect business success and public acceptance.

- Identify unforeseen events that affect the original business plans and what impact they have on the enterprise's success.

The final product of this study, as described earlier, will be a report that includes a comparative analysis of the partners' business experience at the four MMDI sites, identification of critical ATIS business success factors, and a "Lessons Learned" section that provides guidance on what to expect when undertaking such a public-private enterprise.

3.7 ENERGY AND EMISSIONS STUDY

One of the objectives of the *National ITS Program* is to "reduce energy and environmental costs associated with traffic congestion." Three goals associated with this objective are the reduction of harmful emissions, energy consumption, and new transportation right of way requirements. Although the JPO has not identified explicitly emissions or energy consumption as one of the FGMs of the MMDI, the effect of the MMDI deployments on emissions and energy consumption will be estimated in order to conform with the expectations of the *National ITS Program*.

This section describes the approach for assessing the energy and emissions impacts of MMDI deployments. Specifically, following an introduction of the role of energy and emissions considerations within the *National ITS Program*, some of the main technical issues associated with such an assessment will be described. Finally, an overview will be provided with respect to which ITS elements within the MMDI are expected to have the most significant impact on energy and emissions.

3.7.1 Introduction

It is anticipated that ITS strategies can contribute to reductions in pollutant emissions and fuel and energy consumption in a number of ways. Specifically, it is thought that ITS can smooth traffic flow, reduce the number of vehicle stops, reduce the number of Single Occupancy Vehicle (SOV) trips, reduce the length of any trips taken, reduce the congestion exposure of these trips, and reduce the total number of trips taken.

A second-by-second analysis of each trip is recommended as the only effectively capture emission and energy effects by many air quality specialists. Some forms of ITS deployment, such as web pages, tend to effect the very nature of traveler behavior before travelers even leave their destination. These two facts point to a need for an approach that is both broad in scope, and fine in detail. The following section provides a brief overview of how these issues will be dealt with in the MMDI evaluation.

3.7.2 Energy and Emissions Issues

The primary energy and emissions measures to be examined in this study are:

- **carbon monoxide (CO)** The most widely distributed and the most commonly occurring pollutant caused by vehicular traffic. Most atmospheric CO is formed by the incomplete combustion of organic materials used as fuels.
- **hydrocarbons (HC)** These are compounds whose molecules consist of atoms of hydrogen and carbon only. Hydrocarbons are not, by themselves, a health hazard. However they frequently react with oxides of nitrogen and sunlight to produce photochemical haze or smog. The presence of NOx is a precursor to O_3 formation.
- **nitrous oxides (NOx)** These are formed during all high-temperature atmospheric combustion processes in a spontaneous chemical reaction between the nitrogen and oxygen in the air. The health effects can include nose and eye irritations and, with increasing concentration, bronchiololitis and pneumonitis. The presence of NOx is a precursor to O_3 formation.

- **particulate matter (PM)** smoke, fly ash, dust, and fumes that are solid and liquid matter in the air. They may settle to the ground or may stay suspended. They may scatter light and carry poisonous gases to the lungs. The EPA has currently revised its NAAQs to require analysis of PM greater than 2.5 microns. Due to the lack of data and studies currently available to support PM 2.5 analysis, only PM greater than 10 microns will be considered in this study.

- **fuel/energy consumption** usage of fuel reduces its availability as a non-renewable resource, and results in air pollution,

With the exception of fuel/energy consumption, the mere production of these compounds does not represent a direct cost to society. Instead, costs to society arise when these compounds impact health and property. The economic and health impacts of these compounds are largely independent of the source of these emissions. Consequently the evaluation of MMDI will focus only on estimating in detail the amount of emissions that are produced, as a result of changes in traffic patterns and travel demand, without addressing explicitly the where and how of the emissions. When considering emissions, attempts will be made to acknowledge the difference sources of emissions. These include tailpipe emissions, hot/cold start emissions (modal operation), and evaporative emissions.

Given the above, the main focus of this study will be estimating the differential impact of ITS on the quantity of emissions emitted from vehicles. The quantity of these emissions are closely related to the amount and timing of the travel, and the travel conditions under which this travel takes place. Decisions related the amount of travel that takes place, relate to the trip generation, trip distribution and mode shift behavior of drivers, are typically handled using planning types of models. In contrast, the details of how speeds and accelerations of vehicles are a function of traffic demand and controls are typically best handled using microscopic simulation models. Consequently, a combined demand/supply modeling approach is proposed for evaluating the MMDI impacts on emissions and fuel/energy consumption. These two modeling approaches are complementary, and overlap only in terms of the fact that both modeling approaches can address the manner in which drivers select routes through a traffic network.

While a simple average model such as the EPA's Mobile model is sufficient for calculating overall emissions in a large area, such an approach will not be sufficient for capturing the small effects attributable to, for example, a change in signal timing plans. In order to capture these effects, linking emissions and energy effects to second-by-second speed and acceleration data will be necessary. These relationships can then be used in conjunction with a microsimulation model to calculate even small changes in emissions and energy consumption. Data of this type is currently becoming available from a few sources, such as the Oak Ridge National Labs, Georgia Tech, and UC Riverside.

3.7.3 The Study Approach

The study approach will consist of two coordinated phases. The first phase will focus on estimating the impact of select MMDI components on travel demand and traffic flow. The second phase will use the results of the first phase to determine fuel consumption and emissions impacts.

Phase I

It should be noted that the need in phase I to model the impact of MMDI on travel demand and traffic flow is shared between a number of different MMDI study areas, as travel demand and traffic flow are key inputs to any efficiency, throughput, safety and customer satisfaction analyses as well. Consequently, it is proposed that the first phase will be conducted in such a manner as to satisfy all of the above study area needs. Therefore, the energy and emission study needs will only represent a small incremental burden on analyses that would need to be performed anyway, even if no energy and emissions study was contemplated.

