Final Draft

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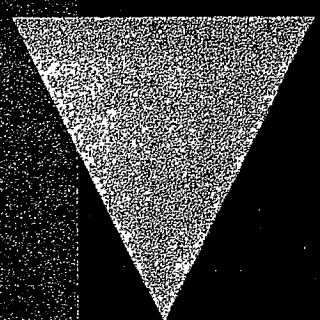
Task 4 - Technical Memorandum
Establish Performance Criteria

ITS
Strategic Plan

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



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SECTION I - PROJECT OVERVIEW

Intelligent Transportation Systems (ITS) (formerly Intelligent Vehicle Highway Systems [IVHS]), is the application of advanced information processing, communications, vehicle sensing, and central monitoring and control technologies to surface transportation. The objective of ITS is to promote more efficient use of the existing highway and transportation network, increase safety and mobility, and decrease the environmental costs of travel (M-IS Primer, July 1993).

The Maricopa County ITS Strategic Plan is an effort undertaken by the Maricopa County Department of Transportation and a coalition of private and public agencies, to develop a plan for deploying ITS technologies. The vision for this project is to identify innovative ITS technologies for deployment in Maricopa County to satisfy regional transportation needs.

In December of 1991, the Intermodal Surface Transportation Efficiency Act (ISTEA) was adopted by Congress. ISTEA authorizes the use of federal funds for various transportation improvement projects over a six year period (1992-1997). ITS applications are a component of these federal aid program funds.

The Federal Highway Administration (FHWA) has developed a Planning Process (Figure 1) to aid local/regional agencies in the development of ITS Strategic Plans. In addition, a National Program Plan for ITS has been prepared to provide an overall framework to guide ITS investment decisions and promote ITS goals.

Maricopa County has outlined a process that closely parallels the National ITS Program Plan and FHWA Planning Process. It has been carefully subdivided into the following eight sequential tasks:

Task 1: Examine the existing coalition/institutional framework for expansion and modification. Develop a vision statement and a mission statement with the coalition. Identify regional transportation needs and deficiencies with respect to safety and mobility.

Task 2: Establish short-, medium- and long-range time frames. Based on the varying perspectives of the coalition members, list the short-, medium- and long-range needs of the present transportation system. Match local transportation needs with the associated ITS user services and develop the specific objectives necessary to achieve the user service goals.

Task 3: Develop a user service plan based upon the needs, goals, and objectives identified in Tasks 1 and 2. Identify and prioritize user services for short-, medium-, and long-range implementation.

Task 4: Establish performance criteria and system measures that can be utilized as a standard to determine how successfully the plan will meet the user service needs, goals, and objectives.

Task 5: Identify which combination of the FHWA's seven basic functional areas would best support the local user services. These seven functional areas include:

- Surveillance
- Traveler interface
- Navigational guidance
- In-vehicle sensors
- Communications
- Control strategies
- Data processing

Task 6: Based upon the functional requirements of the system, define the best system architecture.

Task 7: Identify and evaluate alternative technologies on the basis of performance, reliability, costs, benefits, maintenance and operation requirements, and environmental impacts.

Task 8: Develop a region-wide Strategic Plan that meets the needs, goals, objectives, and standards established in earlier tasks. The plan will include a set of projects for short-, medium-, and long-range implementation.

As a basic set of guidelines for these eight tasks, the project scope of work includes the following six goals:

- Identify and document applicable ITS user services
- Establish system performance criteria
- Assess the functions and requirements of the system
- Identify and evaluate potential technologies on the basis of performance, compatibility, flexibility, and cost
- Assess potential funding and implementation options
- Identify time frames for implementation.

SECTION II - TASK 4 OVERVIEW

As the User Service Plan is implemented, it will be necessary to evaluate the level of success which is achieved in meeting the desired user service objectives. Periodic system performance evaluation is an important element of effective decision-making and resource management. The evaluation results will allow the coalition of ITS stakeholders to re-assess and modify, if necessary, the regional strategic plan.

