

2. PROJECT BACKGROUND

2.1 RURAL ITS PLANNING AND DEPLOYMENT HISTORY IN ARIZONA

ADOT's rural ITS deployment planning has generally adhered to the standard process developed by the U.S. Department of Transportation's (USDOT) Advanced Rural Transportation Systems (ARTS) program. This process emphasizes linking of transportation needs to user services and market packages, which in turn define needed project/technology deployments.

The two ITS plans that defined the needs and set the future direction of rural ITS in Arizona were the I-40 Corridor ITS Strategic Plan and the Statewide ITS Strategic Plan. Completed in 1997, the I-40 plan paved the way for rural ITS planning in Arizona. The 1998 Statewide ITS Strategic Plan combined the results of previous ITS deployment planning, inclusive of the I-40 plan, into a comprehensive ADOT agenda for the future of ITS in rural Arizona. The 1998 statewide plan identified and prioritized the key **needs** that could be addressed with ITS technologies and selected suitable **user services** and **market packages** to deploy in the short term (1999 to 2001), mid term (2002 to 2007), and long term (2008+) timeframes. The plan also included a phased deployment project plan. See Appendix A for tables summarizing needs, user services, market packages, and deployment projects identified under the Statewide ITS Plan.

Importantly, the 1998 statewide plan drafted a statewide ITS architecture concept, tying together the planned systems into a coherent, integrated and interoperable structure (Figure 1). A critical legacy of the plan was the clearly defined methodology to conduct periodic performance evaluations of the deployed systems, based on data collected before and after deployment and using pre-defined performance measures, including:

- Accident rates and fatalities.
- Coverage of early detection and warning systems.
- Emergency service call-outs and tow truck service calls.
- Mayday system performance and system coverage on rural highways.
- Availability of traveler information and timeliness of traveler data.
- Customer survey data (customer feedback).
- Conformance/response to messages.
- Highway Level of Service (LOS).

Based on the results of the ITS early deployment planning, ADOT developed and continues to maintain a detailed infrastructure deployment plan. This is the *ADOT Statewide Plan: Intelligent Transportation Infrastructure*, also known as the ITI Plan (5). The ITI Plan tracks the planned, programmed, and deployed ITS devices throughout the state, including Variable Message Signs, cameras, Road Weather Information Systems, visibility sensors, and electronic clearance systems at ports of entry into the state.

