October 1995

Executive Summary

Strategic Deployment Plan

ITS Strategic Plan

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

Maricopa County Department of Transportation

Kimley-Horn and Associates, Inc.
Lee Engineering, Inc.
Catalina Engineering, Inc.
Rockwell International Corporation

Steering Committee Agencies

AAA
ADOT
ASU
Chandler
DPS
Federal Express
FHWA
Glendale
MAG
Maricopa County
Mesa
Motorola
PAG
Peoria
Phoenix
RPTA
Scottsdale
Sky Harbor
SRPM Indian Comm.
Swift Transportation
Tempe
UPS

Kimley-Horn and Associates, Inc.

TABLE OF CONTENTS

SUMMARY

As in any large and diverse metropolitan area, the mobility provided by the transportation system in the Phoenix metropolitan area is critical to its commercial well being and general quality of life. In order to preserve the level of mobility which is currently enjoyed, local and state transportation agencies are concentrating their resources in two areas, construction of added roadway capacity, and improvement in the operation of all components of the transportation system to maximize efficiency and productivity. This latter effort is being enhanced as advancements in data processing, communications, and sensing are being applied to surface transportation.

The push to begin to incorporate advanced technologies to surface transportation is being led nationally by the Federal Highway Administration which is encouraging metropolitan areas to develop strategic plans for the eventual deployment of these advanced technologies to create Intelligent Transportation Systems (ITS). In response, the Maricopa County Department of Transportation, with support from a coalition of local and state transportation agencies and private transportation providers, has completed a twelve-month study to develop a strategic ITS deployment plan for the region.

The strategic plan which was developed and is described in this Executive Summary was based on the desires and needs as stated by the users of the transportation system in Maricopa County. Utilizing a public outreach program, input from users with a broad range of interest was gathered. The primary needs identified were:

1. Reduce congestion resulting from incidents, construction, special events, and recurrent congestion.
2. Improve operation and surveillance capabilities of signalized intersections.
3. Improve availability, flexibility, and efficiency of transit service.

4. Provide more reliable and frequent information to the traveler regarding conditions on the transportation system.

Based on these needs and on the structure of existing and planned transportation systems in the region, a range of alternative methods of developing and maintaining an intelligent transportation system which would function regionally were evaluated. As a result, it is recommended that the system should incorporate the following architectural features.

- Implementation, operation, and maintenance of arterial signal systems, freeway management systems, and transit systems should remain the responsibility of individual agencies.
- These individual systems should be interconnected so that, if desired but not required, one agency can operate the system of another agency so as to reduce overall costs.
- Each agency should be connected to a central repository so that information regarding traffic conditions, weather, and transit schedules can be made available to all agencies, the general public, and private interests.

In order to achieve this system architecture, the following improvements to the existing transportation systems are recommended.

- Upgrade field equipment to enhance existing traffic monitoring capabilities, particularly on major arterials.
- Upgrade data processing hardware and software at local traffic operations centers (TOC's) to improve central monitoring and control capabilities.
- Implement the necessary communications infrastructure to provide the necessary communications to/from the field elements and between individual TOC's.

- Improve coordination between the TOC's and transit management centers.

It is recommended that deployment of these improvements be carried out in several incremental phases and should focus on the region's major arterials. Deployment of the recommended system features on the freeway system is already underway under the direction of the Arizona Department of Transportation. While the level of deployment of field and TOC equipment will depend upon the needs and resources of individual agencies, interconnection of TOC's and establishment of a regional traveler information center are considered key elements to maximize regional mobility.

Full deployment of the recommended system is expected to occur over a 15-year period, however, initial system deployment can occur over 2-3 years. System deployment costs are highly variable and will depend upon the level of technologies which are implemented. Initial estimates indicate that a minimal regional system will cost $30 million and a highly advanced system could reach $130 million to implement. Deployment of the recommended system, no matter what level, will require active participation and coordination of the coalition agencies which helped guide the development of the ITS strategic plan. A management structure which includes a steering committee for management related to the strategic plan, management team to assist agencies in deployment, and individual agencies to develop and deploy the system elements is recommended. More detailed information on deployment cost, phasing, and management structure is provided in subsequent sections of this document.