Phase I will also involve the bulk of the data collection at the MMDI sites, as efforts will be made to directly measure in-situ the changes in traveler behavior and traffic flow. However, it is contemplated that direct data collection will not be able to measure all of the potential secondary impacts that could emerge. Consequently, the direct data collection will be supplemented with a complementary modeling activity. This modeling activity will be calibrated against the actual field data from the MMDI sites, but will be utilized to track the impacts of MMDI beyond those places where direct data collection was practically feasible.

An example of this is the direct measurement of signal coordination benefits on the arterials being coordinated, but the simulation of the indirect impact of such coordination on the side streets. A similar assessment would involve the direct field measurement of the increase in speeds and throughput on a freeway, following the introduction of ramp metering, but the simulation of the impacts of this diversion on parallel routes.

Phase II

Phase II aims to use the results of Phase I to answer expected outcomes related to specific MMDI projects, provide data for the energy and emissions study of other specific MMDI projects, and also provide input to the benefit-cost study as needed. Given the extensive amount of effort involved in performing emission measurements using fully instrumented vehicles, the intent of the MMDI evaluation is to keep the use of such instrumented vehicles to an absolute minimum. Instead, the results from other experiments using such instrumented vehicles will be utilized to interpret the MMDI impacts noted in Phase I, as per above. The only use of instrumented vehicles, that is contemplated, is the validation of some of the key findings from the combined Phase I and II approach using an independent set of direct measurements.

The next major issue, associated with phase II, is the variety of different vehicle types that need to be modeled explicitly. At the top level, it is planned to explicitly model passenger cars, trucks and buses as different vehicle types. However, within each of these groups it still remains to be decided how many subgroup vehicle types will need to be considered. The reason for the absence of such a decision relates to the fact that there is little research that has addressed the following fundamental question:

> "is the emissions impact, that is estimated with a hypothetical vehicle that has emission characteristics that are a composite of a range of different vehicle types, significantly dif-

ferent from the impacts that would be estimated from modeling each of these different vehicle types explicitly ?"

The intent is, therefore, to answer this question early on during the study and to determine how many subgroups of vehicles need to be considered.

3.7.4 Expected Impacts

Table 3-3 provides a summary of the response impacts that were expected to arise from the deployment of MMDI. Those impacts that relate to changes in speed or acceleration, and route diversion, will be evaluated using a microscopic simulation model. These changes that related to temporal diversion, mode shift, destination change and induced or foregone demand, will be addressed using a demand model. Double check marks represent what are expected to be the main impacts.

3.7.5 Expected Study Tools

The main tools that will be utilized in performing the energy and emissions study will be demand models (where available at the local sites) and simulation models (notably INTEGRATION). New emissions relationships will be embedded directly into INTEGRATION, making it an ideal tool for this task. Wherever possible, model networks already existing at the sites will be pursued to eliminate much model development time, and ensuring consistency between national evaluation work and any local work.

Table 3-3. Summary of Impacts of each ITS Component on Traveler Response

ITI Elements	*Speed or Acceleration Changes*	*Route Diversio*	*Temporal Diversion*	*Mode Shift*	*Destination Change*	*Induced or Foregone Demand*
Traffic Signal Control	✓✓	✓				
Freeway Management	✓✓	✓✓	✓	✓	✓	✓
Transit Management	✓✓	✓	✓	✓		
Incident Management	✓✓	✓✓	✓	✓	✓	✓
Electronic Fare Payment				✓		
Electronic Toll Collection	✓✓	✓	✓	✓		
Railroad Grade Crossings	✓	✓✓				
Emergency Management Services		✓	✓			
R.M.Traveler Information		✓✓	✓✓	✓✓	✓	✓

3.8 References

1. *1996 Report to Congress for the National ITS Program*, FHWA, US Department of Transport

2. *Highway Safety Improvement Program*, FHWA, US Department of Transport, Dec 1981

3. *User Acceptance of ATIS Products and Services: What do we Currently know?* Charles River Associates, October 1996

4. Murakami, E., and Watterson, W. T. (1990). Developing a household travel survey for the Puget Sound Region. *Transportation Research Record*, *1285*, 40-48.

4. Glossary

Acronym	*Term*
ATIS	Advanced Traveler Information System
EFP	Electronic Fare Payment
EMS	Emergency Management System
ETC	Electronic Toll Collection
FGM	Few Good Measure
FHWA	Federal Highway Administration
FM	Freeway Management
FOT	Field Operational Test
HAR	Highway Advisory Radio
HOV	High Occupancy Vehicle
IM	Incident Management
ISP	Information Service Provider
ITS	Intelligent Transportation System
IVN	In-Vehicle Navigation unit
JPO	Joint Program Office
LTSE	Lead Test Site Engineer
MOE	Measure of Effectiveness
MPO	Metropolitan Planning Organization
MMDI	Metropolitan Model Deployment Initiative
NHTSA	National Highway Traffic Safety Administration
NY/NJ/CT	New York, New Jersey and Connecticut
RRX	Railroad Grade Crossing
SAIC	Science Applications International Corporation
TM	Transit Management
TS	Traffic Signal Control System
U.S. DOT	United States Department of Transportation
VMS	Variable Message Sign

5. Appendix A

This appendix contains a brief history of the ITS program in the United States, especially those programs leading to the MMDI.

History of the ITS Program

The National ITS (Intelligent Transportation Systems) program was established by the Intermodal Surface Transportation Efficiency Act (ISTEA) that was passed by Congress and approved by the President in December, 1991. Among the goals this legislation states for the ITS program are:

- Enhancement of the capacity, efficiency, and safety of the highway system, serving as an alternative to additional physical capacity.
- Enhancement of efforts to attain air quality goals established by the Clean Air Act.
- Reduction of societal, economic, and environmental costs associated with traffic congestion.

Other ITS program goals cited by Congress include the development and promotion of an ITS industry in the United States, particularly creating an American presence in this emerging field of technology; development of a technology base for ITS systems; a capability to perform demonstration experiments, using existing national laboratory capabilities where appropriate; and the facilitation of technology transfer from national laboratories to the private sector.

