Final Report
Model Deployment of a Regional, Multi-Modal 511 Traveler Information System

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by:

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Executive Summary

This document presents the findings of the national evaluation of the 511 telephone traveler information system "Model Deployment" in Arizona. The United States Department of Transportation (U.S. DOT) National 511 Model Deployment supported a wide range of enhancements to the existing statewide Arizona 511 system, including the addition of several new types of information and significant redesign of the user interface.

On July 21, 2000, the Federal Communications Commission assigned 511 as the nationwide traveler information telephone number and granted responsibility for it to government transportation agencies. Since that time, 27 statewide and regional 511 systems have been implemented throughout the United States, including the Arizona system.

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) jointly sponsored the Arizona 511 Model Deployment. The Model Deployment sought to demonstrate the potential of 511 services to bring together data from various sources and provide useful information to travelers through a state-of-the-art telephone interface. The national evaluation documented costs and lessons learned, measured the accomplishment of the implementers' hypothesized project impacts, and assessed the extent to which the Arizona 511 project satisfied the following U.S. DOT objectives for the Model Deployment:

- "Push the envelope" on the production and dissemination of quality traveler information.
- Utilize a voice recognition user interface and a menu that balances comprehensive information with ease-of-use.
- Provide information automatically, with no operator needed, and provide users the ability to request information for specific segments of roadways, such as "I-10 in Phoenix" rather than providing them information only at the less specific "route level", that is, "I-10" for the entire state.
- At a minimum, provide a comprehensive set of basic, multi-modal traveler information including roadway congestion, incidents and construction; major transit service disruptions; special events; and abnormal road weather conditions.

Key Recommendations to 511 Deployers

A list of lessons learned is presented later in this Executive Summary and discussed in greater detail in the body of the report. This section highlights the most significant of those lessons learned in the form of recommendations to 511 deployers. The recommendations are as follows:

1. **If specific, near-term impacts are important, prioritize and focus your 511 implementation.** The Arizona Model Deployment consisted of a very broad, ambitious slate of enhancements, none of which were explicitly identified as more or less important. The Model Deployment approach reflected ADOT's traditional "evolutionary-opportunistic" approach to incrementally enhancing their 511 system with the long-term objective of a generally improved system. 511 deployers who have

specific performance levels in mind or who are trying to effect specific changes in 511 usage or travel behavior are strongly encouraged to utilize a directed, "problem-solving" approach. Such an approach would identify a small, manageable and measurable list of specific objectives and then concentrate resources in those few areas.

2. **Voice recognition is not "plug and play"; expect to spend considerable resources on its implementation.** Although voice recognition technology is widely deployed, its successful application to 511 systems is challenging. Statewide, multi-modal 511 systems strain the limits of the technology due to the very large number of potential utterances that the system must detect. Although basic implementation of a voice recognition system is relatively straightforward, troubleshooting, modifying, and testing the system to achieve acceptable performance are very resource intensive. Because of the complicated nature of voice recognition and the changes in technology, agencies that do not have up-to-date technical expertise in-house may consider "turn-key" firms that specialize in voice recognition services. Deployers should expect to devote considerable attention to the testing and refinement of a 511 voice recognition system before it goes on-line.

3. **Pursue a vigorous, targeted 511 marketing program.** Marketing is essential to building awareness and stimulating usage of 511 systems. This Model Deployment demonstrated that dynamic message signs as part of a marketing campaign are highly effective in reaching en-route travelers. It is especially important to market any significant new features or information content enhancements to existing 511 systems so that users know about them. This Model Deployment indicated that simply adding new features and information is not sufficient to stimulate usage. Targeted marketing to the user subgroups who would be interested in the new information is especially important.

4. **In the early planning stages, thoroughly investigate institutional and technical issues associated with data input by partner agencies.** Many of the Model Deployment enhancements that were not completed or not fully successful depended on data entry by new 511 partners. Several of these agencies committed to this role in principle during the very early stages of the Model Deployment (during preparation of the funding proposal) but for various reasons did not fulfill that role. If dependent on key data from other agencies, 511 deployers are strongly encouraged to thoroughly investigate the issues that could impact the ability of partners to deliver data as envisioned and to resolve key issues before moving forward.

5. **Incorporate mechanisms for capturing user feedback for system evaluation.** Because many of the benefits of traveler information systems such as 511 are qualitative, it is important to be able to capture users' experiences as a way of evaluating the system's performance. Although ADOT was initially reluctant to interrupt callers as part of a user survey process, the evaluators and system designers were able to develop and implement a procedure that minimally inconvenienced callers, yet permitted capturing valuable information about the ways that users interacted with the system. This information not only revealed how callers were using the system but also where improvements were needed to make the service easier to use and provide better travel information.

Description of the Model Deployment

The Model Deployment was led by the Arizona Department of Transportation (ADOT) and assisted by a 511 Task Force composed of Tucson and Phoenix area Metropolitan Planning Organizations, airport and transit operators, and other county and municipal transportation agencies. The enhanced 511 system became operational in mid-December 2003.

Table ES-1 identifies the 18 planned Model Deployment enhancements and their operational status relative to the one-year, January – December 2004, post-deployment evaluation period. The enhancements fall into four general categories:

- New information content including arterial streets, airports, etc.
- A redesigned user interface, including conversion from touch-tone (keypad) input to voice recognition and from user selection of roadway information by entire roadway (e.g., "I-10") to roadway segments (e.g., "I-10 in Phoenix").
- Enhanced 511 marketing consisting of advertisements on ADOT dynamic message signs (DMS) statewide, printed materials, radio advertisements, and 50 static roadside signs deployed statewide.
- Partnership with a commercial information provider for fee-based, premium 511 service.

As noted in Table ES-1, 9 of the planned 18 Model Deployment enhancements were deemed by the Evaluation Team to be fully operational and suitable for evaluation within the evaluation period. None of the planned 18 Model Deployment enhancements were considered by the deployers to be more critical than any others, and there was, therefore, no explicit prioritization of the enhancements. However, when it became clear that not all of the enhancements could be implemented concurrently, efforts were focused on the basic user interface enhancements—voice and segment-based road information—which suggests that these may have been viewed as more important. Work continues on all of the unimplemented enhancements with the exception of the partnership with a private premium service provider, which has been dropped. No qualified private partner responded to the ADOT request for partnership proposals.

Table ES-1. Model Deployment Enhancements and Status

Enhancement	Fully Complete & Operational within the Evaluation Period	Completed & Operational After the Evaluation Period	Not Currently Complete & Fully Operational	Comments
Information Content				
Tucson and Phoenix Local Street Data		■		ADOT's plan to increase their capture of arterial street incidents through more intensive monitoring of law enforcement scanners was carried out. However, inputs by cities and counties have been negligible. Inputs by the Tucson region are pending (training has been completed as have necessary map updates); Phoenix area agencies are making a limited number of inputs.
Transit Major Service Disruptions and Call Transfer Capability	■			The original plan called only for Phoenix and Tucson Transit, but the menu system and call transfer capability have been extended to include all regional/rural transit providers statewide.
Phoenix Bus Rapid Transit Estimated Arrival Times			■	Transit currently unable to provide data. Enhancement not implemented and unavailable for evaluation.
Phoenix Arterial Street Travel Times			■	Data collection system completed and now being tested; not available for evaluation.
Data Quality Enhancements	■			Enhanced 511 data entry operator training and 511 message preview function to see how entries will be conveyed on 511.
Phoenix and Tucson Airport Information	■			Phoenix has used the 2-minute message recording capability but Tucson has not.
Grand Canyon National Park Information		■		All necessary technical elements are in place (menu changes and voice-recording capability). During the evaluation period, the Park was not entering any information but now intends to.
Arizona Office of Tourism Call Transfer	■			An unplanned enhancement requested by the Office of Tourism.
Segment Weather Information		■		Came on-line after completion of evaluation.

Table ES-1. Model Deployment Enhancements and Status (Continued)

Enhancement	Fully Complete & Operational within the Evaluation Period	Completed & Operational After the Evaluation Period	Not Currently Complete & Fully Operational	Comments
Downtown Phoenix Special Events and Parking			■	There has been no discernable change in data capture techniques or the type and volume of information in the system.
Sharing Data with Other States (i.e., Utah)			■	Under development. Not available for evaluation.
User Interface				
Regional Roadway "Quick Reports"	■			
Roadway Segment-Based Reporting	■			
Roadway Info. Accessible Via Roadway Name	■			
Voice Recognition	■			
Other				
Premium Service Partnership			■	No viable private partnership proposal was received.
Marketing		■		The only incomplete elements are the 50 static road signs throughout the state, which are being installed now.
Improved System Performance Monitoring	■			Not all data analysis and reporting functions have yet been utilized but many new capabilities have been established and many of them have been used by ADOT.

Evaluation Approach

The evaluation was conducted on behalf of the FHWA by Battelle Memorial Institute in partnership with the University of Arizona. Volpe National Transportation Systems Center served as Evaluation Program Manager on behalf of the FHWA ITS Joint Program Office. The evaluation included four major analyses:

- Usage – Several types of system data, including detailed computer logs of each call into the 511 system, were used to analyze the following usage parameters: call volumes and patterns, including during several special events (e.g., wildfire, winter storm, the DMS ad campaign, and month encompassing the conversion to the enhanced system); call frequency; call durations; wire line vs. cell phone calls; caller geographic location; menu selections; call transfers; system capacity; and unrecognized caller inputs. Data were analyzed over a one-year period and, where baseline data allowed, pre- and post-enhancement data were compared.
- User Survey – 411 users of the 511 system were surveyed to gauge their satisfaction with the enhanced system and reaction to specific features. Users were intercepted by a live survey recruiter during their call to the 511 system and the interview was conducted in a separate, follow-up phone call.
- Enhancement Process – Lessons learned associated with the design, implementation, and operation of the enhanced 511 system were developed through interviews and workshops with 511 Task Force members.
- Costs – Detailed cost information was collected for the baseline and enhanced 511 system, categorized by phase (i.e., planning, implementation and operation), type (i.e., hardware and software/engineering), and enhancement. The total capital (i.e., non-recurring) cost to enhance the system was about $1.4 million, much greater than the approximately $355,000 investment to establish the pre-enhanced system. Operations and maintenance costs for the first post-enhanced year were about $293,000, compared to the pre-enhanced $140,000.

Results

Overall, the Model Deployment succeeded in dramatically improving the Arizona 511 system, although it was not fully successful in a number of respects. Through both the accomplishments and shortcomings of the Model Deployment, a number of insights have been gained that will be useful to ADOT and their 511 partners as well as other 511 deployers around the country. This section summarizes major accomplishments, challenges, lessons learned, and findings regarding hypothesized project impacts.

Major Accomplishments

Major accomplishments of the Model Deployment include:

- Conversion to a voice recognition user interface; touchtone remains an option.
- Conversion to segment-based roadway reporting.
- In response to user requests, addition of regional roadway "Quick Report" congestion and incident summaries.
- Addition of call transfer options to airports, the Arizona Office of Tourism, and all of Arizona's rural/regional transit operators.
- The addition of a 2-minute voice recording capability for transit and airport operators for providing announcements via 511.
- Significant enhancement of 511 coverage, to full statewide coverage.
- No significant 511 system down-time as enhancements were implemented.

In addition to these system enhancements, the Model Deployment facilitated a number of other broader benefits, including:

- Solidification of a 511 philosophy of customer service and continuous quality improvement at ADOT, including many new tools to support on-going system performance monitoring (detailed system data reports) and customer service (e.g., caller comment line).
- Implementation of the first formal Arizona 511 marketing campaign, including a very effective week-long, 24 hour-a-day dynamic message sign (DMS) advertising (Figure ES-1).
- By demonstrating a long-term commitment to the 511 system and establishing it as a truly multi-modal, statewide source of integrated, multi-agency information, the 511 Task Force has created a focal point for, and invigorated, multi-agency ITS operations coordination. Most notably, the Model Deployment resulted in a major increase in the time and attention that the ADOT Traffic Operations Center Information Technologies (IT) Manager—who essentially served as Deputy Model Deployment Project Manager—devotes to the 511 system. One of the most important parts of this greatly expanded role and attention is that the IT Manager now regularly attends the multi-agency AZTech (i.e., Phoenix region ITS) Advanced Traveler Information Systems (ATIS) Committee meetings and his involvement has reinvigorated regional traveler information coordination efforts.

Figure ES-1. 511 Marketing via Dynamic Message Sign

In several important respects, the Model Deployment was well received by users. About 70% of surveyed callers were satisfied with information content. When interpreting user feedback, it is important to note that the Arizona 511 user base is changing rapidly. Call volumes during the one-year evaluation period increased 74% over the prior year (Figure ES-2) and much of the increase was from new 511 users. The week-long 511 DMS advertising was very effective in stimulating calls to the system. Daily call volumes increased three-fold during that time and just over one-third of surveyed callers reported seeing the DMS advertisements (note the May 2004 spike in Figure ES-2). By the time of the caller survey almost six months later, one-third of surveyed users were new callers, that is, the 511 call during which they were intercepted for survey recruitment was their first ever call to Arizona 511 (Figure ES-3).

Comparing the experience of new callers to 511 with that of previous callers provides useful insight into how well the service is performing and how likely it is to retain callers over time. It should be noted that 511 is not heavily utilized even by most repeat callers, among whom half reported that they made three or fewer calls in the last month and virtually all of them were seeking road information. Within that context repeat callers report high levels of satisfaction with the information they receive and cite several specific benefits in using the 511 system; for example, saving time/arriving on time and avoiding traffic congestion due to accidents or construction delays were each cited by about 20% of repeat callers. While most first-time callers also expressed overall satisfaction with the service, they were less likely to articulate specific benefits than were repeat callers and, indeed, 31% said they received no benefit from using 511 the first time they called. In addition, when asked about improvements to 511 that they would recommend, first-time callers tended to want more types of improvements than did repeat callers. On the other hand, repeat callers placed a higher premium on two specific areas for improvement: speech recognition and more details on traffic congestion and delays. While 95% of first-time callers said they would use the service again, surely on future calls to 511 the service must begin to deliver clear benefits to them for them to be converted to regular users.

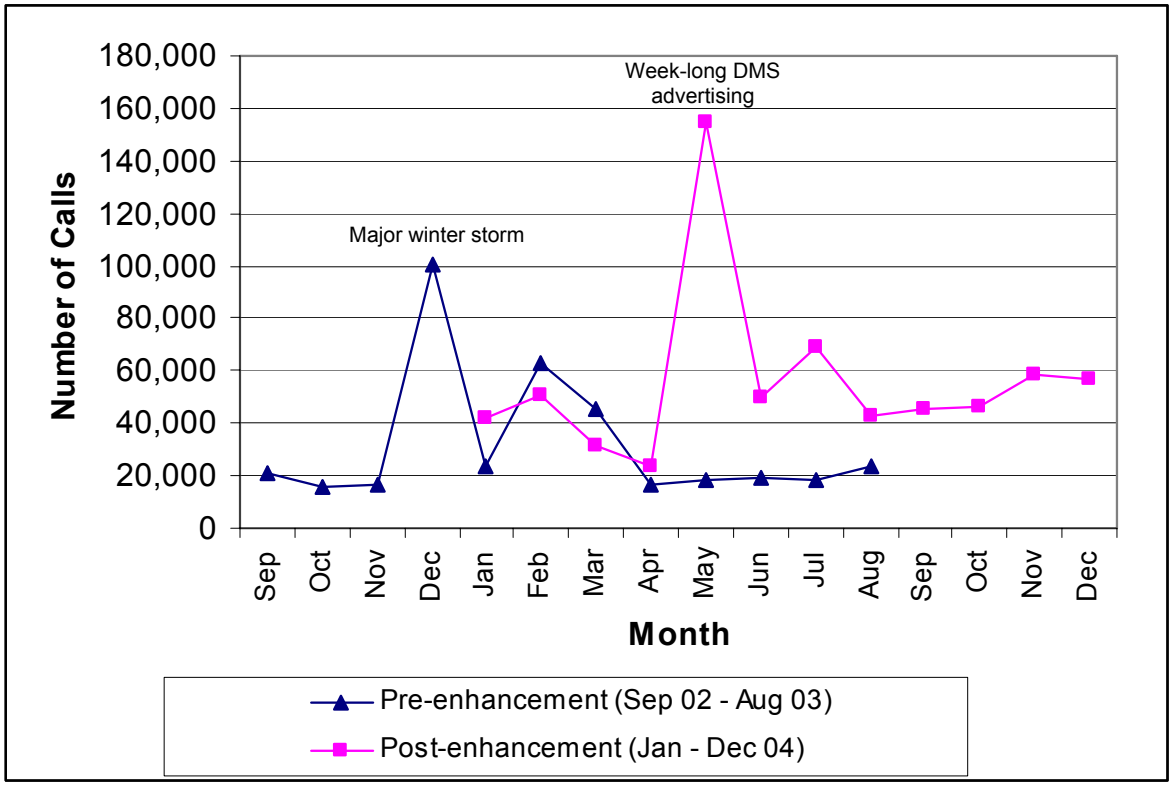


Figure ES-2. Monthly Call Volumes

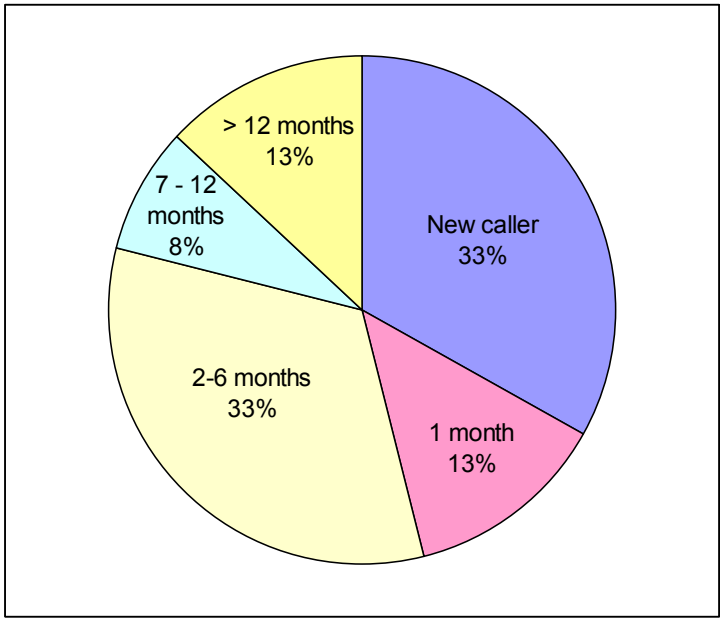


Figure ES-3. Percent of Callers by How Long Ago They First Used 511 (n=404)

Challenges

The major challenges or shortcomings of the Model Deployment are that many of the planned enhancements were not completed within the evaluation period (several of these have since been completed), some 511 partner agencies have not taken significant advantage of their new capabilities to provide information via 511, new information types are not being used significantly by most users, and many users are dissatisfied with the performance of the voice recognition system.

As indicated in Table ES-1, half of the 18 planned enhancements were not fully operational in time for the evaluation, or were not being utilized in a manner that would support evaluation. With the exception of the private partnership, which was cancelled, efforts are continuing on all of the unimplemented enhancements. Delays resulted from a variety of factors not uncommon to complex technology implementations, including assorted technical challenges and limited agency staff resources. That is, ADOT found that there was a limit to how many enhancements they could simultaneously pursue.

Several enhancements were only partially implemented. In a few of these cases, ADOT added the capability for data entry but the partner agency did not, during the evaluation period, take advantage of it. This was the case with the Grand Canyon National Park, Tucson airport, and Phoenix-area municipal traffic information enhancements. In the case of municipal traffic agencies, they indicated that they lack the senior agency support necessary to devote resources to collecting and entering this information into 511.

With regard to user reactions to the Model Deployment, there are two primary concerns. First, very few users consulted the new information available on the 511 system (i.e., tourism, airports, and roadway Quick Reports). Combined, these items accounted for less than 8% of all menu selections over the one-year evaluation period. The vast majority of menu selections—92%—were for the two basic types of pre-enhancement information, roadways and transit. Of those selections, nearly all (91%) were for roadways. These findings are at least in part a result of the fact that, during the evaluation year, little 511 marketing promoted the new types of information to travelers who would have been interested, and, therefore, most were presumably unaware of its availability. They may also be related to the quality or depth of the information available on 511, although very small sample sizes for users of these non-roadway options prevented definitive conclusions. It may also relate to the availability of other options for non-roadway information. In the case of transit, the low utilization relative to roadways reflects very low transit usage—1.2% of all person trips in the Phoenix region.

The second concern from a user perspective is the relatively high levels of dissatisfaction with the performance of the voice recognition feature. About 35% of repeat callers who choose to use voice recognition as their primary means for accessing the service said they were dissatisfied with the feature, and 49% of new callers were dissatisfied. The difficulties with voice recognition are reported on both cell and landline phones and both while holding a receiver and speaking hands free. The performance of the voice recognition system is clearly not acceptable to a large number of users. System data provide support to the perception of voice recognition problems. Over the one-year operational period, 37% of all calls included at least one user input that could not be interpreted by the system. That number was 58% during the first month of

voice recognition operation. The voice recognition feature was the most commonly recommended area for improvement among both new and repeat callers.

Lessons Learned

The major lessons learned of the Model Deployment consist of the following:

- **Invest in formal planning and design documents (e.g., system requirements).** ADOT indicated that the significant efforts that went into developing the Program Plan and System Requirements Definition documents during the design phase were instrumental to the successes of the Model Deployment.
- **Solicit user input during design and system refinement.** Prior to the Model Deployment ADOT had very little input from 511 users. As part of the Model Deployment design effort, several focus groups were conducted with travelers. ADOT found these focus groups very illuminating and one specific enhancement—the regional roadway Quick Reports—came about based directly on focus group input. During the first few months of enhanced system operation 511 caller comments were very useful in identifying and correcting voice recognition system problems.
- **Plan for voice recognition development and refinement to be resource intensive.** A great deal of effort, significantly more than anticipated, was devoted to the voice recognition implementation. The costs for this enhancement, about $560,000, were 61% higher than estimated. The vast number of individual user utterances to which the system must respond, the many Spanish and Native American place name location references, and the significant revision and expansion of the transit portion of the menu all contributed to the magnitude of the voice recognition implementation and refinement effort.
- **Conduct marketing targeted to potential users of new information types.** Even with a large percentage of new users each month, as is the case with the Arizona 511 system, most users do not consult new, non-roadway menu options (i.e., tourism and airports). Targeted marketing of these resources appears to be a necessary, if not necessarily sufficient, activity to stimulate usage of this information.
- **Consider DMS marketing for reaching roadway information users.** Although the lasting impact of short-term DMS marketing is unclear, short-term impacts appear dramatic. During the week-long, 24-hour/day, statewide DMS ad campaign in Arizona, daily 511 usage increased three-fold. Predictably, given the en-route exposure to DMS, the percentage of cell phone calls also spiked—to 83%, up from the post-enhancement pre-DMS campaign level of about 30%.
- **Don't assume a regional, multi-modal 511 systems will "replace" transit customer information lines.** Transit operators believe 511 lacks necessary capacity and that many transit requests can only be handled by customer service agents. They are reluctant to divert callers from the staffed information lines they've spent considerable resources to establish awareness of among their customers. Phoenix and Tucson transit plan to

implement their own interactive voice response systems, although they are open to increasing integration with the 511 system.

- **Vigorously build support among local agencies for their input of roadway information.** Most local agencies have limited congestion and incident information and often lack the staff resources to enter it into a 511 system. Substantial efforts should be anticipated to secure support for 511 data collection and entry among the senior municipal and county agency leaders who provide the resources and technical staff who will be responsible for data entry. Efforts should be made to link 511 systems directly with agencies' construction and incident databases so as to minimize the need for "dual entry" by local agencies (i.e., entering information once into their own system and a second time into the 511 system). Efforts to integrate public safety computer-aided dispatch (CAD) systems with 511 databases should also continue.

Hypothesis Testing Results

A number of hypothesized project impacts were tested as part of the evaluation. Table ES-2 presents the results for the key hypotheses. Some hypothesized impacts were fully supported by the evaluation and others were partially supported or not supported, consistent with the mix of successes and challenges described on the preceding pages.

Table ES-2. Evaluation Results for Key Hypothesized Impacts

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Increase ***usage*** of the 511 system.	The addition of a number of new data types will contribute to increased usage of the 511 system. [NOT SUPPORTED]	• The overall call volume in the post deployment period increased by 74% compared to the same period before the enhancement. However, the old information categories accounted for 91% (Roads) and 2.4% (Transit) of all information requests in the post-enhancement period. The new information categories accounted for 4.3% (Quick Reports), 1.3% (Airports), and 0.4% (Tourism) of all information requests. Thus, it cannot be concluded that new data contributed substantially to increased usage.
	Usage of the 511 system will increase as a result of enhanced marketing. [SUPPORTED]	• During the week-long DMS marketing campaign, call volume increased by a factor of 3.1. Ninety-six percent of the callers during the campaign were new users—they had not used the system in the last five months—and 86% were calling from wireless phones. The DMS marketing campaign, though short-lived, was extremely effective in publicizing the 511 service to highway users. • Based on the survey results, the other marketing activities that were implemented (i.e., distribution of materials at the state fair and freeway opening ceremonies and radio advertisements over an approximately two-week period) had much less of an impact. Nine percent cited the radio ads, and only 2% of respondents cited ADOT as their source of awareness.

Table ES-2. Evaluation Results for Key Hypothesized Impacts (Continued)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Contribute to high levels of ***customer satisfaction*** with the 511 system.	Users will view the information available on the 511 system as comprehensive and multi-modal. [PARTIALLY SUPPORTED]	• Surveyed callers overwhelmingly (90%) used the system to obtain road information for the trip they were taking. Very few (<1%) accessed transit, airport, and tourism information. • 97% of surveyed repeat users viewed 511 as covering the areas and routes in which they are interested. However, only 26% agreed that 511 covers all the bus services of interest. With so very few callers using bus information, the measure cannot be considered reliable. • Only 5 repeat callers had ever used the airport and only 6 had used tourism information. This number was too few to draw conclusions about customer satisfaction with these content areas.
	Users will be satisfied with the quality of the information on the 511 system. [SUPPORTED]	• 71% of surveyed callers expressed overall satisfaction with information they received for the trip they were taking. For each of the high-level menu items selected, satisfaction with the quality of information was even higher. • For all the times they've used 511 the majority of surveyed repeat callers expressed satisfaction with most all the road content. The exception was regional Quick Reports, which was rated a 46% satisfaction level. • 82% of surveyed repeat callers perceived traffic information on 511 to be accurate and timely. • In comparing 511 to radio, a source used by 72% of surveyed callers, 43% of callers felt that that the quality of traffic information on 511 was better, 29% said it was about the same, and 28% thought the radio was better.
	Enhancements to the user interface, including voice recognition, segment-based reporting, and "Quick Reports" will contribute to customer satisfaction. [PARTIALLY SUPPORTED]	• Although voice recognition is used by the majority of callers, it has its drawbacks and receives lower satisfaction ratings than phone buttons. First-time callers are less satisfied with voice recognition than repeat callers. The principal reasons for dissatisfaction were that 511 did not understand the spoken request, 511 gave the wrong information, and background noise caused interference. The problems were not related exclusively to either cell phones or hands free mode, based on survey results. • Segment-based reporting for road information was a feature with which 84% of repeat callers expressed satisfaction. • Regional Quick Reports received mixed reaction for callers. Only 8% of callers used the feature for the surveyed trip, but 73% of them were satisfied with the information they received. On the other hand, most repeat callers had at some time tried Quick Reports, but only 46% of them found them satisfactory. It appears that callers prefer to access specific roads of interest rather than go to the regional summaries.

Table ES-2. Evaluation Results for Key Hypothesized Impacts (Continued)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Promote ***efficiency*** of the 511 system.	The efficiency of information dissemination will be promoted through enhanced arterial street data capture, data entry operator training, and data quality control procedures. [PARTIALLY SUPPORTED]	• The volume of arterial street information input by ADOT increased dramatically as a result of their intensified monitoring of police scanners. Annual entries of this type increased from 234 (2% of the total) to 2,763 (14%). • Information input by Phoenix area cities and counties increased negligibly, from pre-enhanced average of 15 entries per year to 45 entries in the post-deployment year of operations. • No information was input by Tucson area city and county agencies during the post-enhancement period. These agencies achieved the ability to do so only late in the one-year operational period (2004). They intend to begin doing so sometime in 2005. • Interviews with ADOT data entry personnel and other ADOT 511 staff indicate that significant changes have been made that they view as enhancing data quality. Refinements were made to roadway information location references. A key new preview function was added allowing data entry operators to see how their input will be translated to a 511 message. The data entry operator's manual has been revised and training has been conducted on new procedures and features.

Concluding Observations

ADOT's approach to 511 has traditionally been evolutionary and opportunistic—they incrementally enhance the system over extended periods of time with the timing and nature of enhancements significantly impacted in the short-term by funding opportunities and partner interests. This approach was carried into the Model Deployment.

FHWA objectives for the Model Deployment were fairly broadly defined—essentially to "push the envelope" in as many ways possible—and the few specific requirements were not particularly challenging (i.e., certain types of information content were specified but the depth and quality of information was not.) The timeline was also tight—basically providing about a year for planning, design and implementation of a wide range of major enhancements.

Rather than suggesting mediocre success, the outcome of the Model Deployment is really a function of the confluence of ADOT's traditional evolutionary, opportunistic approach, a very ambitious slate of enhancements, and a relatively tight schedule. The fact that several of the enhancements have been completed since the end of the formal evaluation period (e.g., segment road weather information) and that work proceeds on all of the others with the exception of the premium service partnership, also indicate that the success of the Model Deployment—if measured strictly by enhancements completed—is largely a function of perspective.

511 deployers and the agencies that contribute 511 funding should have a shared, explicit understanding of their objectives and how realistic they are in light of resource constraints and the deployers' 511 strategy. If short-term unequivocal successes in many areas are required, those expectations and associated measures of success should be clearly communicated and the deployer should gear their approach accordingly.

1.0 Introduction

1.1 Purpose of this Document

This document presents the findings of the national evaluation of the 511 telephone traveler information system "Model Deployment" led by the Arizona Department of Transportation (ADOT). The United States Department of Transportation (U.S. DOT) National 511 Model Deployment supported a wide range of enhancements to the existing ADOT 511 system, including the addition of several new types of information and significant redesign of the user interface.

On July 21, 2000, the Federal Communications Commission assigned 511 as the nationwide traveler information telephone number and granted responsibility for it to government transportation agencies. Since that time, approximately 27 statewide and regional 511 systems have been implemented throughout the United States, including the current Arizona statewide 511 system.

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) jointly sponsored the Arizona 511 Model Deployment. The Model Deployment sought to demonstrate the potential of 511 services to bring together data from various sources and provide useful information to travelers through a state-of-the-art telephone interface. The national evaluation assessed the extent to which the Arizona 511 project satisfied the objectives of the Model Deployment, which were to:[1]

- Illustrate how the innovative application of technologies can create a highly effective 511 service that sets a standard for high quality telephone traveler information and "push the envelope" on the production and dissemination of quality traveler information.
- Utilize an innovative user interface that promotes ease of use without compromising the user's expectation for personalized information and allows callers to locate the content they desire quickly and efficiently. The user interface must take advantage of proven voice-recognition, voice response, and synthesized speech technologies.
- Provide information to callers automatically on a route segment or corridor basis, with no direct contact necessary between callers and human operators.
- At a minimum, the information content on the 511 system shall include:
  - current traffic conditions;
  - major service disruptions for public transportation properties;
  - current information on active construction and maintenance projects along route segments that may affect traffic flow or restrict lanes;
  - unplanned events, major incidents, or congestion that shut down or significantly restrict traffic for an extended period;

[1] 511 Model Deployment Solicitation, Federal Register: January 16, 2002 (Volume 67, Number 11), Federal Highway Administration, Federal Transit Administration.

- transportation-related information associated with significant special events (fairs, sporting events, etc.); and
- abnormal weather or road surface conditions that could affect travel along the route segment.

The national evaluation of the 511 Model Deployment is intended to generate findings that will help shape U.S. DOT approaches to 511 and that will be of use to others implementing and operating 511 systems. The national evaluation is the primary mechanism for documenting the performance of the Model Deployment and the lessons learned. This report presents an overview of the Model Deployment, the evaluation approach, and the findings of the evaluation.

1.2 Overview of the Model Deployment

The Arizona Department of Transportation (ADOT) led the 511 Model Deployment in partnership with other transportation agencies in the Phoenix and Tucson regions. The 511 Model Deployment implemented a number of key enhancements to the previous statewide 511 system. That prior system became operational in March 2002 when ADOT converted their ten-digit telephone information system, which had been operational for several years, to 511. The planned enhancements to the 511 system included:

- new content on arterial streets, airports, neighboring states (Utah), transit (major service disruptions and estimated arrival times), weather, and downtown Phoenix special events and parking;
- a complete redesign of the menu system, conversion from a keypad system to voice recognition, conversion from highway route-based reporting to segment-based reporting;
- enhanced 511 marketing; and
- partnership with a private, for fee, premium service information provider.

ADOT received the award of the Model Deployment in July 2002 and immediately began the planning and design process. Starting in August of that year, meetings of the 511 Task Force (the name of the 511 Model Deployment committee) were held periodically. A draft Program Management Plan document was completed in November 2002 that includes an overall schedule and high-level scopes of work for the various enhancements. At that same time, a draft System Requirements Document was completed that identifies the requirements for the various enhancements. Implementation of the system began in early 2003. The enhanced 511 system was rolled out in mid-December 2003, with many of the planned system enhancements included, such as several new data types, a complete redesign of the menu system, and implementation of voice recognition. The one-year Model Deployment operational period extended from January through December 2004.

Battelle Memorial Institute is conducting the national Model Deployment evaluation. Battelle was given notice to proceed in September 2002. Battelle is working in partnership with the local evaluator, Dr. Mark Hickman, Assistant Professor at the University of Arizona. Dr. Hickman is consulting to ADOT, providing the required local evaluation of the Model Deployment.

1.3 Overview of the Evaluation Approach

1.3.1 Evaluation Objectives

Nationally, implementation of 511 is still in its early stages. Twenty-seven 511 systems have been set up in the U.S. to date, but many other locations are still considering or planning 511 deployments. Clear "best practices" have yet to emerge in a number of technical and institutional areas. Key questions include how much transit information should be made available directly on 511 versus transferring callers to existing transit agency customer information systems; how to interface with other states' 511 systems in border regions; how much of the cost of 511 should public agencies pay and what sorts of private sector partnerships may be possible; and how to accommodate additional information while keeping menu systems easy to use. The Model Deployment and this evaluation are intended to address these questions.

Specific objectives of the U.S. DOT evaluation of the 511 Model Deployment are to:

- Provide an independent review of the performance of the Model Deployment, including the extent to which it accomplishes the national objectives (which are summarized in Section 1.1).
- Document how the Model Deployment was implemented, including system costs and how technical and institutional issues (especially cross-modal and interstate issues) were resolved.
- Provide ADOT and their 511 partners with feedback that will allow them to improve the effectiveness of the system.
- Deliver lessons learned that will inform the U.S. DOT 511 effort and that will be of use to agencies operating and planning to implement 511 systems.

1.3.2 Evaluation Phasing

The evaluation was conducted in three phases. Table 1-1 identifies the phases, the associated time frames, and the major milestones associated with each evaluation phase. Phase I consisted of the evaluation planning and collection and analysis of baseline (pre-enhancement) data. Phase II consisted of the analysis of the Model Deployment enhancement process and included participation in the local 511 project meetings, two rounds of stakeholder interviews and two rounds of lessons-learned stakeholder workshops. Phase III consisted of the collection and analysis of post-enhancement data, covering a full year of post-enhancement 511 operations. Phase III data collection included a variety of 511 system data collected on a monthly basis (call volumes, phone bills, phone system server log files, etc.) and a survey of 511 users.

Table 1-1. Evaluation Phasing and Milestones

Evaluation Phase	Dates		Milestones	
	Start	End	Activity/Deliverable	Date
Phase I – Planning and Baseline Analysis	August 2002	February 2004	Evaluation Plan	October 2003
			Detailed Test Plans	October 2004
			Interim Analysis Report	February 2004
Phase II – Enhancement Process Analysis	August 2002	February 2005	First Round Stakeholder Interviews	December 2003 – January 2004
			First Round Lessons Learned Workshop	February 2004
			FHWA Interim Enhancement Process Briefing	February 2004
			Second Round Stakeholder Interviews	December 2004 – January 2005
			Second Round Lessons Learned Workshop	February 2005
Phase III – Post Enhancement Data Analysis	January 2004	May 2005	One-Year Enhanced 511 Operations Period	January 2004 – December 2004
			User Survey	October-November 2004
			Complete Post-Enhancement Data Collection	January 2005
			Draft Evaluation Report	March 31, 2005
			Final Evaluation Report	May 31, 2005

1.3.3 Model Deployment Objectives and Hypotheses

In addition to capturing information on deployment and management issues, lessons learned, and costs, the evaluation attempted to test a number of specific hypotheses. The hypotheses were developed by the evaluation team based on the planned 511 enhancements. The hypotheses fall into three of the National ITS Goal Areas: customer satisfaction, mobility, and efficiency. The hypotheses that were planned for testing are listed below. Key hypotheses are shown in bold type.

Usage Hypotheses

- **The addition of a number of types of new data to the 511 system will contribute to increased usage. The new data include information pertaining to:**
  - **Downtown Phoenix parking and special events**
  - **Transit**
  - **Airports**
  - **Arterial streets (including travel times for selected routes)**

  - **Utah roadways**
  - **Segment weather information.**

- **Usage of the 511 system will increase as a result of enhanced marketing.**
- The enhanced 511 system will retain more users.

Customer Satisfaction Hypotheses

- **Users will view the information available on the 511 system as comprehensive and multi-modal.**
- **Users will be satisfied with the quality of information on the 511 system.**
- **Enhancements to the user interface, including voice recognition, segment-based reporting, and "Quick Reports" will contribute to customer satisfaction.**

Mobility Hypotheses

- The addition of transit information, downtown Phoenix information, and a top-level menu selection for the Grand Canyon will promote mobility and access.
- Access to arterial street travel times will allow users to avoid congestion and reduce travel time and travel time variability.
- 511 usage will expose travelers to transit information and encourage consideration of transit as an alternate mode.

Efficiency Hypotheses

- Acceptable system availability/reliability will be maintained through the enhancement process and after the enhancement.
- Menu system enhancements will minimize the number of unrecognized caller inputs.
- **The efficiency of information dissemination will be promoted through enhanced arterial street data capture, data entry operator training, and data quality control procedures.**

1.3.4 Evaluation Analyses

Evaluation analyses were developed to test the hypotheses presented in Section 1.3.3 and to support the analysis of the enhancement process (e.g., lessons learned). The analyses are organized into individual "tests," with each test focusing on particular types of data. The tests and their relationship to the major focal points of national Intelligent Transportation System (of which 511 systems are an example) evaluations are shown in Table 1-2. In addition to these formal tests, a cost analysis was performed and various other types of supporting data were collected and analyzed to aid in the interpretation of test results and to identify management and deployment issues and lessons learned.

Table 1-2. Evaluation Tests

Analysis Area	Tests		
	Usage [1]	User Survey	Stakeholder Interviews
Customer Satisfaction	X	X	
Mobility	X	X	
Efficiency	X	X	X
Management and Deployment Issues			X

[1] The analysis of system usage included consideration of system data content (inputs from the various agencies that supply data to the system) and the reliability (e.g., system downtime) and availability (phone line utilization) of the system.

Table 1-3 identifies the general division of responsibilities for the evaluation activities between Battelle and the Local Evaluator, Dr. Mark Hickman of the University of Arizona. For each test, activities were very closely coordinated between Battelle and Dr. Hickman to ensure that all evaluation needs were met.

Table 1-3. Evaluation Lead and Support Roles by Evaluation Activity

Evaluation Team Member	Usage Logs Test	User Survey Test	Stakeholder Interviews Test	Cost Analysis
Battelle	Support	**Lead**	**Lead**	**Lead**
University of Arizona	**Lead**	Support	Support	Support

The usage analysis consists of three main components. The primary component of the test is the analysis of 511 system usage data based on data gathered from phone system server log files and, in the case of the baseline analysis, electronic phone bill records. The secondary component consists of an analysis of the performance of the 511 system in terms of system downtime and phone line availability/utilization.

The user survey featured a post-enhancement survey of 511 users, conducted in late October and early November 2004, about 9 months after the roll out of the enhanced 511 system. A percentage of calls into the 511 system were intercepted and callers were recruited to participate in a brief survey, which was administered later in a separate call to users who agreed to be surveyed. Approximately 400 completed surveys were obtained. The survey included questions focusing on users' utilization of the system (frequency of use, what sorts of trips, at what stage in the trip, cell phone versus landline, etc.), their satisfaction with the system (ratings of information types, ratings of accuracy/timeliness, ratings of overall satisfaction, perception of

benefits, favorite and least favorite aspects, etc.), and recommended improvements. A decision was made not to undertake a comparison of the enhanced service with the original service because the service had changed substantially and because of the impracticality of trying to find a sufficient number of users of both versions of the 511 service. Thus, the objective of surveying users was to measure their satisfaction with the enhanced system.

The stakeholder interviews were conducted in two rounds. The first occurred in January 2004, shortly after the roll out of the enhanced 511 system. The second round occurred in January 2005, just after the end of the one-year Model Deployment operational period. The interviews were a primary mechanism for collecting lessons learned and other data related to the enhancement process. Interview results were also used in the testing of efficiency-related hypotheses and to support the analysis of costs.

1.4 Scope and Organization of the Final Report

This report presents the results of the national evaluation of the 511 Model Deployment along with context-setting information on the evaluation approach (this section), the Arizona context for traveler information (Section 2.1), and a description of the specific Model Deployment enhancements as planned, and as implemented and available for evaluation (Section 2.2). Section 3.0 describes the data collection approaches associated with the evaluation analyses.

The results of the usage analysis and user survey are presented in Sections 4.0 and 5.0, respectively. Section 6.0 summarizes the results of the hypothesis testing, drawing upon all of the evaluation analyses. Sections 7.0 and 8.0 present the results of the enhancement process and cost analyses, respectively.

The final section, Section 9.0, summarizes major findings and lessons learned. Section 9.0 also presents a number of recommendations for consideration by 511 deployers.

2.0 Model Deployment Context and System Description

2.1 Project Context

2.1.1 Arizona's Geographic Context for Traveler Information

The population of Arizona at the time of the 2000 Census was approximately 5.1 million. Geographically, the vast majority of the state is rural, although 88% of the population resides in urban areas.[2] Over two-thirds of the state's population is concentrated in two counties: Maricopa and Pima. Maricopa County (3.1 million) is located in central Arizona and includes the City of Phoenix and most of the greater Phoenix Metropolitan Area. Pima County (843,000) is located in southern Arizona and includes the greater Tucson Metropolitan Area. Both the Cities of Tucson and Phoenix are partners in the 511 Model Deployment. The overall population density of the state is about 45 persons per square mile (ranked 36 in the US) compared to the overall average for the United States of 80 persons per square mile. Arizona has grown quickly over the last several decades. Between 1990 and 2000, the population increased 40%. Figure 2-1 identifies major cities and highways in Arizona.

