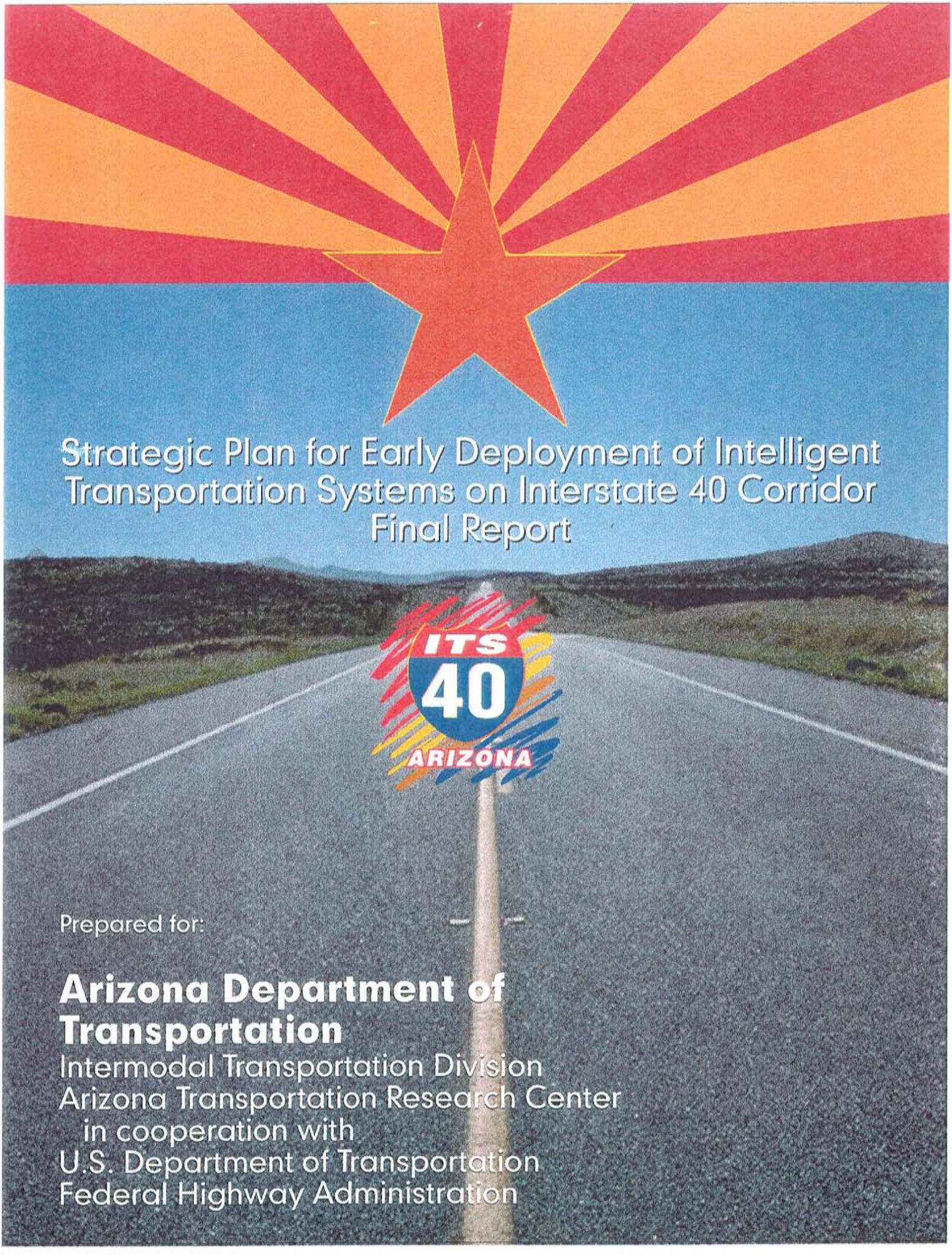

Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor Final Report

Prepared for:

Arizona Department of Transportation
Intermodal Transportation Division
Arizona Transportation Research Center
in cooperation with
U.S. Department of Transportation
Federal Highway Administration

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17. Abstract

This report presents the results of a study by Kimley-Horn and Associates, Inc. for Arizona's Transportation Research Center to develop a strategic plan to deploy ITS rural technologies along the I-40 corridor in northern Arizona. The report describes the participation of a coalition of over 100 stakeholders, both in Arizona and from neighboring states (California and New Mexico). The Final Report presents a summary of the findings and recommendations discussed in the fourteen technical memoranda.

The needs along the corridor were identified through focus groups meetings of Coalition members. Each of the needs were matched, where possible, to one or more of the 30 FHWA User Services defined in the National Program Plan. A systems architecture, patterned after the ITS National Architecture (April 1996), was developed for the I-40 corridor representing an evolutionary, open standards architecture that will incorporate specific technologies and Market Packages for each of three deployment time frames. Twenty-one separate Market Packages were incorporated into the architecture in order to respond to the needs identified in this study.

A Multimodal I-40 Traveler Information System is proposed to accumulate and distribute roadway and weather information; transit information; tourism information including national and state park information; incident information; and traveler services information. A request for private partnerships is proposed as a means of deploying the information dissemination systems. Interoperability between Arizona traffic operations centers and communication systems in New Mexico and California is proposed as a goal for ITS deployment in the corridor.

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METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	2.54	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	6.452	centimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.395	hectares	ha
		MASS (weight)		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.0328	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

Note: Volumes greater than 1000 L shall be shown in m^3.

		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
yd	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
yd^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.53	acres	ac
		MASS (weight)		
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	millimeters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3

		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

These factors conform to the requirement of FHWA Order 5190.1A

*SI is the symbol for the International System of Measurements

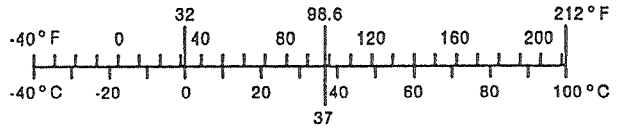


TABLE OF CONTENTS

List of Figures

List of Tables

1.0 INTRODUCTION

The *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor* in Arizona is described in this report documenting the activities, findings and recommendations of the project. This final report is the result of a twelve month study that began in March 1996. The study was initiated and administered by the Arizona Department of Transportation (ADOT), in conjunction with the Federal Highway Administration (FHWA). Fourteen separate, stand-alone Technical Memoranda (TM) were prepared and presented to ADOT and the I-40 Corridor ITS Coalition at strategic milestones during the course of the study. These TMs were revised based on ADOT and Coalition input and review and have been submitted to ADOT. A copy of the complete set of the I-40 ITS Strategic Planning technical memoranda is available from the Arizona DOT. This Final Report presents a summary of the findings and recommendations discussed in these fourteen technical memoranda and also includes additional relevant information describing developments which occurred after the technical memoranda were prepared.

The goals of this study were to develop a Strategic Plan for deployment of rural Intelligent Transportation System (ITS) technologies along the I-40 corridor in northern Arizona and to create a long-term coalition of I-40 stakeholders, both in Arizona and from neighboring corridor states (California and New Mexico). One long-range goal is to expand the implementation of ITS technologies throughout the entire I-40 corridor from Barstow, California to Wilmington, North Carolina.

The 580-km segment of I-40 in Arizona was chosen as a test bed for deployment of rural ITS technologies due to its unique transportation characteristics, including high commercial and freight truck volumes, extreme variations in elevations and weather conditions throughout the corridor, and high volumes of out-of-state visitor traffic. These characteristics, combined with the limited availability of visitor and traveler information, and the need for improved emergency management services on the Interstate, create a unique opportunity to test the implementation of innovative transportation technologies. This strategic planning effort will result in a number of short-term test projects which will be deployed shortly after the completion of the study, and in medium and long-term recommendations for implementation of new technologies and transportation-related services along the corridor over the next 15 to 20 years.

1.1.0 BACKGROUND

The Intermodal Surface Transportation Efficiency Act (ISTEA) signed by the U.S. Congress in December of 1991 called for improvements in surface transportation through technological advancements. The United States Department of Transportation (USDOT) subsequently launched the Intelligent Transportation Systems Program, involving research, strategic planning and operational tests of new technologies. These technologies promise to bring much needed operational improvements to the nation's transportation system, and provide a safer, more convenient, and more efficient trip experience for the traveling public. A total of $659 million was authorized by ISTEA to achieve eight key goals of ITS. The National ITS Program goals are listed in **Table 1.1.0-1**.

The National ITS Program provides a common ground for cooperation among all sectors of the surface transportation community, including state and local governments, motor vehicle

manufacturers, commercial vehicle operators (CVO), railroads, telecommunications and commuter technology companies, universities and other research organizations, consulting firms, and public interest groups. A number of operational tests of ITS technologies have been conducted throughout the country since 1991. These tests, such as the HELP/Crescent project in Arizona and other western states, MAYDAY tests in Colorado, and others, have helped bring state and local decision-makers a greater degree of understanding of the effectiveness of deployed ITS technologies.

In addition to these operational tests, many states have conducted or are in the process of conducting "early deployment" or strategic planning studies. This year, some 75 early deployment studies, including the *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor* are underway or have been completed as shown schematically on **Figure 1.1.0-1.**

Table 1.1.0-1
ITS Program Goals

1. Widespread implementation of intelligent vehicle-highway systems to enhance the capacity, efficiency and safety of the Federal-aid highway system, and to serve as an alternative to additional capacity of the Federal-aid highway system.

2. Enhance, though more efficient use of the Federal-aid highway system, the efforts of several states to attain air quality goals established pursuant to the Clean Air Act.

3. Enhance safe and efficient operation of the Nation's highway system, particularly system aspects that will increase safety. Identify system aspects that may degrade safety.

4. Develop and promote an intelligent transportation system (ITS), and an ITS industry in the United States.

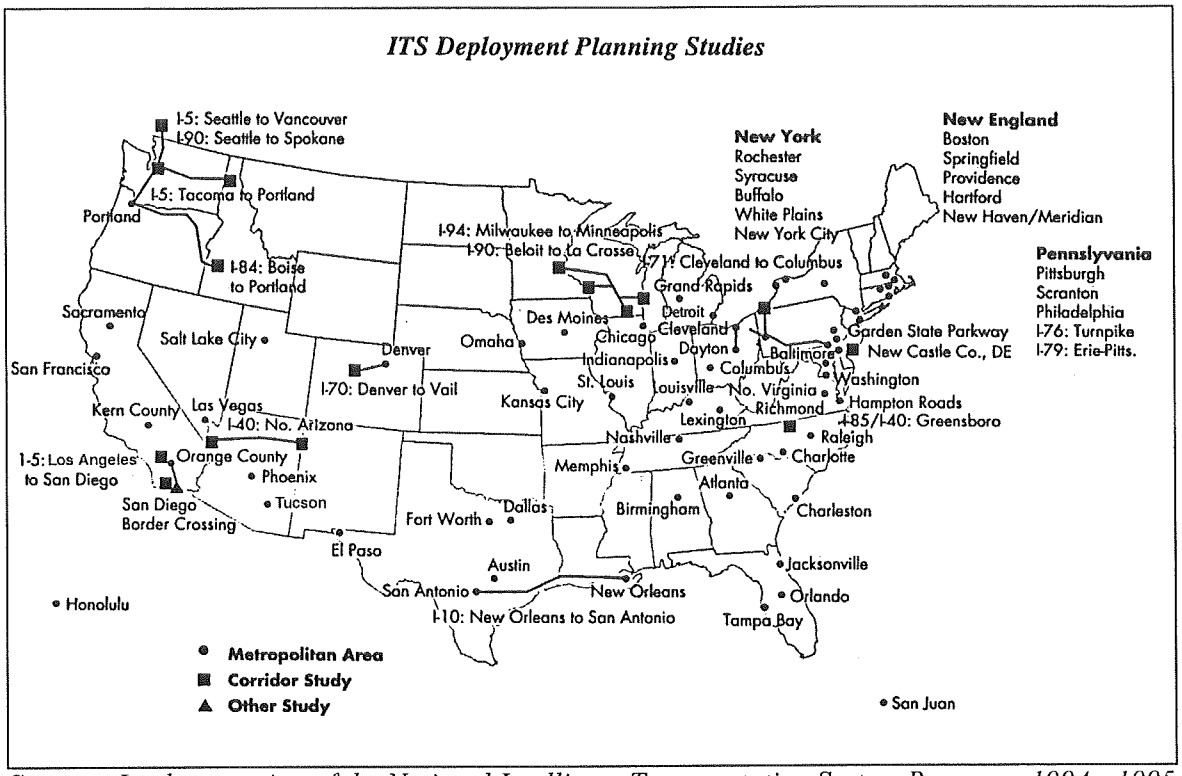
5. Reduce social, economic, and environmental costs associated with traffic congestion.

6. Enhance U.S. industrial and economic competitiveness and productivity.

7. Develop a technology base for intelligent vehicle-highway systems and establish the capability to perform demonstration experiments, using existing national laboratory capabilities, where appropriate.

8. Facilitate the transfer of transportation technology from national laboratories to the private sector.

Source: Implementation of the National Intelligent Transportation System Program, 1994 - 1995 Report to Congress, USDOT, FHWA, ITS Joint Program Office, Washington, DC.



Source: Implementation of the National Intelligent Transportation System Program, 1994 - 1995 Report to Congress, USDOT, FHWA, ITS Joint Program Office, Washington, DC.

Figure 1.1.0-1
ITS Early Deployment Planning Studies

1.2.0 DESCRIPTION OF I-40 STRATEGIC PLANNING STUDY

The National ITS "Early Deployment" Planning Program provides much needed assistance to state transportation agencies and Metropolitan Planning Organizations (MPOs) for the development of local or corridor-wide, long-term strategic deployment plans. This study was launched recognizing that ADOT's efforts to use the I-40 corridor is an excellent location for deployment of rural applications of ITS technologies. This strategic plan for the I-40 corridor in Arizona is a starting point of a multi-state coalition for deployment of ITS throughout the corridor, beginning with the states of Arizona, California, and New Mexico. Interstate 40, from Barstow, California to Wilmington, North Carolina is shown in its entirety in **Figure 1.2.0-1**.

In order to establish a strong technical and policy-oriented base of support for future ITS deployment in the I-40 Corridor, a large group of potential stakeholders was organized into the I-40 ITS Coalition. More detail on the Coalition can be found in Chapter 4.0.

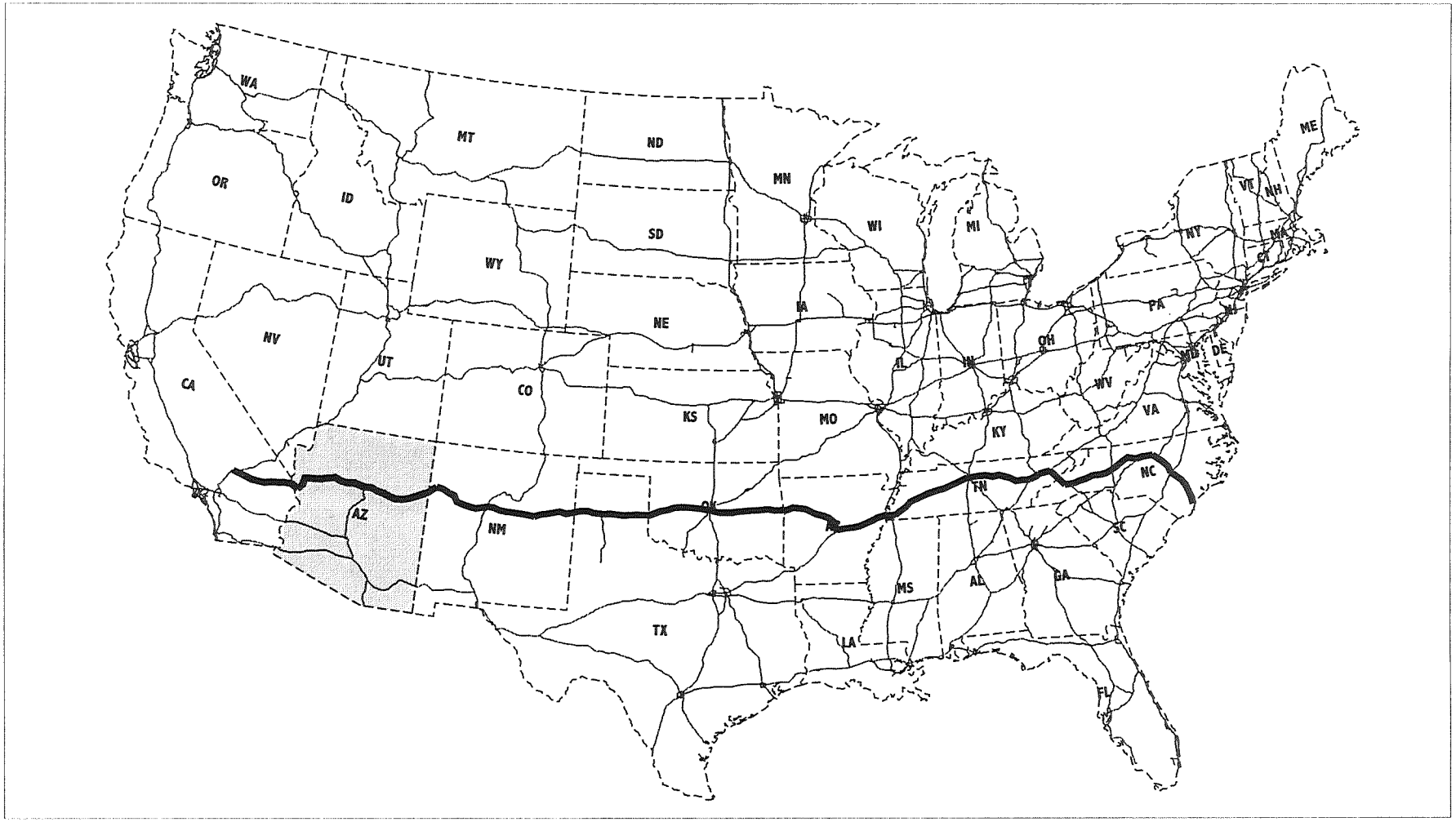


Figure 1.2.0-1
I-40 National Corridor

Membership in the Coalition continued to evolve during the project. It currently includes approximately 350 individuals representing dozens of public agencies and public sector firms from throughout northern Arizona, from statewide organizations based in Phoenix, and from adjoining states. The basic structure of the Coalition was as follows:

- **I-40 ITS Coalition:** approximately 350 individuals in an evolving database (receives briefings and provided input to the planning process through attendance at meetings, newsletters, focus groups, video presentations, etc.)

- **Technical Advisory Committee (TAC):** comprised of 14 representatives from the I-40 Coalition Stakeholders. This oversight committee is required for ADOT funded projects to provide technical review and guidance throughout the project. The committee included ADOT representatives and the Chair of the Project Steering Committee (PSC) and the Chair of the Early Action Committee (EAC) were added to the Technical Advisory Committee after the project started.

- **Project Steering Committee** consists of approximately 55 invited members from the Coalition. One subcommittee of the PSC was established:

  - **Early Action Committee:** to provide political support for ITS deployment projects in the corridor. This group primarily consists of mayors and local government managers from cities and towns along the corridor; however, membership is open to other interested parties.

Since the Coalition itself served as the "umbrella" for all advisory and action-oriented units that will deal with deployment of ITS technologies, it governed the Project Steering Committee and the two subcommittees of the PSC. There was some overlap between the members of the TAC and EAC.

The I-40 corridor in Arizona is shown in **Figure 1.2.0 -2**. The Strategic Plan will serve as a roadmap for implementing ITS technologies and programs along I-40. It also is an excellent summary of the overall transportation and travel-related communications needs that exist in the corridor. To ensure that the Strategic Plan developed through this project leads to rapid implementation, priority is being given to implementing the short-term recommendations of this study by ADOT, other state and regional agencies, local governments within the corridor study area, and private sector partners. Issues such as funding sources, staffing requirements, etc., are being addressed in an ongoing planning process by ADOT and the Coalition. Projects recommended in this study (Chapter 11) are already being evaluated with respect to their potential to be undertaken through the State's transportation funding process as well as through viable public-public or public-private partnerships. A Request for Partnership Proposal (RFPP), to be issued by ADOT in 1997, will seek to assess interest among potential private and public sector partners and their likely roles and contributions.

The Strategic Plan for I-40 identifies short-, medium- and long-term initiatives. One of the project goals is to carry out the necessary groundwork for launching short-term initiatives in early 1997. The National ITS Strategic Planning Process, depicted in **Figure 1.2.0-3,** is consistent with the methodology used in this study.

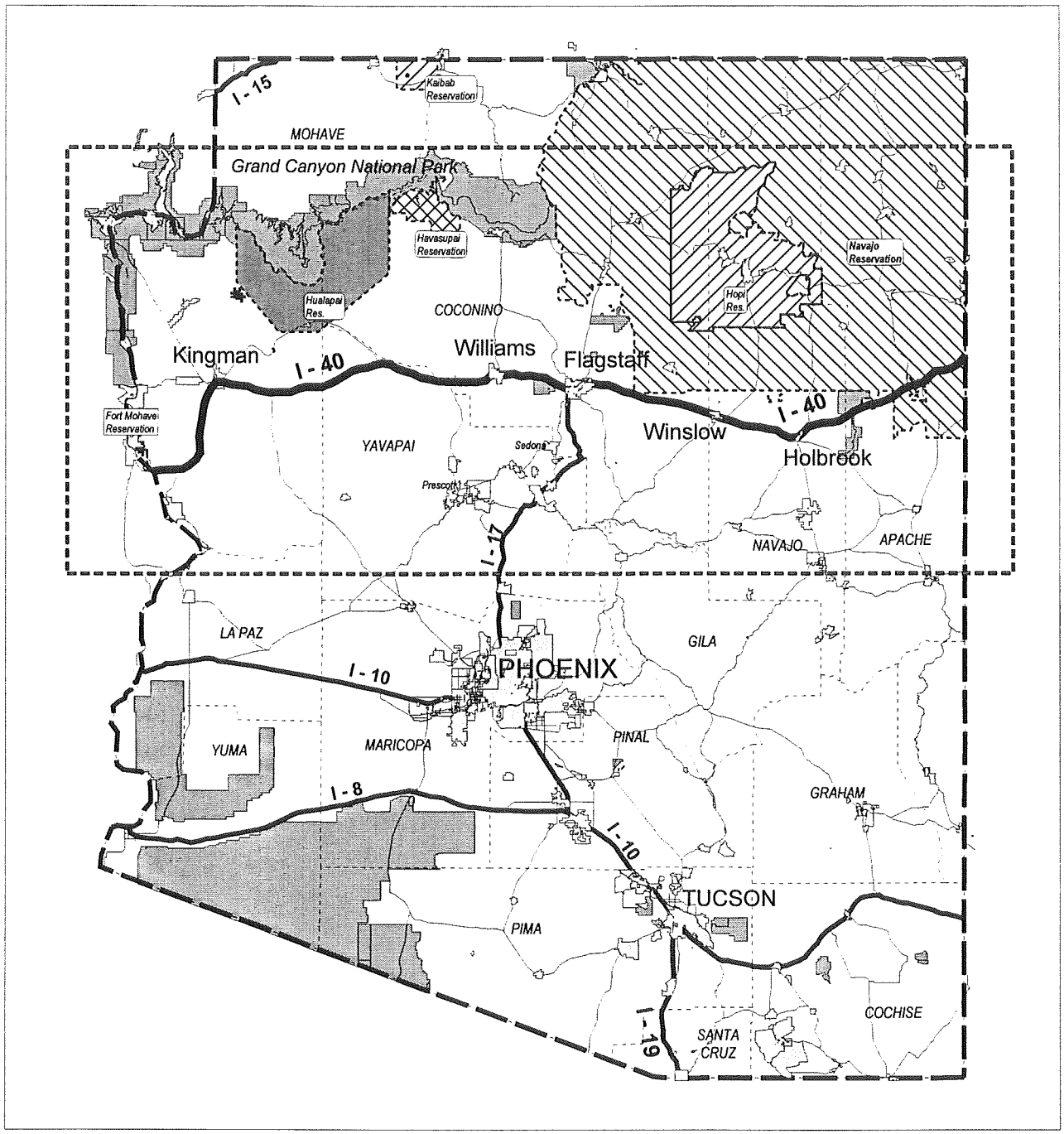


Figure 1.2.0-2
I-40 Corridor in Arizona

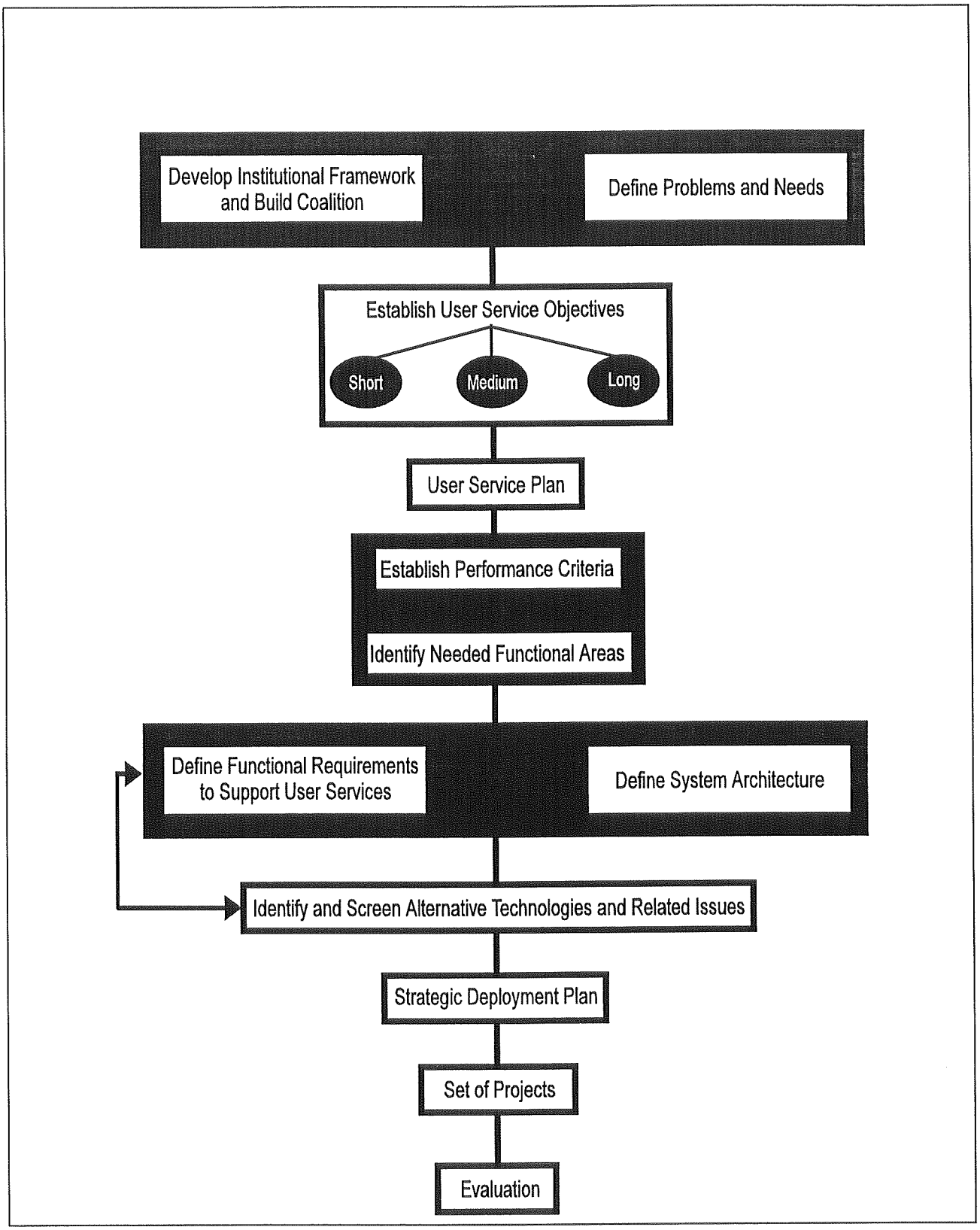


Figure 1.2.0-3
National ITS Planning Process

Major local governmental units in the I-40 corridor are shown in **Table 1.2.0-1**. Cities, towns, and Indian Reservations are listed separately within the counties in which they are located.