ISTEA also established criteria for the ITS (then IVHS) Corridors; and U.S. DOT followed with designation of four corridors, which are:

- I-95 Corridor (including Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia)
- Midwest Corridor (Gary, Indiana to Milwaukee, Wisconsin)
- Houston, Texas
- Southern California

The programs in these four areas are building toward integrated transportation management and traveler information systems and incorporate a wide range of ITS technologies and services. In addition, the institutional relationships that have been developed and strengthened through the initiation of the Corridors Program has led to enhanced working relationships among transit, traffic, and other entities across jurisdictional boundaries.

An *IVHS Strategic Plan* (Intelligent Vehicle Highway Systems, IVHS, was later designated ITS) was transmitted to Congress in December, 1992. It presented the goals and objectives of the national ITS program and described the program delivery process. The Strategic Plan also called for the formulation of a tactical program plan to assure coordination and integration of ITS activities in the public and private sectors. This plan is now referred to as the *National ITS Program*.

The *National ITS Program* was developed in a cooperative effort by the US Department of Transportation (DOT), with advice from ITS America, and input from interested members of the public. Development of this far-reaching plan represented a major accomplishment in fostering public-private cooperation and promoting a consensus view on how ITS will be advanced in the United States. The plan is focused on the development and deployment of a collection of interrelated transportation user services. These user services are defined along the lines of services or benefits that users might receive. The program plan defines specific research, development, testing, and other activities necessary to achieve and support deployment of user services in a nationally compatible intermodal system. The plan also addresses investment tradeoffs and activities necessary to foster the best possible legal and institutional environment for the deployment of ITS.

The *National ITS Program* is a dynamic document that reflects evolving changes in government policy, technology, market conditions, and program successes and failures. Thus, ongoing program assessment is a major element of the ITS program planning process and will serve as a feedback mechanism for evaluating the performance of the program in achieving key goals and objectives.

In 1995, U.S. DOT and ITS America jointly identified a core set of nine metropolitan-area ITS infrastructure components that would share a reasonably common architecture to allow consistent market evolution of ITS technologies:

- Traffic Signal Control
- Freeway Management
- Incident Management
- Transit Management
- Regional Multimodal Traveler Information Systems
- Electronic Fare Payment
- Electronic Toll Collection
- Railroad Grade Crossing
- Emergency Management Services.

Together these nine components are expected to deliver safety, congestion reduction, and productivity benefits. It is hypothesized that the components, when integrated on a common communication structure, will provide the metropolitan sector an intelligent transportation infrastructure that enables easy information access across agency and organizational lines. This integration is expected to substantially enhance individual component functions and create a set of public and private services, several of which possess revenue potential.

On January 10, 1996, Secretary of Transportation Federico Pena announced a major Intelligent Transportation Systems (ITS) deployment goal, called Operation TimeSaver. The Operation TimeSaver goal is to reduce the delay of American travelers by at least 15 percent through deployment of an ITS infrastructure across the United States. Progress toward meeting this goal would be tracked at 75 of the nation's largest metropolitan areas (tracking has been expanded to 78 metropolitan areas). To support this goal, the U.S. DOT launched the Metropolitan Model Deployment Initiative. Four sites were selected which will become deployment showcases of an integrated, metropolitan-area ITS Infrastructure. These model deployments will demonstrate the benefits of integrated transportation management systems that feature a strong, regional, multimodal traveler information services component. In this same time frame, model deployments of the Commercial Vehicle Information Systems and Networks (CVISN) were also initiated. Maryland and Virginia are currently developing a prototype version of CVISN and the following states have begun plans for pilot versions of CVISN: California, Colorado, Connecticut, Kentucky, Michigan, Minnesota, and Washington/Oregon. Comprehensive evaluations are a major part of both the MMDI and CVISN initiatives.

During 1996, U.S. DOT also developed the Advanced Rural Transportation Systems (ARTS) program to plan and deploy ITS technologies and systems in areas outside the urban settings, which comprises roughly 80 % of the total U.S. road mileage and 40 % of the vehicle miles traveled. A Strategic Plan, which includes an evaluation component, was developed.

In 1998, U.S. DOT formulated the Intelligent Vehicle Initiative (IVI). Unlike the Metropolitan, Commercial Vehicle, and Rural infrastructures, this element of the ITS program focuses upon the vehicles. These intelligent vehicles will use the ITS infrastructure to support their safe and efficient operations. Unlike its infrastructure counterparts, the IVI is far from being deployed, has no field operational tests planned for the near future, and remains a part of the U.S. DOT research program. Because the fundamental nature of research is evaluation of concepts and technology feasibility, there are no independent evaluations currently planned.

6. Appendix B

This appendix contains project descriptions for all projects currently being considered for deployment at the four MMDI sites. As some of these projects are still not finalized, it is understood that these projects sheets are a work in progress. The descriptions contained here are current as of November 1998.

6.1 NEW YORK / NEW JERSEY / CONNECTICUT PROJECTS

Project Number	**NY-1**
Project Name	**Traveler Information Center (TIC)**
Planned Features	• The TIC will be operated by a private project partner and will receive information through the TRANSCOM Regional Architecture. • The TIC will be the central ATIS system/server and the operator will manage the PTS services. • Free services will include: • TRIPS web site and phone system • Real-time traffic information web site and phone system. • Free services are marketed as incentives for travelers to purchase paid services available through PTS.
Comments	This MMDI component will not be operational in time to be evaluated within the MMDI Evaluation time frame.
Study Areas	ATIS: Customer Satisfaction, Cost, Benefit/Cost

Project Number	**NY-2**
Project Nname	**Regional Transit Itinerary Planning System**
Planned Features	• Free WWW site with point-to-point itinerary planning across multiple transit operators including incorporation of incident information. • Itinerary planning includes various user-define travel parameters: time of day; special needs; itinerary preference; fare category; land-mark, address or intersection O-Ds; and, walk access map to origin or destination. • Free telephone service providing static schedule and fare information on any single transit route but without itinerary planning as the tech-nology to provide this does not currently exist. • Both TRIPS components viewed as incentives for travelers to sub-scribe to PTS. • Potential for automatic uploads of updated of transit operator sched-ules to the TRIPS server through the Regional Architecture. • TCP/IP compliant.
Comments	Unpublicized availability of the WWW site during the MMDI time frame
Study Areas	ATIS: Customer Satisfaction, Cost, Benefit/Cost