The purpose of this task is to establish appropriate measures which best describe the impact of ITS on the transportation system and which can be used to estimate system effectiveness. These include measures which are appropriate for assessment of the region-wide system, as well as those measures which describe the performance of individual user services.

SECTION III - PERFORMANCE MEASURES

Service Objectives

Performance measures should relate to the service objectives which are desired from region-wide system and individual ITS user services. The objectives of a region-wide system are synonymous with the general goals of the national ITS plan: improve safety, increase efficiency, reduce environmental impacts, and enhance productivity and mobility. Other objectives of a region-wide ITS include support of regional transportation initiatives and programs, including clean air mandates, other regional transportation management systems, including congestion management and inter-modal management systems, and achievement of requirements of the Americans with Disabilities Act (ADA).

In the development of the User Services Plan, improving mobility, as well as the efficiency of the transportation network, were identified as the most important overall goals of early ITS deployment in Maricopa County. Specific region-wide service objectives which were defined include:

- reduce recurrent congestion resulting from normal transportation demands,
- reduce non-recurrent congestion resulting from incidents,
- construction/maintenance, and special events,
- 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, and
- improve the availability and accessibility of traveler information.

Evaluation of the desired service objectives based on the 29 User Service categories defined by FHWA in the National ITS Program Plan resulted in the selection of seven user services on which early deployment of ITS in Maricopa County should focus. The seven user services are:

- Public Transportation Management
- Personalized Public Transit

- En-Route Driver Information
- Route Guidance
- Traffic Control

- Incident Management
- Pre-Trip Travel Information

The specific objectives of each user service are described in the following sections.

Public Transportation Management

The primary objective of the public transportation management user service is to increase transit ridership by improving the reliability of transit service (i.e. on-time performance), providing accessible and up-to-date information on transit schedules, and minimizing transit travel time. Another goal of this user service is to reduce the operations and maintenance costs of the transit provider. These reductions would be realized through more efficient utilization and enhanced productivity of staff for transit planning and scheduling functions, data collection, and maintenance. Many labor intensive tasks, now manually performed, can be automated.

Personalized Public Transit

Personalized Public Transit (PPT) involves the use of flexibly routed transit vehicles to serve the transit dependent (including the economically disadvantaged, the elderly, and the physically impaired), users living in low density areas where fixed route transit service is impractical, and transit users wishing to travel during low-demand periods when fixed route transit operates less frequently (i.e. night time, weekends, and holidays). The primary objective of PPT is to provide accessibility to transit service by providing real-time reservation and vehicle scheduling, and reliable pick-up times (on-time performance). Transit providers can also benefit by increasing revenues through added ridership and reduced operating costs.

En-Route Driver Information

En-route driver information systems, either along the roadway or in-vehicle, convey real-time information about traffic conditions, incidents, construction, transit schedules, hazard warnings, and weather conditions. The primary objective of this service is to minimize delays and travel times by allowing drivers to change their route or mode. A secondary, although important objective, is to warn motorists of upcoming hazards which may cause an accident.

Route Guidance

Route guidance provides in-vehicle routing information to the driver. The objective of route guidance is the same as en-route driver information, reduce travel time. A secondary objective is to reduce traveler stress, particularly to those that are unfamiliar with an area, such as tourists.

Traffic Control

The traffic control user service covers a broad range of monitoring, control, and communications services required to efficiently move traffic on streets and highways. The objectives of the

traffic control user service include those traditionally used by traffic engineers to assess operating conditions, such as delay, number of stops, travel time, average speed, and level of service. As noted in the MAGIC study, transportation agencies in Maricopa County clearly felt that the sharing of real-time traffic data, not only between agencies, but to the general public is critical in order to achieve a regional traffic management objective. Traffic control is also intended to reduce driver frustration by providing smoother traffic flow, particularly across jurisdictional boundaries, and reduce the duration of congestion. Traffic control may also produce the greatest impact on fuel consumption and air quality.

