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Task 3 - Technical Memorandum
User Service Plan

ITS Strategic Plan

The Early Deployment of Intelligent Transportation Systems (ITS)
In Maricopa County

DRAFT

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PREFACE

This third technical memorandum (in a series of eight) documents the User Service Plan for the Maricopa County ITS Strategic Plan. Each technical memorandum documents the system planning efforts and the conclusions resulting from an early deployment planning process composed of eight distinct tasks. The culmination of these tasks will produce Maricopa County's ITS Early Deployment Plan, which will consist of specific ITS projects and a suggested area-wide system architecture.

The intent of this User Service Plan is to present the primary goals, objectives and user services which are likely to achieve early deployment success. This User Service Plan prioritizes the initiatives that have been emphasized in Task 1 and 2. The remaining goals and objectives are also listed.

Specifically, the User Service Plan will address the goals of the ITS program by combining user services into a framework which can be deployed as projects and achieve the goals and objectives of the program. The User Service Plan will identify the roles of key public and private participants, involved in the development and deployment of the user services described in the Plan. The Plan will also identify institutional issues and barriers in deployment. Operational concepts and technologies will be illustrated in the plan to indicate a vision of how the project might be deployed.

The objective of Task 3 is to develop a User Service Plan which will:

- Summarize the efforts and results from Task 1 and Task 2.
- Document the coalition-identified user service goals.
- Prioritize the goals and objectives of ITS in Maricopa County.
- Be a stand-alone document capable of integration with the Strategic Plan.

This paper does not contain the final recommendations for ITS projects nor does it suggest the best course of action. The final report (Task 8) will contain these conclusions after the functional areas, functional requirements, system architecture, and most suitable technologies have been defined. The goal of the User Service Plan is to document the objectives of each project in order that the plan and the deployment methodology will achieve the overall regional ITS goals defined herein.

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SECTION I - INTRODUCTION AND OVERVIEW

Task 1 of the Maricopa County Early Deployment Master Plan focused on identifying the problems, needs, and deficiencies of the present transportation system in the County. To assist in identifying these problems and needs, a Steering Committee and numerous focus groups were formed. The efforts of the MAGIC project provided the public agency framework for this consortium; however, expansion of the MAGIC coalition was necessary to obtain information from a broad base of Valley transportation users and build partnerships among municipal, private industry, and urban/rural users.

The Steering Committee, comprised of 24 representatives from the public and private sectors, includes state, county, and local agency representation, as well as key appointees from the transportation, education, delivery, and high-tech industries throughout Maricopa County. The Steering Committee meets monthly to coordinate and direct the development of the ITS Strategic Plan.

Early in Task 1, the Steering Committee developed mission and vision statements for this Strategic Plan. These statements provide a focus to the goals and objectives of this 12-month study.

Vision: To deploy innovative ITS technologies in Maricopa County to satisfy regional transportation needs.

Mission: To interact with transportation users in order to identify community needs and objectives, and apply the appropriate technology consistent with the national ITS program to solve the area's transportation problems.

Focus groups were formed to assist the Steering Committee in gathering valuable insight from a diverse group of transportation system users throughout the County and promote greater public awareness, education, and involvement in ITS. These groups included representatives from emergency response/rescue teams, air travel and airport-related services, busing/transit, academic institutions, major employers, tourism/resort industry, and special events facilities. In addition, several municipal transportation advisory committees were solicited for information regarding transportation network problems and needs. Surveys similar to those received by the focus groups were also distributed to several members of the general public in an effort to ensure a diverse range of identified transportation needs. These surveys were also used later as a tool to initially prioritize the goals of the Strategic Plan.

With the needs identified, the next step (Task 2) focused on the establishment of deployment time frames and an evaluation of the needs which were identified. The major emphasis of the needs evaluation was to determine the correlation between the needs and the FHWA defined User Services and the goals of the National ITS Program Plan. Additionally, the region's transportation program

was reviewed in Task 2 to assure that a linkage was established between the goals and objectives of both the ITS Strategic Plan and MAGs Long Range Transportation Plan.

The establishment of the deployment time frames was made based upon three major considerations:

- The reauthorization of ISTEA (1997)
- Current plans for ITS and ITS projects in Maricopa County (i.e., FMS, MAGIC Projects, signal system upgrades, etc.).
- The typical five year planning horizon under which most agencies operate.

As a result, the Steering Committee established the following ITS deployment schedules:

- Short Term 1995 - 1999
- Medium Term **2000 - 2005**
- Long Term 2006andbeyond

Each of the needs were matched, where possible, to one or more of the 29 FHWA User Services defined in the National ITS Program Plan. As a result of this evaluation and the development of objectives, the FHWA User Service bundles and User Services presented in Table 1 were found to best represent the focus of early deployment ITS initiatives in Maricopa County.

TABLE 1

USER SERVICES AND USER SERVICE BUNDLES
BASED ON THE NEEDS OF MARICOPA COUNTY

User Service Bundle	User Services Emphasized Based on Maricopa County's Needs, Systems & Problems
Public Transportation Operations	• Public Transportation Management • Personalized Public Transit
Traveler and Transportation Management	• En-Route Driver Information • Route Guidance • Traveler Services Information • Traffic Control • Incident Management • Pre-Trip Travel Information

The needs which resulted in these User Services were also matched to one or more of five national ITS goals. These goals represent an improvement in safety, efficiency, the environment, productivity and/or mobility. Based on this comparison, it was determined that an improvement in both the efficiency and the mobility of the County's transportation network were the most important considerations of significant transportation network users; users want ITS to improve the level-of-service, security, and the accessibility of the transportation system by reducing congestion and the current level of traveler stress.