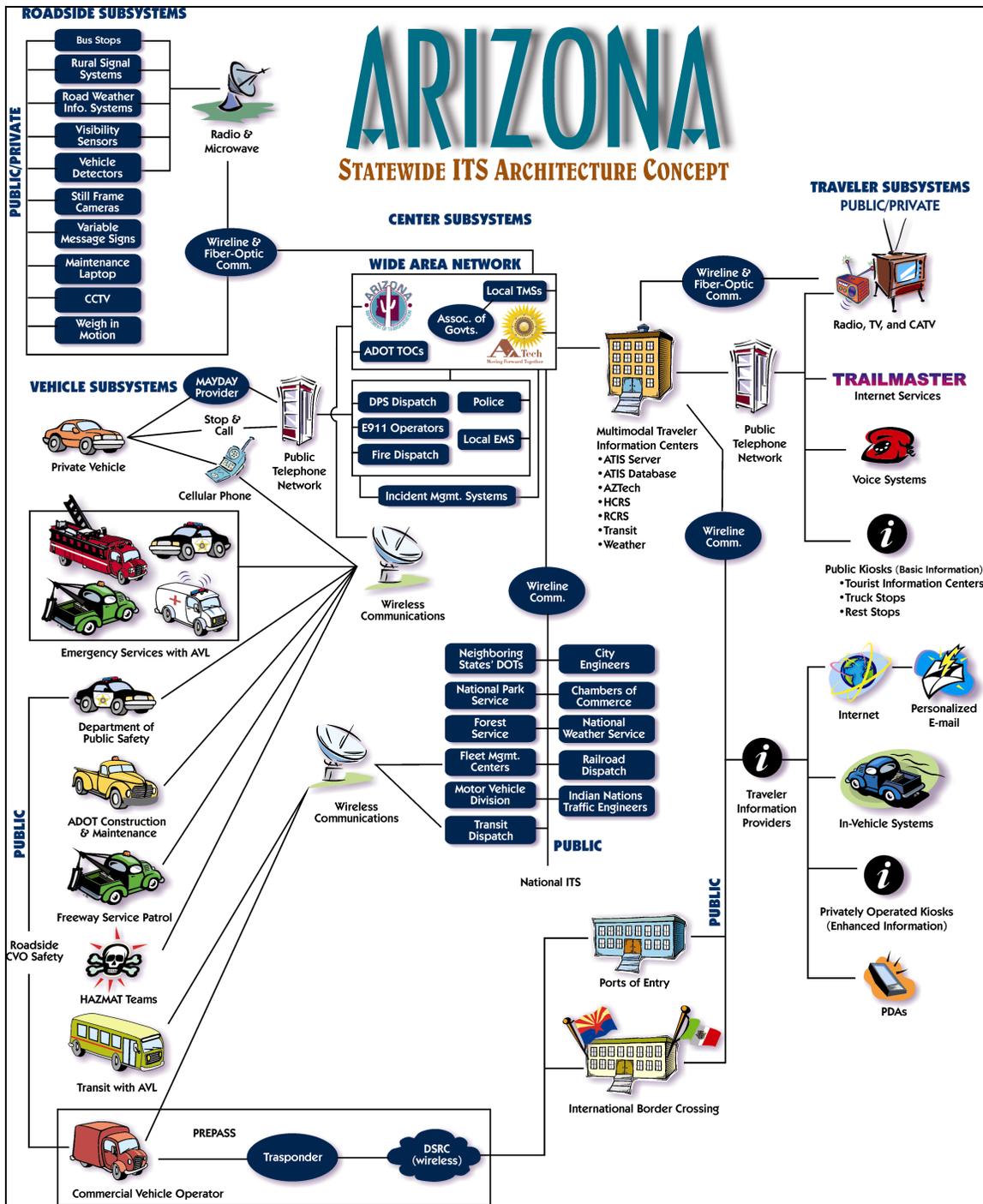


Figure 1: Statewide ITS Architecture Concept - in 1998 (Source: 2:6-3)

The I-40 Corridor Short Term Implementation Plan presents a vision statement that is also representative of rural ITS planning statewide: "To have new, innovative ITS technologies operational (throughout the I-40 corridor), providing a safer and more efficient intermodal transportation system, meeting the short and long-term needs of visitors, local communities, commercial operators, and the traveling public" (3:1). This

vision statement succinctly addresses key goal areas identified by ADOT and its partners (system innovation and functionality, safety and efficiency), user needs (short and long-term), and the rural ITS stakeholders or user groups (visitors, local communities, commercial operators, the traveling public).

2.2 RURAL ITS DEPLOYMENT MODELS

Rural ITI deployments in Arizona fall into one of four physical categories: permanent, semi-permanent, portable and mobile. Rural ITI may be owned or leased by ADOT, its partners, or by both. Most depend on private service providers for power and communications (wireline telephone, wireless telephone, and the Internet). Funding for various ITI has come from a wide variety of sources. Taken together, these aspects of ITI deployment constitute the “deployment model” under which the rural ITI have been implemented in Arizona.