BACKGROUND

During the past 20 years, Maricopa County has emerged as a major population, trade, and service center in the Southwest. The Phoenix metropolitan area, once an area dotted with small communities surrounding the City of Phoenix, is now a large, continuous, interrelated metroplex. The growth in the metropolitan area has been phenomenal, with the population increasing 40.6 percent between 1980 and 1990. The area is also home to many major employers and educational institutions, and is a favorite of winter visitors. Given the employment and educational opportunities along with the fact that Maricopa County is assured of ample supplies of energy and water for years to come, continued growth is a certainty.

As a result of the dramatic growth in population and commerce, increased transportation demands have placed a heavy burden on the transportation system causing degradation in regional mobility and adversely affecting air quality. In response, a massive infrastructure program to expand the freeway system and enhanced efforts to increase transit utilization are underway. Still, increasing transportation demands will affect the quality of life now enjoyed in the region. Given the soaring costs to expand the infrastructure coupled with limits in available funding, local and national transportation agencies realize that building additional capacity is only part of the solution. The transportation system must be operated so as to maximize efficiency and productivity.

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). Unlike previous transportation acts, ISTEA strongly supports the recognized need of improving the efficiency and productivity of existing and future transportation systems. In response to the requirements of ISTEA, the Federal Highway Administration (FHWA) has implemented a program to develop and implement Intelligent Transportation Systems (ITS).

ITS is the application of advanced information processing, communications, vehicle sensing, 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. To support ITS, the FHWA is assisting metropolitan areas to plan for and implement these technologies.

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 objective for this project is to identify innovative ITS technologies for deployment in Maricopa County to satisfy regional transportation needs.

PROJECT OVERVIEW

To develop an ITS Strategic Plan for the region, a process outlined by the Maricopa Department of Transportation was carried out over a twelve month period. The process closely followed the National ITS Program Plan and planning process created by the FHWA to aid local/regional agencies in strategic plan development. The planning process, illustrated in Figure 1, was comprised of eight sequential tasks:

Task 1: Examine the existing institutional framework in Maricopa County relative to transportation and establish a coalition of shareholders, both users and providers . Develop a vision statement (objectives) and a mission statement (goals) with the coalition. Identify regional transportation needs and deficiencies with respect to safety and mobility.