Three major themes of the users were prevalent:

- Reduce congestion resulting from incidents, construction, special events, and recurrent congestion.
- Improve availability, flexibility, and efficiency of transit service.
- Improve operation and surveillance capabilities of signalized intersections thereby improving coordination between signals and across jurisdictional boundaries.

Transportation users were united in the belief that providing traveler information to users was the most appropriate means of achieving the large majority of the goals. Information sharing among operating entities and agencies was also expected to satisfy many of the system objectives.

A User Service Plan must address the goals of the ITS program and provide a framework by which the user services outlined in Table 1 can be combined in order to produce deployable projects. The following sections discuss the two user service bundles and corresponding individual user services in more detail. Each of the following sections assesses the benefits and roles of key public and private sector participants. The discussion of each goal is intended to be illustrative without defining a specific architecture, and is intended to provide a vision without quantifiably defining benefits and costs. The acceptance of the User Service Plan by the community will be the key to its success.

SECTION II - PUBLIC TRANSPORTATION OPERATIONS

The coalition emphasized the need to enhance Maricopa County's existing transit service. Transit oriented transportation needs were cited in six of the nine focus group roundtable meetings. When the needs were prioritized by the coalition, the top three again echoed public transportation. The top three needs, when prioritized, were:

. More frequent transit service
. More bus routes
. Extended/increased hours of service

These needs were matched with the Public Transportation Management and Personalized Public Transit User Services (for demand-responsive service). As a result, it is these two user services which are detailed in this section.

Public transportation modes, by nature, further the goals set for ITS; however, some of the user services contribute more than others toward accomplishing these goals. While travel security might enhance public transit as a mode of choice, personal public transit would foster this same shift and might even replace large transit buses with smaller ones potentially possessing better fuel economy, less pollution and less wear and tear on pavement.

While transit ITS initiatives might have significant benefits in some areas in Maricopa County, the benefits of deploying technology to improve the operation of a limited fleet with limited service was examined and debated in depth by local ITS stakeholders. A general agreement was reached to deploy public transportation ITS technologies concurrent with the growth of the current transit system.

The public transportation user needs which were identified could result largely from a lack of adequate capital to expand the bus fleet and the service coverage. ITS could do little to overcome this type of shortfall.

The future operations and facilities required to support fixed-route and demand-responsive service in Maricopa County over the next l0- 15 years are largely dependent upon the growth of the transit service and how the service providers are structured. The growth is dependent on a wide variety of conditions, and as a result, there is a wide range of possible growth scenarios; however, the growth in transit service will be limited by the availability of transit funding. Existing funding levels in Maricopa County equate to maintaining the current level of service. Interviews conducted with the Regional Public Transportation Authority (RPTA) indicated that the majority of current funding must be allocated to maintaining the majority of current operations and any potential growth must first be allocated to the expansion of existing operations and facilities. If growth does occur, a plan

must be available to implement ITS technologies. This plan has been initiated by the RPTA, and some of the potential project are cited in this section. RPTA representatives basically agree that while ITS initiatives can improve transit operations, the initial focus of transit initiatives in the Phoenix area must be on maintaining the existing level-of-service (first), expanding the level-of-service (second), and then implementing technology concurrently with the growth of transit in the Phoenix metropolitan area.

2.1 Public Transportation Operations - Existing Conditions

In 1992, the RPTA developed a general plan for facility improvements which outlines the requirements of a planned regional transit system. The intention of the plan was to make future procurements consistent with regional objectives. The systems and facilities to be evaluated in the plan included office automation, mobile communications, automatic vehicle location, revenue collection, and security. Many of the objectives of this 1992 plan have been initiated. This section discusses the current and planned programs relating to transit initiatives.

Existing; Fixed-Route and Demand Resuonsive Onerations

There are approximately 60 fixed-routes provided by various private operators serving the Maricopa County area. The fixed-route services cover the urbanized areas, while the demand-responsive services (Dial-A-Ride) serve outlying regions. The fixed-route providers are Amett Transportation Services, Inc.; Dave Transportation Services, Inc.; Phoenix Transit System (PTS); and Valley Coach.

Existing: Revenue Collection Facilities

The Phoenix Transit Bus Card Plus Program is a special debit card that is issued by employers for fixed-route trips. Through the use of this card, the system tracks all boardings and bills the appropriate account. This program is not available to the general public, but with its initial success it is seen as **a** first step toward advancing the use of smart cards for all transit passengers. The fixed-route fleet predominately uses electronic fare boxes, classic drop-in fare boxes or manual wallet-type payment (especially for Dial-A-Ride).

Existing Communication Facilities

Each of the fixed-route service providers (except Dave Transportation Services, Inc.) are currently dispatched at the South Division Complex near Lower Buckeye and 22nd Avenue. Radio communications are deployed for both fixed-route and demand responsive services. While most of the fixed-route services are dispatched at the South Division Complex, demand-responsive services operate autonomously at separate locations. As a result of multiple dispatching locations, demand-

responsive providers communicate over a broad spectrum encompassing VHF, UHF and 800 MHZ bands.

In general, each provider operates its service with minimal interaction with other providers; consequently, very few facilities have been installed to promote communication among providers and other external agencies. Passenger transfers are scheduled by Dial-A-Ride based upon fixed-route schedules and do not require radio communications.

Management Facilities

The management capabilities provided for fixed-route services vary based upon the service provider. PC-based systems and a Management Information System are used extensively by one provider, while the others use them to the extent limited by operating budgets.

All providers gather data on the performance of their service for monitoring their operations. Performance data is manually gathered and then manually entered into an office computer which generates performance-related reports.