Project Number	**NY-3**
Project Name	**Personalized Traveler Services**
Planned Features	• Subscription service. • Information specific to traveler’s route and time of travel. • Dissemination of information via telephone, fax, pager, or e-mail. • It is expected that the originally targeted media with be included in the PTS. • In addition, the project partners will be exploring emerging markets such as in-vehicle units.
Comments	This service will not be available within the MMDI evaluation time frame.
Study Areas	ATIS: Customer Satisfaction, Cost, Benefit/Cost

Project Number	**NY-4**
Project Name	**SATIN kiosks**
Planned Features	• The SATIN project is expected to become a self-supporting traveler information service. • SATIN will support iTravel functions of TIC and TRIPS.
Comments	Currently no private partner under contract to deploy SATIN
Study Areas	ATIS: Cost, Benefit/Cost

Project Number	**NY-5**
Project Name	**NY E-Z Pass**
Special Funding	No MDI funding involved.
Planned Features	• Electronic Toll Collection (ETC) system deployed by multiple agencies throughout the NY/NJ/CT region. • Covers both personal and commercial vehicles
Comments	EZ Pass is already deployed on facilities operated by New York MTA Bridges and Tunnels, Port Authority of New York New Jersey, the New York State Thruway Authority, and others. Expansion on the NY Turnpike and Garden State Parkway are planned for the year 2000.
Study Areas	ETC: Cost, Benefit/Cost

Project Number	**NY-6**
Project Name	**TRANSMIT**
Special Funding	No MDI funding involved.
Planned Features	• TRANSCOM's TRANSMIT system provides real-time traffic information on instrumented roadways using ETC-equipped vehicles as traffic probes. The traffic information is made available throughout the region via the TRANSCOM Regional Architecture and will also feed the MDI-funded TIC, PTS, and TRIPS services.
Comments	NA
Study Areas	ATIS: Cost, Benefit/Cost

Project Number	**NY-7**
Project Name	**Long Island Railroad Intermodal Control System.**
Original Planned Features	No MDI funding involved
Current Features	• Minimize conflicts between trains and intersecting at-grade highways • Increase information to motorists at railroad crossings • Make engineers aware of vehicles blocking crossings • Reduce necessary downtime for crossing gates • Provide preemption for emergency vehicles
Comments	N/A
Study Areas	RRX: Cost, Benefit/Cost

6.2 PHOENIX PROJECTS

Project Number	**PH-1**
Project Name	**Southern Baseline Corridor Signal Coordination**
Planned Features	• implement signal coordination • implement traffic detection; install additional detectors • install 2 CMS on each arterial • integrate Mesa loop detectors • install communications • coordinate timing with Mesa, Tempe, Phoenix, and ADOT • CMS installed to US 60
Comments	• US 60 was added to Southern/Baseline pair • Needed to add CMS on US 60 to effect diversion • Mesa not connected yet • 22 Corridors were identified in the EDP; eight corridors proposed for the MDI after funding was approved: Southern; Baseline; Rural/Scottsdale Road; Bell Road; Grand Avenue; Glendale Road; Tatum; 7th Street
Study Areas	TS/FM – Safety, Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**PH-2**
Project Name	**Bell Road Corridor Signal Coordination**
Planned Features	• Implement signal coordination • Implement traffic detection; install additional detectors • Install communications • Coordinate timing: ADOT, MCDOT, Peoria, Glendale, and Phoenix
Comments	None
Study Areas	TS – Integration, Safety, Cost, Benefit/Cost

Project Number	**PH-3**
Project Name	**Scottsdale/Rural Road Corridor Signal Coordination**
Planned Features	• Implement signal coordination • Implement traffic detection; install additional detectors • Install communications • Coordinate timing with Scottsdale, Tempe, and ADOT
Comments	Implemented – 1998
Study Areas	TS – Safety, Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**PH-4**
Project Name	**Computer-aided Incident Investigation**
Planned Features	• Purchase two "Total Stations" for DPS • Provide training on use of equipment • Coordinate among ADOT, DPS, Phoenix FD, and local police
Comments	• DPS purchased two additional Stations • In use since January 1997 • Other Valley agencies are purchasing equipment • Project improved inter-agency coordination
Study Areas	IM – Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-5**
Project Name	**Transit Vehicle Dispatch with AVL and MDT**
Planned Features	• Implement on four fixed routes • 55 buses in Phoenix, 10 in the East Valley • Install AVL • Install MDT • 23 buses (Mesa Transit) added (91 buses total)
Comments	• City of Mesa expressed interest and provided 50% of their project cost • Data will be generated in early 1999 • ADS needs to develop server; data will be passed to AZTech server
Study Areas	TM - Cost, Benefit/Cost

Project Number	**PH-6**
Project Name	**Paratransit Vehicle Dispatch with AVL and MDT**
Planned Features	• Install AVL • Install MDT
Comments	• 75 vehicles were equipped • cost was part of match
Study Areas	TM - Cost, Benefit/Cost

Project Number	**PH-7**
Project Name	**Service Vehicle Dispatch AVL**
Planned Features	• Install AVL • Install MDT
Comments	• 15 vehicles equipped • cost was part of match
Study Areas	TM - Cost, Benefit/Cost

Project Number	**PH-8**
Project Name	**Bus Card Payment**
Comments	Completed a few years ago
Study Areas	EFP - Cost, Benefit/Cost