Incident Management

The incident management user service is intended to address both planned (roadway maintenance, special events, etc.) and unplanned incidents. The primary objective of incident management is to reduce delays and travel times associated with incidents. Incident management if closely related to the traffic control, en-route driver information, and pre-trip travel information user services. In the case of unplanned incidents, the primary service objective is to reduce incident detection, response, and clearance times, thereby reducing impacts on the traveler. A secondary objective is to reduce accidents.

Pre-Trip Travel Information

Pre-trip travel information systems are intended to support travel demand management (TDM) programs by providing travelers with real-time information needed to select the best transportation mode, departure time, and route. By providing real-time information to the traveler prior to beginning a trip, this user service may impact transit ridership, vehicle occupancy, duration of congestion, travel time, fuel consumption and air quality.

Candidate Performance Measures

Candidate performance measures were identified from several sources, including the ITS National Program Plan, other transportation management systems already in place including the congestion management system (CMS) and freeway management system (FMS), as well as discussions with transportation agency staff in Maricopa County.

Congestion Management System

The CMS is a transportation management program intended to monitor and analyze the magnitude of congestion on the MAG transportation system and to evaluate the benefits of alternative transportation investments. The CMS has identified a number of performance measures to be used as indicators of transportation system performance and deficiencies. These performance measures include:

- level of service
- vehicle emissions
- reduction in drive alone trips
- travel time
- trip length
- vehicle-hours of delay
- person-hours of delay

- vehicle-miles of travel

Freeway Management System

As part of the FMS implementation, ADOT is performing a before and after study to quantify the effectiveness of the overall system and specific system components on freeway traffic conditions. The measures of effectiveness being used in the evaluation include:

- travel speed
- travel time
- vehicle-hours of travel
- person-hours of travel
- vehicle emissions
- fuel consumption
- accident rate
- accident severity
- total incident clearance time
- driver response/conformance to messages

Agency Interviews

Several transportation agencies in Maricopa County were contacted to discuss current methods employed to monitor transportation system performance. Informal discussions were held with staff from Phoenix, Tempe, Scottsdale, ADOT, and RPTA. The input received from the agency contacts is summarized below.

Traffic signal engineers from Phoenix, Tempe, and Scottsdale indicated that travel time was the preferred measure used to gauge performance of the traffic signal system on a corridor or area-wide level. However, travel time studies are infrequently performed due to the significant amount of staff time which is required.

- Spot speeds estimated from detector occupancy data are also used to monitor traffic conditions on the network

- All of the agencies stated that maintenance and staff requirements/utilization are important factors in determining system performance. Measures of effectiveness which were cited include number of maintenance calls, percentage of time controllers are on-line, and amount of staff overtime.

- All of the agencies indicated that public complaints/comment is closely monitored and helps to identify deficiencies within the system and overall public acceptance. Public acceptance was cited as an important measure of system effectiveness, particularly traveler information systems.

- One agency indicated that ease of access to regional traffic and incident information will be an important measure of how well a regional system is performing.

- RPTA cited travel time and maintenance of bus headways as the key indicators of how well the transit system is operating.

The candidate system performance measures are summarized in Table 1 with respect to applicability to the seven ITS user services which have been selected as the focus for early deployment. Many of the measures have derivative applications which are possible. For example, travel time or delay can be applied by mode or trip purpose. For the purpose of this task, it was not deemed necessary to explore all of the potential derivative applications of the measures.

Assessment of Performance Measures

In order to establish performance measures for an ITS, on both a region-wide basis and for each individual user service, it is necessary to consider the characteristics of each measure which will determine how well it describes system performance. A number of characteristics, desirable of a performance measure, are listed below.