Table 1.2.0-1
Local Governments, Population, and Other Corridor Characteristics

County/ City/ Indian Reservation	Population (1990 US Census)	Approx. Elevation Range (meters) **	ADOT Engineering District	Approx. Coverage along I-40 In rural areas: (kilometers)	(In towns)
Mojave Co.	93,497	182- 1220	Kingman	150	
Kingman	12,722				(11)
Bullhead City	21,951				---
Fort Mojave Reservation	997*				
Hulupai Reservation	1,979*				
Yavapai Co.	107,714	1220-1820	Flagstaff	85	
Coconino Co.	96,591	1530-2240	Flagstaff	160	
Wiliams	2,461				(11)
Flagstaff	45,857				(21)
Hulupai Reservation	350 (est.)				
Havasupai Reservation	634*				
Hopi Reservation	9,137*				
Navajo Reservation	175,000*				
Navajo Co.	77,658	1470-1690	Holbrook	97	
Winslow	8,190				(11)
Holbrook	4,686				(6)
Hopi Reservation					
Navajo Reservation				40	
Apache Co.	61,591	1690-1880	Holbrook	85	
		182-2240		580	(61)

*Total number of enrolled tribe members. Current numbers for Fort Mojave and Navajo Reservations not available. Source: *1995-1996 Tribal Directory of the 21 Federally Recognized Indian Tribes of Arizona Commission of Indian Affairs.*

**Conversion values: 1 meter = 3.28 feet, 1 kilometer = 0.62 miles

1.3.0 PROJECT TASKS

The I-40 Strategic Plan consists of fourteen tasks which closely follow the ITS planning process outlined in the National ITS Program Plan. These tasks, with the documenting chapter numbers from the notebook of technical memoranda, are listed in **Table 1.3.0-1**, and the interrelationships of the tasks are depicted in **Figure 1.3.0-1**.

Table 1.3.0-1
Project Tasks

No.	*Task*	*Task Objective*	*Chapter*
1	*Define Problems and Systems*	To produce a comprehensive document describing the current transportation system and the needs and problems in the I-40 corridor, that may be alleviated by the application of ITS technologies.	1, 2
3	*Identify Audience/Stakeholders*	To identify people and organizations interested in ITS solutions for the transportation problems and needs of the I-40 corridor.	3
4	*Establish Institutional Framework, Build Coalition, and Inform Stakeholders*	To form an I-40 Coalition which will be an expansion of the Project Steering Committee to include other interested stakeholders and representatives from California and New Mexico. This Coalition will be kept up-to-date on all activities of the project through the I-40 Coalition Newsletter.	4
5	*Identify User Services*	To determine from the users of the I-40 corridor which of the 30 ITS user services are needed and when they should be provided: short-, medium- or long-term.	5
6	*Establish User Service Objectives and Performance Criteria*	To formulate the objectives to be achieved by implementing identified user services and to specify the criteria that measure the degree of success (performance) of the user services when they are deployed.	6
7	*Development of an Integrated User Service Plan*	To group the needed user services into program categories, establish the interactions among the needed user services, and to categorize the user services as having short-, medium-, or long term potential for implementation.	7
8	*Identify Needed Functional Areas*	To match the needed user services with the appropriate functional areas as defined in the National ITS Program Plan and to further define the technologies available to support the user service plan.	8
9	*Define the System Architecture*	To develop a system architecture meeting the needs and providing the required ITS services that is affordable, open (to the extent possible), technology independent, compliant with ADOT's Statewide Communications Plan, and consistent with the National ITS Architecture.	9

No.	*Task*	*Task Objective*	*Chapter*
10	*Identify and Screen System Components*	To provide a physical architecture with recommended technologies based on optimization of system availability, supportability, expandability, compatibility (with existing infrastructure and standards), affordability, and implementable in phases in accordance with the ITS User Services Plan (Task 7).	10
11	*Define Implementation and Operational Strategies*	To define operations and maintenance issues addressed; to identify funding options including public/private partnership opportunities; to assess the benefits and costs; and to determine a phased implementation plan.	11
12	*Strategic Deployment Plan*	To prepare a business plan and a deployment plan of the ITS elements identified to provide the needed user services on I-40. This plan will include project descriptions, estimates for deployment, funding sources, and scheduling information.	12
13	*Evaluation Plan*	To develop a plan for evaluating the effectiveness of ITS technologies deployed along the I-40 corridor.	13
14	*Final Report*	To deliver a final, stand-alone document that summarizes the entire project and presents the pertinent conclusions of the study.	

The flow of tasks and subtasks that was developed for this study followed the diagram shown in **Figure 1.3.0-1.**

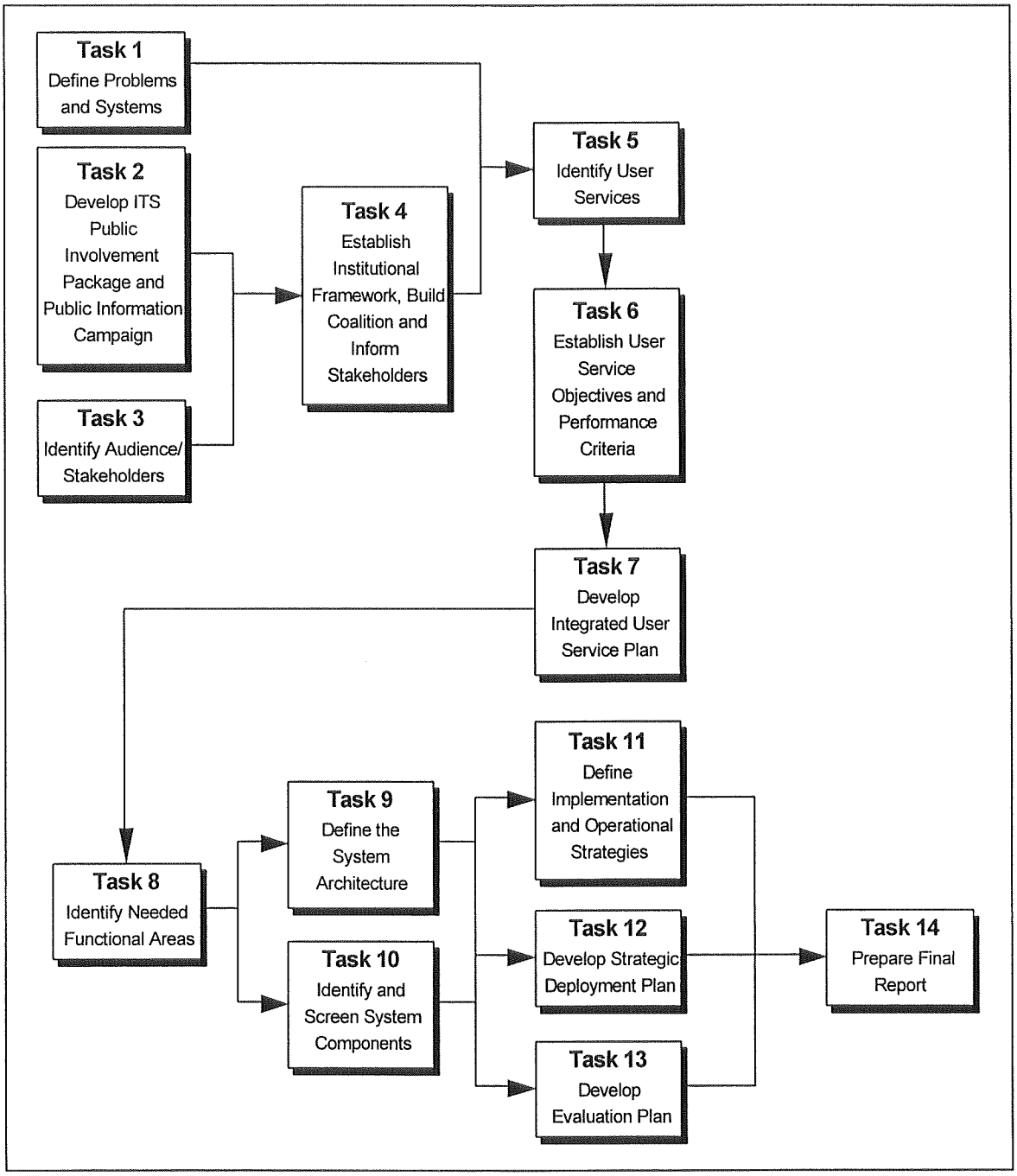


Figure 1.3.0-1
Project Task Flow Diagram

2.0 TRAVEL AND COMMUNICATIONS NEEDS IN THE I-40 CORRIDOR

Chapter 2 of this report gives an overview of the extensive data collection and inventory effort associated with Task 1 of the *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor*. In this task, a substantial amount of information was compiled regarding corridor conditions, existing facilities, and travel and communication needs of travelers using the I-40 corridor in northern Arizona. Specific needs, opportunities for ITS deployment, and constraints that have been investigated, discussed, and documented, include:

- Weather conditions in the high elevations in the vicinity of Flagstaff.
- Tourists' need for traveler information on nearby services, attractions, and road conditions.
- Plans for expanding the road weather information systems (RWIS) coverage.
- Plans for installing variable message signs (VMS) at strategic locations.
- Consideration of video monitoring of key locations.
- Port-of-entry (POE) bypass capability for trucks with proper credentials.
- Foggy areas.
- High wind areas.
- Road segments susceptible to icing.

Interstate 40 stretches some 580 km across northern Arizona from the Arizona/California border at Topock to the Arizona/New Mexico border at Lupton. The Interstate serves as a major commercial trucking route which stays open during winter periods considerably longer than any other east-west trucking route in the state, and as such, carries 35-40 percent trucks. The terrain of I-40 ranges in elevation from over 152 m to approximately 2,225 m, which presents unique temperature and weather issues, particularly during the winter months.

With the Grand Canyon National Park, Painted Desert National Park, a number of national monuments, state and county parks, as well as many other attractions in the vicinity of I-40, there is considerable tourist traffic in the area. The Hopi, Navajo, and Fort Mojave Indian tribes also adjoin the I-40 corridor. All these scenic, recreational, and cultural assets combined together present a unique opportunity for solving transportation needs with ITS technologies. The data collecting effort of this task has resulted in a compilation of corridor issues and concerns as highlighted in this chapter. The following sections describe the findings relative to the existing and planned transportation and communications infrastructure in the corridor.

2.1.0 INVENTORY

The inventory of the deployed or planned ITS-related technology indicates that I-40 currently operates the following ITS-related facilities:

- Seven Strategic Highway Research Programs, combined weigh-in-motion (WIM), and automatic vehicle classification (AVC) stations.
- An additional four automated traffic recorder (ATR) count stations.
- Seven RWIS.
- Two ports-of-entry.

No permanent VMS or surveillance equipment are currently in place on I-40. Six VMS sites and a like number of RWIS sites are currently in the design stage, to be located on I-40 and I-17 just south of Flagstaff. **Figure 2.1.0-1** summarizes the locations of ITS-related technology installations on I-40.

2.2.0 TRAVELER FACILITIES AND SERVICES

Traveler services on I-40 are limited to rest areas, truck stops and the Painted Cliffs Welcome Center near the Arizona/New Mexico border. While truck stops abound, the number of open rest areas is diminishing. The majority of I-40 users and stakeholders interviewed agreed that there was considerable room for improvement in the area of traveler services within the corridor. Of the 41 truck stops listed in Arizona business directories, 17 are located along I-40. The services offered by the truck stops vary from gas and food to full service hotels. The truck stops, and a few major gas/retail outlets along I-40, represent a scarce resource for visitors to obtain travel information about tourist attractions or word-of-mouth travel information.

There are four rest areas on I-40, most equipped with restrooms, telephones, and vending machines. One of the rest areas is currently permanently closed, while one other will re-open after the drought season. From discussions with I-40 users and stakeholders, it was evident that there is a need not to reduce the number of open rest areas on I-40 but to build more. Since the State budget does not include capital improvements for rest stops on I-40 as a priority item, ADOT is considering privatizing rest area operation to address this need.

Weather and incident/detour information is available en-route only via a network of CB radios, used primarily by truck operators or from local radio broadcasts. Available sources of pre-trip information for corridor travel include Internet pages (Grand Canyon, Flagstaff, Kingman, Williams, Holbrook) and information kiosks (which previously existed, fell into disuse, but are currently planned again in Flagstaff). At the Meteor Crater rest stop at MP 235, there is a National Weather Service "dial-up" weather report available on a speaker at the restroom facilities. There are currently no traveler information kiosks in operation, and no comprehensive radio-based travel information service offered along the corridor. Extreme changes in elevations and weather conditions, coupled with limited availability of alternate routes, rest stops or pull-out areas make deployment of traveler information technologies, such as advance warning systems, very desirable for the I-40 corridor.

With the Grand Canyon heading up the list of tourist attractions in the corridor, there is a vast amount of information on a large number of interesting or historical sites that could be communicated to tourists. The I-40 corridor provides access to over 20 major national and state parks and other attractions. Perhaps an equal number of city and county parks are also reasonably accessible along the corridor. A number of locally-managed recreation areas provide a rich mix in visitor attractions, particularly for all types of outdoor recreation.

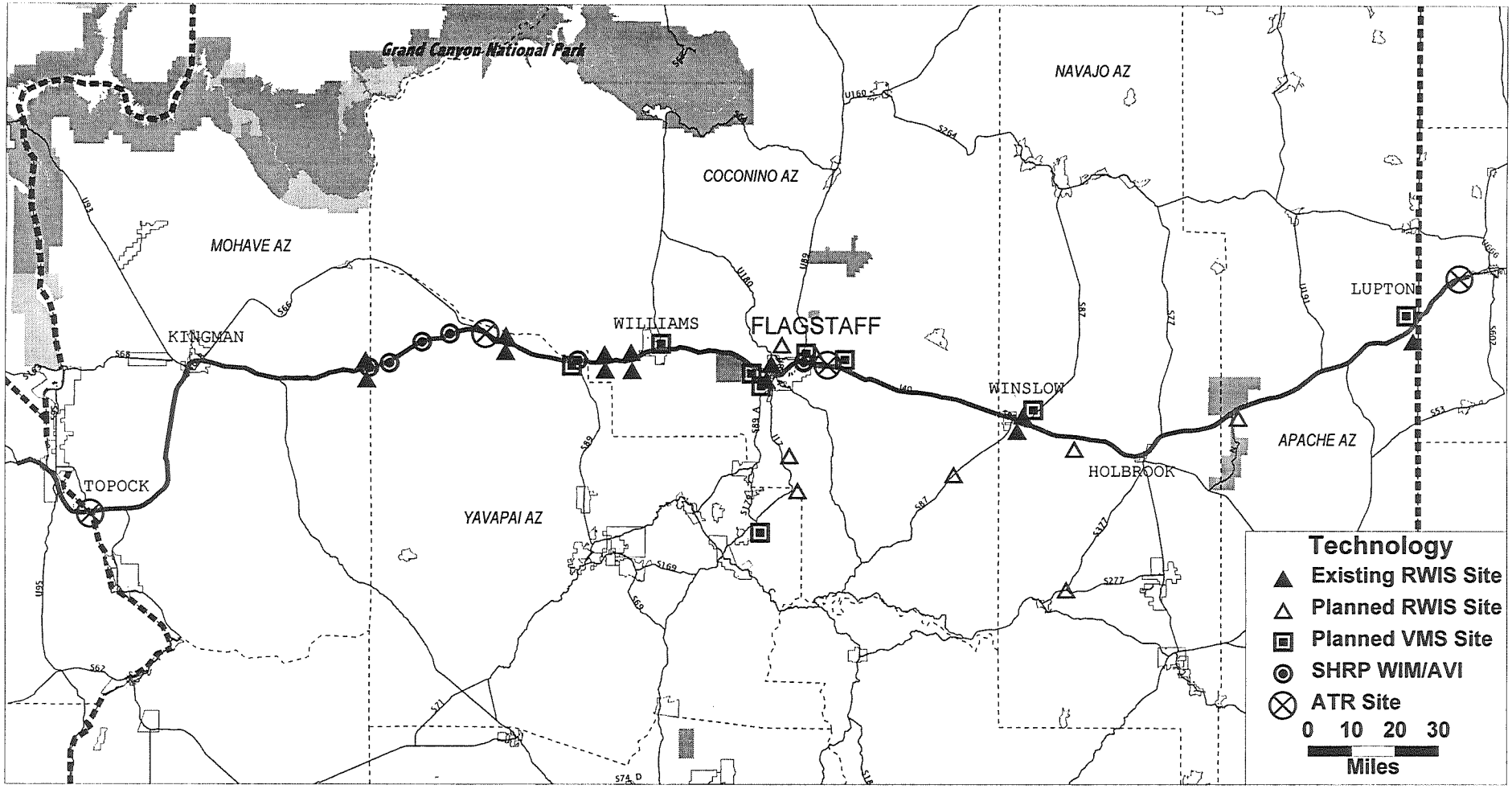


Figure 2.1.0-1
I-40 ITS Technology Summary

The need to communicate to tourists information on local attractions, lodging, restaurants, and other services is well understood among the corridor stakeholder agencies. As visitors approach Flagstaff, more comprehensive information on the various services/attractions available at specific highway exits would be of considerable value. Currently, travelers on I-40 have access to a very limited set of information sources.

Less attention has been placed to date on handling safety issues, emergency response, and incident management, at least with ITS applications; therefore, perhaps the greatest unmet opportunity exists in developing a strong incident management component for the I-40 corridor. On the other hand, a strong case could be made for placing more emphasis on the areas that have already seen some successful deployments, such as CVO and traveler information. In reality, much remains to be done in all of these areas.

3.0 PUBLIC INVOLVEMENT

Chapter 3 of this report describes the methodology and activities of Task 2 of the *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor.* This *Public Involvement and Public Information* package was developed with a focus on rural applications of ITS and their impact on the I-40 corridor communities, businesses, and travelers. The campaign was designed to inform, educate and encourage participation and gain consensus of the I-40 users, stakeholders and media. The communication of this project and ITS objectives was programmed to occur through a proactive communication program, community outreach, informative presentations and public events.

3.1.0 MEDIA COMPONENTS

Communication vehicles such as media kits, educational collateral pieces, a video, web page, a dedicated 1-800 telephone hotline, and a quarterly newsletter were used to educate, promote awareness, and gain public consensus on the application of ITS to meet various needs of the I-40 users. Through Focus Groups, an 800 access telephone line, the Project Steering Committee, and various communication pieces, this plan aimed at building a foundation of interest, involvement and participation in the deployment of ITS in the corridor.

Media Components
■ Educational collateral pieces ■ Video ■ Web page ■ Dedicated 1-800 telephone hotline ■ Quarterly newsletter

Each community along I-40 has differing needs relative to ITS, and offers different media coverage and public event/presentation opportunities. It was the objective of the proactive plan to be flexible and responsive to the needs of each community.

3.1.1 Stakeholder and Media List

The proposed list of stakeholders and key media along the I-40 corridor, as well as the more populated areas, was an evolving list reflecting updates and additions of newly identified individuals with an interest in ITS and its applications for the corridor.

The stakeholder list included representatives from the following groups:

- Media.
- Large employers.
- Government and local service agencies.
- Community services.
- Trucking/busing firms.

This list was compiled considering those firms and agencies with an interest and potential impact on this study and through the initial stakeholder list provided by Kimley-Horn and Associates, Inc. All stakeholders were provided with the established 800 hotline number to allow for easy contact and to gather input.

3.2.0 COLLATERAL MATERIALS

Collateral materials were produced, explaining the scope of the project while educating and informing the intended audience(s) about ITS, their purpose and objectives. The focus included rural applications of ITS. The following pieces of collateral material were planned, compiled and prepared during Task 1:

- **News Releases:** News releases were issued to statewide media organizations via broadcast fax to inform the public about ITS applications, and encourage interest and attendance at public workshops. In addition, local radio broadcast stations conducted interviews with coalition members publicizing the study.

- **Press Kits:** A press kit containing a fact sheet, news release, and video footage (as necessary) was provided to all media to support the I-40 findings.

- **ITS Video:** The video introduced the news media and the public to ITS and its applications in Arizona. This introductory video was also shown at special events to introduce the public to ITS technologies and programs.

3.3.0 PUBLIC/PRIVATE EVENTS

A schedule was developed for all stakeholder meetings, public meetings, presentations to businesses and service clubs, and other events and venues. Presentations to service clubs were arranged concurrently with Project Steering Committee meetings. The general public was notified through the media via press releases to local newspapers.

A review of area events was conducted. It was important to review each event carefully to determine its value to achieving project goals. Most calendars of events were developed quarterly in an effort to capture all local events; therefore, the available calendars did not necessarily reflect the true local event opportunities. The following venues were selected:

- Flagstaff - Coconino County Fair, August 30 - September 1, 1996.
- Kingman - Mohave County Fair, September 19-22, 1996.
- Holbrook.

3.4.0 QUARTERLY NEWSLETTERS

Quarterly newsletters were produced to update stakeholders and the public on the ITS study on I-40. The newsletters introduced readers to ITS and to the potential applications of ITS technologies to address various needs along the corridor. The newsletter distribution was structured quarterly to enable time between issues to gather pertinent project information and conduct research for additional informative material to include. The first newsletter was prepared after the conclusion of the "initial phase" to report objectives, progress, and to provide for the timely notification of scheduled public meetings. Thereafter, the newsletters were distributed quarterly and contained valuable information about the study's progress, informative articles on ITS, and reminders of upcoming project meetings.

3.5.0 MEDIA RELATIONS

Media relations were conducted to build working relationships with statewide media organizations, educate them about ITS and inform them about the rural applications of ITS along the I-40 Corridor. The media was introduced to ITS through a fact sheet and video providing background information about the areas that were included in ITS. ADOT's Community Relations Office (ADOTCRO) served as the direct link to the media for inquiries, and promoted ITS issues for coverage by the media. ADOTCRO received input from the PSC and TAC on the progress of the I-40 study and updated information to pass on to the media.

Media (newspaper, radio and TV) were initially contacted to determine which reporters cover the transportation beat. An initial introduction to the project was provided on the telephone. A media kit was developed which included the following:

- Project fact sheet.
- Press release.
- Black and white photographs of I-40 issues.
- Video tape describing the project (TV stations only).
- Schedule of public group meetings.
- Public service announcements of specific project concerns.

3.6.0 INTERNET WEB PAGE

An Internet web page was jointly prepared as part of ADOT's existing Trailmaster Web Page and specifically under **http://www.azfms.com** in the existing ITS Research and Development area of: **http://www.azfms.com/About/ITSRD/its_r&d.html** under item titled I-40 Corridor ITS Strategic Plan or **http://www.azfms.com/About/ITSRD/i-40_edp.html**. An icon illustrating Rural ITS was used to generate interest in this page outside of Arizona.

The following information was included as part of the I-40 project web page:

- An update on the study's progress (updated monthly).
- Current press release(s).
- Newsletter text;
- Contact telephone number and E-mail address.
- Project hotline (1-800 number).
- Schedule of public meetings.

Updates will continue to be provided as new information becomes printed and available, and this information will be included in the web page. The objective of using this form of media was to provide information to a broader range of the public, both in and outside of Arizona, about the I-40 study and its progress. Another objective for using the Internet was to provide for an additional communication link to receive information from the public in and around I-40, throughout Arizona, and anyone who wanted to respond.

4.0 CORRIDOR STAKEHOLDERS AND INSTITUTIONAL FRAMEWORK

This chapter presents a summary of the activities of Task 3, *Identify Audience/Stakeholders,* and Task 4, *Establish Institutional Framework, Build Coalition, and Inform Stakeholders.*

I-40 Coalition Groups	
Group	Membership
■ All of I-40 stakeholders identified	350
■ Project Steering Committee	106
■ Technical Advisory Committee	14

The purpose of Task 3 was to identify the people, organizations, and agencies with a vested interest in finding solutions to the transportation needs along the I-40 corridor. The key to the long-term success of deploying ITS on the I-40 corridor is to have a strong coalition of people who are promoting the projects identified in this study. The objective of Task 3 was to create a database of individuals and organizations interested in ITS solutions for the transportation needs of the I-40 corridor.

Task 4 called for developing an I-40 Coalition which would expand of the Project Steering Committee to include other interested stakeholders and representatives from California and New Mexico. This Coalition would be kept up-to-date on all activities of the project through the Project Newsletter.

4.1.0 TARGET AUDIENCE/STAKEHOLDERS

In addition to key users of the corridor, Task 3's focus included identifying potential public and private partners and keeping them informed of the project's progress and opportunities.

The following individuals and organizations were contacted to solicit interest and support for the study:

- Mayors and council persons of cities along the corridor.
- County supervisors along the corridor.
- Key city staff (i.e. city engineers, public works directors, transportation directors, etc.).
- Tribal leaders.
- Major employers in the corridor.
- Representatives of AAA, ATA, UPS, U.S. Postal Service, Federal Express, bus companies, tour companies, etc., that are regular users of the corridor.
- Representatives of the Department of Public Safety and their counterparts in California and New Mexico.
- Representatives of Departments of Transportation in Arizona, New Mexico, and California.
- Radio and television stations covering the corridor.
- Railroad representatives.
- Representatives of the Arizona Office of Tourism, both at the local and state levels.
- Chambers of Commerce.
- National Parks and Forest contacts.
- Representatives of major private and public tourist attractions in the corridor area.

The efforts of Task 3 resulted in a database of I-40 stakeholders, which continued to change and grow throughout the project, and included over 350 records as of early 1997.

4.2.0 I-40 COALITION

The first step in developing the I-40 Coalition was the formation of the Project Steering Committee (PSC). The members of the PSC, which includes ADOT's Technical Advisory Committee (TAC), were identified from the I-40 stakeholder database developed in Task 3. This list of potential members of the PSC was then reviewed by the TAC and invitations to the first PSC meeting were sent to approximately 55 stakeholders. The PSC subsequently grew to include over 100 members. A complete listing of PSC membership is included in **Table 4.2.0-1.**

This committee, forming the heart of the I-40 Coalition, includes representatives of city governments, counties, ADOT, DPS, FHWA, chambers of commerce, tourism agencies, the National Parks Service, Native American tribes, the National Weather Bureau, railroads, transit, Universities, and numerous other stakeholder agencies.

The I-40 Coalition provided support and guidance for this Early Deployment effort, complementing the strong project support from the Arizona Department of Transportation and the Federal Highway Administration.