Project Number	**PH-9**
Project Name	**Cable TV**
Planned Features	• Provide real-time traffic (freeway and arterial) data • Road closures and restriction added
Comments	• Information provided on Tempe Channel 11 • Etak wanted to make it part of interactive cable TV but technology is not available • Information may be provided on cable systems in Mesa, Glendale, and Scottsdale
Study Areas	ATIS - Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-10**
Project Name	**Kiosks**
Planned Features	• Install up to 29 kiosks • Include real-time traffic (freeway and arterial) and transit data and transit schedules
Comments	• 22 kiosks fully funded with MDI funds • outdoor kiosks took longer to manufacture
Study Areas	ATIS - Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-11**
Project Name	**In-vehicle navigation**
Planned Features	• Install units in 50 rental cars and 20 “project” cars • Provide route planning, turn-by-turn guidance, and point-of-interest information
Comments	• AZTech wanted self-sustained, commercially deployed system • Scientific Atlanta stopped STIC receiver production, changed business plan – no future as supplier of devices • AZTech cancelled contract, dropped as partner • AVIS was to supply 15 vehicle, but never made a commitment • AVIS started own experiment in Florida and moved cars • MDI funding for developing interface and hardware for signal trans-mission
Study Areas	ATIS – none

Project Number	**PH-12**
Project Name	**Fastline PCD**
Planned Features	• Develop traveler information for hand-held computers • Distribute software free via internet • Provide speeds and incidents (freeways and arterials), road closures, special events, route planning, transit schedules, airline information, and yellow pages
Comments	• Fastline developed interface • Fastline wants to be Content provider and not Internet provider - users will have to have own Internet provider to access information • Fastline services may be offered by some wireless service providers at point of sale • AZTech bought six devices for testing
Study Areas	ATIS – Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-13**
Project Name	**Personalized Messaging System**
Planned Features	• Provide traffic information by time of day and specific corridors • Transmitted by e-mail • Intended to be commercially viable
Comments	• E-mail system in beta test, available to partners free of charge • Etak will probably offer subscription service • Etak wants to be information wholesaler and not system operator – looking for paging service to operate. Paging companies not interested in transportation • Etak started Traffic Angel – cellular phone system; carried by AT&T Smart Phone
Study Areas	ATIS - Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-14**
Project Name	**Web page**
Planned Features	• Free access to information • Provide real-time traffic conditions (freeways and arterials), CCTV snapshots, road closures, special events, real-time bus status • Both Web sites implemented • June 1999 - AZTech server delayed, may impact whether arterial information reported in evaluation time frame
Comments	• “bus status” includes schedules, the rest of the project awaites the completion of AVL activity • ADOT web page provides live video from selected cameras • Etak built a national web site; includes information on Phoenix • Etak page does not contain transit or video; links to ADOT page • Real-time information from arterials not available yet
Study Areas	ATIS – Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**PH-15**
Project Name	**Transit Status Information**
Planned Features	• LED signs at 3 transit centers (Phoenix, Scottsdale, and Tempe) announcing arrival times of AVL-equipped buses • Kiosks at all transit centers with enhanced transit information • 5 bus shelters on Route 72 will display arrival status on LED signs • develop data server to supply transit info to AZTech server
Comments	• Telephone company did not appear to be interested • One large sign (one 4” line of display) installed in Phoenix center • Signs at shelters have one 2” lines • Waiting for Tempe center to be built • Sign needs to be ordered for Scottsdale center • Data server developed • Mesa will install four signs
Study Areas	ATIS – Customer Satisfaction, Cost, Benefit/Cost

Project Number	**PH-16**
Project Name	**Integration of FMS and Arterial Street Signal Systems**
Planned Features	• Integrate FMS and eight arterial traffic control systems • Allow pre-determined traffic control strategies to be dynamically implemented for congestion, incidents, and special events
Comments	• Systems of five cities will be connected to share control • 13 centers will be connected and have access to data • Tempe is connected • Mesa connection to be completed in Nov. 1998 • Scottsdale and Phoenix waiting on procurement • Chandler is the fifth city
Study Areas	TS/FM – Safety, Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**PH-17**
Project Name	**Integration of TOCs, Transit, and Emergency Services**
Planned Features	• Integrate nine TOCs, with Phoenix Transit and 911 emergency services • Provide real-time traffic information to transit and emergency services from AZTech • Provide traffic-related incident information to AZTech from 911 • Provide real-time bus status to AZTech from transit
Comments	13 centers will be connected – nine cities, 911, Phoenix FD, ADOT, and MCDOT real-time status being provided on four routes
Study Areas	EMS – Cost, Benefit/Cost

Project Number	**PH-18**
Project Name	**Integration of Highway Closure Reporting System (HCRS)**
Planned Features	• Integrate HCRS between ADOT and participating jurisdictions • Provide HCRS interface on workstations at eight jurisdictions
Comments	• Now called Roadway Closure Reporting System • Interface installed in Mesa, Tempe, and Glendale • Phoenix needs a server • Three other jurisdictions will be connected • Etak can access data • 150 events have been entered
Study Areas	ATIS- Integration Cost, Benefit/Cost

6.3 SAN ANTONIO PROJECTS

Project Number	**SA-1**
Project Name	**Medical Center Corridor**
Planned Features	• All signals in and around the South Texas medical Center • City-owned twisted pair, leased phone lines, and TransGuide fiber network • Replace existing Type 170 PROM with an enhanced PROM • Single central server • 9 arterial VMS • incident diversion strategies and timing plans • SA City TOC
Comments	None
Study Areas	TS/FM – Safety, Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**SA-2**
Project Name	**Freeway Management Expansion**
Planned Features	• No MDI funding involved • 27 additional miles
Comments	None
Study Areas	TS/FM – Customer Satisfaction, Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SA-3**
Project Name	**LifeLink**
Planned Features	• One hospital site, one work station • 10 ambulances operated by the SAFD • 59 receiver sites • Spread spectrum ethernet radio links between EMS units and fiber hub • Microwave link from TransGuide to hospital • Notepad computer, video screen, camera, microphone, speaker in rear • New ambulance configuration • Fiber optic network replaced microwave link from TransGuide to hospital
Comments	• Significant reduction in features (reduced hospitals, ambulances, coverage area, and data) • Ambulances reduced to 10 due to budget constraints; SAFD provided $1/2 million • Equipment to transmit telemetry data not selected yet • Installation of fiber optics funded jointly by VIA, SAPW, and TxDOT • Management of other hospitals want a more in-depth medical evaluation of LifeLink before joining program; TxDOT is seeking funs for the evaluation
Study Areas	EMS – Customer Satisfaction, Safety, Cost, Benefit/Cost