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

Based on these characteristics, the candidate performance measures listed in Table 1 can be evaluated in order to determine the most appropriate measure for each user service, as well as the region-wide system. Table 2 represents an assessment of each performance measure relative to the desirable characteristics. The results of the performance measure evaluation provides a general level of understanding regarding which measures might be best suited for ITS in Maricopa County. However, given the differing objectives of the selected ITS user services, Table 1 clearly indicates that a variety of performance measures will be needed. A more detailed discussion of performance measures relative to the region-wide system and individual user services is provided below.

Region-Wide Performance Measures

A region-wide ITS will be composed of a number of different user services, each with differing, although in some cases, overlapping service objectives. As described early in this section, efficiency and mobility were identified as the most important overall objectives of an ITS in Maricopa County. Five sub-objectives were also identified; reduce recurring congestion, reduce non-recurring congestion, improve transit service, and availability of traveler information.

As ITS is still primarily in the planning stage, information on quantifiable benefits is vague or non-existent for many user services. Several efforts to derive estimated benefits for different user services and implementation strategies, utilizing simulation, are currently underway and may provide useful information. The National ITS Architecture program is also attempting to quantify ITS benefits and develop a set of standard benefit criteria. As ITS user services are

Table 1
Candidate Performance Measures

Performance Measures	User Services						
	Public Transportation Management	Personalized Public Transit	En-Route Driver Information	Route Guidance	Traffic Control	Incident Management	Pre-Trip Travel Information
Conformance/response to messages			X	X			
Amount of diversion			X				
Level of participation/usage				X			X
Travel time	X	X	X	X	X		
Vehicle-hours of delay					X	X	
Person-hours of delay					X	X	
Vehicle occupancy							
Transit ridership	X	X					
Level of service					X		
Total incident clearance time						X	
Accident rate			X			X	
Accident severity							
Vehicle emissions	X	X	X	X	X	X	X
Fuel consumption	X	X	X	X	X	X	X
Maintenance/operations requirements	X	X	X	X	X	X	X
Life-cycle costs	X	X	X	X	X	X	X
Cost per transit rider	X	X					
Benefit/cost ratio			X	X	X	X	X
Number of stops					X		
Number of on-time transit arrivals	X	X					
Maintenance of transitheadways	X						
Trip length							
Vehicle-miles of travel	X						
Number of congested locations					X		
Duration of congestion			X		X	X	
Number of air quality “hot spots”					X		
Public reaction/acceptance	X	X	X	X	X	X	X
Availability of traveler information						X	X
Interagency communication/coordination					X	X	
Availability of real-time traffic data for operations	X	X			X		
Availability of data for transportation planning	X				X		
Staff utilization	X	X			X	X	
Accessibility of transportation to disabled groups		X					
Average speed					X		
Support other transportation management systems	X				X		X

Table 1
Candidate Performance Measures

Performance Measures	User Services						
	Ability to describe system performance	Measurable	Ease of data collection	Understanding of measure	Sensitivity of measure	Applicability of region-wide assessment	Ease of computation/estimation
Conformance/response to messages	■	■	▒	■	▒	■	▒
Amount of diversion	■	■	▒	■	▒	▒	▒
Level of participation/usage	■	▒	▒	■	■	■	▒
Travel time	■	▒	□	■	▒	▒	□
Vehicle-hours of delay	■	□	□	▒	▒	▒	▒
Person-hours of delay	■	□	□	▒	▒	▒	▒
Transit ridership	▒	■	■	■	▒	■	▒
Level of service	▒	□	▒	▒	▒	□	▒
Average Speed	▒	▒	▒	▒	▒	□	▒
Total incident clearance time	■	▒	▒	■	▒	▒	▒
Accident rate	▒	■	■	■	□	▒	▒
Vehicle emissions	▒	□	□	■	□	▒	▒
Fuel consumption	▒	□	□	■	□	▒	▒
Maintenance/operations requirements	▒	■	▒	■	▒	▒	▒
Life-cycle costs	▒	▒	▒	■	▒	□	▒
Cost per transit rider	▒	■	▒	■	▒	▒	▒
Benefit/cost ratio	▒	▒	▒	■	▒	□	▒
Number of stops	▒	▒	▒	■	▒	□	▒
Number of on-time transit arrivals	■	▒	▒	■	▒	▒	□
Maintenance of transitheadways	■	▒	▒	▒	▒	▒	▒
Vehicle-miles of travel	□	▒	□	■	□	□	▒
Number of congested locations	▒	▒	▒	■	□	■	▒
Duration of congestion	▒	▒	▒	■	□	■	▒
Number of air quality “hot spots”	□	□	□	■	□	▒	□
Public reaction/acceptance	▒	▒	▒	■	▒	■	□
Availability of traveler information	▒	▒	▒	▒	▒	▒	□
Interagency communication/coordination	▒	□	□	▒	▒	■	▒
Availability of real-time traffic data for operations	▒	▒	▒	▒	▒	■	▒
Availability of data for transportation planning	▒	▒	▒	▒	▒	■	▒
Staff utilization	▒	■	■	■	▒	▒	□
Accessibility of transportation to disabled groups	▒	▒	▒	▒	▒	■	▒
Support other transportation management systems	□	□	□	▒	□	▒	▒