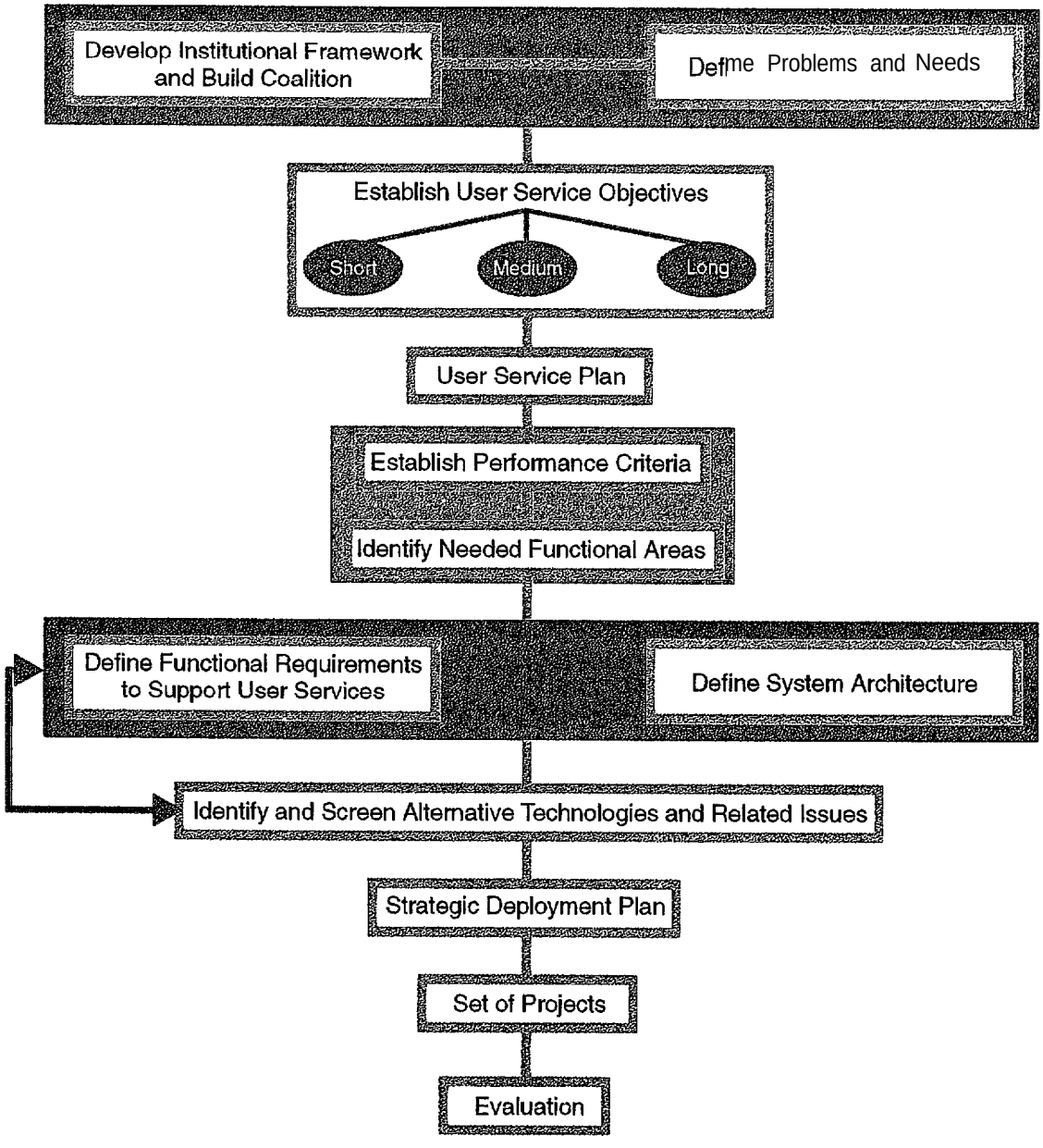
Task 2: Establish short-, medium- and long-range time frames. Based on the varying perspectives of the coalition members, list the short-, medium- and long-range needs of the present transportation system. Match local transportation needs with the associated ITS user services and develop the specific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

Figure 1

ITS Planning Process



Task 5: Identify which combination of the FHWA's seven ITS functional areas best support the local us

- 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.

A Steering Committee, comprised of representatives from 22 public and private agencies met monthly and provided input and guidance throughout the project. A significant goal for the success of the Maricopa County ITS Strategic Plan was to build upon the coalition established by the MAGIC project. For the ITS Strategic Plan to ultimately reflect regional transportation goals, it was necessary to expand the MAGIC coalition in order to build partnerships among municipal, private industry, and urban/rural users.

The Steering Committee agencies included:

- Arizona Automobile Association
- Arizona Department of Transportation
- Arizona State University
- City of Chandler
- Department of Public Safety
- Federal Express
- Federal Highway Administration
- City of Glendale
- Maricopa Association of Governments
- Maricopa County
- City of Mesa
- Motorola
- Pima Association of Governments
- City of Peoria
- City of Phoenix
- Regional Public Transit Agency
- City of Scottsdale
- Sky Harbor Airport
- Salt River/Pima/Maricopa Indian Communities
- Swift Transportation
- City of Tempe
- United Parcel Service

To provide a base for the direction and goals of the project, the Steering Committee early on developed vision and mission statements to guide the project objectives.

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.

USER SERVICE PLAN

User Needs and Service Objectives

Focus groups were formed to assist the Steering Committee in gathering valuable insight regarding transportation needs and problems 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 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.