Project Number	**SA-4**
Project Name	**Bus Incident Management System (BIMS)**
Planned Features	• On-demand real-time or near real-time video from vehicle to dispatcher • Possible use of vehicles as probes
Comments	• VIA staff saw no benefit to external cameras • Contract signed two months ago • Still under development
Study Areas	TM – Delayed

Project Number	**SA-5**
Project Name	**Advanced Warning to Avoid Railroad Delays (AWARD)**
Planned Features	• Six sensors at three grade crossings (two per crossing) • Infrared sensors replaced by radar and acoustic sensors due to problems with infrared in detecting low speed/stopped trains • Sensors not placed on railroad ROW
Comments	• Fundamental shift in nature of project from safety to traffic information and network efficiency • Railroads expressed liability concerns (did not want to know if there were vehicles on tracks, train probably would not be able to stop in time even if alerted)
Study Areas	RRX – Customer Satisfaction, Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**SA-6**
Project Name	**Kiosks**
Planned Features	• 40 kiosks • Transit and traffic information • Trip planning • Kiosks reduced from 100 to 40 (36 indoor, 4 outdoor) • Airport information is not available
Comments	• Significant reduction in number of units • Rental car information (telephone numbers available) • Some “yellow page” information available • Will eventually include airport automated parking (probably second half of 1999) and real-time flight schedule information
Study Areas	ATIS - Customer Satisfaction, Cost, Benefit/Cost

Project Number	**SA-7**
Project Name	**IVN**
Planned Features	• 590 navigation (IVN)units • Locally operated public agency vehicles
Comments	• Fundamental shift to solely public vehicle deployment • Legal issues with providing free/subsidized units to private citizens (state law prohibits state-owned equipment being provided to non-government entities)
Study Areas	ATIS - Customer Satisfaction, Safety, Cost, Benefit/Cost

Project Number	**SA-8**
Project Name	**Web Page**
Special Funding	• No MDI funding involved
Planned Features	• Incident map, lane closure map, connection to Texas Highway Conditions System, State Roadway Closure System, and all MDI documentation
Comments	None
Study Areas	ATIS - Customer Satisfaction, Cost, Benefit/Cost

Project Number	**SA-9**
Project Name	**IVN Paratransit**
Planned Features	590 IVN units
Comments	None
Study Areas	TM – Customer Satisfaction, Safety, Cost, Benefit/Cost

Project Number	**SA-10**
Project Name	**Travel Speed Database (AVI Probes)**
Planned Features	• 77,000 intelligent vehicle registration tags (IVRTs) • 52 AVI readers • Data collected in 15-minute intervals • Data collection in 5-minute intervals • Changed from IVRTs to off-the-shelf traffic tags • Changed to a voluntary program
Comments	• Originally TxDOT planned to distribute approximately 800,000 (number of registered vehicles in Bexar County) intelligent vehicle registration tags but later determined the cost was too expensive. TxDOT then planed to distribute 400,000 • Distributing 400,000 tags through the DMV would mean that the DMV would have to revert to a manual method (they currently have an automated distribution system) • Had to rely on voluntary method – led to significant reduction in market penetration • Traffic tag more expensive - led to significant reduction in number of tags (IVRTs would have a short battery life) (IVRTs would have to be replaced annually) (O-T-S tags are activated by the readers and donot contain a battery) • 34,000 tags distributed, 30,000 tags may be distributed through USAA to its members (1/2 within the next two months, remainder in three-four months) • Marketing effort still on going (it is difficult to market the use of AVI tags in San Antonio because there are no toll facilities that would help to explain the function to users) (a mandatory program may have created a large number of questions) • Using system that reads off-the-shelf tags from Amtech allows system to read tags on cars from other areas that use Amtech tags (Houston, Dallas, Oklahoma Turnpike)
Study Areas	ATIS – Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

6.4 SEATTLE PROJECTS

Project Number	**SE-1**
Project Name	**North Seattle ATMS**
Planned Features	• Integrate traffic signals among five cities • Develop signal timing plans • Implement NTCIP throughout region
Comments	• The NSATMS started as an FOT; it includes 16 jurisdictions • The five cities listed in the proposal are outside of the NSATMS area • Delay in the transit signal priority function is due to the delay in Metro implementing its prototype program • Jurisdictions want to test the signal priority concept before committing to it • Questions regarding delays on cross streets
Study Areas	TS/FM – Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**SE-2**
Project Name	**Eastside ATMS**
Planned Features	See notes from SE-1
Comments	None
Study Areas	TS/FM - Integration, Cost, Benefit/Cost

Project Number	**SE-3**
Project Name	**Southside ATMS**
Planned Features	See notes from SE-1
Comments	None
Study Areas	TS/FM - Integration, Cost, Benefit/Cost

Project Number	**SE-4**
Project Name	**Seattle TMS**
Planned Features	• No MMDI funding involved rebuilding (installing) a TMS in the City
Comments	• Center will not be finished within MDI time frame
Study Areas	TS/FM – Integration, Cost, Benefit/Cost

Project Number	**SE-5**
Project Name	**SeaTac Airport TMS**
Planned Features	• Install detectors on airport access roadways to provide congestion information • Incorporated information into agency transportation management and traveler information delivery systems • Provide traveler information kiosks at the airport to provide real-time, multimodal traveler information to a selection of destinations
Comments	• Airport staff learned to do surface transportation management within regional context • Kiosks are display only, not interactive
Study Areas	TS/FM - Customer Satisfaction, Integration, Cost, Benefit/Cost

Project Number	**SE-6**
Project Name	**Bellevue TMS**
Planned Features	• Upgrade signal hardware and software • Implement transit signal priority
Comments	• See SE-1 for comments on transit signal priority task • RT-TRACS activity was not part of the MDI
Study Areas	TS/FM – Integration, Cost, Benefit/Cost