Ability of measure to describe characteristic:

□ Poor
▒ Moderate
■ Good

implemented, information on traditional transportation benefits (i.e. reduced delay or travel time, reduced emissions and fuel consumption, increased throughput, and reduced maintenance and operating costs) will become available.

Commonly used measures to assess the performance of the transportation system within a region include vehicle or person miles of travel (VMT/PMT), vehicle or person hours of travel (VHT/PHT), vehicle occupancy, number of trips, and mode choice or utilization. VMT/PMT, VHT/PHT, and number of trips are typically estimated utilizing regional travel forcasting models or corridor and network traffic simulation models. However, estimation of these performance measures generally requires an understanding of the effect of a strategy or user service on other traffic parameters, such as average travel speed, delay, mode choice, and vehicle occupancy. Therefore, as the understanding of the effects of ITS on these parameters becomes available, estimates of impacts on VMT/PMT and VHT/PHT will be possible.

Accessibility and availability of traveler information can be determined by such factors as geographic coverage (freeways, arterials), time-of-day coverage (morning and evening commute periods, weekdays, weekends, etc), system coverage (roadway and transit), sources of information (kiosks, changeable message signs, cable television, etc), locations of interface (i.e. at home, office, activity centers, in-vehicle, etc.) and accuracy of information. Perhaps of greater importance is the frequency which the information is being accessed or utilized. Public perception of the value of traveler information will also be critical.

The effectiveness of a region-wide system in reducing non-recurring congestion may best be determined by the reduction in incident clearance times on both freeways and arterials. Reduced clearance times generally infer cost savings to both users and providers and benefits to air quality. Another important measure is the availability and accessibility of information regarding planned and unplanned incidents.

Improved transit service generally translates into increased ridership, which is currently monitored by RPTA. However, it may be difficult to separate out the effects of ITS on transit ridership from other transportation demand management (TDM) strategies which are implemented. Transit ridership will have to be evaluated on a per vehicle basis to account for changing fleet size. Transit ridership will also be a measure of the accessibility of transit to disabled and disadvantaged users, and low density areas. Again, public opinion will be an important performance measure regarding the transit system.

Availability of real-time traffic data, level of interagency coordination/communication, number of congested locations, and duration of congestion are all performance measures which can be used to assess the effectiveness of increased traffic control from a region-wide perspective. Maintenance/operations requirements and staff utilization are currently used by agencies to determine how well traffic control systems are operating.

Assessment of the impacts of ITS on reducing recurring congestion is difficult. Number of congested locations and duration of congestion can be used, however, it will be difficult to separate the impacts associated with ITS improvements with other TDM and transportation systems management (TSM) improvements. Measures of air quality, such as number of hot spots are applicable to many ITS user services. However, these types of measures are not particularly sensitive to small changes in travel patterns, mode shift, or travel demand. Also, air quality measures are not necessarily indicative of improved mobility or transportation efficiency

and they are sensitive to other environmental factors such as temperature, weather conditions, and the existence of stationary pollution sources.