Based on the input received from the Steering Committee, focus groups, and transportation committees, improving mobility and the efficiency of the transportation network, were identified as the most important overall transportation service objectives in Maricopa County. 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. Specific region-wide service objectives which were identified include:

- reduce recurrent congestion resulting from normal transportation demands,
- reduce non-recurrent congestion resulting from incidents,
- reduce congestion caused by 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.
- reduce air pollution

User Service Focus

As part of the ITS National Plan, FHWA has defined 29 user services (categories of ITS measures) on which a strategic plan can be based. The service objectives which were identified from user input were matched to the 29 user services in order to identify and focus on those user services which are considered most appropriate for Maricopa County. As a result, it was found that the focus of early deployment of ITS initiatives in Maricopa County should focus on user services related to Public Transportation Operations and Traveler and Transportation Management. Specifically, the user services which should be focused on initially are listed in Table 1.

Table 1

User Services Reflecting Identified Needs in 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	• Traffic Control • Pre-Trip Travel Information • En-Route Driver Information • Route Guidance • Incident Management

Not surprisingly, these user services represent five of the seven features identified by FHWA as core ITS infrastructure. These five features are:

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

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, it is recommended that the Maricopa County ITS Strategic 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.

Based on established infrastructure deployment programs, including ISTEA, Maricopa Association of Governments (MAG) Long Range Transportation Plan, and planned ITS projects in Maricopa County, the Steering Committee adopted the following timeframe definitions relative to ITS deployment :

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

SYSTEM ARCHITECTURE

Functional Requirements

Each user service will be achieved through the application of a number of technologies which perform one or more system functions. The FHWA has recognized seven basic functional areas that support user services. These functions are:

Surveillance	***Collection of speed volume, densities, travel time, queue length, position, classification, weather, and hazardous material (etc.) information for use in providing user services.***
Traveler Interface	***Means by which a user interacts with information devices.***
Navigation/Guidance	***Systems to assist travelers in route planning, position identification, and route following.***
In-vehicle Sensors	***Monitoring of vehicles, driver and external driving environment that pertains to vehicle operations.***
Communications	***Transmission of voice, data, and video information among vehicles and system infrastructure.***
Control Strategies	***Strategies implemented by a system to help regulate traffic flow and ensure traveler safety.***
Data Processing	***Management, integration, and quality control of all data and algorithms pertaining to ITS.***

Each user service was matched with the functional areas based upon the relationships known to exist between the specific user service requirements and specific system functions identified within each functional area. Table 2 summarizes the functional requirements and implementation time frame for the successful implementation of the user services.

Short-term user services requirements will need the support of the following functional areas: surveillance, traveler interface, communications, control strategies, and data processing. Based on

the number of user services matched with each functional area, communication appears to be the most needed area, followed by surveillance and data processing, traveler interface, and control strategies, in that order. Navigational guidance, although matched with all seven user services does not appear as urgently needed as the first five technological areas. Lastly, in-vehicle sensor technologies were associated with five of the seven user services, and their implementation is envisioned in the mid- to long-term horizon.

Table 2

User Service Functional Requirements and Implementation Horizons

	Functional Areas						
User Services	Surveillance	Traveler Interface	Navigational Guidance	In-vehicle Sensors	Communi-cations	Control Strategies	Data Processing
Traffic Control	I	III	III	III	I	I	I
Pre-Trip Travel Information	I	I	II		I		I
Route Guidance	I	I	II	II	I		I
En-route Driver Information	I	I	II	III	I		I
Incident Management	I	I	III		I	I	I
Public Transportation Management	II	II	II	II	I	I	II
Personalized Public Transit	II	II	II	II	II		II

I	Short-term
II	Medium-term
III	Long-term

Logical Architecture

The functional requirements of the user services form a logical architecture for the system. The logical architecture identifies the relationships and interfaces between the functional requirements and provides a framework on which the physical architecture can be developed. Utilizing a real-time structured analysis methodology, the functional requirements for the seven identified user services, as well as for the Emergency Notification and Personal Security user service which was considered relevant to incident management, were analyzed to defme all data and control flows which are generated or consumed within the architecture, along with the external sources and sinks for the conveyed information and control.

The major data flows that influence development of the physical architecture are:

- TOC to TOC Coordination,
- Traveler Information, and
- Driver, Traveler, and Transit User Inputs and Outputs.