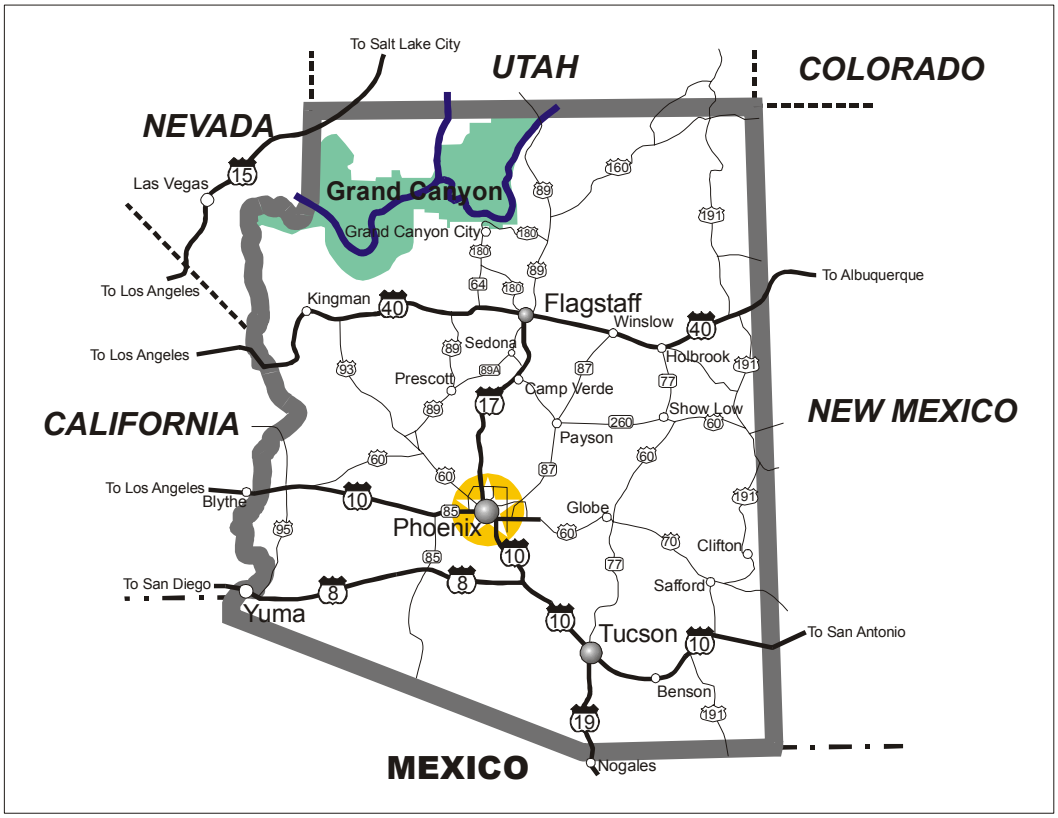


Figure 2-1. Location Map

[2] Bureau of Transportation Statistics, 1990 Census figures; July 2003, www.bts.gov/publications/transportation.

Arizona is a major destination for US and international tourists. Arizona ranked 13th among US states in travel and tourism, with approximately 550,000 international visitors in 2002.[3] Major attractions include the Grand Canyon and over 30 other national parks and monuments; vacation resorts in Phoenix and Tucson; old west towns like Tombstone, Bisbee, and Jerome scattered throughout the state; and the "red rock country" surrounding Sedona. The Grand Canyon National Park alone had over 4 million visitors in 2002.[4]

Arizona's highway system includes three major east-west Interstate Highway routes: I-8 in the southern portion of the state that serves as one of the major routes between Phoenix and San Diego; I-10 in the central portion of the state that links Phoenix with the Los Angeles area to the west and to southern New Mexico to the east; and I-40 in the north. Both I-10 and I-40 are major international trade corridors. Arizona is traversed by two major north-south interstates: I-17, which links Tucson, Phoenix and northern Arizona, and I-19 which links Tucson with Nogales, located on the international border with Mexico. Several major international border crossings with Mexico are situated in Arizona, including San Luis Rio Colorado (in the west), Nogales (central), and Douglas (east).

Both the Tucson and Phoenix regions are characterized by low-density development and heavy reliance on the personal vehicle for transportation. In both urban areas a very low percentage of total person trips are made by transit—in the Phoenix region the Maricopa Association of Governments, the Metropolitan Planning Organization for the area, estimates that transit trips comprise about 1.2% of total trips. Traffic congestion is significant in Phoenix, but below the levels of the most congested urban areas in the United States, such as Los Angeles, San Francisco, Chicago, and Washington, D.C. According to the 2000 Urban Mobility Study conducted by the Texas Transportation Institute (TTI), which studied 75 urban areas in the United States, Phoenix ranked 11th based on the "travel time index." The travel time index measures the amount of additional time needed to make a trip during a typical peak travel period in comparison to free-flow speeds. The average travel time index for all 75 urban areas is 1.39. Phoenix's travel time index of 1.40 is just above that average and indicates that a trip that would take 20 minutes at free-flow speed takes about 28 minutes (20 x 1.40 = 28). For comparison, the most congested urban area—based on the travel time index—is Los Angeles with 1.90. Of the ten urban areas that have travel time index values higher than Phoenix, eight of them are between 1.41 and 1.47, indicating that relatively little separates Phoenix from most of the more congested locations.

Tucson is much smaller than Phoenix and is far less congested. With a travel time index of 1.20, Tucson ranks 40th among the 75 urban areas studied by TTI. Although below the average for all 75 urban areas (1.39), the Tucson travel time index is just above the average for urban areas of similar size (1.18).

Both Tucson and Phoenix have well-developed grid networks of major arterial streets at one-mile spacing. Consequently, in both areas there are a number of alternative routes for the portion

[3] United States International Trade Administration, Office of Travel and Tourism Industries web site (http://tinet.ita.doc.gov), July 2003.
[4] National Park Service web site, http://www2.nature.nps.gov/stats/, 2003.

of trips using local streets. However, both areas were relatively late in beginning to develop their urban freeway systems and there are very few viable alternate freeway routes in these areas.

Many miles of Interstate, State, and US Highway routes in Arizona are located in high-altitude areas that receive considerable snow and ice, thus making winter-weather traveler information important. These high-altitude areas encompass most of northern Arizona, including the Grand Canyon area; I-40, which traverses east-west across Arizona and is a major national freight corridor; Flagstaff; and large portions of eastern Arizona.

2.1.2 Traveler Information Services Prior to the Model Deployment

ADOT 511 System

For several years prior to 511, ADOT operated a ten-digit statewide road conditions telephone information system, which they termed the "Voice Response Activated System" (VRAS). ADOT converted that system to "511" in March 2002, keeping the ten-digit number in operation. Before it was enhanced by the Model Deployment, the 511 system allowed users to obtain either highway (state highways and interstates) or transit information (via routing to transit agencies' customer information systems) using touch tone (keypad) menu selections. Information was updated every 5 minutes. Figure 2-2 illustrates the system menu structure prior to the Model Deployment.

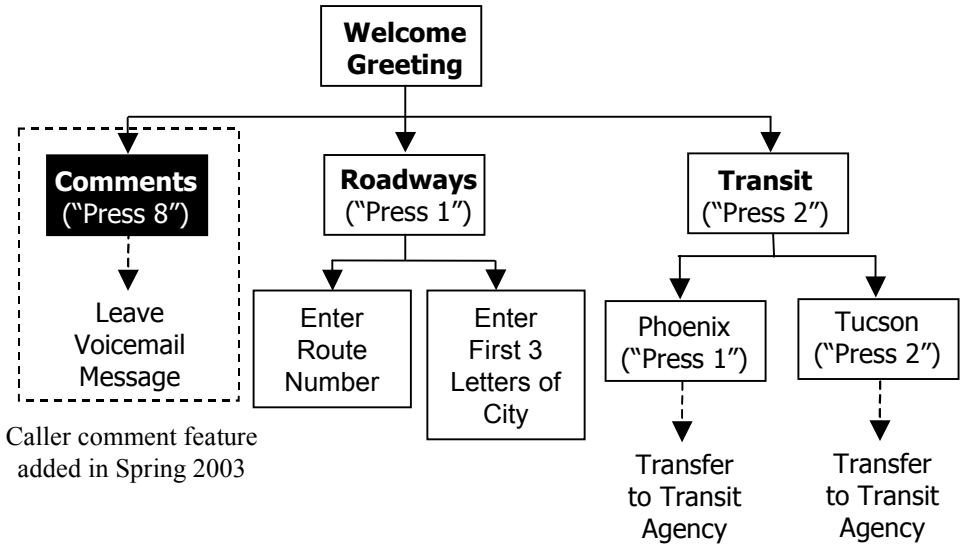


Figure 2-2. Pre-Enhanced ADOT 511 System Menu Structure

All transit information requests in the pre-enhanced 511 system were call-forwarded to the transit agencies where they were handled by the agencies' existing system; no transit information was provided directly through the 511 system. For highway information, users entered the route number of the highway and were provided recorded messages describing various "events,"

including roadway construction, closures, incident reports, weather updates, etc. The user could not request information for only a portion of a given highway. Rather, once a given road was selected, all events pertaining to locations along the entire length of the route were described, in sequence, based on mile post marker. Events were not prioritized; that is, incident-related events were not reported first. Users could also receive reports on local arterial streets in Maricopa County by entering the first three digits of the city in which they wanted information. Historically, however, this feature very seldom had information available, because the local agencies that are the source of that information did not regularly enter information into the system.

Figure 2-3 illustrates the major components of the pre-enhanced 511 system. The ADOT Highway Condition and Reporting System (HCRS), shown in the lower right portion of the diagram, is the database that fed information to the 511 system (and still does) as well as the ADOT traveler information website (not shown). HCRS was developed in the mid-1990s by ADOT principally as a means of coordinating the construction and maintenance activities among various ADOT jurisdictions statewide; the "C" and "R" stood for "Closures" and "Restrictions." However, the potential benefits of providing this information to the public were soon realized, and HCRS was linked to both a website, where a statewide traffic map with various traveler information icons was made available, and a ten-digit statewide telephone traveler information system. That ten-digit phone system and website were co-branded as the "Trailmaster" system.

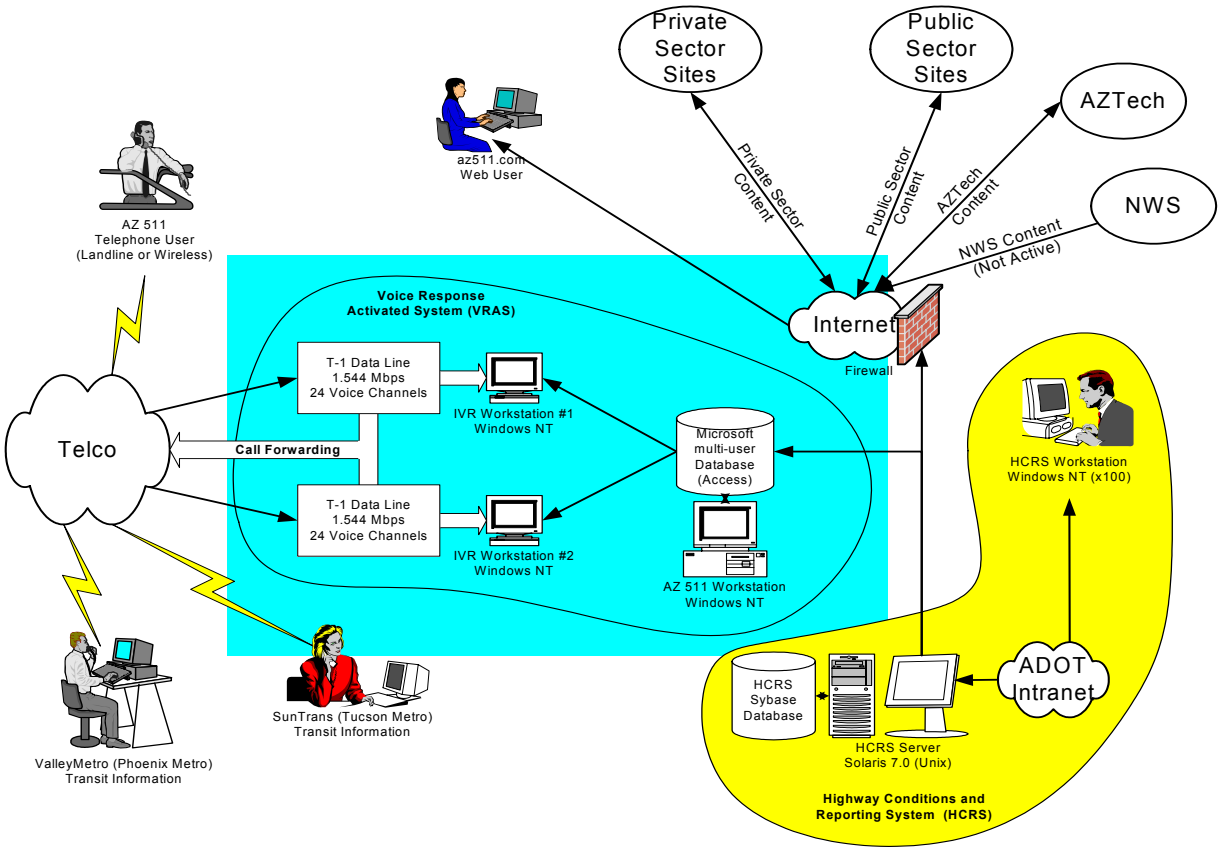


Figure 2-3. Pre-Enhanced ADOT 511 System Diagram

Information was, and is, entered into HCRS via the Internet from HCRS workstations located at ADOT facilities statewide, including the nine ADOT District Offices and field offices within each District. As indicated in the upper right portion of Figure 2-3, members of the AZTech ITS consortium could also input information to HCRS [including the local traffic jurisdictions and Department of Public Safety in the Phoenix region that compose the regional AZTech ITS consortium]. AZTech was created as part of the Phoenix Region Metropolitan Model Deployment Initiative (MMDI) in the late 1990s. In years past, as part of the I-40 Traveler and Tourism Information System (TTIS) deployment, approximately 20 additional organizations in the I-40 (Northern Arizona) Corridor also had the ability to enter information into HCRS. These agencies included Chambers of Commerce, a private tour operator, Arizona Department of Emergency Management, Grand Canyon National Park, and 911.

HCRS events are entered via an on-screen event form, which includes a number of different fields. HCRS event entries are translated to roadway advisory messages automatically. That is, the information in key fields, including location (type of route, such as "interstate" or "state route;" route number and direction, such as "eastbound") and the subject matter of the event, expressed using International Traveler Information Interchange Standard (ITIS) "category" and "description" information, is pulled from HCRS and converted to a synthesized speech message. The message is then pushed from the HCRS server to the VRAS server that powers the 511 service.

The pre-enhanced VRAS included a server and two T-1 phone line processors, or "boxes" as ADOT refers to them. Each T-1 unit included 24 voice channels or phone lines. Consequently, the 511 system could accommodate up to 48 incoming calls simultaneously.

Other Traveler Information Systems

Aside from the 511 telephone system and the customer service telephone lines at the major transit operators, the other major public traveler information dissemination tool in Arizona was the ADOT traveler information web site, as indicated in the upper center portion of Figure 2-3. At about the same time that ADOT converted their ten-digit telephone information number to 511 in March 2002, they co-branded their existing traveler information web site, adding the 511 logo and making the site reachable via either http://az511.com or the previous address of http://azfms.com. The ADOT traveler information web site draws information from the same data engine as the 511 system: HCRS. The pre-enhanced web site[5] contained three types of information, as shown at the top of Figure 2-4. The main page contained still images and live views from closed-circuit television cameras located on freeways throughout the Phoenix area. A color-coded map of the Phoenix freeway system contained congestion and construction information. A statewide map contained "clickable" icons showing highway closures, restrictions, accidents, and weather information. Figure 2-5 shows the Phoenix area color-coded freeway conditions map. Figure 2-6 shows the statewide roadway conditions map.

[5] Various enhancements were made to the website over the last couple of years, including throughout the model deployment.

Figure 2-4. ADOT Traveler Information Web Site Main Page

Figure 2-5. ADOT Web Site Freeway Conditions Map

Other sources of traveler information in Arizona include traditional commercial broadcast radio and television, which feature peak hour traffic condition reports oriented toward urban area commuters. As part of the AZTech MMDI, cable TV traffic information was established in four jurisdictions in the greater Phoenix area. Traveler information is also provided on websites operated by a number of Independent Service Providers in the Phoenix area, including the Travel Advisory News Network (http://traffic.tann.net/) and Tele Atlas/Metro Networks (http://www.aztech.org/traffic2.htm). Both services were initiated as AZTech partnerships and both provide regional traffic maps containing information provided by ADOT, and are similar in format to the ADOT Phoenix region traffic map that is available on the ADOT AZ511 website. Figures 2-7 and 2-8 present the Phoenix region traffic maps from the Tele Atlas and Travel Advisory News Network websites.

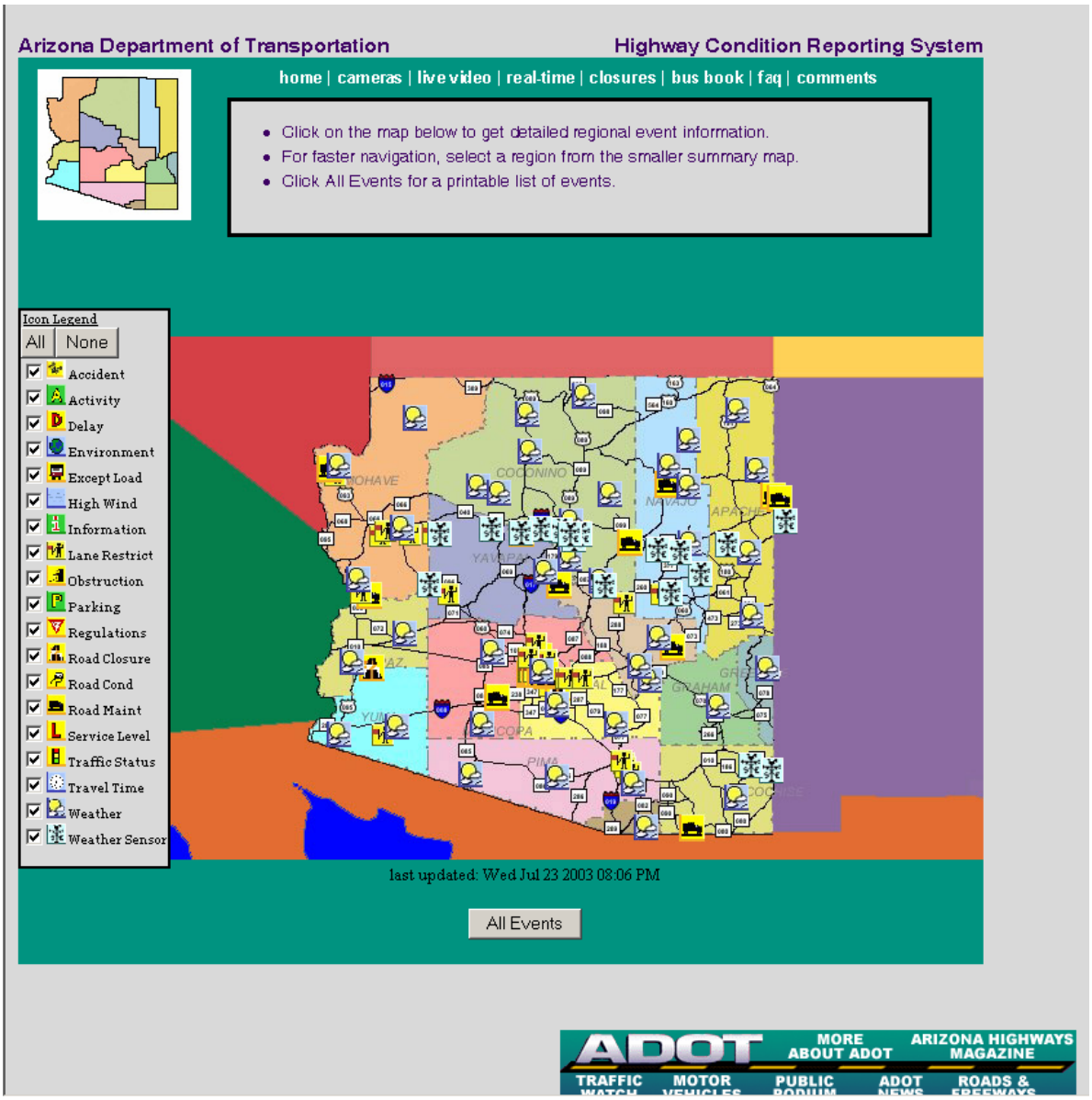


Figure 2-6. ADOT Web Site Statewide Traveler Information Map

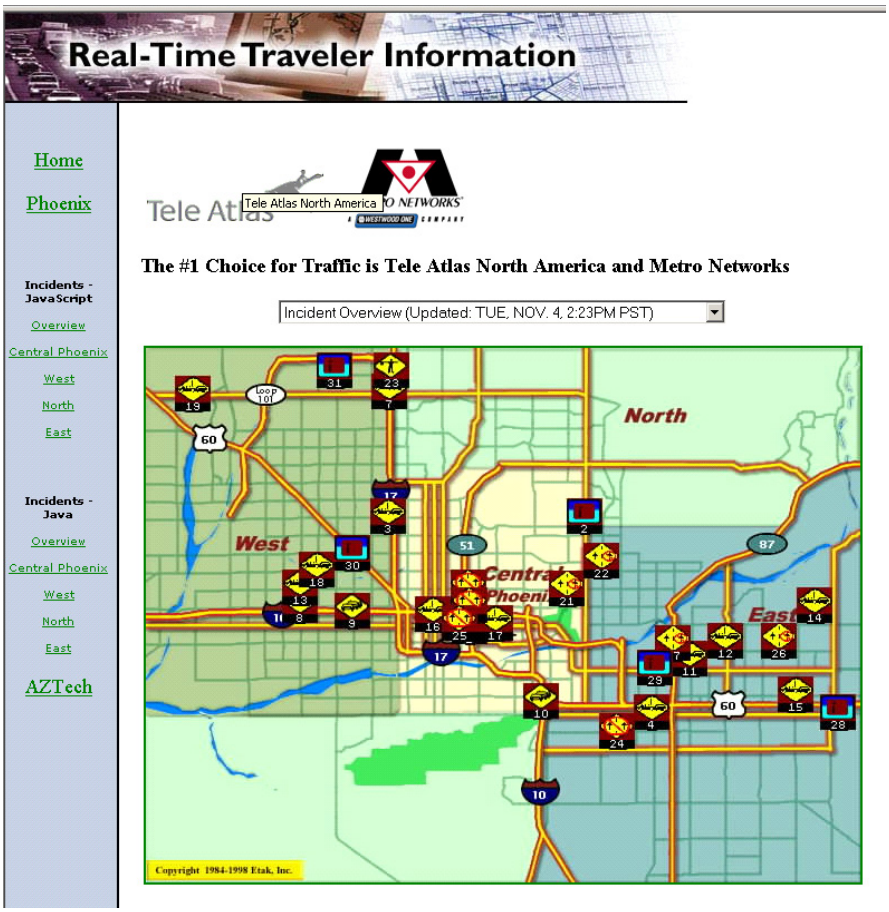


Figure 2-7. Tele Atlas/Metro Networks Phoenix Region Traveler Information Map

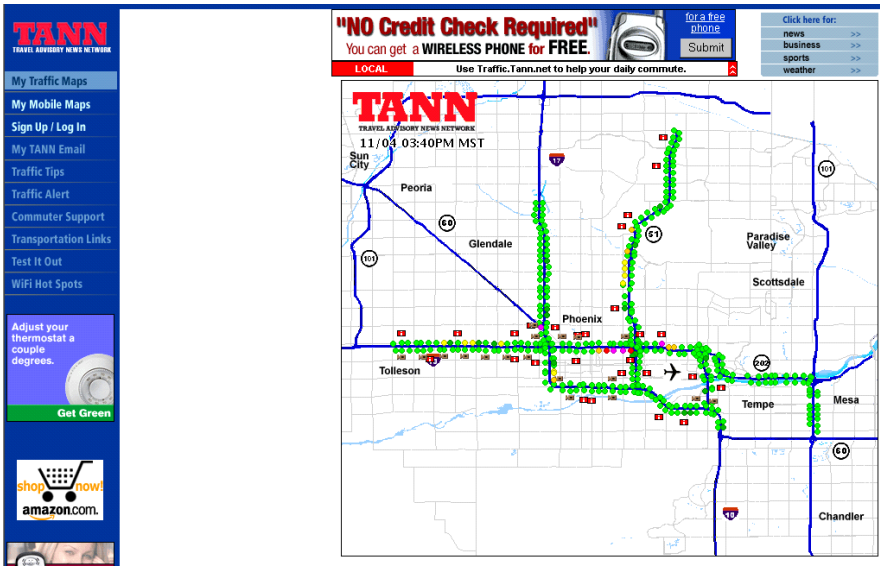


Figure 2-8. Travel Advisory News Network Phoenix Region Traveler Information Map

2.2 511 Model Deployment Enhancements

2.2.1 Planned Features for the Model Deployment

The plan for the Model Deployment included numerous enhancements to the existing ADOT 511 system. The planned enhancements can be divided into three major categories: information content enhancements, telephone system interface enhancements, and other enhancements.

Planned information content improvements included a wide range of new data types, including information on arterial streets; downtown Phoenix events and parking; airport information; additional weather information (including information from the state's Road Weather Information System); and information from Utah. Planned system interface improvements included converting to voice recognition, with the previous touch tone option retained as an alternative; a complete redesign of the menu system to accommodate new data types; roadway segment and region-based reporting of roadway conditions rather than only at the roadway level; and reporting of roadway conditions based on named roadways (e.g., "Maricopa Freeway") rather than only route numbers (e.g., "I-10"). Other planned enhancements included a premium service partnership, marketing of the 511 system, and enhanced system performance monitoring capabilities. Table 2-1 lists and describes the various planned Model Deployment enhancements.

Table 2-1. Planned Model Deployment Enhancements

Type of Enhancement	Enhancement	Comments
Information Content	Tucson and Phoenix Local Street Data	Pre-enhanced system contained very little information and what was included was input by ADOT based on police radio scanner monitoring.
	Transit Major Service Disruption Information and Call Transfer Capability	To include a 2-minute voice recording where major service disruptions can be noted and an option to transfer to the Phoenix or Tucson transit agencies' customer service lines.
	Phoenix Bus Rapid Transit Estimated Arrival Times	Estimated arrival times for some of the Phoenix-area bus rapid transit stops.
	Phoenix Arterial Street Travel Times	Travel times for four North Phoenix arterial streets paralleling I-17.
	Data Quality Enhancements	Various enhancements, including refinement of landmarks and terminology used in HCRS and operator training.
	Phoenix and Tucson Airport Info.	To include a 2-minute voice recording where conditions can be summarized and other sources of information referenced and the ability to transfer to Phoenix and Tucson airport customer service lines.
	Grand Canyon Info.	To include information on travel conditions impacting park visitors, including roadway and parking conditions, information on shuttle services, etc.

Table 2-1. Planned Model Deployment Enhancements (Continued)

Type of Enhancement	Enhancement	Comments
Information Content (Con't)	Segment Weather Info.	To utilize a new National Weather Service (NWS) data product—2 kilometer grid weather reports—to provide weather information for Arizona roadway segments.
	Downtown Phoenix Special Events and Parking	To include enhanced information on downtown Phoenix special events and parking information, including possibly data from the Downtown Phoenix Parking Management System, such as real-time parking occupancy information.
	Sharing Data with Other States (Utah)	To include exchange of roadway condition data with the Utah Department of Transportation. Utah data to be included in roadway segment reports for Arizona roadway segments near the Utah border.
User Interface	Regional Roadway "Quick Reports"	To provide a region-based (e.g., "Central Phoenix" or "East Phoenix Valley") summary of major roadway conditions.
	Roadway Segment-Based Reporting	To provide roadway information at the segment level (e.g., "I-10, California Border through Phoenix") rather than the previous route level (e.g., "I-10), in which every incident on an entire route, statewide, was provided.
	Roadway Info. Accessible Via Roadway Name	To provide roadway information for named roadway segments (e.g., "Maricopa Freeway") rather than only by route number (e.g., "I-10").
	Voice Recognition	To provide a comprehensive voice recognition interface (with touch tone backup) rather than the former touch tone only system.
Other	Premium Service Partnership	Establish a partnership with a commercial information provider to provide one or more 511 premium (for fee) services, such as customized information.
	Marketing	Implement a 511 marketing program consisting of a media kit and press releases; 50 static highway signs throughout the state; dynamic message sign references to 511; public service radio announcements; printed materials (rack cards, pamphlets); and promotional items (key chains, etc.). The pre-enhanced 511 system was not marketed. The only media exposure it received was during the initial conversion from the former 10-digit number to 511 and when ADOT and Department of Public Safety personnel referred the public to 511 during wildfires in June and July 2002.
	Improved System Performance Monitoring	Establish the ability to preserve a wide range of data (such as phone server log files); tabulate useful data (e.g., tally selections for various menu items); and generate reports.

2.2.2 System Features Available for the Evaluation

From the beginning, the Arizona 511 Model Deployment was envisioned by both the FHWA and by ADOT and their 511 partners as "pushing the envelope." As indicated in Table 2-1, wide-ranging enhancements were planned for the Model Deployment, including many new types of data to be provided by organizations not previously involved in the Arizona 511 system. The enhancements also involved a complete overhaul of the menu system and user interface, introduction of a 511 marketing program, and partnership with a commercial information provider. Despite the ambitious goals, not all of the planned 511 enhancements were completed in time, or in a manner, to support the evaluation activities identified in the Evaluation Plan document.[6]

Part of the reason that several of the Model Deployment enhancements were delayed and were not operational within the evaluation period is that the enhancements were implemented in a phased manner. Mid-way through the implementation process, in approximately July 2003, ADOT recognized several factors that made completion of all of the enhancements unlikely by the time of the planned enhanced system roll out in the fall of 2003. Data availability was a key factor. Several types of new data, including data from other states, segment weather, and estimated bus arrival times, were not going to be available in 2004. Staffing resource constraints were another factor. ADOT and consultant personnel were fully engaged in implementing the fundamental user interface enhancements and were unable to move forward simultaneously on the other enhancements. In view of these factors, ADOT determined that the on-time roll out of the major user interface enhancements could be jeopardized by continued attempts to move forward on all enhancements. As a result, ADOT decided to explicitly phase the enhancements, postponing several until 2004 or 2005. Most of those enhancements were not available for evaluation. As discussed in Section 8.0, this phased approach also meant that 2004 included both operations and continuing implementation, which has implications in differentiating implementation and operations costs.

Most of the enhancements shown in Table 2-1 that have been implemented were rolled out by ADOT on December 17, 2003, when the enhanced service was launched, and were included in the evaluation. Also included were two unplanned enhancements, which were not part of the original Model Deployment concept but were identified during design and implementation as desirable features. Those consist of the addition of a call transfer capability to the Arizona Office of Tourism and expansion of the transit menu system to include all of the regional/rural transit providers throughout Arizona.

[6] "Final Evaluation Plan: Model Deployment of a Regional, Multi-Modal 511 Traveler Information System"; Battelle for FHWA; October 15, 2003.

Ultimately, 7 of the 17 individual planned Model Deployment enhancements shown in Table 2-1 were either not operational or not fully operational (i.e., not all features operational or utilized) during the Model Deployment evaluation period and therefore not available for evaluation. Several of these 7 enhancements were completed in the sense that a capability for new data input was established by ADOT, but not fully operational because agencies did not input data. The marketing enhancement is another example of a partially completed enhancement. All of the planned activities were completed within the evaluation time frame except for installation of the 50 static 511 road signs statewide, which was deferred until later in 2005. A few of the enhancements have simply been delayed, usually due to unavailable data, and are still planned for implementation. The estimated bus arrival times and segment weather information are examples of these types of enhancements. Only one enhancement has been formally canceled, the premium service partnership. In that case an effort was made but no viable partner was identified. Table 2-2 summarizes the status of each of the planned enhancements relative to the evaluation. Figures 2-9 and 2-10 show the post-enhanced Arizona 511 menu system.

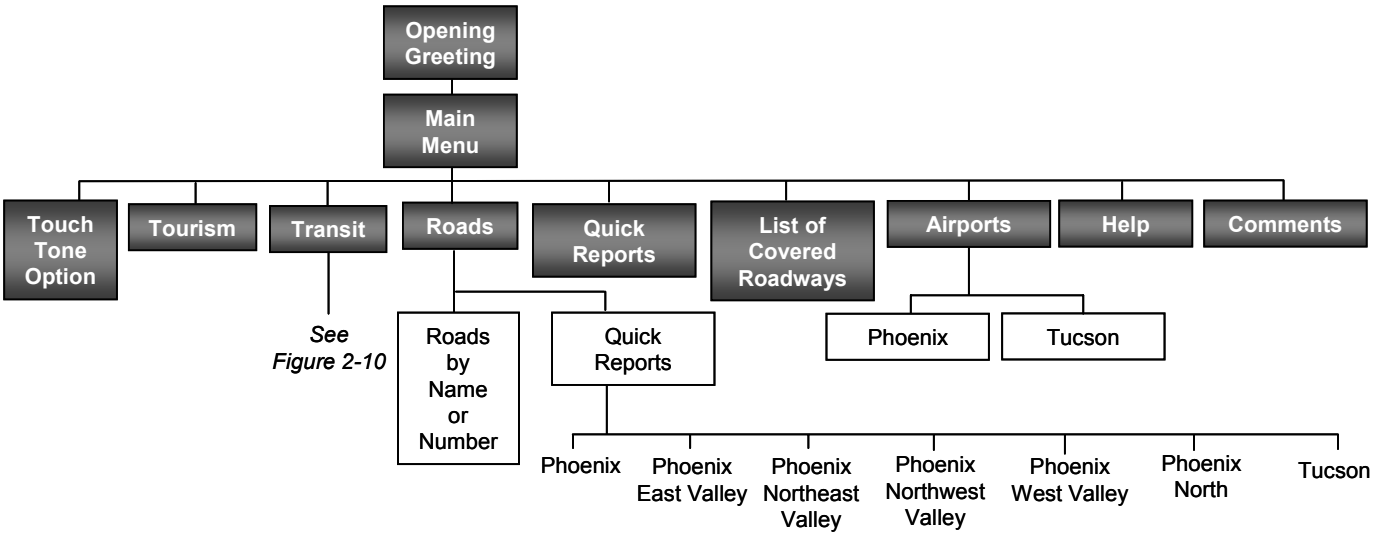


Figure 2-9. Post-Enhanced Menu System

Table 2-2. Model Deployment Enhancements and Status

Enhancement	Fully Complete & Operational within the Evaluation Period	Completed & Operational After the Evaluation Period	Not Currently Complete & Fully Operational	Comments
Information Content				
Tucson and Phoenix Local Street Data		■		ADOT's plan to increase their capture of arterial street incidents through more intensive monitoring of law enforcement scanners was carried out. However, inputs by cities and counties have been negligible. Inputs by the Tucson region are pending (training has been completed as have necessary map updates); Phoenix area agencies are making a limited number of inputs.
Transit Major Service Disruptions and Call Transfer Capability	■			The original plan called only for Phoenix and Tucson Transit, but the menu system and call transfer capability have been extended to include all regional/rural transit providers statewide.
Phoenix Bus Rapid Transit Estimated Arrival Times			■	Transit currently unable to provide data. Enhancement not implemented and unavailable for evaluation.
Phoenix Arterial Street Travel Times			■	Data collection system completed and now being tested; not available for evaluation.
Data Quality Enhancements	■			Enhanced 511 data entry operator training and 511 message preview function to see how entries will be conveyed on 511.
Phoenix and Tucson Airport Information	■			Phoenix has used the 2-minute message recording capability but Tucson has not.
Grand Canyon National Park Information		■		All necessary technical elements are in place (menu changes and voice-recording capability). During the evaluation period, the Park was not entering any information but now intends to.
Arizona Office of Tourism Call Transfer	■			An unplanned enhancement requested by the Office of Tourism.
Segment Weather Information		■		Came on-line after completion of evaluation.

Table 2-2. Model Deployment Enhancements and Status (Continued)

Enhancement	Fully Complete & Operational within the Evaluation Period	Completed & Operational After the Evaluation Period	Not Currently Complete & Fully Operational	Comments
Downtown Phoenix Special Events and Parking			■	There has been no discernable change in data capture techniques or the type and volume of information in the system.
Sharing Data with Other States (i.e., Utah)			■	Under development. Not available for evaluation.
User Interface				
Regional Roadway "Quick Reports"	■			
Roadway Segment-Based Reporting	■			
Roadway Info. Accessible Via Roadway Name	■			
Voice Recognition	■			
Other				
Premium Service Partnership			■	No viable private partnership proposal was received.
Marketing		■		The only incomplete elements are the 50 static road signs throughout the state, which are being installed now.
Improved System Performance Monitoring	■			Not all data analysis and reporting functions have yet been utilized but many new capabilities have been established and many of them have been used by ADOT.

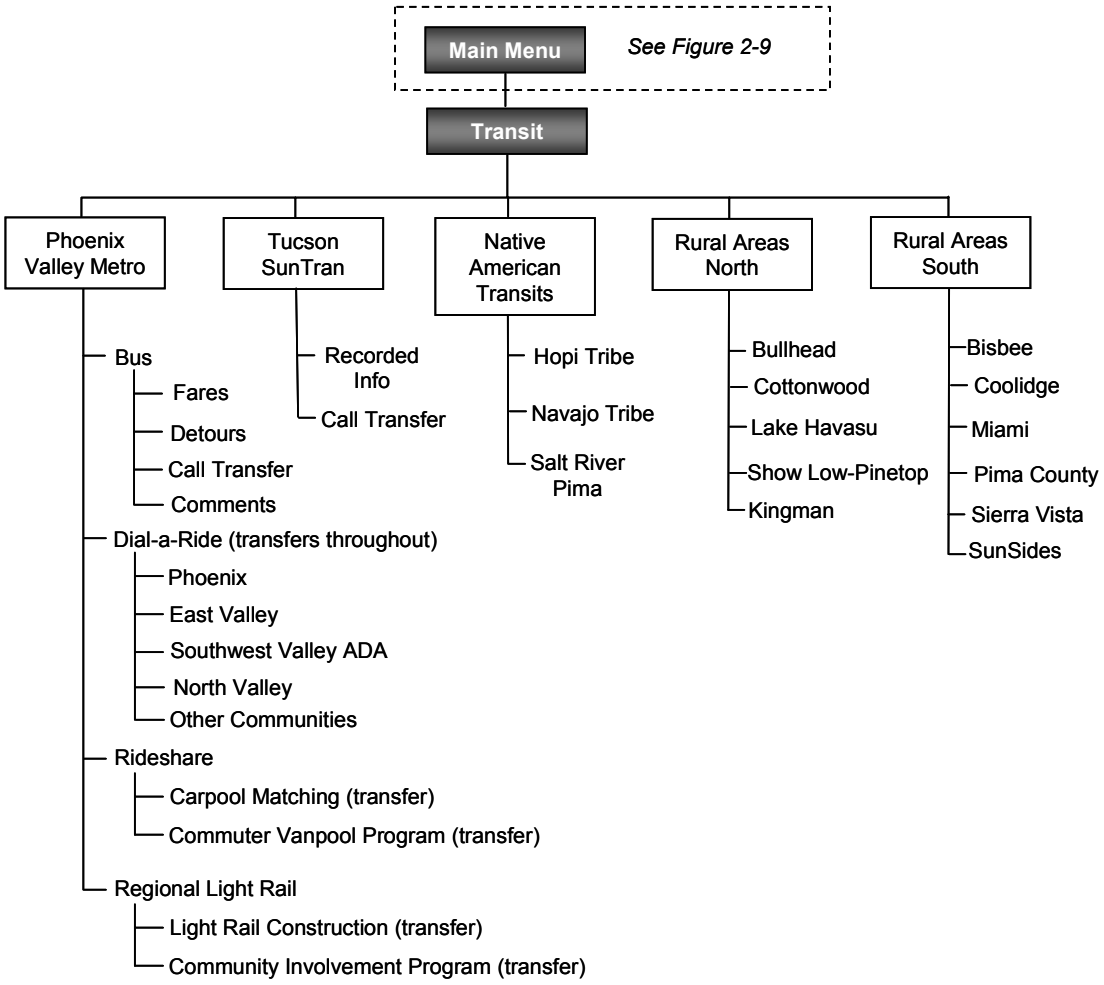


Figure 2-10. Transit Portion of Post-Enhanced Menu System

A useful way to assess the extent to which plans for various new data types have been realized—and thus establish context for the evaluation analyses—is to examine the data content of the 511 system during the one-year Model Deployment operational period (January – December 2004). Data are input to 511 via one of two mechanisms: through HCRS entries from an HCRS workstation (available to non-ADOT agencies via the Internet), or by recording a digital voice message (a .WAV file). The voice messages are recorded remotely, by dialing into the 511 system and leaving, in essence, a voicemail message that can then be added to the 511 system. HCRS logs provide an excellent record of HCRS data entry by inputting organization and type of entry. Unfortunately, although .WAV logs exist, they are not parsed and it was not possible to analyze them. The alternate source for information on agencies' input of .WAV data is anecdotal information from ADOT and the agencies that were provided .WAV recording capability. Table 2-3 identifies the planned HCRS and .WAV new data enhancements and summarizes their status and data sources.

Table 2-3. Input Sources for New Data Types

Input Source	Enhancement Status	Data Analyzed
HCRS		
Tucson and Phoenix Local Street Data	Implemented	HCRS logs
Downtown Phoenix Special Event and Parking Information	Implemented	
Phoenix Arterial Street Travel Times	Implemented	
Grand Canyon Information	Implemented	
Other States' Data	Not Implemented	None available
Phoenix Estimated Bus Arrival Times	Not Implemented	
Voice Recordings (.WAV files)		
Transit Major Service Disruptions	Implemented	Anecdotal reports from agencies
Phoenix and Tucson Airport Information	Implemented	Anecdotal reports from agencies

As indicated in Table 2-3, several planned enhancements with new data were implemented; the capability was established for agencies to input the information, either via HCRS or .WAV recordings. However, analysis of pre- and post-enhancement HCRS logs and anecdotal information from ADOT and the .WAV-enabled agencies indicates that in several cases these capabilities were not utilized, or not utilized significantly, by the agencies.

Table 2-4 compares pre- and post-enhancement HCRS entries by inputting organization. Appendix A provides additional background information on HCRS event classifications. Overall, the number of HCRS entries has increased considerably. However, various ADOT entities account for the entire increase; inputs from new organizations associated with the Model Deployment (Grand Canyon, cities and counties) are negligible. Figure 2-11 presents the percentage of entries by organization. The vast majority (about 70%) of all HCRS entries continue to be made by the ADOT Traffic Operations Center in Phoenix. The negligible quantities of post-enhancement data input by non-ADOT agencies indicate that these organizations have taken very little advantage of the new 511 data input capability, and interview data from the local agencies support this conclusion. There are a number of reasons that agencies feel they have not been able to input 511 information (see Section 7.0).

As indicated in Table 2-4, it is clear that Model Deployment plans to significantly increase the volume of arterial street information entered by cities and counties have not succeeded. However, results are much more encouraging relative to ADOT. ADOT's role in entering more arterial street incident information (Model Deployment plans included more intensive monitoring of police scanners) can be gauged by considering the number of ADOT HCRS entries by type of road. In 2002, ADOT entered just 234 entries pertaining to arterial streets, accounting for just 2% of total entries. After the Model Deployment (2004) that number jumped to 2,763, accounting for 14% of total entries. This indicates that ADOT followed through, and was successful, in their plans to increase arterial street incident data capture.