Table 4.2.0-1
I-40 Project Steering Committee

Name	Title	Agency
Agah, Manny	Project Manager	ADOT Technology Group
Almarez, Ernie	Citizen	Pine Country Transit
Anderson, Carol S.	Ex-Mayor	City of Kingman
Archuleta, Ernest	Traffic Services Engineer	NMSHTD
Arhnberger, Robert	Superintendent	Grand Canyon National Park
Barbee, Charles	District Engineer	NMSHtD
Barber, David	Deputy Director, Transportation Planning	Western AZ Council of Governments
Barnes, Michael L.	District Engineer	NMSHTD
Bavasi, Christopher J.	Mayor	City of Flagstaff
Bermen, Karen	Assistant	Hornovi State Ruins Park
Blanton, Tom	Transportation Specialist	ADOT Maintenance - Kingman District
Boles, James L.	Mayor	City of Winslow
Boren, Ervin	District Engineer	ADOT
Brisk, Debra	Acting District Engineer	ADOT
Bryant, Marshall	Citizen	Grand Canyon Railway
Burdick, Matt	Community Relations Officer	ADOT Community Relations
Buskirk, Dale	Transportation Planning	AZ Department of Transportation
Byram, Les	Mayor	City of Kingman

Name	Title	Agency
Cahoon, Sgt. Rob	District III	DPS
Call, Kevin	Chief Financial Officer	Grand Canyon Railway
Campbell, Mike	Meteorologist In Charge	National Weather Bureau
Cavello, John	Council Member	City of Flagstaff
Chaco, Paulson	Department Director	Navajo Nation DOT
Confer, Jim	CEMMS Analyst	ADOT
Craig, Gerald	Traffic Engineer	City of Flagstaff
Cuoco, Christopher J.	Warning Coordination Meteorologist	National Weather Bureau
DeBoer, Terry	District Commander	DPS
DeModica, Cydney	Public Relation Manager	AZ Automobile Association
Dillard, Diane	Director of Product & Tourism Development	AZ Office of Tourism
Dorman, Don	Flagstaff District Maintenance Engineer	ADOT Maintenance
Dredge, Jeannette	Winslow Supervisor	Department of Public Service
Fetzer, Chris	Transportation Planner	NACOG
Forsythe, Kerry	O.E.D.	Sanbag
Fowler, Marilee	Director of Convention & Visitors Bureau	City of Flagstaff
Gabaldon, Tony	Chairman, Board of Supervisors	Coconino County
Gerard, Lt. Jim	District Commander	AZ Department of Public Safety, District Two Patrol Bureau
Hale, Albert	President	Navajo Nation
Hansen, Alan	Transportation Engineer	FHWA
Harper, John	Regional District Traffic Engineer	ADOT
Harris, Steven P	District 3 Traffic Services	NMSHTD
Hassell, M. Jean	Deputy State Forester	AZ State Land Department
Hauser, Edd	Senior Engineer/Project Manager	Kimley-Horn and Associates, Inc.
Hicks, Norm	Mayor	City of Bullhead City
Hill, Carlton	Regional Manager	MVD
Hoffman, James	Mayor	City of Williams
Holt, Pat	Supervisor (District 3)	Mohave County
Hunt, Roy W.	City Manager	City of Holbrook
Johnson, Dennis	Hwy Maint. Tech.	ADOT
Johnson, Rita	Council Member	City of Flagstaff
Joshua, Sarath	Project Manager	ADOT ATRC
Kennelley, Kevin	Owner	AZ WebView
Killian, John	ITS Coordinator, ITS Program Office	Colorado Department of Transportation
Kolb, Sgt. Brian	District	AZ DPS Highway Patrol
Kruse, Carol	Enterpretive Specialist	NPS
Kube, Ken	Transportation Planner	Navajo Co. Public Works
Kwail, David	Chairman	Yavapai-Apache Tribe
LaCavita, Bob	VP of Operations	Grand Canyon Railways
LaFond, David	Procurement Officer	AZ Department of Transportation

Name	Title	Agency
Lang, Brian	Supervisor	Painted Cliffs Welcome Center, AZ Office of Tourism
Lee, Arthur N.	Chairman of the Board	Apache County
Lere, Steve	Program Director	City of Flagstaff
Lidell, Janice	Director of Public Affairs	NAU
Lisiewicz, Stan	District Director	CALTRANS
Lopez, Rick	Vice Mayor	City of Flagstaff
Lupe, Ronnie	Chairman	White Mountain Apache Tribe
Maki, Keith	Chief, Research Division	Nevada DOT
McCallister, Michael	Field Engineer	BNSF
McCauley, Frances	Highway Maintenance Supervisor	ADOT
McDaniel, Don	Administrator	City of Winslow
McDermott, Mark	Director	AZ Office of Tourism
Meador, Bill	Sales & Service Manager for State Government Accounts	US West Communications
Mester, Richard	Mayor	City of Holbrook
Miller, Joel	Maintenance Superintendent	ADOT / Maintenance
Mirth, Dr. Richard	Associate Professor	NAU College of Engineering
Morgan, Lawrence	Chairman	Navajo Nation Transportation and Community Development Committee
Roche, John	Development Service Director	City of Winslow
Russell, Daniel	Maintenance Superintendent	ADOT
Scoffield, Larry A.	Director/ATRC	ADOT ATRC
Secakuku, Ferrell H.	Chairman	The Hopi Tribe
Sharp, Barry W.	Lead Ticket Agent	AMTRAK
Shumway, Peter D.	Chairman of the Board	Navajo County
Shupla, Fred	Research Assistant	The Hopi Tribe
Smalley, Terry	Executive Vice President	AZ Motor Transport Association
Smith, George	Branch Chief	Caltrans
Smith, Zachary	Council Member	City of Flagstaff
Sorensen, Lou	City Manager	City of Kingman
Stalnaker, Jim	Highway Superintendent	Coconino County
Straub, Richard	Director of Public Works	Yavapai County
Swan, Jeffrey	District Engineer	ADOT
Swanson, Rick	Council Member	City of Flagstaff
Thompson, Ph.D., Jim	City Manager	City of Bullhead City
Thrift, Foster	Transportation Coordinator	Yavapai County
Tracey, Willie, Jr.	Transportation & Information Director	NDOT
Tuck, Jim	Transportation & Information Director	Grand Canyon National Park
Upchurch, Jonathan	Past President	ITS AZ
Van Wagner, Marilyn	General Sales Manager	KTNN
Vollmer, Karen	General Manager	Navajo-Hopi Tours
Wall, Henry	Senior Vice President	Kimley-Horn and Associates, Inc.

Name	Title	Agency
Wallen, Norm	City Staff Member	City of Flagstaff
Wang, William T.	Transportation Engineer	ADOT
Warnaca, Sharon	Tourism Specialist	Holbrook Chamber of Commerce
Wengert, Delwin T.	Engineer	Apache County
West, John	Program Manager	CALTRANS New Technology Research MS #83
Williams, Chuck	Engineer	Navajo County
Williams, Garry	Superintendent	BNSF Railway Company
Wolfe, Tim	Assistant State Engineer	ADOT Technology Group

The Committee's specific functions included:

- Review project progress.
- Review project deliverables, such as project technical memoranda.
- Participate in the project workshops and focus groups.
- Provide input and guidance.
- Assist in encouraging their respective community, business, and agency leaders in participation in the focus groups.

Over the course of the 12-month study, the PSC became the foundation of the I-40 ITS Coalition. Individuals, private companies, and government agencies at all levels showed an interest in the successful deployment of ITS solutions on the I-40 corridor.

4.3.0 TECHNICAL ADVISORY COMMITTEE (TAC)

The TAC is comprised of 14 representatives from ADOT and the FHWA (sponsoring agencies for this project), and the PSC Chairman. The role of this Committee was to guide the project efforts, participate in periodic TAC and PSC meetings to review project progress, and to review draft and final project reports and other project materials. The TAC was also responsible for helping to solicit input and participation from the local corridor communities. In a word, the TAC's role was that of state coordinators and local ITS champions. The members of the TAC are listed in **Table 4.3.0-1** below.

Table 4.3.0-1
Technical Advisory Committee Members

Name	Title	Agency
Agah, Manny	Project Manager	ADOT /Technology Group
Blanton, Tom	Transportation Specialist	ADOT/ Kingman (Retired)
Boren, Ervin	District Engineer	ADOT/Flagstaff
Brisk, Debra	Acting District Engineer	ADOT/Kingman
Burdick, Matt	Community Relations Officer	ADOT/Phoenix
Buskirk, Dale	Transportation Planning	ADOT/Phoenix

Name	Title	Agency
Dorman, Don	District Maintenance Engineer	ADOT/Flagstaff
Hansen, Alan	Transportation Engineer	FHWA/Phoenix
Harper, John	Regional District Traffic	ADOT/Flagstaff
Joshua, Sarath	Project Manager	ADOT/ATRC
McCallister, Michael	PSC Chairman	BNSF Railway Co./Flagstaff
Swan, Jeffrey	District Engineer	ADOT/Holbrook
Wang, William	Transportation Engineer	ADOT/Kingman
Wolfe, Tim	Assistant State Engineer	ADOT/Technology Group

5.0 USER SERVICES

The basic premise for ITS early deployment projects is to first identify the transportation problems and needs and then to identify technologies that can be used to address these needs. The purpose of Task 5, *Identify User Services*, was to determine, based on the I-40 user input, which of the 30 ITS user services are needed and when they should be provided (i.e., in the short-, medium-, or long-term time frames).

5.1.0 NEEDS IDENTIFICATION

Information from users on the problems, concerns and other issues in the I-40 corridor was assembled from the following sources:

- Mailed survey forms.
- Focus group meetings.
- Personal interviews at truck stops.
- Telephone interviews.
- Other sources (including a World Wide Web survey form).

5.1.1 Mail Surveys

Corridor problems/issues identification survey forms were mailed to approximately 200 stakeholders which were identified in Task 3 of this Early Deployment Plan.

The following illustrates some of the key findings of the mailed survey:

- *What do you see as the biggest transportation problems in the corridor? Where (by milepost, if possible)?* A number of respondents indicated generally poor weather conditions in their responses to this question. Snow and wind were identified as part of the weather-related problems.

- *Are you aware of any regularly occurring weather-related problems (e.g., high winds, fog, snow or iced bridges)?* Seventy-five percent of the responses were "yes" to this question.

- *Are you aware of other safety problems in the corridor/roadway?* Over 60 percent of the respondents indicated wildlife crossings in their response to this question. Livestock (2) and rock slides (2) were the second most common response to this question.

- *Are there problems at tourist attractions?* Over 40 percent of those who replied to this question answered "yes". *Is there a need for additional information for tourists within the corridor?* Sixty seven percent of respondents who addressed this question replied "yes".

- *Is there a need for additional information for tourists within the corridor?* Sixty-seven percent of respondents who addressed this question replied “yes”.

- *Do conflicts between truck and automobile traffic in the corridor cause significant problems?* Sixty percent of those who answered this question replied "yes".

5.1.2 Focus Group Meetings

Focus group meetings were held at each of the following locations in order to obtain user input on I-40 needs:

- Kingman (June 17, 1996), City Hall.
- Williams (June 18), Ramada Inn.
- Flagstaff (June 19), Days Inn.
- Holbrook (June 20), Firehouse.

Each focus group meeting included a video on ITS, a discussion of the project, demonstrations of other ITS projects, a summary of preliminary survey results, and a brainstorming session for identifying corridor problems and concerns.

In general, the issues discussed included: safety and environmental conditions; roadway geometry and pavement features; prevailing vehicle types traveling the corridor and the associated concerns, traffic volumes and speed; tourism considerations; communication and coordination issues; driver behavior; and other considerations.

5.1.3 Personal Interviews at Truck Stops

Personal interviews were conducted at four truck stops along the I-40 corridor, including stops in Winslow, (June 19-20, 1996), near Flagstaff, (June 19-20), Belmont, and Ash Fork, (both on June 20). Participants were given an ITS-America publication *Imagine ....Tomorrow's Travel Today.* Fifty truck operators agreed to participate, including thirty-one at Winslow, three at Little America, ten at Belmont, and six at Ash Fork.

Among the key findings of the truck stop survey responses were:

- *What specific weather conditions affect your driving performance and safety? Where?* Thirty-seven (74%) of the respondents indicated snow, ice or both in their response to this question.

- *Do you experience congestion on I-40?* Thirty-two (64 %) of the respondents indicated that they did not experience congestion on I-40.

- *Do you use a cellular phone, CB, laptop, telephones, radio and/or signage?* The participants responded as follows:

Cellular phone: (four)	8%
CB: (forty-seven)	94%
Laptop: (four)	8%
Telephones: (seven)	7%
Radio: (thirty)	60%
Signage: (twenty-three)	46%

- *Do you have any conflicts with other types of vehicles?* Twenty-three (46%) of the respondents replied "no" to this question.

Personal interviews were also to be conducted at two rest areas along I-40. Attempts were made to conduct interviews at these locations, but the motorists in these areas were found to be unable or unwilling to respond to the interviewer. Given the relative isolation of these facilities, no additional efforts were made to conduct personal interviews at highway rest areas within the time-frame of this submittal. It is assumed that the fifty interviews conducted at the four truck stops, together with the corridor issues identified through focus groups, mail survey and telephone interviews, adequately identify the problems and concerns perceived by the I-40 corridor users.

5.1.4 Telephone Interviews

The mailed survey was followed up with telephone calls to a number of survey recipients who did not provide a response within the suggested time. Approximately 20 additional surveys were collected through this effort. These telephone survey responses were combined with the mailed survey results (same format was used for both surveys).

5.1.5 Other Data Sources

A survey form, identical to the form used in the mail survey, was placed on the World Wide Web at **http://www.pcslink.com/khaphx/intervi1.htm**, which was linked to **www.azfms.com/About/ITSRD/i-40_edp.html** to provide an additional opportunity for concerned citizens and/or stakeholders to provide input to the identification of I-40 needs. A very limited response was received to this electronic survey, due most likely to the limited publicity that the web site received and the resulting lack of awareness of the survey page among the public.

5.2.0 ITS USER SERVICES

The next step in this task focused on identifying appropriate user services based on the previously identified corridor needs. The following paragraphs provide a brief description of each of the 30 user services defined in the National ITS Program Plan:

Travel and Transportation Management

En-Route Driver Information. *Provides driver advisories and in-vehicle signing for directions and safety.*

Route Guidance. *Provides travelers with simple instructions on how to best reach their destinations.*

Traveler Services Information. *Provides a business directory, or "yellow pages," of service information.*

Traffic Control. *Manages the movement of traffic on streets and highways.*

Incident Management. *Helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic.*

Emissions Testing and Mitigation. *Provides information for monitoring air quality and developing air quality improvement strategies.*

Travel Demand Management

Pre-Trip Travel Information. *Provides information for selecting the best transportation mode, departure time, and route.*

Ride Matching and Reservation. *Makes ride sharing easier and more convenient.*

Demand Management and Operations. *Supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion.*

Public Transportation Operations

Public Transportation Management. *Automates operations, planning, and management functions of public transit systems.*

En-Route Transit Information. *Provides information to travelers using public transportation after they begin their trips.*

Personalized Public Transit. *Provides transit vehicles on flexible routes to offer more convenient customer service.*

Public Travel Security. *Creates a secure environment for public transportation patrons and operators.*

Electronic Payment

Electronic Payment Services. *Allows travelers to pay for transportation services electronically.*

Commercial Vehicle Operations

Commercial Vehicle Electronic Clearance. *Facilitates domestic and international border clearance by minimizing stops.*

Automated Roadside Safety Inspection. *Facilitates roadside inspections.*

On-Board Safety Monitoring. *Senses the safety status of a commercial vehicle, cargo, and driver.*

Commercial Vehicle Administrative Processes. *Provides electronic purchasing of credentials, and automated mileage on fuel reporting, and auditing.*

Hazardous Material Incident Response. *Provides immediate description of hazardous materials to emergency responders.*

Commercial Fleet Management. *Provides communication among drivers, dispatchers, and intermodal transportation providers.*

Emergency Management

Emergency Notification and Personal Security. *Provides immediate notification of an incident and immediate request for assistance.*

Emergency Vehicle Management. *Reduces incident response time for emergency vehicles.*

Advanced Vehicle Control and Safety Systems

Longitudinal Collision Avoidance. *Helps prevent head-on, rear-end or backing collisions between vehicles, or between vehicles and other objects or pedestrians.*

Lateral Collision Avoidance. *Helps prevent collisions when vehicles leave their lane of travel.*

Intersection Collision Avoidance. *Helps prevent collisions at intersections.*

Vision Enhancement for Crash Avoidance. *Improves the driver's ability to see the roadway and objects that are on or along the roadway.*

Safety Readiness. *Provides warnings about the condition of the driver, the vehicle, and the roadway.*

Pre-Crash Restraint Deployment. *Anticipates an imminent collision and activates passenger safety systems before the collision occurs, or much earlier in the crash event than is currently feasible.*

Automated Highway Systems. *Provides a fully automated, "hands-off" operating environment.*

Rail-Highway Intersection. *Provides improvement to automated crossing control systems.*

5.3.0 ASSIGNMENT OF USER SERVICES TO IDENTIFIED NEEDS

A five-step process was used to refine the original statements of problems and concerns and to identify appropriate user services for I-40. **Figure 5.3.0-1** illustrates this process in a graphical format. **Table 5.3.0-1** is a matrix that summarizes the matching of need statements to user services.

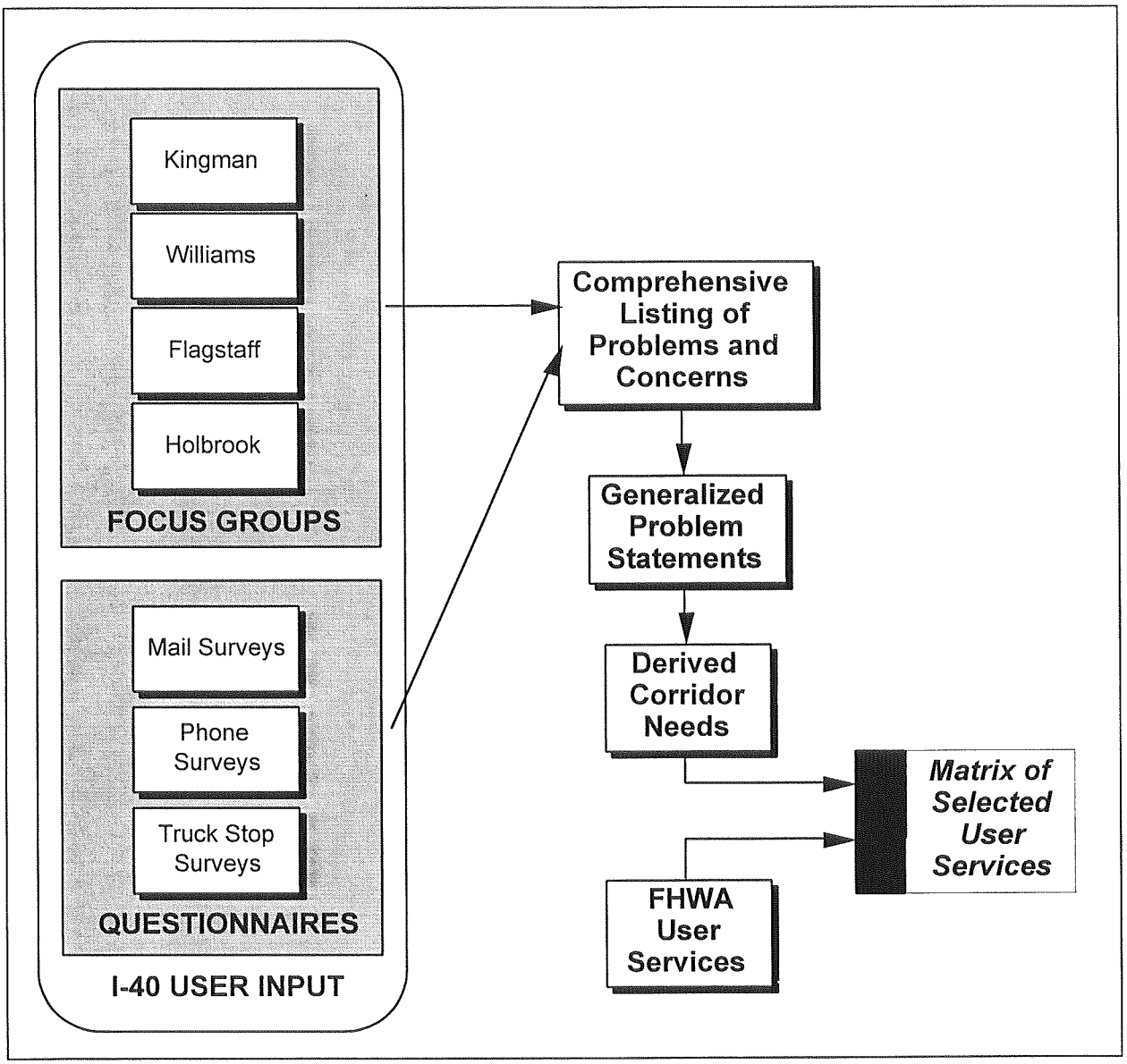


Figure 5.3.0-1
Identification of Needs and User Services

Table 5.3.0-1
Summary of Corridor Needs and Matched User Services

CORRIDOR NEED ID #	CORRIDOR NEEDS (SORTED ALPHA ASCENDING)	NON-ITS NEED	TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSPORTATION OPERATIONS					COMMERCIAL VEHICLE OPERATIONS						EMERG. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS							OTHER
			EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	DEMAND MANAGEMENT AND OPERATIONS	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESS	HAZARDOUS MATERIALS INCIDENT RESPONSE	FREIGHT MOBILITY	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	LONGITUDINAL COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR CRASH AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	
1	Address safety concerns due to trucks on downhill grades																		X												
2	Improve efficiency of heavy vehicles on upgrades					X											X														
3	Improve RV travel time on upgrades					X																									
4	Need for around the clock traveler information availability		X		X					X			X																		
5	Avoid accidents due to tourists stopping in wrong places		X	X			X			X													X		X						
6	Improve signage for tourist information			X	X																										
7	Give motorists information on I-40 travel conditions before trip									X																					
8	Provide travel information via rental cars in Phoenix and Las Vegas				X					X																					
9	Provide easy access to accurate travel information		X		X					X	X	X																			X
10	Improve delivery of visitor information to international visitors				X																										
11	Improve wireless communications infrastructure for traveler information, emergency services, etc.				X																		X								X
12	More signs appropriately placed with ability to change message content		X	X		X																									
13	Provide an alternative to cellular communication																														X
14	Improve inter and intra agency cooperation																														X
15	Central auth. agency to distribute Grand Canyon visitor information			X	X					X																					
16	Provide a 1-900 "ENJOYAZ" infomercial line				X					X																					
17	Real time weather condition information exchange		X		X					X			X																		
18	Increase number of communication channels																														X
19	Implement variable speed limit signs, based on weather conditions		X			X	X																								

Table 5.3.0-1
Summary of Corridor Needs and Matched User Services

CORRIDOR NEED ID #	CORRIDOR NEEDS (SORTED ALPHA ASCENDING)	NON-ITS NEED	TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSPORTATION OPERATIONS					COMMERCIAL VEHICLE OPERATIONS							EMERG. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS								
			EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	DEMAND MANAGEMENT AND OPERATIONS	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESS	HAZARDOUS MATERIALS INCIDENT RESPONSE	FREIGHT MOBILITY	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	LONGITUDINAL COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR CRASH AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	OTHER
20	Provide advance warning of congestion spots to general traffic		X	X	X	X	X		X	X	X																					
21	Provide early warning of weather conditions ahead to prevent drivers from being stranded on the road		X		X		X			X																						
22	Provide easily available, correct visitor information at public places				X					X		X																					
23	Increase cellular coverage along the I-40 corridor																																X
24	Reduce incidents/accidents due to conflicts between trucks and RVs																					X			X	X			X			
25	Resolve conflict with livestock and vehicles																								X			X	X			X
26	Centralize and inform public as to where roadway condition info is available		X		X					X																						
27	Reduce congestion at truck stops		X	X		X																X										
28	Improve emergency management in remote areas						X																X	X								
29	Improve reliability of HAR																																X
30	Increase number of weather stations along the corridor		X		X																											
31	More advance notification of detour information		X	X		X	X			X																						
32	Provide a means to detect emergencies in remote areas																						X									
33	Provide weather and roadway conditions information at truck stops		X							X		X										X										
34	Inform motorists where cellular coverage is available		X		X					X																						
35	Reduce congestion on the facility (I-40)		X	X	X	X	X		X	X	X		X	X			X	X	X	X		X	X	X								
36	Drivers need to be able to identify route and location on Indian reservations for emergencies			X			X																X									
37	Early warning of congestion at traffic interchanges		X	X		X	X																									

Table 5.3.0-1
Summary of Corridor Needs and Matched User Services

CORRIDOR NEED ID #	CORRIDOR NEEDS (SORTED ALPHA ASCENDING)	NON-ITS NEED	TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSPORTATION OPERATIONS					COMMERCIAL VEHICLE OPERATIONS						EMERG. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS								OTHER
			EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	DEMAND MANAGEMENT AND OPERATIONS	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESS	HAZARDOUS MATERIALS INCIDENT RESPONSE	FREIGHT MOBILITY	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	LONGITUDINAL COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR CRASH AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	
38	Prevent accidents between vehicles and bicycles																								X	X	X				X	
39	Prevent accidents between vehicles and pedestrians																							X		X	X					
40	Provide yellow-pages type traveler information via radio		X		X					X																						
41	Make drivers aware of the effects of sun glare																												X			
42	Monitor and detect driver fatigue																												X			
43	Provide counteractions to driver fatigue																		X										X			
44	Need to communicate to motorists appropriate locations to stop		X	X	X					X												X									
45	Reduce congestion generated by high truck volumes		X	X		X																X									
46	Improve safety at cloverleaf ramps																		X										X			
47	Provide alternative forms of tourist information to motorists		X	X	X					X			X																			
48	Detect and warn of spot ice conditions or hydroplaning conditions		X																										X	X			X
49	Improved HAZMAT notification and emergency management infrastructure																					X		X								
50	Improve safety at rest areas																							X								
51	Provide route guidance to Visitor Info Center		X	X	X					X			X																			
52	Provide early warning to drivers of falling rock						X																							X	X		
53	Provide early warning to drivers of reduced visibility, planned burns, etc., ahead				X		X																					X	X			
54	Need to determine method to automatically detect and enforce speeding in winter conditions					X	X																									
55	Improve notifications to drivers at Petrified Forest Welcome Center and at Painted Cliffs Welcome Center			X	X		X			X													X								

Table 5.3.0-1
Summary of Corridor Needs and Matched User Services

CORRIDOR NEED ID #	CORRIDOR NEEDS (SORTED ALPHA ASCENDING)	NON-ITS NEED	TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSPORTATION OPERATIONS					COMMERCIAL VEHICLE OPERATIONS							EMERG. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS							OTHER
			EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	DEMAND MANAGEMENT AND OPERATIONS	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESS	HAZARDOUS MATERIALS INCIDENT RESPONSE	FREIGHT MOBILITY	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	LONGITUDINAL COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR CRASH AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	
56	Advance clearance information for overpasses on detour routes		X	X																									X			
57	Early warning of severe roadway geometry		X							X																						
58	Improve congestion and parking information at interchanges		X	X	X																											
59	Need to detect illegal combinations of chemicals early																				X								X			
60	Automatically detect vehicles with tire chains																															X
61	Provide information on congestion status		X	X	X					X		X																				
62	Provide travel time information		X		X					X		X																				
63	Provide travelers with all options for tourist services which can be requested upon demand		X		X					X		X																				
64	Reduce and warn of congestion on I-40 near Flagstaff		X	X		X				X																						
65	Reduce long truck stops at POEs by improving P.O.E. throughput															X	X															
66	Separate bus traffic from commuter traffic			X		X																										
67	Reduce the speed differential in the traffic stream																														X	
68	Need to provide drivers w/ information relative to safe stopping distances based on conditions (longitudinal warning)		X																						X							
69	Need to warn drivers that insufficient lateral clearance exists		X																							X						
70	Detect flooding conditions and provide warning		X				X			X													X						X			
71	Eliminate heavy truck traffic from interchanges not designed to accommodate them			X																				X								

Table 5.3.0-1
Summary of Corridor Needs and Matched User Services

CORRIDOR NEED ID #	CORRIDOR NEEDS (SORTED ALPHA ASCENDING)	NON-ITS NEED	TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSPORTATION OPERATIONS					COMMERCIAL VEHICLE OPERATIONS						EMERG. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS								
			EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	DEMAND MANAGEMENT AND OPERATIONS	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	COMMERCIAL VEHICLE ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	COMMERCIAL VEHICLE ADMINISTRATIVE PROCESS	HAZARDOUS MATERIALS INCIDENT RESPONSE	FREIGHT MOBILITY	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	LONGITUDINAL COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR CRASH AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	OTHER
	Non-ITS Needs:																															
72	Do not close rest areas	X																														
73	Eliminate visual clutter	X																														
74	Improve interchanges to accommodate heavy truck traffic	X																														
75	Improve local signage	X																														
76	Improve sign visibility against sun glare	X																														
77	Improve speed limit signing/enforcement on Indian Reservations	X																														
78	Increase number of road side service stations	X																														
79	Increase number of RV pullouts	X																														
80	Increase number of truck pullouts	X																														
81	Increase number of visitor welcome centers	X																														
82	Provide additional parking for trucks and RVs at rest areas	X																														
83	Provide more alternate routes	X																														
84	Provide more capacity at rest areas	X																														

5.4.0 EXISTING TRANSPORTATION-RELATED SERVICES

5.4.1 Inventory

An inventory of existing transportation-related facilities serving I-40 was assembled as part of Task 1 of this Early Deployment Plan. Review of this information, together with data provided by ADOT and other sources, indicates that the following key transportation-related facilities exist on I-40:

Traveler and Tourist Facilities

- Seven highway rest areas (three eastbound and four westbound).
- One tourist Welcome Center in Lupton (at the Arizona-New Mexico border).
- A series of tourist information kiosks in the Flagstaff area (referred to as Infoguide).