A major data flow in the logical architecture is TOC to TOC coordination. TOC coordination is currently under examination by the National ITS Architecture program for standardization recommendation. In Maricopa County, this TOC coordination is essentially intra-regional and thus, driven by local requirements, i.e., the region is somewhat self-contained with the interconnection to Pima County as potentially the only major inter-regional connection consideration. Definitions of both Traffic Information and Traveler Information are provided in the National ITS Architecture program. The major considerations of these data flows are the information requirements of the users in Maricopa County.

Major databases which are required include:

- Traffic Flow, Control, and Information,
- Traffic Incident and Demand,
- Roadway Conditions,
- Yellow Pages,
- Maps,
- Transit Operations,
- Emergency Response Plans, and
- Special Events Plans.

Physical Architecture

The physical architecture identifies the physical subsystems, data flows between subsystems, and interconnections between subsystems that will support the logical architecture. Recommendation of an appropriate ITS architecture for Maricopa County was based on an evaluation of five candidate architectures which are possible given existing and planned systems/subsystems and their capabilities, jurisdictional and organizational boundaries, institutional barriers and opportunities, and conformance with the ITS National Architecture.

Five physical architecture alternatives were defined and evaluated. These architectures are:

Fully Centralized

Would provide for direct interconnection between a central control and management center and all field controllers/elements. No local agency control over controllers would exist with all jurisdictional field communications integrated with the control center. The control center would also have direct interconnection with travelers and transit systems providing regional traveler and transit information.

Centralized Advanced Traveler Information System (ATIS) with Distributed Control

Would provide for local agencies to maintain control over their systems; however, the local systems would be integrated with a centralized management center. In this configuration, local systems could still work out localized agreements. Transit agencies would be connected to the centralized management center. In addition, the centralized management center would provide regional ATIS and transit information.

Peer-to-Peer with Distributed ATIS

A peer-to-peer configuration with distributed ATIS architecture would provide the backbone network, namely a Metropolitan Area Network (MAN). This network would provide interconnection between local agencies and traveler information distribution sites. Travelers and vehicles would receive distributed ATIS from local agencies. This architecture allows local agencies to maintain their dedicated communications with field control devices.

Peer-to-Peer with Centralized ATIS

A peer-to-peer with centralized ATIS architecture is similar to peer-to-peer with distributed ATIS, with the exception that a regional ATIS capability would be established. This architecture supports the collection and storage of all ATIS data for regional assimilation and distribution. Interface with travelers and vehicles for ATIS information as well as inter
connection with information suppliers and generators would be through a regional ATIS center.

Peer to Peer with Centralized ATIS and Permissive Control

A peer-to-peer with permissive control and centralized ATIS architecture would provide for a MAN with a jurisdictional controllable “gateway” interconnection capability at a layer where field controllers and other local agency systems are interconnected. This MAN would allow local agencies to maintain their dedicated communications with field controllers, but also provide a capability for control to be handed off to another agency by “opening the gateway” to their field

controller devices. The obvious advantage in this architecture is inherent fault tolerance plus cost savings during night and weekend shifts by sharing monitoring and control; however, the flexibility of the architecture leaves all decisions on shared control to the jurisdiction. This retains the regional ATIS described in the previous architecture which supports single point traveler interface.

The candidate architectures were evaluated utilizing both formal criteria established in the National ITS Architecture development program and through a general assessment of the pros and cons associated with each. Based on these analyses and on input from the Steering Committee, a peer-to-peer architecture with centralized ATIS and permissive control is recommended for Maricopa County. A centralized ATIS would provide a regional database for the assimilation and distribution of information to agencies, the traveler, and private entities.

Functional Technologies

A broad range of communications, traffic surveillance and monitoring, traffic control, route guidance, and traveler information technologies were evaluated to determine its suitability for deployment in Maricopa County. The evaluation criteria included:

- Functions performed
- Technology status
- Interface and operational standards
- Reliability
- Environmental compatibility
- Benefits
- Maintainability
- Jurisdictional supportability
- Comparative features with conventional technology
- Architectural compatibility
- Cost

As a result, the following technologies are recommended as a means to implement the recommended system architecture and achieve the desired ITS user services.