Table 2-4. HCRS Entries by Organization

Organization	Annual Average 2000-2002	2004	Change	Percent Change
Unidentified	36	0	-36	-100%
ADOT Phoenix – TOC	10,039	13,709	3,670	37%
ADOT Phoenix – Other	290	1,434	1,144	395%
ADOT Tucson	62	199	137	221%
ADOT Yuma	56	195	139	248%
ADOT Globe District	185	532	347	188%
ADOT Safford District	105	313	208	197%
ADOT Flagstaff	458	1,183	725	158%
ADOT Kingman	338	675	337	100%
ADOT Holbrook	548	1,017	469	85%
ADOT Prescott	55	323	268	487%
Cities and Counties	15	48	33	213%
Other-DPS	33	0	-33	-100%
Grand Canyon	0	0	0	0%
Other-Out of State	6	0	-6	-100%
Total	**12,226**	**19,628**	**7,402**	**61%**

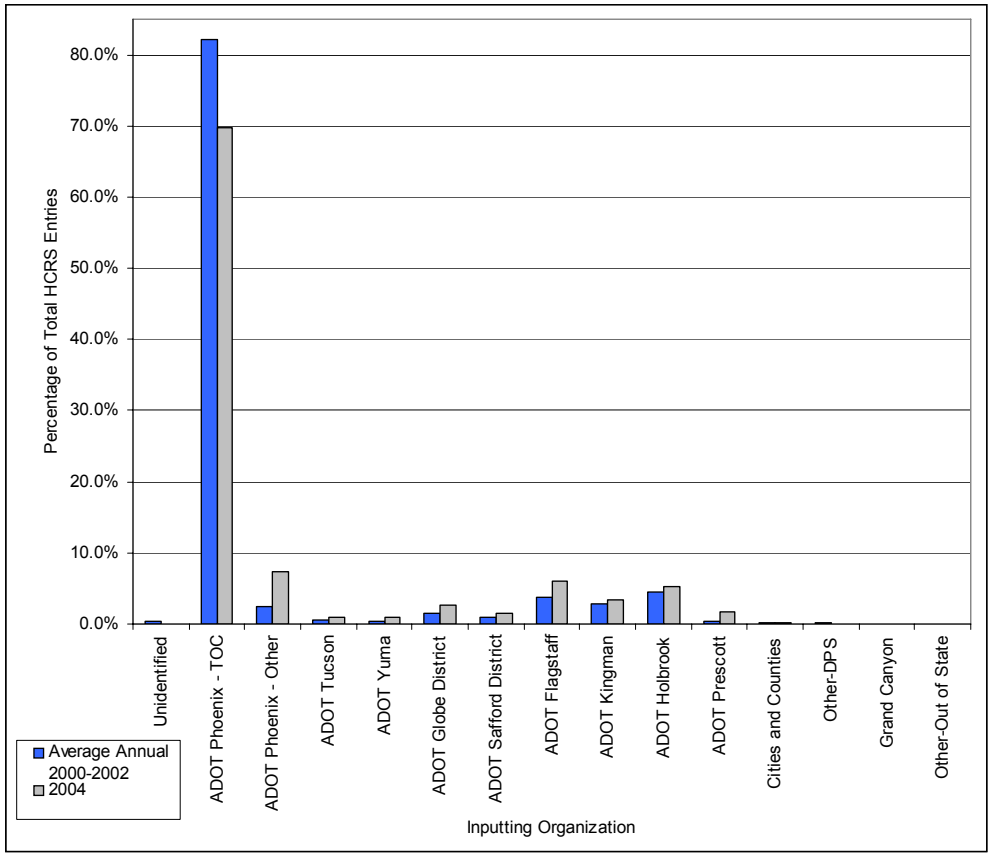


Figure 2-11. HCRS Entries by Organization as Percent of Total Entries

Examining HCRS entries by type of entry provides another means to gauge realization of planned new data enhancements. Table 2-5 compares pre- and post-enhancement HCRS entries by type. The number of entries related to interstate traffic incidents and level of service (traffic congestion) has increased significantly, although no specific Model Deployment enhancements focused on these data. Very little data has been entered pre- or post-enhancement pertaining to downtown Phoenix special events and parking (which would appear in the "Activities" or "Parking" categories), or travel times. Although total weather-related entries ("weather", "winds", "winter storm codes" and "temperature" in Table 2-5) have increased by about one-third, there were no Model Deployment enhancements completed within the evaluation period, or other known changes in procedures, that would explain this overall increase. The reduction in "weather" entries reflects the fact that ADOT began phasing out this category during the analysis period, replacing it with the other weather-related event types. Figure 2-12 indicates that the increases in incident and level of service information have been significant enough to shift the overall roadway data composition of the 511 system. These two categories of real-time information have replaced planned event (construction and maintenance, i.e., "lane restrictions" and "road maintenance") as the most prevalent types of information.

Table 2-5. HCRS Entries by Type

ITIS Category	Average Annual: April 1998-Jan. 2003	2004	Change	Percent Change
Activities	14	21	6	43.6%
Closures	1,442	1,478	36	2.5%
Dangerous Vehicles	2	1	-1	-57.1%
Delays/Cancellations	16	69	53	334.6%
Environment	55	69	14	25.6%
Exceptional Loads	16	6	-10	-62.3%
Headways	0	0	0	No Change
Incidents/Accidents	1,705	6,903	5198	304.8%
Information	218	740	522	239.6%
Lane Restrictions	3,355	2,782	-573	-17.1%
Level of Service	183	3,948	3765	2056.4%
Obstruction Hazards	920	509	-411	-44.6%
Parking	0	0	0	No Change
Road Conditions	370	71	-299	-80.8%
Road Maintenance	1,829	652	-1178	-64.4%
Temperature	11	0	-11	-100.0%
Traffic Equipment Status	412	160	-252	-61.2%
Traffic Regulations	16	2	-14	-87.6%
Travel Times	1	0	-1	-100.0%
Weather	399	97	-302	-75.7%
Winds	156	329	173	111.2%
Winter Storm Codes	1,104	1,790	686	62.1%
Total	**12,226**	**19628**	**7402**	**60.5%**

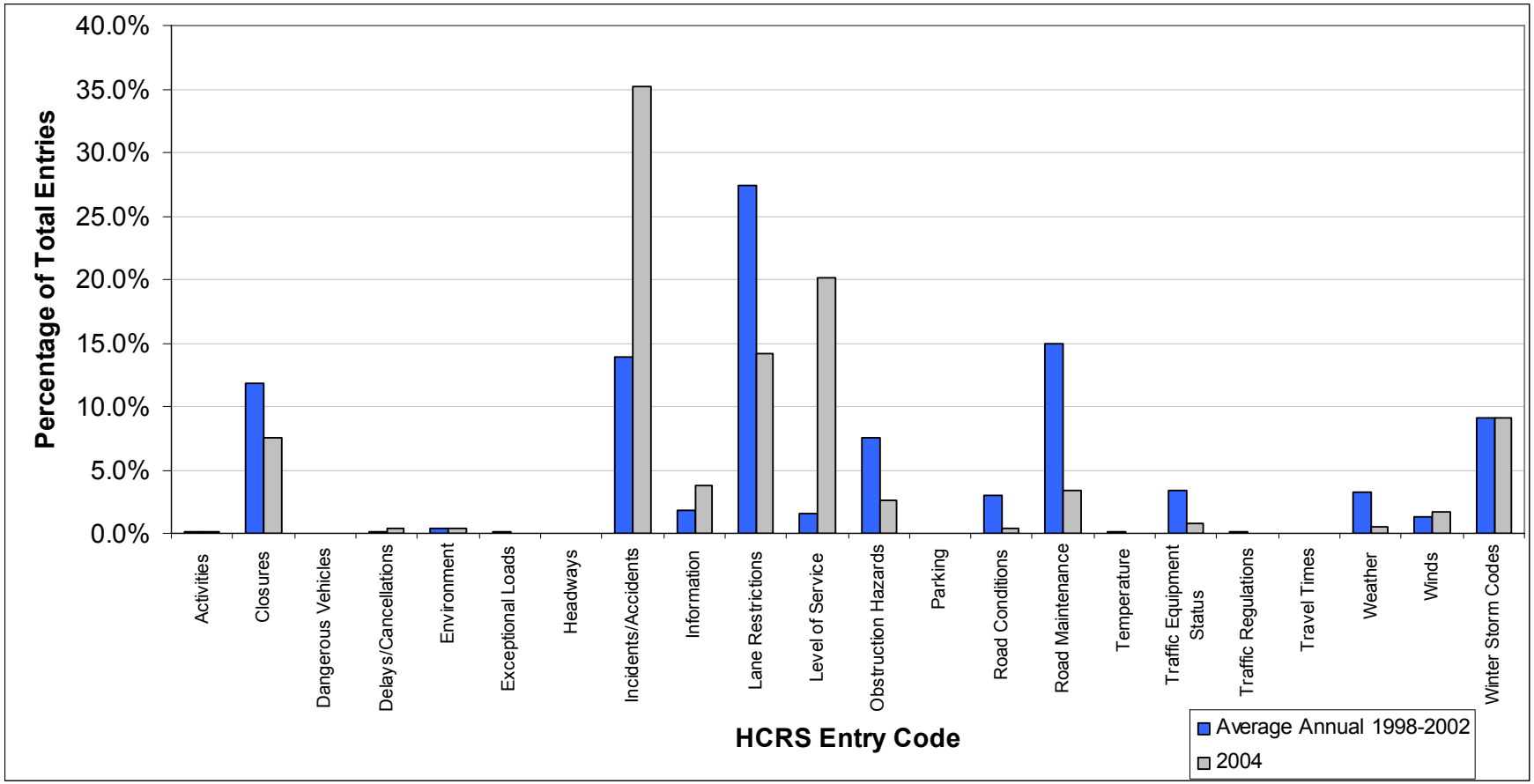


Figure 2-12. HCRS Entries by Type (Entry Code) as Percent of Total Entries

According to anecdotal information from ADOT and the .WAV-enabled agencies, only the Phoenix airport has made any significant use of the voice recording feature in 2004. The airport has used the feature extensively, maintaining a current summary of airport information on 511 throughout the year. Neither the Tucson airport nor Tucson transit agency made much use of the .WAV feature. In late 2003 to early 2004, ADOT recorded very basic placeholder messages for these agencies, which simply noted that additional information could be obtained by transferring to those agencies' customer information lines. Tucson transit (SunTran) reports at least one attempt to update their .WAV file in 2004, but they apparently have not used the feature with any regularity. Phoenix transit (Valley Metro) began recording .WAV files in mid-2004, but those messages generally only referred callers (via the call transfer option) to the Phoenix transit customer service line. Aside from references to the call transfer options, apparently little to no meaningful information (e.g., transit major service disruptions) was input to 511 in 2004 by Phoenix transit, Tucson transit, or the Tucson airport.

3.0 Evaluation Approach

This section describes the data collection methods associated with each of the evaluation analyses: system usage, 511 user telephone survey, stakeholder interviews and workshops, and costs.

3.1 Usage Analysis

Two types of usage analyses were carried out. First, the general usage analysis focused on the assessment of changes in usage patterns before and after the enhancements. One year of usage before (2003) was compared and contrasted with one year of usage after (2004). The analysis considered call volume distribution, call duration, type of phone, call geographic location, new and repeat users, and content assessed.

Second, over the course of the post-enhancement, 511 usage during specific scenarios such as marketing campaigns, major traffic incidents, major holidays, significant regional events (e.g., forest fire) were analyzed in the scenario-based analyses. While the before-and-after comparison assessed the overall usage patterns and changes brought along by the enhanced system, the scenario-based analyses provided a more in-depth look into 511 usage in response to special events.

During the post-enhancement period, ADOT systematically noted events that could have significant impacts on 511 usage. Subsequently, a list of scenarios was identified for evaluation including:

- Usage during transition to enhanced system
- Marketing campaign using dynamic message signs
- Wildfires
- Major snows
- Major crash

The primary source of data for usage analysis is the logs generated by the 511 VRAS computers. The VRAS logs contain detailed information on time/date of call, duration, caller ID, line used (of 23 available lines on each of the 4 VRAS computers), and information assessed (detailed menu navigation). The line used and call duration information were used to derive information on line capacity that indicated the number of current calls in the 511 system at any given time. Phone bills were used to supplement the analysis of the pre-enhancement system because the old system did not preserve the caller ID information.

A number of ancillary data sources were exploited in support of the analysis. For example, system availability information was collected using ADOT's monthly system outage report during the post-deployment period. Information on VRAS update history was obtained to identify the incremental changes in the 511 menu and data contents over the course of post-deployment period. Information on the 511 marketing campaign such as the messages posted on dynamic message signs to promote 511 usage was obtained from ADOT.

A computer program was created by the University of Arizona to parse the VRAS logs and produce statistics of interest. External data such as block assignment telephone numbers was used to distinguish the wireless from wireline calls and identify registered location of the calls.

One critical data set of interest, ANI II (advanced Automatic Number Identification), was not collected because it is not available from the 511 line communication service provider Qwest. Such data are essential in accurately identifying wireless line vs. wireline, especially after FCC's rule change in November 2003 to allow a wireline number to be changed to wireless service and vice versa. Consequently, it was necessary to use block assignment methods for identifying type of phone service. Although this was suboptimal, it was the only method available to the evaluation team.

3.2 User Telephone Survey

Assessment of 511 users' experience with the service was a key component of the evaluation. A decision was made not to undertake a comparison of the enhanced service with the original service because the service had changed substantially and because of the impracticality of trying to find sufficient numbers of users of both versions of the 511 service. Thus, the objective of surveying users was to measure their satisfaction with the enhanced service only. The focus was on their attitudes toward the type of content offered on 511 and its quality, the user interface, the benefits they perceived the service provided, and how using the information impacted their travel. To achieve this objective a representative cross section of 511 callers was needed. This section describes the approach used for the user survey. The findings from the survey are presented in Section 5.0.

The study team considered alternative methods for identifying the target population of 511 users and determined that the most efficient means was to use the 511 service itself by intercepting incoming calls to the system. A live recruitment of users by an operator was used to increase the potential for a representative sample of 511 users compared to a self-selected sample of users who respond to an automated recruitment message on the 511 service. Thus, the recruitment of survey subjects relied on the intercept of calls to the 511 system by professional call takers. The intercepted calls, before reaching the 511 greeting message, were transferred to the call takers located in a local (Phoenix, AZ) survey firm.

3.2.1 Creating the Intercept Function

Conducting a live intercept survey required close coordination among ADOT, their software provider, the national evaluation team, and the local survey research firm. The functional requirements for the intercept survey included:

- Ability of the 511 system to randomly sample (select) and forward a call to an outside number based on a specifiable interval (every n^{th} call);
- Avoidance of additional long distance charges by forwarding the intercepted calls only to a local number;

- An off-premises transfer of an intercepted call from the 511 system to the designated number, thereby not occupying available lines of the 511 system; and
- Upon the completion of recruitment, transfer of the caller back to 511 using the off-premises transfer mechanism at the survey research firm.

Figure 3-1 shows the high-level configuration of the Arizona 511 system and the call intercept mechanism in support of survey recruitment. The intercept function underwent a variety of tests to assure that it would operate properly once going "live" with actual 511 callers, and it was deemed successful so that pre-testing of the survey with callers could begin in October 2004.

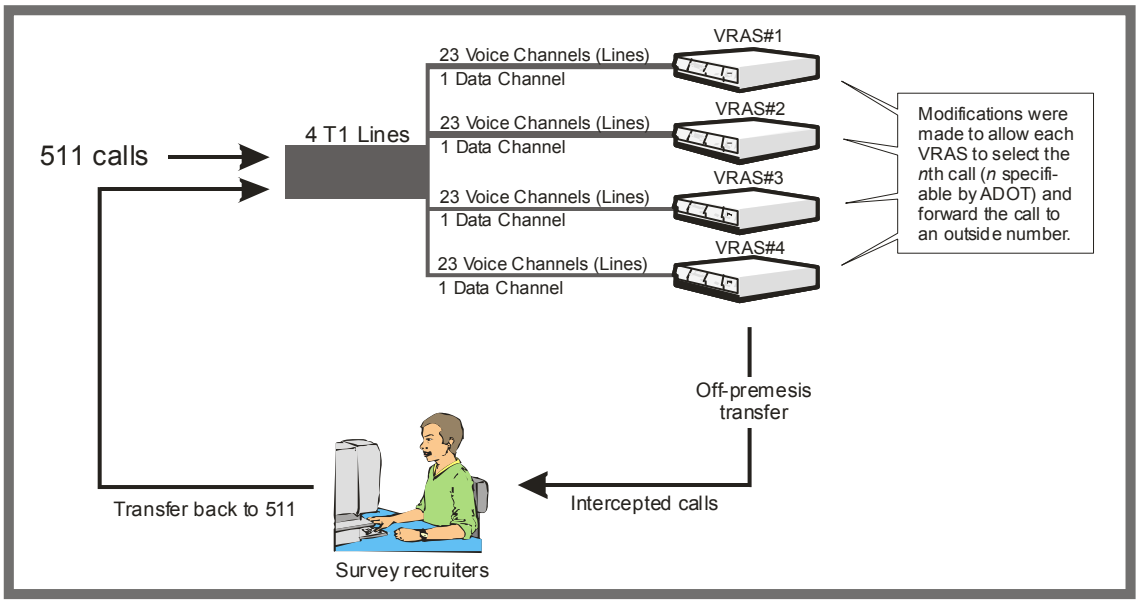


Figure 3-1. High-Level 511 System Configuration in Support of Call Intercept

3.2.2 The Sampling Plan

The design of the sampling plan included the following elements: target population and sampling frame; sample sizes and anticipated power; and sampling methodology.

Target Population and Sampling Frame

The 511 system in Arizona can be used by virtually anyone because there are no restrictions other than requiring a working telephone and the ability to hear and comprehend the instructions. Therefore, the likely users of the system include a wide variety of people, such as commuters, tourists, commercial vehicle operators, etc., and obtaining the perception of the 511 system from all of these users was of interest. This implied that the target population includes any person who is a user of the 511 system. The sampling frame, or population from which persons were selected, consisted of all users of 511 during a two-week period. However, the sampling frame needed to be further restricted because it was not cost-feasible to sample earlier than 5 a.m. or later than 9 p.m. (none of the candidate Phoenix-area research firms routinely staffed longer

hours.) Thus, the results of the survey were viewed as representative of daytime and early evening users of 511 assuming that users during the two-week field period are representative of all such users.

Sample Sizes and Statistical Power

A key component of the sampling plan was establishment of the number of 511 callers who would complete the telephone survey, i.e., the sample size. Estimation of sample size rests on a combination of several factors, including the level of precision sought for the survey results in statistical terms, an understanding of how the results might be analyzed, such as comparison of subgroups of types of users, and the resources available for the survey. One key measure collected through the survey of 511 users is the percentage of respondents who answer a question about an attribute of 511 in a particular way. Based on these factors, a sample size of 400 completed interviews was estimated to provide adequate precision (95% confidence) for the estimation of the percentage of participants with a characteristic of interest (e.g., satisfaction). Further, a sample size of 400 completed interviews would also permit the identification of statistically significant differences in the responses among subpopulations (e.g., repeat callers versus new callers) of 14% to 21%, depending on the balance of the sample. Smaller differences would not be identified as statistically significant, but that trade-off was considered acceptable from a resource consideration.

Sampling Methodology

A two-stage interviewing process was employed to elicit information from users of the 511 system. First, an intercept of "live" calls was conducted to obtain contact information from users and willingness to participate during a call averaging 2 minutes in duration. Upon the completion of the intercept interview, callers were transferred back into the 511 system. Among 511 callers who agreed to the survey, a second interview initiated by the survey administrators was conducted at a time convenient to each caller to collect detailed information about their experience with the 511 service. The second interview averaged 16 minutes in length.

The general sampling approach to identify initial users for the intercept interview was a stratified, systematic sample of calls to the 511 system. Day-of-the-week and time-of-the-day (in one hour increments) formed the sampling strata. Within each stratum, a systematic random sample of 511 callers was selected. That is, every n^{th} call was intercepted. A proportional allocation based upon the percentage of all calls that were observed during June 2004 was used to preserve the inherent distribution of 511 calls over weekdays and times. This was important since it is likely that different types of users access the 511 system at different times of the day or on different weekdays. With a proportional allocation, it was expected that the sample distribution would be roughly similar to the actual distribution of users. To minimize the possibility of a sampling bias and to maximize the call volumes during the data collection period, calls from all four VRAS boxes were sampled simultaneously, though with the same sampling interval.

The sampling interval (i.e., the n^{th} caller) is a function of the expected response rates at each data collection phase, the anticipated call volumes, the degree of repeat callers, and the expected 511 usage during the data collection period. Based upon the evaluation team's experience with

previous customer satisfaction surveys, it was assumed that roughly 20% of the intercepted callers, or every 5th caller, would agree to participate in the survey, with approximately 60% of them actually participating in the second stage of data collection. VRAS log data from June 2004 indicate that there were 45,512 calls into the Arizona 511 system during the month of June. These calls were distributed throughout the day and days-of-the-week, though a higher volume of calls was observed during weekday rush-hours and on the weekends, particularly Saturday. During the first two weeks of June 2004, the majority of callers (62.5%) used the system only once; 19.2% used the system more than once, but on a single day; and the remainder or 18.3% used the system on multiple times on multiple days. Based upon these factors, it was estimated 4,315 callers would need to be intercepted to achieve the target of 400 completed detailed interviews. In summary, the plan estimated that 21.5% (4,315) of all daytime callers in a two-week period would be intercepted between 5:00 a.m. and 9:00 p.m. That would yield roughly 3,333 unique users of the 511 system, of which 667 were expected to complete the intercept interview and agree to participate with a more extensive survey (20%). Approximately 60% of the 667 initial respondents would actually complete the detailed interview (400 respondents).

Fielding of the Survey

The evaluation team selected a local survey firm that used a Computer Assisted Telephone Interview (CATI) methodology to conduct both the intercept survey and the detailed survey. Under this approach, trained interviewers administered the survey by reading the questions to the respondents as they appeared on the interviewer's computer terminal. Responses from the respondent were keyed into the computer as they were given (i.e., real-time data entry of respondents' information).

The CATI system includes automated range checks and other checks to ensure that the data collected are within pre-determined criteria. This is the major advantage of collecting data using a CATI system. It allows for instantaneous clarification of inconsistent respondent information. Errors in logic are avoided by programming the questionnaire skip patterns into the system. The "customized" questionnaires also greatly speed interviewing by reducing redundancy. This substantially reduces respondent burden, and as a result there is a corresponding increase in response rates and the accuracy and completeness of data provided.

The objective of the telephone survey was to collect data on 511 users' experience with and perceptions of the 511 system in Arizona in approximately 15 minutes. The questionnaire was based on the set of "core questions" that were developed by the 511 Evaluation Panel, consisting of 511 deployers and other interested parties. The Panel was established in January 2003 to work with U.S. DOT and the evaluation team to provide input on the evaluation of the 511 Model Deployment and to develop a set of common metrics and methods that 511 deployers can use to evaluate their systems. A set of core questions for assessing customer satisfaction was developed by the Panel in 2003 to address the following areas:

- Frequency of use
- Occasion for use of 511 when caller was intercepted
- Satisfaction with the 511 service

- Recommended improvements to 511
- Demographic information.

The core questions were adapted to the Arizona 511 service by adding or deleting items or rewording as appropriate to test the hypotheses for the national evaluation. Pre-testing of the questionnaire demonstrated that not all the core questions could be accommodated within the 15-minute targeted length of the survey, and therefore the Arizona survey would not constitute a valid test of the national core questions. As a result, once the 400 interviews were completed, a set of 30 additional interviews was conducted to test the core questions that did not fit within the Arizona questionnaire. Guidelines on the use of the standard evaluation approach and core questions are available in a separate report.[7]

Following pretests of the survey instruments in late October 2004, the telephone survey of callers to 511 was undertaken from November 3 through 17, approximately eleven months after the enhanced service was launched in December 2003. The November time frame had the advantage of providing sufficient time for regular callers to 511 to have become fully acquainted with the service, and it avoided the holiday periods when it might have been difficult to reach individuals for interviews.

The procedures for response rate calculation are based on the guidelines established by the Council of American Survey Research Organizations (CASRO) in defining a response rate. The initial response rate (i.e., those that agreed to make an appointment to be interviewed) and final response rate (i.e., those that completed the interview) for the survey were obtained using the following formulas:

$$Initial\ Response\ Rate = \frac{No.\ of\ \ Appointments\ Made}{\left(No.\ of\ \ Eligibles + \left[No.\ of\ Unknown\ Eligibility * \frac{No.\ of\ \ Eligibles}{No.\ of\ \ Eligibles + No.\ of\ \ Ineligibles} \right] \right)}$$

$$Final\ Response\ Rate = \frac{No.\ of\ Completed\ Interviews}{\left(No.\ of\ \ Eligibles + \left[No.\ of\ Unknown\ Eligibility * \frac{No.\ of\ \ Eligibles}{No.\ of\ \ Eligibles + No.\ of\ \ Ineligibles} \right] \right)}$$

Table 3-1 presents the distribution of intercept attempts by disposition category. The number of attempts in each category was then used in the above formulas to calculate initial and final response rates of 31% and 22%, respectively.

[7] Volpe to issue a report on the pilot of the core questions in 2005.

Table 3-1. Distribution of Intercept Attempts by Disposition Category

Disposition Category	Number of Cases
Total Intercepts	2,205
Total Eligible	1,604
Made appointment*	581
Hung up	797
Refused	226
Total Ineligible	283
Automated message	60
Recruited before	72
Wrong number	70
Other-ineligible**	81
Total Unknown Eligibility	318
Silence	200
Other-unknown	118

* 411 respondents completed the actual interview

** Transcription logs were reviewed, resulting in the determination that 81 cases were not available respondents, e.g., children calling 511, ADOT personnel checking lines, and beeping.

The response rates for the survey were better than the original estimates. Prior to the survey, it was estimated that 20% of intercepted callers would agree to be interviewed and 60% of those would complete the actual survey. As shown above, the actual response rate of callers agreeing to be interviewed was 31%, and 71% of them (411/581) completed the survey.

Post Survey Analysis

The first step in the analysis was to compare the actual intercept frequencies by time of day and day of week with those in the sampling plan and apply weights to adjust the sample distribution. A standard survey practice, weighting helps reduce bias and improve the precision of estimates. Appendix B describes the weighting scheme applied to the data.

Using the weighted results, the next step in the analysis was to calculate simple frequencies of responses for each question. For selected questions, the next step was to prepare cross-tabulations to examine possible relationships between dependent and independent variables. For verbatim comments made by respondents to open-ended questions, coding the responses into categories was performed when responses were sufficient to make coding a useful means for assessing the data. The findings from the analysis are reported in Section 5.0. The frequencies of responses for each of the questions are presented in Appendix C.

3.3 Stakeholder Interviews and Workshops

Interviews with 511 stakeholders—the agencies and consultants who participated in the Model Deployment—and "lessons learned workshops" were the primary mechanisms for collecting enhancement process data. A useful secondary source of information was the many meetings attended by the evaluation team throughout the planning, implementation, and operational stages of the Model Deployment. These meetings included the half dozen 511 Task Force meetings as well as regular teleconferences between the local (Arizona) members of the evaluation team and the ADOT 511 evaluation point-of-contact (the manager of the Information Technology Section). The teleconferences in particular provided an excellent opportunity to collect information reflecting ADOT's perspectives throughout the project. Much of that information was critical in providing input to the interviews with other stakeholders.

Two rounds of stakeholder interviews and follow-up lesson learned workshops were held. The first round of interviews and the first workshop were held in January and February 2004, at the conclusion of the planning and implementation stage of the project. The second round of interviews and second workshop were conducted in January and February 2005, following the conclusion of the one-year post-enhancement period.

The stakeholder interviews were conducted either one-on-one or with small groups of stakeholders. The interviews provided an opportunity to collect in-depth information from specific stakeholders. This information was then synthesized and used to guide group discussions with the full 511 Task Force at the lessons learned workshops. The purpose of the workshops was to allow all of the stakeholders to comment on the evaluation team's interview observations. For the workshops, brief bullet-item summaries of input from the interviews were used as a discussion guide without attribution to individual stakeholder agencies.

The specific questions and topics covered in the discussion guide varied somewhat by interview, depending on the role played by the interviewee in the Model Deployment. The general questions and topics addressed at the interviews included the following:

- Overall role in the 511 project
- Organization's specific Model Deployment activities
- Experience in inputting data to the 511 system (discuss each type of data)
- Major successes of the Model Deployment
- Shortcomings and challenges encountered (including solutions to problems)
- Plans and desires for "next steps" for their agency and the overall 511 program
- Major unanswered questions for the Model Deployment and for 511 as a national program/strategy
- Lessons learned (i.e., advice to other regions deploying or operating 511, or what they would do differently)
- Feedback from their customers/constituency regarding their 511 involvement.

The stakeholder interview discussions were also facilitated with a list of potential issues, reflecting the evaluation team's expectations and input from other organizations. This list provided prompts to stimulate discussion in various areas. A formal list of potential issues was developed during the evaluation planning stage and supplemented informally with information gained over the course of the implementation and operation.

Most of the stakeholder interviews were conducted by telephone and lasted between 30 and 90 minutes. Table 3-2 identifies the stakeholder agencies' participation in both rounds of interviews and workshops. Fewer stakeholder interviews were conducted in the first round, which was restricted to the relatively small group of agencies and their consultants who had played a key role in the Model Deployment through the planning and implementation stage. Stakeholder participation in both rounds of interviews and the first workshop was excellent. Although the turn-out for the final workshop was small, it included most of the stakeholders who played major roles in the Model Deployment.

3.4 Cost Data

All cost data were provided by the ADOT evaluation point-of-contact, the Information Technologies Manager, who played a key role in most of the data enhancements, including directing the work of the ADOT consultants. In developing the overall approach to the cost analysis and preparing specific ADOT cost data requests, the evaluation team coordinated with Mitretek, U.S. DOT's consultant that manages the National ITS Benefits and Costs Database. The purpose of the coordination was to help ensure that the cost data for the Model Deployment would be as comprehensive and as consistent as possible with the national cost data, especially data for other 511 and conventional (10-digit) traveler information systems.

The overall approach to the cost analysis and associated data requirements was shared with ADOT during the planning stage of the evaluation. Cost data were collected in two rounds. The first occurred in December 2003-January 2004 and focused on pre-enhanced system costs. The second round of data collection occurred in December 2004-January 2005 and focused on post-enhancement data.

The evaluation team provided ADOT with a spreadsheet template identifying the desired pre- and post-enhancement cost data. That template included cost break-downs by enhancement and by phase (planning and design, implementation, and operation). Implementation costs were broken-down into hardware and software (including engineering) elements. ADOT gathered the cost data from various sources, including monthly phone bills, consultant contracts, and internal records and provided the data to the evaluation team. Remaining issues were resolved through follow-up phone conversations and e-mails.

Table 3-2. 511 Stakeholder Participation in Evaluation Interviews and Workshops

Stakeholder Organization	Interview Participation		Lessons Learned Workshop Participation	
	Round 1 January 2003	Round 2 January 2004	Round 1 January 2003	Round 2 January 2004
Agencies				
ADOT Headquarters (Phoenix) – Management	■	■	■	■
ADOT Headquarters – HCRS Operators	■	■	■	
City of Glendale		■		
City of Phoenix (Traffic)		■		
City of Tucson (Traffic)		■	■	
Federal Highway Administration (District)		■	■	■
Maricopa Association of Governments (MPO)			■	
Maricopa County Department of Transportation (MCDOT)		■		■
Phoenix Airport (Sky Harbor)	■			
Phoenix Transit (Valley Metro)	■	■		
Pima Association of Governments (MPO)		■		
Tucson Airport		■		
Tucson Transit (SunTran)	■	■	■	
Consultants				
Call Processing (IVR system)	■	■	■	
Kimley-Horn (Marketing)	■		■	■
OZ Engineering (HCRS)	■	■	■	
PBS&J (ADOT Program Support)	■	■	■	
PIPS (Arterial Street Travel Time System)		■		

4.0 Usage Patterns

This section discusses 511 usage based on an analysis of system data. The analysis contains two components. The first considered overall usage patterns, including call volume distributions (by time, day, type of phone, call geographic location), line utilization, and contents accessed. The changes in usage pattern before and after the enhancement are discussed, excluding enhancements not previously available. The second component examines post-enhancement usage under several specific scenarios. Those scenarios were identified based on events that could result in significant impacts on 511 usage, such as forest fires, marketing activities, major traffic incidents, and winter storms.

4.1 General Usage Patterns

4.1.1 Call Volumes

Distribution of daily call volumes during the post-enhancement period (year 2004) is presented in Figure 4-1. The 511 system recorded 670,369 calls in this period, averaging 1,832 calls per day. By comparison, the pre-enhancement period (September 2002 through August 2003) experienced an average of 1,055 calls per day. This represents a growth of 74% in daily overall call volume. As elaborated in Section 4.2.1, the increase in call volumes is attributable to the statewide dynamic message sign (DMS) marketing campaign that occurred in May 2004. The extremely high volumes during the week-long campaign, and the somewhat increased volumes that persisted over the months after the DMS campaign, drove the overall annual increase. There is no indication that the content or user interface enhancements to the 511 system increased usage of the system. In fact, the post-enhancement call volumes for the four-month period prior to the DMS campaign (January – April 2004) are actually about 2% lower than those for the same period immediate prior to the Model Deployment (January – April 2003). The absence of an increase in call volumes following the introduction of new content is not surprising because no 511 marketing whatsoever was conducted prior to the May DMS campaign and almost none of the marketing conducted over the course of the year focused on the new data content.

Of particular note in Figure 4-1 is a number of dates where the call volumes are well over 2,000 calls per day, including several dates in January (3rd), February (3-5, 21-24, 27-29), March (4-6) and again in November (21-22, 28-29) and December (4-6, 29-31). These volumes are correlated with snow in northern and eastern Arizona. Other exceptional dates in June (5, 12-13) and July (16-17) correspond to wildfires in Arizona. The very large spike in call volumes that occurred in early May (with highest daily call volume of 17,265, approximately 9.4 times the annual average daily volume) corresponds to the marketing campaign on dynamic message signs throughout the state. Many of the daily spikes in call volumes are investigated further in Section 4.2, 511 Usage in Special Occasions.

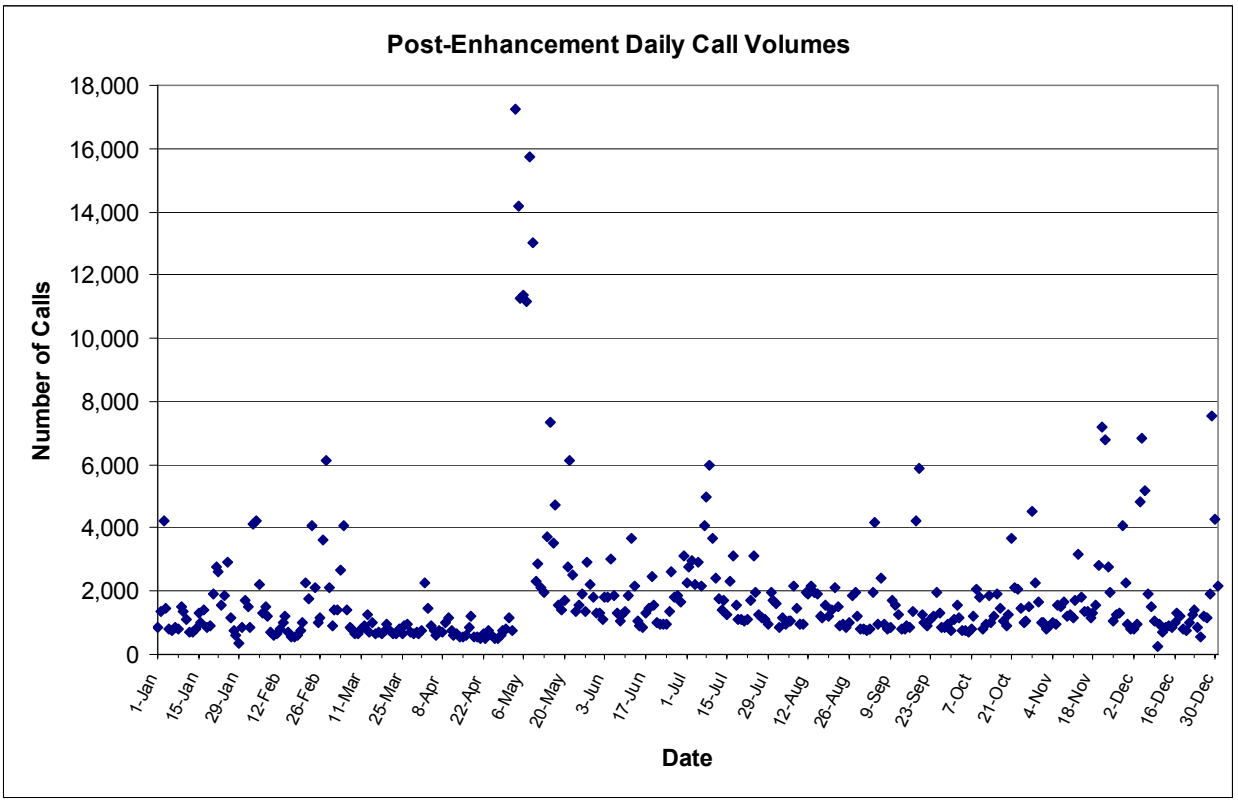


Figure 4-1. Post-Enhancement Daily Call Volumes

Figure 4-2 compares the monthly call volumes of the pre- and post-enhancement periods. The highest volume, in May of the post-enhancement period, was contributed by ADOT's week-long promotion of 511 on dynamic message signs statewide. Other than the spike in May, the general trend is an increase in call volume toward the end of 2004, ending the year with two to three times the usage of the pre-enhancement period.

Call Volumes by Time of Day and Day of Week

Figure 4-3 presents the call volume distributions by day of week for pre- and post-enhancement periods. The data indicate a significant increase in the percentage of call volumes on weekends. In the pre-enhancement period, call volumes were relatively flat throughout the week, with the weekly peak occurring on Tuesday. In the post-enhancement period call volumes show a more pronounced peak on the weekend. Post-enhancement call volumes average over 2,500 calls per day (about 20% of all calls) for Saturday and over 2,000 calls per day (about 15% of all calls) for Sunday. Post-enhancement weekday volumes peak on Fridays at around 1,800 calls per day, with the lowest volumes on Tuesdays (about 1,400 calls per day), the opposite of the pre-enhancement phase.

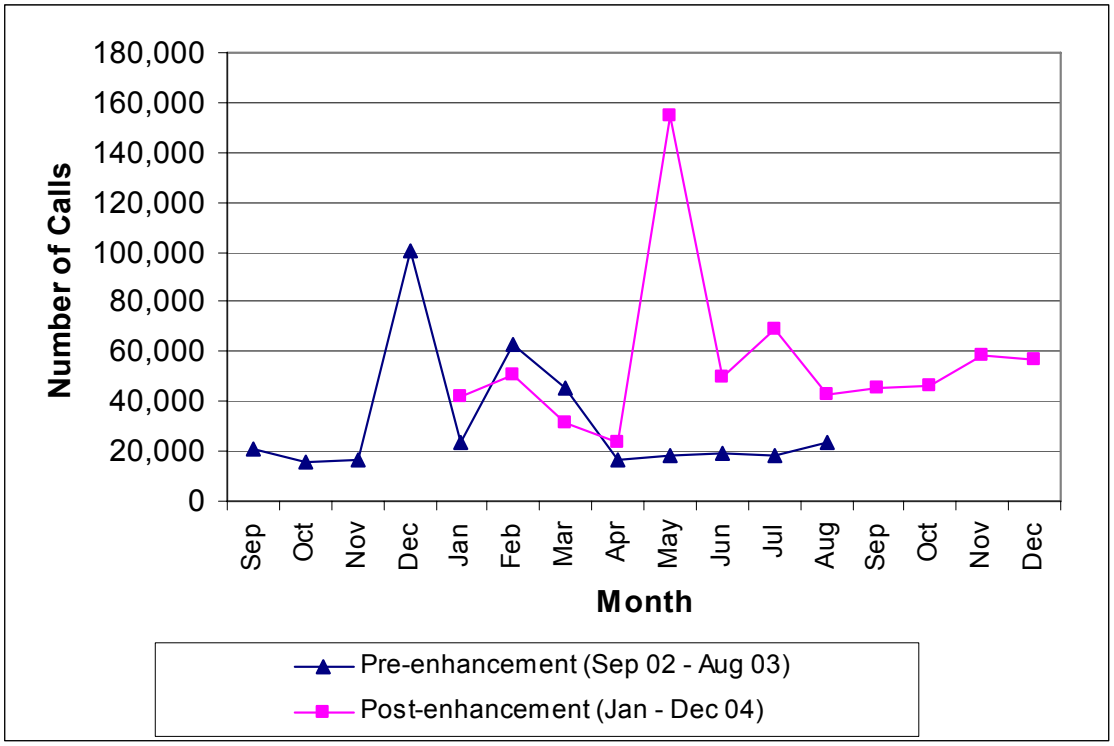


Figure 4-2. Monthly Call Volumes

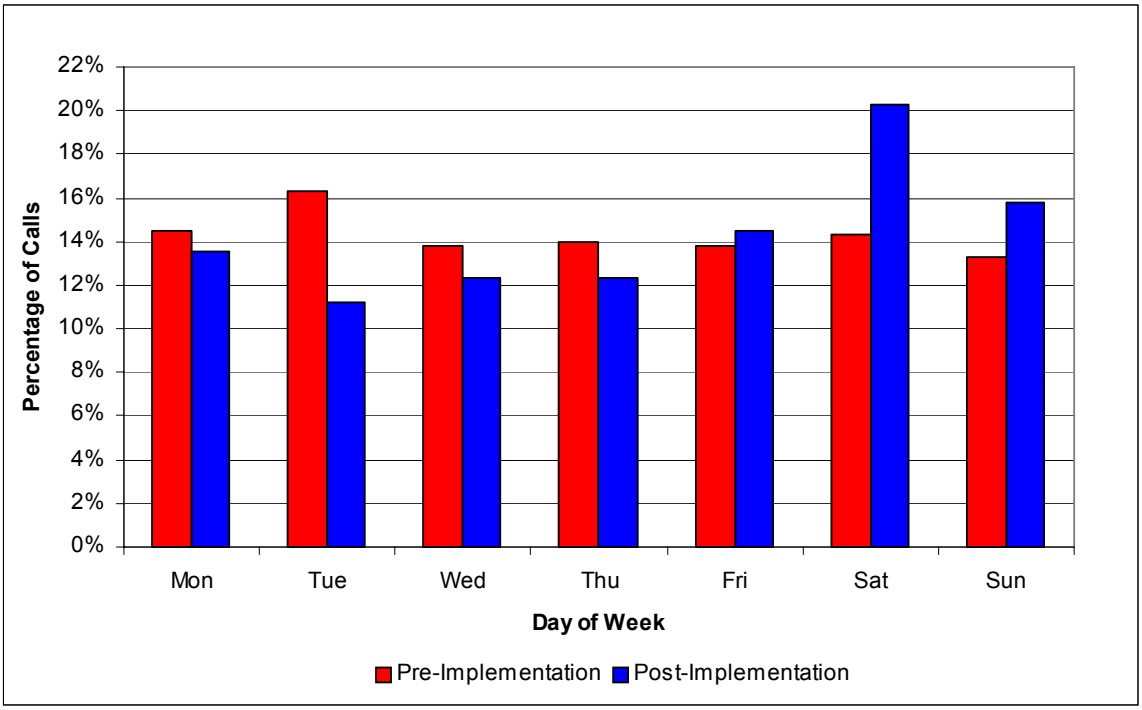


Figure 4-3. Percentage of Call Volumes by Day of Week

The post-enhancement results suggest that the Arizona 511 system is used more frequently during weekends for non-commute trips than before the enhancements. Moreover, in comparison with the pre-enhancement period, it shows that in overall call volume during the post-enhancement period came from the weekend travelers than the weekday travelers.