Commercial Vehicle Operations

- Ports of Entry at the California and New Mexico borders.
- Seven WIM/AVI devices.
- Truck stops.

Weather and Emergency Management Facilities

- Seven RWIS snow and ice detection system sites/weather stations.
- DPS weather information telephone line.
- HAR.
- Portable VMS.

Inter-agency Communication/Coordination

- Telephone.
- Fax.
- Internet (increasing use nationwide, but not found to be widely used by users of the I-40 corridor).

5.4.2 Evaluation of Existing Facilities

User assessments of the existing transportation-related infrastructure, collected during the May 21, 1996 Project Steering Committee meeting and subsequent focus group meetings, are summarized below:

Traveler and Tourist Facilities

- Inadequate signage can make it difficult to find the visitor centers.
- Tourists have no place to get information after closing hours of the visitor centers.
- The visitor centers often do not have the latest traveler information available (roadway closures, accidents ahead, etc.).

Commercial Vehicle Operations

- Truck stops are limited at some locations in corridor.
- Truck stops increase local congestion at some installations (e.g. Kingman).
- POE facilities are outdated.

Weather and Emergency Management Facilities

- Spotty cellular coverage within some parts of the corridor.
- DPS weather information telephone line frequently overloaded.
- Emergency response on Reservation may be constrained by lack of mileposts.

Inter-agency Communication/Coordination

- Limited coordination/data-sharing opportunities

In addition to these specifically-cited concerns, some further issues might exist, such as:

- ITS education and training, particularly in forming partnerships for deployment.
- Increased personnel to operate and maintain ITS infrastructure.
- Political support, particularly at the local level, for ITS funding.
- Overall strategy to develop major project funding sources and user-based funding.

5.4.3 Identification of User Service Deployment Time-Frames

The National ITS Program anticipated deployment of ITS based upon the following schedule:

Term	Time-Frame	Envisioned ITS Deployment
Short	1997-1999	Travel Information/Fleet Management
Medium	2000-2005	Transportation Management
Long	2010	Enhanced Vehicles

The National ITS Program defines the beginning of the short-term time frame (1997) to coincide with the reauthorization of ISTEA. Considering the typical planning, design, and implementation schedules of transportation projects, the short-term encompasses a relatively brief time frame (three years). This schedule reflects the desire by FHWA to implement, as quickly as possible, visible and effective ITS projects that will stimulate public support for the funding levels required to implement the future medium- and long-term deployment programs. **Table 5.4.3-1** summarizes deployment time-frames for all user services selected for I-40 needs.

Table 5.4.3-1
Number of Identified Needs Met by Projected Staging of ITS User Services

		TRAVEL AND TRANSPORTATION MANAGEMENT						TRAVEL DEMAND MGMNT.			PUBLIC TRANSP. OPERATIONS				DITTO	COMMERCIAL VEHICLE OPERATIONS						EMER. MGMT.		ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS							
PROJECTED TIME OF DEVELOPMENT	**NON-ITS NEED**	EN-ROUTE DRIVER INFORMATION	ROUTE GUIDANCE	TRAVELER SERVICES INFORMATION	TRAFFIC CONTROL	INCIDENT MANAGEMENT	EMISSIONS TESTING AND MITIGATION	PRE-TRIP TRAVEL INFORMATION (INCLUDES KIOSKS)	RIDE MATCHING AND RESERVATIONS	DEMAND MGMT AND OPERATIONS	PUBLIC TRANSPORTATION MANAGEMENT	EN-ROUTE TRANSIT INFORMATION	PERSONALIZED PUBLIC TRANSIT	PUBLIC TRAVEL SECURITY	ELECTRONIC PAYMENT SERVICES	CV ELECTRONIC CLEARANCE	AUTOMATED ROADSIDE SAFETY INSPECTION	ON-BOARD SAFETY MONITORING	CV ADMINISTRATIVE PROCESS	HAZMAT INCIDENT RESPONSE	COMMERCIAL FLEET MANAGEMENT	EMERG. NOTIFICATION AND PERSONAL SECURITY	EMERGENCY VEHICLE MANAGEMENT	"LONGITUDINAL" COLLISION AVOIDANCE	LATERAL COLLISION AVOIDANCE	INTERSECTION COLLISION AVOIDANCE	VISION ENHANCEMENT FOR COLLISION AVOIDANCE	SAFETY READINESS	PRE-CRASH RESTRAINT DEPLOYMENT	AUTOMATED HIGHWAY SYSTEM	OTHER
SHORT (1997 - 1999)	10	16	9	12	7	10	-	15	3	2	3	4	1	-	-	2	1	3	1	-	3	6	3	4	3	2	2	5	-	1	9
MEDIUM (2000 - 2005)	7	12	9	9	3	4	-	8	-	-	1	4	-	-	1	1	-	-	-	1	3	3	-	-	-	-	2	6	1	-	2
LONG (After 2010)	2	3	2	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	-	1	-	1	-
TOTAL	19	31	20	21	11	15	-	24	3	2	4	8	1	-	1	3	1	3	1	1	6	10	4	6	4	2	4	12	1	2	11

6.0 PERFORMANCE CRITERIA

The purpose of Task 6, *Establish User Service Objectives and Performance Criteria*, is to state the objectives to be achieved by implementing the user services identified in Task 5 of the I-40 Early Deployment Plan, and to specify the criteria to be used to measure the degree of success (performance) of the user services when they are deployed.

A number of alternative indicators of effectiveness, referred to as performance measures, are available to assess the degree to which the selected user services achieve each specific goal. Performance measures can be grouped into quantitative or qualitative categories and consist of a wide range of transportation-related, environmental and other indices. The following paragraphs summarize the identification and assessment of alternative performance criteria.

6.1.0 CANDIDATE PERFORMANCE MEASURES

Candidate performance measures were identified based on a review of several sources, including:

- USDOT's National Program Plan for ITS.
- USDOT's Advanced Public Transportation Systems: Evaluation Guidelines.
- *ITS Architecture* reports.
- ITS America *Proceedings.*
- Pima Association of Governments (PAG) Technical Memorandum 5: User Services/Options Study.
- Professional literature search.
- Evaluation of specific objectives in the I-40 corridor.

System Objectives
■ Improve Safety ■ Provide timely emergency services ■ Disseminate and share information to travelers ■ Provide efficient flow of traffic ■ Ensure conformance with laws ■ Ensure that agencies and offices cooperate efficiently

A total of 81 performance measures were assembled during the research effort for this task. Although a number of the measures were found to be more oriented toward urban conditions, many others were found to be applicable to the typically rural character of I-40. **Table 6.1.0-1** illustrates the grouping of candidate performance measures into system objective categories.

Table 6.1.0-1
Summary of Candidate Performance Measures

	Objectives					
	A. Improve Safety	B. Provide Timely Emergency Services	C. Disseminate and Share Information to Travelers	D. Provide Efficient Flow of Traffic	E. Ensure Conformance with Laws	F. Ensure that agencies and offices cooperate effectively
Ability to gear safety messages to particular types of vehicles			X			
Ability to obtain current information about rest & truck stop locations & space availability			X			
Ability to use roadside AVI to obtain current vehicle location			X			
Acceptance by operations & maintenance personnel						X
Access for emergency vehicles		X				
Access to transit service				X		
Accessibility of transportation to disabled groups				X		
Accident rate	X					
Accident severity	X					
Accurate incident detection		X				
Accurate & effective detour information delivery to affected drivers			X			
Amount of out-of-direction travel				X		
Arrival time predictability				X		
Availability of data for transportation planning						X
Availability of real-time traffic data for operations				X		
Availability of traveler information			X			
Cargo and vehicle security	X					
Citations issued					X	
Comfort and convenience				X		
Commercial productivity level				X		
Conformance/response to messages			X			
Cost per transit user				X		
Cost/Benefit ratio	X	X	X	X	X	X
Delays at weigh stations and ports of entry				X		
Driver stress	X			X		
Duration of congestion				X		
Effective transport capacity				X		
Emergency response time		X				
Emergency service call-outs		X				
Fuel consumption				X		
Hazardous materials spills	X	X				

Table 6.1.0-1
Summary of Candidate Performance Measures

	Objectives					
	A. Improve Safety	B. Provide Timely Emergency Services	C. Disseminate and Share Information to Travelers	D. Provide Efficient Flow of Traffic	E. Ensure Conformance with Laws	F. Ensure that agencies and offices cooperate effectively
HOV usage				X		
Incident detection rate		X				
Incident notification	X	X				
Incident removal time		X				
Information reliability			X			
Interagency communication/coordination						X
Intermodal transfer volumes				X		
Level of participation/usage				X		
Level of service (LOS)				X		
Level of SOV use/other modes				X		
Life-cycle costs	X	X	X	X	X	X
Maintenance/operations requirements	X			X		X
Noise pollution				X		
Number of accidents involving vehicles leaving the roadway	X					
Number of communication channels			X			
Number of congested locations				X		
Number of fatal accidents	X					
Number of hours in which information is available			X			
Number of incident-related accidents	X					
Number of non-congestion-related accidents	X					
Number of on-time transit arrivals				X		
Number of stops				X		
Number of visitor centers with information kiosks			X			
Number of visitors			X			
On-time delivery				X		
Passenger/driver security	X					
Person-hours of delay				X		
Person-hours of travel				X		
Production delay				X		
Public acceptance/reaction						X
Quality of incident information collection & sharing among agencies			X			X

Table 6.1.0-1
Summary of Candidate Performance Measures

	Objectives					
	A. Improve Safety	B. Provide Timely Emergency Services	C. Disseminate and Share Information to Travelers	D. Provide Efficient Flow of Traffic	E. Ensure Conformance with Laws	F. Ensure that agencies and offices cooperate effectively
Quality of travel due to the improved incident mitigation				X		
Rear-end collisions	X					
Sales of in-vehicle navigation equipment			X			
Schedule information accuracy			X			
Service reliability						X
Staff utilization						X
Support other transportation management						X
Tow truck service calls		X		X		
Traffic data quality			X			
Transit operating costs				X		
Transit ridership				X		
Transit travel time				X		
Travel cost				X		
Travel speed				X		
Travel time				X		
Truck/fixed object collisions	X					
Vehicle density per lane				X		
Weather station coverage	X		X			
Wireless communications coverage			X			

6.2.0 ASSESSMENT OF CANDIDATE PERFORMANCE MEASURES

In order to establish ITS performance measures, it is necessary to evaluate the relative advantages and disadvantages of the 81 candidate criteria. Each candidate performance measure identified in the preceding subsection was evaluated based on the following considerations:

- Ability to describe system performance in a meaningful way and to identify system deficiencies.
- Measurability.
- Ease of data collection.
- General use or understanding of the measure among transportation professionals.
- Sensitivity of the measure to system expansion or enhancement.
- Applicability to corridor-level assessment.
- Ease of computation/estimate.

Each performance measure was evaluated against each of the above considerations and rated as "poor", "moderate" or "good." These ratings were assigned corresponding numeric values, such that poor =1, moderate = 2, and good = 3. Each candidate performance measure, then, has a theoretical maximum score of 21. Using this approach, candidate performance measures ranged from a value of 9 to 19.

6.3.0 RECOMMENDATION OF PERFORMANCE MEASURES

Thirty-two performance measures, approximately 40 percent of all measures evaluated, had scores of 17 or better. These measures, incorporating both quantitative and qualitative criteria, were selected for the purposes of evaluating the effectiveness of the selected user services in implementing the specific objective of each need. **Table 6.3.0-1** summarizes these final performance measures. It should be noted that the generalized measures listed in this table are assumed to incorporate a more detailed breakdown of the information each provides. For example, the accident rate performance measure is assumed to provide accident rates for alternative roadway and environmental conditions.

Table 6.3.0-1
Summary of Performance Measures

QUALITATIVE	QUANTITATIVE
Accurate incident detection	Accident rate
Availability of traveler information	Arrival time predictability
Conformance/response to messages	Citations issued
Level of Service (LOS)	Emergency response time
Maintenance/operations requirements	Emergency service call-outs
Accurate & effective detour information delivery to affected drivers	Hazardous material spills
Interagency communication/coordination	Incident detection rate
*Customer Surveys:**	Incident notification
- *Understanding of ITS*	Incident removal time
- *Utilization of ITS*	Level of SOV use/other modes
- *Satisfaction with technologies*	Number of accidents involving vehicles leaving the roadway
	Number of communications channels
	Number of fatal accidents
	Number of hours in which information is available
	Number of visitor centers
	Number of visitors
	Person-hours of delay
	Rear-end collisions
	Tow truck service calls
	Travel speed
	Truck/fixed object collisions
	Vehicle density per lane
	Weather station coverage
	CVO operations and impacts
	Wireless communications coverage
	*Timelines and traveler data**

**Measure added later in the study*

7.0 INTEGRATED USER SERVICES

7.1.0 OVERVIEW OF THE USER SERVICES PLAN

The area of emphasis for this ITS strategic planning effort is a comprehensive assessment of the immediate and long-range ITS deployment opportunities in this rural, high-use corridor. Based on the broad-based needs assessment and input from more than 100 stakeholders of this northern Arizona corridor, the documentation shown in the previous six chapters, and the review of the ITS Coalition and Project Steering Committee, the User Services Plan developed under Task 7 of this study identifies three elements that need more attention than other user service categories:

- Developing of a corridor-wide Advanced Traveler and Tourist Information System (ATIS).
- Developing an approach to incorporating ITS technologies in an Incident Management System stretching across the entire 580-km corridor, including an advanced weather-reporting system.
- Addressing CVO improvements, including information available to truckers.

7.2.0 USER SERVICE CATEGORIES

As the delineation of a national rural ITS program evolved during the course of this study, the concept of "market clusters" was raised by the team. The rural concept was patterned after the market clusters that evolved in the National Architecture effort in place of the original set of user service "bundles" that were described in earlier versions of the ***National ITS Program Plan.*** A comparison of the Rural Market Clusters and the urban user service groups (or "bundles") is shown in **Table 7.2.0-1.** The FHWA Rural Market Clusters and User Services presented in **Table 7.2.0-2** are recommended as best representing the focus of ITS Early Deployment initiatives in northern Arizona. Corridor needs, grouped by Rural Market Cluster, are listed in **Table 7.2.0-3**.

Table 7.2.0-1
Comparison of User Service Groups and Rural Market Clusters

Urban User Service Groups (1)	**Rural Market Clusters (2)**
Travel & Transportation Management	Tourism and Traveler Information Services
Travel Demand Management	Traveler Safety and Security
Urban Transit Systems	Public Traveler/Mobility Services
Emergency Notification & Emergency Mgmt.	Emergency Services
Electronic Payment Services	Fleet Operations & Management
Commercial Vehicle Operations	Commercial Vehicle Operations
Advanced Safety & Control Systems	Infrastructure Operations & Maintenance
Note (1): Groups of User Services are called "bundles" in the **National ITS Program Plan.**	
Note (2): Rural Market Clusters are now referred to as Critical Program Areas in the ARTS Strategic Plan - December 1996	

The specific user services that were originally identified by FHWA and ITS-America have been carried forward. A complete description of the original 29 User Services is included in the ***National ITS Program Plan.*** All of the FHWA User Services are not included in the I-40 corridor Integrated User Service Plan; only those eleven User Services that are considered directly applicable to further consideration and possible deployment in this region are being included in this Plan. These User Services are incorporated in six of the seven Rural Market Clusters. The seventh market cluster, Fleet Operations and Management, is incorporated into the Corridor Architecture Plan, Chapter 12, in order to accommodate fleet operations in future years. The only reason that it is omitted in the user services plan is that no specific needs were identified in the corridor that fall under the fleet operations category, other than commercial fleets, which is a separate category.

Table 7.2.0-2
User Services Based on the Needs in the Arizona I-40 Corridor

Rural Market Clusters	**Specific ITS User Services**
Traveler Safety and Security	Rail-Highway Grade Crossings Other Safety-related Services
Tourism and Traveler Information Services	Pre-trip Travel Information En-route Driver Information Route Guidance Traveler Services Information
Public Traveler/Mobility Services	Transit Management
Commercial Vehicle Operations	Electronic Clearance
Emergency Services	Emergency Notification & Personal Security Emergency Vehicle Management
Infrastructure Operations and Maintenance	Incident Management

Table 7.2.0-3
Compilation of Needs by Rural Market Cluster

Needs Grouped by Rural Market Cluster	
I.	**Traveler Safety and Security** (addresses the spectrum of safety issues in terms of accident prevention)
1.1	Address safety concerns due to trucks on grades
1.2	Implement variable speed limit signs based on weather
1.3	Resolve conflict between livestock and vehicles
1.4	Drivers need to identify routes on Native American lands
1.5	Prevent accidents between vehicles and bicycles
1.6	Prevent accidents between vehicles and pedestrians
1.7	Provide counteractions to driver fatigue
1.8	Improve safety at rest areas
1.9	Automatically detect and enforce speeding in winter conditions
1.10	Provide drivers with safe stopping distance information based on conditions (longitudinal detection)
1.11	Warn drivers of insufficient lateral clearance
1.12	Improve RV travel time on upgrades
1.13	Improve safety at cloverleaf ramps
II.	**Tourism and Traveler Information Services**
2.1	Around-the-clock traveler information availability
2.2	Avoid accidents due to tourists stopping at wrong places
2.3	Communicate to drivers appropriate locations to stop
2.4	Give motorists travel condition information before the trip
2.5	Easy access to accurate travel information
2.6	Central agency to distribute Grand Canyon N.P. visitor information
2.7	Advance warning of congestion spots to general traffic
2.8	Centralize and inform public where roadway condition information is available
2.9	Reduce congestion at truck stops
2.10	Reduce congestion on I-40
2.11	Early warning of congestion at traffic interchanges

Needs Grouped by Rural Market Cluster
2.12 Improve wireless communications infrastructure for travel information, emergency services, etc.
2.13 Provide an alternative to cellular communication
2.14 Improve inter- and intra-agency communications
2.15 Increase number of communications channels
2.16 Increase cellular coverage along the I-40 corridor
2.17 Inform motorists where cellular coverage is available
2.18 Increase number of weather stations along the corridor
2.19 More advance notification of detour information
2.20 More signs appropriately placed with ability to change message content
2.21 Real time weather condition information and exchange
2.22 Provide early warning of weather conditions ahead to prevent drivers from being stranded on the road
2.23 Provide easily available, correct visitor information at public places
2.24 Provide weather and roadway condition information at truck stops
2.25 Provide yellow-pages traveler information via radio
2.26 Make drivers aware of the effects of sun glare
2.27 Reduce and warn of congestion on I-40 near Flagstaff
2.28 Advance clearance information for overpasses on detour routes
2.29 Detect and warn of spot ice or hydroplaning conditions
2.30 Automatically detect vehicles with tire chains
2.31 Early warning of severe roadway geometry
2.32 Improve congestion and parking information at interchanges
2.33a Improve notifications to drivers at Petrified Forest Welcome Center
2.33b Improve notifications to drivers at Painted Cliffs Welcome Center
2.34 Improve reliability of HAR
2.35 Provide alternative forms of tourist information to motorists
2.36 Provide route guidance to visitor information centers
2.37 Provide information on congestion status
2.38 Provide travel time information
2.39 Provide travelers with tourist services information
2.40 Detect flooding conditions and provide warning

Needs Grouped by Rural Market Cluster	
2.41	Provide northern Arizona travel information via rental cars in Phoenix and Las Vegas
2.42	Provide a 1-900 "ENJOYAZ" infomercial line
2.43	Improve signage for tourist information
2.44	Improve delivery of visitor information to international visitors
III.	**Public Traveler/Mobility Services**
3.1	Separate bus traffic from commuter traffic
IV.	**Commercial Vehicle Operations** (addresses other specific trucking issues)
4.1	Improve efficiency of heavy vehicles on upgrades
4.2	Reduce incidents and accidents due to conflicts between trucks and RVs
4.3	Reduce long truck stops at POEs by improving POE throughput
4.4	Reduce the speed differential in the traffic stream
4.5	Eliminate heavy truck traffic from interchanges not designed to accommodate them
4.6	Provide counteractions to truck driver fatigue
V.	**Emergency Services**
5.1	Improve emergency management in remote areas
5.2	Improve HAZMAT notification and emergency management enforcement
VI.	**Infrastructure Operations and Maintenance** (addresses incident management and other functions of highway operations)
6.1	Provide a means to detect emergencies in remote areas
6.2	Reduce congestion caused by high truck volumes
6.3	Provide early warning to drivers about falling rock
6.4	Provide early warning to drivers of reduced visibility, planned burns, smoke, fog, etc.
6.5	Provide counteractions to driver fatigue
6.6.	Need to detect illegal combinations of chemicals early

8.0 FUNCTIONAL AREAS

Each of the user services identified in Chapter 7 was matched with relevant ITS functional areas as identified in the National Architecture. Functional areas are also consistent with the descriptions in the FHWA s *National ITS Program Plan*. **Table 8.0-1** presents the matching of each of these user services with functional areas that will be required for implementation.

Table 8.0-1
ITS User Services Mapped to Functional Areas

	Functional Areas						
User Services	**Surveillance**	**Data/Voice Communic.**	**Traveler Interface**	**Control Strategies**	**Navigation Guidance**	**Data Processing**	**In-vehicle Sensors**
Incident Management	X	X			X	X	
En-Route Driver Information	X	X	X		X	X	X
Route Guidance	X	X	X		X	X	
Pre-Trip Travel Information	X	X	X		X	X	
Traveler Services Information	X	X	X			X	
Emergency Notification & Personal Security		X	X			X	X
Emergency Vehicle Management		X	X	X	X	X	X
Commercial Vehicle Electronic Clearance	X	X	X		X	X	X
Rail-Highway Grade Crossings	X	X	X	X		X	X
Transit Management	X	X	X		X	X	X
Other Safety-Related Services	X	X	X		X	X	X

Table 8.0-1 was developed from the output of previous tasks. For each functional area, the User Services identified as most applicable to the I-40 corridor have been highlighted. ITS projects addressing these services and functions should be immediately identified. Cells marked with an "X" identify potentially promising deployment opportunities, but most likely apply to more long-term deployment.

9.0 SYSTEM ARCHITECTURE

9.1.0 ARCHITECTURE OVERVIEW

The focus of Task 9 of the I-40 Strategic Plan was a) to define a set of functional requirements which satisfy the user needs identified in the User Services Plan, Chapter 7; and b) to develop an ITS architecture for the I-40 Corridor. Both of these activities are based upon and consistent with the work done to develop the National ITS Architecture by Lockheed-Martin Federal Systems and Rockwell International.

The User Services for the I-40 Corridor, defined by this study, represent a subset of the overall User Services defined in the National Program Plan for ITS. The I-40 Corridor functional requirements define what functions must be performed to satisfy the User Needs. Further, these functions are partitioned to the elements of the architecture which must perform the functions.

What do we mean by system architecture? It is a framework based on user requirements, for system design. It is not a system design, but a structure for how to design systems.

An architecture defines the functions (e.g. gather traffic information, provide traffic information to travelers) that must be performed to implement a specific user requirement, the physical entities (or subsystems) where these functions reside (e.g. a vehicle or kiosk), the interfaces/ information flows between the physical subsystems, and the communications requirements for the information flows.

The I-40 Corridor ITS Architecture was developed by defining the portions of the National ITS Architecture needed to support each user need, extracting those portions, and then developing additional levels of detail to define and explain how the elements interconnect. The I-40 Corridor ITS Architecture was developed in increments for the following timeframes:

- Short- Term 1997-1999
- Mid- Term 2000-2005
- Long- Term 2006 - 2010

Figure 9.1.0-1 summarizes the process used to create the I-40 Corridor Architecture. The architecture for I-40 follows the pattern established for the National Architecture (N.A.). The National Architecture. shows three layers - a communications layer, a transportation layer, and an institutional layer. The first two layers are described in this section. The institutional layer is described in Section 11.0, the Operations and Management Plan.