User Service Performance Measures

Public Transportation Management

The key measures available to monitor how this user service is performing include ridership, travel time, maintenance of headways, on-time arrivals, and maintenance/operations requirements. Again, ridership must be considered carefully, given that a number of other factors, unrelated to ITS, can affect this measure. Transit travel time can also be impacted by a number of other factors, including number of stops, number of boarding and lighting, and roadway traffic conditions. However, ridership also provides a basis for estimating reductions in vehicle emissions and fuel consumption, and is indicative of public reaction to improved transit service. Maintenance and operations requirements is also an important measure of the performance of this user service.

The cost effectiveness of this user service perhaps can best be described by assessing the transit cost per rider or per 1000 riders since its objective is to increase transit ridership while reducing the maintenance and operating costs associated with a transit system. Transit costs and ridership information is readily available. Assessment of total user benefits and costs will require much more detailed and difficult to gather information, including reduction in vehicle or person travel time due to increased transit ridership, as well as an estimate of the value of time. An additional benefit of the cost per rider performance measure is that it does not include a value of time, which is often controversial and typically has the biggest impact in determining the cost effectiveness of transportation improvement projects.

Personalized Public Transit

Ridership may be better suited to assessing the performance of personalized public transit since this user service is intended to extend transit service beyond fixed routes. One complaint often voiced by users of Dial-a-Ride services is that arrival times are unreliable. Therefore, on-time arrival rate can be a useful measure of system performance in improving customer service. Another frequent complaint is that the current system requires scheduling up to 24-hours in advance of the desired pick-up. As such, reduction in advance scheduling requirements could be a useful performance measure.

Although it seems reasonable to also use cost per rider to assess the cost effectiveness of personalized public transit it is important to consider the objectives of this user service. Since this user service is primarily intended to increase transit accessibility and convenience, it may be difficult to assess its cost effectiveness based on this measure alone. Given that personalized public transit systems can replace or delay more expensive fixed route transit service, a comparative cost analysis can also be informative.

En-Route Driver Information

The usefulness of roadside and in-vehicle information systems is determined by how drivers respond to the information that is provided. Therefore, conformance/response to messages can

be a key performance measure and is also indicative of public acceptance of this user service. Since one objective of en-route information systems is to advise drivers of upcoming congestion, delays, or hazardous conditions, the amount of diversion to alternative routes or modes can also be a useful measure of performance. The impact of diversion on travel time is also worth considering. However, estimation of a reduction or increase, in travel time as a result of diversion is difficult given that trip lengths can vary considerably. Another potential measure of the effects of this user service on traffic may be duration of congestion, particularly in the case of incidents. However, incident clearance time may have a stronger impact on congestion duration than en-route information.

Evaluations of the cost effectiveness of ATMS and ATIS systems currently in operation throughout the United States primarily utilize benefit/cost ratio as a primary measure. These evaluations have focused on the cost effectiveness of instrumenting roadway corridors with a variety of traffic monitoring, control, and information dissemination technologies. Given that en-route driver information will likely be one component in a corridor system, as it currently is in the ADOT FMS, breakout of benefit/costs for each component is generally not feasible. However, should some level of privatization of en-route driver information occur, it may be worthwhile to consider assessment of the rate of return which is generated through liscensing or user fees.

Route Guidance

Appropriate measures of route guidance system performance include conformance/response to suggested routes, level of participation/usage, and travel time. Since route guidance services are expected to be developed and offered by the private sector, subscription to the service is an obvious indicator of its usefulness to the traveler. Unlike en-route information systems, estimation of travel time savings to the individual traveler can be more readily achieved for this user service. This availability of travel time information allows for the estimation of benefit/cost ratios or present values in order to evaluate cost effectiveness. However, these measures may be based on individual users of this service, rather than the total user population.