Figures 4-4, 4-5, 4-6, and 4-7 present hourly call volumes for Monday-Thursday, Friday, Saturday, and Sunday, respectively. Figure 4-4 shows that during weekdays, call volumes peak in the morning between 7 and 9 a.m. and in the evening between 3 and 5 p.m. The call volumes remain fairly steady during the middle of the day. This generally conforms to the commute traffic patterns in the Phoenix and Tucson areas.

In Figure 4-5, on Fridays the volume distribution is more accentuated for the evening peak period. There is a slight peak in the morning, but the highest calling volumes occur during the hours of 2 to 6 p.m. There is also a fairly high volume well into the evening (7 to 10 p.m.) during which volumes are comparable to those of the morning peak.

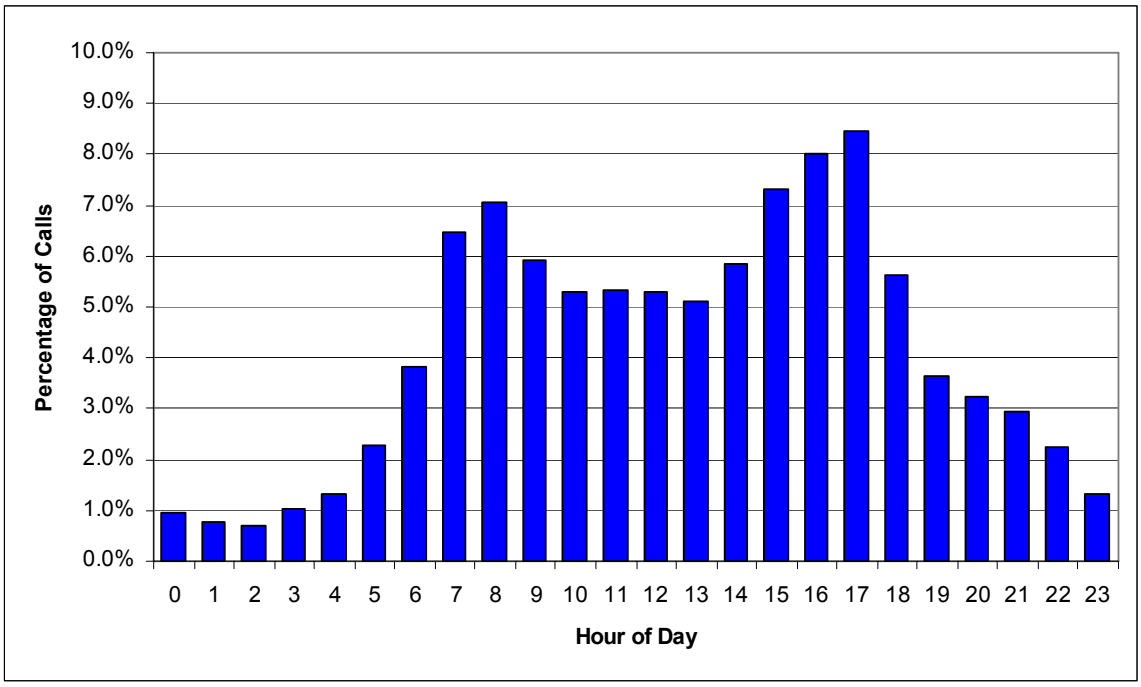


Figure 4-4. Hourly Call Distributions During Weekday (Post-enhancement)

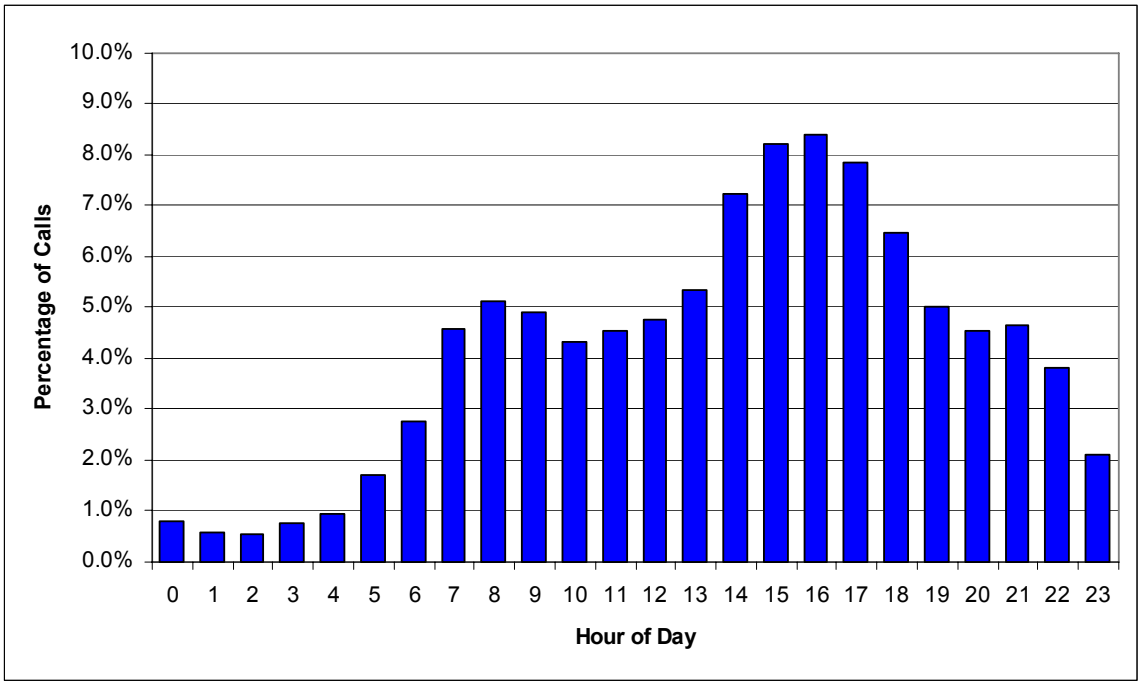


Figure 4-5. Hourly Call Distributions on Friday (Post-enhancement)

Figure 4-6 shows peak call volumes during the morning hours (8 to 11 a.m.), continued heavy use throughout the day (12 to 5 p.m.) and declining volumes through the evening. The patterns of Sunday call volumes (Figure 4-7) are similar to those of Saturday, with the exception that the heavy call volumes sustain longer into the evening, perhaps indicative of weekend recreational travelers returning home.

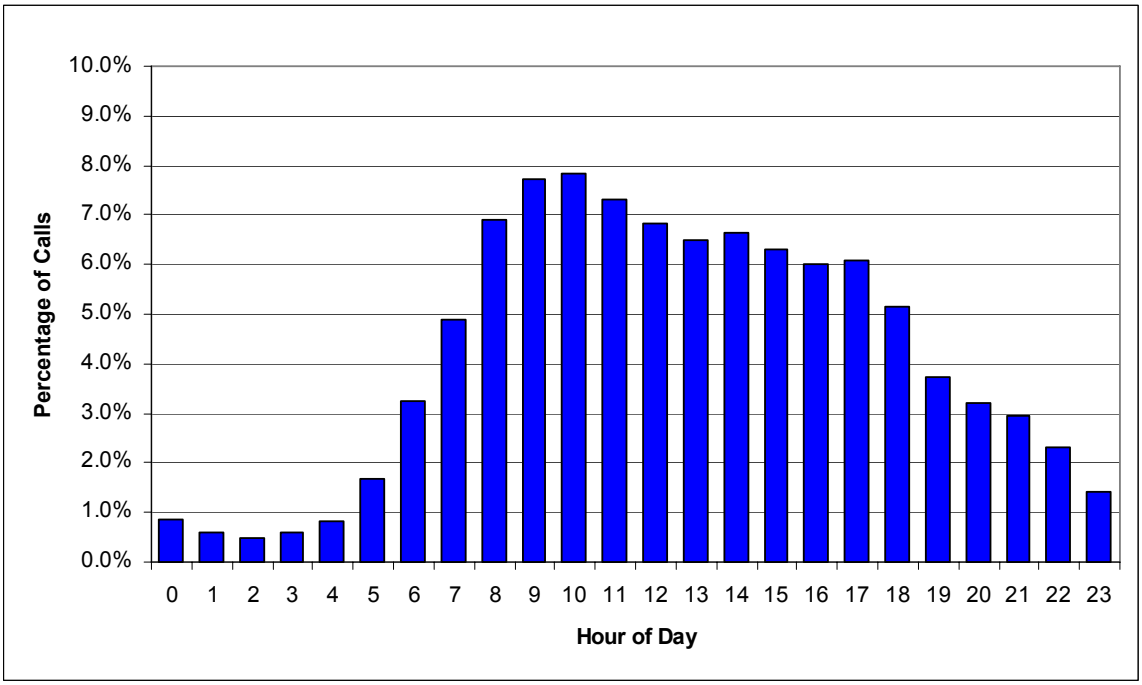


Figure 4-6. Hourly Call Distributions on Saturday (Post-enhancement)

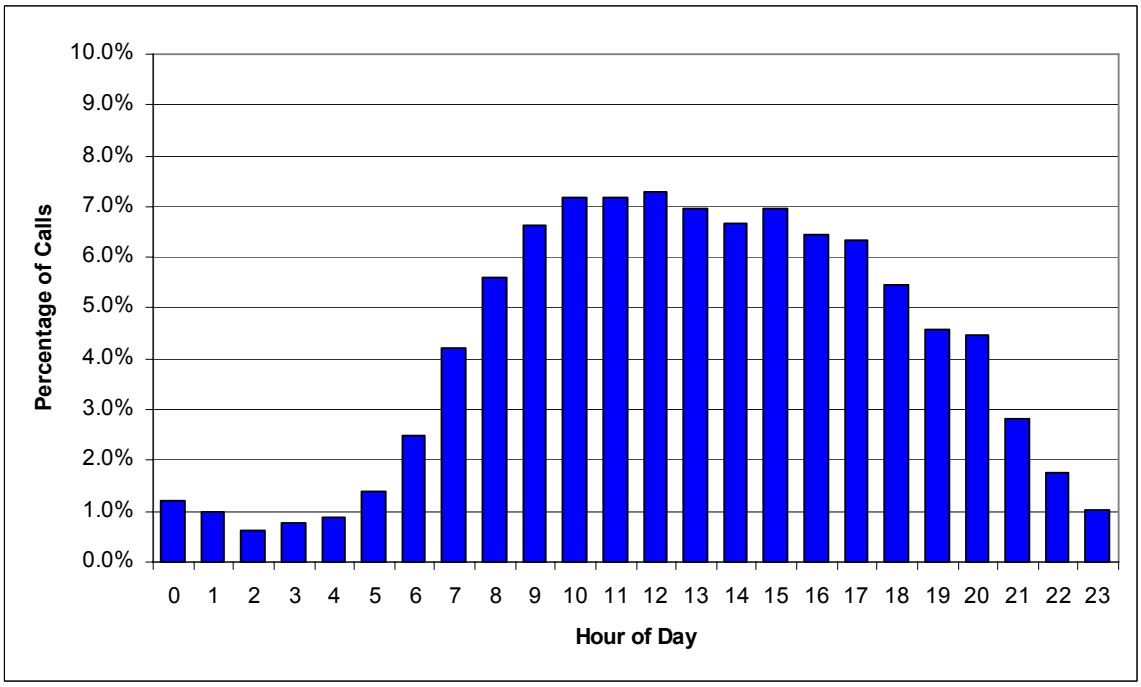


Figure 4-7. Hourly Call Distributions on Sunday (Post-enhancement)

The call patterns discussed above are similar to those observed during the pre-enhancement period in some respects. In particular, the strong orientation of weekday calling toward peak travel hours (morning and evening), with a steady demand during the mid-day period, are very similar to that observed in the pre-enhancement period. However, the overall patterns of call volumes shows a slight shift toward weekend use. The strong orientation of calls on Fridays toward the evening peak, the heavy demand on Saturday mornings, and the relatively level demand throughout the day on Sunday are characteristic of heavy use for weekend travel.

4.1.2 Call Frequency and Repeat Callers

Frequency of Use

In the examination of usage patterns, it is useful to understand how often users called 511. Table 4-1 shows the number of calls made from the same phone number in a month averaged across the post-enhancement period. It shows 291,245 unique calling numbers yielding a total of 670,369 calls during the one-year post-enhancement period, which equates to approximately 2.3 calls per phone number. This is slightly higher than in the pre-enhancement period, with approximately 2.0 calls per phone number, indicating a slight increase in call frequency. Figure 4-8 shows the call frequency by month in the post-deployment period which generally conforms with the overall call frequency patterns shown in Table 4-1.

Table 4-1. Frequency of Calls

Number of 511 calls from the same phone number per month	Percentage of Calls	
	Pre-Enhancement	Post-Enhancement
1	72.2%	68.0%
2-3	21.7%	24.5%
4-5	3.4%	4.7%
6-7	1.0%	1.4%
>7	1.8%	1.4%
Total unique phone numbers	7,261 (3 months)[8]	291,245 (12 months)
Total 511 calls	14,682 (3 months)	670,369 (12 months)

One confounding factor in this analysis is that the use of private branch exchange (PBX), which are common to offices, could potentially obscure this analysis by showing the same *external* number for all company phones tied to an exchange (PBX affects only the wireline calls). In this case, the observed increased call frequency may reflect higher use from a single phone, thus demonstrating legitimately increased call frequency, or it may reflect increased usage by multiple users, from a common PBX phone line.

[8] Phone bills from the months of July, August, and September 2003 were used for the pre-enhancement analysis due to data availability. Post-enhancement data are for the 12-month operational period and are from the VRAS logs.

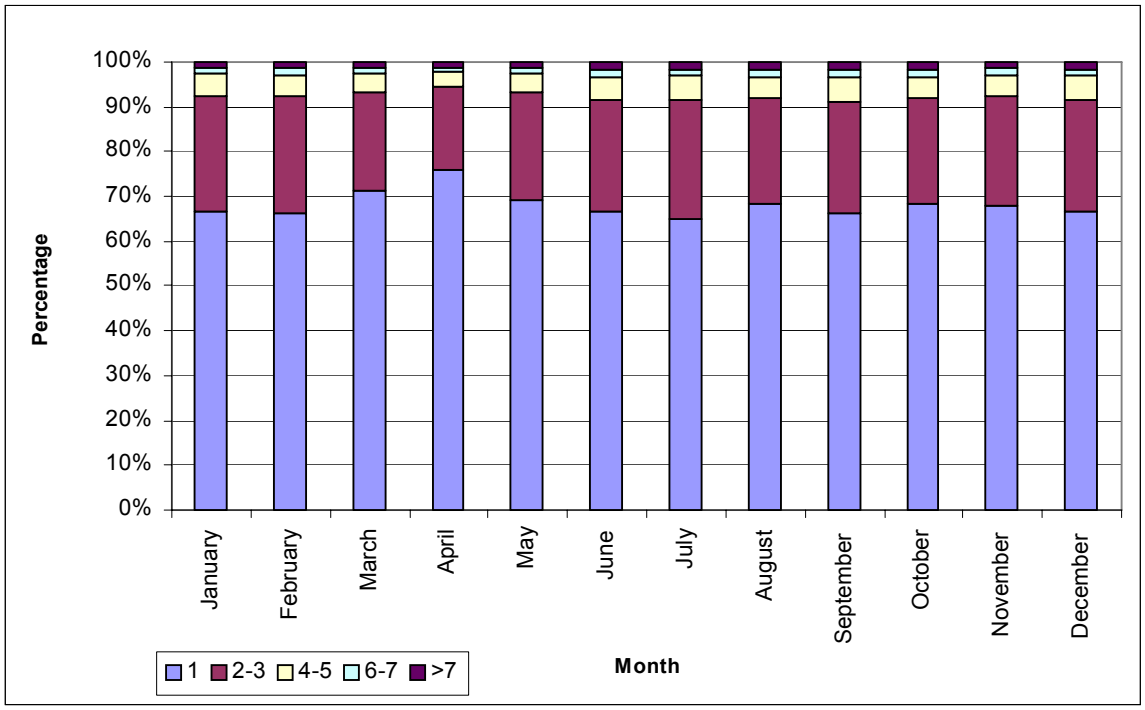


Figure 4-8. Call Frequency by Month (Post-Enhancement)

New and Repeat Callers

An analysis was conducted to examine the number of new callers in each month during the post-enhancement period. As shown in Table 4-2, the end of the month of December was used as the baseline (the new system went on-line on December 17, 2003) and new phone numbers were identified by comparing with all numbers accumulated over the previous months. Repeat callers are defined as those who made more than one call in the post-enhancement period. This analysis is useful in gauging 511's ability to retain repeat users (as an inverse function to the percentage of new users).

Table 4-2 shows that the enhanced system attracts significant (64 to 96%) new users every month. The highest percentage of first-time callers (96%) was recorded in the month of May, which corresponds to the week-long dynamic message sign (DMS) marketing campaign. It suggests that DMS is a very effective tool in promoting the awareness and first use of 511. The percentage of new users after the DMS campaign hovered between 64% and 73%, although overall calls increased, suggesting that 511 generated more repeat callers than the period before the DMS campaign, when new users accounted for 81% to 95% of all callers. The slightly upward trend of the percentage of new users in November and December could be due to the influx of winter visitors.[9]

[9] Estimated approximately 400,000 visitors lived in the state of Arizona during the winter seasons, in addition to the tourists.

Table 4-2. Percentage of New Callers (Post-Enhancement)

Month	Total Calling Numbers	New Callers	Percent New
December 2003	6,902	6,902	100.0%
January 2004	17,287	16,453	95.2%
February 2004	19,199	16,983	88.5%
March 2004	13,380	11,097	82.9%
April 2004	10,548	8,510	80.7%
May 2004	77,652	74,598	96.1%
June 2004	20,849	13,795	66.2%
July 2004	29,009	21,151	72.9%
August 2004	18,157	11,543	63.6%
September 2004	19,309	12,376	64.1%
October 2004	19,576	12,512	63.9%
November 2004	19,876	13,772	69.3%
December 2004	26,230	18,713	71.3%
Total	**291,072**	**231,503**	

The percentage of new users identified in this analysis (about two-thirds) is considerably higher than the one-third finding from the user survey (see Section 5-1). There are several factors contributing to the discrepancy:

- A disproportionate share of veteran users agreed to participate in the survey.
- The usage analysis, by necessity, counted unique calling numbers rather than actual unique callers. Individual users accessing the system from various phone numbers (e.g., phone, home, office) would appear as multiple users.
- Some 2004 callers who were actually veteran users may have appeared as new users in the usage analysis because they were not reflected in the (by necessity) limited baseline pool that was utilized (i.e., they had called before but it was pre-December 2003).

4.1.3 Call Durations

Average call duration increased approximately 41% in the post-enhancement period, from 63 seconds to about 93 seconds. Figure 4-9 shows the distribution of call durations in 10-second increments, during the post-enhancement period. Over half of the calls were completed within 80 seconds, and 75% were completed within 130 seconds (slightly over 2 minutes). Ninety-four percent were completed within 4 minutes (240 seconds).

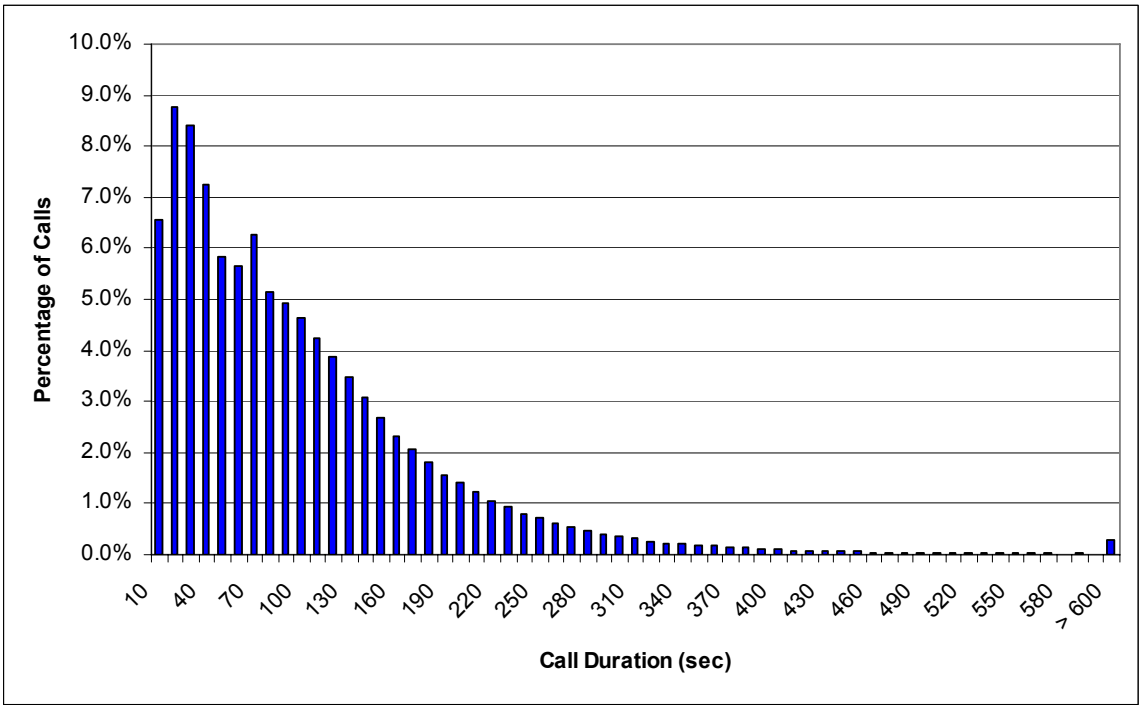


Figure 4-9. Call Durations (Post-Enhancement)

About 15% of post-enhancement calls were completed within 20 seconds, compared to 51% in the pre-enhancement period. This could bode well or poorly for the Model Deployment, depending on the nature of these calls. If very short calls are those where the caller hangs up in frustration before getting specific information, this reduction is positive. If short calls are those where skilled users quickly work through the menu system and obtain their information, then the findings are ambiguous. If it's taking callers longer to access the same amount of information, then this is obviously not a positive development. If users are collecting more information per call, that would be a positive outcome.

Based on analysis of content accessed, it is estimated that slightly over 9% (or 1 in 11) of the calls during the post-enhancement period did not remain on the line past the initial greeting. Comparable data from the pre-enhancement period is not available.

4.1.4 Wireless Versus Wireline

This analysis is based on thousand-block (prefix) number assignment data, which assigns phone numbers in a block of one thousand to wireless and wireline service providers, last published in October 2003. The prefix assignment has been relaxed since the FCC ruled to allow number portability (i.e., changing a wireless number to a wireline service, and vice versa; as well as keeping the same wireless number with a different service provider) effective November 2003. Therefore, the accuracy of this analysis depends on the magnitude of changes between the wireless and wireline registrations of phone numbers in the state of Arizona. It is estimated that the impacts of number portability on this analysis is limited, because most phone companies

started marketing campaigns in mid-2004 and only focused on the portability among wireless providers.

Given the resource-intensive thousand-block number matching analysis technique that was necessitated for this analysis, it was only feasible to examine Arizona registered phone numbers. Those numbers constituted approximately 69% of all calls to the 511 system. Non-Arizona registered numbers accounted for the remaining 31%.

During the post-enhancement period, the percentage of calls from Arizona-registered telephone prefixes averaged about 53% wireless and 47% wireline. Notably, average wireless call percentage (for all of 2004) of 53% is much higher than that of the pre-enhancement period (20%). A significant portion of the increase may be related to the very large number of calls fielded during the week-long DMS marketing campaign, a very high percentage of which (84%) were from cell phones. Figure 4-10 shows the percentage of wireless calls by month after enhancement. Wireless use was hovering between 22% and 29% prior to the DMS campaign and after the campaign tapered back to just slightly higher than the pre-enhancement level, finishing the year at about one-third of the total calls.

If it was possible to take into account the 31% of 511 calls originating from non-Arizona registered phone numbers, it is quite likely that the percentage of wireless calls would be significantly higher. This is because it is likely that many of these calls are made by Arizona visitors using cell phones registered in their home area.

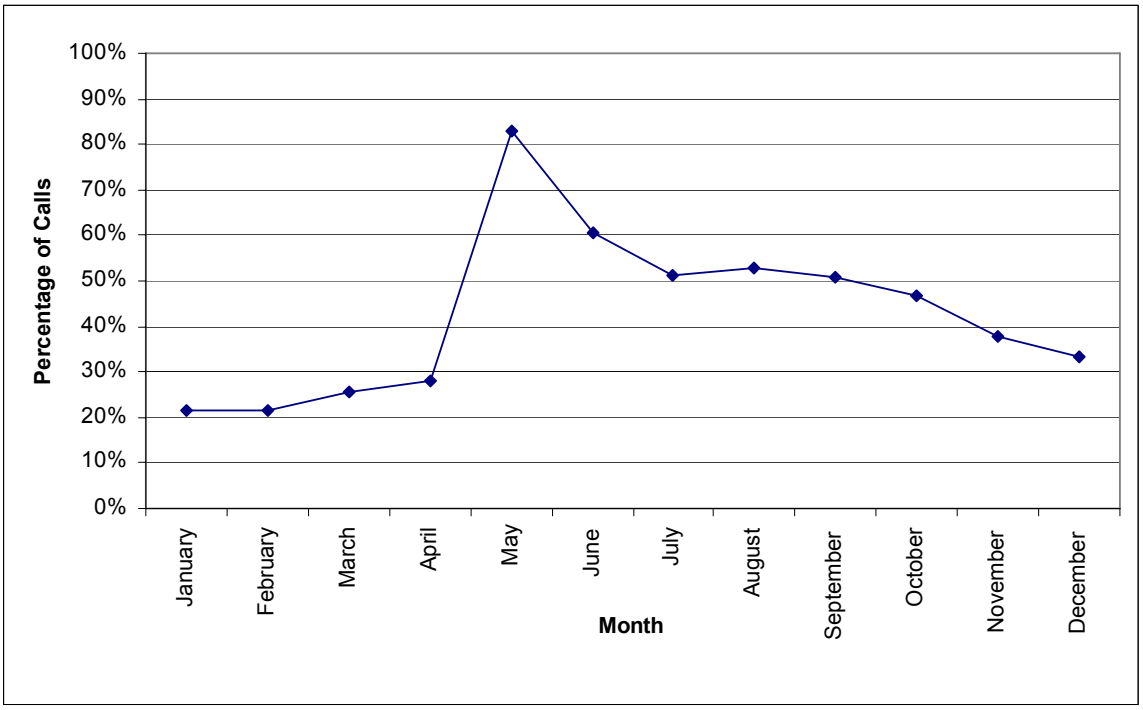


Figure 4-10. Percentage of Wireless Calls by Month

The average post-enhancement percentage of wireless calls, at 53%, corresponds closely to the 56% obtained in the user survey (see Section 5.0), but is significantly higher than the approximately 40% that occurred during the specific time of the survey (November 2004). The explanation may be that the survey included a disproportionate share of repeat callers, which the survey identified as having significantly higher cell phone use (65%) than first-time users (about 37%).

4.1.5 Call Geographic Location

The distribution of call locations is approximated using data from ADOT 511 phone bills during the three-month period August-October, for the both the pre- (2003) and post-enhancement (2004) periods. This analysis provides only an approximation because it was not possible to analyze all of the call data. The phone bills that were used (from Qwest) cover much of the state, including Phoenix and Flagstaff, but omit Tucson, a number of rural areas, and out-of-state calls. Data for these calls, served by a different provider (AT&T) were not available in a format that could be efficiently analyzed.

Table 4-3 presents the percentage of calls by origin (only locations with 0.5% of total calls or more are shown) for the pre- and post-enhancement periods. Expectedly, call origins correlate closely with population concentrations, with the largest population center, Phoenix, accounting for the greatest percentage of calls before and after the Model Deployment. The percentage of calls from the Phoenix region identified in this analysis is lower than the Phoenix area residency findings in the user survey (73%; see Table 5-2). The difference is likely a combination of the fact that the survey sample contained far fewer first time users than repeat users, with the Phoenix residency of the former being much closer (48%) to the results here, and the fact that some callers residing in Phoenix make 511 calls from other locations.

The concentration of Phoenix calls increased dramatically, from about 19% to about 59%. The explanation for this is unclear. It may be that the enormous spike in Phoenix call volumes observed during the statewide DMS marketing campaign (see Section 4.2.2), and the slowly diminishing but still higher than pre-campaign call volumes observed in the months after the campaign skewed the annual statistics. It is also possible that the other marketing activities (radio ads, ADOT promotions at Phoenix area freeway openings, etc.), which were oriented more to Phoenix, stimulated Phoenix 511 usage. Arguing against this explanation, however, is the user survey finding (see Table 5-1 in Section 5.0) indicating that these other marketing activities did not have a major impact.

Table 4-3. Location of Call Origin

Location of Call Origin	Pre-enhancement Percent	Post-enhancement Percent
Phoenix	19.4%	59.2%
Flagstaff	12.4%	8.3%
Payson	2.1%	4.6%
Prescott	9.1%	4.0%
Yuma	6.6%	3.3%
Casa Grande	3.9%	1.9%
Sedona	2.2%	1.5%
Pine	0.2%	1.0%
Show Low	1.6%	1.0%
Mesa	2.3%	0.8%
Eloy	1.7%	0.7%
Camp Verde	1.5%	0.7%
Coolidge	2.0%	0.7%
Cottonwood	1.4%	0.7%
Heber	0.2%	0.7%
Chandler	1.7%	0.7%
Winslow	0.5%	0.7%
Williams	0.7%	0.5%
Maricopa	0.7%	0.5%
Somerton	0.8%	0.5%

4.1.6 Handoffs and Transfers

Handoffs are transfers out of the 511 system to other agencies or to the 511 comment line voicemail box. Table 4-4 presents the post-enhancement percentage of all 511 calls that included various types of call transfers, and the percentage of total hand-offs by type. Overall, about 11% of calls to the 511 system included transfers out of the system. This is generally consistent with the menu selection results (which showed that about 91% of all information requests were for roadways) since the non-roadway menu items include call transfer options and relatively little in the way of imbedded content. The most common transfers, accounting for a combined 45% of all transfers and about 5% of all calls, were to either the Phoenix or Tucson transit services. Other fairly popular transfers were to the Arizona Office of Tourism (10% of all transfers; 1% of all calls) and the 511 caller comment voice mailbox (18% of all transfers; 2% of all calls).

Table 4-4. Call Hand-Offs

Handoffs	Number of Handoffs	Percentage of Handoffs	Percentage of Calls
Airports – Phoenix Sky Harbor	12,198	16.2%	1.8%
Airports – Tucson International	7,240	9.6%	1.1%
Transit – Phoenix Valley Metro	19,826	26.3%	3.0%
Transit – Tucson Sun Tran	13,900	18.5%	2.1%
Transit – Others	501	0.7%	0.1%
Tourism	7,781	10.3%	1.2%
Comment	13,853	18.4%	2.1%
Total	**75,299**	**100.0%**	**11.2%**

4.1.7 Line Utilization

In the pre-enhancement period, the total line capacity was 48 lines, consisting of 2 servers each managing 24 phone lines. In the post-enhancement period, the total number of phone lines available within the 511 system is 92 lines, distributed as 23 lines on each of 4 servers (one line is reserved for data transmission for each server). Calls entering the system are first assigned to one of the servers and then are assigned randomly to a specific line on that server.

Figure 4-11 indicates the percentage of calls in the 511 system occurring under various line utilization levels. The horizontal axis records, to the nearest four lines, the total number of lines in use when a call comes in. About 43% of the calls enter the system when there are 4 or fewer calls in the system; about 22% of the calls enter the system when there are between 5 and 8 calls in the system; etc.

In over 95% of the cases, the number of lines in use is less than or equal to 32 lines, with about 4.7% of the calls entering the system when at least 32 lines are in use. In 99% of the cases, there are 48 or fewer lines in use (about 50% of the total capacity), and at no point did the total lines in use exceed 84 lines, with this maximum being reached during the May marketing campaign. Clearly, the system has significant available capacity.

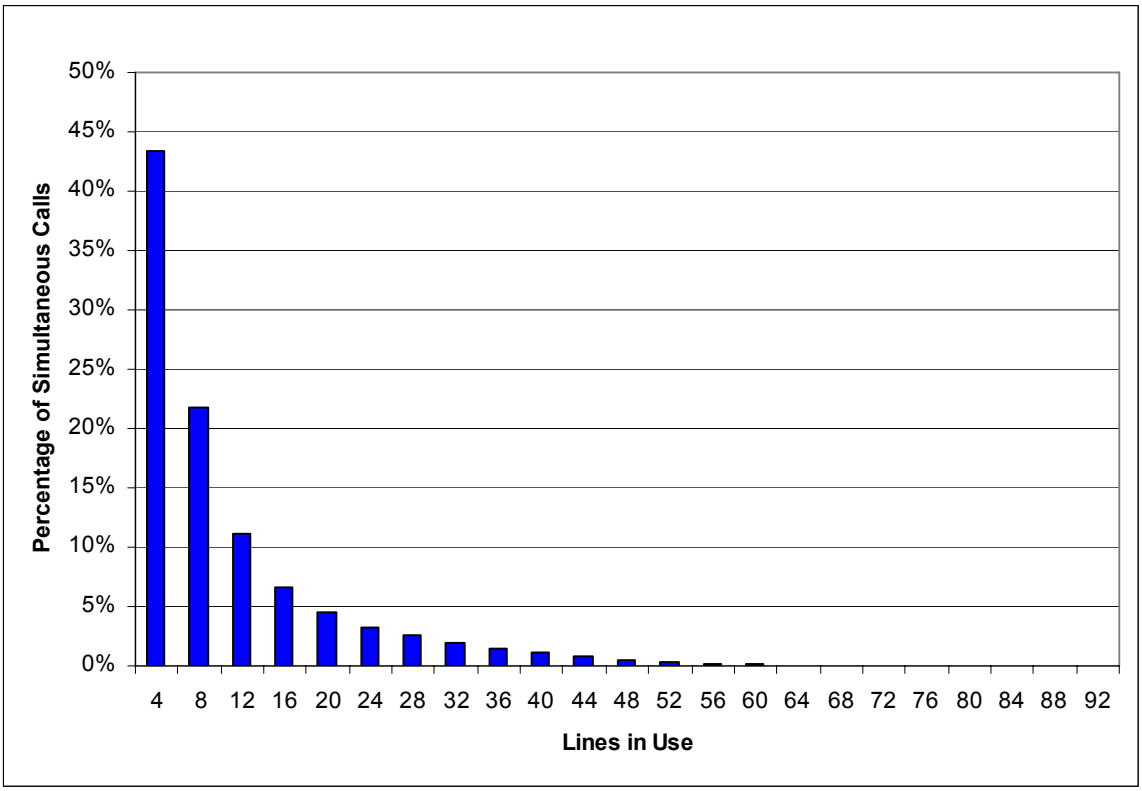


Figure 4-11. 511 System Line Utilization (Post-Enhancement)

4.1.8 Contents Accessed

The variety of information available in the enhanced 511 system is very broad. During the one-year post-enhancement period, the 511 system interpreted over 2.1 million information requests (with multiple requests per call possible). In general, these requests break out into the categories as shown in Table 4-5. About 91% of the total requests went through the Roads menu, while slightly over 4% of the requests fell under the Quick Reports. Smaller volumes of requests were observed for transit information (2.4%), airport information (1.3%), tourism and Grand Canyon information (0.4%), and to leave a comment (0.6%). The relatively low percentage of transit requests is in part a function of the fact that very few person trips in the Phoenix region (a major source of 511 calls) are made by transit—just over 1% of all trips (per the Maricopa Association of Governments)—and that very little 511 marketing was targeted to transit users.

It is important to note that in this table the "requests" include requests for the category in the menu structure, as well as the specific piece of information under a category. For example, a call asking for "Roads" followed by "I-17" would appear twice in the "Roads" requests in this summary. A call in which the caller asked for "Roads" followed by "I-17" and "I-40" would appear as three requests in the "Roads" category. That is, the statistics reported in Table 4-3 include some top-level menu requests, as well as requests for specific information. In the analysis that follows, however, only specific information requests within each category are analyzed. As a result, the sample sizes are smaller than the totals in the Table 4-5.

Table 4-5. Contents Accessed by Category (Post-Enhancement)

Category	Requests	Percent
Roads	1,983,457	91.0%
Quick Reports	94,556	4.3%
Transit	52,646	2.4%
Airports	28,205	1.3%
Tourism	7,781	0.4%
Comment	13,853	0.6%
Total	**2,180,498**	**100.0%**

As shown in Table 4-5, "Roads" is the most requested type of information. At only 4.3%, "Quick Reports" is utilized infrequently. This feature was added a few months after the debut of the enhanced system.

Roads

In this analysis, roadways with equivalent names and numbers are grouped together under a single heading. For example, "One Oh One" is the same as "Loop One Oh One" and, depending on the specific segment, is also known as the "Price", "Pima", and "Agua Fria" freeways.

One of the most fundamental findings is that there are a large number of roadway information requests that were not successfully interpreted by the system. For example, 38% of all requests for roadway information were rejected by the system because they did not include a valid numeric roadway reference. Some additional, perhaps substantial, percentage of requests can assumed to have been rejected because they included no valid roadway name (it was not possible to isolate these instances). Section 4.1.9 considers the issue of unrecognized call inputs in greater depth.

Table 4-6 presents the number and the percentage of requests for all roads (the 38% of all road information requests that could not be interpreted by the system are not included; Table 4-6 shows the break-down of the 61% of requests that were interpreted.) The total number of requests for information on specific roadways is 935,767. Table 4-6 identifies those numbered or named roadways receiving more than 1% of these requests. The high number of requests for I-8 are probably a function of the fact that (as discovered by ADOT) the voice recognition system tends to interpret many extraneous noises as the utterance "eight". If most of the I-8 requests shown in Table 4-6 are in fact spread out proportionately over the other roadways, the findings here are much closer to those obtained in the user survey (see Table 5-8). After I-8, the highest percentage of roadway requests was for Loop 101 (18.6%), a Phoenix area freeway. Interstates 10 and 17, both of which include considerable inter-city and urban area mileage, also had high fractions (almost 10% each) of the requests. Smaller but significant fractions were also observed for SR 51, US 60, Loop 202, and I-40 freeways (all except I-40 are located in the Phoenix area).

Table 4-6. Roadways Accessed (Post-Enhancement)

Roadway	Number of Requests	Percentage
I-8	174,872	18.7%
Loop 101	174,455	18.6%
I-10	92,432	9.9%
I-17	90,765	9.7%
SR 51	60,287	6.4%
US 60	47,198	5.0%
Loop 202	53,877	5.8%
I-40	45,872	4.9%
SR 87	18,018	1.9%
SR 277	14,725	1.6%
SR 587	13,468	1.4%
US 89	10,463	1.1%
SR 143	18,103	1.9%
Others	121,232	13.0%

Quick Reports

Among the 65,246 requests for Quick Reports, the number and percentage of requests are shown in Table 4-7. Most requests (about 69%) are for the Phoenix metropolitan area, with slightly over 30% of the requests for a quick report from Tucson. Within the Phoenix area, Phoenix (includes "Phoenix" and "Central Phoenix", which are the same area) accounts for about 27% of the requests. The West Valley and the East Valley both received about the same amount of requests (about 11% each), with smaller shares for the Northeast and Northwest Valley (around 9% each). The North Phoenix area received the smallest share, at 2.3%.

Table 4-7. Quick Report Accessed (Post-Enhancement)

Area	Number of Requests	Percentage
Tucson	20,105	30.8%
Phoenix	12,418	19.0%
West Valley – Phoenix	7,258	11.1%
East Valley – Phoenix	7,047	10.8%
Northwest Valley – Phoenix	5,854	9.0%
Northeast Valley – Phoenix	5,658	8.7%
Central Phoenix	5,249	8.0%
North Phoenix	1,518	2.3%
West – Phoenix	88	0.1%
East – Phoenix	51	0.1%

4.1.9 Unrecognized Caller Inputs

A useful surrogate measure of the overall effectiveness of the 511 user interface and specifically, the effectiveness of the voice recognition system, is the proportion of caller inputs that were not comprehended by the system. Caller comments during the first month or two after the roll out of the new user interface—coupled with the first-hand observations of some members of the evaluation team—indicate that the system's misinterpretation of inputs, including mistaking background noise for an input, can be a major source of frustration.

Table 4-8 illustrates the percentage of requests that were not understood by the 511 system during the post-enhancement period. For interpreting these data, these "errors" were situations where the caller received the following response from the system: "I'm sorry, I didn't understand your selection…" The nature of these errors include requests for information that is simply not available in the current location where the caller is in the 511 system (e.g., there is no roadway named "Five") as well as cases where the system could not correctly interpret the caller input.

Table 4-8. Percentage of Requests with Errors in Post-Enhancement Period

Month	Total Requests	Errors	Percentage Errors
January	171,694	42,891	25.0%
February	191,356	31,153	16.3%
March	106,840	20,810	19.5%
April	60,266	14,442	24.0%
May	495,838	68,484	13.8%
June	160,901	23,870	14.8%
July	213,037	37,227	17.5%
August	148,511	28,323	19.1%
September	155,120	31,051	20.0%
October	127,319	24,338	19.1%
November	144,667	26,178	18.1%
December	204,949	39,724	19.4%
Total	**2,180,498**	**388,491**	**17.8%**

The highest percentage of errors (25%) occurs at the beginning of the post-implementation period, in January 2004, when the voice recognition system was still being refined (as noted in item 1 in Section 7.2.1 the voice recognition consultant believed that additional time for testing would have been useful.) By May 2004, the system was at the lowest error rate in the year, at 13.8% of all requests. This number has gradually increased, to the point where it was back near 20% by the end of the year. The average error rate over the one year post-enhancement period was 17.8% of all requests. The exceptionally low rate in May might have been a result of many

new callers attracted by the May DMS ad campaign exploring the system, making only one simple information request from the top menu (e.g., simply saying "roads" then hanging up without making a specific roadway request.)

Curiously, as indicated in Table 4-9, almost all (93%) of unrecognized inputs occur at the top-level (main) menu. This may be because either the potential for errors is highest at the main menu (as every call includes activity at that level), or it may be because the voice recognition system has to "listen" for a much wider range of utterances at that level and therefore the possibility of misinterpretation is greater.

Table 4-9. Percentage of Errors by Menu Location

Menu Location	Total Errors	Percentage of Errors
Airports	20	0.0%
Comment	32	0.0%
Help	12,902	3.3%
Main Menu	361,822	93.1%
Misc Transfers	8,760	2.3%
Quick Reports	175	0.0%
Roads	1,538	0.4%
Tourism	350	0.1%
Transit	2,892	0.7%
Total	**388,491**	**100.0%**

Table 4-10 presents the percentage of calls with unrecognized user input errors by month (as opposed to Table 4-8 which examines the percentage of requests, with most calls containing multiple requests.) Overall, about 37% of all post-enhancement (2004) calls to the 511 system included errors of this type. The fact that this is higher than the 18% figure in Table 4-8 is because it only takes one misinterpreted request to be considered an "error call" in Table 4-10 (and conversely, it indicates that not all of the multiple requests common to most calls were misinterpreted.) Expectedly, errors were much more common (about 54%) in the first month of enhanced operation, consistent with the caller comments which indicate significant difficulties and frustration with the early voice recognition system. The percentage of errors declined over the first couple of months, probably reflecting both the refinements to the user interface and users' increasing familiarity. After March, the percentage of errors fluctuated in the range of 30-37%.