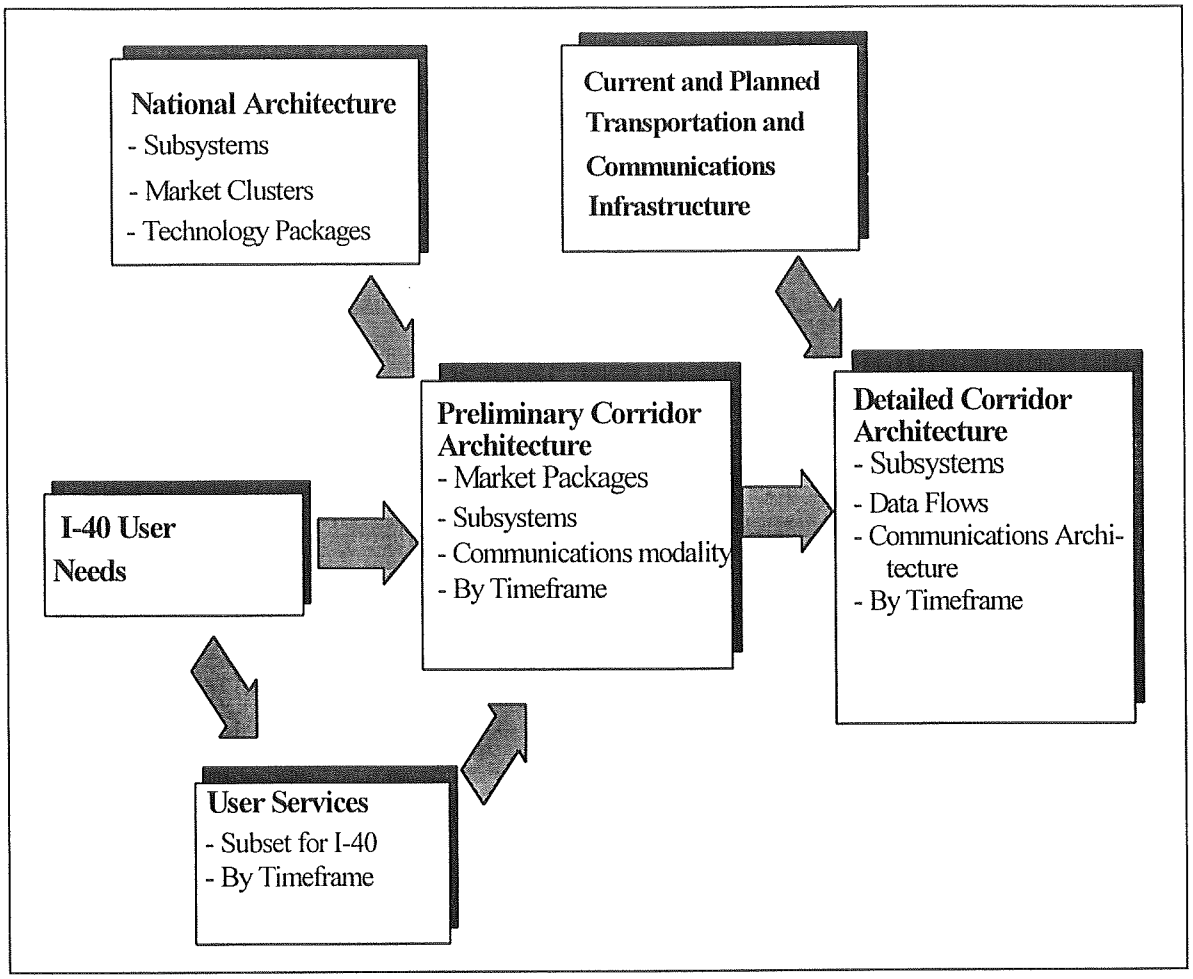


Figure 9.1.0-1 Architecture Development Process

9.2.0 FUNCTIONAL REQUIREMENTS

The functional requirements for the I-40 Corridor Architecture were derived from the stated I-40 Corridor User Needs using the Process Specifications developed for the ITS National Program Plan. In order to assure consistency with the National ITS Architecture, each User Need was mapped to its closest equivalent User Service.

This process resulted in a set of concise functional requirements specific to meeting the I-40 corridor needs, while at the same time consistent with, and traceable to elements of the ITS National Program Plan.

9.3.0 GENERAL DESCRIPTION OF ITS ARCHITECTURE

The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement a given user service, the physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle) and the interfaces/information flows between the physical subsystems, as well as the communication requirements for the information

flows (e.g., wireline or wireless). The architecture is comprised of two technical layers, a Transportation Layer and a Communications Layer.

The basic elements of the Transportation Layer are ***subsystems, equipment packages*** **and** ***market packages***. The subsystem is the highest level building block of the architecture. It represents a set of transportation functions (or processes) which are likely to be collected together under one physical agency, jurisdiction, or physical location (e.g. within a vehicle).

The interfaces between subsystems represent key communication links that will be defined by the architecture. The information contained in these key interfaces is defined by dataflows. Subsystems are further subdivided into equipment packages, which represent the lowest level of functionality in the architecture. Usually there are several equipment packages within a subsystem. As shown in the example in **Figure 9.3.0-1**, the Information Service Provider Subsystem (ISP) contains the Basic Information Broadcast Equipment package defined in the National Architecture.

Subsystems identified in the National ITS Architecture that have been selected for deployment in the I-40 ITS architecture are illustrated in the adjacent sidebar.

Selected Subsystems

- Traveler Subsystems:
  - Personal Information Access.
  - Remote Traveler Support.
- Center Subsystems:
  - Traffic Management.
  - Information Service Provider.
  - Emergency Management.
  - Transit Management.
- Roadside Subsystems:
  - Roadway.
  - Parking.
- Vehicle Subsystems:
  - Personal (or Basic) Vehicle.
  - Transit Vehicle.
  - Commercial Vehicle.
  - Emergency Vehicle

A number of equipment packages are imbedded in the architecture. While equipment packages are useful in defining the functions within a single subsystem, they do not easily translate into user services (or user needs). To provide a direct link between user services/ needs and the architecture, the concept of market packages has been developed. Fifty-three ITS Market Packages are described in the National Architecture Plan. The Market Packages that are suggested as applicable to the I-40 rural corridor are listed in the sidebar. These Market Packages are listed in a very general order in which they would be implemented, recognizing that many will be deployed concurrently.

The next concept is the market cluster. A market cluster is the set of subsystems, equipment packages, and market packages that are required to provide some portion of a user service or user need. Figure 9.3.0-1 is an example of one Market Package (Broadcast Traveler Information) within the Tourism and Traveler Information Market Cluster:

Market Packages Applicable to the I-40 Corridor

- Broadcast Traveler Information (ATIS 1).
- Interactive Traveler Information (ATIS 2).
- Incident Management (ATMS 08).
- Traffic Information Dissemination (ATMS 06).
- Freeway Operations (ATMS 04).
- Traffic Control
- Traveler Security.
- Emergency Response (EM 1).
- Emergency Routing (EM 2).
- HAZMAT Management (CVO 10).
- MAYDAY Support (EM 3).
- Highway-Rail Intersection (not yet delineated in National Architecture).
- Traffic Network Performance Evaluation (ATMS 09).
- ITS Planning (ITS 1).
- Fleet Administration (CVO 01).
- Traffic Surveillance (ATMS 01).
- Surface Street Control (ATMS 03).
- In-vehicle Signage (ATIS 9).
- Intermodal Traveler Fare Management.
- Multimodal Coordination (APTS 7).

Note: National Architecture references shown in parenthesis.

The Broadcast Traveler Information Market Package contains the Basic Information Broadcast Equipment Package within the Information Service Provider Subsystem and the Personal Basic Information Reception Equipment Packages within the Personal Information Access Subsystem. The Market Package provides broadcast traveler information to a variety of users. In total, the Market Cluster of Tourism and Traveler Information would contain the following Market Packages: Broadcast Traveler Information, Interactive Traveler Information, Traffic Information Dissemination, and In-vehicle Signing.

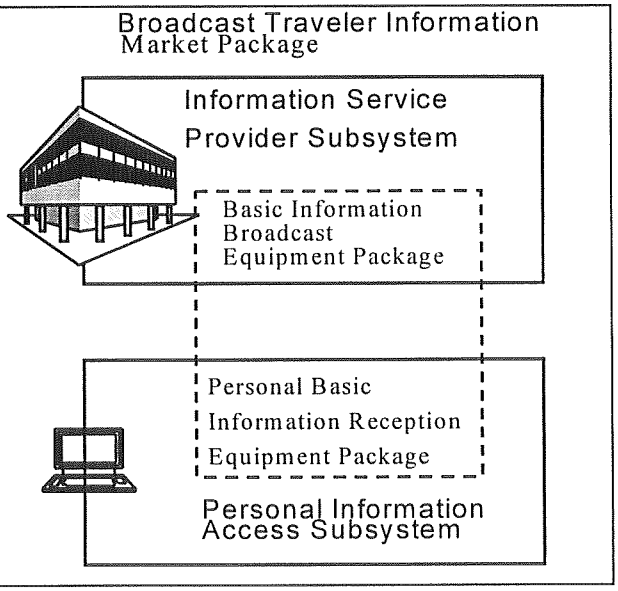


Figure 9.3.0-1
Sample Market Package of a Market Cluster

During the course of the strategic planning study for the I-40 corridor, the National Program Plan for rural areas went through a development phase in the FHWA ITS program office. The concept of "market clusters" essentially replaced the previous concept of "bundles" of user services, as had been used in the original program plan for urban areas. The two concepts were summarized in **Table 7.2.0-1**. Due to this change in the National Plan, the system architecture for I-40 is structured around the market clusters identified first in Chapter 7 and carried forward throughout this report.

In deployments, the character of a subsystem deployment is determined by the specific equipment packages chosen. For example, one municipal deployment of a *Traffic Management Subsystem* might select "*Collect Traffic Surveillance* and *Basic Signal Control"* equipment packages, while a state traffic management center might select "*Collect Traffic Surveillance* and *Freeway Control"* packages. In addition, subsystems may be deployed individually, in "aggregations", or combinations that will vary by geography and time based on local deployment choices.

A traffic management center might include a *Traffic Management Subsystem*, *Information Provider Subsystem*, and *Emergency Management Subsystem*, all within one building, while another traffic management center might concentrate only on the management of traffic with the *Traffic Management Subsystem* or the coordination of alternate modes. Such a function could occur, for example, at a center to be located in the Flagstaff area to coordinate and be a clearinghouse for information on tours to area attractions such as the Grand Canyon, schedule information on the Grand Canyon Railroad, Amtrak, etc., and perhaps other tourist information such as river rafting companies, ski area schedules, etc. A discussion of the function of each subsystem is provided in the following sections.

9.4.0 SHORT, MEDIUM, AND LONG TERM ARCHITECTURE SUBSYSTEMS

The Short, Medium, and Long Term I-40 Corridor ITS Architecture provides the functionality to satisfy the User Needs defined for these terms. **Tables 9.4.0-1** through **9.4.0-3** summarize the short, medium, and long term needs and map them to Market Clusters and Market Packages deployed in each time period. The description of needs presented in these tables have been synthesized; however, they incorporate all of the needs identified in Chapter 7, the Integrated User Services Plan. Needs and market packages added in the mid-, and long-term deployment are shown in **bold** type.

Each Market Package consists of several subsystems, equipment packages within the subsystems, and dataflows which define information that goes from one subsystem to another. When all of the Market Packages are combined at the subsystem level, the subsystems required to satisfy the short, medium, and long term needs are those shown in **Figures 9.4.0-1, 9.4.0-3, and 9.4.0-5**. These subsystems are grouped in four systems: Traveler, Center, Roadside, and Vehicles.

There are four basic communication media types to support the communications requirements between the subsystems defined for ITS. They are *wireline* (fixed-to-fixed), *wireless wide area* (fixed-to-mobile), *dedicated short range communications* (fixed-to-mobile), and *vehicle-to-vehicle* (mobile-to-mobile). For the I-40 Corridor Short-Term Architecture, only the first three

of these communications modes are required. The top level interconnect diagrams for the short, medium, and long-term deployments are shown in **Figure 9.4.0-2, 9.4.0-4, and 9.4.0-6**. The Center Subsystems and Roadside Subsystems interconnect using wireline communications. The Vehicle Subsystems receive information via wireless (primarily broadcast wireless in the short term architecture). The Roadside Subsystem and the Vehicle Subsystems interconnect using dedicated short-range communications. The Traveler Subsystems initially will connect to the centers via wireline communications, but the possibility exists for some of the devices represented by the Personal Information Access Subsystem to connect via two-way wireless.

Table 9.4.0-1
Short Term Needs Mapped to Market Clusters and Market Packages

Rural Market Cluster	Needs	Market Packages
Tourism and Traveler Information Services	Route, destination information; Tourism, special event information; Travel services information	Broadcast Traveler Information; Interactive Traveler Information
	Traffic, congestion information; Parking information	Interactive Traveler Information
	Traffic reports; Weather information	Traffic Information Dissemination; Broadcast Traveler Information
Infrastructure Operations and Maintenance	Incident detection and notification to motorists	Incident Management; Freeway Operations;
Emergency Services	Improved emergency management; Faster incident response	Emergency Response
Traveler Safety and Security	Collision avoidance	
Commercial Vehicle Operations	Improve safety, efficiency	Fleet Administration
N.A. (not in National Architecture)	Continuing comprehensive, coordinated project planning and evaluation	ITS Planning; Traffic Network Performance Evaluation

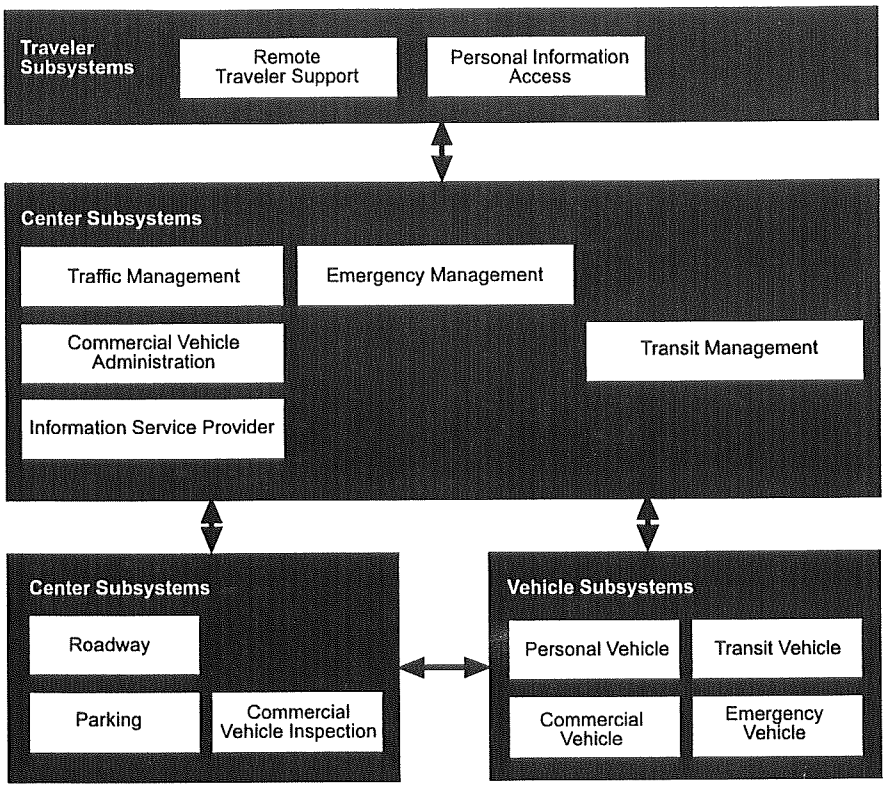


Figure 9.4.0-1 Subsystems of Short-Term Architecture

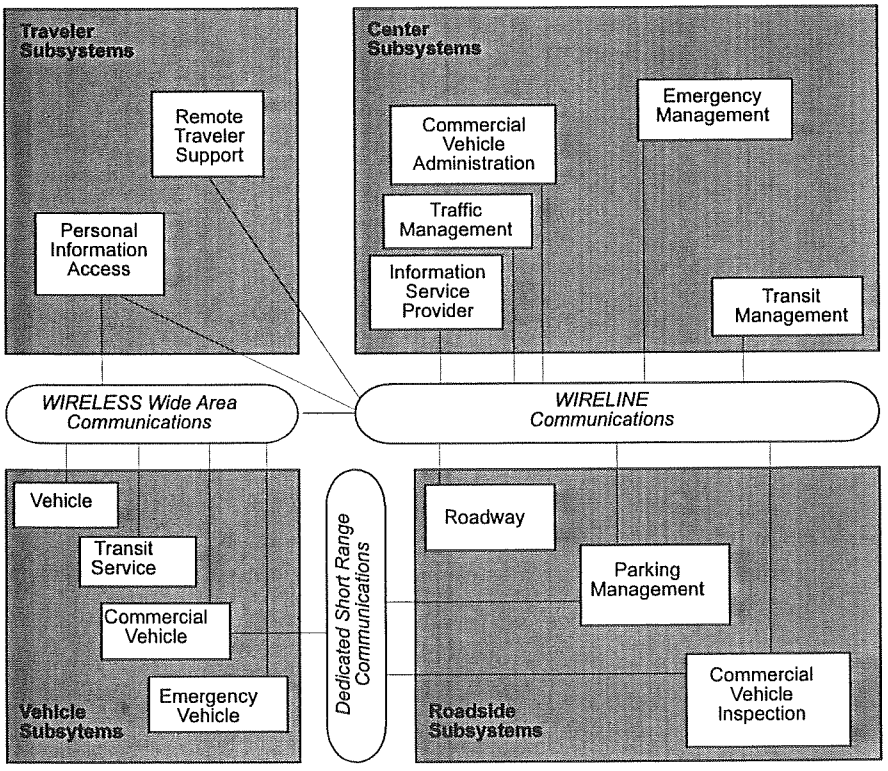


Figure 9.4.0-2 Short-Term Architecture Interconnect Diagram

Table 9.4.0-2
Mid-Term Needs Mapped to Market Clusters and Market Packages

Market Cluster	Need	Market Package
Tourism and Traveler Information Services	Route, destination information; Tourism, special event information; Travel services information	Broadcast Traveler Information; Interactive Traveler Information
	Traffic, congestion information; parking information	Interactive Traveler Information
	Traffic reports; Weather information	Traffic Information Dissemination; Broadcast Traveler Information
Infrastructure Operations and Maintenance	Incident detection and notification to motorists; **Early warning of severe roadway geometry, ice and hydroplaning conditions, falling rock, reduced visibility**	Incident Management; Freeway Operations; **Traffic Control**
Emergency Services	Improved emergency management; Faster incident response **Increase availability of automated emergency notification receivers;** **Improve HAZMAT notification and emergency management enforcement**	Emergency Response; **Emergency Routing** **HAZMAT Management** **MAYDAY Support**
Traveler Safety and Security	Collision avoidance	**Traveler Security** **Highway Rail Intersection** (architecture not yet defined)
Commercial Vehicle Operations	Improve safety, efficiency	Fleet Administration
N.A. (not in National Architecture)	Continuing comprehensive, coordinated project planning and evaluation	ITS Planning; Traffic Network Performance Evaluation

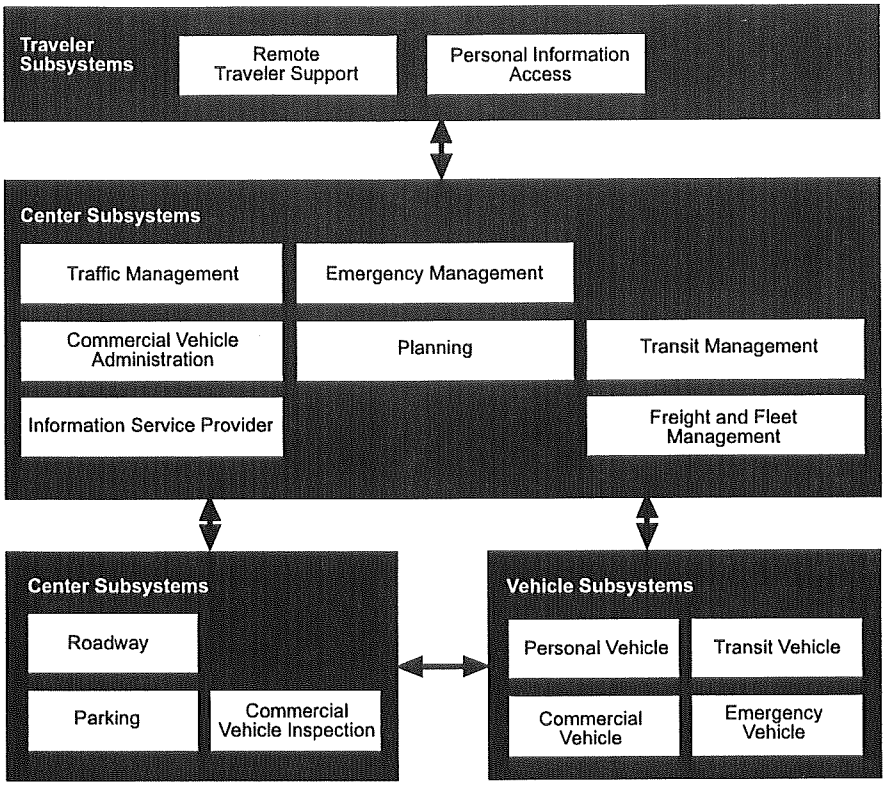


Figure 9.4.0-3 Subsystems of Medium-Term Architecture

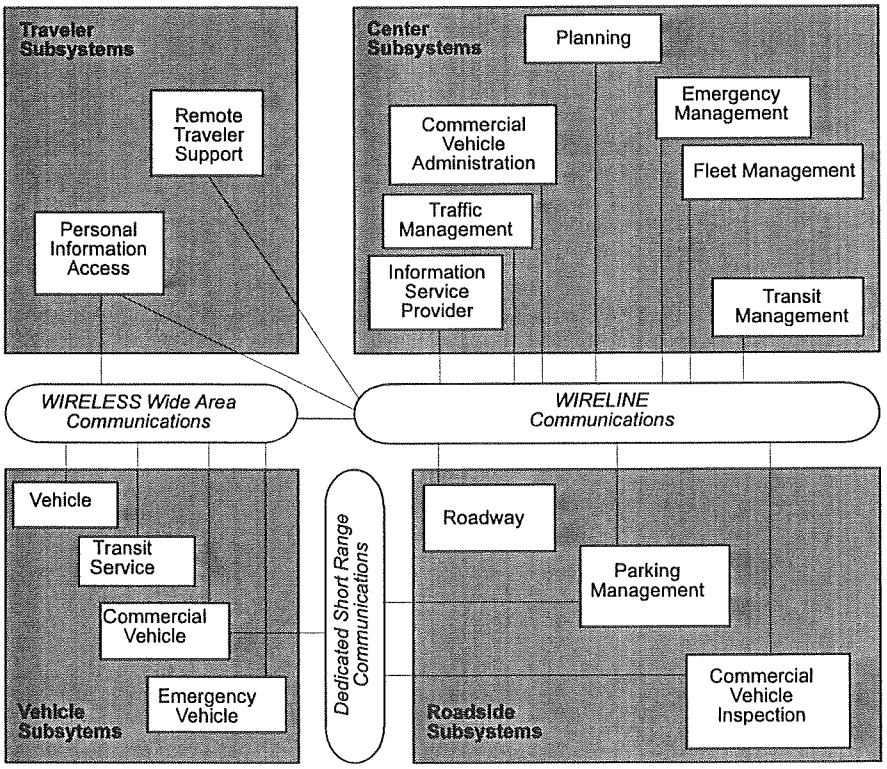


Figure 9.4.0-4 Medium-Term Architecture Interconnect Diagram

Table 9.4.0-3
Long-Term User Needs Mapped to Market Clusters and Market Packages

Market Cluster	Need	Market Package
Tourism and Traveler Information Services	Route, destination information; Tourism, special event information; Travel services information	Broadcast Traveler Information; Interactive Traveler Information; **In-vehicle Signing**
	Traffic, congestion information; Parking information	Interactive Traveler Information; **In-vehicle Signing**
	Traffic reports; Weather information	Traffic Information Dissemination; Broadcast Traveler Information; **In-vehicle Signing**
Infrastructure Operations and Maintenance	Incident detection and notification to motorists; Early warning of severe roadway geometry, ice and hydroplaning conditions, falling rock, reduced visibility; reduced congestion	Incident Management; Freeway Operations; Traffic Control; Surface Street Control
Emergency Services	Improved emergency management; Faster incident response; Increase availability of automated emergency notification receivers; Improve HAZMAT notification and emergency management enforcement	Emergency Response; Emergency Routing; HAZMAT Management; MAYDAY Support
Traveler Safety and Security	Collision avoidance	Traveler Security; Highway Rail Intersection ; **Traffic Surveillance**
Commercial Vehicle Operations	Improve safety, efficiency	Fleet Administration
N.A. (not in National Architecture)	Continuing comprehensive, coordinated project planning and evaluation	ITS Planning; Traffic Network Performance Evaluation
Public Traveler/ Mobility Services	**Improved coordination among modes**	**Multimodal Coordination; Intermodal Traveler Fare Management**

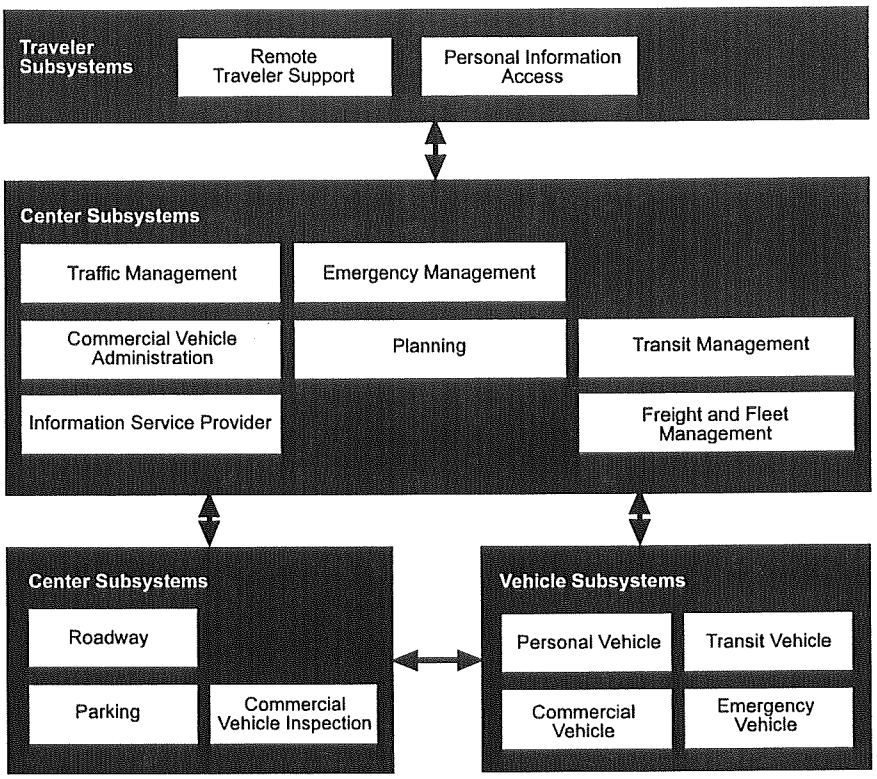


Figure 9.4.0-5 Subsystems of Long-Term Architecture

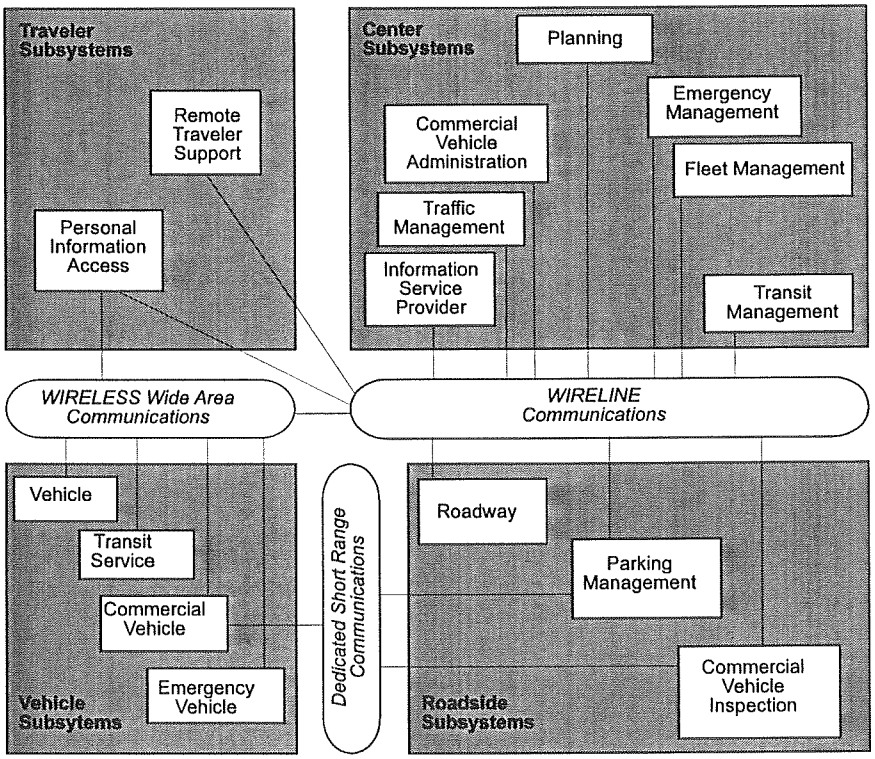


Figure 9.4.0-6 Long-Term Architecture Interconnect Diagram

10.0 ALTERNATIVE TECHNOLOGIES

10.1.0 CANDIDATE TECHNOLOGIES

Table 10.1.0-1 lists the candidate technologies for deployment within the I-40 corridor, grouped by functional areas, functional subsection classifications, and candidate technology nomenclature. Not all of the technologies listed here were selected for deployment in the corridor; however, they are all listed to provide a complete "menu" for future application. The technologies that are recommended for deployment are marked by a " ✓". Further descriptions and ratings of each technology are provided in the full text of the Strategic Plan.