Communications

- Fiber optic communications backbone.
- ATM and ETHERNET to establish local area networks between operations centers.
- Various wire and wireless media for links to low-speed and video devices in the field.

- Video compression/decompression (CODEC) equipment.
- Radio digital data systems(RDDS) for communicating with in-vehicle traveler information and route guidance devices.
- Radio frequency (RF) tag readers to monitor commercial vehicles.
- Establishment of a dedicated radio frequency for use by commercial vehicles to receive traffic information.
- Digital cellular communication with other traveler information devices in the field.

Traffic Surveillance and Monitoring

- Closed-circuit television (CCTV)
- Loop detectors
- Video image detection systems
- Acoustic detectors

Traffic Control

- Type 2070 Controller.

Route Guidance

- Global positioning system (GPS) based navigational systems.

Traveler Information

- Full Service ATIS to include :
  - + Integrated traffic conditions and public transit schedules/status.
  - + Links with privatized ATIS service centers, public broadcast and cable-TV, cellular telephone and data services, and commercial vehicle and transit dispatch centers.
  - + User-paid communications service.
  - + Interactive services provided to users by private ATIS information suppliers.

- Limited deployment of public kiosks to encourage private partnership.

- Jurisdictions to deploy:
  - + variable message signs and pathfinder signs on selected corridors.
  - + Highway Advisory Radio.

- Radio digital data service deployed through partnering with a local FM radio station.

STRATEGIC DEPLOYMENT PLAN

Strategic deployment of the recommended system architecture was based on the following guidelines:

- Develop an ITS Strategic Deployment Plan for implementation in Maricopa County in the form of one large project composed of a set of smaller, modular projects, focusing on the following user services:
    - Traffic Signal Systems
    - Incident Management
    - Pre-Trip Traveler Information
    - Traveler Services Information
    - En-Route Driver Information
    - Route Guidance
- The project should provide a set of implementation guidelines, to be followed by the area jurisdictions on a voluntary basis, providing step-by-step directions on the infrastructure deployment and upgrades necessary to achieve a modern and coherent system architecture for the region.
- The project should address the issue of air quality in Maricopa County and propose mitigation measures which could be implemented and become part of the ITS infrastructure.

In addition, the strategic plan is intended to adhere to the seven core infrastructure features established by the FHWA so as to focus near-term deployment and maximize future opportunities to implement widespread, advanced ITS user services.

Recommended Plan

Recommended for Maricopa County is a strategic plan which identifies a set of incremental projects to achieve the required ITS services and recommended system architecture. The plan recommends providing:

- Field infrastructure upgrades to support needed sensor information to determine traffic congestion on corridors and rapid detection and response to incidents.
- Upgrades to jurisdictional TOC environments to provide needed processing hardware, software and display equipment to support field infrastructure upgrades.
- Implementation of a communications infrastructure to support interoperability between TOCs and to support improvements in traveler information support to the public and commercial vehicle operations.
- Interoperability between traffic and transit management.

Each phase of the plan will provide a building block which, upon completion, will meet the consensus needs of the Maricopa County transportation system. The Strategic Plan is designed to support the current and planned improvement initiatives of each city/jurisdiction. The recommended project covers the basic area of the Maricopa County with specific focus on the area's major corridors, as identified in the MAGIC (July 1994) study.

Implementation Phasing

Implementation of the plan will occur in three phases, with the first phase being comprised of three sub-phases. The phases are described below.

Phase 1A: Field Implementation

The first increment in the strategic plan is to design, install, integrate and test traffic sensors, and modem controllers along priority corridors within Maricopa County. The following technologies should be considered for deployment.