Table 2: Summary of ADOT’s Rural ITS Deployment Models

ITI	Type of Installation	Ownership	Service Dependencies*	Funding Source(s)
Road Weather Information System (RWIS)	Permanent	Owned (ADOT)	P, T	State Highway Construction Funds
Passive Acoustic Detector (PAD) at RWIS	Permanent	Owned (ADOT)	P, T	State Highway Construction Funds
Remote Camera at RWIS	Permanent	Owned (ADOT)	P, T	State Highway Construction Funds
Remote Camera at Variable Message Sign (VMS)	Permanent	Owned (ADOT)	P, T	District minor funds; in the future, State Highway Construction Funds
Speed Detection/Warning Device	Permanent	Owned (ADOT)	P	Kingman District
License Plate Readers	Semi-permanent	Leased by Contractor	P, T, M	Construction bid item
Highway Condition Reporting System (HCRS) Data Entry	Permanent	Owned (ADOT)	P, T, I	Phoenix FMS Phase 2 software development
511 Telephone Information	Permanent	Owned (ADOT)	P, T	National 511 Model Deployment funds; ADOT maintenance funds

Table 2 (cont'd): Summary of ADOT's Rural ITS Deployment Models

ITI	Type of Installation	Ownership	Service Dependencies*	Funding Source(s)
www.az511.com Website	Permanent	Owned (ADOT)	P, I	TTG; ADOT maintenance funds
Overhead VMS	Permanent	Owned (ADOT)	P, T	District minor funds; State Highway Construction Funds
Shoulder-Mounted VMS	Semi-Permanent	Owned (ADOT) Or Leased (Contractor)	T	Construction bid item
Portable Trailer-Mounted VMS	Portable	Owned (ADOT) Or Leased (Contractor)	T	Equipment Services revolving fund; construction bid item
HAR - Highway Advisory Radio	Semi-Permanent	Leased (Contractor)	T, S	Construction bid item
Portable Traffic Signals	Portable	Leased (Contractor)	P	Construction bid item
Electronic Clearance at Interstate Borders (PrePass)	Permanent	Owned (Vendor)	P, M, I	None required for equipment
Expedited Processing at International Crossings (EPIC)	Permanent	Owned (ADOT)	P, I	ADOT Motor Vehicle Division and Federal Motor Carrier Safety Administration
Instrumented Truck Escape Ramp	Permanent	Owned (ADOT)	T, E	Construction bid item
Emergency Roadside Call-boxes	Permanent	Owned (ADOT)	T	Grant (US 93)
Motorist Assist Patrols	Mobile	Leased (Contractor)	T, R	Construction bid item

* P=Power; T= Telephone; M= Microwave; I= Internet; S= Satellite; E= e-mail; R=Radio

The capital (installation) funding for the key ITI elements (e.g. VMS, RWIS) statewide is centrally controlled by TTG. ADOT Regional Traffic Engineering offices are provided with maintenance funding designed to cover the needs of all ADOT-maintained traffic control devices, including the ITI. ADOT Districts may use excess construction funds to install needed ITI or incorporate certain services, such as the US 93 motorist service patrols, into the project construction budget. ADOT Equipment Services works with Districts to determine appropriate specifications for and numbers of portable trailer-

mounted VMS to be purchased. The requested units are purchased using competitive procurement policy and procedures through ADOT Contracting. Equipment Services then “owns” the equipment and “rents” them to the Districts.

Periodically, ADOT receives demonstration project funds or grants, e.g., ADOT won a \$250,000 USDOT grant to fund the I-40 corridor traveler information kiosks deployment in the late 1990s. Other examples follow:

- In 1994, the Governor’s Office of Highway Safety awarded a grant to a multi-agency effort called Project Elk Alert. The grant was specified for use in installing two shoulder mounted VMS for elk warnings along State Routes (SR 260).
- In 1999, ADOT’s US 93 Mayday research project (6:16-18) recommended the installation of five callboxes along US 93 between milepost 136.8 and milepost 153.6, but the Kingman District had no funding to install them. One research TAC member, a nurse at the Kingman Regional Medical Center (KRMC), took the initiative of applying for a Department of Health Services grant to fund the callboxes. The Kingman District advised the KRMC on the grant application process, and when the grant was awarded, also supported the design and installation of a four-unit callbox system with the available grant money.