Table 10.1.0-1
Technology Functional Areas and Candidate Technologies

Functional Area	Functional Subsection	Candidate Technologies
Surveillance	Speed/Density/ Volume	✓ Inductive loop detectors ■ Fiber optic loop detectors ■ Video image detection systems (low end) ■ Video image detection systems (medium) ■ Video image detection systems (high end) – includes license plate reading capability ■ Infrared sensors ✓ Acoustic sensors ■ Microwave sensors ■ Radar
	Classification	✓ Inductive loop ■ Video image processing (medium) ■ Video image processing (high) ■ Infrared ■ Acoustic ■ Microwave ■ Strain gauge WIM ✓ Fiber optic WIM
	Weather	✓ Wind direction and speed ✓ Weather sensor systems (ALERT) ✓ Visibility detectors
	Ice on Bridges/Roadway	✓ In-pavement weather condition sensors ■ Video (CCTV) ■ IR ice detection

Functional Area	Functional Subsection	Candidate Technologies
Surveillance	Hazardous Material Spills and Warning	■ Diffusion type electrochemical sensors ■ Infrared gas detectors ■ Video (CCTV) ■ Video image processing ✓ CVO RF intelligent tag (HAZMAT warning)
Communications	Infrastructure-to-Infrastructure (Backbone)	✓ LANs, WANs in communities along the corridor ✓ Synchronous Optical Network (SONET) ✓ Asynchronous Transfer Mode (ATM) ■ Fiber Data Distribution Interface-1 (FDDI-1) ■ Fiber Data Distribution Interface -2 (FDDI-2) ■ DS-X or OC-X digital microwave ■ Non-standard fiber optic links using frequency and time division multiplexing ■ Integrated Services Digital Network (ISDN)
	Infrastructure-to-Infrastructure (Field-to-Backbone)	■ Digital spread spectrum packet radio ■ Digital spread spectrum frequency-hopping packet radio network ■ Point-to-point digital wireless, Serial Control and Data Acquisition (SCADA) ■ Optical transceivers (EIA 232 & 485, DS-1 & -3) ✓ Short-haul microwave ■ Short-haul LASER ■ Video Optical Transceiver (VOTR) Simplex Video with fully-duplexed camera and pan/tilt control ✓ Video 4-channel multiplexer over single-mode fiber ✓ Twisted pair co-axial cable
	Video CODEC/ Infrastructure-to-Infrastructure	■ Video CODECs 1) H.261 5) MPEG-IV 2) H.263 6) JPEG 3) MPEG-I 7) M-JPEG 4) MPEG-II 8) Vector-Horace

Functional Area	Functional Subsection	Candidate Technologies
Communications	Infrastructure-to-Vehicle (One-way)	✓ Advanced Highway Advisory Radio (AHAR) ✓ Broadcast AM/FM radio ✓ Radio Digital Data System (RDDS), Radio Data System (RDS), and subband FM digital ■ Radio Digital Data System (RDDS) AM ✓ VMS (fixed) ✓ VMS (portable)
	Infrastructure-to-Vehicle (Two-way)	✓ Radio frequency toll tags, Radio Frequency Identification (RFID), CVO RF "Intellitag," Advantage Partnership RF tag ■ Infrared optical wavelength communications; ✓ Cellular telephone, AMPS, CDPD, or digital cellular service (DCS) ■ Cellular telephone, Cellular Digital Packet Data (CDPD), or new digital service ■ Land mobile ✓ Personal Communications Service (PCS) ■ Citizens-band radio ■ Private packet network radio, ARDIS, RAM mobile, etc.
	Infrastructure-to-Other Agency	✓ Switched public telephone dial-up ■ Integrated Services Digital Network (ISDN) ✓ Synchronous Optical Network (SONET) interconnects ✓ Cellular telephone voice
	Traveler Safety and Security	■ Emergency roadside telephones ✓ Cellular telephone ■ Mobile radio to central dispatch ■ Citizens band radio ✓ Motorist Assistance Patrols (MAPs) ■ In-vehicle sensors linked to route guidance for reporting position and crash severity to a center ✓ Impact sensors – Fire sensors – Gas leak sensors – Occupancy sensors ■ Manual panic button – request for mechanic services ■ Cellular provided as an additional service

Functional Area	Functional Subsection	Candidate Technologies
Communications	Communications (Infrastructure-to-Vehicle)	✓ Portable signs ✓ Fixed signs ✓ HAR ✓ VMS ✓ In-vehicle route guidance systems ■ Special low-power hazard beacon
Traveler Interface	Pedestrian	■ Pager ✓ AM/FM radio ■ Portable television ✓ Cellular telephone ✓ Kiosk terminal ✓ Personal Digital Assistant (PDA)/digital cellular ■ SMART call box
	Home/Office	✓ Broadcast radio ✓ Broadcast TV ✓ Cable TV ■ Interactive cable TV ■ Computer/modem ■ PDA/modem
	Hotel	■ Interactive hotel TV/video system ■ Visitor Information channel ✓ Kiosk ✓ Broadcast radio ✓ Broadcast TV
	Public Transportation Vehicle	■ Cellular telephone/DCS ■ Broadcast radio receiver (portable) ■ Broadcast TV receiver (portable) ■ PDA ■ Kiosk on bus/train ■ Automated announcement ✓ VMS

Functional Area	Functional Subsection	Candidate Technologies
Traveler Interface	In-vehicle (private)	■ Integrated vehicle information system (part of Route Guidance) ✓ Broadcast radio ■ VMS ✓ Cellular telephone ✓ PDA ■ Paging terminal ■ Pathfinder signs ✓ RF tag (Type III with display) ■ RDDS stand alone terminal
	Commercial Vehicles	■ Same as private vehicle ■ Computer aided dispatching link ■ Call box/SMART call box
Control Strategies	Software/Control Strategy	✓ Conventional ✓ Closed loop ■ UTCS ■ Hybrid ■ Adaptive ■ Dynamic
	Controller Devices	■ NEMA TS-2 ✓ 170 Controller ■ 179 Controller ■ 2070 Controller
	Emergency Vehicle Preemption	■ Manual override ■ Infrared detection systems ■ Optical (flashing light) detection system
Navigation Guidance	Real-time (in-vehicle)	✓ Global Positioning Satellite (GPS) ■ Differential GPS (DGPS) ■ Dead reckoning with GPS update ■ Dead reckoning with sign post update ■ Inertial navigation
	Dispatching Center Oriented	■ Time difference of arrival ■ Direction Finding (DF)/Cross Correlation
	General Guidance	■ Map matching ✓ Cellular phone
	Field Device (alternate route)	✓ Pathfinder Signs ✓ VMS

Functional Area	Functional Subsection	Candidate Technologies
	In-vehicle	■ Data link with communications to "Yellow Page" service center ■ "Yellow Page" database (in-vehicle) ✓ Subband FM one-way communications ✓ Area FM broadcast station
In-Vehicle Sensors	All Vehicle Subsections	✓ Collision avoidance – acoustic obstacle detection, ultrasonic obstacle detection, microwave radar, millimeter wave radar, LIDAR, wide-band radar ✓ Over speed limit, infrastructure-to-vehicle reporting and vehicle-to-driver alarm system identifying violation ✓ Night vision enhancement ✓ Anti-lock brake system (ABS) ✓ Traction control system, anti-wheel spin regulation, road environment sensor, intersection sensors ✓ Restraint system – Infrared sensors, machine-vision sensors, acoustic sensors, heating elements ✓ Magnetic lane control, visual TV lane control, infrared imaging lane control, radar and reflectors
	Commercial Vehicle Operation	■ All technologies above, plus . . . ✓ Steep hill warning (infrastructure-to-vehicle) ■ Acoustic tire wear sensor ✓ Type III toll tag ■ Monitoring mechanical performance of public transit and commercial vehicles. ✓ WIM for overweight enforcement ■ Airbrake pressurization alarm

10.2.0 RECOMMENDED TECHNOLOGIES

This section presents a summary of the technology recommendations in support of the short-term and long-term deployment of ITS within the I-40 corridor. Based on direction from ADOT only two deployment horizons were selected for this summary to facilitate the identification of the immediate deployment opportunities that exist within the corridor. **Table 10.2.0-1** lists these recommended technologies.

Table 10.2.0-1
Summary of Technology Recommendations

Deployment Horizon	Recommended Technologies
Short-term	RWIS VMS Broadcast radio LANs, WANs in communities along the corridor Twisted pair co-axial cable Advanced Highway Advisory Radio (AHAR) Switched public telephone dial-up Cellular telephone voice AM/FM radio Wind direction and speed Weather sensory systems (ALERT) Visibility detectors Portable signs Fixed signs
Long-term	SONET backbone with ATM Acoustic sensors Inductive loop detectors RDDS for FM subband Traveler Information kiosks Client/service TOC architecture Broadcast Radio Terminal Broadcast Radio FM Subband Digital Broadcast TV Cable TV (CATV) Variable Message and Pathfinder Electronic Signs Short-haul microwave Video 4-channel multiplexer over single-mode fiber Radio frequency toll tags, Radio Frequency Identification (RFID), CVO RF "Intellitag", Advantage Partnership RF tag Cellular telephone, AMPS, CDPD, or digital cellular service (DCS) Personal Communications Service (PCS) WIM, including fiber optic Personal Digital Assistant (PDA)/digital cellular

Deployment Horizon	Recommended Technologies
Long Term	RF tag (Type III with display) Closed loop signal systems 170 Controller Global Positioning Satellite (GPS) Subband FM one-way communications Motorist Assistance Patrols (MAPs) Impact Sensors In-vehicle route guidance systems Collision avoidance - acoustic obstacle detection, ultrasonic obstacle detection, microwave radar, millimeter wave radar, LIDAR, wide-band radar Over speed limit, infrastructure-to-vehicle reporting and vehicle-to-driver alarm system identifying violation Night Vision enhancement Anti-lock brake system (ABS) Traction control system, anti-wheel spin regulation, road environment sensor, intersection sensors Restraint system - Infrared sensors, machine vision sensors, acoustic sensors, heating elements Magnetic lane control, visual TV lane control, infrared imaging lane control, radar and reflectors Steep hill warning (infrastructure-to-vehicle)

A summary view of the short and long-term deployments of the recommended technologies within the I-40 corridor are shown schematically on Figures **10.2.0-1** and **10.2.0-2**, respectively.

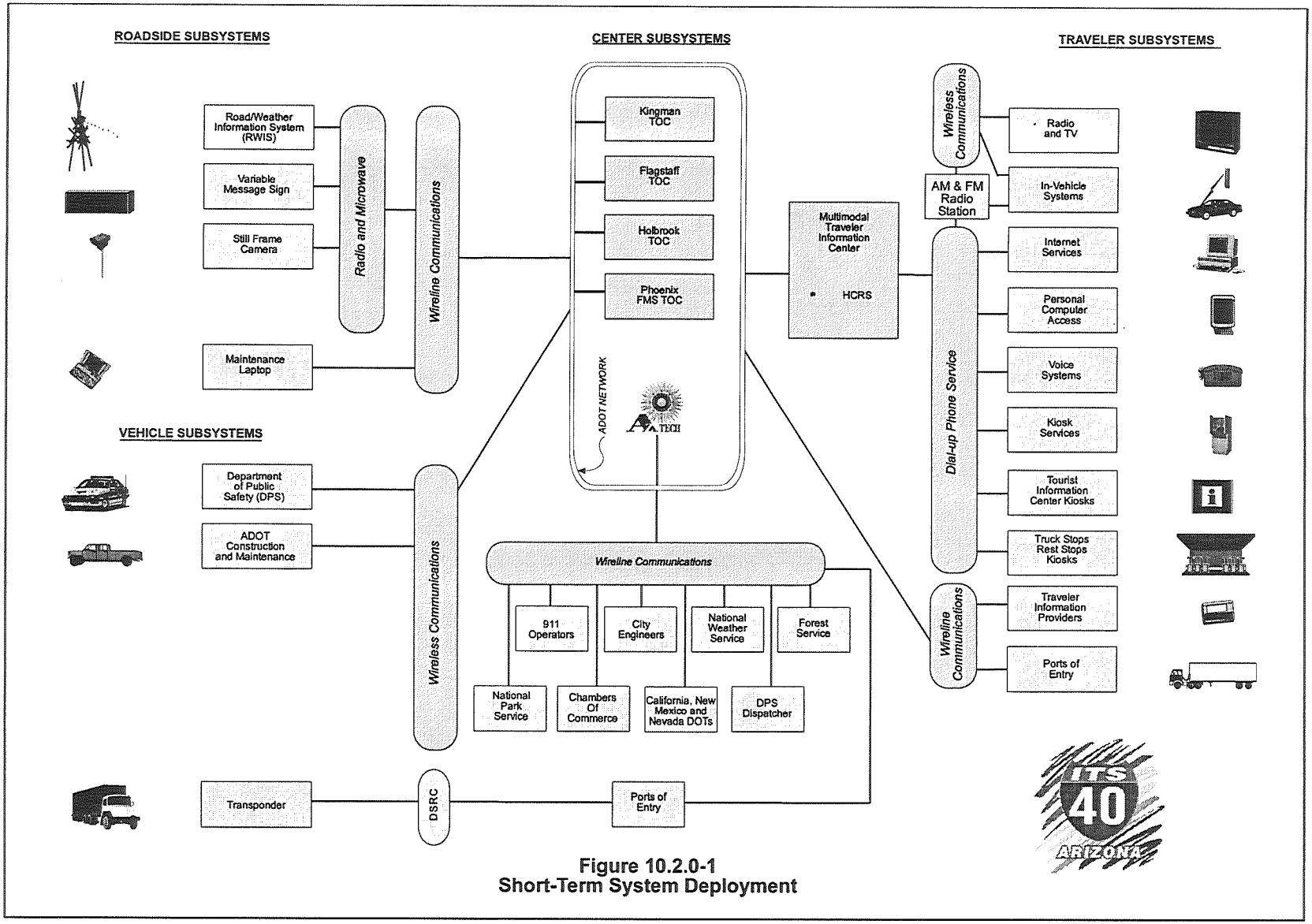


Figure 10.2.0-1
Short-Term System Deployment

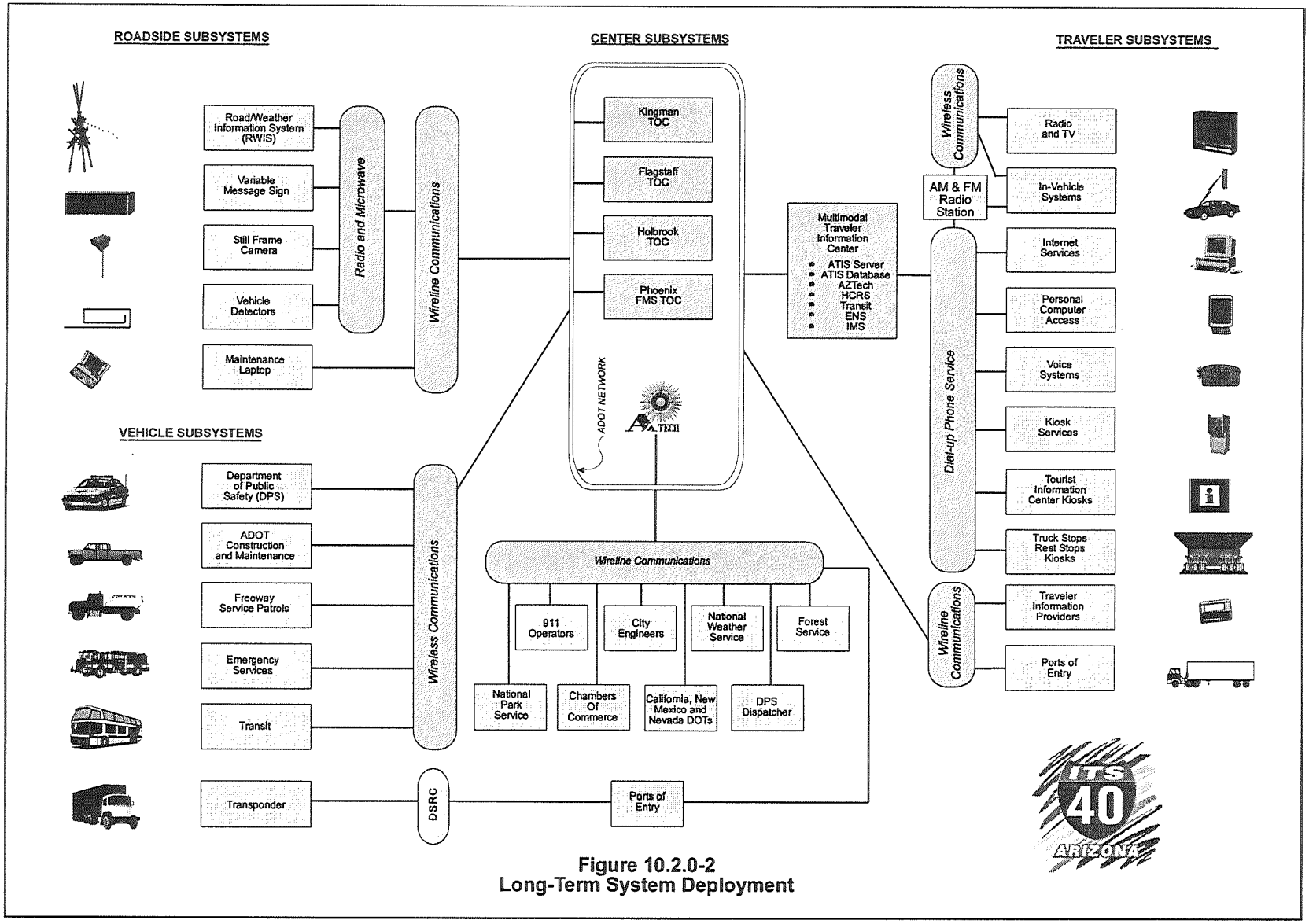


Figure 10.2.0-2
Long-Term System Deployment

11.0 STRATEGIC DEPLOYMENT PLAN

11.1.0 MARKET PACKAGE DEPLOYMENT BY TIME FRAME

In order to focus on the immediate, most critical needs on I-40, the projects have been broken into three phases corresponding to the three deployment horizons: short- mid-, and long-term.

Phase 1:	Short-term 1997-1999
Phase 2:	Mid-term 2000-2005
Phase 3:	Long-term 2006-2010

11.1.1 Phase 1, Short-term Market Packages (immediate through 1999)

Market packages that are recommended for immediate deployment (within the next six months) include:

- Broadcast Traveler Information.
- Interactive Traveler Information.
- Traffic Information Dissemination.
- ITS Planning (continuing process to be integrated with STIP programming).
- Traffic Network Performance Monitoring and Evaluation (also integrated with STIP programming).

These market packages and the technologies that support them comprise the various components of an Advanced Traveler Information System (ATIS). Other market packages that should be implemented within the next two years include:

- Freeway Operations.
- Incident Management.
- Emergency Response.
- Fleet Administration.

These latter four market packages will require more infrastructure and therefore will take a longer deployment time than the Advanced Traveler Information System.

11.1.2 Phase 2, Mid-term Market Packages (2000 - 2005)

Market Packages to be deployed in this time period, in addition to the short-term deployment, include:

- Emergency Routing.
- HAZMAT Management.
- Mayday Support.
- Traveler Security.
- Traffic Control.
- Highway Rail Intersection

11.1.3 Phase 3, Long-term Market Packages (2006 - 2010)

These projects will of course come under further review and an update of the I-40 Strategic Plan will likely occur within the next decade in order to provide more specificity to the additional projects that will be undertaken at that time. Traffic surveillance using various means, including technologies that are non-intrusive and do not require placement in the pavement, will become more commonplace and cost-effective during the next decade. Technologies such as acoustic detectors are recommended for this purpose in the mid-term. Market Packages expected to be deployed during the long-term include:

- Traffic Surveillance.
- Multi-modal Coordination.
- Intermodal Traveler Fare Management.
- In-vehicle Signing.

11.2.0 PROJECTS BY MARKET PACKAGE

11.2.1 Phase 1, Short-Term Deployment

The following projects, listed by market package, are categorized as short-term deployment projects in the I-40 area. These projects are already in the deployment stage by some public or private entities in the region.

Broadcast Traveler Information and Incident Management.

- Variable Message Signs (VMS) - Electronic signs to communicate corridor traffic status, weather information, and to advise alternate routes. Currently being designed for Traffic and Travel Information System at 2 locations on I-40 (EB @ MP 145, WB @ MP 212.5), and NB on I-17 @ MP 297.4 south of Flagstaff.

- FM Traveler Advisory Radio - Provide interface to RDS subsystem of FM radio stations (FM sub-band digital broadcast); and transmission of corridor conditions to in-vehicle route guidance systems.

- Provide interface to other public broadcast media for use and distribution to viewers/listeners: TV, AM and FM radio, and cable TV. Stations should be selected and operated as public private partnership. Request for Partnership Proposal (RFPP).

- Highway Closure and Restrictions System (HCRS). Project currently being deployed by ADOT on entire I-40 corridor. Includes consolidation of ATIS reports from District TOCs and preparation of consolidated information on corridor conditions and hazards.

Interactive Traveler Information

- Highway Closure and Restrictions System (HCRS). Project currently being deployed by ADOT on entire I-40 corridor.

- Voice Remote Access System (VRAS). Provide interface to cellular/DCS telephone management center providing traffic reports. Project currently being deployed statewide by ADOT. Accessible on dial-up 1-800 number.

- Internet. HCRS will be available on the Internet.

- Traveler Information Partnership. RFI for public-private partnership currently being developed by ADOT.

- Public Remote Access System (PRAS). Project currently being deployed statewide by ADOT. Accessible by dial-up line.

- Kiosks subsystem will be deployed by ADOT along I-40.

Traffic Information Dissemination and Emergency Response.

- Roadway Weather Information System (RWIS). Currently being designed for three locations in the Flagstaff District (two on I-17 and one on I-40 @ MP 205 east of Walnut Canyon); and three in the Holbrook District (I-40 @ MP 311.6; SR 87 south of Winslow; and at intersection of SR 377 and 277.

ITS Planning (continuing process to be integrated with STIP programming).

- All projects involved under this market package.

Traffic Network Performance Monitoring and Evaluation (also integrated with STIP programming).

- All projects included under this market package.

- ADOT's Transportation Planning Group will be conducting a "before" and "after" evaluation.

Freeway Operations and Fleet Administration.

- ADOT is seeking truck by-pass technologies to deploy system for trucks equipped with RF tags at all four Arizona Ports-of-Entry, including both ends of I-40.

- Real time coordination for all "smart" corridor controllers by utilizing GPS time base which will further support infrastructure-to-vehicle time base coordination. This is accomplished by real-time coordination between trucking firm dispatching and traffic control and generally includes:

    - GPS time coordination between vehicle and traffic control
    - Accurate vehicle location reporting
    - Knowledge by the dispatcher of congestion locations and duration in order to schedule truck departures by an amount of time that will avoid traffic congestion.

These projects have the endorsement, commitment, and funding stream identified for deployment. One or more agencies and/or private sector firms are already involved in implementation.

11.2.2 Phase 2: Mid-Term Deployment

Phase 2 meets the market packages identified as mid-term, roughly 2000 to 2005. Phase 2 projects grouped by market package are listed below:

Emergency Routing.

- HCRS and VRAS - continued deployment

HAZMAT Management.

- RF tag readers should be deployed at the entrances to the corridor (from all directions) for detection of HAZMAT vehicles.

MAYDAY Support.

- Provide interface to a private security monitoring service (such as Westinghouse Security Services) for monitoring cellular alarms (same as homes) and reporting MAYDAY to associated TOCs and for incident coordination via ATIS link.

- Private users or commercial companies pay security monitoring cost (similar service provided by Ford Motor Company in Lincoln Continentals, in 1997 Cadillacs, and other models).

Traveler Security.

- Installation of surveillance CCTV at selected locations, such as rest areas, to support incident response and enhance security at these locations.

Traffic Control and Highway Rail Intersection.

- Parking management system and transit service to Grand Canyon National Park (GCNP). Feasibility study completed by National Park Service. Recommend project be included as part of regional ITS.

- More projects to be identified as part of continued planning process. Not many specific needs identified to date in this strategic planning process, but the market packages are important and should continue to be considered.

11.2.3 Phase 3: Long-Term Deployment

The next increment in the ultimate build-out of ITS on I-40, roughly in the years 2006 through 2010, is to design, install, integrate and test traffic sensors and real-time traffic information

devices (i.e. additional VMS, other) along the entire length of the I-40 Corridor, thus providing capability for monitoring and control of each corridor segment by the responsible jurisdiction. The following technology should be considered for deployment:

Traffic Surveillance.

- Passive-acoustic detectors along priority sections.
- Integrate controllers on alternate routes (for full incident management capabilities) with communications infrastructure necessary to support the surveillance, monitoring, and control objectives.
- RF tag readers will likely be deployed strategically along major corridors to support the opportunistic use of tag-equipped vehicles as probe vehicles.

Multi-modal Coordination.

- Deployment of RF tag readers in transit vehicles for calibration and verification of public transit vehicles position.

Intermodal Traveler Fare Management.

- Electronic fee collection is expected to be much more common by this era.

In-vehicle Signing.

- Provide roadside infrastructure to support future in-vehicle signing technology as it becomes widely available

Phase 3 complies with core CVO electronic clearance capability and completes the core capability stated as important to ITS success by FHWA for major rural interstate corridors.

11.2.4 Project Deployment Compared with Identified Needs

To demonstrate that the priority projects correspond with the identified priorities placed on the needs of the corridor, the set of market packages in each time period was paired with the needs that would be addressed by each set. The result is shown in **Table 11.2.4-1.**

Table 11.2.4-1
Comparison of Projected Market Packages with Needs

Time Period	**Sets of Market Packages**	**Needs addressed by Market Packages**, assuming deployment of technologies needed (Reference numbers are from **Table 7.2.0-3**)
1997 to 1999	Broadcast Traveler Info. Interactive Traveler Info. Traffic Information Dissemination	2.1 Around the clock traveler information availability 2.2 Avoid accidents due to tourists stopping at wrong places 2.3 Communicate to drivers appropriate locations to stop 2.4 Give motorists travel condition information before the trip 2.5 Easy access to accurate travel information 2.8 Centralize and inform public on where roadway condition information is available 2.9 Reduce congestion at truck stops 2.16 Increase cellular coverage along the I-40 corridor 2.17 Inform motorists where cellular coverage is available 2.18 Increase number of weather stations along the corridor 2.19 More advance notification of detour information 2.25 Provide yellow-pages traveler information via radio 2.26 Make drivers aware of the effects of sun glare 2.33a Improve notifications to drivers at Petrified Forest Welcome Center 2.33b Improve notifications to drivers at Painted Cliffs Welcome Center
	Incident Management Traveler Security Emergency Response	1.1 Address safety concerns due to trucks on grades 1.2 Implement variable speed limit signs based on weather 1.4 Identify routes for drivers on Native American lands 1.5 Prevent accidents between vehicles and bicycles 1.6 Prevent accidents between vehicles and pedestrians 1.8 Improve safety at rest areas 5.1 Improve emergency management in remote areas 6.1 Provide a means to detect emergencies in remote areas 6.2 Reduce congestion caused by high truck volumes 6.3 Provide early warning to drivers about falling rock 6.4 Provide early warning to drivers of reduced visibility, planned burns, smoke, fog, etc.