PTS is the centralized source for transit information in the region. Passengers call a single customer service number to obtain all transit information independent of the requested service and/or the provider.

Many customer requests are turned down at the present time due to limitations in operating budgets; however, an automated call distribution system to handle the majority of routine inquiries using recorded messages is programmed to replace the existing telephone system. The use of this automated system will free operators to concentrate on complaints and trip planning assistance. The next step in the distribution system is planned, although not budgeted, for 1996-l 997. This next step is called the Automated Trip Planner which would assist callers in accessing the correct services and providers for their anticipated trip. The Automated Trip Planner Project, if funded, would automatically plan a customer's trip from information obtained over the phone.

Security

Two park-and-ride lots are equipped with CCTV for full-time monitoring by a separate security company. There are currently no monitoring facilities at transit centers, bus shelters, or other park-and-ride lots. Mall security guards patrol transit centers at the malls and random visits by security agencies are conducted at other locations.

Existing Vehicle Location Facilities

There are currently no automatic vehicle location (AVL) systems in use by any of the providers. A small demonstration project has been initiated to retrofit approximately 18 buses with a voice annunciation system based upon Global Positioning System (GPS). This project is in the functional design stages. The project would not.result in a true AVL system because no signal is planned to be sent back to the dispatch center. The voice annunciation will announce the upcoming transit stop in order to comply with the American with Disabilities Act (ADA).

2.2 Public Transportation Management

The Public Transportation Management user service is one of the user services under the Public Transportation Operations User Service Bundle which was matched with the highest priority needs. The Public Transportation Management user service employs advanced vehicle systems to generate data and improve service to the public. In reality, the transit provider is the user of this service.

Three subservices are included in Public Transportation Management:

. Operation of Vehicles and Facilities
. Planning and Scheduling
. Personnel Management

As discussed in Section 2.1, each of these functions is currently being performed manually in Maricopa County.

The three top needs (transit frequency, increased routes, and extended service hours) were matched to this user service because it was viewed that better management of the system would result in improved service to the traveler. It is imperative to effectively manage the transit schedule so customers can rely on published schedules. Confidence in the system (to a degree) equates to an increase in ridership.

The essence of this user service (as well as all the others under the Public Transportation Operations Bundle) is the computer, the communications system and an AVL to generate real-time information. This real-time data from fleet vehicles to the computer is normally transmitted through a digital link in order to reduce time sensitive chores and to free up voice radio channels. The computer identifies schedule discrepancies, determines modifications to put the vehicle back on schedule, and displays these to the dispatcher. This same application also has much value with regard to time transfers.

The Planning and Scheduling subservice uses the data collected for off-line analysis. Analysis scenarios include ridership, running times of buses, mileage, etc. A principle user of the planning

and scheduling information is the telephone service department. Most transit authorities have customer information systems that have almost instantaneous access to schedule information. This information is not currently available to the RPTA and, as a result, it is an intensive effort to train a telephone operator on the intricacies of the various schedules and routes. Plans for studying this element of the region's transit service are programmed (but not budgeted) for 1996- 1997.

The primary benefit realized under the personnel management subservice is the off-line activity of scheduling periodic maintenance and automated daily work assignments in case of an unscheduled alteration in schedule and/or work force.

2.3 Personalized Public Transit

The Personalized Public Transit (PPT) user service is the other FHWA-defined user service matched with the highest priority transit-related needs. Each of these needs suggest that transportation users want a more flexible transit system. Flexibility is exactly the benefit gained by deploying PPT. PPT includes random-route transit and fixed-route buses capable of deviating on-call and then resuming the fixed route. The random-route or demand-responsive services are offered in Maricopa County via Dial-A-Ride; however, as described in Section 2.1, little or no automation currently exists in this system. If automated, the Dial-A-Ride system would no longer require passengers to place travel request reservations long before the intended travel time. This flexibility is expected to increase ridership. Reservations could be secured with consideration to cost effectiveness, especially for the fixed-route (flexible) transit services. The goal of PPT is to allow reservations, vehicle assignments, and scheduling to be developed in real-time. In order for PPT to be successful, it must keep close track of the fleet, the passengers and the amount of time each passenger must ride so passenger ride time and inconvenience are minimized. If the service area is expanded beyond the fleers capability, ride times will increase and the benefits and passenger satisfaction will diminish. A subscriber discount could be offered for passengers using this service on a regular basis.

2.4 Roles of Key Participants Related to Public Transit ITS Initiatives

Services and equipment relating to Public Transportation Management will generally be provided by the private sector. The deployment of public transportation user services will generate maintenance and equipment requests best provided by private industry.

The public at large will be a key participant, especially when the user service is tied to the Pre-Trip Traveler Information user **service.** The public will also benefit, primarily because much of the existing fleet is publicly-owned.

The transit service providers will play a key role in the operation and maintenance of this user service. They will be largely responsible for day-to-day activities and the availability of this

information to other public and private agencies and quasi-public institutions (i.e. airports, universities) that could use this information.

The RPTA will manage and administer this public transportation user service. Their role will also be vital in determining the degree of centralization necessary and in other policy-related issues dealing with data sharing. Other public agencies may be involved in this process, especially when considering the task of data dissemination to all potential end users.