2.3 KEY ORGANIZATION ROLES

ADOT Transportation Technology Group (TTG) bears responsibility for planning, funding, installation and maintenance of ITI statewide. ADOT TTG is also responsible for the operation of the Phoenix Traffic Operations Center (TOC), which serves as the focal communications node for all Districts statewide as well as the emerging Tucson TOC. “Amber Alerts” issued by DPS are sent directly to the TOC and represent the TOC’s highest priority for posting of VMS messages. The TOC also responds to requests from the ADOT Districts to post VMS messages. The TTG plays an integral role in the establishment of VMS usage policies. TTG staff works with ADOT’s Information Technology Group (ITG) to provide hardware and software resources required to integrate the operation of the various ITS resources throughout the state. In doing so, TTG’s focus is on field equipment, communications, and the software applications that help control various ITI. ADOT TTG makes a multitude of critical decisions that shape ADOT’s rural ITS program, from determining device locations, to selecting specific vendors and products, to contracting for outsourced maintenance support, to identifying and programming the funding for all aspects of the program.

The ADOT Maintenance and Construction Districts are the primary end users of Arizona’s rural ITS. Their use of ITS includes monitoring field information systems such as RWIS, updating HCRS events, verifying event accuracy as posted in 511, developing and posting VMS and HAR messages, and sponsoring or providing resources for motorist assist patrols. The Districts field a significant level of phone calls and emails from the public about road and weather conditions and roadwork. In the course of performing these activities, they often coordinate with ADOT TTG, DPS and neighboring state departments of transportation. The Districts typically call on their Regional Traffic

Engineering personnel (RTEO) for support in the event of equipment problems. In the Kingman District, because of the unique nature of some of their rural ITI, some special arrangements have been made for equipment maintenance.

ADOT Information Technology Group (ITG) is responsible for installing and maintaining computer hardware, operating systems, and other software in support of many ADOT functions, including ITS. ITG contributions to rural ITS include: setup of central server systems and telephone lines for the VMS and RWIS remote camera sites; setup of HCRS terminals; setup of 511 subsystems; EPIC subsystems; and the Kingman District's instrumented truck escape ramps. ITG's focus is on providing the foundational hardware and operating systems to which TTG connects field equipment and on which TTG installs central control software.

ADOT Motor Vehicle Division (MVD), particularly the Ports of Entry (POEs), depends on rural ITS elements such as VMS, HCRS, PrePass and EPIC. VMS are used in conjunction with PrePass transponders to provide messages to commercial vehicle operators approaching the POE. Information on load width, clearance heights or other restrictions, available through 511 and based on information posted through the HCRS data entry system, facilitates the issuing or denial of permits. EPIC has recently been enhanced (EPIC II) to further facilitate and streamline international border crossing activities at Nogales on Arizona's border with Mexico.

ADOT Equipment Services Group has responsibility for purchasing new portable ITS equipment such as the portable, trailer-mounted VMS. They provide such equipment to the ADOT Districts at internal rental rates intended to ensure that they can repair or replace the equipment when breakdowns occur.

The Department of Public Safety (highway patrol) provides law enforcement on all of Arizona's state highways. The highway patrol districts coordinate closely with the ADOT districts and TTG on critical matters such as timing and duration of road closures (in the event of heavy snow, dust storms, hazardous materials accidents, etc.) and preparation of resulting detour routes. DPS also initiates "Amber Alerts" and may suggest specific usage for VMS in response to emergencies. DPS officers provide enforcement of reduced speeds and overall traffic control in highway construction zones. Supporting the DPS in rural areas of the state are their own Civilian Reserve volunteers as well as ADOT's motorist assist patrols (MAPs) on US 93. These programs reduce the demand on DPS resources by responding to minor motorist problems. Also, DPS highway patrol officers may be dispatched to respond to calls received from emergency roadside callboxes or to emergencies on truck escape ramps.

DPS Operational Communications Centers are regional dispatch centers that handle emergency ("911") calls, whether they come from regular landline or cellular telephones or from emergency roadside callboxes located along US 93 and I-19.