- Install vision sensors along the corridors to provide information on traffic congestion and to support incident detection where other sensors are unavailable or to support technology testing.
- Install acoustic sensors along the corridors to complement video sensors in areas where video sensors may be obstructed or lighting may be a problem.
- Install modern controllers along the corridors to provide real time monitoring for traffic information.
- Controllers along the corridors should provide real time coordination using Global Positioning Satellite (GPS) time base.
- Install closed-circuit television (CCTV) along the corridors to support incident and traffic congestion evaluation.
- Install electronic signs, including dynamic routing signs to communicate corridor status and to advise of alternate corridor(s).
- The corridor communications architecture should allow implementation of national standard protocols.
- The fiber optic infrastructure along the corridors should be developed in such a manner as to support formation of the peer-to-peer, backbone communications network.
- Wireless interconnection should be utilized where the impact of construction on traffic conditions or access to adjacent property will not allow fiber installation.
- Corridor controller communications should be terminated into a standard jurisdictional communications gateway. The gateway should be an intelligent multiplexer that controls access to the jurisdictional low-speed controller links, complies with NEMA TS-2 environmental requirements, is fault tolerant, and includes an internal bridge/routing capability.

- The gateway should be integrated with the TOC optical communications link.

Prior to deployment of Phase 1A elements, it is recommended that an extensive analysis of the communications system in Maricopa County and the transportation needs identified in this study be undertaken. This Pre-Phase 1A should recommend a communication system that best addresses the transportation communication requirements of Maricopa County and is consistent with the architecture framework as defined in this strategic plan.

Phase 1 B: Creating Interoperable Communications Between Traffic Operations Centers

Phase 1B will consist of completing any future communications path, not established by segment corridor implementation, facilitating installation of the fiber optic backbone. Microwave may be utilized in areas where in-ground installation is not feasible. The Phase 1 B build-out, includes:

- Backbone network implementation.
- Installation of fiber optic equipment.
- Interconnecting the intelligent gateway with fiber optic network.
- Interconnecting the field video equipment with fiber optic network.
- Interconnecting the fiber optic network with video equipment at the TOC's.
- Adding ATM Ethernet switch to support communication between TOC's.

Phase 1C: Transition of Existing Field Infrastructure to the System Architecture

Phase 1C consists of the integration of the field infrastructure with the gateway. This phase may include the upgrade of field controllers to types recommended for the common architecture. Where controllers are upgradeable to a common protocol, they may be maintained. As jurisdictions transition to a common field protocol, they will become capable of "full membership" in the peer-to-peer architecture. To the extent that jurisdictions maintain an incompatible protocol and/or control strategy, they are capable of "partial membership" in the peer-to-peer architecture.

Phase 2: Expansion of ATIS

Phase 2 provides a core ATIS capability integrated with the Maricopa County network. Each jurisdiction provides corridor conditions data to the central ATIS. The ATIS center consolidates corridor status data for user distribution. Similarly, transit system(s) schedule and status data is also received and combined by the ATIS center. The ATIS center provides consolidated traveler and transit information over the network for jurisdictional, public, and private use.

The ATIS capability includes the following functions:

- Consolidation of area information from agencies.
- Preparation of consolidated information on corridor conditions and hazards .
  - + Provide interface to the RDS system broadcast by FM radio stations.
  - + Provide interface to other public media for use and distribution to viewers/listeners.
  - + Provide interface to cellular telephone operations center providing traffic conditions reports.
- The core ATIS will partner with a privatized service to provide full service ATIS.

Phase 3: Deployment of Additional Technologies

During Phase 3, several additional technologies will be deployed:

- Electronic fee collection: under a separate project the Sky Harbor Airport will implement electronic toll tags for parking fee collection and taxi management at the airport, Airport Authority - Maricopa County partnership will standardize an RF tag which will meet the needs of commercial, private, and public transit vehicles and taxies within the area. Electronic toll and traffic management readers with Sky Harbor airport electronic tag compatibility will be encouraged for use at the America West Arena and at other future major transit centers.
- RF tag readers will be deployed at entrances to major commercial corridors for

detection of vehicles carrying hazardous material and for vehicle identification.

- RF tag readers will be deployed strategically along major corridors to support:
  - + Use of RF tagged vehicles as probes.
  - + Calibration and verification of public transit vehicle position,
  - + Hazard warning to vehicles with toll tags and not equipped with route guidance.