Table 4-10. Percentage of 511 Calls Encountering Interface-Related Errors by Month

Month	Calls	Calls with Errors	Percent
January	38,170	20,548	53.8%
February	41,680	18,053	43.3%
March	26,923	11,002	40.9%
April	20,417	6,857	33.6%
May	149,310	49,955	33.5%
June	45,513	15,847	34.8%
July	62,533	22,835	36.5%
August	39,459	14,428	36.6%
September	42,329	15,176	35.9%
October	42,069	14,734	35.0%
November	44,959	13,519	30.1%
December	53,943	19,975	37.0%
Total	**607,305**	**222,929**	**36.7%**

4.2 Usage During Special Occasions

Several scenarios that could have potential impacts on 511 usage during the post-enhancement period were identified as follows:

- The transition to the enhanced 511 system during December 2003 and January 2004
- The statewide marketing of 511 via dynamic message signs
- Wildfires and snow events
- A major traffic accident

4.2.1 Usage During Transition to Enhanced 511

On December 17, 2003, the new voice recognition-based 511 system replaced the old touch tone system without formal announcement from ADOT. Other enhancements included the addition of call transfer options to airports. One major concern was whether there would be a significant adverse impact on 511 use immediately following the roll out of the new user interface. It was speculated that callers accustomed to using the old system might react negatively, including no longer using the system. This concern reflected the understanding that the performance of the voice recognition system was less than optimal at the time of the roll out.

Figure 4-12 illustrates the call volumes during the transition period between December 2003 and January 2004. During this period, call volumes averaged near 1,000 calls per day, with slightly higher volumes observed in January. No adverse effects on the number of 511 calls during the transition were seen.

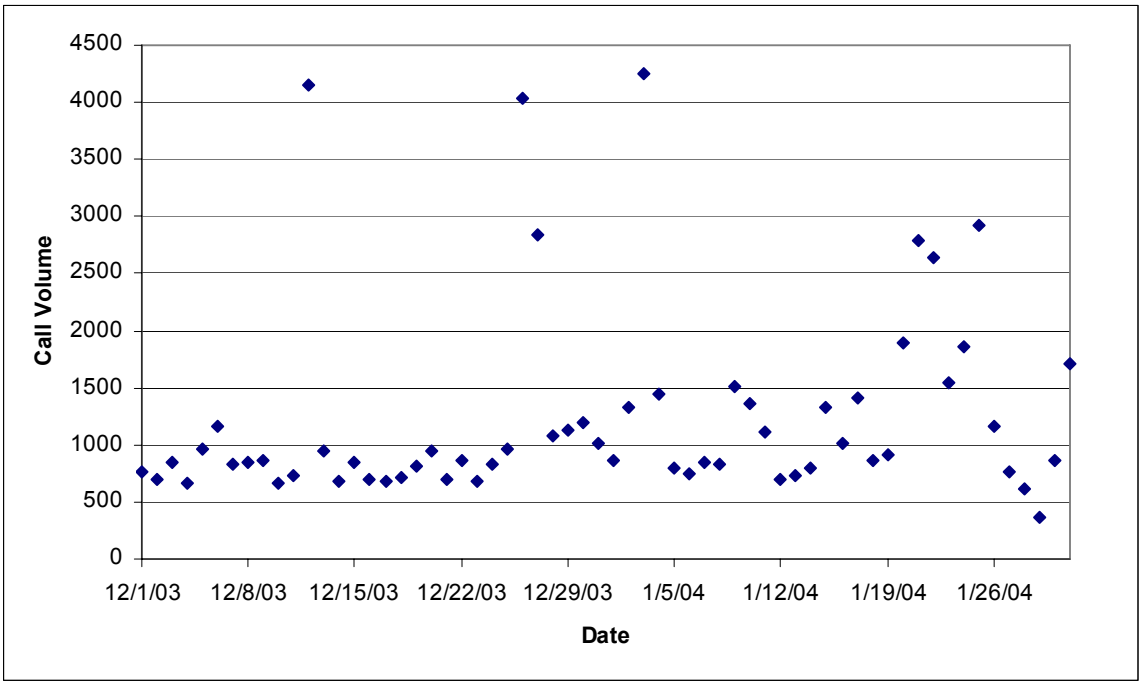


Figure 4-12. Call Volumes at Transition to Enhanced 511 System

In the months of December and January, only 8.6% and 8.3% of the total calls for each month, respectively, were found to have ended before the caller made a request. While slightly higher than the average for the entire post-implementation period, these values suggest that only a small fraction of 511 users chose not to interact with the new system.

During the transition, 23,355 individual callers (unique phone numbers) were identified in the 511 system. By the end of April 2005, 3,263 of these individual callers (about 14%) had called back. This compares closely to repeat call behavior during the pre-enhancement period.

4.2.2 Marketing Campaign Using Dynamic Message Signs

During the course of 2004, ADOT posted general (not incident or location specific) references to 511 messages on DMS throughout the state. The campaign occurred during the week of May 3-9, 2004 when the message "ROAD CONDITIONS, DIAL 511" was displayed 24 hours a day for the entire week (see Figure 4-13). The effects of the marketing campaign have been profound in publicizing the Arizona 511 system.

Figure 4-13. Picture of 511 Marketing Campaign via Dynamic Message Sign

Daily call volumes during the marketing campaign are presented in Figure 4-14, showing the magnitude of the calls in each day of the marketing effort compared with the weeks over April, May, and June. Call volumes during the DMS marketing campaign were dramatically higher, up to 20 times higher, than during the preceding weeks. There was a maximum daily volume of 17,265 calls on Monday, May 3, 2004, and daily volumes well over 11,000 all week, including the weekend (May 8 and 9). At total of 94,023 calls were made over the week-long DMS marketing campaign.

During this week, the call volumes by time of day reflect much higher volumes during the morning and evening peak periods. This is shown in Figure 4-15, illustrating the strong demand from 7 a.m. (hour 8) to 8 p.m. (hour 19), with the highest call volume in the evening peak period. Such a pattern is not unexpected since the DMS advertising has the most immediate impact on en-route travelers and these time periods correspond to peak traffic hours.

During the week of the marketing campaign, approximately 84% of all calls were made from a wireless phone, which is also not unexpected given the exposure of en-route travelers to DMS. This significantly increased the percentage of wireless calls for the month of May (83.1%) compared with other months in 2004 (ranged from about 20 to 60%).

Only 7.6% of calls made during the marketing campaign ended before information was requested. This percentage is actually slightly lower than that observed throughout 2004. This suggests that many first-time callers were probably curious and were willing to explore the new system.

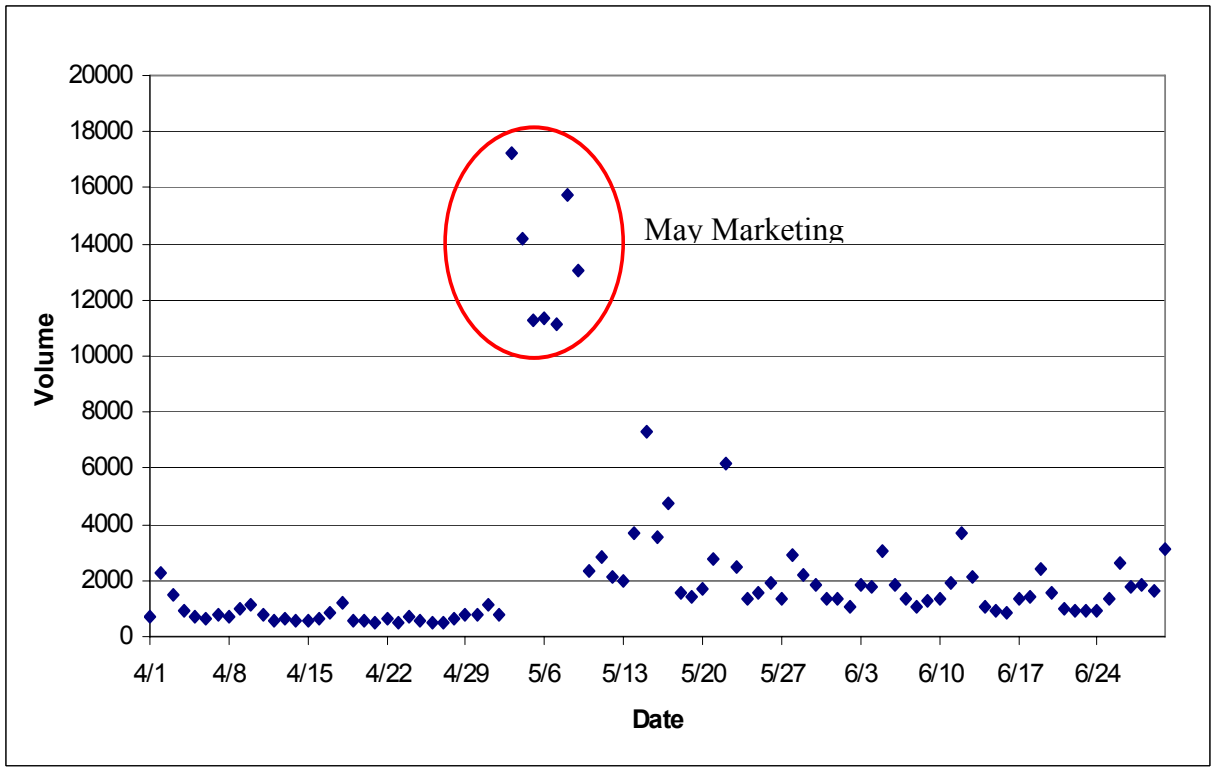


Figure 4-14. Call Volumes During DMS Marketing Campaign

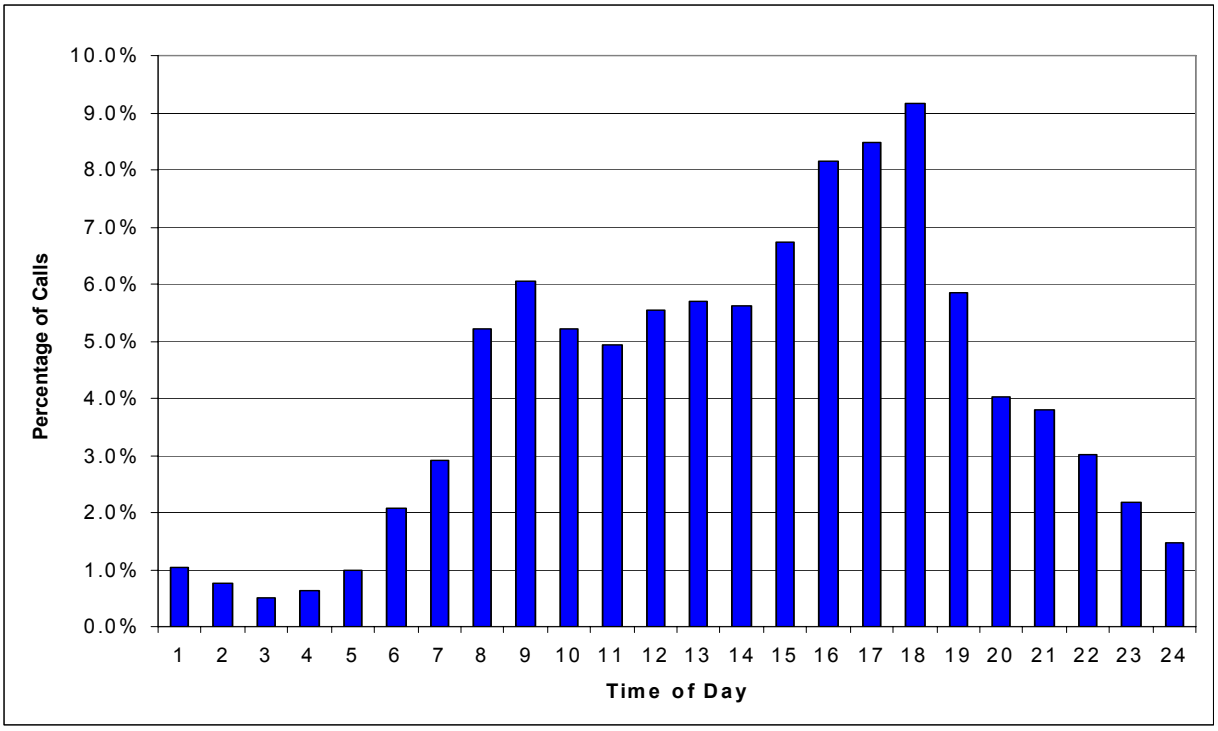


Figure 4-15. Percentage of Calls by Time of Day During DMS Marketing Campaign

4.2.3 Wildfires

Primarily during the months of June and July, Arizona often experiences significant wildfires. In both 2003 and 2004, during the implementation of the Arizona 511 system, several major wildfires occurred. Roadways are often closed or restricted during wildfires.

There were a number of major wildfires that could be analyzed. The National Forest Service listed 34 major fires (over 100 acres) in Arizona during 2004 and 26 during 2003. However, rather than addressing all fires, one example is given to illustrate the potential effects on 511 use. As was noted previously, fairly high call volumes were observed during the first and second weeks of July 2004. During that time, there were several major fires burning in Arizona, which included most notably the Willow fire, to the northwest of Payson along State Route 87 (begun June 24 and contained July 21, 2004), and the Ponderosa fire, just east of Payson in the Tonto National Forest, off of State Route 260 (begun and contained on July 8). The combination of these fires affected traffic patterns in and around Payson (2 hours northeast of Phoenix), and as a result generated some calls to the 511 system.

Higher-than-average call volumes for several state routes in the vicinity of the fires, including 87,587, and 260 were recorded. Table 4-11 illustrates the road information requests from July 7 through July 10, 2004, during these fires. The volume of calls on these days ranged from over 3,600 to about 6,000 calls per day, compared with the annual average daily call volume of 1,832. The percentage of information requests for wildfire-impacted roadways (e.g., SR 87, SR 587 and SR 260) was higher during the wildfires than for the one-year average. Evidently, travelers concerned about travel in areas near wildfires turned to 511 for information on road closures and restrictions.

Table 4-11. Requests for Wildfire-Impacted Roadways

Roadway	Percentage of All Roadway Requests	
	During Fire	Annual Average
SR 87	11.5%	1.9%
SR 587	3.8%	1.4%
SR 260	3.3%	< 1.0%

4.2.4 Major Snows

Table 4-12 identifies dates of major snowfall in northern Arizona, as recorded in Flagstaff by the National Oceanic and Atmospheric Administration (NOAA). Major snowfalls obviously impact travel and would presumably increase the demand for traveler information.

Table 4-12. 2004 Major Snow Storms

2004 Major Snow Storms in Northern Arizona (Post-Enhancement Period)[10]
January 3-5 and 20-21
February 1, 4, 19, 21-25, 27-29
March 2-3, 5, 13
April 3-4
October 22, 28-29, 31-November 4
November 21-23, 27-29
December 5-9, 29-30

The major snowfalls identified in Table 4-12 are circled in Figure 4-16, which presents daily 511 call volumes. Snow events appear to be closely related to 511 usage. In fact, with the exception of the DMS marketing in May 2004, the snow events produced the highest volumes of calls to 511.

During those snow events, higher volumes of information requests were received for roadways in northern and eastern Arizona. As an example, during the major snow event of December 5-9, 2004, call volumes began climbing on December 4 (a Saturday), peaked on December 5, and began to drop off over December 7-9, as the snow tapered off.

The major roadway information requests received during this snow event are shown in Table 4-13. Relative to other times of the year, a heavier volume of requests was observed for roadways with significant mileage in snowfall areas: I-40 (16.8%) and I-17 (12%). In addition, State Routes 89, 87, 587, 260, and 80 also received a significant number of requests during this snow event. Such a pattern of information requests can be considered typical of major snow events in northern and eastern Arizona.

[10] Major Arizona Snow Events in 2004, as recorded in Flagstaff (Source: NOAA)

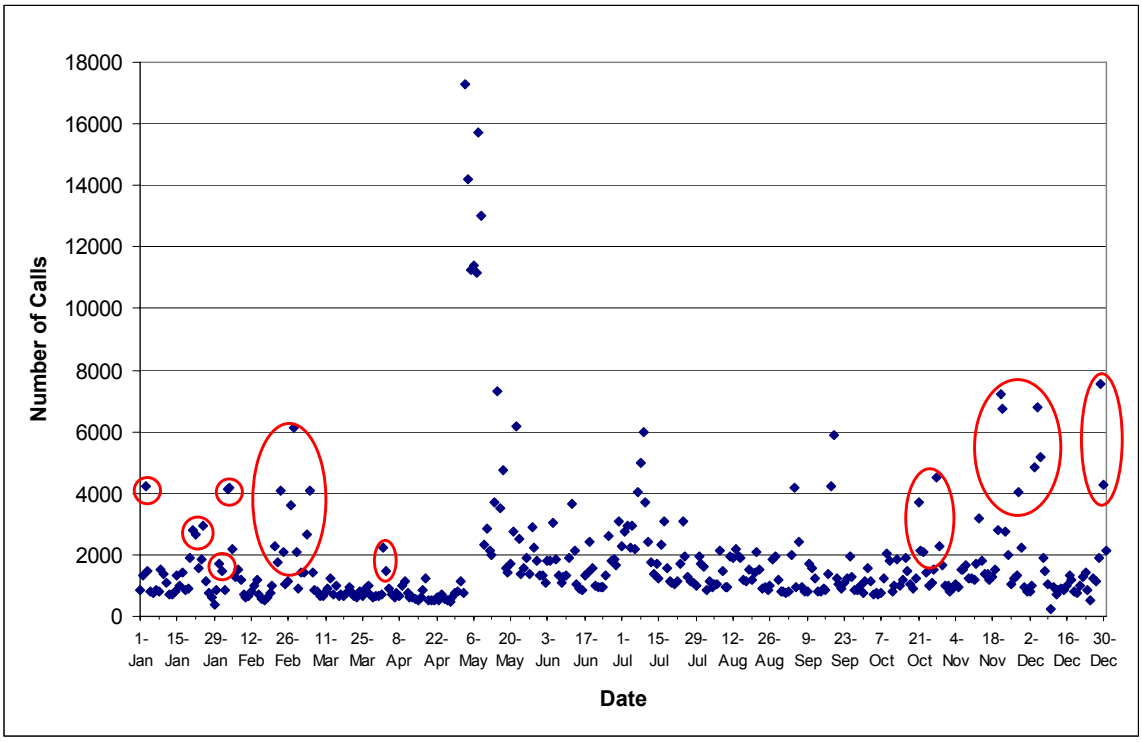


Figure 4-16. 511 Usage Spikes Correlated with Major Snows

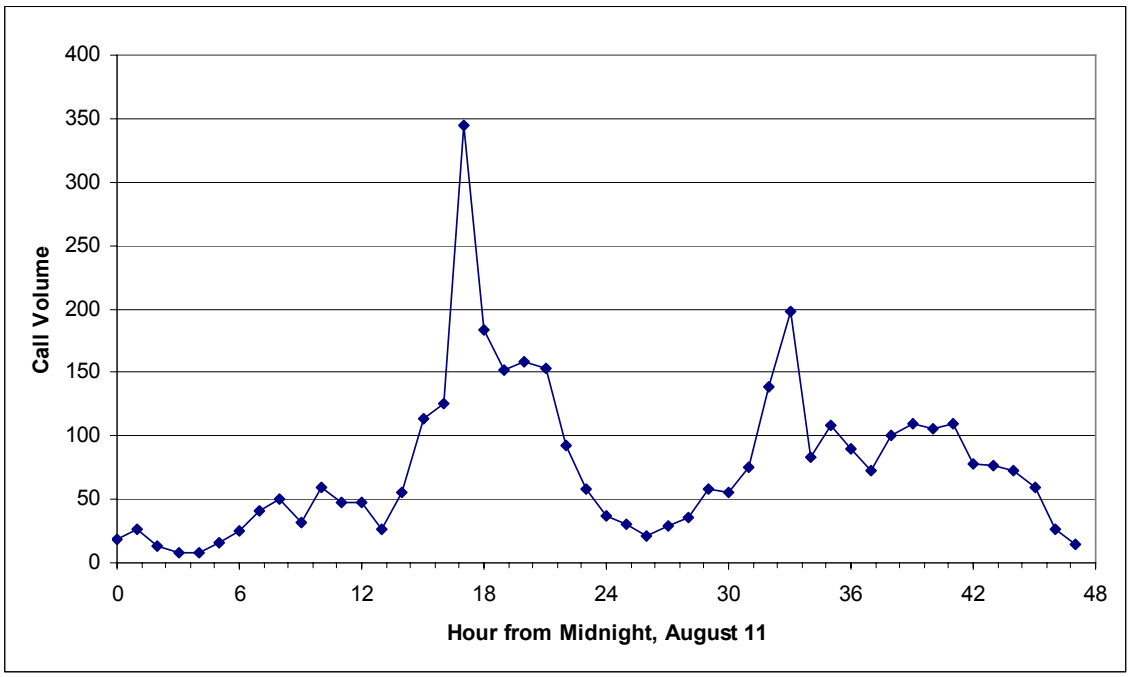
Table 4-13. Requests for Major Snow-Impacted Roadways

Roadway	Percentage of Total Roadway Requests	
	During Major Snow	Annual Average
I-40	16.8%	4.9%
I-17	12.0%	9.7%
SR 89	2.3%	1.1%
SR 87	2.0%	1.9%
SR 587	1.7%	1.4%
SR 260	1.5%	< 1.0%
SR 80	1.2%	< 1.0%

4.2.5 Major Crash

On the afternoon of August 11, 2004, a sandstorm crossed I-10 west of Buckeye, at Milepost 96 between Phoenix and the California state line. During the storm, a fiery crash in the westbound lanes of I-10 caused several fatalities. The roadway was closed for over 24 hours, until late in the day on August 12.

During this time, the 511 system carried typical total volume of daily calls, with 1,961 calls on August 11 and 1,887 calls on August 12. However, the calling patterns by hour of the day reveal a considerable peaking of calls during the evening of August 11 and again during the morning of August 12, as shown in Figure 4-17. A very large spike of 344 calls occurred during the first hour after the incident (5 p.m. on August 11, or hour 17 in the figure), followed by much heavier volumes for the next four hours (up to about 10 p.m. or hour 22). There was also a considerable peak the following morning, around 9 to 11 a.m. (hours 33 and 34 in Figure 4-17).



Note: Twelve hours from midnight August 11 is Noon, August 12; 18 hours from midnight is 4 p.m., August 12.

Figure 4-17. Call Volumes During Major Traffic Incident in Phoenix

Not surprisingly, the percentage of information requests for I-10 increased substantially during August 11-12, 2004, to about 26% of total requests (up from the 10% annual average).

4.3 Conclusions

- **Considerable usage increase in the post-deployment period.** The overall 511 usage increased by 74% during the one-year post-enhancement period with a total of 670,369 calls. The increased usage appears to be attributable to the week-long statewide DMS marketing campaign. Considering only the four post-enhancement months prior to the campaign (January – April 2004) call volumes were actually about 2% lower than the same period in the previous (pre-enhancement) year.

- **Significantly higher call volume (36%) was observed during weekends with the peak on Saturdays (20%) in the post-enhancement period.** Such a pattern was not found in the pre-enhancement period, which showed a relatively flat weekly call distribution, with the highest call volumes on Tuesdays. This suggests that the growth in call volume during the post-enhancement period was accounted for by the weekend users more than by the daily commuters.

- **Call frequency increased slightly in the post-enhancement period but it is still low for most callers.** Average call frequency increased slightly, from 2.0 to 2.3 calls per year per unique phone number. The data show that 68% of users made one call per month, a decrease from 71% in the pre-enhancement period, and that 24% of users made two or three calls per month, essentially the same as the 23% before the enhancement. Relatively low call frequency may suggest that the overall dependency on 511 is relatively low in the state of Arizona. A plausible explanation is the competition from other information sources (e.g., dynamic message signs, radio) and degrading but relatively manageable commute conditions.

- **Increased repeat users in post-enhancement period, despite the somewhat low overall percentage of repeat users.** Overall percentage of repeat users increased significantly from 10% to19% before the DMS marketing campaign to approximately 27% to 37% after the campaign. However, the relatively low percentage of repeat users suggests a small user base and also reveals that the potential of Arizona 511 is yet to be fully exploited. This is not surprising considering that it is only one year after the enhancement and the lack of sustained, intensive marketing efforts (e.g., roadside signs, periodic promotion on DMS, etc.).

- **Longer call durations experienced with enhanced 511.** Average call duration increased about 41%, from 66 to 93 seconds in the post-enhancement period. The percentage of very short calls, of 20 seconds or less, dropped significantly (15% post-enhancement versus 51% pre-enhancement). If very short calls are those where the caller hangs up in frustration before getting specific information, this reduction is positive. If short calls are those where skilled users quickly work through the menu system and obtain their information, then the findings are ambiguous. If it's taking callers longer to access the same amount of information, then this is obviously not a positive development. If users are collecting more information per call, that would be a positive outcome.

- **The proportion of wireless calls increased.** The overall percentage of wireless calls increased from 20% (pre-enhancement) to 53% in the post-enhancement period. However, much of this increase is probably due to the very high (84%) cell phone use during the week-long statewide DMS ad campaign. Wireless percentages before and after the DMS campaign were 20-30%.

- **Significant growth in 511 use from greater Phoenix area.** The overall share of calls from the greater Phoenix metropolitan area (including Mesa, Tempe, Chandler, North Phoenix) has grown from 36% to 62% in the post-enhancement period. This most likely reflects the impact of wider marketing in the Phoenix metropolitan area, when compared with other areas in the state.

- **The enhanced system still has significant available capacity.** The enhanced 511 has a total capacity of 92 lines managed by 4 servers. In 99% of the cases, 48 or fewer lines were in use (about 50% of the total capacity), and at no point did the total lines in use exceed 84 lines, with this maximum being reached during the May 2004 DMS marketing campaign.

- **Road conditions are the predominant type of information requested.** "Roads" accounted for 91% of all information requests during the post-enhancement period. At only 4.3%, "Quick Reports" are very little utilized, although this feature was added a few months after the debut of the enhanced system. Transit, airport, and tourism were minimally used at 2.4%, 1.3%, and 0.4% of all requests, respectively. These results are not unexpected given the absence of 511 marketing emphasizing these new information types (e.g., announcing and explaining Quick Reports) and the absence of marketing directed to the specific user groups that would have an interest in these new, non-roadway information types (e.g., transit riders). The relatively low utilization of transit information is also consistent with the very small regional transit mode share (about 1.2% of all regional trips).

- **Many of the large number of misinterpreted commands related to the performance of voice recognition.** Over the entire post-enhancement year, 37% of calls included one or more user inputs that could not be interpreted by the 511 system. That percentage was highest (58%) in January 2004, just after the enhanced system was rolled out. This number gradually declined over the first several months of 2004, presumably as a result of the intensive refinements that were made to the user interface, and by July had settled in at about the annual average.

- **A freeway dynamic message sign is an effective marketing tool in promoting the awareness of 511 service.** Call volumes increased dramatically during the month of the campaign (May 2004) and although they decreased in the following weeks and months, they remained higher than pre-campaign levels. During the month of DMS marketing, monthly call volume increased by a factor of 3.1, with 96% of users being new to the system. Approximately 84% of 511 calls during the DMS marketing campaign were made from cell phones, up from about 30% immediately prior to the campaign. This suggests that the DMS marketing campaign had, expectedly, a disproportionate impact on en-route travelers. The DMS marketing campaign, though short-lived, was extremely effective in publicizing the Arizona 511 system.

- **511 usage is strongly correlated with regional events such as wildfires and major snows.** The scenario-based analyses showed that the 511 call volumes and content being accessed correlate closely with the time and area (in terms of affected roads) of the events. In the case of snows, the major snow events appear to be closely related to increased 511 usage.

- **511 usage surged during a major crash on I-10 west of Phoenix.** Despite minimal changes in total daily call volumes, the analysis of hourly call volumes and peaking patterns indicated that calls to the system increased in the hours following the crash and the percentage of calls on the impacted roadway (I-10) increased.

5.0 511 Users and User Perspectives

This section presents the results of the telephone survey of 511 callers described in Section 3.2. The section addresses the following questions:

- When did callers start using 511 and how frequently do they call?
- Who uses 511?
- What is their occasion of use?
- What type of phone are callers using to access 511?
- What content do they seek?
- How satisfied are callers with the information they obtain?
- How does the service benefit them and impact their travel?
- What is their experience with the user interface?
- What improvements would they like to see to the service?

The reader is reminded that the results presented in Section 5.0 are weighted data. As noted previously in Section 3.2, and further elaborated in Appendix B, weighting is a standard survey practice used to reduce bias and improve the precision of estimates. Thus, the number of respondents (n) in the tables below is the weighted frequency for a specific survey question. Appendix C presents the unweighted and weighted frequencies for each question.

5.1 Frequency of Use of 511

The proportion of callers who were new to the service at the time of the survey was large. Figure 5-1 shows that a third of the callers report using it for the first time, and 13% had started using the service within the past month. Only 13% had first used 511 over a year ago, even though 511 has been available in Arizona since March 2002. Although the enhanced service was launched in December 2003, it was not heavily advertised until May 2004. This might explain why almost half (46%) of callers had started since then.

The number of unique individuals using 511 can be important to the future of the service. As long as usage of the service continues to grow, having a high percentage of new callers is a healthy sign, because some of them will become repeat callers. If the overall service plateaus or declines in overall usage, this might signify that new callers are trying the service but are not being converted to regular users at a significant rate. As noted in Section 4, the overall trend has been upward, which bodes well for the turnover in users of the service. Except for peaks of usage related to extreme weather conditions, calls made to 511 in the fall of 2004 were about 20,000 higher per month than during the same period in 2003.

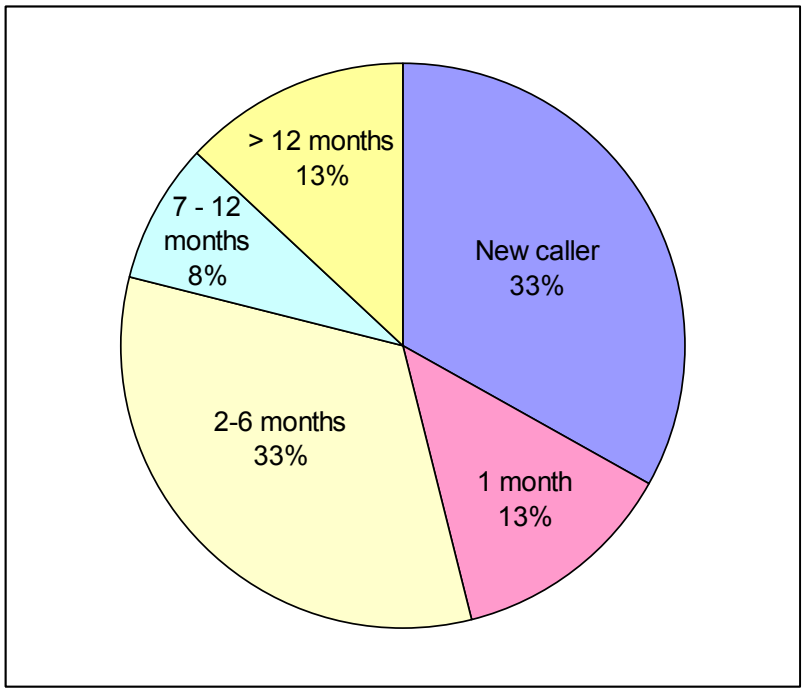


Figure 5-1. Percent of Callers by How Long Ago They First Used 511 (n=404)

There is another reason for noting the proportion of new and repeat callers. Previous research[11] suggests that new users of a traveler information service may differ from repeat users in how they use the service, in their expectations, and in user characteristics. Thus, differences between repeat and new users will be noted where appropriate in Section 5.0.

Figure 5-2 shows the distribution of percent of repeat callers according to the number of calls they made to 511 in the previous month. Over half (53%) made one to three calls, 31% made four to ten calls, and 16% made eleven or more calls. As noted in Section 4.1.2, there are several reasons that the survey-reported percentage of new users is lower than that found in the usage analysis, including the fact that repeat users were much more strongly represented in the survey sample.

When callers were asked how they first heard about 511 (Table 5-1), the electronic signs (dynamic message signs) used by ADOT to promote the enhanced system for a short while in the spring of 2004 were most frequently mentioned (34%). Friends and co-workers influenced 15% of the respondents to use 511, and websites, principally ADOT's, accounted for an additional 11%. Radio was cited by 9% of the respondents. This could reflect the short radio ad campaign conducted by ADOT in May and early June 2004 or possibly local news coverage of the 511 system (some television and newspaper coverage was observed at the enhanced system roll out

[11] Petrella, M. and J. Lappin. "Comparative Analysis of Customer Response to Online Traffic Information in Two Cities: Los Angeles, California, and Seattle, Washington," Transportation Research Record, Vol. 1886, 2004.

in late 2003 and early 2004). Interestingly, 511 road signs were cited by 3% of the respondents even though they had not been deployed by the time of the survey. Perhaps some callers had become aware of 511 by seeing road signs in neighboring Utah, or perhaps they were thinking about the dynamic message signs when they said road signs.

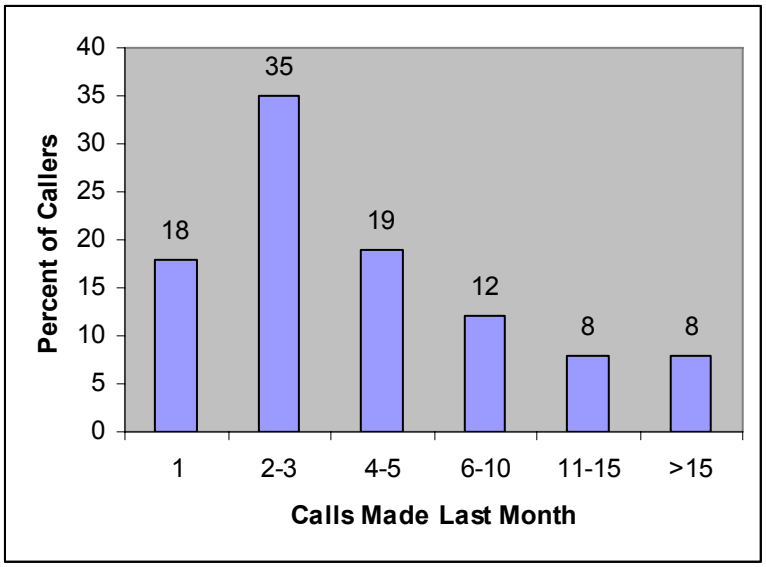


Figure 5-2. Percent of Repeat Callers by Number of Calls Made to 511 in Last Month (n=277)

Table 5-1. How Respondents First Became Aware of Arizona's 511 Service

How did you first hear about 511?	Percent of Respondents*
Electronic sign over road	34
Friend or co-worker	15
DOT website/Internet	11
Radio	9
Phonebook	7
TV	5
Newspaper	4
Police department	4
Road sign	3
Map or atlas	3
Arizona DOT	2
Other	5

*May not sum to 100% due to rounding.

Only 5% of repeat callers reported using 511 in a different state. At the time of the survey, 511 was available in 24 locations in the U.S., including the neighboring state of Utah. Utah was one of the most frequently mentioned of the sixteen states identified by respondents. All but two of the states named are west of the Mississippi, which may reflect regional patterns of travel by these 511 callers. However, respondents' recall of exactly where they had used 511 was not very reliable. Of the sixteen states named, only nine had 511 service at the time of the survey. Nevertheless, the results indicate that a small portion of the callers are aware of 511 being available outside Arizona and have used it. The finding can be viewed as an indication that 511, if not yet a national brand, is starting to be recognized by callers as more than a service of a single state.

5.2 Who Uses 511?

This section examines the characteristics of Arizona 511 users in terms of their place of residence and demographic and socioeconomic attributes. In general, the data reveal that residents of Phoenix are the dominant users of the service, but out-of-state residents and those from more rural parts of Arizona are well represented among first-time users. Men and women use 511 in about the same numbers. Measures of age, education, and income reveal important differences between repeat users and those using 511 for the first time. First-time users tend to be older, less educated, and have somewhat lower income than repeat users. These overall characteristics of 511 users are discussed in more detail below.

The distribution of all respondents' zip codes of residence on the day of the survey (Table 5-2) shows that a considerable majority of callers live in the Phoenix metropolitan area as defined by Maricopa County (73%), a higher concentration than the 61% of the state's population that live there.[12] However, when residence of repeat users is compared to first-time users, striking and statistically significant differences in the distribution of callers by geographic residence were observed (p-value < 0.0001[13]). Eighty-five percent of repeat users are from the Phoenix area versus 48% for first-time callers (p-value < 0.0001). Tucson accounts for very few users among either group. Of the 52% of callers that are non-Phoenix first-time users, 6% are from Tucson, 23% are from other parts of Arizona (i.e., locations other than Tucson) and 23% are from out of state. Arizonans who reside outside Phoenix or Tucson may have recently become aware of 511 and tried it for the first time. Out-of-state callers may be vacationers or "snowbirds" making their annual trip to Arizona.

Turning to gender and age of users, men hold a slight majority among both repeat and first-time users, 52% and 54% respectively, but the difference between the two groups is not statistically significant (p-value = 0.829). More important than gender are differences in the age profile of the two groups, where there are statistically significant differences (p-value < 0.0001). As shown in Figure 5-3, first-time users tend to be somewhat older than repeat users. Indeed, 24% of first-time users are 65 or older, compared to only 2% among repeat users (p-value < 0.0001).

[12] U.S. Census Bureau website, www.census.gov, March, 2005.

[13] A p-value represents the probability that an observed difference could occur by chance. The smaller the p-value, the greater the significance of the difference between the numbers being tested.

Table 5-2. Residence of Callers at the Time of the Survey

Where Resided on Day of Survey	Percent of Repeat Users (n=272)	Percent of First-Time Users (n=131)	Percent of Total Users
Out of state	2	23	9
Phoenix metro area (Maricopa County)	85	48	73
Tucson metro area (Pima County)	<1	6	2
Other part of Arizona	13	23	16

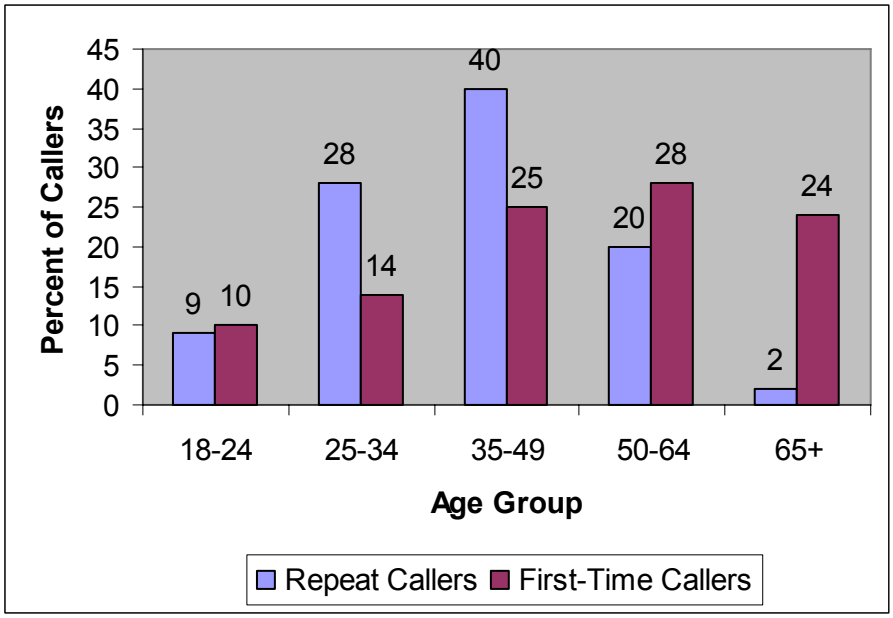


Figure 5-3. Percent of Callers by Age Group

Household income and education of the surveyed individual were the socio-economic characteristics measured in the survey, and repeat users tended to have higher incomes and education levels than did first-time callers (Table 5-3). There is a significant difference for income (p-value = 0.007), but not for education (p-value = 0.154). The median education level of callers is two years of college, but only 7% of first-time users have postgraduate degrees compared to 15% among repeat users (p-value = 0.0545). Nearly twice as many first-time callers (41% vs. 21%) have a household income less than $40,000 (p-value = 0.0036), although slightly more (but not statistically significant) first-time callers have a household income exceeding $100,000 (p-value = 0.2048). Lower income along with higher age and somewhat lower education levels may reflect a higher concentration of retirees among the first-time users, although employment status was not included in the survey. Conversely, the lower age and higher income of repeat callers suggest that they tend to be working age and probably more likely to use 511 on a regular basis for work-and school-related travel.

Table 5-3. Socio-Economic Characteristics of 511 Callers

Characteristic	Percent of Repeat Callers	Percent of First-Time Callers
Education	(n=275)	(n=132)
Less than high school graduate	1	4
High school graduate	23	31
Two years of college	31	26
Bachelor degree	32	32
Postgraduate degree	15	7
Annual Household Income	(n=236)	(n=63)
Less than $15,000	5	15
$15,000 – 24,999	2	6
$25,000 – 39,999	14	20
$40,000 – 59,999	27	19
$60,000 – 99,999	37	18
$100,000 or more	14	22

5.3 Occasion of Use and Type of Phone Used

This section characterizes the occasion of use of 511 in Arizona by describing the caller's situation when he or she placed a call to obtain information. The data include the caller's location, trip purpose, and mode of travel. This section also profiles the type of phone—landline or cell phone—callers are using to access 511.

As shown in Table 5-4, a significant 61% majority (95% confidence interval of 50% to 72%[14]) of 511 callers placed their calls from a private vehicle as either a driver or passenger. Another significant 30% of callers (95% confidence interval of 24% to 37%) used 511 from home. A surprisingly small, though statistically significant, 6% (95% confidence interval of 4% to 9%) accessed the service while at work, suggesting that workers may not be checking on travel conditions for their commute home before setting out, but instead are calling from their vehicles.

Trip purpose, as shown in Figure 5-4, reveals that 511 is providing callers with information for a broad range of trip purposes. Slightly more than half (52%) of the calls were for information for trips for family or personal reasons, and for social, religious, or recreational purposes. The remaining 48% of calls were for information related to commute or other trips for work or school. The split in use of 511 based on trip purpose is consistent with the system usage data based on day of week presented in Section 4. Data in Section 4 showed that about half of the calls were placed from Monday through Thursday and exhibited the morning and afternoon peaks typical of commute patterns. The other half of calls occurred on Friday afternoon and

[14] This confidence was constructed using the normal distribution and represents + or – 1.96 multiplied by the standard error. The interpretation of this interval is that if the survey was completed an infinite number of time, this interval would be about the true proportion 95% of the time.

evening and on Saturday and Sundays—indicative of weekend travel not related to work and school.