Time Period	**Sets of Market Packages**	**Needs addressed by Market Packages**, assuming deployment of technologies needed (Reference numbers are from **Table 7.2.0-3**)
1997 to 1999 (cont.)	Incident Management Freeway Operations Traveler Security Emergency Routing	2.6 Central agency to distribute Grand Canyon N.P. visitor information 2.7 Advance warning of congestion spots to general traffic 2.10 Reduce congestion on I-40 2.11 Early warning of congestion at traffic interchanges 2.12 Improve wireless communications infrastructure for travel information, emergency services, etc. 2.13 Provide an alternative to cellular communication 2.14 Improve inter-and intra-agency communications 2.15 Increase number of communications channels 2.20 More signs appropriately placed with ability to change message content 2.21 Real time weather condition information exchange 2.27 Reduce and warn of congestion on I-40 near Flagstaff 2.28 Advance clearance information for overpasses on detour routes 2.41 Provide Northern AZ travel information via rental cars in Phoenix and Las Vegas 2.42 Provide a 1-900 "ENJOYAZ" infomercial line
2000 to 2005	Emergency Routing HAZMAT Management MAYDAY Support Fleet Administration	5.2 Improve HAZMAT notification and emergency management enforcement 2.22 Provide early warning of weather conditions ahead to prevent drivers from being stranded on the road 2.23 Provide easily available, correct visitor information at public places 2.24 Provide weather and roadway condition information at truck stops 2.29 Detect and warn of spot ice of spot ice or hydroplaning conditions 2.30 Automatically detect vehicles with tire chains 2.31 Early warning of severe roadway geometry 2.32 Improve congestion and parking information at interchanges 2.34 Improve reliability of HAR 2.35 Provide alternative forms of tourist information to motorists 2.36 Provide route guidance to visitor information centers

Time Period	Sets of Market Packages	Needs addressed by Market Packages, assuming deployment of technologies needed (Reference numbers are from **Table 7.2.0-3**)
2006 to 2010	Traffic Surveillance Multi-modal Coordination Fare Coordination In-vehicle Signing	2.37 Provide information on congestion status 2.38 Provide travel time information 2.39 Provide travelers with tourist services information 2.40 Detect flooding conditions and provide warning 1.3 Resolve conflict between livestock and vehicles 1.7 Provide counteractions to driver fatigue 1.9 Automatically detect and enforce speeding in winter conditions 1.10 Provide drivers with safe stopping distance information based on conditions (longitudinal detection) 1.11 Warn drivers of insufficient lateral clearance 6.6 Need to detect illegal combinations of chemicals early 3.1 Separate bus traffic from commuter traffic 4.1 Improve efficiency of heavy vehicles on upgrades 4.2 Reduce incidents and accidents due to conflicts between trucks and RVs 4.3 Reduce long truck stops at POEs by improving POE throughput 4.4 Reduce the speed differential in the traffic stream 4.5 Eliminate heavy truck traffic from interchanges not designed to accommodate them

11.3.0 ADOT RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE PLAN

A number of ITS - related projects have already been scheduled for deployment within the I-40 corridor. The deployed technologies will include Road Weather Information Systems (RWIS), Variable Message Signs (VMS), traffic control systems, CCTV, and information kiosks. Each project will build upon the capabilities of the other related projects and infrastructure. These projects are presented with their respective time of deployment, but are seen as continuing projects that will constitute major ITS efforts in the three ADOT districts for the foreseeable future. These projects are listed in **Table 11.3.0-1**:

Table 11.3.0-1
ADOT Rural Intelligent Transportation Infrastructure Plan

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II									
FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
97	1	Flagstaff	VMS	I-17 @ MP 297	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS	I-40 EB @ MP 145	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS	I-40 WB @ MP 213	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	RWIS	I-17 @ MP 307	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	RWIS	I-17 @ MP 314	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	RWIS	I-40 @ MP 206	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS	I-40 @ MP 312	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS	SR87 @ MP 291	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS	SR377 @ SR277	$50,000.00	0.4	$20,000.00	$70,000.00	
								1,260,000.00	
							FY97 TOTAL:		$1,260,000.00
98	2	Flagstaff	VMS	I-40 WB @ MP 167	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS	I-40 WB @ MP202	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS	I-40 EB @ MP 190	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS	I-17 SB @ MP 339	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	RWIS	I-40 @ MP 270	$100,000.00	0.4	$40,000.00	$140,000.00	
		Holbrook	VMS	I-40 WB @ MP 357	$200,000.00	0.4	$80,000.00	$280,000.00	
								1,540,000.00	
							FY98 TOTAL:		$1,540,000.00
99	3							$-	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
99	4	Holbrook	VMS-38	I-40 EB Holbrook	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-42	I-40 WB Sanders	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-52	I-40 WB Winslow	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	RWIS-29	SR77 S. Holbrook	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-39	SR264 @ Ganado	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-40	SR264 @ Keams Cyn	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-43	US160 @ Tuba City	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-46	US64 @ Teec Nos Pass	$50,000.00	0.4	$20,000.00	$70,000.00	
		Kingman	VMS-73	I-40 WB @ Ash Fork	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-76	I-40 EB @ US93	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	RWIS-52	SR66 @ Peach Spr.	$50,000.00	0.4	$20,000.00	$70,000.00	
								$1,820,000.00	
							FY99 TOTAL:		**$1,820,000.00**
00	5	Flagstaff	RWIS-47	SR89 N. Flagstaff	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	RWIS-48	SR64 N. Williams	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	RWIS-49	I-17 S. Flagstaff	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	RWIS-50	I-17 @ Stoneman Lake	$50,000.00	0.4	$20,000.00	$70,000.00	
		Flagstaff	VMS-60	SR89 @ Dead Mans Fl	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-40	I-40 EB @ SR77	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-41	I-40 WB @ SR77	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-77	I-40 WB @ US93	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-78	I-40 EB @ US93	$200,000.00	0.4	$80,000.00	$280,000.00	
								$1,680,000.00	
00	6							**$-**	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
00	7							$-	
							FY00 TOTAL:		$1,680,000.00
01	8	Holbrook	VMS-46	EB US160 @ US191	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-48	WB US160 @ US191	$200,000.00	0.4	$80,000.00	$280,000.00	
								$560,000.00	
01	9							$-	
01	10							$-	
							FY01 TOTAL:		$560,000.00
02	11	Holbrook	RWIS-30	I-40 @ Sanders	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-31	I-40 @ New Mexico Ln	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-32	I-40 West of Sanders	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-33	I-40 W. of Holbrook	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-34	I-40 E. of Winslow	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-35	I-40 W. of Winslow	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-36	SR87 S. of Winslow	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	VMS-53	EB I-40 @ Winslow	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-49	WB US160 @ POE	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-56	I-40 @ I-17	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-57	I-40 @ I-17	$200,000.00	0.4	80,000.00	$280,000.00	
		Flagstaff	VMS-58	I-17 @ I-40	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-59	I-17 @ I-40	$200,000.00	0.4	$80,000.00	$280,000.00	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
		Flagstaff	VMS-65	WB I-40 @ SR64	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-67	EB I-40 @ SR64	$200,000.00	0.4	$80,000.00	$280,000.00	
								$2,730,000.00	
02								$-	
							FY02 TOTAL:		**$2,730,000.00**
03	12	Kingman	VMS-72	EB I-40 @ SR89	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-75	WB I-40 @ US93	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-79	SB US93 @ I-40	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	RWIS-51	I-40 @ SR89	$50,000.00	0.4	$20,000.00	$70,000.00	
		Kingman	RWIS-53	I-40 @ US93	$50,000.00	0.4	$20,000.00	$70,000.00	
		Kingman	RWIS-55	US93 N. of Kingman	$50,000.00	0.4	$20,000.00	$70,000.00	
								$1,050,000.00	
03	13							$-	
03	14							$-	
03		Holbrook	TSS-10	Winslow	$100,000.00	0.4	$40,000	$140,000.00	
								$140,000.00	
							FY03 TOTAL:		**$1,190,000.00**
04	15							$-	
04	16							$-	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
04		Flagstaff	TSS-13	Flagstaff	$100,000.00	0.4	$40,000	$140,000.00	
		Kingman	TSS-17	Kingman	$100,000.00	0.4	$40,000	$140,000.00	
								$280,000.00	
							FY04 TOTAL:		**$280,000.00**
05	17	Holbrook	VMS-43	WB SR264 @ POE	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-44	NB US191 @ Chinle	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-45	SB US191 @ Chinle	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	CCTV-4	Holbrook	$35,000.00	0.4	$14,000.00	$49,000.00	
		Holbrook	CCTV-5	Winslow	$35,000.00	0.4	$14,000.00	$49,000.00	
		Holbrook	CCTV-6	Sanders POE	$35,000.00	0.4	$14,000.00	$49,000.00	
								$987,000.00	
05	18							**$-**	
05	19	Kingman	VMS-74	NB US93 @ I-40	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-80	SB US95 @ Hoover Dm	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-81	EB US95 @ Cal. Ln	$200,000.00	0.4	$80,000.00	$280,000.00	
								$840,000.00	
05								**$-**	
							FY05 TOTAL:		**$1,827,000.00**
06	20	Flagstaff	VMS-61	WB US160 @ SR89	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-63	WB US180 @ SR64	$200,000.00	0.4	$80,000.00	$280,000.00	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
		Flagstaff	VMS-64	NB SR64 @ US180	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	CCTV-10	Flagstaff	$35,000.00	0.4	$14,000.00	$49,000.00	
								$889,000.00	
06	**21**							**$-**	
06								**$-**	
							FY06 TOTAL:		**$889,000.00**
07	**22**	Flagstaff	VMS-68	WB I-40 @ SR89	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-69	NB SR89 @I-40	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-70	EB I-15 @ VRG	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-71	WB I-15 @ VRG	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-66	SB SR64 @ I-40	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VMS-62	SR89 @ POE	$200,000.00	0.4	$80,000.00	$280,000.00	
		Flagstaff	VDS-10	Flagstaff	$5,000.00	0.4	$2,000.00	$7,000.00	
		Flagstaff	Kiosk-31	WB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-28	EB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk35	SB US89 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-30	SB SR65 @ GCNP	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-27	WB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-29	SB US89 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-32	EB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-33	SB I-17 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Flagstaff	Kiosk-34	NB I-17 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Holbrook	VMS-39	WB I-40 @ SR77	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-47	NB US191 @ US160	$200,000.00	0.4	$80,000.00	$280,000.00	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
		Holbrook	VMS-50	SB US163 @ POE	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-51	SB US163 @ Kayenta	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-58	DE ADD ON	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	VMS-59	DE ADD ON	$200,000.00	0.4	$80,000.00	$280,000.00	
								$3,682,000.00	
07		Kingman	TSS-18	Lake Havasu City	$100,000.00	0	$-	$100,000.00	
								$100,000.00	
							FY07 TOTAL:		**$3,782,000.00**
08	**23**	Holbrook	VMS-60	DE ADD ON	$200,000.00	0.4	$80,000.00	$280,000.00	
		Holbrook	CCTV-7	POE	$35,000.00	0.4	$14,000.00	$49,000.00	
		Holbrook	CCTV-8	POE	$35,000.00	0.4	$14,000.00	$49,000.00	
		Holbrook	CCTV-9	MP 436; US160	$35,000.00	0.4	$14,000.00	$49,000.00	
		Holbrook	VDS-4	Holbrook	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	VDS-5	Winslow	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	VDS-6	POE	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	VDS-7	POE	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	VDS-8	POE	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	VDS-9	MP 436; US160	$5,000.00	0.4	$2,000.00	$7,000.00	
		Holbrook	RWIS-37	SR77	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-38	SR264 @ Window Rock	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-41	SR264 W. of Orabi	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-42	SR264 E. of Tuba City	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-44	US160 E. of Kayenta	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	RWIS-45	US160 @ US191	$50,000.00	0.4	$20,000.00	$70,000.00	
		Holbrook	Kiosk-24	WB I-40 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
		Holbrook	Kiosk-25	WB264 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
		Holbrook	Kiosk-26	WBUS160 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
		Kingman	VMS-82	EB SR95 @ POE	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	VMS-83	NB US93 @ SR97	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	RWIS-54	I-40 E. of Kingman	$50,000.00	0.4	$20,000.00	$70,000.00	
		Kingman	CCTV-11	Kingman	$35,000.00	0.4	$14,000.00	$49,000.00	
		Kingman	VDS-11	Kingman	$5,000.00	0.4	$2,000.00	$7,000.00	
		Kingman	ES-1	WB I-40 @ MP87	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	ES-2	EB I-40 @ MP87	$200,000.00	0.4	$80,000.00	$280,000.00	
		Kingman	Kiosk-36	EB I-40 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
		Kingman	Kiosk-37	WB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Kingman	Kiosk-38	EB I-40 @ Rest Area	$25,000.00	0.4	$10,000.00	$35,000.00	
		Kingman	Kiosk-39	EB I-40 @ POE	$25,000.00	0.4	$10,000.00	$35,000.00	
								$2,380,000.00	
08	**24**							**$-**	
08		Holbrook	TSS-9	Holbrook	$100,000.00	0.4	$40,000	$140,000.00	
		Holbrook	TSS-11	Chinle	$100,000.00	0.4	$40,000	$140,000.00	
								$280,000.00	
							FY08 TOTAL:		**$2,660,000.00**
09	**25**							**$-**	
09		Holbrook	TSS-12	Kayenta	$100,000.00	0	$-	$100,000.00	
								$100,000.00	
							FY09 TOTAL:		**$100,000.00**

RURAL INTELLIGENT TRANSPORTATION INFRASTRUCTURE V.II

FY	PHASE	DISTRICT	ID #	DESCRPTION	COST	D;CE;CON	SUB	TOTAL	
10	26							$-	
							FY10 TOTAL:		$-

FISCAL YEAR ANALYSIS

	FY	Phases					# Locations		
	97	1		$1,260,000.00			9		
	98	2		$1,540,000.00			6		
	99	3; 4		$1,820,000.00			11		
	00	5;6;7		$1,680,000.00			9		
	01	8;9;10		$560,000.00			2		
	02	11		$2,730,000.00			15		
	03	12;13;14		$1,190,000.00			6		
	04	15;16		$280,000.00			2		
	05	17;18;19		$1,827,000.00			9		
	06	20;21		$889,000.00			4		
	07	22		$3,782,000.00			22		
	08	23;24		$2,660,000.00			32		
	09	25		$100,000.00			1		
	10	26		$-			-		
				$20,318,000.00			128		

11.3.1 I-40 Corridor-Wide Projects

In addition to the projects listed in the "Arizona Statewide Plan for an Intelligent Transportation Infrastructure", the recommended Corridor-Wide strategic projects focus on traveler and tourist information, corridor-wide coordination, and traveler safety. They include the following:

- ITS Planning, Performance Monitoring, and Evaluation.
- Multi-modal I-40 Traveler Information System.
- Incident and Resource Management Coordination.
- Emergency Notification System.
- Communications Enhancements.
- Travel Information Radio.
- Enhanced Web Page.

11.3.1.1 ITS Planning, Performance Monitoring, and Evaluation

ITS ongoing strategic planning, performance monitoring, and evaluation objectives entail collecting the statistical volume, classification, and speed data required for ADOT and FHWA strategic planning and annual reporting.

11.3.1.2 Multimodal I-40 Traveler Information System

The purpose of the Multimodal I-40 Traveler Information System is to provide critical traveler and tourist information. This will serve to accumulate and disseminate the corridor information developed from other projects. This project will develop the infrastructure to provide information via telephone, Internet, VMS and in-vehicle devices.

11.3.1.3 Incident and Resource Management Coordination (Project Corr-10)

The purpose of the Incident and Resource Management Coordination System is to provide coordination of the incident management and resource management functions in the corridor. This system will facilitate sharing of real-time data between the District TOCs.

11.3.1.4 Emergency Notification System

The purpose of the Emergency Notification System is to facilitate providing emergency notification to authorities by the vehicle operator. Since this is still an emerging technology, it is recommended that the current project focus on a study of how to integrate the Emergency Notification System into the corridor emergency management procedures.

11.3.1.5 Communications Enhancements

Additional capability is needed to transmit voice and data via microwave transmitters from TOC to TOC throughout the I-40 corridor, and voice and data (and selected video) from each of the three TOCs in the corridor to the Phoenix TOC.

11.3.1.6 Advanced Traveler Information Radio

A minimum of three FM radio stations need to be equipped with FM sideband transmitters to send traffic messages to vehicles equipped with receivers. These types of receivers will be coming on-line in selected models in the near future and will ultimately be standard equipment on most vehicles.

11.3.1.7 Enhanced Web Page

A common, supplemental traffic and travel advisory home page will be developed and made available to selected home pages of agencies and organizations in the corridor. Those that are expected to subscribe to this supplement would include the Grand Canyon National Park and local communities with home pages throughout the corridor.

12.0 MANAGEMENT AND OPERATIONS PLAN

The Strategic Plan recommended in chapter 11 for the I-40 corridor is based on a common architecture, but leaves individual stakeholders free to pursue an integrated set of incremental projects. Individual stakeholders that will lead deployment efforts include ADOT, FHWA, local governments, travel and tourist industry, trucking companies, DPS, NPS, NWS, travel information providers, and others.

Project Management Structure
■ I-40 ITS Coalition ■ I-40 ITS Management Team ■ Early Action Team ■ Partnerships for ITS Deployment

The recommendations contained in this section are for the ultimate build-out of ITS components in the I-40 Corridor. There is **no** implication that all of these components apply to projects that are recommended for short-term deployment. Short-term projects are recommended based on short-term needs as identified in Chapter 11, as are projects that will take a longer time to fund, design, and deploy. This Management and Operations Plan includes the following recommendations:

- Adoption of the common architecture outlined in Chapter 9 supporting incremental build-out of ITS capabilities and services.

- Field infrastructure upgrades to support needed sensor information to determine weather information on the corridor, plus rapid detection and response to incidents.

- Integrated TOCs in each of the three ADOT Districts, to control response to incidents on the freeway and other state highways, assist local jurisdictions in emergency response, and be a sub-regional clearinghouse for traveler information.

- A Multimodal I-40 Traveler Information Center to provide needed processing hardware, software, and display equipment to support field infrastructure upgrades. This center should be established near the middle of the Arizona I-40 corridor in Flagstaff.

- Implementation of a communications infrastructure as outlined in the ***ADOT Strategic Plan for Communications.*** This element should include upgrading the current communications backbone to support interoperability between TOCs in the region, as well as the Phoenix TOC. It should support improvements in information to the traveler and tourist information system, commercial vehicle management, public transportation, and other components. Development of a detailed communications plan for the I-40 corridor based on the Statewide Communications Protocol is recommended.

- Interoperability between traffic management systems in various local jurisdictions in a district. District TOCs are recommended to provide commonality among traveler information and incident management functions.

- Interoperability between communications systems in New Mexico and California transportation department districts in the corridor from Albuquerque to Bakersfield should be established.

It is recommended that this rural corridor extend beyond Barstow to Bakersfield in order to connect with the San Joaquin Valley ITS corridor and ultimately with the San Bernardino ITS system. The latter will ultimately connect to Barstow from the southwest. Each phase of the I-40 Strategic Plan will provide a building block which, upon completion, will meet the consensus needs of Arizona's I-40 transportation system.

12.1.0 BUSINESS PLAN FOR DEPLOYMENT

The objective of preparing a business plan and management structure is to establish a framework for policy, process, and action among the public and private jurisdictions involved. By establishing a management structure, the interest and involvement of the coalition created for the development of the Strategic Plan for Early Deployment of ITS Technologies in I-40 Corridor will continue. This interest must continue in order for deployment of the technologies to become a reality.

12.1.1 Plan Oversight: I-40 ITS Coalition

During the development of the I-40 Strategic Plan, the Coalition met regularly to receive updates on the status of the plan development and to offer their input and to review the deliverables from the study. The interaction of this Coalition brought about a strengthening of the coalition of governmental agencies and private entities active in the I-40 Corridor. These public and private agencies and, in particular, the individuals representing them, are an excellent cross-section of the stakeholders with interest in developing a better transportation system for the I-40 Corridor. It is suggested that the present Coalition be expanded and continue to function as the oversight and policy guidance body of the deployment plan.

A second function of the Coalition should be to review new technologies and new concepts, as they become available, and to determine if any changes are needed in this Strategic Plan. The Coalition should work directly with ADOT and other state and federal agencies in order to respond to questions or issues dealing with direction, funding, administration, deployment, and operation and maintenance of ITS projects as they come on-line.

12.1.2 I-40 ITS Management Team

The management structure is a significant element of any corridor-wide plan. A management team, made up of dynamic individuals from the sponsoring agencies, needs to be created to serve as the foundation for project implementation. As the Strategic Plan is further developed into specific tactical plans with funding secured and implementation proceeding ahead, a flexible approach should be maintained by the management team.

It is therefore suggested that an ITS Management Team be formed to deal with day to day execution of the I-40 ITS Strategic Plan. It is suggested that this Management Team be chaired by a "champion" of ITS for the region, one the Coalition feels has the energy and desire to see the deployment plans carried out and who is in a strong position to influence funding priorities for the corridor.

Due to the anticipated complex logistics of the deployment issues, it is recommended that the Management Team create an executive group within the team, designed to deal with important policy issues and resolve issues that cannot be resolved at the project management level. Initially, it is recommended that this Executive Committee consist of the three ADOT District Engineers and Transportation Technology Group Manager, and a comparable manager from the Department of Public Safety.

12.1.3 Early Action Team

A third element of the management structure consists of an Early Action Team. This component of the I-40 ITS Coalition consists of the elected officials who have participated in the Project Steering Committee, plus appropriate staff of the Arizona Department of Transportation, Department of Public Safety, local governments (cities and counties), private industry, and other entities that are or should be involved in the ATIS project. This Early Action Team is envisioned as the "champion" to carry the Phase 1 ATIS projects into the State Transportation Improvement Program (TIP) process. The development of the projects and presentation to the TIP process would be supported by the ITS management team, previously discussed.

12.1.4 Partnerships for ITS Deployment

Arizona has a history of successful ITS partnerships. For example, RAPID, the RBDS deployment project in Maricopa County, is a public-private partnership of the ADOT Phoenix TOC, private airborne traffic reporters (Metro Networks and Skyview Traffic), FHWA, and other ITS technology vendors. Traffic information collected from several sources is coded and sent via modem to be broadcast from an FM radio station to an innovative kiosk developed by another partnership. Data is made available to the public at these kiosks and through in-vehicle GPS monitoring devices, such as the Volvo Dynaguide. The Phoenix area was selected by the FHWA to be funded as a Model Deployment Initiative site to showcase ITS deployment. Private partners are included in the initiative to package and distribute traveler information. The partnership includes ETAK, the supplier of the street and highway database, TRW, and Scientific Atlanta.

Another type of partnership is the MAGIC project, a coalition of ADOT, Maricopa County, the cities of Chandler, Gilbert, Glendale, Mesa, Paradise Valley, Peoria, Phoenix, Scottsdale, and Tempe, and RPTA. Partnerships developed through the Early Deployment Plans in these areas have been beneficial in supporting innovative initiatives and encouraging actual deployment of projects. Partnerships are also recommended for the Northern Arizona/ I-40 ITS corridor.

The fourth public-private partnership in Arizona is the Expedited Passing at International Crossings (EPIC) project in Nogales. EPIC, which is currently underway, will expedite the processing of commercial vehicles at the Nogales port of entry.

12.2.0 MANAGEMENT STRUCTURE FOR OPERATION AND MAINTENANCE

The Coalition was instrumental in working with the consulting team to identify appropriate responsibilities and involvement by various organizations is shown in **Table 12.2.0-1**.

Table 12.2.0-1
Coalition Organizations with Responsibility for ITS Deployment

Market Packages for Deployment	Responsible Organizations and Potential Partners *
Travel Information Dissemination	ADOT/FHWA * Information Service Providers (Internet, radio, TV, cable, telephone) local governments Department of Public Safety (DPS)
Incident Management	DPS * EMS operators and managers ADOT/FHWA railroads local governments corridor attractions tow truck industry
Interactive Travel Information	Local governments (municipal, county, tribal) * Tourist industry (AAA, other) * Traffic information providers * AZ Office of Tourism U.S. Forest Service (USFS) ADOT/FHWA adjoining states (CA, NM) National Weather Svc. (NWS) all transit services National Park Service (NPS) trucking companies DPS corridor attractions
Broadcast Traveler Information	ADOT/FHWA * Federal Communications Commission (FCC) Local governments all transit NWS tourist industry DPS traffic information providers all broadcast media corridor attractions NPS ITS equipment vendors adjoining states
Traveler Security	DPS * railroads private security companies all media ADOT/FHWA NPS Local governments USFS
Emergency Routing	Local governments (EMS/ 911 Operator) * ADOT (TOCs) visitor centers DPS towing industry NPS USFS
HAZMAT Management	DPS * trucking companies ADOT/FHWA railroads HAZMAT teams Dept. of Environmental Quality (DEQ)
Emergency Response	DPS * cellular industry Local governments * all media ADOT/FHWA ITS equipment vendors NPS, USFS towing industry
MAYDAY Support	DPS * cellular industry ADOT/FHWA ITS equipment vendors adjoining states all media FCC
Freeway Operation	ADOT/FHWA * adjoining states DPS * corridor attractions
ITS Planning	ADOT/FHWA * other participants in the I-40 ITS Coalition
Traffic Network Performance Monitoring and Evaluation	ADOT * Northern Arizona University local governments NACOG, WACOG NWS DPS

Market Packages for Deployment	Responsible Organizations and Potential Partners *	
Traffic Surveillance	ADOT/FHWA * DPS local governments	transit (bus, tour bus and shuttle companies) trucking companies traffic information provider
Highway Rail Intersection	ADOT* local governments railway companies	
Fleet Administration	ADOT* trucking companies tour bus companies	traffic information providers
Traffic Control	ADOT* local governments	
In-vehicle Signage	ADOT/FHWA*	vehicle manufacturers* traffic information providers
Intermodal Traveler Fare Management	local governments transit	
Multimodal Coordination	local governments transit*	railroads tour bus companies

* NOTE: The first organization(s) listed in each partnership (and identified with an asterisk *) are the most likely lead organization for deployment, operation and maintenance, for projects within each market package.

In general, the organization that is responsible for building a system or having ownership of the system is the organization responsible for operation and maintenance (O&M). Obviously, an owner can contract out any services that are needed, in situations where cost advantages or the availability of individuals with special skills are needed, and are not available to a system owner/ builder. Such has been the case with some aspects of public-private partnerships to build, operate and maintain ITI features.

12.3.0 COSTS AND BENEFITS

12.3.1 Cost Estimates for I-40 ITS Corridor

Table 12.3.1-1 is a rough order of magnitude estimate for the costs that would be required to provide basic communications and ITS infrastructure for the system. These estimates are based on the definitive work on communications for ITS elements, NCHRP Project Report 3-51, prepared by Kimley-Horn for the National Cooperative Highway Research Program. Costs are based on an assumed microwave linkage between TOCs in the corridor, plus coverage of the entire 580-km length of I-40. It does not account for costs of integrating local systems but serves as an estimate of the public costs to ADOT for deploying the basic ITS infrastructure for the I-40 ITS Corridor.