Neighboring State Departments of Transportation include California, Nevada, Utah, Colorado and New Mexico. A significant level of coordination of ITS-related issues

already takes place with these departments of transportation, often on an informal basis and at a sub-District level. ADOT maintenance staff in areas bordering other states will frequently need to know and communicate with their counterparts across the border (for instance, in response to incidents with potential cross-border impacts). Truck restrictions and other issues associated with the Hoover Dam, located on US 93, naturally require significant coordination with both Nevada and the Hoover Dam Police. Events such as the annual Four Corners Maintenance Conference (Arizona, Utah, Colorado, and New Mexico) are held to discuss shared issues and relevant technologies, including rural ITS. Despite differences in the level of ITS development and commitment to specific technologies in the neighboring states, many of the issues faced are similar from state to state. ITI for which some degree of coordination (or at least mutual understanding) is particularly important include VMS, RWIS, HCRS, 511, HAR and Commercial Vehicle Electronic Clearance (e.g., PrePass).

The National Weather Service (NWS) has an interest in accessing ADOT's RWIS data. While some of the RWIS data is available via the 511 website, the NWS has expressed interest in obtaining more complete data, more directly. At this point ADOT and NWS have not yet worked out all the details of data sharing. In one case, NWS has installed their own field equipment at the ADOT Willcox Maintenance Yard. The data from this equipment originally passed through the Phoenix TOC, but now is linked directly to a NWS computer in the Tucson area. ADOT staff provide a minimal level of support in checking the equipment and/or local computer server if any problems arise.

ADOT's highway contractors are frequently required to use specific ITS elements during construction projects, or, they simply find that certain ITS elements are cost effective to have on hand to enhance work zone safety. As a result, contractors often use or deploy portable trailer-mounted VMS, HAR, license plate readers, MAPs, and portable traffic signals. ADOT district staff frequently interfaces with the contractors throughout the course of highway project to obtain current information about construction activities and provide guidance on use of rural ITS elements, such as messages to be posted on portable trailer-mounted VMS.

Equipment Vendors: ADOT recognizes the need for continuing vendor support after making purchasing commitments to specific makes and models of rural ITS elements. This support is critical both during and after the warranty period. ADOT has established maintenance agreements with vendors to ensure both periodic preventive maintenance support and access to parts when device failures occur.

Third-Party Information Providers: ADOT districts sometimes outsource the public information tasks on construction projects. This frees up ADOT resources to focus on project management. Third-party information providers exist that specialize in providing turnkey HAR systems, from setup to broadcast updates to equipment maintenance and removal at the end of the project. Commercial radio stations, TV stations, and traffic information websites also provide traffic information to the public. This information can come in the form of Public Service Announcements (PSAs), or as regularly scheduled

programming. Such information is obtained both independently and with cooperation from ADOT.

2.4 PRIOR AND CURRENT RURAL ITS ACTIVITIES

ADOT and its partners are involved in research, planning, design, construction, operation, maintenance, and evaluation functions with regard to rural ITS. The following list summarizes some of ADOT's notable prior and current activities with respect to rural ITS. The next section provides details about Kingman District's rural ITS innovations.