Table 5-4. Respondent's Location When 511 Call Was Placed (n=411)

Location	Percent of Respondents
Home	30
Work	6
Driving a private vehicle	56
Passenger in private vehicle	5
Bus passenger	0
Waiting at bus stop	1
Somewhere else	2

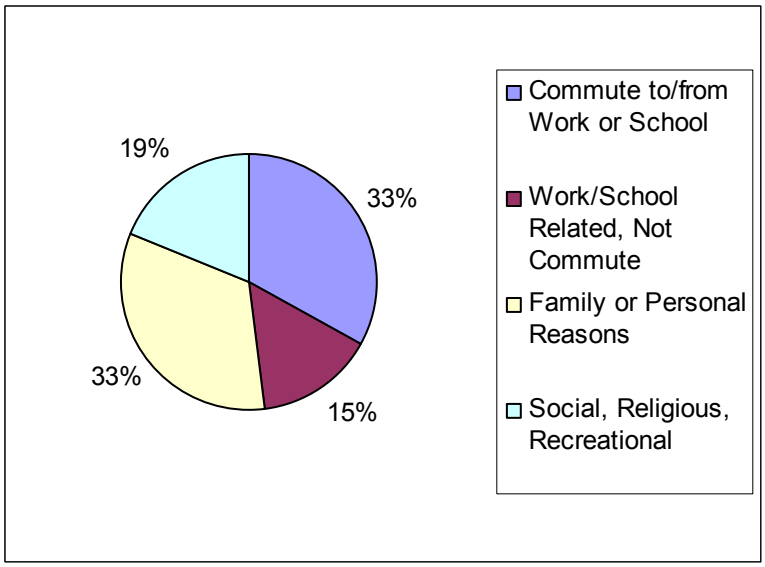


Figure 5-4. Callers by Purpose of Trip When Called 511 (n=378)

Another aspect of occasion of use of 511 is the timing of the call. The question of interest is whether users are calling 511 pre-trip to plan their trip based on what they hear about travel conditions and other information, or are calling 511 while en route to make trip adjustments if the information so warrants. The survey revealed that a 65% majority (95% confidence interval of 58% to 72%) of 511 users made their calls while traveling (Table 5-5), which suggests that real-time information would be important to most 511 users. An additional 23% called the same day before setting out, and only 11% used 511 to plan a trip a day or more in advance, perhaps

for a long-distance trip to check potential construction delays or rural weather conditions. However, there is no significant difference in the percentage of callers who called within 15 minutes before, more than 15 minutes but on the day of the trip, and a day or more in advance of trip.

Table 5-5. When Respondents Place Calls to 511 (n=411)

Time of Call Relative to Trip	Percent of Respondents
While traveling	65
Within 15 minutes before	8
More than 15 minutes before on day of trip	15
A day or more in advance of trip	11

When asked about their mode of travel for the trip they were taking (Figure 5-5), the vast majority of callers were either drivers (87% with a 95% confidence interval of 83% to 92%) or passengers (5% with a 95% confidence interval of 3% to 8%) in a private vehicle. Commercial vehicle operators accounted for 8% of callers (95% confidence interval of 4% to 12%), with two-thirds of them driving "semi's." Arizona's 511 system is used by very few transit riders, as only 1% of the callers reported their trip was by bus (not a statistically significant percentage), which confirms the findings in Section 4.0 that road information is the type of information that callers are accessing.

As shown in Table 5-6, 56% of all callers used cell phones to access the 511 service, although that was not a significant majority (95% confidence interval of 50% to 62%). On the other hand, relative to land line callers the distribution of cell phone use differed significantly between repeat and first-time callers (p-value <0.0001). Among repeat callers, 65% indicated they were using a cell phone for the trip when intercepted for the survey. Moreover, when asked about all the calls they have made to 511, 81% of repeat users said that they usually call from a cell phone. Cell phone usage among repeat callers correlates with the high percentage of callers who said they called from a private vehicle (61%) and while driving (65%). In contrast, among first-time callers, only 37% were using a cell phone when they called 511 at the time of the survey. This may be because users' first exploratory call to 511 is more often a general familiarization call, made from home, and not necessarily pertaining to a specific trip. It may also be related to the fact that first-time callers tend to be older and to have somewhat lower incomes than repeat callers, which could indicate lower cell phone ownership.

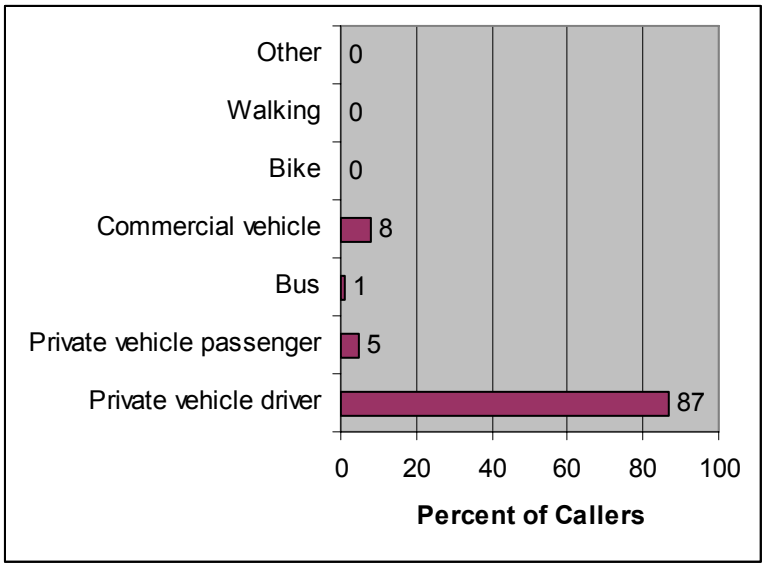


Figure 5-5. Mode of Travel of Trip (n=382)

Table 5-6. Type of Phone Used to Access 511 for the Surveyed Trip

Phone Type	Repeat Callers (n=283)	First-Time Callers (n=128)	Total (n=411)
Cell phone	65%	37%	56%
Landline	35%	63%	44%

The survey data imply that cell phone usage is higher than that seen in the wireless vs. wireline usage analysis in Section 4.0, which shows only about 40% of the calls to 511 were from cell phones during the month of November 2004 when the survey was in the field. One explanation might be that first-time callers, who reported lower usage of cell phones (p-value < 0.0001), had a higher incident of refusal for participation in the survey.

5.4 Content Selected

Callers were asked to identify the sections of the 511 menu that they accessed for information for the trip they were taking. The modal split in content selected is pronounced (Table 5-7). Ninety percent of callers selected road information, 8% selected the regional quick reports on roadway conditions, and less than 1% asked for information on buses for the trip they were taking when surveyed. All the bus inquiries were for Phoenix Valley Metro rather than Tucson Sun Tran or other bus systems around the state. When callers were asked if they had ever sought certain types of content on 511, not for just this trip, the numbers rose by only one to three points, and

the overall pattern remained the same. Clearly, at the time of the survey, the Arizona 511 service was being used almost entirely for information on roads. These findings are consistent with those of the usage analysis (Section 4.0). Factors which could account for modest usage of 511 for transit, airport, and tourism information are low levels of advertising of these features, seasonality of demand in the case of tourism, and possibly callers' dissatisfaction with the information provided in these areas, leading to low repeat use. The issue of satisfaction is taken up in Section 5.5, but it should be noted that the number of respondents using these content areas is too small for the results to be considered reliable.

Table 5-7. Menu Selections by Callers for the Surveyed Trip

Content Area	Number of Callers Requesting for Current Trip	Percent of Callers Requesting for Current Trip**
Roads	334	90
Transit	3	<1
Phoenix Valley Metro	3	<1
Tucson Sun Tran	0	0
Other Transit Systems	0	0
Airport	2	<1
Phoenix Sky Harbor	2	<1
Tucson International	0	0
Tourism	1	<1
Arizona Office of Tourism	0	0
Grand Canyon	1	0
Quick Reports*	29	8
Northwest Valley	2	<1
North Phoenix	7	1
Northeast Valley	2	<1
East Valley	13	3
Phoenix	4	1
West Valley	2	<1
Tucson	1	<1

*Numbers may not sum due to rounding
**Do not sum to 100% because caller could select more than one content area

For callers requesting road information (Table 5-8), the interstates and freeways accounted for 70% of all roads that callers mentioned. The leading roadways were I-10, a major route through both Phoenix and Tucson, and I-17, the major north-south route between Phoenix and Flagstaff. U.S. 60, between Phoenix and the state border to the east, was the only other road that received mentions of 10% or more by callers.

Table 5-8. Roads for Which Callers Requested Information

Roads for Which Information was Requested	Number of Times Road Was Requested	Percent* of All Roads Requested
Interstates/Freeways		
I-10	96	22
I-17	76	17
101	54	12
202	43	10
I-40	39	9
I-8	1	<1
U.S. Highways		
60	42	10
89	7	2
93	4	1
Other U.S. highways (9)	9	2
State Highways		
51	18	4
87	12	3
260	9	2
Other state highways (10)	10	2
Other Roads	13	3
Total, All Roads	440	100

*Percent may not sum to 100 due to rounding

5.5 Satisfaction with 511 Service

A key objective of the evaluation is to measure user satisfaction with the 511 service. The enhancements to the service discussed in Section 2.2 were expected to improve the service in ways that would be perceived positively by the traveling public. Thus, a substantial portion of the survey was devoted to assessing satisfaction through various means. One type of measurement was to ask callers about their satisfaction for the particular trip they were taking when surveyed. Callers rated on a scale of 1 to 5 their satisfaction with the information they received from 511 in general and for the specific content areas they selected from the 511 menu. In addition to the particular trip, repeat callers were asked about their satisfaction for all the past calls they had made to 511. Another satisfaction measure involved the comparison of 511 to radio traffic reports, another popular form of traveler information. Satisfaction was also measured by using a series of statements to which they could agree or disagree, and whether they

would use the service again and recommend it to a friend. This section discusses the findings from these various measurements.

5.5.1 Satisfaction with Information for the Trip Taken

Table 5-9 presents callers' level of satisfaction with the quality of information they received for the menu options they selected for the trip they were taking when intercepted for the survey. For all the content areas, over 70% of callers were satisfied with the information they received for the particular trip. For both road information and Quick Reports, over 20% of callers expressed dissatisfaction with the information. The potential sources of that dissatisfaction are explored later in this section. (The responses for use of bus, airport, and tourism information were too few (≤ 2) to calculate meaningful percentages, and, thus, are not shown.)

Table 5-9. Satisfaction with Quality of Information Received for This Trip

Content Selected from Menu	Very Satisfied	Somewhat Satisfied	Neither Satisfied or Dissatisfied	Somewhat Dissatisfied	Very Dissatisfied
Overall Content (n=378)	49%	22%	4%	9%	16%
Roads (n=334)	47%	28%	3%	7%	14%
Quick Reports (n=29)	30%	43%	3%	17%	8%

5.5.2 Repeat Callers Satisfaction with 511

As noted in Section 5.1, two-thirds of the surveyed callers had used 511 prior to the survey. Based on their weeks or months of experience with 511, repeat callers can provide valuable insights into how 511 is performing for those users who have made the decision to keep using the service, and, thus, Section 5.5.2 focuses on repeat callers' satisfaction with the service. Table 5-10 examines levels of satisfaction with specific aspects of menu items that repeat callers may have used throughout their entire history with 511. Whereas satisfaction with information for the specific trip taken when the caller was intercepted was examined in Table 5.9, Table 5.10 considers all previous calls and the repeat callers' satisfaction with the quality of the information received. Many of the information types listed in Table 5.10 were added in the enhancement process, such as quick reports, bus, airport, and tourism information. Assessing how well those features are performing in the eyes of users is one objective of the evaluation.

Table 5-10. Repeat Callers' Satisfaction with Quality of Information Received for All Calls to 511

Content Selected from Menu	Very Satisfied	Somewhat Satisfied	Neither Satisfied nor Dissatisfied	Somewhat Dissatisfied	Very Dissatisfied
Road-Related Information					
Weather-related roadway conditions (n=196)	38%	25%	32%	2%	4%
Traffic incidents and accidents (n=255)	38%	36%	13%	10%	4%
Traffic congestion (n=241)	42%	36%	14%	6%	3%
Roadway construction projects (n=240)	47%	39%	9%	4%	2%
Quick reports providing regional summaries (n=179)	24%	22%	46%	5%	3%
Bus Information					
On major bus service disruptions (n=5)	85%	15%	-	-	-
When you asked to be transferred to a bus agency for more information (n=4)	-	19%	81%	-	-
Tourism and Airport Information					
Airport conditions (n=5)	20%	61%	19%	-	-
The Grand Canyon (n=5)	19%	34%	47%	-	-
Tourism information available by transfer to the Arizona Office of Tourism (n=6)	18%	4%	79%	-	-

Because the vast majority of repeat callers to 511 are seeking road information, their satisfaction with this part of the menu is very important to the success of the service. In general, most repeat callers said that they were very satisfied or somewhat satisfied with the road-related information. Repeat callers were especially pleased with the information on traffic incidents, congestion, and construction. For these content areas satisfaction levels (very and somewhat) were 74% (66% to 81%), 78% (70% to 85%), and 86% (81% to 91%) respectively, which were all a statistically significant majority. Road information also garnered high marks from repeat callers when they were asked to express agreement or disagreement with the following statements:

- "The traffic information I get from 511 is accurate and timely." 57% agreed and 25% strongly agreed for a total of 82% (95% confidence interval of 76% to 88%).
- "511 covers the areas and routes I'm interested in." 50% agreed and 47% strongly agreed for a total of 97% (95% confidence interval of 95% to 99%).[15]

[15] In focus groups held in 2002 during the design of the Arizona 511 enhancements, information on arterials was recommended by the participants. The survey, on the other hand, indicates that callers are satisfied with current coverage, which has little information available on arterials. This discrepancy could be attributed to the difference in the size and representativeness of participants in focus groups and surveys. Alternatively, it could be the way that the question is asked that could influence how the participants responded.

- "I prefer to get information on segments of roads, like I-10 from Phoenix to Tucson, rather than for an entire road, like all of I-10 in Arizona." 30% agreed and 54% strongly agreed (84% with a 95% confidence interval of 76% to 92%).

Quick report summaries were one road-related feature for which a large percentage of repeat callers did not indicate satisfaction (54% with 95% confidence interval of 43% to 65%), but most of those (46%) were simply ambivalent about the feature. It is interesting to note that the quick reports were added to the service based upon interest voiced by focus group participants during the design stage of the service in 2002. Perhaps a sizeable portion of users of road information prefer to access specific roads of interest, like the route of their daily commute, rather than try to get the information through the quick report summaries.

Another area of ambivalence was weather-related roadway information, for which 37% (95% confidence interval of 27% to 47%) of the repeat callers using that information were either ambivalent or dissatisfied (32% were neutral and 5% were dissatisfied.) As noted in Section 2.2, the roadway segment weather enhancement was not implemented, although some road weather information has continued to be provided through HCRS. Fortunately, weather concerns are not the primary reason for calling 511. In a related question, repeat callers were asked to rate their agreement with the following statement: "I call 511 most often when the weather is bad." Only 27% (95% confidence interval of 20% to 35%) agreed or strongly agreed with that statement.

The survey revealed that Arizona 511 is used very little to obtain information related to buses. There are several possible explanations for the low usage: travelers' preference for their own vehicles, the extent and quality of information on buses, or lack of awareness among travelers, especially transit users, about the availability of information. With only five repeat callers reporting use of the information on bus service disruptions, their 100% satisfaction level cannot be considered a reliable indicator. Of the four repeat callers who had used the feature to transfer from 511 to a bus agency operator, three were neither satisfied nor dissatisfied with that feature. Other questions in the survey provide some additional insight about repeat callers who have accessed bus information on 511. Five users responded to the following statements:

- "511 covers all of the bus services I'm interested in." One agreed or strongly agreed, three were neutral, and one stated he/she did not use that aspect of the service.
- "On 511 I can quickly get through to a live operator to help plan my trip." One agreed, one strongly disagreed, and the rest had not used that feature.

In the area of tourism and airport information, only six repeat callers reported using those features, and, thus, the results should be interpreted with caution. None of the repeat callers expressed dissatisfaction with these features, but they expressed higher satisfaction with airport information than tourism information. Of the five that responded to satisfaction levels with airport information, three were somewhat satisfied and one was strongly satisfied. Three of the five respondents on Grand Canyon information were satisfied, but only one of six expressed satisfaction with the ability to transfer to the Arizona Office of Tourism. One possible explanation for dissatisfaction with the tourism transfer option is that, having heard the opening greeting identify "tourism information" as one of the 511 options, they may have expected actual tourism content on the 511 system itself.

5.5.3 Comparison of 511 to Radio Reports

Radio is the most frequently used source of traffic information throughout the U.S.[16] It serves as a benchmark from which advanced traveler information services such as 511 can be measured. Indeed, many Arizona 511 users also report using radio traffic reports. Seventy-two percent of repeat 511 callers reported they used radio traffic reports as a source of travel information, and their median usage was 13.4 times per month. Figure 5-6 shows callers' comparison of the quality of information on 511 with radio traffic reports for those using both radio and 511. Forty-three percent felt that radio was worse than 511, only 28% thought radio was better, and 29% felt it to be about the same quality of information. Thus, one can conclude that, if not quite a majority, many callers find 511 a better alternative to radio, and a substantial portion think that it is no worse. It is not clear why 511 users who find 511 superior to radio would continue to use radio as a source of traveler information. It may be that they do not specifically seek out information via radio but are still exposed to radio traffic reports through their regular radio listening or are "information seekers" who like to have as much information as possible, preferably from different sources.

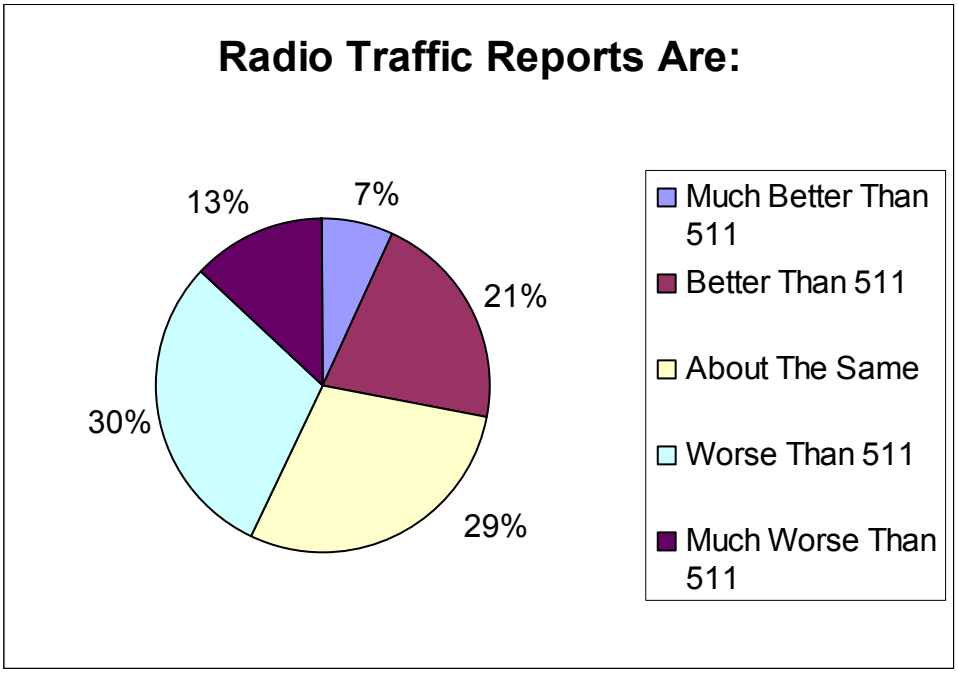


Figure 5-6. Repeat Callers' Comparison of 511 and Radio Traffic Reports

[16] For example, 93% of respondents to a telephone survey in Phoenix in 1999 said they listened to traffic radio broadcasts for traveler information. The survey was conducted as part of the AZTech national evaluation. (Zimmerman, C. et al. "Phoenix Metropolitan Model Deployment Initiative Evaluation Report," Report No. FHWA OP-00-015, April, 2000.)

5.5.4 Willingness to Use Service Again and Recommend to Friends

Willingness to use the 511 service again is another reflection of satisfaction with the service. Table 5-11 shows that almost all callers, repeat and first-time callers alike, reported that they are likely to phone 511 again. They are also willing to recommend the service to a friend. For both these measures, first-time callers were slightly less likely to do so than repeat callers, though this was not statistically significant (p-value = 0.0996). This is not surprising because most repeat callers have shown a greater commitment to the service through their repeated usage. The fact that nearly all first-time users would use the system again in spite of the fact that 31% cited no particular benefit (see Section 5.6) may suggest that first-time callers are willing to withhold final judgment until they've had more experience with the system. It may also suggest that they derived some diffuse, non-specific benefit.

Although few users indicated that they would not use the system again or recommend it, the reasons given by those who said no can be instructive, and these are shown below.

Table 5-11. Expectation about Being Likely to Phone 511 Again and Recommend to a Friend

	Percent of Repeat Callers	Percent* of First-Time Callers
Likely to phone 511 again	(n=276)	(n=134)
Yes	98	95
No	2	5
Would recommend 511 to a friend	(n=276)	(n=132)
Yes	96	91
No	4	10

* Percentages may not sum to 100 due to rounding.

The reasons for not calling 511 again included:

- Got no information
- Information not timely
- Information from Highway Patrol is better
- Information not accurate
- Voice recognition didn't work well
- Hard to use or navigate
- Dangerous
- Won't be going to that area again
- Didn't help; Wasted my time
- No information for sites outside the valley.

Explanations of why they would not recommend 511 to a friend included:

- Inconsistency
- Not helpful
- Difficulty in using
- Needs improvement
- Not enough information outside Phoenix
- Doesn't work
- Too confusing
- Didn't get any information
- Prefer to talk to a person
- Hard to navigate
- Not reliable; not what caller was experiencing on road
- Not satisfied enough to recommend
- Only useful on the road. At home, suggest the Web.
- Not good enough.

Although those who would not use the service again or recommend it to a friend are a small minority, the source of their dissatisfaction is helpful for understanding where the service may be falling short for some users. These results could be helpful as changes and upgrades to the service are considered in the future.

5.6 Benefits and Impacts of Using 511

The ultimate objective of 511 is to have an impact on the callers who receive the information. What benefits did callers believe they had received from 511 in Arizona? What, if any, changes did they make after receiving the information?

To assess the benefits, the respondents were asked to identify benefits they perceived from using 511. The question was open-ended, in that respondents were not provided with a predetermined list of benefits and asked to respond. Instead, the benefits were volunteered by the respondents themselves. Table 5-12 shows the types of benefits that the respondents said they derived from 511, based upon the study team's classification of the verbal responses. The approach was to identify the principal benefit that the respondent was articulating in the response to the question. When the caller's response included more than one thought about benefits, the study team selected the dominant theme of the comment. For example, "rerouting myself and getting to my destination on time" was designated as emphasizing the time-saving aspect of having the information.

The most notable aspect of Table 5-12 is that repeat callers and first-time callers differ markedly in the benefits they say they received from 511 (p-value <0.0001). Not surprisingly, the more experienced repeat users identified certain benefits in higher proportions than the new users. Even more significant is the fairly large percentage (31% with 95% confidence interval of 23% to 42%) of first-time callers who perceived no benefit at all. However, as indicated in Table 5-

11, the lack of a specific perceived benefit does not appear to impact most first-time users' willingness to try the system again or recommend it to a friend.

Table 5-12. Benefits of Using 511

Perceived Benefits of 511	Percent* of Repeat Callers (n=263)	Percent* of First-Time Callers (n=124)
Ability to receive road and weather information	33	28
Saving time/arriving on time	21	6
Avoiding traffic congestion due to accidents or construction delays	20	2
Ability to change route based on information on traffic or road conditions	15	5
More relaxing or easier travel	1	3
Other comment not dealing with a benefit	5	15
Satisfied, but no specific benefit	<1	10
No perceived benefit	7	31

*Percentages may not sum to 100 due to rounding.

Among the perceived benefits, having the ability to access current road and weather information was cited most frequently by both repeat (33%) and first-time users (28%). The implication is that other sources of traveler information are either not as accurate or accessible as 511. Having the information leads to other benefits that users identified. The ability to either save time or arrive on time was recognized by 21% of repeat users versus only 6% of first-time callers (p-value = 0.0014), suggesting that only with the experience with 511 gained by repeat usage over several weeks or months can those benefits be fully appreciated. Similarly, avoiding traffic congestion and changing routes were identified by 20% and 15% of repeat callers respectively and only 2% and 5% of first-time callers (p-values of < 0.0001 and 0.0172, respectively). A few callers emphasized the "serenity" benefit of 511, feeling it made travel more relaxing or easier. Finally, in the categories of "other" and "satisfied," callers did not cite specific benefits but, instead, made comments about the user interface or simply expressed general satisfaction with the service. These types of comments were more prevalent among first-time callers than the repeat callers.

5.6.1 Impact of 511 on Travel Decisions

To assess the impact of information from 511 on travel decisions, the survey provided callers with a list of possible changes they had made as a result of calling 511 for the particular trip when they were intercepted for the survey. Table 5-13 presents the types of changes and the percent of respondents who made the change. Respondents could report more than one change to their trip, and the total changes mentioned across all respondents numbered 168. Based on the small percentage of respondents making any particular change, one can conclude that most callers did not feel compelled to change their plans based on information on 511. This should

not be construed negatively, because under most circumstances travel conditions can be considered "normal," being free of incidents or other adverse conditions that would warrant a change in plans. For those callers who did make a change, taking a different route was the most frequent type of change mentioned (12% of callers). It is not known whether the decision to change route was made en route or before setting out. Callers changed their behavior while on the road by changing lanes (12%), slowing down or changing speed (9%), or making stops along the way (4%). Pre-trip changes were less frequent, but included change in departure time either earlier (2%) or later (2%) or canceling the trip entirely (1%). No respondents indicated that they took a different bus than the one planned.

Table 5-13. Changes Made to Travel as a Result of 511 Information for This Trip

Type of Change (n=number of respondents answering question yes or no)	Percent of Callers Making Change*
Took different route (n=380)	12
Changed lanes (n=379)	12
Slowed down or changed speed (n=381)	9
Made stops on the way (n=379)	4
Left earlier (n=381)	2
Left later (n=381)	2
Other/didn't go (n=381)	1
Took different type of transportation (n=381)	1
Took different bus (n=379)	0

*Multiple changes possible per person

*Multiple changes possible per person

By providing multimodal information to travelers, one potential benefit of 511 systems is facilitating use of transit and attracting travelers away from their private vehicles. For the particular trip the caller was making when intercepted, only 1% of respondents reported a change in mode. To explore whether callers would consider taking a bus based on traveler information, repeat callers were queried about their agreement with the following statement:

> "I am more likely to take the bus due to information on 511."

Those who disagreed (34%) and strongly disagreed (22%) with this statement significantly outnumbered those who agreed (3%) or strongly agreed (<1%) (p-value <0.0001). These results could be interpreted as simply an entrenched commitment to use of private vehicles. An alternative explanation could be that most callers to 511 have not yet heard information that is so dire to cause them to consider switching from their normal mode of travel.

5.7 Customer Experience with the 511 User Interface

This section deals with the 511 caller's experience with the mechanics of 511. This includes the interactive voice response (IVR) feature with voice recognition, as well as menu design, ability to understand the information, and ability to reach 511 without busy signals.

Three aspects of the user experience were explored though questions that were statements to which the respondents expressed their level of agreement. These are shown in Table 5-14. Only repeat callers responded to these questions in the survey.

Table 5-14. Repeat Callers' Reactions to Aspects of User Interface

Aspect of Interface	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Aspect Not Used
It is easy to navigate through the 511 menu to get the information I need (n=275)	29%	42%	7%	11%	10%	<1%
I am able to get through to 511 without any busy signals (n=277)	60%	40%	-	-	-	-
I can easily understand the information on 511 (n=275)	42%	52%	2%	3%	1%	-

A significant 71% majority of callers (95% confidence interval of 63% to 79%) are able to navigate easily through the 511 menu. However, 21% express a level of disagreement. Whether their concern is a result of the structure of the menu or perhaps difficulties with the IVR cannot be determined from this question.

Callers appear to have no problem with busy signals on 511. One enhancement to the 511 service was the expansion of the capacity of the system to serve 96 simultaneous calls, and that expansion has proved satisfactory to all callers surveyed.

Ninety-four percent of repeat callers (95% confidence interval of 90% to 98%) indicate that they can easily understand the information being delivered on 511. On the other hand, as noted below, concern was expressed about the system understanding the caller.

5.7.1 Voice Recognition Feature

One major enhancement of Arizona's 511 service was the conversion of the system to voice recognition. The expectation was that enabling callers to speak their requests would be an easier and more convenient feature compared to the previous push button (touch tone) interface. After voice recognition was launched in December 2003, ADOT received considerable negative feedback through its 511 comment line. Consequently, ADOT devoted more effort to improving

the IVR, and also made the alternative touch tone interface option more comprehensive and prominent. The survey, occurring ten months after voice recognition was instituted, provided an excellent opportunity to assess callers' experience with voice recognition and phone button access.

Callers were asked what method—voice recognition, phone buttons, or both—they used to make menu selections for the trip they were taking and how satisfied they were with the method. Table 5-15 shows that while voice recognition was used exclusively by repeat callers more than 5 to 1 (224 vs. 38) and by first-time callers over 2 to 1 (81 vs. 32), the experience with phone button access tended to be more satisfactory. For example, of repeat callers using one method exclusively only 30% said they were very satisfied with voice recognition whereas 72% said they were very satisfied with phone buttons (p-value < 0.0001). Among repeat callers using both methods, a significant percentage of callers (34% with 95% confidence interval 14% to 62%) were satisfied with voice recognition, but 66% (95% confidence interval of 38% to 86%) were dissatisfied. The overall propensity of callers to use voice recognition regardless of their satisfaction with it may be because it is the default option.

Table 5-15. Callers' Satisfaction with Method of Making Menu Selections

Type of Method Used	Very Satisfied	Somewhat Satisfied	Neither Satisfied nor Dissatisfied	Somewhat Dissatisfied	Very Dissatisfied
Repeat Callers					
Voice recognition only (n=224)	30%	31%	4%	16%	19%
Phone buttons only (n=38)	72%	27%	-	-	1%
Used both—satisfaction with voice recognition (n=13)	16%	18%	-	26%	40%
Used both—satisfaction with phone buttons (n=12)	47%	24%	19%	7%	3%
First-Time Callers					
Voice recognition only (n=81)	25%	21%	4%	20%	29%
Phone buttons only (n=32)	54%	36%	-	4%	5%
Used both (n=16)	12%	15%	7%	4%	14%

Rows may not sum to 100% due to rounding.

First-time callers generally used only one method, apparently not choosing to experiment with the alternative method on their first call to 511. Among this group, 46% of voice recognition users expressed satisfaction, but nearly one-half expressed dissatisfaction, whereas among phone button users 90% were satisfied. Although a smaller proportion rated phone buttons very satisfactory than did repeat callers, the difference was not significant (p-value = 0.1051).

As indicated in Section 5.2, 24% of first-time callers were age 65 and over. It is interesting to note that in a focus group study of Arizona seniors conducted in 2004,[17] seniors using 511 for the first time were frustrated with the voice recognition feature. They reported that it did not understand their requests or gave them the wrong road information. The difference in dissatisfaction with voice recognition between first-time callers versus repeat callers found in the survey, although not statistically significant, may be a reflection of the large proportion of seniors among the new-user group (given the findings of the earlier focus group study).

One inference to be drawn from these results is that as callers become more experienced in using the 511 system, some of the initial difficulties with voice recognition that first-time callers might have encountered go away. Nevertheless, even among repeat callers, a sizeable portion still find the voice recognition feature unsatisfactory in some way.

Callers who were somewhat or very dissatisfied were asked why. Their explanations were recorded during the telephone survey and later coded by the study team into major types of reasons. As shown in Table 5-16, the major complaint was that the system misunderstood the caller's request, and related to that, gave the wrong information. Those two reasons accounted for 56% of repeat callers and 82% of first-time callers who were dissatisfied with the voice recognition feature. Another reason cited by a third of the repeat callers was that voice recognition was especially sensitive to background noise. Such sensitivity could lead to the system not understanding the request, of course. A small number of callers felt the menu options were unsatisfactory in some way. For example, one first-time caller knew the desired road by name and not by number, but his/her perception was that the system asked for the number. The system in fact says "you can say the roadway name or number." A number of "other" type of explanations were offered by first-time callers, such as "it seemed difficult to use" or "it was okay but I got cut off," but such remarks were less frequent among repeat callers who had a more definitive complaint based on longer experience with the system.

Table 5-16. Reasons for Dissatisfaction with Voice Recognition Feature

Reason	Percent* of Repeat Callers (n=88)	Percent* of First-Time Callers (n=51)
Did not understand request	36	55
Gave wrong information	20	32
Background noise interferes	33	2
Poor menu options	9	3
Wanted option to speak to live operator	2	-
Other	<1	8

*Percentages may not sum to 100 due to rounding.

[17] Kihl, M. et al. "ITS Technologies and Mature Drivers," prepared for the Arizona Department of Transportation, July, 2004.

To further explore the nature of callers' difficulties with voice recognition, those who had expressed dissatisfaction were asked under what circumstances their problems occurred. Table 5-17 reveals that the majority of problems occurred on cell phones (versus landline) and while holding the receiver (versus speakerphone). However, a quarter of the repeat callers, by virtue of their weeks or months of experience with the voice recognition features, reported having problems on both types of phone and talk modes. Thus, there would appear to be either fundamental problems with the voice recognition technology, a need for further education of 511 callers on how to use it most effectively, or both. Focus groups or other types of research with actual users might help pinpoint the problems and potential solutions.

Table 5-17. Circumstances of Problems with Voice Recognition

	Repeat Callers	First-Time Callers
Type of phone	(n=107)	(n=48)
Only cell phone	62%	87%
Only landline	11%	13%
Both	27%	NA
Talk mode	(n=106)	(n=45)
Speakerphone/handsfree	6%	2%
Holding the receiver	69%	82%
Both	25%	16%

5.8 Potential Improvements to 511

The survey provided an opportunity to identify areas of improvement by asking respondents to rate several aspects of the 511 service which could be enhanced or improved. Shown in Table 5-18 are five specific improvements about which respondents were questioned and the priorities—high, medium, and low—that callers assigned to five potential improvements. In addition to these questions, respondents could also volunteer other areas of improvement that were important to them, and their recommendations are reported in Table 5-19.

The results reveal a consistency in the responses of repeat and first-time callers, with the five types of improvements ranked in the same order by both groups. The top-ranked requested enhancement was improvements to the speech recognition feature. Note though, that the percentage of repeat callers requesting this enhancement was not statistically significantly higher than those requesting more detailed information on general traffic congestion levels and delays (p-value = .2579), and among first-time callers, the percentage was not statistically significantly different from those who requested more detailed information on general traffic congestion levels and delays and those who requested the addition of more roads (p-value = 0.0922). The least sought improvement was information on bus arrival time. Eighty-three percent of repeat callers and 75% of first-time callers rated that improvement low in their priorities, which was not statistically different (p-value = 0.0783). It is interesting to note that the bus arrival time feature

and the information on roads in neighboring states were enhancements originally planned for the Arizona 511 Model Deployment, but they have not yet been deployed.

Table 5-18. Potential Improvements to 511

Improvement	High Priority	Medium Priority	Low Priority
Repeat Callers			
Improvements to the speech recognition feature (n=277)	72%	13%	15%
Providing more detailed information on general traffic congestion levels and delays (n=277)	66%	25%	9%
Adding more roads than currently aren't covered (n=262)[18]	24%	37%	39%
Providing information on roads in neighboring states (n=266)	17%	27%	56%
Providing information on when a bus will arrive at a particular stop (n=252)	7%	10%	83%
First-time Callers			
Improvements to the speech recognition feature (n=126)	60%	19%	21%
Providing more detailed information on general traffic congestion levels and delays (n=126)	56%	35%	9%
Adding more roads than currently aren't covered (n=117)	52%	34%	14%
Providing information on roads in neighboring states (n=125)	21%	27%	52%
Providing information on when a bus will arrive at a particular stop (n=120)	11%	14%	75%

Row totals may not sum to 100% due to rounding.

From the standpoint of satisfying the priorities of current 511 customers, these findings provide direction for future enhancements to the service. On the other hand, if 511 is to be as multimodal as possible and reflect the information needs of other segments of travelers (bus riders in particular) who might not be using 511 very much right now, some enhancements should be considered that may not be high priorities among current 511 callers. With transit riders are virtually absent among current callers, it is not surprising that the addition of bus arrival time would be a low priority.

Respondents also were given the opportunity to volunteer other improvements that they were interested in seeing made to 511. Their verbatim comments were coded into several general

[18] Note that as shown in Section 5.5.2, 97% of repeat callers agreed that 511 covered the areas and routes in which they were interested, whereas 24% of repeat callers in Table 5-18 gave adding more road coverage a high priority. This discrepancy could be a function of how the question was asked and its context.

categories as shown in Table 5-19. Respondents were also asked to assess whether the suggested improvement was a high, medium, or low priority. Eight-five percent of the repeat callers who volunteered an improvement considered the improvements in Table 5-19 to be high priorities as did 98% of the first-time callers (p-value = 0.0223).

Table 5-19. Types of Improvements Volunteered by 511 Callers

Improvement	Percent* of Repeat Callers (n=97)	Percent* of First-Time Callers (n=55)
Information on traffic and road conditions (e.g., more timely or more detailed)	35	15
User interface (e.g., voice recognition)	27	13
Menu-related	9	18
Road segments and road names	6	11
Coverage of more areas and roads	3	1
Ability to talk to a live operator	3	25
New content (e.g., weather)	1	6
Website related	2	1
Other (e.g., marketing, education)	16	11

*Percentages may not sum to 100 due to rounding.

Whereas the repeat callers most often mentioned (35%) improvements related to information on traffic and road conditions, such as more timely or more detailed information, the most frequently volunteered (25%) improvement among first-time callers was the ability to talk to a live operator. Perhaps their expectation in calling the service for the first time was that they would be getting information from a live operator, or they would have the option of transferring to an operator (for traffic and road information) if they had difficulty with the system or wanted more detail. Setting callers' expectations appropriately would appear to be an important activity for future marketing.

5.9 Conclusions

The conclusions to be drawn from the results of the telephone survey of 511 callers are:

- **A significant portion of callers—33%—are new users of the 511 service.** With an overall upward trend in usage, the large percentage of new callers is a healthy sign as some of them will convert to repeat callers if their experience with 511 is satisfactory.
- **Only 21% of those surveyed had used the system prior to the May 2004 marketing campaign in which ADOT used its dynamic message signs to promote the service for a few days.** Those signs were the most frequently mentioned source of their first awareness of 511.

- **Phoenix residents dominate usage of 511 (73%), and few callers (2%) are from Tucson.** The low level of usage by Tucson residents is not surprising. As noted in Section 2.2, 511 includes relatively little information specific to Tucson, and there has been little to no Tucson-focused marketing.
- **Over half of repeat callers make three or fewer calls per month to 511, indicating that usage of the service is not dominated by commuters seeking travel conditions on their daily commute.** Indeed, more than half of the survey respondents were making a trip not for work or school but for other purposes.
- **First-time callers tend to be older, less educated, and have somewhat lower income than repeat users, perhaps indicative of a high proportion of retirees among the new-user group.** The repeat callers are more likely to be working age and more technology-savvy and perhaps more motivated to learn to use 511 effectively for the commute and other trip-making.
- **The situational profile of usage indicates that a majority of calls are being placed en route on a cell phone in a private vehicle.** The content callers are seeking is almost exclusively (90%) road-related information, mostly for interstates and freeways (as opposed to state or U.S. highways).
- **Overall satisfaction with content on 511 is high, more than 70% among both repeat and new callers.** Because most callers are seeking road-related information, the high positive satisfaction ratings for most road-related content speaks well of the enhancements made in that area. One surprising result was that 54% (95% confidence interval of 43% to 65%) of repeat callers were ambivalent about the value of the quick report regional summaries or dissatisfied, which suggests that there may be some more work to do on how that feature is implemented or promoted.
- **Experienced users feel more strongly than inexperienced users about the benefits of using 511.** Repeat callers perceived benefits in higher proportion than first timers. Moreover, for the call for which they were intercepted, 31% of first-time callers saw no benefits at all versus 7% among repeat callers. To repeat callers, the benefits included the ability to access road and weather information, saving time or arriving on time, avoiding traffic congestion, and the ability to change routes based on information received. Clearly, repeated usage has led callers to appreciate how 511 can assist them in their ongoing travel decisions, whereas new users are drawing on only one call to make the judgment about benefits. With repeated usage, they too should realize how 511 can assist their travel. Thus, it appears that callers need to have a longer term view to realize the full benefits of 511. Indeed, first-time callers seem willing to give 511 another chance, as 95% said they were likely to call again.
- **Callers are using 511 very little for bus information.** Current usage represents only about one percent of all callers. This is in part a result of the fact that transit usage in Arizona is low (e.g., about 1.2% of all person trips in the Phoenix region) and that there was no significant marketing targeted to transit users. While the small number of respondents prohibits extrapolation of the results beyond the sample itself, it appears that those five respondents have not made full use of the bus information on the service, such as the ability to access a live operator through the call transfer feature. The question must

be asked if the low usage of 511 bus content is due to the lack of marketing among bus passengers, the quality of bus information on 511, or some other factor.

- **As with bus information, only one or two callers who were surveyed accessed tourism and airport information, respectively.** While one could argue that the low interest in tourism information might be due to a seasonal fluctuation, only six repeat callers indicated they had ever used the tourism content. Only five repeat callers had used the airport information. While no dissatisfaction was expressed by callers who had used the airport and tourism information, there are several possible explanations for the low usage levels. It could be that 511 callers are not interested in the information, they do not look to 511 as the source for obtaining the information, or there has been insufficient promotion of these features to reach the audience who might find the information of value.
- **The 511 service fares well in comparison to radio traffic reports, typically the most common source of information with which travelers are familiar.** Even though 72% of repeat callers used traffic reports on the radio, 43% regard 511 as better than radio reports, and only 28% regard 511 as worse.
- **Under normal circumstances, information on 511 will tell callers that they will not need to deviate from their planned route.** When callers decide to make a change to their trip in response to information they obtain on 511, the most frequent changes are taking a different route, changing lanes, and slowing down or changing speeds.
- **Resistance to changing mode of travel remains strong no matter what information is provided on 511.** For most callers, changing mode of travel would mean switching from private vehicle to bus or some other alternative. Less than 4% would consider taking the bus based on information on 511; and over 50% of callers indicated that information on 511 was unlikely to cause them to take a bus. This view might reflect an entrenched preference for their current mode, or it may be simply that information on 511 was not sufficiently compelling for them to change their mode of travel.
- **Except for the voice recognition feature, callers are generally satisfied with the user interface.** They can navigate easily, have no problems with busy signals, and are able to understand the information being delivered to them on 511.
- **Even though voice recognition is used by repeat callers more than 3 to 1 and by first-time callers over 2 to 1, the experience with phone button access tends to be more satisfactory.** As callers become more experienced in using voice recognition, some of the initial difficulties that first-time callers may have encountered go away to some extent. Nevertheless, 35% of repeat callers who choose to use voice recognition as their primary means for accessing the service said they were dissatisfied with the feature. The difficulties with voice recognition are reported on both cell and landline phones and both while holding a receiver and speaking handsfree. Thus, there are either fundamental problems with the voice recognition technology, a need for further education of 511 callers on how to use it most effectively, or both.
- **Repeat and first-time callers are consistent in the improvements they would like to see on 511, and voice recognition tops their list, followed by more detailed information on traffic.** Bus arrival time was the least sought improvement, and

information on neighboring states also was given low priority by a majority of callers. These findings suggest that future enhancements to the service could focus on the highest priority improvements to satisfy current callers. On the other hand, to attract a more multi-modal user base, the bus, airport, and tourism content cannot be ignored, even though current callers appear to have little interest in these areas.