2.5 Issues and Barriers Related to Public Transit ITS Initiatives

Section 2.1 of this report provided an overview of the existing conditions related to transit in metropolitan Phoenix. The isolated application of technology has proven adequate to meet the service provider's needs for the current level of service they provide. The institutional arrangement of current providers, the current service requests coverage, and the decentralization of current transit providers have resulted in a lack of compatibility and a reliance on manual procedures which creates barriers for significant early deployment of Public Transportation Operation initiatives. The following summarizes these locally-oriented barriers:

- Payment and fare box equipment differs among providers.
- Some of the mobile radio systems are incompatible. No communication data link has been established to reduce the reliance on voice communications.
- As a result of incompatible radio systems, the dispatching facilities are not centralized.
- All Dial-A-Ride dispatching (except for one provider) is done manually. The size of a Dial-A-Ride fleet and service area that can be dispatched manually is limited.
- The different providers use different office software for report generation. Mapping and graphic applications have limited standardization.
- Data collection and reporting procedures for performance monitoring are done manually.
- Information exchange between the service providers does not exist.
- The two current security monitoring systems are not compatible; however, the radios used by transit security are compatible with police and fire.

While the above reflects more of a technology/funding barrier, probably the largest institutional barrier that must be overcome related to PPT is integrated service payment. Financial institutions must invest heavily in magnetic strip cards and, if the balance is not readily available to the user automatically, travelers may overextend their limit.

2.6 Public Transit Operational Concepts and Technologies

Communication and AVL is the common element for both PPT and Public Transportation Management. Voice and data transfers must be accomplished between the vehicle and the central or regional control facility. These user services rely heavily on advanced electronic systems such as on-board sensors, GPS, automated demand-responsive dispatching systems, and smart card readers. An efficient communication protocol must be established so incoming messages do not conflict and to conserve the communication spectrum, thereby minimizing data transmission.

Another technology critical to Public Transportation Operations is the software required to control operational scenarios, route scheduling, automated dispatching, and facilitate efficient data processing activities. For example, Public Transportation Management services would require that the system know when a bus is off schedule, develop alternative route or schedule instructions for the driver, and transmit these instructions automatically. This would require a GIS using GPS or dead reckoning with map matching to offer accurate location information. The cost of these technologies is presently high.

The following represents specific issues and recommended activities defined in the National ITS Program Plan relating to the deployment of the public transportation-related user services described herein:

TABLE 2

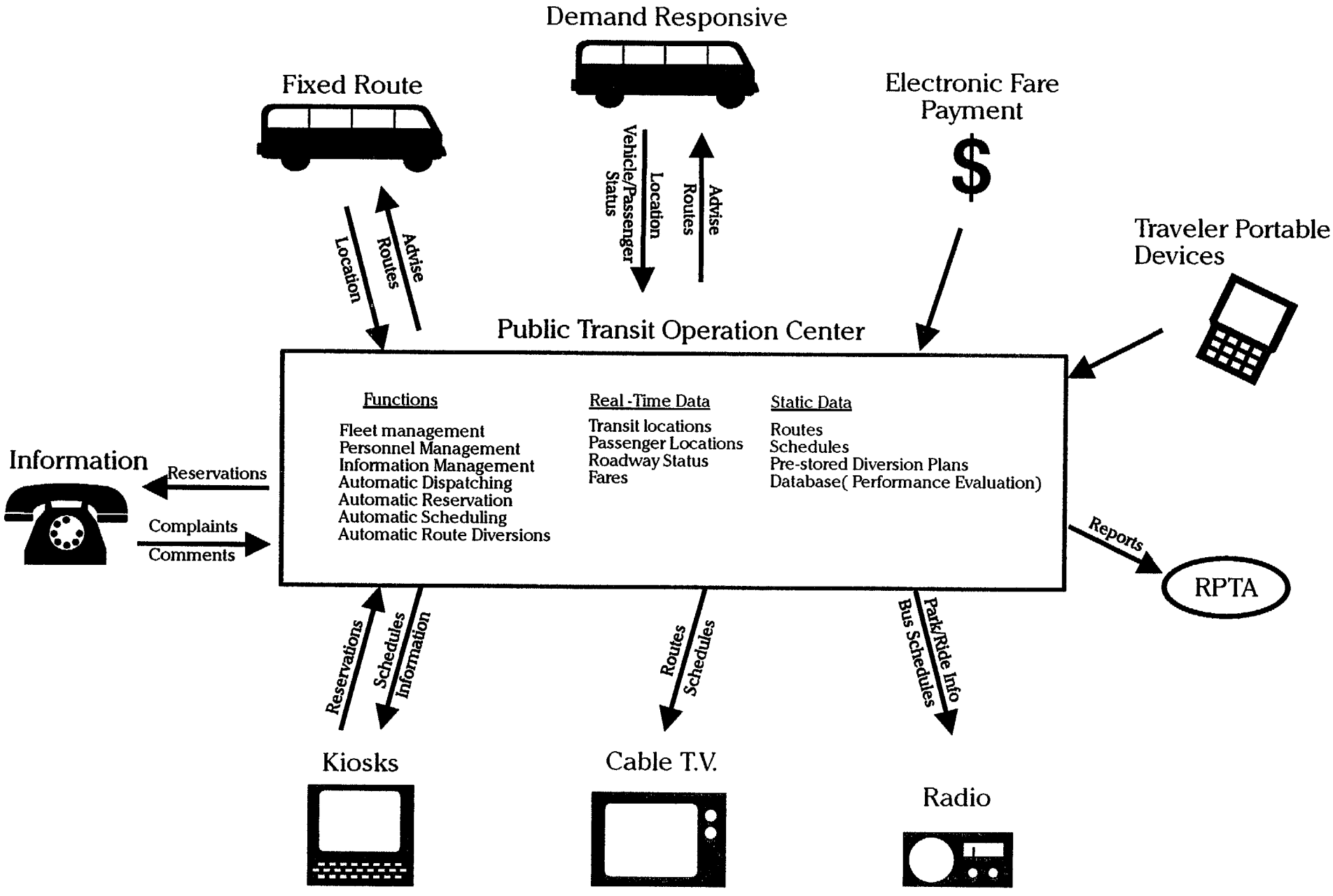
ISSUES AND ACTIVITIES ASSOCIATED WITH PUBLIC TRANSPORTATION ITS INITIATIVES

USER SERVICE	ISSUES	ACTIVITIES
Public Transportation Management	1. Select appropriate technology for local applications. 2. Modify work tasks and organizational structure to adapt to technologies. 3. Radio spectrum availability. 4. Cost/Benefit.	1. Identify technology, subsystem and operator requirements. 2. Consult FTA research on human factors, system architecture and user requirements. 3. Use analysis studies by VNTSC and ITS America.
Personalized Public Transit	1. Increase efficiency of the service thereby increasing productivity. 2. Provide real-time capabilities and customer satisfaction. 3. Efficient response to ADA requirements.	1. Identify technologies 2. Identify customer base 3. Identify service suppliers 4. Identify system issues

Operational tests are recommended to validate concepts before full deployment measures are enacted. Figure 1 displays a graphical illustration of a potential operational concept for these user services.

Figure 1

Public Transit Operations



SECTION III - TRAVEL AND TRANSPORTATION MANAGEMENT

The majority of the identified needs were matched with the Travel and Transportation Management user service bundle. Focus group participants identified many diverse areas of deficiencies in our current transportation system; however, the large majority related to the following user services:

- En-Route Driver Information
- Route Guidance
- Traffic Control
- Incident Management
- Pre-Trip Traveler Information

The only two user services within the Travel and Transportation Management bundle that were not significantly represented were the Emission Testing and Mitigation and the Traveler Services Information User Services. The following represents a summary of the high-priority goals and objectives associated with the Travel and Transportation Management bundle:

- Improved coordination and information sharing among agencies
- Computerized regional signal and integrated freeway control
- Provide accurate and timely traffic reports to the public relative to incidents, construction activity, special events, and normally congested routes

An emphasis on these goals was also addressed in a number of previous studies and current or planned projects throughout metropolitan Phoenix. The MAGIC study developed a number of recommended projects that are germane to the needs and user services related to Travel and Transportation Management. The following table presents these projects.

TABLE 3
RECOMMENDED MAGIC PROJECTS RELATED TO SHORT-LISTED TRAVEL AND TRANSPORTATION MANAGEMENT USER SERVICES

PROJECT TITLE	DESCRIPTION
Regional Signal Coordination and Operating Strategies	Ten arterials of regional importance will be analyzed and improvements in traffic signal operations and coordination will be implemented. Operating strategies which provide regional mobility and smoother traffic flow will be assessed.
Wireless Communications for Signal Control	A field demonstration of wireless communications technologies for traffic signal systems. Up to three different technologies will be installed and tested to determine effectiveness, reliability, and costs operating in the environment of Maricopa County.
Region-wide Signal Synchronization	Traffic signal equipment at local intersections throughout the metropolitan area will be brought to a minimum standard by adding time-based coordination equipment and WWV equipment so that all signals in the region can be synchronized to a universal standard time base.
Region-wide Communication	Installation of a communication infrastructure will support requirements of arterial signal systems, the FMS, and future ATIS programs. The FMS fiber optic network will be extended to directly connect with each local jurisdiction's traffic control facility.
Freeway/Arterial Corridor Operations	A field demonstration of the benefits of integrating a city signal system with a freeway management system. The corridor selected for the demonstration is along Interstate 17 in northwest Phoenix.
Cellular Probes	A limited number of motorists will be equipped with cellular phones to monitor freeway and arterial traffic conditions. Operators will receive the probe reports and will record important information into a database.
Arterial/Special Event ATIS	Variable message signing (VMS) complemented by video cameras and vehicle detection systems will be installed along major corridors and in the vicinity of a major stadium. The operation of the ATIS system will be coordinated with the operation of the ADOT FMS system.
Regional Traveler Information System	A "traffic status" map for the region will be developed. The information on the map will be made available to the traveling public, agencies, and media for assisting in travel routing and diversion routing under congested conditions.

Projects which are planned or currently nearing completion that relate to Travel and Transportation Management user services include:

- FMS Phase I
- City of Scottsdale Signal System and ITS Initiatives Study
- City of Tempe RHODES/Signal System and Special Event ATIS Study
- City of Phoenix Signal System Design Upgrade
- City of Glendale Signal System Design Upgrade
- Volvo Demonstration Project

A more detailed explanation of current Travel and Transportation Management initiatives is provided in Technical Memorandum 1.

3.1 Travel and Transportation Management Overview

Although each user service within the Travel and Transportation Management bundle is different, there are a number of commonalities shared among the user services within this bundle. Information sharing is one of the major inter-relationships among these user services. The Transportation Management Services (Traffic Control and Incident Management) collect, process, act upon, and disseminate information about the current status of the surface and freeway transportation system. The Travel Management Services (En-Route Driver Information and Route Guidance) receive the information and actually deliver it to the traveler. Another common thread is the subsystems which are shared among these user services. The functions of surveillance, communication, user interfaces, and data base processing are required for all of the Travel and Transportation Management user services. Further benefits will be realized to the extent that interagency coordination is added.

3.2 En-Route Driver Information

The En-Route Driver Information User Service consists of two subservices:

- Driver Advisory - provides real-time information on traffic and transit conditions.

- In-Vehicle Signing - provides in-vehicle displays of roadway signing and warning of hazards, traffic controls, or special roadway conditions.