Project Number	**SE-7**
Project Name	**WSDOT Northwest Region TSMC**
Planned Features	• Develop an automated CD-ROM system for recording and distributing historical traffic detector data
Comments	• Freeway data is being archived on CD-ROM; waiting for completion of MIST to get arterial data • An incident detection algorithm is included in the MIST
Study Areas	TS/FM – Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**SE-8**
Project Name	**WSDOT Olympic Region TSMC**
Planned Features	• Install additional CCTV cameras on I-5 through Tacoma • Install camera on SR 16 • Connect cameras to Olympic Region TSMC • Link cameras to Northwest Region TSMC • Create Internet and cable TV flow maps for I-5 and SR 16 in the Tacoma area
Comments	• Waiting for construction project on I-5 to install camera • Flow maps not on cable TV
Study Areas	TS/FM - Integration, Cost, Benefit/Cost

Project Number	**SE-9**
Project Name	**Regional Video System**
Planned Features	• Allow for 448 cameras and 80 monitors to be connected • Connections made among state and city CCTV cameras and operations center • Provide more roadway surveillance video to TV stations and other public and private entities
Comments	• Used fiber network to connect UW, Seattle, and Bellevue
Study Areas	TS/FM – Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

Project Number	**SE-10**
Project Name	**Bartizan Mayday Services**
Planned Features	Whole project dropped due to lack of consumer response
Comments	• Car manufacturers are producing the units at a cheaper price • Competition (OnStar and RESCU) was not present at start of MDI
Study Areas	EMS

Project Number	**SE-11**
Project Name	**XYPOINT Mayday Services**
Planned Features	Whole project dropped
Comments	• Same comments as SE-10 • XYPOINT unit would cost approximately $2000; could not compete with OEMs • MDI wanted travel time data; privacy issues avoided if information came from Mayday service provider
Study Areas	EMS

Project Number	**SE-12**
Project Name	**Improved Incident Capture and Processing**
Planned Features	• Improve the interface and processing of incident reports between the WSP dispatch system, WSDOT NW Region TSMC, Mayday service providers, and ISPs
Comments	• Incident information will be given to Web users • NavTech software translate street name to lat./long. coordinates
Study Areas	IM – Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-13**
Project Name	**Improved Incident Video**
Planned Features	• Install two-way video communications equipment in incident response vehicles (IRVs) • Establish a video link between TSMC and the IRVs • Provide slow-scan video of traffic at incident scenes • Provide real-time video “snapshots” and WSDOT flow map to IRVs • Provide capability for full-motion video recording at scene • Because IRVs would not be close to accident, mounted cameras would not provide adequate video, digital cameras added
Comments	• Project was added through discussions with Harbor View Medical Center and based on knowledge of San Antonio’s LifeLink • A digital camera, notebook computer, wireless modem, and password protected Web site are used to send pictures from incident scene to trauma center (LifeLink Lite) • Computers in IRVs provide access to Web for traffic data and videos • Equipment placed with two IRVs • Still working to convince trauma centers of value
Study Areas	IM – Safety, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-14**
Project Name	**Emergency Operations Center**
Planned Features	• Install communication links between WSDOT's TSMC and Seattle's and King County's emergency response centers to facilitate transfer of traffic data and video • Install GPS equipment in incident response vehicles to provide enhanced incident location information • Install communication links between WSDOT's TSMC and Seattle's and King County's emergency response centers to facilitate transfer of traffic data and video
Changes	Focus changed from providing video on Web to voice communications, 18 800 MHz WSDOT radios provided to County and City emergency response centers
Comments	• Incident information was to obtained from XYPOINT mayday devices • Some GPS devices were installed as part of the PuSHMe FOT • Regional coordination of emergency response entities not as great as assumed; there is a need for an agency to take a regional coordination role
Study Areas	EMS – Safety, Cost, Benefit/Cost

Project Number	**SE-15**
Project Name	**King County Metro Transit AVL System**
Planned Features	• Install hardware on 1200 King County buses to integrate AVL system with automatic passenger count (APC) system (APC may have been installed on 150 buses)
Comments	• Hardware allows APC to be integrated with AVL system but does not add APC to all buses • Hardware makes buses part of an area-wide network
Study Areas	TM – Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-16**
Project Name	**AVI Bus Signal Priority**
Planned Features	• Install AVI equipment on King County for transit priority on selected routes • Install communications to collect AVI information and deliver it to the TSMC • 26 intersections within King County
Comments	• Hardware installation started • South Snohomish Region Transit Priority Signal Project is on-going and not part of the MDI, use MDI infrastructure • CT ASAP project is a congressional earmark, MDI would receive data and install equipment to display information
Study Areas	TM – Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-17**
Project Name	**Microsoft Sidewalk**
Planned Features	• Allow Microsoft to expand its internal Internet service • Microsoft will build World-Wide Web-based application that will enable users to receiver traveler and other information • Microsoft will generate revenues through advertising • Provide personalized service to user – travel time data from point to point
Comments	• Microsoft eventually signed a contract with WSDOT • Microsoft did not provide MDI with evaluation material
Study Areas	ATIS – Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-18**
Project Name	**Etak / Metro Networks / Seiko**
Planned Features	• Provide data to Seiko as well as numerous other ISPs • Expand the Etak/Metro Traffic traffic work station to handle more data sources • Metro Traffic will operate additional servers for increased information dissemination • Seiko will provide 1,000 Remote Receiver Modules to device manufacturers at a reduced price subsidized by the project • The RRMs will receive information using the Seiko HSDS protocol and will be suitable for a wide range of display devices and traveler information applications • Etak providing information via Traffic Angel, a cellular phone system with a web browser.
Comments	• Seiko having trouble getting companies to incorporate their product. Also Seiko has cut their work force; have been affected by the Asian financial crisis; and have had engineers doing marketing. • Still possible that Seiko will provide pager answering services • Etak cannot get airtime on cable stations – TCI has been unresponsive. • Etak also went to King County. County's public access station has little airtime available and feels information provided on UW station. • County management also has problems with Etak getting revenues from use of publicly funded station.
Study Areas	ATIS - Energy and Emissions, Throughput, Cost, Benefit / Cost