6.0 Testing the Hypotheses

This section presents the results of the testing of specific evaluation hypotheses (identified in Section 1.3.3), summarizing relevant findings from the various evaluation analyses. The results are presented in Table 6-1. A total of 12 hypothesized impacts were tested. Six of those impacts are identified as "key" (shown in bold in Table 6-1).

One hypothesis, which was related to arterial street travel times, could not be tested because the enhancement was not completed within the evaluation period. Of the remaining 11 hypotheses that were testable, four were fully supported, two were partially supported, and five were not supported.

Hypotheses are grouped into four areas, corresponding to the four main project objectives pertaining to increasing usage, contributing to high levels of customer satisfaction, promoting mobility and access, and promoting efficiency. Gains were made in three of the four objectives; that is, at least one hypothesis was supported by the evaluation findings. The exception was the area of mobility and access. This is not unexpected since impacts in this area are "secondary" in that they depend not only on successfully implementing new data and features, but also on how and to what extent those features are used by callers. Those factors are not easily influenced in the short term. ADOT and the project partners never believed measurable benefits in these areas were likely, although they do view them as very desirable long term objectives. Generally, within the areas that might impact mobility and access, ADOT and the partners focused primarily on the first, fundamental step: getting quality information into 511.

Table 6-1. Hypothesis Testing Results
("Key" hypotheses are shown in bold type)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Increase ***usage*** of the 511 system.	**The addition of a number of new data types will contribute to increased usage of the 511 system. [NOT SUPPORTED]**	• The overall call volume in the post deployment period increased by 74% compared to the same period before the enhancement. However, the old information categories accounted for 91% (Roads) and 2.4% (Transit) of all information requests in the post-enhancement period. The new information categories accounted for 4.3% (Quick Reports), 1.3% (Airports), and 0.4% (Tourism) of all information requests. Thus, it cannot be concluded that new data contributed substantially to increased usage.
	Usage of the 511 system will increase as a result of enhanced marketing. [SUPPORTED]	• During the week-long DMS marketing campaign, call volume increased by a factor of 3.1. Ninety-six percent of the callers during the campaign were new users (had not used the system in the last five months) and 86% were calling from wireless phones. The DMS marketing campaign, though short-lived, was extremely effective in publicizing the 511 service to highway users. • Based on the survey results, the other marketing activities that were implemented (distribution of materials at the state fair and freeway opening ceremonies and radio advertisements over an approximately two-week period) had much less of an impact. Nine percent cited the radio ads, and only 2% of respondents cited ADOT as their source of awareness.
	The enhanced 511 system will retain more users. [SUPPORTED]	• Based on system usage data, the overall percentage of repeat users increased significantly from 10 to 19% before the DMS marketing campaign to approximately 27 to 37% after the campaign. In light of the increasing call volumes, the relative low percentage of repeat users indicates that the user base of the system is expanding. • 95% of first-time users that were surveyed said they would use the system again.

Table 6-1. Hypotheses Tested in the Evaluation (Continued)
("Key" hypotheses are shown in bold type)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Contribute to high levels of ***customer satisfaction*** with the 511 system.	**Users will view the information available on the 511 system as comprehensive and multi-modal. [NOT SUPPORTED]**	• Surveyed callers overwhelmingly (90%) used the system to obtain road information for the trip they were taking. Very few (<1%) accessed transit, airport, and tourism information. • Too few users utilized the transit information to allow any valid assessments of their satisfaction to be made. • Only 5 repeat callers had ever used the airport information and only 6 had used tourism information. This number was too few to draw conclusions about customer satisfaction with these content areas.
	Users will be satisfied with the quality of the information on the 511 system. [SUPPORTED]	• 71% of surveyed callers expressed overall satisfaction with information they received for the trip they were taking. For each of the high-level menu items selected, satisfaction with the quality of information was even higher. • For all the times they've used 511 the majority of surveyed repeat callers expressed satisfaction with most all the road content. The exception was regional Quick Reports, which was rated a 46% satisfaction level. • 82% of surveyed repeat callers perceived traffic information on 511 to be accurate and timely. • In comparing 511 to radio, a source used by 72% of surveyed callers, 43% of callers felt that the quality of traffic information on 511 was better, 29% said it was about the same, and 28% thought the radio was better.
	Enhancements to the user interface, including voice recognition, segment-based reporting, and "Quick Reports" will contribute to customer satisfaction. [PARTIALLY SUPPORTED]	• Although voice recognition is used by the majority of callers, it has its drawbacks and receives lower satisfaction ratings than phone buttons. First-time callers are less satisfied with voice recognition than repeat callers. The principal reasons for dissatisfaction were that 511 did not understand the spoken request, 511 gave the wrong information, and background noise caused interference. The problems were not related exclusively to either cell phones or hands free mode, based on survey results. • Segment-based reporting for road information was a feature with which 84% of repeat callers expressed satisfaction. • Regional Quick Reports received mixed reaction from callers. Only 8% of callers used the feature for the surveyed trip, but 73% of them were satisfied with the information they received. On the other hand, most repeat callers had at some time tried Quick Reports, but only 46% of them found them satisfactory. It appears that callers prefer to access specific roads of interest rather than go to the regional summaries.

Table 6-1. Hypotheses Tested in the Evaluation (Continued)
("Key" hypotheses are shown in bold type)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Promote ***mobility and access*** by providing new information pertaining to transit, major destinations, and arterial street travel times.	The addition of transit information, downtown Phoenix information, and tourism information will promote mobility and access. [NOT SUPPORTED]	• Transit and tourism information was used by so few callers (<1%) that no connection can be made to mobility and access. • Downtown Phoenix information was implemented as one of the Quick Report regional summaries and not as a separate item focusing on events and parking in downtown. Because only 1% of callers asked for the Phoenix Quick Report, no connection can be made about this specific feature for promoting mobility and access.
	Providing users with arterial street travel times will allow them to avoid congestion and reduce travel time and travel time variability. [NOT TESTED]	• The arterial street travel time enhancement was not implemented in time for the evaluation, and, therefore, could not be tested.
	511 usage will expose travelers to transit information and encourage consideration of transit as an alternate mode. [NOT SUPPORTED]	• Only 1% of the callers reported that they changed mode based on the information from 511 for the trip they were taking. In addition, only 4% of callers indicated they would be more likely to take the bus due to information on 511, when asked without regard to the specific trip they were taking. Private vehicle use is the dominant mode of travel (92%) among 511 callers. The information they've heard on 511 has not yet been compelling enough for any appreciable portion to consider bus as an alternate mode.

Table 6-1. Hypotheses Tested in the Evaluation (Continued)
("Key" hypotheses are shown in bold type)

Project Objective	Hypothesized Project Impacts	Evaluation Findings
Promote ***efficiency*** of information dissemination by providing an easily understood menu system, improving data quality, and increasing system capacity.	Acceptable system availability/reliability will be maintained through the enhancement process and after the enhancement. [SUPPORTED]	• 100% of the callers agreed that they could get through to 511 without any busy signals. Thus, necessary availability was maintained. • Line capacity was never exceeded after the Model Deployment. During all but a few peak periods each year, only a small fraction of available capacity was utilized.
	Menu system enhancements will minimize the number of unrecognized caller inputs. [NOT SUPPORTED]	• Percentage of information requests that could not be comprehended by the 511 system was highest, at 25%, in January 2004. By May 2004, the system was at the lowest error rate of the year, at 13.8% of all requests. This number gradually increased to nearly 20% by the end of the year. The average error rate over the one year post-enhancement period was 17.8% of all requests. • In total, slightly over one-third of all calls to the 511 system generated errors. This percentage decreased over the course of the post-implementation period, starting with almost 54% of calls including errors in January 2004 dropping to 30% to 37% over the last nine months of the year.
	The efficiency of information dissemination will be promoted through enhanced arterial street data capture, data entry operator training, and data quality control procedures. [PARTIALLY SUPPORTED]	• The volume of arterial street information input by ADOT increased dramatically as a result of their intensified monitoring of police scanners. Annual entries of this type increased from 234 (2% of the total) to 2,763 (14%). • Information input by Phoenix area cities and counties increased negligibly (from pre-enhanced average of 15 entries per year to 45 entries in the post-deployment year of operations). • No information was input by Tucson area city and county agencies during the post-enhancement period. These agencies only achieved the ability to do so late in the one-year operational period (2004). They intend to begin doing so sometime in 2005. • Interviews with ADOT data entry personnel and other ADOT 511 staff indicate that significant changes have been made that they view as enhancing data quality. Refinements were made to roadway information location references. A key new preview function was added allowing data entry operators to see how their input will be translated to a 511 message. The data entry operator's manual has been revised and training has been conducted on new procedures and features.

7.0 The Enhancement Process

This section presents the results of the enhancement process analysis. The analysis focuses on identifying management and deployment issues encountered in planning, implementing, and operating the enhanced 511 system, including lessons learned.

7.1 Overview of the Enhancement Process

The 511 Model Deployment enhancement process consisted of three phases. Figure 7-1 identifies the phases and corresponding milestones. The planning and design of the system began in August 2002, with the first meeting of the 511 project committee (511 Task Force). That committee continued to meet throughout the duration of the Model Deployment. As indicated in Figure 7-1, the design, implementation, and operation phases overlapped somewhat, as enhancements were designed, implemented, and refined over time. Although the major design document—the System Requirements Definition Report—was completed in March 2003, the design of some enhancements, including the menu, continued on for several months. Likewise, after the main roll out of the enhanced system in mid-December, 2004 (thus concluding the main implementation effort), further refinement of implemented enhancements (such as voice recognition) and implementation of additional enhancements (such as the call transfer to the Arizona Office of Tourism) continued throughout 2004. Although the formal one-year Model Deployment operations period ended in December 2004, design and implementation of some enhancements continues.

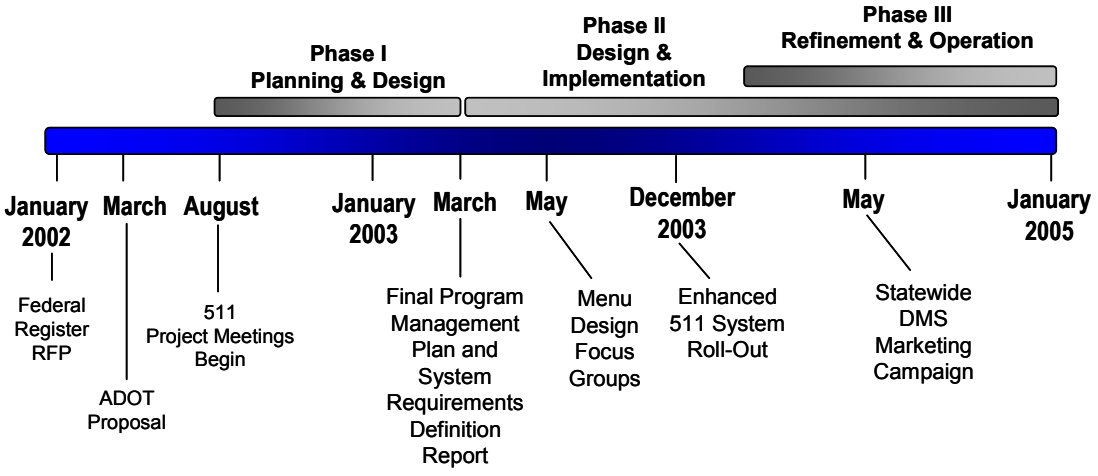


Figure 7-1. Enhancement Process Timeline

7.2 Enhancement Process Findings

This section presents the perspectives of the 511 participants, based on their interview and workshop input. These findings are not the overall conclusions of the evaluation and, in a few cases, are not supported by the usage and user survey evaluation analyses presented in Sections 4.0 and 5.0 of this report. This is not unexpected since the interviews and workshops occurred before evaluation results in these areas were available. Findings are presented in several topic areas, as listed in Table 7-1.

Table 7-1. Organization of Enhancement Process Findings

Topic Area	Topics Covered
General Management, Deployment, and Operations Issues	• Schedule and phasing • Budget and costs • Public and private partners
Successes	• Overhaul of the user interface • Increased ADOT capture of arterial street incident data • Increased capture of freeway incident and congestion information • New data types implemented • Increased call volumes • Increased (statewide) 511 coverage • Data quality tools and processes • System performance tracking capabilities • Focal point for continued regional cooperation
Challenges and Unresolved Issues	• User interface • New data types not implemented
Overall Lessons Learned	• Management and deployment issues • Technical issues
Next Steps for Arizona 511	• Continued pursuit of planned Model Deployment enhancements • Other planned enhancements

7.2.1 General Management, Deployment, and Operations Issues

Schedule and Phasing

1. **The overall implementation schedule was tight and played a role in postponement of some of the enhancements** – Design and implementation took longer than anticipated. It was not possible to design and implement all of the planned enhancements fully within the original, approximately 15-month, implementation period. ADOT always planned to phase in the enhancements. However, the schedule also played a role in delaying some

enhancements, as ADOT found they were unable to devote enough manpower, simultaneously, to complete all of the enhancements on time. With a more protracted schedule, allowing for greater phasing, available implementation staff resources would have been sufficient. Apart from these obvious impacts on the timing of enhancements, project participants voiced few concerns about the overall Model Deployment timeline. The IVR consultant noted that the schedule provided very limited time for testing of the voice recognition system. In fact, considerable testing and refinement of the enhanced user interface occurred "in the field," in the first month or two after the system was deployed. Project participants' opinions vary as to the extent to which the "refinement-on-the-fly" approach was an unfortunate result of schedule constraints or an effective way to maintain momentum and get the product in the hands of users. The only other specific schedule concern was noted by the ADOT Information Technology Section Manager, the technical lead for the 511 project, during the early stages of planning and design. At that time, he was somewhat concerned that the short schedule did not allow for a competitive procurement of a traveler information voice recognition specialist, but rather necessitated ADOT's use of their existing IVR consultant, whose transportation-related IVR expertise was less certain. Later, however, this person indicated that he was very pleased with the work of their existing IVR consultant.

2. **Phasing of enhancements is inevitable** – As noted in the preceding item, some phasing of enhancements was always envisioned. Although a tight time frame appears to have delayed some enhancements, most of the project participants did not find schedule constraints to be a major concern. Generally, they find phasing and even some delays to be an expected, inevitable aspect of large, complex technology implementations.

Budget and Costs

3. **ADOT has not identified budget as a significant concern** – Although the cost of several enhancements significantly exceeded estimates, ADOT has not identified any concerns related to the overall budget. This is consistent with the findings of the cost analysis (Section 8.0) that, assuming the remaining Model Deployment enhancements can be completed on-budget, the cost of the Model Deployment will exceed the original estimate by only about 4% ($52,000).

4. **Increased ADOT 511 program staffing costs not identified as a concern** – ADOT has not identified 511 program staffing costs as a concern, although the staff-related operational costs of the system have clearly increased (see Section 8.0). This may be because none of the costs are "new costs" per se, but rather represent marginal increases in pre-enhanced 511-related staff costs. It may also reflect the fact that the Model Deployment has not created any new, strictly 511, staff position and therefore cost increases may not be obvious. (In assembling post-enhancement cost data, ADOT indicated that it was necessary to estimate the ADOT staff time associated with 511 because that information is not formally recorded).

5. **Phone charges have not been a concern but may be an issue in the future** – Average daily call volumes increased about 74% after implementation of the 511 enhancements. ADOT has not expressed any concern about the associated increase in phone charges—

about 8.5%, from about $129,000 in 2003 to $140,000 in 2004. However, ADOT notes that significant increases in call volumes and phone charges may become an issue. One factor that could contribute to escalating phone charges is an increase in calls from the Tucson area, which will be long distance. ADOT indicates that if such call charges become a concern they would consider decentralizing the 511 IVR, placing one or more phone servers in Tucson to eliminate the long distance call (to Phoenix, where all of the phone servers are now centralized).

Public and Private Partners

6. **Project momentum cements agency commitments and fosters participation** – Several project participants—both at ADOT and at other agencies involved in the Model Deployment—noted that it is difficult to get partner agencies fully engaged before the basic user interface enhancements are completed. This includes the partners who formally committed to participate during the proposal stage. This was generally attributed to a (not unexpected) "wait and see" attitude. One ADOT staffer indicated that the obvious "holes" in the 511 system associated with any given agency, which are only apparent once the basic menu enhancements have been implemented, help stimulate participation by those agencies.

7. **Potential for private partnerships for premium services is very limited** – ADOT received only one responsive proposal from a private premium service provider. Upon investigation, that provider did not appear to be sufficiently financially stable and ADOT did not pursue a partnership. ADOT feels that the experience in trying to find a private sector partner indicates that there is currently little interest among private providers, reflecting the very limited perceived profit potential.

8. **Leveraging existing data sharing agreements with commercial information providers is useful but a small part of the solution** – Both ADOT and the City of Tucson currently partner with commercial traveler information providers. In ADOT's case, the provider is allowed to operate from the ADOT Traffic Operations Center, in exchange for access to their traveler information. In the case of Tucson, the private partner actually operates the regional traveler information system on behalf of the City. It is too early to tell in Tucson because they have not begun inputting data to the 511 system, but in Phoenix, it appears that the information from the commercial provider does not constitute a significant or comprehensive source of information.

7.2.2 Successes

This section identifies what the project participants believe are the major successes of the Model Deployment. Topmost among those successes are the major redesign of the user interface and the addition of several new types of information to the 511 system.

9. **The significant overhaul of the user interface is one of the most significant accomplishments** – Nearly all of the project participants point to the major redesign of the user interface as the single most important accomplishment of the Model Deployment. The

redesign included conversion to voice recognition and segment- and region-based ("Quick Reports") reporting of roadway conditions. These profound changes brought the previously very simplistic and outdated ADOT 511 user interface up to the state-of-the-practice level. However, as indicated in Section 5.0, a significant number of 511 users are dissatisfied with the voice recognition system.

10. **ADOT is inputting much more arterial street information** – ADOT followed through with their plans to significantly increase their commitment to monitoring police scanners for arterial street incident information. The Model Deployment increased the number and quality of the scanners and, where possible, an additional HCRS operator tasked with monitoring scanners has been added to key shifts. As indicated in Section 2.2, the number of arterial street events entered by ADOT into the 511 system has increased ten fold, from 234 entries (2% of total entries) to 2,763 entries (14%) per year.

11. **ADOT is inputting much more incident and congestion information** – Although not an explicit Model Deployment objective, the volume of roadway congestion and incident information input to 511 by ADOT has increased significantly. This may have been stimulated by the opinions expressed by focus group participants that more of this type of information was desirable. Entries pertaining to roadway congestion (level of service) increased from 181 per year (representing 1.5% of all HCRS entries) to 3,999 per year (representing 20% of all HCRS entries.) Entries pertaining to incidents/accidents increased from 1,686 per year (representing 14% of all HCRS entries) to 5,306 entries per year (representing 35% of all HCRS entries.)

12. **Several new types of data have been added to the system** – Second only to the major redesign of the user interface, project participants point to the addition of new types of data to the 511 system as a major project success. These additions include Amber Alert information, a call transfer to the Arizona Office of Tourism, information on all of the regional/rural transit providers statewide, airport information, and transit information. These additions have fundamentally transformed the 511 system from its previous highway-orientation to a multi-modal information resource. (However, as noted in Section 4.0 (usage analysis) and Section 5.0 (survey analysis), the new, non-highway data are utilized by very few users, and therefore in terms of usage, the system remains very much a roadway-oriented resource.) Also, even though local agencies are not yet making much use of it, establishing the capability for local agencies to securely enter information directly into HCRS via the Internet is an important accomplishment related to new data.

13. **Call volumes have increased steadily, seemingly in part due to enhanced marketing, while sufficient phone line capacity has been maintained** – Total annual 511 calls increased about 95% between 2003 and 2004, from about 345,000 calls to about 670,000 calls. At the same time, as indicated in the analysis of system usage (Section 4.0), acceptable system availability has been maintained.

14. **Gains have been made in ensuring data quality** – ADOT feels that important actions have been taken to support continued enhancement of data quality. These actions include re-training of ADOT operators, including significant refinement in the use of landmarks in

referencing roadway information, and implementation of a "preview' capability in HCRS. That feature allows HCRS operators (who are instructed to use it) to see how their event entry will be converted to an actual advisory message on the 511 system. This is critical because HCRS operators do not literally compose the advisory message, but rather the message is automatically composed drawing upon various event content input by the operator. In the future ADOT plans to enhance the preview capability so that the operator can hear what the 511 advisory will sound like.

15. **System performance tracking capabilities have been greatly enhanced and an overall philosophy and process for continuous quality improvement have taken root** – Prior to the Model Deployment, ADOT was able to collect only total hourly call volumes for the 511 system. There was no capability to analyze usage by menu selection and there was no mechanism for user input—ADOT conducted no surveying or focus groups and had no formal caller comment capability. The Model Deployment has greatly enhanced capabilities in these areas. The overall focus on the 511 system and user perspectives has ushered in a new philosophy of continuous quality improvement and customer service. Whereas ADOT previously only had one monthly report available (hourly call volumes), they now generate a number of reports on a monthly basis, including enhanced call volume tracking and system performance (e.g., outages). With their new capabilities, ADOT plans to monitor 511 usage by menu selection (e.g., roadways versus transit, etc.) and repeat callers in the future. The implementation of the caller comment voicemail feature in 511 has provided a powerful tool for user input and is being utilized significantly by ADOT to continuously improve the system and manage customer satisfaction. The new caller comment feature was very important in guiding the intensive refinement of the voice recognition and menu system in the couple of months following the initial roll out. Finally, the Model Deployment significantly increased the 511-related activities conducted by the Public Information Officer, including institution of the first formal 511 marketing ever carried out by ADOT.

16. **The enhanced 511 system provides a working model and focal point for continued regional ITS operational coordination** – The AZTech Metropolitan Model Deployment Initiative in the late 1990's was successful in bringing many agencies from throughout the Phoenix region together to coordinate in the area of ITS. However, the unifying influence of AZTech diminished over the years, in part because some of the coordinated activities were abandoned (a number of them were demonstrations not necessarily envisioned as long term activities). To some extent, regional coordination suffered from the lack of a clear, concrete, sustained application to "bring the players to the table" to partner in actual ITS operations. The 511 system has provided such a concrete, long-term coordinated application. Coordination has been enhanced through specific Model Deployment enhancements, such as the local agency Internet HCRS entry capability, as well as the general dialog on regional traveler information and agency data sharing that the 511 Model Deployment has fostered, and which will continue.

17. **The 511 Model Deployment vision establishes a good target and will continue to facilitate improvement of the system** – Several of the project participants feel strongly that even though not all of the planned enhancements have been implemented, the 511

Model Deployment vision is still a very viable and a very good one, noting that only one enhancement has been formally dropped (private partner premium service). They feel that the objectives of the Model Deployment will continue to provide guidance to system enhancements into the future.

18. **511 system coverage has increased substantially, to full statewide coverage** – Prior to the Model Deployment there were many gaps in 511 service statewide, including many cell phone providers who did not support 511. As part of the overall 511 Model Deployment effort ADOT has greatly increased service coverage. Coverage now is essentially statewide.

19. **The 511 system was never "down" for any significant period of time, despite the major changes made to the system** – Despite modifying nearly every major component of the 511 system, the system remained operational. Although there were a number of complaints about the very early version of the menu system and voice recognition, the system remained fully operational and available to callers throughout the Model Deployment.

7.2.3 Challenges and Unresolved Issues

This section discusses challenges encountered in the 511 Model Deployment, approaches used to address those challenges, and unresolved issues. Although, as described in Section 7.2.2, user interface and new data type enhancements represent some of the most important successes of the Model Deployment, they also are recognized by the participants as the areas where the greatest challenges were encountered.

New Data Types

20. **Collecting data from new partner agencies is challenging** – The Model Deployment experience indicates that it can be difficult to collect data from agencies who do not have the overall responsibility for operating the 511 system and who have not historically contributed data to the system. These challenges are both technical and institutional in nature. Examples of technical challenges include the difficulties in establishing a secure means for local agencies to access the ADOT secure intranet to input HCRS data, and the difficulty of Valley Metro (Phoenix transit) in exporting bus schedule status information from their vendor's proprietary system. In terms of institutional challenges, the issues are primarily related to a lack of support of higher management for traveler information, which manifests itself in a lack of resources to support what is viewed as a new, unfunded, operational responsibility.

21. **The relationship between Arizona 511 and established transit customer service lines is clarifying, but is not yet completely clear** – No definitive relationship between the two services—which could be seen as overlapping in so much as 511 is intended as a multi-modal service—has been established, but the Model Deployment has been successful in stimulating coordination and has established some parameters for how the systems may relate. In this sense, the Model Deployment has not answered the "big questions" for

transit and 511 around the country, e.g., can 511 replace traditional transit customer information lines, and how much transit information should be put directly on 511? However, the Model Deployment has brought ADOT and the transit agencies together and begun to establish a framework for how those questions may be addressed in Arizona. Currently, both Phoenix and Tucson transit agencies plan to implement their own IVR systems. Phoenix transit cites three reasons for continuing to pursue their own IVR: they (and ADOT) do not believe 511 is ready to handle the massive volume of transit information calls; many of the calls will still require a skilled transit customer service operator to address; and they have spent many years and considerable resources firmly establishing their existing phone numbers as the comprehensive source of transit information. Tucson transit has the same concern about call volume. They also need to integrate their IVR with their demand-response trip reservation system, which would be more difficult to link with via 511. Although Phoenix and Tucson transit plan to retain and even partially automate (implement IVR) their own phone services, both transit agencies are finding 511 as a useful extension and supplement to their own traveler information activities. Phoenix transit in particular has a substantial number of call transfer options in 511, corresponding to the many types of services they offer. As they implement their own IVR they plan to further integrate 511 and their systems, e.g., transfers directly from various portions of the 511 menu into various portions of their own IVR menu. Phoenix transit feels 511 may be a particularly useful resource for new residents and visitors who are more likely to come to the area knowing about 511 and less likely to know the transit customer information number.

22. **Little use has been made of the ability to record information on major transit service disruptions** – Although both Phoenix and Tucson transit do have general messages referring 511 users to the option to transfer to their customer service operators, they have not recorded much information related to major service disruptions. In this sense, little to no actual transit information content has been made available through 511. It is unclear whether there is simply little need or benefit to providing such information or whether the agencies have not embraced 511 as an outlet for such information dissemination. Conversations with Phoenix transit indicate the latter is more likely than the former. They note that there are not very many system-wide events and that it would be difficult to note the disruptions that impact only certain routes.

23. **Significant work remains in the area of arterial street data collection, and a number of significant challenges must be overcome** – As described in Section 2.2, local agencies are not yet inputting information to 511 in any significant volume. So far, only a handful of Phoenix area agencies have input a combined total of less than 50 HCRS entries pertaining to arterial streets. Nearly all of those entries have pertained to scheduled (e.g., construction and maintenance) rather than real-time events (e.g., congestion and accidents). Local agencies indicate that they lack the resources to input this information, and in the case of planned events, which most of them enter into their own internal databases (for internal schedule coordination purposes, generally), they wish to avoid having to enter the information twice; once into their own system and once into HCRS. Some local agencies feel that the lack of resources reflects a general lack of support for traveler information activities on the part of their agency leadership. Traveler information is, as they put it, “a

tough sell" to senior agency and political leadership who want tangible results and infrastructure they can point to. One local traffic agency representative noted that in an environment where even something as tangible as an arterial street dynamic message sign is difficult to get funded, it is next to impossible to engender support for a relatively "invisible" regional traveler information service, especially when it is operated by the state department of transportation.

24. **A lack of comprehensive and accurate roadway incident information greatly limits the ability to provide this information through 511** – One of the reasons that good real-time information on roadway incidents is not entered into 511 by local agencies is that they have very little of this information themselves. The situation is the same for ADOT when it comes to arterial streets, and only somewhat better for interstates. ADOT synthesizes interstate incident information from a variety of sources, including their own closed-circuit television camera observations, monitoring of law enforcement scanners, and reports directly from the highway patrol (Department of Public Safety). However, they know that these sources of information do not accurately capture all notable incidents.

25. **Little to no information content was added for Tucson during the Model Deployment, although the stage is now set for bringing Tucson Region data into 511** – Three of the Model Deployment enhancements focused on adding Tucson region information to 511, essentially making the former Phoenix and intercity-centric 511 system truly more of a statewide resource. To this point, those enhancements are not yet bearing much fruit. Neither Tucson transit or the Tucson airport have taken much advantage of the ability to record traveler information summaries on 511, and the City of Tucson traffic department is only now poised to begin inputting data to the system. It is too early to say whether the traffic data inputting will be successful. In the case of transit, and with regard to the airport it is unclear why 511 has not yet been viewed as a significant resource.

26. **Technical challenges have greatly delayed the arterial street travel time enhancement** – The major challenge was related to communications. The problem has been in getting the data from the license plate readers located in the field (which gauge traffic speeds by matching individual vehicles at the beginning and end of specific arterial street corridors) back to the system server in ADOT. It took the better part of 2004 to implement the field elements and develop an effective wireless communications strategy. The system is now operating in test mode but no information is yet provided via 511.

27. **Data availability and format concerns have slowed the segment weather and neighboring states' data enhancements** – Neither of these enhancements were completed within the Model Deployment evaluation time frame. In the case of the weather data, much of the delay was due to the fact that the National Weather Service data product that ADOT had intended to use was not, at least early on, the product they had envisioned. To a lesser extent the postponement of this enhancement also seems related to the fact that ADOT found they lacked the staff resources to simultaneously implement all of the planned enhancements and therefore postponed some of them. In the case of other states' data, the early plan to include Utah roadway information in the 511 system was abandoned after it was determined that the Utah data was categorized at a much higher level and would be

difficult to mesh with the more finely categorized Arizona data. Instead, ADOT is awaiting the development (through an effort led by other states) of an import-export utility between HCRS and the other major national commercial alternative to HCRS, the "Condition Acquisition and Reporting System," CARS. In reflecting on the experience with the "other state's data" enhancement overall, The ADOT 511 project manager noted that it is harder when, as is the case with Arizona, there are no large cities on either side of the state borders.

28. **No significant gains appear to have been made in the area of Downtown Phoenix special event and parking information** – The original vision was somewhat ambiguous in this area. It was not clear to what extent the enhancement would consist of merely increasing the volume of information of the sort already in the 511 system (downtown Phoenix sporting events) through traditional mechanisms (information acquired and entered into the system by ADOT personnel), and to what extent the enhancement focused on getting information directly from the new Downtown Phoenix Parking Management System, such as real-time parking occupancy information. Regardless of the vision, it does not appear that the volume of information or the mechanism for inputting this information has changed. Also, based on interviews with both ADOT and the City of Phoenix it does not appear that the City is any more engaged in this activity than they were in the past.

User Interface

29. **The transition to voice recognition constitutes a major accomplishment as well as one of the major challenges, and opinions vary somewhat on the process used and final quality** – Some participants feel the voice recognition deployment was somewhat rushed and could have benefited from more extensive bench testing. Others feel the tight schedule added needed urgency and that the only way to get good feedback is to let users experience the system. Similarly divergent opinions exist as to the adequacy of the final performance of the voice recognition system. Nearly everyone agrees that continued refinement will be beneficial. Where they differ is the extent to which the current system is acceptable. The same participants who feel that the roll out was not premature cite the fact that the system was greatly improved in the first couple of months of operation (largely in response to caller criticisms and suggestions) and feel that, although it could be better, it is now generally effective. Those who felt the roll out was somewhat rushed tend to acknowledge the improvements that have been made but find the voice recognition capability still in need of attention. To the extent that they agree that improvements would be desirable, both groups generally feel that background noise is the major issue. In theory, background noise causes the system to misinterpret user utterances, either attributing the background noise incorrectly as a user input or failing to recognize the user input because of the background noise.

30. **An obvious and comprehensive touch tone back-up capability is important, especially to veteran 511 users** – As originally deployed, the enhanced 511 system had a partial touch tone menu capability and the touch tone option was not prominent. Within the first month or so of operation there were many negative caller comments complaining that there appeared to be no touch tone option and expressing considerable frustration with the voice recognition feature. A number of the callers appeared to be experienced 511 users, who

seemed surprised to find the user interface so changed and their familiar touch tone interface seemingly eliminated. In response to the complaints, the touch tone feature was enhanced to provide a fully redundant, parallel method of interface and the option was moved to a more prominent location in the menu.

31. **"Power users" were a driving force in refining the voice recognition system** – As noted in the preceding item, negative comments from experienced 511 users played a role in refining the touch tone menu option. These "power users"—veteran 511 users intimately familiar with the menu system and adept at quickly obtaining the information they wanted—also played a more general role in shaping the extensive refinement of the 511 system that occurred over the first couple of months of post-enhancement operation. In addition to the concern with the touch tone menu option these users were very concerned in general that the new system retain the features that allowed them to move quickly through the menu system. For example, with the old system they could quickly enter a memorized sequence of digits to access the appropriate menu and obtain information on a specific roadway, and they were inpatient with the new system which they felt did not provide the same level of short cutting. Such inputs from power users are part of the reason that ADOT has endeavored to keep the opening greeting—when no user inputs are accepted—as short as possible and to keep the number of similarly unavoidable "floodgate" messages (such as Amber Alerts) to an absolute minimum.

32. **Anticipating users' preferences for roadway segmentation schemes and selection of universally meaningful roadway reference points has proven challenging** – One of the major activities associated with conversion to a roadway-segment based reporting scheme was the identification of meaningful roadway segments. In an attempt to ensure that any caller looking for information on the portions of interstates within major urban areas could easily obtain such information, ADOT included them in both the preceding and following roadway segment. For example, the Phoenix area portion of I-10 was included in both the "California border to Phoenix" and the "Phoenix to Tucson" segments. This seemed to confuse some users and the segmentation has since been revised to include the Phoenix area information in a single segment. Similarly, it has been challenging for ADOT to identify meaningful roadway reference points in rural areas. No single approach—mileposts, nearby towns, or other place references (washes, canyons, etc.)—seems to resonate with a majority of users.

7.2.4 Overall Lessons Learned

Management and Deployment Issues

33. **As is expected with any complex technology project, the reach of the 511 Model Deployment exceeded its grasp, and that's not necessarily a bad thing** – Few of the project participants were surprised that all of the planned enhancements were not deployed on time or were being utilized by agencies entirely as planned. They generally feel that delays and even some failures are fully expected in an ambitious technology project, especially one that was explicitly intended to "push the envelope" and that relied upon

many different agencies for various data. To some extent, failure to implement all enhancements is evidence that the Model Deployment truly did aim high.

34. **Initial investments in a structured planning and design process will pay off** – The ADOT 511 project manager noted that the time and effort spent early on to develop the Program Management Plan and System Requirements Definition document were instrumental in the project successes. He also indicated that outside consultant program management support was critical (the program management consultant led the development of the two documents, among many other support activities).

35. **Partner agency relationships and participation commitments must be nurtured through the process** – Having agencies sign a general memorandum of understanding as part of the Model Deployment funding proposal did not prove to be sufficient to ensure active participation by all agencies. In a few cases agencies participated in early meetings but later fell out of the process, and as a result did not actively participate in data entry. In the opinion of the evaluation team, ADOT was conscientious in laying out an inclusive plan for the Model Deployment and getting meeting invitations to all participants, in essence, erecting "the tent." However, they were not particularly proactive in reaching out to new 511 participants throughout the deployment and leading them into the process—bringing them under the tent. This is not to suggest that ADOT was in any way negligent, but merely to point out that for at least some partner agencies, simply providing the forum and game plan for coordination did not necessarily prove sufficient to stimulate meaningful participation.

36. **User input during design is important** – Prior to the Model Deployment ADOT had no formal user input regarding the 511 system. During the design of the enhanced system they conducted six focus groups with travelers, including both 511 users and non-users. ADOT found these sessions to be extremely useful, both in directly driving the menu design and other aspects of the Model Deployment but also in providing insights into general traveler attitudes and perspectives. These focus groups resulted in the implementation of "Regional Quick Reports," regional summaries of traffic conditions, which was an enhancement that was not part of the original Model Deployment plan. These focus groups also revealed that there was a perception that the 511 system contained little congestion and incident information, which may have helped stimulate the increase in this type of data that has been observed.

Technical Issues

37. **An in-house 511 system provides certain advantages** – ADOT noted that the fact that they operate the 511 system themselves, as opposed to out-sourcing it to a commercial operator, has provided them a great deal of flexibility and control in modifying the system. They also believe that although the initial costs for an in-house system are higher, the recurring costs are lower.

38. **Although a potentially powerful mechanism for adding data to a 511 system, there are significant challenges and some trade-offs associated with relying on other agencies to input that data** – ADOT HCRS operators indicated that, although potentially effective in

getting new data into the system, reliance on other organizations (outside the ADOT TOC) sacrifices a measure of consistency and control that is possible when data is input from a central location.

39. **Allow plenty of time for voice recognition fine-tuning** – Implementation and refinement of the voice recognition capability required more time and effort than was anticipated. Several of the participants involved in this enhancement feel that voice recognition is as much an art as it is a science.

40. **In order to ensure data quality and consistency, human data entry operators need to play a central role; a fully automated system cannot provide acceptable quality and consistency** – The ADOT 511 project manager noted that the Arizona 511 system features considerable human data input. Although plans for the system entail increased reliance on automated data entry—such as inputting of estimated travel times automatically based on roadway vehicle detector data—a continuing significant level of human operator involvement is viewed as necessary in order to maintain data quality.

7.2.5 Next Steps for Arizona 511

Continued Pursuit of Planned Model Deployment Enhancements

As noted in Section 7.2.2, the overall 511 vision established through the Model Deployment is seen as a very useful framework for continued enhancement of the 511 system. Although not all of the enhancements have yet been implemented, and a few are not yet operating fully as intended (e.g., agencies are not inputting significant data) they are still viewed as good ideas, and worth further pursuit. Therefore, most of the plans for the 511 system consist of implementing the remaining Model Deployment enhancements:

- Ongoing marketing (including the 50 static road signs)
- Next bus arrival times
- Sharing data with other states
- Phoenix arterial street travel times.

In addition to these enhancements, ADOT intends to continue to refine HCRS and to continue with quality assurance activities, including system performance monitoring. Also, the Maricopa County Department of Transportation intends to increase their role in entering local street data, thus helping to address some local agencies' concerns in that area.

Other Planned Enhancements

In addition to continued pursuit of the unimplemented Model Deployment enhancements, ADOT has near-term plans to improve roadway incident data collection through the addition of a Department of Public Safety (highway patrol) computer-aided dispatch (CAD) workstation at the ADOT Traffic Operations Center. This will provide an important new source of accurate incident information. ADOT, along with the Maricopa County Department of Transportation, are also in the midst of implementing travel times for selected Phoenix area freeways. These

travel times will use the Phoenix airport as a standard reference point and will be derived directly from freeway vehicle detectors (inductive loops).

7.3 Conclusions

The overall conclusions of the enhancement process analysis are as follows:

- **ADOT and most of the Model Deployment participants view the project as essentially successful.** Foremost among the project accomplishments are the major redesign of the user interface and the addition of several new types of data and capabilities to the system. The user interface redesign was very substantial and moved the 511 system from an antiquated, touch tone only interface to a voice recognition interface, which is the state-of-the-practice type of user interface for 511 systems. Conversion to segment and region-based roadway reporting (Quick Reports) was another major improvement to the user interface.

  In terms of successes related to new data and capabilities, project participants point to the introduction of airport and transit information and call transfer capabilities, call transfer to the Arizona Office of Tourism, a floodgate message capability that has been used for Amber Alerts, and call transfer capabilities to all of the regional/rural transit providers statewide. These new data sources have done much to move the formerly highway-oriented 511 system to a multi-modal system. Although not an explicit, planned 511 Model Deployment enhancement, the amount of information pertaining to roadway congestion and incidents has increased significantly.

  In terms of shortcomings, most project participants cite the failure to implement the next bus arrival time information as one of the more significant disappointments of the Model Deployment. The relative lack of Phoenix area arterial street data entered by local agencies is also identified as a concern by many participants. Overall, the project participants view the unimplemented enhancements as regrettable, but not entirely unexpected, given the ambitious plans for the Model Deployment and the inevitability of delays and some failures for large, multi-agency technology projects like this one.

- **Several technical challenges were encountered, primarily related to availability of new data.** Schedule and resource (primarily staff) constraints played a role in postponement of enhancements. However, difficulties in obtaining new data from "outside" (non-ADOT) agencies were a more significant factor. Such difficulties largely explain the delays in the segment weather, next bus arrival times, and other states' data enhancements. Other technical challenges that were encountered and which played a role in delayed enhancements include: development of a secure means to allow non-ADOT agencies to enter data into HCRS via the Internet (that is, providing them secure access to the ADOT computer network where HCRS resides); major telecommunications issues associated with getting the arterial street travel time data from the field to the ADOT Traffic Operations Center; and the magnitude of HCRS base map revisions needed to accommodate Tucson and Phoenix arterial street data entry.

- **Within the formal Model Deployment period, participation by partner agencies was uneven and slow building.** There are a few enhancements that the project partners generally consider "implemented," or accomplished—because the menu changes have been made and the data entry mechanisms have been established—but which the evaluation team has identified as not yet operating fully as intended. These enhancements are the downtown Phoenix parking and special event information, Phoenix arterial street information, and Grand Canyon National Park information. The Tucson airport and transit information enhancements could, arguably, be included in this group. In all of these cases, some information is being input to 511, but it is mostly by ADOT and/or it is very limited information.

  The project partners associated with these enhancements did not remain fully engaged throughout the Model Deployment and did not, at least during the evaluation period, embrace their data entry role in the 511 system. In some cases, the level of involvement of the partner agencies increased significantly as the Model Deployment progressed, and after the basic enhanced system became operational. This is the case with Phoenix transit, who became very involved during the one-year operational period in greatly expanding their portion of the 511 menu. In other cases, there are promising indications that the level of participation is improving. For example, during the post-enhancement interview with the Tucson airport conducted just after the conclusion of the one-year operational period, the airport representatives were unaware that the Model Deployment was completed and unaware that they were able to input information. They expressed great interest in doing so and will presumably now be more involved.

- **Early reactions from veteran 511 users were strong, and were very influential in early, post-enhancement refinements of the user interface.** Agencies that are significantly revamping long-established 511 or other telephone traveler information systems should expect that, although potentially small in number, some veteran users of the system will, at least initially, react strongly and fairly negatively. In the case of the Arizona 511 Model Deployment much of the adverse reaction can probably be attributed to the fact that there were many menu system "glitches" in the initial enhanced user interface and the voice recognition system was not performing well. However, it can be hypothesized that even when enhancements perform as intended, if they significantly alter the "feel" of the system and impact veteran users' ability to use shortcuts, they may initially be viewed critically. In the case of the Model Deployment, comments from such users, including some fairly scathing ones, were very useful in the significant refinement of the menu and voice recognition systems that occurred over the first couple of months following deployment.