Both of these subservices provide information in real-time to drivers after their trips have started. This information is provided not only to permit drivers to choose alternative routes, but also to advise drivers to switch to alternative modes. Some of the driver advisory elements of En-Route Driver Information currently in use in Maricopa County include variable message signs (freeways only) and radio broadcasts. Although these technologies can be categorized here, the real intent of

this user service is to enhance timely and reliable information to drivers by providing more information and to focus this information into the vehicle.

3.2.1 Operational Concepts and Technologies - En-Route Driver Information

The National ITS Program Plan estimates that widespread required deployment of the in-vehicle signing subservice would take 10 or more years. Local deployment for in-vehicle messages in the short-term would have to be funded through rental car companies, delivery fleets, or other groups of users. It is envisioned that, as more vehicles become equipped with ITS equipment, the role of stand-alone signing will be diminished to verifying the operation of in-vehicle signing.

Based upon the National Program Plan definition, even driver advisory functions require specialized equipment for each vehicle. Driver advisory subservice technologies include auditory messages using the FM sideband, spread spectrum radio, Highway Advisory Radio (HAR), cellular, and transponder-based systems. Many of these technologies are also being evaluated for several other user services.

Although current technology relating to driver advisory is available today on Maricopa Freeways via variable message signing, it is uncertain whether that additional operational tests will be funded for this technology.

3.3 Route Guidance

The Route Guidance user service is closely related to En-Route Driver Information. Route Guidance, based upon the National Program Plan definition, is an extension of En-Route Driver Information in that it processes the information into directions to the traveler. A map display about the network is considered En-Route Driver Information, while Route Guidance uses the current information to derive a suggested route and instructions. In addition to the in-vehicle devices, Route Guidance would be available through hand-held portable units to non-motorized travelers, including pedestrians and bicyclists. Route Guidance has application to the entire gambit of vehicular modes, including commercial vehicle operations, carpooling, fixed route, and Dial-A-Ride transit.

Although not specifically specified in the National Program Plan, current technologies such as variable message signing were also matched to this user service category.

3.3.1 Operational Concepts and Technologies - Route Guidance

The two different modes of Route Guidance Systems are static and real-time systems. As the name implies, static systems include unchanging traffic network information such as roadway maps, transit schedules or fixed bus routes. Real-time systems provide current roadway conditions resulting from a number of variable factors. As development of the user

service proceeds, routing instructions will be based on predictions of forecasted traffic conditions.

Route determination can be accomplished in a mobile fashion or by processors installed in the transportation infrastructure. If the route is determined by the equipment in the vehicle, it then can operate autonomously and be tied into information from the road network. The exchange of information with the traveler can occur via keypad, monitors, or audio messages.

All operational concepts require a manageable digital map database. This database must be current, accurate, and have attributes such as locations of stop signs, one-way streets, turn prohibitions, and signalized intersections. GPS is a critical element to be integrated into the digital map database so that relative position within the network can be identified.

3.4 Traffic Control

Traffic Control is the cornerstone of many other user services. The surveillance, control, support systems, and communication infrastructure of Traffic Control form the framework for the core elements of ITS. The goal of this service is to maximize the efficiency of the transportation network. Improvement in the network efficiency is the single highest ranked National ITS Goal that was emphasized by local users.

The Traffic Control user service involves adaptive signal systems and integrated freeway control measures such as ramp metering and lane control. The user service also includes the preferential treatment of transit and other HOVs.

Metropolitan Phoenix area cities, as well as the state and county, are acquainted with this user service through operation of signal systems and/or the FMS. To properly operate traffic control or other ITS-related systems, a sustained commitment to maintenance is required. With the exception of the FMS, most of the traffic control systems currently operational in the Valley lack both adaptive control algorithms and sufficient surveillance capabilities to provide surface street information to other subsystems or to the traveler. The strength of the area's current resources rests in the area of Traffic Control; however, there is much improvement to be made before advanced system concepts and true ITS deployment can be achieved.

3.4.1 Operational Concepts and Technologies - Traffic Control

A number of subsystems, operational concepts, and technologies are included in the Traffic Control User Service. They are:

- Adaptive signal control
- Incident detection and reporting capability

- Decentralized approach linking individual Traffic Management Centers (TMCs)
- Advanced surveillance capabilities
- Vehicle probes
- Electronic Tolls and Traffic Management (ETTM)
- Real-time database processing

Most of these advanced operational concepts and technologies are understood by system-related personnel in Maricopa County. From a surveillance standpoint they include loop, microwave, and infrared sensors. Other surveillance technologies are CCTV cameras, environmental sensors, aerial surveillance and ultrasonic/radar detectors. In addition, equipped vehicles may act as probes to determine traffic conditions. These vehicles may also be equipped with cellular telephones or advanced GPS route guidance systems. Most of the DOTs have systems that provide the platform for expansion into subsystems and technologies that would provide these ITS-related traveler benefits. The institutional issues, integration of the various systems involved, and funding for long-term operations and maintenance which serve as the focus of the next step in deployment.

3.5 Incident Management

The Incident Management user service, as defined by the National Program Plan, enhances existing capabilities for detecting incidents and takes the appropriate actions to respond. Both unpredicted incidents (accidents) and predicted incidents (planned lane closures, etc.) are covered. Incident Management is closely related to Traffic Control; the development of response actions is part of Incident Management, while the implementation of appropriate traffic control measures would be executed through the Traffic Control user service.

The Incident Management user service in Maricopa County is implemented via the FMS. The FMS uses advanced sensors, data processing, and communications to improve the incident management capabilities of transportation and public safety agencies. While the FMS monitors freeways, little or no incident management measures are available on the Valley's surface streets. Surface street incident management might include incident detection as well as coordinating the schedules of construction or other planned special event activities. While the direct users of the Incident Management service are emergency response fleets, enforcement agencies, the private towing and recovery industry, and those that operate and maintain the transportation system, the ultimate beneficiary is the traveling public.