- **Research and Planning:** ADOT's Arizona Transportation Research Center has performed many research projects in the past decade with ties to rural ITS, such as:
 - SPR-406: Advanced Traveler Information Systems for Rural Arizona (*not published, refer to 431*)
 - SPR-407: SCAN Weather System Evaluation (*not published; ref. 431, 457, 525*)
 - SPR-416: I-10 / I-17 Phase I Freeway Management System Evaluation
 - SPR-422: Strategic Plan for ITS Communication for Arizona
 - SPR-431: I-40 Corridor Strategic Plan for ITS Deployment (and the Short Term Implementation Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor)
 - SPR-435: Incident Management Systems & Strategies: TOC Operations Manual
 - SPR-457: Strategic Plan for Statewide Deployment of ITS in Arizona
 - SPR-466: Fuzzy Variable Speed Limit Device Project (Phases I and II)
 - SPR-473: Arizona Intelligent Vehicle Research Program (Phases I, II, II(b), III)
 - SPR-480: Rural Highway MAYDAY Deployment Plan
 - SPR-481: RHODES-ITMS-MILOS Ramp Metering System Test
 - SPR-485: Arizona Statewide Alternate Route Plan
 - SPR-497: Arizona Statewide Incident Management Plan
 - SPR-507(3): Tourism's Impact on Future Transportation Needs
 - SPR-507(4): Technology and ITS: The Implications for Future Transportation
 - SPR-512: ITS Traffic Data Master System (*in progress*)
 - SPR-513: Alternate Routing Information System (ARIS)
 - SPR-525: Road Weather Information System (RWIS) Communications Plan
 - SPR-532: Variable Speed Limit Research (Phase III) (*not published*)
 - SPR-535: CVISN Safety Information Exchange Needs Assessment, Nogales Port of Entry
 - SPR-542: Congestion Mitigation Resources and Strategies for Arizona's State Highway System
 - SPR-561: Transportation Communications Interoperability: Phase 1 - Needs Assessment
 - SPR-562: ITS Technologies and Mature Drivers

Additionally, the TTG has developed and periodically updates the ADOT Statewide ITI Plan (5). Currently, ADOT Districts are in various stages of planning for use of ITI. For instance, the Kingman District is considering deployment of "advanced" HAR for dissemination of information for travelers approaching key decision points.

- **Design:** ADOT is involved in ongoing design of ITS infrastructure.
- **Construction / System Enhancement:** ADOT is involved in ongoing construction of ITS infrastructure. ADOT is actively involved in enhancements to the 511 system and the az511.com website.
- **Operation:** ADOT Districts, TTG, MVD and contractors are involved in the operation of rural ITS throughout Arizona.
- **Maintenance:** ADOT Districts, TTG, ITG, RTEOs and Equipment Services (with contractor and vendor support when required) are involved in the maintenance of rural ITS throughout Arizona.
- **Evaluation:** Through this project (SPR-570), ADOT is evaluating rural ITS statewide.

2.5 KINGMAN DISTRICT INNOVATIONS

The Kingman District is a leader in the innovative use of ITS for rural applications. The District has aggressively pursued obtaining the maximum benefit from the available hardware, which includes:

- **Shoulder-Mounted (Semi-Permanent) Variable Message Signs (VMS)** – Kingman is currently the only ADOT District that has installed shoulder-mounted VMS on semi-permanent basis. The shoulder-mounted VMS have radar capability and are used to display speed warning messages and HAR station information.
- **Speed Detection/Warning Devices** - Kingman is the only ADOT District to have installed a permanent speed detection/warning device. The District coordinated with the City of Kingman because the device is located so close to the city boundary, but ADOT is the sole owner and operator of the device. The District is working to standardize the messages provided on such devices.
- **Highway Advisory Radio (HAR)** - The District is a leader in the use of HAR for construction projects and is currently planning to implement what would be Arizona's first "Advanced HAR" system, to provide route, condition and incident information to drivers approaching decision points at key junctions.
- **Emergency Roadside Callboxes** - Only the Kingman and Tucson Districts have emergency roadside callboxes. The Kingman District's callboxes were procured via a grant application by an outside local agency working together with ADOT.
- **Instrumented Truck Escape Ramps** - The Kingman District is the only ADOT District to have instrumented their truck escape ramps with sensors, cameras, shoulder-mounted VMS, and communications to provide a warning system of ramp occupancy to the TOC, the District, and highway users upstream of the ramps.
- **License Plate Readers** - Kingman is the only ADOT District to have managed a project for which the contractor made use of license plate readers to verify travel times through the work zone.
- **Motorist Assist Patrol (MAP)** - The Kingman District is the only ADOT District currently sponsoring a MAP in conjunction with a construction project, and pioneered the operation of a MAP during the nighttime. As one US 93 project is completed, the MAP becomes part of the next project, thus assuring continuity of service.