Project Number	**SE-19**
Project Name	**Fastline Handheld PC**
Planned Features	• Develop software for an interactive hand-held PC (HPCs) program that displays traffic flows and incidents, area maps, turn-by-turn route planning, transit schedules and conditions, yellow pages, and general information • Program will work on Windows CE software platform, such as Casio and Hewlett Packard(HP) HPCs
Comments	• Project initially dropped during negotiations; Fastline came back and proposed to do their project for about half the cost. (they were able to reduce costs because they were on the Phoenix MDI team also and since both Seattle and Phoenix got funded they didn't need full funding from any one team) • More funding has been added so Fastline can show Pocket BusView (implemeted) • Software has been downloaded approximately 180 times
Study Areas	ATIS - Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-20**
Project Name	**Cable Television Traffic Channel**
Planned Features	• Restore a traffic channel to the region's cable TV • Provide as many traveler applications as feasible over the UW's educational TV channel • Create cable TV flow maps for Tacoma area • Provide information on ferry queues and waiting times at four ferry terminals via cable TV • Provide congestion maps and real-time surveillance video of freeways and arterials during peak travel times • Coverage includes Seattle and King, Pierce, and Snohomish Counties
Comments	• Traffic is not on the main UW cable channel • UW2 (Channel 75) only reaches 60,000 residences; may expand to 600,000 households (full coverage) • Traffic data broadcast three times per day – morning, noon, evening
Study Areas	ATIS - Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-21**
Project Name	**WIN Kiosks**
Planned Features	• Build an application that adds traffic and transit information to WIN kiosks • Purchase several kiosks for locations especially needing traveler information
Comments	• Department of Information Services decided to discontinue kiosk services • Internet browser was built for kiosks • Funding issue – WIS needed to produce revenues to cover O&M costs of kiosks • Selling of hunting and fishing licenses via the kiosks was a potential source but did not materialize • Increasing use of Internet also sparked dropping this project
Study Areas	ATIS

Project Number	**SE-22**
Project Name	**Seattle Center Advanced Parking Info System**
Planned Features	• Install systems to collect parking information at the Seattle Center • Information will be provided via CMS
Comments	• Detectors in parking garages are installed; waiting for permits from City of Seattle to install CMS • Information may be provided via the Web and telephone • There was a Toll Free cellular phone company it was getting too many calls and needed to generate revenues it could not get enough revenues from advertising (not enough calls to interest advertisers • AT&T bought out Toll Free company and dropped free service
Study Areas	ATIS - Customer Satisfaction, Cost, Benefit/Cost

Project Number	**SE-23**
Project Name	**King County Web Page (RiderLink & BusView)**
Planned Features	• Deploy the BusView prototype application on the Internet (real-time bus location information)
Comments	• Now called Easy Rider • Need latest Web browsers to access BusView
Study Areas	ATIS - Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-24**
Project Name	**King County Transit Center Displays**
Planned Features	• Deploy the BusLink application to provide real-time bus arrival information at two transit transfer facilities on television monitors • Develop public-private partnership to provide for operations and maintenance of monitors in exchange for advertising rights
Comments	• Two sites operating (Bellevue and Northgate) • Third site at Boeing Renton facilities to be added • Another display may be added at the airport when fiber cable is in place • Metro management not convinced of benefits of displays • MDI will do surveys to identify benefits and customer satisfaction to convince Metro to provide funds for O&M • There is a delay in looking for a public-private sector partnership
Study Areas	ATIS – Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-25**
Project Name	**Washington State Ferries ATIS**
Planned Features	• Deliver ferry boat GPS location information to the Ferry System Operations Center • Install detectors to measure vehicle queues at ferry terminals • Provide this information to the public • Provide information on ferry queues and waiting times at four ferry terminals via VMS, HAR and the Internet • Delay information to be presented on Web page • Ferry locations will be provided on the Internet
Comments	• There is currently a one to two hour delay in providing information • GPS installed on 29 vessels; information not provided to public yet • Two locations functioning; Colman Docks and Mukilteo Ferry • Web site uses BrandtCo images at Anacortes, Friday Harbor, and Orcas
Study Areas	ATIS – Customer Satisfaction, Cost, Benefit/Cost

Project Number	**SE-26**
Project Name	**WSDOT Web Page**
Planned Features	• Upgrade WSDOT Internet connection to allow more data sources to be linked to congestion map • Create Internet flow maps for Tacoma area • Add arterial congestion and incident information to the remote congestion graphic that is delivered via telephone, the Internet, or cable TV. • Gather information on weather, road conditions, and the current speed limit from the I-90 Snoqualmie Pass Travel Aid project and deliver it via the Internet • Provide information on ferry queues and waiting times at four ferry terminals via the Internet
Comments	• In order to present arterial data in a flow map, additional loops must be installed; difficult getting level of data needed) • Arterial data being shown via video images (Bellevue on line, Seattle may be connected) • Y2K issue for Travel Aid must be fixed
Study Areas	ATIS – Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-27**
Project Name	**Traffic Telephone**
Features from proposal	⇒ add arterial congestion and incident information to WSDOT's commuter information hotline
Comments	There is not enough arterial data; most systems (stop bar loops) dump data after used for operational control
Study Areas	ATIS – Customer Satisfaction, Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-28**
Project Name	**Dynamic Ridematch/Rideshare**
Planned Features	• Expand existing ridematch portion of SWIFT operational test to encompass a wider user group than the University community • Didn't expand system, but rather coordinated existing systems • Will use Internet rather than paper to submit request • Driver can be contacted via e-mail
Comments	• Originally dropped; FTA pushed to have it re-installed • Redmond TMA and Metro wanted systems • No agency wanted to take over the UW system • Greater Redmond TMA hired a developer to develop system for its members • System will be turned over to Metro to adopt it for their use • "instant" match was deemed not viable; one issue was security
Study Areas	TM - Energy and Emissions, Throughput, Cost, Benefit/Cost

Project Number	**SE-29**
Project Name	**ITS Backbone**
Planned Features	• Enhance the information backbone currently in place • Build additional connections to current, planned, and future data sources and fusion nodes
Comments	Incident information will be added in the future
Study Areas	Int.: **-** Energy and Emissions, Throughput, Integration, Cost, Benefit/Cost

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