Table 12.3.1-1
15-Year Deployment Costs for Basic Intelligent Transportation Infrastructure in the I-40 Corridor

Item	Quantity	Unit Price	Estimated Corridor Cost	Subtotals
Communications Infrastructure				
10/11 GHz microwave OC-3 backbone links	4	$ 400,000	$ 1,600,000	
SONET Field Multiplexers	3	LS	$ 33,000	
TOC Multiplexers	3	LS	$ 62,000	
EIA-232 SMFO Transceivers	3	LS	$ 23,000	
Video Communications	8	LS	$ 158,000	
Installation and testing	lump sum	LS	$ 100,000	
COMMUNICATIONS SUBTOTAL				$ 1,986,000
Field Hardware/ Software				
Controllers	15	$ 7,500	$ 112,500	
Variable Message Signs	55	$ 200,000	$ 11,000,000	
Video cameras	8	$ 15,000	$ 120,000	
Traveler Information Kiosks	30	$ 25,000	$ 750,000	
Ports-of-Entry	9	$ 200,000	$ 1,800,000	
Other Weigh-in-Motion	23	$ 50,000	$ 1,150,000	
Traffic Operation Center	3	$ 200,000	$ 600,000	
Road Weather Information System	34	$ 100,000	$ 3,400,000	
Elk crossing signs	2	$ 30,000	$ 60,000	
Traffic Signal Coordination	7	$ 100,000	$ 700,000	
HW/SW SUBTOTAL				$ 19,692,500
SUBTOTAL ITI CAPITAL COSTS				**$ 21,678,500**
Design, Contingency, Construction Engineering, Operation & Maintenance	@ 40% of capital costs			**$8,671,000**
TOTAL ITI Costs				**$30,349,500**

Using the data shown in **Table 12.3.1-1**, it is estimated that the public costs of developing the field infrastructure and the three TOCs in the corridor would be approximately $30 million (1996 dollars) over the next 15 to 20 years. This estimate represents a "first cut estimate" of the major public intelligent infrastructure envisioned. Assuming a 15-year build-out, this would be about $2 million per year.

The communications infrastructure costs are based on adding new equipment at the four ADOT radio towers along I-40, three TOCs to be instrumented with SONET field multiplexes and 11 sites along I-40 requiring communications equipment.

Using the data in the "*ADOT Statewide Plan: Intelligent Transportation Infrastructure*," September 1996, and input from the I-40 ITS Coalition meeting on December 9, the following number of installation locations are assumed for the I-40 corridor. For this purpose, all of Northern Arizona is counted as a part of the study area, roughly north of a line from Prescott to Show Low. The number of individual locations projected for this region are as follows:

ITI Equipment	Number of locations
Travel information kiosks	30
CCTV	8
POE	9
WIM (other than POE)	23
RWIS	34
Elk signs	2
Railroad crossings	TBD
Traffic signal synchronization	7
VMS locations	55

In addition to the basic ITS infrastructure for I-40, there are other project costs, which are presented in **Table 12.3.1-2**. In addition to the $30 million for the basic ITS Infrastructure, the cost of the other projects total $16 million for a total of $46 million.

The cost estimate is for public Intelligent Transportation Infrastructure (ITI) only. No estimates are available at this time for the cost of cellular or digital communications service (DCS) phone coverage, nor for equipment to handle 1-800 travel advisory numbers or MAYDAY calls. The more significant (and higher) public costs for these systems will be in the operation and maintenance areas, which is estimated as an additional one percent of annual O&M.

Although no definitive studies have been made to suggest the level of private funding anticipated in rural areas specifically, estimates up to 2.5 times the public investment have been made for overall private ITS technology deployment. Using a more conservative multiplier of 2.15, it might be assumed that the prorated private investment in ATIS, AVCS, and CVO technologies in Northern Arizona could total $100 million, or an overall total of about $143 million public and private investment over the next 15 years. It is interesting to note that this total compares with a total investment in capital and operation of the ITI in metropolitan Phoenix of about $285 million through 1997 (ref. ***AZTech: Model Deployment Initiative for the Phoenix Metropolitan Area,*** ADOT, April 1996).

Table 12.3.1-2
15-year Deployment Costs for All ITS Projects,
I-40 Corridor in Arizona

Item	Quantity	Unit Price	Estimated Corridor Cost	Subtotals
Basic ITS Infrastructure (from Table 12.3.1-1)				$ 30,349,500
ITS Planning, Performance Monitoring, Evaluation	15 years	$ 100,000	$ 1,500,000	$ 1,500,000
Communications enhancements (included in Table 12.3.1-1)				
VMS (included in Table 12.3.1-1)				
RWIS (included in 12.3.1-1)				
Interactive Traveler Kiosks (included in 12.3.1-1)				
Advanced Traveler Information Radio: a) Capital b) Operating - 3 stations	 3 stations 15 years	 $ 10,000 $ 10,000	 $ 30,000 $ 450,000	$ 480,000
Enhanced Web Page	Lump Sum	$ 60,000	$ 60,000	$ 60,000
GCNP Parking Management	Lump Sum	$ 2,500,000	$ 2,500,000	$ 2,500,000
Multimodal I-40 Traveler Information System a) Implementation b) Operations (@ 5 percent/yr.)	 Lump Sum 15 years	 $ 2,500,000 $ 125,000	 $ 2,500,000 $ 1,875,000	$ 4,375,000
Freeway Service Patrols (3 units per district) a) Capital costs b) Operating costs	 3 15 years	 $ 75,000 $ 100,000	 $ 225,000 $ 1,500,000	$ 1,725,000
Incident and Resource Management Coordination a) Capital Costs b) Operations	 Lump Sum 15 years	 $ 15,000 $ 25,000	 $ 15,000 $ 375,000	$ 390,000
District TOCs (included in 12.3.1-1)				

Item	Quantity	Unit Price	Estimated Corridor Cost	Subtotals
AVL/AVI (agency vehicles, trucks operating regularly in the corridor, selected transit vehicles)	1,000 vehicles	$ 250	$ 250,000	$ 250,000
Slow Vehicle/ Road Widening Program a) Deployment b) Operations	 5 15 years	 $ 150,000 $ 10,000	 $ 750,000 $ 150,000	$ 900,000
Emergency Notification System a) Research	Lump sum	$ 250,000	$ 250,000	$ 250,000
Sub-total of additional ITS Costs (in addition to Basic Infrastructure from Table 12.3.1-1)				$ 12,430,000
Design, contingency, and construction engineering	@ 30% of costs			$ 3,729,000
TOTAL I-40 ITS Deployment				$ 46,508,500

12.3.2 Estimate of Rural ITS Benefits

At this point in the development of ITS programs in rural areas, there are no available, definitive studies that quantify the benefits of ITS technology deployment. Data are available from some urban areas that document the results of several years of ATMS and ATIS deployment. In this section, these data have been extrapolated to make a very general estimate of overall benefits of ITS deployment in the I-40 corridor.

To begin, the Intelligent Transportation Society of America (ITS-A) has a seven-year active Committee on Benefits, Evaluation and Costs (BEC), that in the early stages of the ITS program in this country developed a "taxonomy" of ITS benefits that have been proven adequate to serve as an evaluation framework in other Strategic Deployment Plans. This taxonomy of benefits is shown in **Table 12.3.2-1**.

Table 12.3.2-1
Taxonomy of Benefits from ITS Deployment

	Impacted Groups						
	ITS Highway Users		Other ITS User Groups			General Population	
Benefits	**Urban**	**Rural**	**Public Transport**	**Truckers**	**Other Industry**	**Other ITS Users**	**Non-travelers**
Travel/ Traffic Information Transfer	X	X	X	X	X	X	
Safety Improvements	X	X	X	X		X	
Congestion Relief	X		X	X		X	
Regional Economic Growth	X	X	X	X	X	X	X
Environmental Mitigation	X						X

Source: Adapted from the "Final Report of the Working Group on IVHS Benefits," *Proceedings of the Mobility 2000* Workshop, Dallas, Texas, March 1990.

13.0 EVALUATION OF DEPLOYED ITS TECHNOLOGIES

13.1.0 RATIONALE FOR PROJECT EVALUATION

There are numerous advantages and benefits of conducting an evaluation. An evaluation will:

- Assess or quantify improvements in transportation service and performance. These demonstrated benefits will promote future public and private sector investment in ITS projects in the corridor. Demonstrating these benefits will be important in maintaining support among the public sector partners, private sector partners, and the general public. Each of these groups will be seeking assurance that their investment in I-40 corridor ITS projects is well spent.

- Identify possible enhancements to ITS systems deployed in the corridor. Additional capabilities would serve additional needs.

- Recommend geographic expansion of individual projects and systems in future years.

Several principles guided development of the evaluation plan; including:

- The evaluation plan must focus on the ITS projects that have been recommended for implementation. The plan must be designed to assess how well these projects are meeting corridor needs.

- The evaluation plan must use performance measures that are readily available and easily and inexpensively measured. It will be most convenient, when possible, to select data that are already being collected. This will minimize the resources that must be devoted to evaluation.

- Baseline data (representing conditions before the implementation of ITS projects) must be currently available or collected before deployment of the ITS projects.

- An organization who will be responsible for evaluation should be identified and given and accept responsibility for evaluation to assure that the evaluation task is not overlooked or forgotten.

- An evaluation budget should be established so that resources can be allocated to the evaluation task.

Evaluation must be a continuing and ongoing effort in conjunction with the deployment of ITS technologies. Projects will be deployed in the short, medium, and long term. The geographic coverage of individual services is likely to expand with the passage of time. Over time, implementation of ITS technology will change from the current plan, due to emerging technology, changes in needs in the corridor, and in response to the results of evaluation in the early years of deployment. It will be important to know the impacts of ITS projects and services at each step in time so that better decisions can be made about deployment of ITS projects for subsequent steps in time.
The evaluation plan developed now will be designed to assess the initially recommended ITS projects. As projects and services to be deployed in later time periods become more clearly defined, the evaluation plan will need to be updated.

The evaluation results must be shared with all participants in the I-40 corridor project. Results demonstrating positive benefits will be important in maintaining support among the public sector partners, private sector partners, and the general public.

13.2.0 KEY SELECTION OF PERFORMANCE MEASURES

The key steps in development of the evaluation plan are as follows:

1. Make a commitment to the organization that will be responsible for the evaluation (this may require a contract by ADOT with another agency or organization).
2. Summarize user service objectives and performance measures.
3. Summarize projects recommended for deployment.
4. Specify measures for assessing effectiveness.
5. Identify data to be collected and design of data collection.
6. Plan collection of baseline data.
7. Plan for analysis and interpretation of data; and
8. Plan for sharing evaluation results with participants.

The remainder of this Chapter is organized around these key steps. Task 6 reviewed the needs in the I-40 corridor and summarized User Service Objectives in the following six System Objectives:

- Improve safety.
- Provide timely emergency services.
- Disseminate and share accurate and up-to-date information.
- Provide efficient flow of traffic, including use of alternate modes.
- Ensure conformance with laws.
- Ensure that responsible agencies and offices coordinate effectively.

Task 6 also identified and selected 31 Performance Measures to be used in evaluating I-40 Corridor ITS projects and the degree to which those projects meet the System Objectives. They are divided into qualitative and quantitative measures as follows:

Qualitative measures:

- Accurate incident detection.
- Availability of traveler information.
- Conformance / response to messages.
- Level of Service (usually developed as a quantitative measure but recommended as a subjective measure in any rural corridor).
- Maintenance / operations requirements.
- Accurate and effective detour information delivery to affected drivers.
- Interagency communication / coordination.

Quantitative measures :

- Accident rate.
- Arrival time predictability.

- Citations issued.
- Emergency response time.
- Emergency service call-outs.
- Hazardous material spills.
- Incident detection rate.
- Incident notification.
- Incident removal time.
- Level of SOV use / other modes.
- Number of accidents involving vehicles leaving the roadway.
- Number of communications channels.
- Number of fatal accidents.
- Number of hours in which information is available.
- Number of visitor centers with information kiosks.
- Number of visitors.
- Person-hours of delay.
- Rear-end collisions.
- Tow truck service calls.
- Travel speed.
- Truck / fixed object collisions.
- Vehicle density per lane.
- Weather station coverage.
- Wireless communications coverage.

Task 6 also identified which of the Performance Measures could be used to evaluate each of the 64 corridor needs.

13.3.0 MEASURES FOR ASSESSING EFFECTIVENESS

13.3.1 Candidate Measures

The 31 Performance Measures selected in Chapter 6 were further reviewed in this task. Final selection of measures for assessing effectiveness was guided by the following considerations.

- Performance Measures should be used that are associated with a large number of corridor needs rather than just one or two.
- Performance Measures should be used that provide the best chance of detecting an improvement.
- Performance Measure information must be readily available and easily measured.
- Performance Measures with existing available data are preferable.

The evaluation plan has been designed to use these eight performance measures:

- Quantitative measures:

  Accident Rate
  Number of Fatal Accidents
  Emergency Service Call-Outs

Tow truck service calls
Number of Visitors

- Qualitative measures:

  Availability of Traveler Information
  Conformance / Response to Messages
  Level of Service (LOS)

13.3.2 Challenges in Use of Performance Measures

One of the challenges in evaluation is determining whether changes in performance measures over a period of time are the result of ITS projects or can be attributed to other factors. In other words, can it be proven that the ITS project is reason for the improvement? Another challenge relates to multiple, simultaneous project deployment when multiple ITS projects are deployed, a performance measure may be affected negatively by one project while having a positive effect on another.

13.4.0 PROCESS FOR DATA COLLECTION AND ANALYSIS

13.4.1 Data Collection

Baseline data will serve as the frame of reference by which changes in performance will be measured. At present, very little ITS technology is deployed in the I-40 corridor. However, it is anticipated that improvements to the existing technologies will continue to be made and that additional ITS projects will be deployed within the coming year. Therefore, baseline data should be collected soon. I-40 user surveys should be utilized extensively in the data collection effort, including the AQI survey. The following baseline data should be collected in mid-1997:

- Accident rate:

  Total number of accidents (by year) on I-40 in 1994, 1995, and 1996.

  Number of accidents involving trucks (by year) on I-40 in 1994, 1995, and 1996.

  Number of accidents involving wet or icy pavement (by year) on I-40 in 1994, 1995, and 1996.

  Total number of accidents (by year) on other Arizona rural Interstate mileage in 1994-1996.

  Total number of accidents (by year) on other U.S. and State routes in I-40 corridor in 1994-1996.

  Total traffic count / VMT data (by year) for I-40 in 1994, 1995, and 1996.

  Truck traffic count / VMT data (by year) for I-40 in 1994, 1995, and 1996.

  Total traffic count / VMT data (by year) for other Arizona rural Interstate mileage in 1994-1996.

Total traffic count/VMT data (by year) for other U.S. and State routes in I-40 corridor in 1994-96.

Starting and ending mileposts for segments of I-40 with steep grade.

Starting and ending mileposts for segments of I-40 subject to congestion.

- Number of fatal accidents:

  Number of fatal accidents (by year) on I-40 in 1994, 1995, and 1996.

  Number of fatal accidents (by year) on other U.S. and State routes in 1-40 corridor in 1994-1996.

- Emergency service call-outs:

  Agencies and private providers of emergency services within I-40 corridor.

  Number of emergency service call-outs in 1996 for roadway-related emergencies on I-40 and on U.S. and State numbered routes and occurring outside of urban areas.

- Tow-truck service calls:

  Private providers and government agencies that provide tow truck service in I-40 corridor.

  Number of tow truck service calls in 1996 on U.S. and State numbered routes and occurring outside of urban areas.

- Availability of traveler information (qualitative):

  Number of traveler information kiosks currently deployed in the corridor.

  Amount of traveler information available in kiosks (number of pages, quantity and quality of information).

  Traveler information currently available on web pages.

  Geographic coverage of the Road Weather Information System (the data collection stations).

  Usage of current sources of traveler information.

- Conformance/response to messages (qualitative):

  Recommend that no baseline data be collected.

- Number of visitors:

  Number of visitors at visitor information centers in 1996.

  Number of visitors to selected visitor attractions in 1994, 1995 and 1996.

- Level of Service (LOS):

  Recommend that no baseline data be collected.

- Customer satisfaction

  "Before" and "after" data should be collected.

13.4.2 Analysis and Interpretation of Data

Subsequent data should be collected after initial ITS projects have been deployed and been in operation for at least a few months. Since some performance measures are based upon annual counts of information, complete impacts might not be obvious until one year following implementation. Continuing evaluation can be done at annual intervals. Data collected each year can be compared with prior years to assess changes in performance.

Analysis and interpretation of the data can help to identify possible enhancements to the ITS systems in the corridor, suggest geographic expansions of the deployed technology, and identify additional systems for deployment.

13.4.3 Sharing Evaluation Results with Stakeholders

Sharing of evaluation results with residents and travelers in the I-40 corridor, both public and private, is important to the continuing success of ITS in the corridor. Evaluation results represent feedback on the effectiveness of the participants' commitment of resources to ITS projects in the corridor. The feedback is vital for their continued interest and participation.

It is recommended that a report documenting the baseline data be distributed to the participants within three months following collection of baseline data. In future years the results of annual evaluation analyses should also be distributed to the participants in the form of a written report.

13.4.4 Responsibility for Evaluation

ADOT's Transportation Planning Group is the designated organization with responsibility for executing the evaluation plan. This assures that the evaluation task will not be overlooked or forgotten.

An evaluation budget should be established so that resources can be allocated to the evaluation task. It is estimated that the budget to collect the baseline data would be about $40,000. The Transportation Planning Group (ADOT) will perform a "before" and "after" evaluation study. The recommended budget for the study is $150,000.

14.0 SUMMARY

This *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor* in Arizona has described the results, findings and recommendations of an ITS rural corridor planning study. This 12 month study, which began in March, 1996, was initiated and administered by the Arizona Department of Transportation, in conjunction with the Federal Highway Administration. The study consultant team was lead by Kimley-Horn and Associates, Inc. The goal of this study was to develop a Strategic Plan for deployment of ITS rural technologies along the I-40 corridor in northern Arizona and to create a long-term coalition of I-40 stakeholders, both in Arizona and from neighboring corridor states, with the prospect of expanding the implementation of ITS technologies throughout the entire I-40 corridor.

The 580 km segment of I-40 in Arizona was chosen as a test bed for deployment of rural ITS technologies due to its unique transportation characteristics, including high truck volumes, extreme variations in elevations and weather conditions throughout the corridor, and high volumes of out-of-state visitor traffic. The unique situation of a major interstate corridor within a less than one-hour drive of the Grand Canyon also provided a unique opportunity to enhance travel on the corridor and to coordinate this effort with current plans to improve accessibility and protect the environmental quality of the Grand Canyon National Park. In addition, the I-40 corridor passes through the Petrified Forest National Park and within close proximity to a large number of other national monuments and forests as well as state, county, and municipal parks and recreation areas.

These characteristics, combined with the limited availability of visitor and traveler information, and the need for improved emergency management services on I-40, create a unique opportunity to test the implementation of innovative transportation technologies along the corridor.

The success of this Strategic Plan depends largely on the continued deployment of ITS technologies in the I-40 corridor by applying the appropriate technological solutions to address the transportation and traveler information needs identified in this document. Technology exists, or is rapidly emerging, to implement a wide range of programs that will make the transportation of people and goods safer and more efficient, less impacting on air quality and the environment, and more accommodating to the transportation needs of a heavily traveled rural interstate.

A reasonable amount of technology already exists or is planned for implementation on I-40. Enhancement and interconnection of these facilities with additional system elements can achieve the comprehensive intelligent corridor system desired to improve safety and operation of I-40 from Albuquerque, New Mexico, to Barstow, California. Coordination with state and regional agencies in both states was initiated during the course of this study.

The study also produced a database of people and organizations who are stakeholders in the corridor. A significant number of these organizations and individuals were brought into the strategic planning process. The overall Coalition that was formed has been kept abreast of study findings and recommendations through activities such as focus groups and newsletters. In addition to transportation system users in the corridor, key public and private partners were identified.

Specific user services were stratified into categories that apply to rural interstate corridors, while maintaining a consistency with the ***ITS National Program Plan*** (March 1995). The combining of user

services into categories is based primarily on the Rural Market Cluster approach that was unveiled publicly for the first time at the Rural ITS Conference in Spokane, Washington on September 30, 1996. The market cluster terminology was subsequently changed to Critical Program Areas in the December 1996 ARTS Strategic Plan published by the FHWA. This approach by the FHWA and FTA, representing the Secretary of Transportation in developing a multimodal ITS program plan for rural areas, was the primary driving factor in the manner in which the Arizona I-40 Corridor Integrated User Services Plan is presented. Coincidentally, however, this grouping of user services represents a coherent rural corridor ITS program. The I-40 Integrated User Services Plan simply makes sense because it is formulated on the basis of the needs identified in the corridor itself.

The following ITS deployment schedules were established for this User Services Plan:

- Short Term 1997 - 1999
- Medium Term 2000 - 2005
- Long Term 2006 - 2010

Each of the needs were matched, where possible, to one or more of the original 29 FHA User Services defined in the ***National Program Plan***. The list of 29 user services has grown to include a 30th user service, railroad-highway grade crossing improvements. The ***ITS National Architecture*** (April 1996) was also used extensively for developing the I-40 User Service Plan. To a large degree, many of the specifics in the Arizona I-40 Strategic Plan have also been tailored to meet the needs of a rural corridor, since the National Architecture was developed primarily for urban areas.

As the delineation of a national rural ITS program has evolved during the course of this study, the concept of Market Clusters (subsequently Critical Program Areas) has been adopted by the FHWA/ FTA ITS program team, and program descriptions have used the concept of Market Clusters rather than the original set of user service "bundles" that were described in earlier versions of the ***National ITS Program Plan.*** As a result of the evaluations and analyses conducted in this project, the following Market Clusters and User Services are recommended as best representing the focus of ITS initiatives on the I-40 corridor:

Major Market Clusters	Specific ITS User Services
Tourism and Traveler Information	Pre-trip Travel Information En-route Driver Information Route Guidance Traveler Services Information
Infrastructure Operations and Maintenance	Incident Management
Emergency Services	Emergency Notification and Personal Security Emergency Vehicle Management
Traveler Safety and Security	Rail-Highway Grade Crossings Other Safety-related Services
Commercial Vehicle Operations	Electronic Clearance and Border Crossings
Public Traveler/ Mobility Services	Public Transportation Management

A systems architecture was developed for the I-40 corridor representing an evolutionary, open standards architecture that will incorporate specific technologies and Market Packages for each of the three deployment time frames. Twenty-one separate Market Packages were incorporated into the architecture, in order to respond to the needs identified in this study. This deployment will make the I-40 corridor one of the premier rural ITS corridors in the country. The long-term deployment of Market Packages, corresponding with Market Clusters and user needs specific to the I-40 corridor, are outlined below:

Market Cluster	General Needs	Market Package
Tourism and Traveler Information	Route, destination information; Tourism, special event information; Travel services information	Broadcast Traveler Information; Interactive Traveler Information; In-vehicle Signing
	Traffic, congestion information; Parking information	Interactive Traveler Information; In-vehicle Signing
	Traffic reports; Weather information	Traffic Information Dissemination; Broadcast Traveler Information; In-vehicle Signing
Infrastructure Operations and Maintenance	Incident detection and notification to motorists; Early warning of severe roadway geometry, ice and hydroplaning conditions, falling rock, reduced visibility	Incident Management; Freeway Operations; Traffic Control
Emergency Services	Improved emergency management; Faster incident response; Increased availability of automated emergency notification receivers; Improve HAZMAT notification and emergency management enforcement	Emergency Response; Emergency Routing; HAZMAT Management; MAYDAY Support
Traveler Safety and Security	Collision avoidance	Traveler Security; Highway Rail Intersection ; Traffic Surveillance
Commercial Vehicle Operations	Improve safety, efficiency	Fleet Administration
Public Traveler/ Mobility Services	Improved coordination among modes	Multimodal Coordination; Intermodal Traveler Fare Management

ADOT is currently deploying several ITS technologies on the I-40 corridor, including projects to design several variable message signs (VMS) and road weather information systems (RWIS) at specific locations in the Flagstaff area. A complete list of projects currently being implemented under the "umbrella" of three rural Traffic Operations Centers (TOCs) and freeway management programs includes:

- HCRS - Highway Closure and Road Restriction Systems.

- PRAS - Public Remote Access System.
- VRAS - Voice Remote Access Systems.
- An expanded Web Page.
- RWIS - Road Weather Information Systems.
- VMS - Variable Message Signs.
- Communication Enhancements - dial up in short-term, satellite in long-term.
- PrePass for trucks on the corridor at both ports of entry.

In addition to the above projects, a number of other projects are also seen as short-term ITS activities. The projects individually will come under the umbrella of a single, coordinated Multimodal I-40 Traveler Information System. Included under the Multimodal I-40 Traveler Information System effort will be the following:

- Traveler Kiosks - a public-private partnership is envisioned.
- Grand Canyon National Park Transit Service and Parking Management System.
- Traveler Information Radio.
- Planning, Performance Monitoring, and Evaluation System.

Other short-term projects are proposed to address incident management and increasing traveler security along the remote reaches of this combination desert - mountain corridor:

- Freeway Service Patrols.
- Incident and Resource Management Coordination.

Mid- to long-term projects recommended in this I-40 Strategic Plan are:

- Automated Vehicle Location and Identification.
- Slow Vehicle/ Road Widening System.
- Emergency Notification System.

An overall ITS Corridor Management and Operations Plan was developed which includes the following recommendations:

- Adoption of a common architecture supporting incremental build-out of ITS capabilities and services.

- Field infrastructure installations at selected locations to support needed information to determine weather information, plus rapid detection and response to incidents.

- Integrated TOCs in each of the three ADOT Districts, to control response to incidents on the freeway and other state highways, assist local jurisdictions in emergency response, and be a sub-regional clearinghouse for traveler information.

- A Multimodal I-40 Traveler Information Center to provide needed processing hardware, software, and display equipment to support field infrastructure upgrades. This center should be established near the middle of the Arizona I-40 corridor in Flagstaff.

- Implementation of a communications infrastructure as outlined in the ***ADOT Strategic Plan for Communications.*** This element should include upgrading the current communications backbone to support interoperability among TOCs in the region, as well as ADOT's Phoenix TOC. It should support improvements in information to the traveler and tourist information system, commercial vehicle management, public transportation, and other components. Development of a detailed communications plan for the I-40 corridor based on the Statewide Communications protocol is recommended.

- Interoperability among Traffic Management Systems in various local jurisdictions in a district. District TOCs are recommended, in order to provide commonality among traveler information and incident management functions.

- Interoperability between Arizona I-40 TOCs and communications systems in New Mexico and California transportation department districts in the corridor should be established. (It is also recommended that this rural corridor extend beyond Barstow to Bakersfield to provide a seamless interconnect with the San Joaquin Valley and the San Bernardino ITS systems).

Each phase of the I-40 Strategic Plan will provide a building block which, upon completion, will meet the consensus needs of Arizona's I-40 transportation system as well as provide an interstate connection throughout the Southwest.

Finally, a plan for evaluating the effectiveness of ITS technologies deployed in the I-40 corridor was developed as part of this Early Deployment Study. The evaluation plan will be carried out during the coming years as ITS technologies are deployed. It was recommended that an immediate database be developed by collecting data in the following categories:

- Accident rates.
- Fatal accidents.
- Emergency service call-outs.
- Tow truck service call-outs.
- Availability of traveler information.
- Conformance / response to messages.
- Number of visitors.
- Level-of-service at perhaps a half dozen more congested locations on the corridor.

The continuing deployment of ITS on the I-40 corridor has become a priority for the Arizona Department of Transportation and the I-40 ITS Coalition. Federal assistance and recognition is currently being sought, as well as participation from public and private sector partners from Arizona and throughout the country.