The Incident Management user service helps in scheduling or forecasting predicted incidents so that actions can be taken in advance to minimize their impacts. Predicted incidents include events such as roadway/transit facility construction and maintenance efforts, facility closures, special events, and certain weather conditions that can be anticipated. The service will also provide the capability to coordinate the scheduling **of** many predictable incidents so as to minimize their traffic flow impacts. Predicted incidents often do not occur exactly as predicted; therefore, both predicted and unpredicted

incidents will require detection, verification, and response activities. Transportation system users do not see the direct outputs of the Incident Management service. Instead, users see the traffic control, pre-trip, and en-route driver and transit information, route guidance instructions, and response vehicles that are the outputs of other user services. For this reason. Incident Management must be linked to these other user services.

3.5.1 Operational Concepts and Technologies - Incident Management

The operational concepts of Incident Management are fairly self-defined. They involve surveillance, detection, notification, integration/analysis, and response. Computer-based incident detection algorithms monitor traffic conditions that result from a variety of sources. Integration and analysis of the data could take place at a single location (e.g., the FMS TOC) or could include several traffic management centers and transit operation centers that are connected through a communications network to share traffic information. A regional coordinating committee could compile and disseminate incident or other related user service transportation information. Response plans will also involve a number of organizations, based on the conditions of the incident.

From a technology standpoint, reports might come from call boxes or calls to 911 services. Surveillance and monitoring of traffic conditions can be based upon loops, infrared, microwave, acoustic, beacon, cellular, or video image processing detector technologies. These sensors could also be used to support the Traffic Control user services. CCTV cameras have been the technology of choice in metropolitan Phoenix for verifying incidents. Data processing technologies exist to automate the selection of response plans and, as processing matures, artificial intelligence and traffic modeling algorithms can be employed.

The relationship between the concepts and technologies involved in each of the user services outlined in this section can be combined to produce a multifaceted core ITS infrastructure.

3.6 Pre-Trip Travel Information

Actually, the Pre-Trip Travel Information User Service is linked with the Travel Demand Management User Service Bundle in the final version of the National Program Plan. During initial drafts, Pre-Trip Travel Information was part of the Travel and Transportation Management Bundle. For Maricopa County, we consider this user service as part of Travel and Transportation Management; it serves to encourage alternative mode choice, and it will aid in planning trips, scheduling departures, or help in reaching decisions to not make the trip at all.

Pre-Trip Travel Information is the means by which traffic conditions and available or alternative transportation modes can be made available to the public. Travelers can access a complete range of traffic-related information at home, work, or at other sites where trips originate. Information available to the public can include transit routes, schedules, transfers and fares; updates of surface

street and highway conditions including real-time information on incidents, accidents, road construction, special events, and alternative routes; and predicted conditions related to congestion, speeds and even parking conditions and fees.

3.6.1 Operation Concepts and Technologies - Pre-Trip Travel Information

In order for the traveler or commercial operator to get a snapshot of travel conditions, his/her options, and available services, a common information medium must be established. Traffic Control systems generating data about highway and surface street conditions must be established and integrated with public transportation systems providing transit location and route information. After this initial step is implemented, more advanced features of the user service can be integrated, such as route calculation and itinerary development based upon user interfaces. As interactive television and other advances emerge from the telecommunications industry, including the National Information Infrastructure, Pre-Trip Travel Information systems will complement other home infrastructure networks such as home shopping, banking, or educational services, perhaps even using the same electronic payment system used for personal transactions.

Pre-Trip Travel Information technologies focus on four main areas:

- Data collection
- Data communications
- Data processing
- Presentation to the user

Data collection might include travel time obtained from probe vehicles using cellular telephone triangulation techniques and automatic vehicle location tracking of public transportation vehicles. Vehicle positions might be determined using roadside beacons, GPS, land-based radio navigation systems and other technologies. Highway and surface street condition information can be collected through the Traffic Control and Incident Management user service technologies.

Data communication occurs between the data collection and data processing systems, and between the data processing systems and the user. Spread spectrum radio, cellular telephones, pagers, and modems are some potential data communication technologies.

Data processing will take multi-modal information and convert it for presentation to users. It will require algorithm and software development once interactive systems are implemented. Data processing also includes geocoding, or finding a location on a map from an address so the traveler knows the location of his/her destination prior to making trip decisions. The processing of the data needs to calculate and compare travel times, distances, potential routes, and mode alternatives.

Presentation might include voice interface through a menu via telephone for simple systems. If an information network is developed, personal computers with modem can also be used for information presentation. Similarly, cable television or video text can be provided. Personal Communication Devices (PCDs) are also being tested that combine technologies into a small palmtop computer. The form of data presentation can take many options and the degree of user inactivity can vary greatly as well.

3.7 Roles of Key Participants Related to Travel and Transportation Management

The deployment of each of the Travel and Transportation Management user services previously described will be a joint effort between the public and private sectors. The development and sale of the systems and services will largely be the responsibility of private industry. Defining the specific functions, features, architecture, and operating and maintaining the system will be the responsibility of public government. The local governments will likely accumulate and process real-time information. The information or communication networks that are used to collect and disseminate this information will be both public and private.

With regard to freeway incident management. the roles of the various agencies have been well defined. What remains is the formulation of area-wide policies and procedures which can expand services on a regional basis for the surface streets, highways, and alternate modes involved. The centralized or decentralized approach for information processing and dissemination has yet to be formally addressed. It is clear that control of local roads will remain with the current governmental body; however, where area-wide approaches are envisioned, enhanced communication and coordination of project development concepts, system architectures, interface standards, design/construction schedules, and operation/maintenance responsibilities between agencies are crucial.