Estimated Costs

Rough order of magnitude costs were developed for phases 1 A, lB, and 2 of the recommended implementation plan and are presented in Table 3. Total implementation costs as well as annual operations and maintenance costs are provided. For Phase IA, high and low end costs were estimated and reflect a broad range of technologies and the level of deployment that could occur. The high end cost reflects full deployment, as defined, of advanced traffic management capabilities within each corridor and TOC. The low end cost reflects a "bare-bones" deployment of detection, traveler information systems, and central control. Table 4 presents an estimate of high and low end costs per corridor mile and for an individual TOC.

Table 3

Estimated Implementation Costs ($ 000's) for Recommended Project

	Implementation Cost		Annual O& M Cost	
Phase	**High**	**Low**	**High**	**Low**
Phase Pre-1A	**200**			
Phase 1A	105,000	**3,500**	**4,500**	**624**
Phase 1B	**24,600**	**-**	**464**	**-**
Phase 2	2,130		149	
Total	**131,930**	**3,500**	**5,113**	**624**

Table 4

Estimated Incremental Costs ($000' s) for Phase 1A

	Implementation Cost		Annual O& M Cost	
Phase	**High**	**Low**	**High**	**Low**
Phase 1A - Corridor Upgrade per mile	**532**	**23**	**22**	**3**
Phase 1B - TOC Upgrade	**642**	**82**	**37**	**6**
Total	**1,174**	**105**	**59**	**9**

Schedule

The schedule for deployment of the recommended plan will depend upon a number of factors, including availability of funding, coverage of the transportation network, and the level of implementation which is desired. Assuming that full system deployment will eventually be desired and the funding will be available, a realistic deployment schedule is presented in Table 5. It

should be noted that efficiencies in deployment will occur through overlap of tasks within each phase as well as between phases.

Table 5

Deployment Schedule

Phase	Deployment Period	Comment
Phase Pre-1A	1 Yr	Conduct prior to system deployment
Phase 1A	5 Yr	Initial corridor deployment in 18 months.
Phase 1B	10 Yr	Initial TOC-TOC links in 18 months.
Phase 1C	15 yr	Incorporate ITS infrastructure deployment into TIP process as part of roadway projects.
Phase 2	15 yr	Begin deployment of initial ATIS elements immediately.
Phase 3	15yr	Long term deployment as new technologies become available.

Funding

In order for funding to be obtained for ITS projects in Maricopa County, projects must be identified with regional appeal and acceptance. The various governmental entities must agree on the need for and mutual benefit of the proposed project. These agencies must depart from the past practice of competition among regional agencies and identify potential projects with citizen support across political boundaries. The proper forum for this process is the Maricopa Association of Governments (MAG). Possible funding sources include:

- Federal
  - CMAQ
  - STP
- Local
  - Highway User Revenue Funds (HURF)

- + Added Local Sales or Gas Tax
- Private or public/private partnerships

Management Structure

In order to continue the interest that was generated in the development of the ITS strategic deployment plan and to set in place the organizational requirements necessary to carry this plan to deployment, establishment of a functional management structure is needed. The recommended management structure utilizes existing organizational arrangements and agencies to the maximum extent possible to reduce duplication of effort. The key components of the recommended management structure are summarized below.

Steering Committee - Plan Management. This committee would be a continuation of the Steering Committee which oversaw development of this ITS strategic deployment plan. It would be responsible for management of the strategic plan to ensure that deployment projects are in conformance with its concepts and architecture. In addition, this committee would update the plan, as necessary, as new technologies and concepts become available.

ITS Management Team. This team would be responsible for overseeing the day-to-day deployment activities of the various phases and elements defined in the strategic plan. The major roles of this team would be to develop deployment strategies and priorities, identify opportunities for deployment as part of other transportation infrastructure improvements, identify alternative funding sources, and promote the concept of ITS to the public. This team would be consist of key agencies involved in funding during implementation and it would be chaired by a "champion" of ITS for the Valley. This person needs to be one that the Steering Committee feels the energy and desire to see the deployment carried out.

Deployment Teams. Member agencies of MAG would be responsible for actual project deployment. These agencies would develop projects which reflect their needs yet are in conformance with the strategic plan, and carry the projects through the MAG TIP process. Once funded, the responsible agency or agencies would carry out deployment.