Traffic Control

The traffic control user service lends itself to the application of more traditional performance measures, including travel time, delay, level of service, travel speed, and number of stops. In turn, estimates of fuel consumption and vehicle emissions based on these measures is relatively straight forward. Number of congested locations and duration of recurring congestion can also reflect the effectiveness of traffic control, however, these measures are also sensitive to available roadway capacity and demand on the network. Availability of real-time traffic data to all agencies, maintenance/operations requirements, life-cycle costs, and staff utilization are also important performance measures of a traffic control systems effectiveness. As previously mentioned, benefit/cost ratios have successfully been used to assess the cost effectiveness of advanced traffic control systems.

Incident Management

Total incident clearance time, including the time required to detect, respond, and clear an incident provides perhaps the clearest measure of the effectiveness of incident management. It is indicative of impacts of non-recurring congestion on delay and air quality. Estimates of delay, vehicle emissions, and fuel consumption can be calculated based on the duration of an incident.

These measures can readily be used to estimate user benefits, or reduced costs due to congestion. Since incident management is closely related to traffic control, en-route driver information, and pre-trip traveler information, accurate estimation of costs associated with this user service may be difficult.

Pre-Trip Traveler Information

The effectiveness of pre-trip travel information user services, which are also expected to rely on private sector participation, will be dependent upon the level of participation/ usage of the variety of services which are provided. Availability of traveler information with respect to geographic coverage, periods of coverage, and accessibility to real-time information are also factors which are useful in determining how well this user service is received by the public. Estimation of the impact of this user service on other performance measures, such as reduction in travel time, vehicle emissions, and fuel consumption, is not easily accomplished. Similar to en-route driver information, estimation of benefits associated with pre-trip traveler information services is difficult. Depending upon the level of privatization which occurs with this user service, rate of return may be considered as a potential measure of cost effectiveness.

SECTION IV - RECOMMENDED PERFORMANCE MEASURES

Based on the defined user services and review of a range of potential performance measures, the measures listed in Table 3 are recommended for assessment of the performance of both the region-wide ITS and individual user services which are planned for early deployment in Maricopa County. Other, more specific measures, may be added as specific ITS projects are developed as part of the ITS strategic plan.

Table 3

Recommended Performance Measures

	Primary	Secondary
Region-Wide	. Availability/accessibility of traveler information . Total incident clearance time. . Transit ridership. . Availability of real-time traffic data between agencies. . Public acceptance/reaction. . Maintenance/operations requirements.	. Number of congested locations • On-time transit arrivals. . Vehicle or person miles of travel . Vehicle or person hours of travel or delay
Public Transportation Management	• Transit ridership. . Maintenance of transit headways. . Number of on-time arrivals. . Maintenance/operations requirements. . Public acceptance/reaction . Cost per transit rider	. Transit travel time.
Personalized Public Transit	• Number of on-time arrivals. . Advance scheduling requirements. . Maintenance/operations requirements. . Public acceptance/reaction	. Transit travel time. . Cost per transit rider
En-Route Driver Information	• Response/conformance to messages. . Amount of diversion. . Public acceptance/reaction. . Maintenance/operations requirements.	. Travel time. . Duration of congestion. • Benefit/cost ratio
Route Guidance	. Response/conformance to messages. . Level of participation/usage.	. Travel time. . ratio
Traffic Control	. Availability of real-time traffic data. . Maintenance/operations requirements. . Staff utilization. • Travel time. . Travel speed. . Public acceptance/reaction. . Benefit/cost ratio	. Number of congested locations. . Duration of congestion. . Level of service. . Delay . Fuel consumption. . Vehicle emissions.
Incident Management	• Total incident clearance time. . Delay . Benefit/cost ratio	. Vehicle emissions. • Fuel consumption. . Operations/maintenance requirements.
Pre-Trip Traveler Information	. Level of participation/usage. . Availability/accessibility of traveler information. . Public acceptance/reaction.	. Operations/maintenance requirements. . Benefit/cost ratio