Public agency officials need to agree on how the responsibilities for operation of a regional ITS system will be shared among jurisdictions or how they will cooperate to support a multi-jurisdictional Transportation Management Center. The responsibilities of transportation agencies, the transit authority, and law enforcement must be agreed upon for a regional approach involving both freeways and surface streets.

3.8 Issues and Barriers Related to Travel and Transportation Management

For each of the user services described in this section, there are six issues or barriers that are common to each which must be addressed in order to achieve successful, large-scale, regional deployment for any Travel and Transportation Management user services. They are:

- **Data Collection and Processing.** This represents the most significant technological issue affecting the deployment of these user services. Since all of the user services are data-oriented, collection and processing are key. Software quality and integrity must be

maintained in order to obtain and integrate dynamic information from multiple sources. Maintaining an accurate and reliable real-time data base is a monumental task in itself. This is compounded when the responsibility for transmission of all, or portions of, this information in a useful form to other agencies and to the traveler is added.

- **Interjurisdictional Cooperation.** The traveler's desire to access information about the network is dependent upon the trip origin, destination and his/her schedule. This may be a regional desire involving many public and private agencies.

- **Transportation Planning.** We must consider ITS solutions as part of our normal transportation planning process. A Congestion Management System (CMS) is now being developed based upon ISTEA mandates. The CMS is a systematic process that provides information on system performance and alternative strategies to alleviate congestion. These user services produce opportunities to support CMS.

- **Operations and Maintenance.** The planning and funding for long-term O&M is essential. Funding must consider O&M because easy maintenance and operation as a design feature cannot alone address this issue. To what extent are travelers willing to pay for these services?

- **Public/Private Partnerships.** The products and services of all user services will largely be developed by the private sector; however, these products and services will often rely on information and subsystem elements provided by the public sector. As a result, private/public involvement early in the planning process will aid in successful deployment of identified technologies.

- **User Acceptance.** Whether the end user will be the travelling public or the public transportation agency, it is critical that the user be educated and aware of Travel and Transportation Management user service benefits.

While the above issues and barriers are relevant to each user service within the Travel and Transportation management bundle, there are some that are more specific to the type of service they provide. Table 4 illustrates these specific barriers and the user service to which they relate.

TABLE 4
USER SERVICE SPECIFIC ISSUES/BARRIERS

USER SERVICE	ISSUE/BARRIER
En-Route Driver Information	What kind of information do drivers react to and how much do they (or can be expected that) they use it?
	Safety Issues
	How can reliable information be ensured?
	- Terminology conventions
	- Human factors
Route Guidance	- Liability issues for incorrect information
	- Route optimization across jurisdictional boundaries
	- Legal issues (i.e., routing in unsafe areas, in front of hospitals, etc.)
	- Long-term development and maintenance of accurate database
	- Compatible databases
Traffic Control	. Developing, integrating and training for real-time adaptive control and surveillance support systems
	. Integration of freeway and surface street systems
Pre-Trip Traveler Information	. Reliability, affordability and availability of alternative modes
	. How to obtain and integrate dynamic information from multiple sources
	. Willingness of private agencies to share information
Incident Management	· Interjurisdictional issues associated with notifying multiple agencies and having them respond

SECTION IV - USER SERVICE SUMMARY

The user services detailed in this memorandum, while in some cases are quite advanced from a technical perspective, represent five of seven features identified by the USDOT as core ITS infrastructure. These five features are:

1. Regional multimodal traveler information center
2. Traffic control systems
3. Freeway management systems
4. Transit management system
5. Incident management program

The USDOT suggests that feature(s) which can be readily deployed in the near term using "state-of-the-art" concepts and technologies (versus existing "state-of-the-practice") would typically be eligible for federal aid funding. Many of the user services and features of the core ITS infrastructure can use either state-of-the-practice or state-of-the-art technologies, and it seems that the optimum conditions for concurrent deployment possibilities exist where capability, compatibility and communication infrastructure are already present.

Concurrent deployment possibilities are best represented in Maricopa County by Traffic Control Systems, Regional Multimodal Traveler Information Center, and the development of an incident management program on valley surface streets. In order to deploy the user services relating to these basic features, the following fundamental enhancements to current systems and procedures need to occur:

- Enhancement of traffic control systems' surveillance and detection capability.
- Expansion of current infrastructure-based communication system linking field equipment with TMCs.
- Development of formal interagency agreements for information sharing and coordination.
- Development of software and a real-time data base system(s) for information processing and dissemination.
- Identification of sufficient resources for operations, maintenance, and management of the systems, programs, or resulting subsystem elements.
- Funding enhancements need to occur, especially related to the growth of our current transit facilities, in order to encourage technological means of improving current transit efficiency.
- An assessment of the willingness of private agencies to share information regarding their operations.

As a result, it is recommended that the focus of Maricopa County's Early Deployment Plan emphasize the following goals and objectives:

Early Deployment Goals/Objectives

1. Enhance traffic control systems by integrating surveillance, detection capabilities, and adaptive control algorithms.
2. Expand the current infrastructure-based communication system.
3. Develop information sharing agreements and procedures between private and public agencies regarding multijurisdictional traffic control, and information collection and dissemination.
4. Develop a region-wide travel information database.
5. Develop en-route driver and route guidance systems to disseminate travel information.
6. Facilitate the development of a transit management center and the integration of transit information into a regional information center as growth in transit facilities occur.

A conceptual deployment concept is graphically illustrated in Figure 2. The model illustrates the current building blocks of the above initiatives as they relate to Maricopa County.

Figure 2

Regional Data Flow