- **Many significant, lasting improvements were made to the 511 program that go far beyond the user interface and data enhancements.** Clearly, the major redesign of the user interface and the introduction of several new types of multi-modal data are the successes that are most visible and, in concept, most immediately useful to users. However, there are many accomplishments of the Model Deployment, some explicitly planned and some not, that are as important or more important to the long-term success of the program and ongoing value to users. Foremost among these accomplishments is the institution of a continuous quality improvement philosophy for the 511 program. Under the leadership of the 511 project

manager and the Traffic Operations Center Information Technologies Manager (who led much of the technical work), a pervasive, new emphasis on ongoing system performance monitoring has been instilled. This includes implementation of a number of important new data archival, analysis and reporting capabilities, and a demonstrated interest and commitment to using those capabilities to monitor and refine the system. It also includes a new focus on customer service, including the caller comment capability (and the seriousness and thoroughness with which ADOT follows up on the comments) and the many enhanced 511 activities of the Traffic Operations Center Public Information Officer (including 511 marketing and caller comment resolution).

Finally, there are a number of "halo effects" of the Model Deployment—benefits not directly associated with the planned 511 enhancements or necessarily even restricted to the 511 program. These include the improvements in overall agency partnerships and working relationships (such as has been noted by Phoenix transit). These benefits also include, through the 511 Model Deployment and the demonstration of a long-term commitment to 511, creation of a new focal point for enhanced regional, multi-jurisdictional ITS coordination in the Phoenix region. In recent years, efforts in this area have been constrained to some extent by the absence of a robust, long-term, truly multi-jurisdictional ITS operations project or program. The 511 system is now providing a focus and a forum for addressing more fundamental regional traveler information coordination and data sharing issues.

8.0 Cost Analysis

This section presents the costs associated with the Model Deployment and compares them to the costs associated with the pre-enhanced 511 system. Costs are categorized by Model Deployment phase (design and development; implementation; and operation) and by type, i.e., implementation and operations costs are broken down into their major subcomponents (hardware and software, phone charges, etc.). All costs reported for the "Model Deployment" or "post-enhancement" period are for the period approximately 2003 – 2004. Costs for the pre-enhancement period are for the period approximately 1998 – 1999.

8.1 Model Deployment Costs

Table 2-1 in Section 2.2.1 presented the complete list of the Model Deployment enhancements. For budgeting purposes, ADOT organized most of those enhancements into ten individual "projects." Since this is the way ADOT tracked costs, and is the format of the cost data provided by them to the evaluation, this cost analysis presents the individual enhancement costs using this same ten-project categorization. In many cases the relationship between the project and a specific enhancement is obvious. For example, the segment weather enhancement was fully contained within the "segment weather information" project. In some cases, however, a number of enhancements are addressed within a single "project." For example, the ADOT portion of many of the new data enhancements consisted solely of revisions to the HCRS database and the IVR menu system and were carried out in those two "projects." Table 8-1 presents the relationship between the ten ADOT Model Deployment projects and the enhancements as they have been categorized for evaluation.

Table 8-2 presents the total costs of the Model Deployment, organized by deployment phase (design and development, etc.) and by Model Deployment activity. Note that the "Total" column reflects the total costs of the Model Deployment, including operations and maintenance (O & M) costs for the 12-month post-enhancement evaluation period (the total capital costs for the pre- and post-enhanced versions of the 511 system—that is, all costs excluding O & M—are presented in Table 8-4.) The Model Deployment activities include the ten ADOT Model Deployment projects as well as ADOT staff costs and telecommunications costs. ADOT did not formally track their staff costs and, therefore, the figures in Table 8-2 represent approximations. ADOT did not formally track costs by phase either, and as noted in Section 2.2.1, the Model Deployment design, implementation and operations phases overlapped somewhat. Therefore, the breakdown of costs by phase (developed by the evaluation team with ADOT input) should also be viewed as approximate.

Table 8-2 indicates that the total cost of the ten Model Deployment "projects"—which is what ADOT formally defines as the "Model Deployment" per se—was about $1.477 million. That includes obligated, but not yet expended, budget associated with the enhancements that are still being implemented. The total cost exceeded the funding available for the entire Model Deployment by about 4% ($52,000). Several of the enhancements were significantly more costly than anticipated. The most significant cost over-runs were associated with the VRAS enhancements (61%), program management support (37%), and the travel time trial (8%).

Table 8-1. ADOT Model Deployment "Projects" vs. "Enhancements"

ADOT 511 "Project"	Enhancement
HCRS Enhancement	Tucson and Phoenix Local Street Data
	Transit Major Service Disruptions
	Phoenix and Tucson Airport Info
	Grand Canyon Info
	Downtown Phoenix Special Events and Parking
	Sharing Data with Other States (Utah)
	Regional Roadway "Quick Reports"
	Roadway Segment-Based Reporting
	Roadway Info Accessible Via Roadway Name
VRAS Enhancement	Voice Recognition
	Improved System Performance Monitoring
Operations Enhancement	Data Quality Enhancements
Segment Weather Information Enhancement	Segment Weather Info
Travel Time Trial	Phoenix Arterial Street Travel Times
Bus Arrival Time Trial	Phoenix BRT Estimated Arrival Times
Marketing Research	Marketing
Premium Service Research	Premium Service Partnership
Evaluation Support	Local (University of Arizona) evaluation
Program Management Support	511 program support consultant (prepared Program Management Plan, System Requirements Definition, etc.)

The total federal funding for the Model Deployment funding totaled $1.140 million. This means that ADOT and their 511 partners expended about $337,000 of their own funding for the ten Model Deployment projects and an additional $228,000 of their own funds on other 511 enhancement activities, including their own staff time, which they do not formally consider a Model Deployment cost.

Of the total cost of the Model Deployment (about $1.705 million), about 24% ($406,508) was spent on design and development. About 59% ($1,005,752) was spent on implementation. The remaining 17% ($292,578) was spent to operate the system during the 1-year Model Deployment operational period. As indicated in Table 8-2, the cost to operate the system in future years is expected to be about 28% (~$83,000) lower. Most of the cost reduction results from the elimination of consultant program support, which amounted to approximately $75,000 during the one-year operational period.

Table 8-2. 511 Model Deployment Costs

511 Cost Components	Model Deployment Costs				Operations (Estimated Annual Cost for Future Years)
	Design and Development	Implementation	Operation (One-Year Model Deployment Operational Period)	Total	
ADOT Staff					
Project Manager	$4,059	$12,341	$4,100	$20,500	$2,600
IT Manager	$3,089	$10,951	$4,680	$18,720	$3,900
IT Staff	$515	$1,435	$390	$2,340	$78
Public Information Officer	$1,716	$6,084	$2,600	$10,400	$2,080
Subtotal	$9,379	$30,811	$11,770	$51,960	$8,658
511 Enhancements (ADOT "Projects")					
HCRS Enhancement	$39,300	$181,072	$11,250	$231,622	$7,500
VRAS Enhancement	$219,676	$340,660	$18,714	$579,049	$17,600
Operations Enhancement	$7,377	$66,389	$0	$73,765	
Segment Weather Information Enhancement	$9,552	**Postponed**		$9,552	
Travel Time Trial	$18,058	$162,523	**Still in Testing**	$180,581	
Bus Arrival Time Trial	**Postponed**				
Marketing	$17,210	$42,137		$59,347	
Premium Service Research	**Cancelled**				
Evaluation Support	$25,000	$25,000		$50,000	
Program Management Support	$60,957	$157,160	$74,809	$292,926	
Subtotal	$397,129	$974,940	$104,773	$1,476,842	$25,100
Other Operations Costs					
Phone Charges (toll free, call transfers, etc.)			$139,577	$139,577	$139,577
T-1 Line Rental (4 T-1's, totaling 96 lines)			$36,458	$36,458	$36,458
Subtotal	$ -	$ -	$176,035	$176,035	$176,035
Total	**$406,508**	**$1,005,752**	**$292,578**	**$1,704,837**	**$209,793**

Most of the Model Deployment costs were associated with ADOT's consultants. The total cost for the ten projects, all of which utilized consultants, was about $1.477 million, representing about 87% of the total costs to enhance the 511 system. ADOT staff costs account for about 3% ($51,960) of total costs. Various phone charges account for the remaining 10% ($176,035) of total costs.

The marketing costs shown in Table 8-2 do not reflect the costs to deploy 50 static roadside 511 signs at various locations throughout Arizona. Those signs have not yet been deployed. ADOT estimates that the cost to produce and deploy the signs will be approximately $50,000.

ADOT's estimate of the break-down of their Model Deployment staff hours is shown in Table 8-3. During the design and development phase, ADOT estimates that they devoted a total of about 19 staff hours per week to the project. This effort was spread fairly evenly across the 511 project manager, the IT manager, IT staff, and the Public Information Officer. Much of this time was spent in meetings, including meetings with the consultants performing the various enhancements. During the 1-year operations period, a time when design and implementation activities were continuing, ADOT estimates that they spent about the same number of staff hours (16) per week. Expectedly, during the operations phase, a smaller proportion of time was spent in meetings. As indicated in the two columns at the far right of Table 8-3, ADOT estimates that significantly less staff will be required for ongoing operation of the 511 system, about 7 staff hours per week.

Table 8-3. ADOT Staff Hours Detail

ADOT Staff	Average Staff Hours per Week							
	511 Model Deployment						Post-Model Deployment	
	Design, Development and Implementation Phase			Refinement and Operation Phase (One Year of Model Deployment Operations)				
	Mtgs.	Coord., QA & QC	Total	Mtgs.	Coord.	Total	Hrs.	Activities
Project Manager	4	2	6	2	2	4	1.25	QA/QC; strategic direction
IT Manager	4	2	6	2	4	6	2.5	QA/QC coordination w/vendors; reports
IT Staff	2		2	1		1	1	Hardware support (maintenance, security patches, system lock-ups, etc.)
Public Information Officer	4	1	5	2	3	5	2	Marketing; reviewing and responding to 511 caller voicemail comments
Total	**14**	**5**	**19**	**7**	**9**	**16**	**6.75**	

8.2 Comparisons to Pre-Enhancement Costs

Table 8-4 compares the Model Deployment costs—the costs to enhance the 511 system—with the costs associated with implementing the original (pre-enhanced) system. Much more was spent in enhancing the system than in implementing the original telephone information system, about 3.5 times as much. This underscores just how significant the Model Deployment enhancements were and how fundamentally they have changed the previous 511 system. A very small percentage, about 4% ($60,069) of the Model Deployment costs were for hardware. The only hardware purchases were for a machine to record the .WAV file digital voice recordings ($5,000) and for the four new IVR servers ($55,070), both of which were part of the "VRAS Enhancement" ADOT project. Software and engineering costs, which are defined here to include ADOT staff costs and all consultant support services costs, were associated with all six of the ADOT Model Deployment "projects" that were not postponed or cancelled. The projects requiring the greatest software and engineering expenditures were the VRAS Enhancement (31% of total software and engineering costs), HCRS Enhancement (20%), Travel Time Trial (18%) and Program Management Support (17%) projects.

Table 8-4. Comparison of Previous and Model Deployment Capital (Non-Recurring) Costs

Deployment Cost Component	Pre-Model Deployment 511 System	Enhanced (Model Deployment) 511 System
Design & Development	$ 270,000	$ 406,508
Implementation	$ 85,020	$ 1,005,752
Hardware	$ 48,370	$ 60,069
Software & Engineering	$ 36,650	$ 903,546
Marketing	$ –	$ 42,137
Total	**$ 355,020**	**$ 1,412,260**

Table 8-5 compares annual operations costs of the pre- and post-enhanced 511 system. The annual costs to operate the system during the one-year Model Deployment period was $292,578, about twice as much as for the pre-enhanced 511 system. Almost half of that increase is accounted for by the program support consultant. Increased phone charges account for about 24% of the increase in annual costs. As indicated in the far right column of Table 8-5, ADOT estimates that the annual system operations costs will be significantly lower for future years, but still considerably higher than the pre-enhanced costs.

Table 8-5. Comparison of Previous and Model Deployment Annual Operations Costs

Annual Operations Cost Component	Pre-Model Deployment 511 System	Model Deployment Year of Operations	Future Years of Operation
ADOT staff	$ 270	$ 11,770	$ 8,658
Consultant support	$ 9,400	$ 104,773	$ 25,100
HCRS	$ 3,000	$ 11,250	$ 7,500
IVR	$ 6,400	$ 18,714	$ 17,600
Program Management	$ –	$ 74,809	$ –
Phone charges	$ 102,464	$ 139,577	$ 139,577
T-1 Line Rental	$ 27,600	$ 36,458	$ 36,458
Total	**$ 139,734**	**$ 292,578**	**$ 209,793**

8.3 Conclusions

- Assuming ongoing enhancements are completed on-budget, the total cost of the Model Deployment (i.e., the cost of the ten "projects", which ADOT views as the entirety of the Model Deployment) is estimated to exceed the original budget by only about 4% ($52,000). Costs were higher than expected in several areas: VRAS enhancements (61%), which included all of the changes to the IVR system (menus, voice recognition) and consultant program management support (37%).
- The cost of the Model Deployment was substantial in relation to the cost to deploy the original system. This underscores the scope and scale of the Model Deployment and how significantly it altered the Arizona 511 system.
- ADOT expended considerable additional funds in support of the 511 enhancements (including the one year of operations), totaling about $565,000. About 60% of these additional funds were for cost over-runs among the ten Model Deployment enhancement projects. About 31% was for various telecommunications charges. The remaining 9% was for ADOT staff time.
- Although extensive consultant support was utilized, considerable time investments on the part of ADOT staff were required, accounting for about 3% ($52,000) of the total Model Deployment costs.
- Operations costs represented about 17% ($292,578) of the total Model Deployment cost. These costs are expected to decrease in the future, as less ADOT staff time and consultant support is required.
- Consistent with the fact that the Model Deployment consisted primarily of user interface and new data enhancements, and built upon an existing 511 system, hardware costs represented a small percentage (4%) of total capital (non-recurring) costs.

9.0 Conclusions

This section presents the overall conclusions of the Model Deployment. Preceding sections included detailed discussions of the conclusions based on individual evaluation analyses and hypotheses (Sections 4.0 - 8.0). This section focuses on conclusions relative to the four major objectives of the evaluation, which are to:

- Provide an independent review of the performance of the Model Deployment, including the extent to which it accomplishes the national objectives (which are summarized in Section 1.1).
- Document how the Model Deployment was implemented, including system costs and how technical and institutional issues (especially cross-modal and interstate) issues were resolved.
- Provide ADOT and the other partners with feedback that will allow them to improve the effectiveness of the system.
- Deliver lessons learned that will inform the U.S. DOT 511 effort and that will be of use to agencies operating and planning to implement 511 systems.

9.1 Performance of the Model Deployment and Accomplishment of National Objectives

The objectives for the 511 Model Deployment set forth by the U.S. DOT fall into three areas. First, the Model Deployment was to "push-the-envelop" in telephone traveler information, in terms of innovative techniques and the quality of the service. Second, the user interface was to effectively balance comprehensiveness with brevity and usability, and to require no direct contact with human operators. Third, the 511 system was to provide information, including but not limited to the following: information related to current traffic, public transportation, roadway incidents and construction, special events, and weather or road surface conditions. This section summarizes evaluation findings in each of these three areas.

9.1.1 Innovation and Quality

Overall, the Model Deployment dramatically improved on the previous Arizona 511 system, greatly enhancing the quality of the product available to travelers and establishing the means to maintain and further enhance the quality and effectiveness of the system. Thus, with regard to system structure, the Model Deployment is a success. Highlights of the structural enhancements realized through the Model Deployment include:

- Introduction of user input into the design and ongoing operation of the system, providing a critical source of customer feedback (the comment line), both as input to the Model Deployment and for ongoing quality improvement.

- Replacement of the cumbersome, roadway-based touch tone menu system with a voice recognition system featuring roadway-segment and region-based reporting (Quick Reports).
- Introduction of several new types of information, fundamentally changing it from a heavily roadway-oriented to a more multi-modal information resource.
- Ability to deliver much more information of the type desired by design focus group participants: arterial street, incident, congestion, and regional traffic summary (Quick Report) information.
- Creation of a philosophy of "customer service" and "continuous quality improvement," including the necessary system performance monitoring tools and framework for continuing enhancement.

In addition to the accomplishments that were realized during the Model Deployment, work continues on several fronts to fully realize the original, ambitious Model Deployment vision. This work focuses on the numerous planned new data types that were not successfully integrated by the time of the evaluation: segment weather, estimated bus arrival times, arterial street travel times, and information on bordering states.

Finally, the overall 511 system effectiveness has increased substantially in several areas, some directly related to the Model Deployment and some benefiting from the associated overall increase in focus on the system. These gains include significant expansion of the coverage area to essentially statewide coverage and maintenance of adequate capacity and system availability (i.e., minimal downtime) in the face of major system renovation and significantly increased call volumes.

In terms of dramatically improving the previous 511 system, the Arizona 511 Model Deployment has been extremely successful, thus meeting the U.S. DOT model objective to improve quality. However, in regard to "pushing the envelope" and creation of a truly innovative system, results to date are mixed. This conclusion is based on the following three considerations.

First, the enhancement of the user interface, institution of the first real Arizona 511 marketing campaign, incorporation of user input, and addition of links to several types of new data represent dramatic improvements in the Arizona 511 system. However, relative to state-of-the-practice 511 systems around the country, such as the systems in Virginia, Washington State and Maine, they have brought the Arizona system into the mainstream of current 511 approaches.

Second, many of the truly innovative, "envelop-pushing" aspects of the Model Deployment were not completed within the evaluation time frame (other states' data, segment weather information, arterial street travel times, and estimated bus arrival times). ADOT and its 511 partners are continuing to vigorously pursue these enhancements (several have been completed since the evaluation period ended) but the ultimate success of a number of them is still uncertain. One of the areas where innovation was anticipated failed completely—the premium service partnership with a commercial information provider. It was the only planned enhancement to be dropped entirely, after no viable partner and business model could be identified.

Third, some of the 511 enhancements that have been implemented are not yet being used by any significant number of users, and/or are not universally well regarded by users. The usage and survey analyses indicate that although a number of new data types (many consisting of call transfers) have been introduced, very few callers are using them. From a usage perspective, the system remains highway-centric. Of course, this may change significantly over the next couple of years, as the impacts of the ongoing marketing campaign are felt, including growing national recognition of 511 as a resource, and with the continued enhancement of the system. The survey analysis also indicates that although 71% of users are satisfied with the system, there is some lingering concern with the quality of the voice recognition system, specifically in its ability to correctly interpret user utterances. Over one third (35%) of callers who primarily use the voice recognition option (rather than the touch tone option) said they were dissatisfied with the feature. This sentiment is shared by several (although not all) of the agency participants in the 511 Model Deployment.

9.1.2 User Interface

As described in Section 9.1.1, the Model Deployment dramatically enhanced the Arizona 511 user interface. The system now provides the option of voice recognition, which, although not yet perfect, is operational and is well received by a majority of users. Roadway information is now available at the segment and regional level, a dramatic improvement over the old system that provided information only at the roadway level. The previous method required callers to listen to or skip through every event on a given roadway over the entire state until they found the information they were looking for. The regional traffic reports—"Quick Reports"—provide summary traffic information for specific regions, such as portions of the Phoenix area. Perhaps most importantly, most 511 users are generally satisfied with the user interface, finding it easy to navigate and understandable. This suggests that so far, the Model Deployment has been successful in adding many new menu options without making the system onerous to use. Of course, this perception could change if and when more users seeking non-roadway information begin using the system in significant numbers.

These successes in accomplishing user interface-related Model Deployment objectives are mitigated by two factors. First, many users are not fully satisfied with the voice recognition system. Second, the analysis of unrecognized user inputs (Section 4.1.9) suggests that many user inputs are not comprehended by the system.

9.1.3 Information Content

The enhanced 511 system includes all of the targeted data types identified by the U.S. DOT and information content was enhanced through the Model Deployment. Improvements in information content include dramatic increases in the amount of roadway incident and congestion information, the addition of a call transfer option to the Arizona Office of Tourism, pre-recorded information from the Phoenix airport, and call transfer options to the Phoenix and Tucson airports and transit operators throughout the state. These accomplishments are, however, somewhat lessened by a number of factors:

- Some key new data types planned for the Model Deployment were not completed within the evaluation time frame, including several of the most innovative and challenging: estimated next bus arrival times, segment weather information, arterial street travel times, arterial street information overall, and bordering states' data. Of these enhancements, segment weather information has, since the end of the evaluation period, been successfully implemented.
- Most 511 callers are not using the new data.
- A couple of information content enhancements could be considered only partially complete or effective. For example, there has been no notable increase in the amount of Downtown Phoenix special event or parking information, although it is hard to draw conclusions since the deployment plan did not identify specific enhancements. Other examples include information for Grand Canyon National Park and Tucson's transit system and airport. Although all three organizations now have the means to input information into the system, they are not taking much advantage of it. In the case of transit and the airport, this may be because the organizations do not feel that they have notable specific information to disseminate.

9.2 The Enhancement Process

This section includes two components. The first presents conclusions relative to the overall effectiveness of the enhancement process, including scope (success in implementing planned enhancements), schedule and budget considerations. The second section highlights a number of specific technical and institutional issues that were encountered in the enhancement process.

9.2.1 Overall Effectiveness

Overall, the Model Deployment process was partially effective. Successes include:

- Completion of many enhancements, including some key ones like voice recognition and the addition of a couple of new data types.
- Strengthening of ADOT relationships with some partner agencies.
- Reinvigoration of statewide and Phoenix region ITS partnering, especially in the area of traveler information.

Shortcomings of the process include:

- Several incomplete enhancements (as of the conclusion of the evaluation period), including some of the most innovative and nationally significant ones (e.g., other states, arterial street travel times, bus arrival times, segment weather).
- Costs for several enhancements significantly exceeded estimates, although ADOT made up short-falls with their own funds.

- Several partners did not actively participate (at least during the evaluation period), including local traffic agencies that did not contribute the local street information that was expected.
- No private premium service partner was identified (although an adverse outcome, this is not necessarily a shortcoming of the process.)

Most of the project participants view the preceding shortcomings of the enhancement process as regrettable but not unexpected given the scale and ambition of the project. This perspective also reflects the fact that efforts continue on almost all of the delayed enhancements.

9.2.2 Specific Issues

Institutional

A comprehensive list of issues is presented in Section 7.0. Among the most significant institutional issues were:

- It was difficult to engage some partners before the basic enhanced system was deployed in December 2003, and some partners never did fully engage (at least within the evaluation period.)
- Inability or unwillingness of cities and counties to enter a significant volume of local street roadway information (incident, congestion and construction). Agencies indicated that they lacked the staff resources to enter the data into HCRS. It is also the case that most cities and counties have a very limited amount of accurate incident and congestion information.

Technical

Several technical challenges were encountered. With the exception of those related to the user interface, these issues directly contributed to the delays which prevented a number of enhancements from being completed within the Model Deployment time frame. Technical issues include:

- Discovering that Utah's roadway information was categorized differently and at a much higher level, and therefore would be difficult to synchronize within ADOT's much more elaborate coding scheme.
- Inability to export Phoenix bus estimated arrival time data from the proprietary automatic vehicle location system, either to other parts of the transit operation or to the 511 system.
- Difficulties in identifying a workable communications scheme to relay arterial street travel time information (based on vehicle-matching using license plate readers) from the field to a central processing location.
- Challenges in mapping the National Weather Service's 2-kilometer grid weather data to the much longer roadway segments used in the 511 system.

- The unexpectedly extensive enhancement of HCRS base maps necessary to accommodate local street data to be entered by the City of Tucson.
- Computer network security challenges encountered in providing non-ADOT agencies secure access to the ADOT computer system where HCRS resides.
- Segmenting interstates that serve both heavy intercity and urban area demand in a way that would be intuitive to users, both those interested in information on the roadway throughout the state and those interested in information for the roadway only within a given urban area.
- The process of implementing and refining the voice recognition system proved more challenging than anticipated—"more of an art than a science." Specific technical challenges included the effort to build the large library of human voice-recorded roadway location references (necessary as the system moved from text-to-speech to concatenated speech) and the significant fine-tuning and de-bugging of the voice recognition system. For example, it was discovered that the system tended to interpret many extraneous background noises as the utterance "eight" and therefore often mistakenly provided information on Interstate 8.

9.3 Suggested Improvements to the Arizona 511 System

Through the evaluation process, a number of suggested improvements to the Arizona 511 system have been identified. The need for a number of these improvements became clear to most participants based on the results of the enhancement process, and some are being pursued. Other suggestions are based on the results of the usage and survey analysis and may not be as widely perceived among the Model Deployment participants. Suggested improvements consist of the following:

- **Further Refine the Voice Recognition System** – The concerns on the part of several participants and the evaluation team that the voice recognition needs further improvement were supported by the results of the user survey. More than a third (35%) of repeat callers surveyed who primarily used the voice recognition interface (as opposed to the touch tone option) said they were dissatisfied with it. It may be useful to perform controlled testing of the voice recognition system with real 511 users, to observe first hand the problems they encounter and why they encounter them.
- **Continue to Pursue Unimplemented Enhancements** – None of the experiences of the enhancement process or any findings of the evaluation suggest that any of the unimplemented enhancements were ill conceived and should be entirely dropped. ADOT and the 511 partners are encouraged to continue their efforts to implement these enhancements, informed by the results of this evaluation. As they pursue non-highway related enhancements (e.g., estimated bus arrival times) they should keep in mind that current users do not appear very interested in such information. Therefore, the addition of this information should be accompanied by marketing efforts targeting the intended users of such information, i.e., non-traditional 511 users.

- **Continue to Work to Increase Arterial Street Information** – Creating the mechanism for city and county data entry directly into HCRS was an important Model Deployment accomplishment. However, additional efforts are obviously needed in order to stimulate data entry. ADOT is working with regional ITS partners on this issue and should continue to do so. An approach suggested by one of the few cities that has input information (City of Glendale) was to start with a smaller, more manageable goal of capturing all planned event information in the Phoenix area. Later efforts could advance to real-time information, which is even more challenging, given that most cities and counties do not have this information for their roads. Those efforts should probably include outreach to law enforcement. One prong of the overall effort in the area of arterial street information could focus on building support among senior agency leadership, since many technical staff point to a lack of resources as one of the obstacles to data entry. ADOT's efforts to identify an automated approach to importing planned event information from city and county data systems directly into HCRS could also help address this challenge.
- **Continue to Utilize the New Performance Monitoring Tools** – The Model Deployment has greatly increased the amount of data available to ADOT to monitor the performance of the system and to guide ongoing enhancements. This includes the caller comments feature and the ability to generate reports providing many of the data presented in the usage analysis portion of this evaluation, including menu selections by topic. ADOT should take advantage of these new tools. It is also recommended that ADOT consider adopting the performance measures recommended by the national 511 Deployment Coalition.
- **Plan on Additional Surveys and/or Focus Groups in the Future** – The caller comment feature is a good tool but does not replace the sort of input that can be obtained through surveys and interviews. ADOT and the 511 partners should strive to include periodic surveys and/or focus groups as part of their long range 511 monitoring and enhancement program. Other statewide surveys conducted by ADOT or Metropolitan Planning Organizations may provide an opportunity to ask a few basic questions about 511, which if nothing else could help gauge overall awareness and the impact of ongoing marketing. Future surveys or focus groups could also explore some of the apparent inconsistencies observed in this evaluation. For example, Quick Reports were identified by design focus group participants as a very desirable feature but are hardly used.
- **Continue the 511 Marketing Program, Focus It, and Leverage Partners** – Although ADOT is clearly continuing some aspects of the 511 marketing program, to some extent it appeared that they may have considered the Model Deployment marketing as something of a special "one-time" effort. It is recommended that ADOT and their partners continue marketing 511. Those efforts should include a focus on the non-highway data types that are not currently being utilized and the associated user submarkets, such as transit riders and tourists. Although the 511 partners have provided some assistance in marketing, considerably greater efforts on their part are possible and can play a major role in reaching non-highway information users. Also, the usage analysis and the caller survey indicated that dynamic message signs were an effective marketing outlet. ADOT should consider periodically repeating the statewide 511 message postings, perhaps quarterly, as a way to remind long-term residents and inform

tourists and new residents. With Tucson area cities and counties now able to input information, and with the massive reconstruction of I-10 looming, increased marketing in Tucson on the part of ADOT and/or Tucson-area 511 partners also seems warranted.

- **Reconsider Expectations Relative to Commuter Versus Recreational Use** – One of ADOT's broader, informal objectives of the Model Deployment was to make the system more commuter oriented. They traditionally have viewed the system as oriented primarily toward intercity recreational travel, presumably based on the historically limited amount of urban area incident and congestion information available on the system and the relatively high weekend call volumes. This evaluation indicates that the system was and is utilized fairly equally for commuting and intercity/recreational trip purposes. This suggests that ADOT may have underestimated the commuter usage of the system or had expectations for even a truly commuter-dominated system. The balanced usage is in fact a positive finding, indicating that the system has value for different types of travelers and different trip purposes. From that perspective, expectations that the system should or can become more commuter-oriented may be ill founded. It is also the case that recurring traffic congestion is not as extreme anywhere in Arizona as it is in cities like New York, San Francisco and Los Angeles, and therefore the Arizona 511 system may not demonstrate the heavy levels of commuter usage typical of those systems.

9.4 Lessons Learned of National Significance

This section summarizes the evaluation conclusions most relevant to other 511 deployers and the national 511 community, including federal agencies. Conclusions are presented in two areas: those stemming from the enhancement process and cost analyses and those from the usage and survey analyses.

9.4.1 Enhancement Process and Cost-Related Conclusions

- **Invest in Formal Planning and Design Documents (e.g., system requirements)** – The ADOT 511 project manager noted that the time and effort spent early on to develop the Program Management Plan and System Requirements Definition document were instrumental in the project successes. He also indicated that outside consultant program management support was critical (the program management consultant led the development of the two documents, among many other support activities).
- **Nurture Partner Agency Relationships and Commitments Throughout the Process** – A number of agencies who had pledged to participate in the Model Deployment did not play an active role during the first year of post-enhancement operations. ADOT's attempts to involve these agencies, which were sincere but somewhat limited, were unsuccessful in stimulating their participation. This suggests that when involving new partners in a 511 operation traditionally associated with a single agency, extensive outreach may be needed to stimulate meaningful participation by all partners.
- **Solicit User Input During Design and System Refinement** – Prior to the Model Deployment ADOT had essentially no user input regarding the 511 system. Focus groups conducted as part of the design process were very useful, both in expanding

ADOT's appreciation of how real users relate to 511 and identifying specific issues and preferences. The focus groups resulted in the implementation of "Regional Quick Reports," regional summaries of traffic conditions, an enhancement that was not part of the original Model Deployment plan. These focus groups also revealed that there was perception that the 511 system contained little congestion and incident information, which may have helped stimulate the increase in this type of data that has been observed.

- **Consider the Potential Advantages of In-House 511 Operation if In-House Expertise is Available** – ADOT noted that the fact that they operate the 511 system themselves, as opposed to out-sourcing it to a commercial operator, has provided them a great deal of flexibility and control in modifying the system. They also point out that although the initial costs for an in-house system are higher, they believe the recurring costs are lower. Based on their experience, they encourage other 511 deployers to consider in-house operation. However, one of the key ingredients underlying ADOT's success with the in-house approach is that they have had experienced technical personnel able to devote extensive time and effort to the system. Because of the complicated nature of voice recognition and the changes in technology, agencies that do not have up-to-date technical expertise in house may consider "turn-key" firms that specialize in voice recognition services.
- **Budget Resources for Data Entry Training and Quality Control When Relying on Partner Agencies' to Input Data** – Utilization of other agencies (those not fundamentally responsible for the 511 operation) to enter their data into the system is, in theory, a highly efficient way to quickly increase the data content on a system. Getting the agencies to actually do so, however, can be difficult. Even if the agencies do input the data as planned, there is some risk that they may not fully comply with data entry procedures, or they may be inconsistent in judgment calls, such as the prioritization given to various types of incidents (an inherently subjective process). In short, a decentralized approach to data collection sacrifices a measure of consistency and control that is possible when data is input from a central location. This suggests that when a decentralized approach is used, training and explicit data entry and data quality procedures are especially important.
- **Consider the Possible Advantages of Retaining Some Human Operator Role in Data Entry** – ADOT believes that in order to ensure data quality and consistency, human data entry operators need to play a central role. They feel that a fully automated system cannot provide acceptable quality and consistency. The ADOT 511 project manager noted that the Arizona 511 system features considerable human data input and that a continuing significant level of human operator involvement is viewed as necessary in order to maintain data quality.
- **Plan for Voice Recognition Development and Refinement to be Resource Intensive** – Plenty of time should be allowed for this activity. Implementation and refinement of the voice recognition capability required more time and effort than was anticipated. Specific challenges had to do with voice-recording the large number of road names and roadway location references (e.g., place names) associated with the conversion from a text-to-speech approach to a concatenated speech approach, and the significant fine-tuning and de-bugging of the voice recognition system. For example, it was discovered that the

system tended to interpret many extraneous background noises as the utterance "eight" and therefore often mistakenly provided information on Interstate 8. 511 deployers lacking specific in-house voice recognition expertise should plan to utilize a contractor experienced in this area to support their in-house efforts or utilization of a "turn-key" firm to provide the full 511 voice recognition service.

- **Build In a Call Intercept Capability** – Deployers should periodically conduct caller surveys to monitor customer satisfaction and obtain other useful information about callers' use of 511. Since a live intercept is the most effective means for obtaining a representative sample, a built-in survey capability will facilitate live intercepts and automated surveys without the time and expense of retrofitting the system.
- **Plan for the Possibility that Costs for Significant Upgrades to 511 Systems May Exceed Costs for the Basic, Initial Deployment** – Cost considerations will likely vary considerably by system. Therefore, it may not be possible to generalize the Model Deployment findings. In the case of the Arizona 511 system enhancement, the cost of enhancing the system far exceeded the initial cost to develop it (assuming the cost of the HCRS data engine are excluded); costs associated with the menu design and voice recognition were significantly (61%) higher than estimated; and the cost to operate the system during the post-deployment year (about $293,000) represented a significant proportion (17%) of the total cost of the Model Deployment.

9.4.2 Usage and Survey Analysis-Related Conclusions

- **Target Marketing to Users of New Information** – For a traditionally roadway-oriented system, the addition of multi-modal information is not enough to stimulate significant usage of that information. The analysis of call logs indicates that 91% of all information requests during the post-enhancement period were for roadway information. The user survey results were consistent with this finding. Not unexpectedly, when a 511 system has an established roadway-oriented user base, simply adding multimodal information and carrying out general (radio ad) and highway-oriented marketing (DMS) is not enough to attract significant numbers of transit, airport, or tourist information users.
- **DMS Marketing is an Effective Way to Reach Roadway Travelers** – Of the several marketing activities conducted by ADOT, a week-long, 24/7 statewide DMS campaign had by far the greatest impact. DMS was cited by 34% of survey respondents. The other marketing activities (ADOT appearances at the State Fair and other events; a two-week period of radio advertisements) were much less effective, with 2% and 9% of respondents, respectively citing these activities. The impact of the DMS campaign was also reflected in call volumes, which skyrocketed during the period. During the DMS campaign, call volume increased three fold, with 96% of users being new to the system. Expectedly, DMS was especially effective in reaching en-route highway travelers. A much higher percentage of (83% versus the annual average 53%) of 511 calls were made by cell phones during the DMS advertising. These findings suggest that deployers can cost effectively take advantage of their own assets, such as DMS, to raise awareness of 511.

- **Don't Assume A Regional, Multi-Modal 511 System will Replace Transit Agency Telephone Information** – Major national questions about how 511 systems will relate to transit customer information telephone systems (both IVRs and human operators) remain. Progress was made in the Phoenix area in determining how the systems will mesh (and the general answer is that both systems will have transit information) but a definitive relationship/overall strategy has not been identified.
- **Vigorously Build Support Among Local Agencies for their Input of Roadway Information** – Arterial street data capture is a major challenge. Most cities and counties do not have good real-time information (congestion and incidents). They are often resistant to inputting their planned event information, because they already enter it into their own systems and do not want to perform "dual entry", or because they do not do it at all and do not have the time to start doing it. ADOT has managed to significantly increase their capture of arterial street information by more intensely monitoring police scanners, but they recognize this approach, in itself, as inadequate. It is labor intensive and does not always garner all the desired information, especially notification of incident clearance. ADOT looks for the upcoming addition of a state police computer-aided dispatch work station to significantly improve the situation.
- **Build Support for 511 by Emphasizing User-Reported Benefits** – Among repeat 511 users, the most commonly cited benefits were saving time/arriving on time(21%); avoiding traffic congestion due to accidents or construction delays (20%); and ability to change route based on information on traffic or road conditions (15%). Only 1% of repeat users indicated that 511 made their trip more relaxing or easier, suggesting that 511 information is valued for its specific use in travel decisions. Attracting first time users and getting them to try the system again is, obviously, critical to long-term customer satisfaction and realization of 511 benefits. This evaluation clearly indicates that the more callers use the system the greater their appreciation of benefits. So, it is critical that their first experience is satisfactory enough to warrant a repeat use—benefits will snowball from there. Nearly all (95%) first-time callers surveyed were willing to try the system again. Also, although definitive conclusions were not possible, the analysis of system usage during the initial roll out of voice recognition—a time when many complaints were received—suggests that callers, existing or new, were not quick to dismiss the (at that time flawed) 511 system.
- **Don't Assume Transit Information on 511 Will Impact Mode Choice** – 511 users appear resistant to mode choice changes, although this may be significantly influenced by the fact that few transit users appear to be using the Arizona 511 system. At least among traditional travelers (auto users), it does not appear that having some transit information on 511 is likely to contribute to use of transit.
- **Understand that for Many or Most 511 Calls, No Change in Travel Plans Will Result** – Drivers do make changes in their travel plans based on 511 information, but such changes are the exception; in most cases the information on 511 does not impact their travel plans. It is not clear whether this is because the information shows the intended travel route as trouble free, or whether roadway conditions sufficiently severe enough to warrant a change are uncommon. The specifics of the Phoenix travel environment could have much to do with these findings. When callers decide to make a

change to their trip in response to 511 information, the most frequent changes are taking a different route (12%), changing lanes (12%) and slowing down or changing speeds (9%).

APPENDIX A

BACKGROUND ON THE HIGHWAY CONDITION AND REPORTING SYSTEM

The subject matter of HCRS event entries is characterized using International Traveler Information Interchange Standard (ITIS) "category" and "description" information. There are 22 different ITIS categories in all, and each ITIS category includes anywhere from a few to several hundred specific messages or "descriptions." There are a total of 1,374 ITIS descriptions. The table below lists the ITIS categories and a couple of ITIS description examples from each category.

Table A-1. ITIS Categories Used in HCRS Event Entries and Example ITIS Descriptions

ITIS Categories	Examples of Associated ITIS Descriptions
Level of Service	Stop and go traffic for 3 miles
	Expect Traffic Congestion
Incidents/Accidents	Disabled vehicle. Delays
	Overturned vehicle
Closures	Road blocked ahead. Long delays
	On- and off-ramps blocked
Lane Restrictions	Narrow lanes. Expect slow traffic
	Right lane closed
Road Maintenance	Road marking operations. Two lanes closed
	Road construction. Heavy traffic.
Obstruction Hazards	Object on roadway
	Flooding. Expect heavy traffic.
Road Conditions	Fuel on roadway
	Loose gravel. Caution
Weather	Rain. Visibility reduced.
	Partly cloudy weather
Winds	Tornado watch
	Strong winds
Environment	Sandstorms
	Patchy fog
Activities	Sports event. Traffic building up
	Closed due to parade
Delays/Cancellations	Delays for buses. Irregular service
	Delays up to 20 minutes
Dangerous Vehicles	Objects falling from moving vehicle
	High-speed chase
Exceptional Loads	Wide load
	Military convoy

Table A-1. ITIS Categories Used in HCRS Event Entries and Example ITIS Descriptions (Continued)

ITIS Categories	Examples of Associated ITIS Descriptions
Traffic Equipment Status	Traffic lights working incorrectly. Delays
	Railroad crossing failure. Slow traffic
Traffic Regulations	Police directing traffic
	Temporary axle load limit
Headways	30 minute headway
	5 minute headway
Travel Times	5 minute travel time
	20 minute travel time
Parking	No parking
	Parking garage full
Information	Gas station closed
	Rest area closed
Winter Storm Codes	Ice
	Winter storm advisory

As an example, the following message was the sixth of eight messages for I-10, at 2:00 p.m. on Wednesday, October 29, 2003:

> "Height limit 16 feet 5 inches, width limit 24 feet, east and westbound from 22nd Street to 6th Avenue. Roadway reduced to two lanes. Expect slow traffic. Until July 31, 2004."

This message was generated by an event entry that utilized the "Lane Restriction" ITIS category, description #561: "Roadway reduced to two lanes. Expect slow traffic." The height and width limit and schedule information were pulled from other parts of the HCRS event entry form (in addition to specifying ITIS categories and descriptions other information, including restrictions, can be added to each event).

APPENDIX B

SAMPLE WEIGHTS

The construction of survey weights is a standard survey practice. Weighting of survey data is typically performed to adjust the relative importance of any one response to reflect that not all survey respondents were selected with the same probabilities, to reduce bias in survey estimates from differing patterns of response, and to align sample respondent distributions to known population distributions to improve coverage and precision.

Evaluation of the Need for Weights

The survey was designed as a stratified systematic probability sample with time-of-day and day-of-week as stratification factors. The sample size was proportionally allocated to each stratum based upon historical call volumes, and the same intercept rate was to be employed in each stratum. Therefore, each respondent would have a roughly equal probability of selection regardless of the stratum. However, due to logistical constraints and other factors, the intercepts were not conducted at a uniform rate, resulting in unequal probabilities of selection that need to be adjusted for with the survey weights. Additionally, the response rates for this survey varied significantly between the strata (see Figure B-1). Both of these factors resulted in the distribution of completed interviews differing from the distribution of callers into the 511 system (see Figure B-2 and Figure B-3). In particular, a higher percentage of interviews were completed during the end of the week than the beginning of the week compared to the distribution of all calls, and a higher percentage of completed interviews were from the evening rush compared to the distribution of all calls.

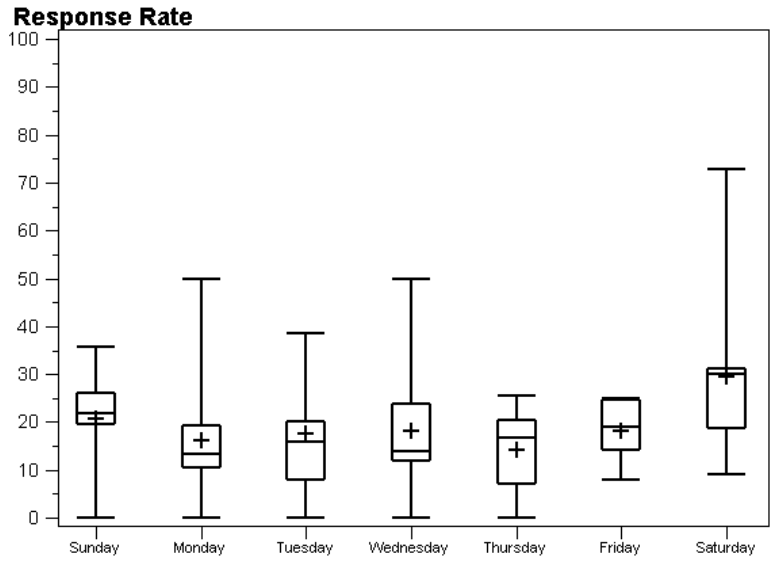


Figure B-1. Box-and-Whisker Plot of Response Rates by Day-of-Week (mean indicated by "+")

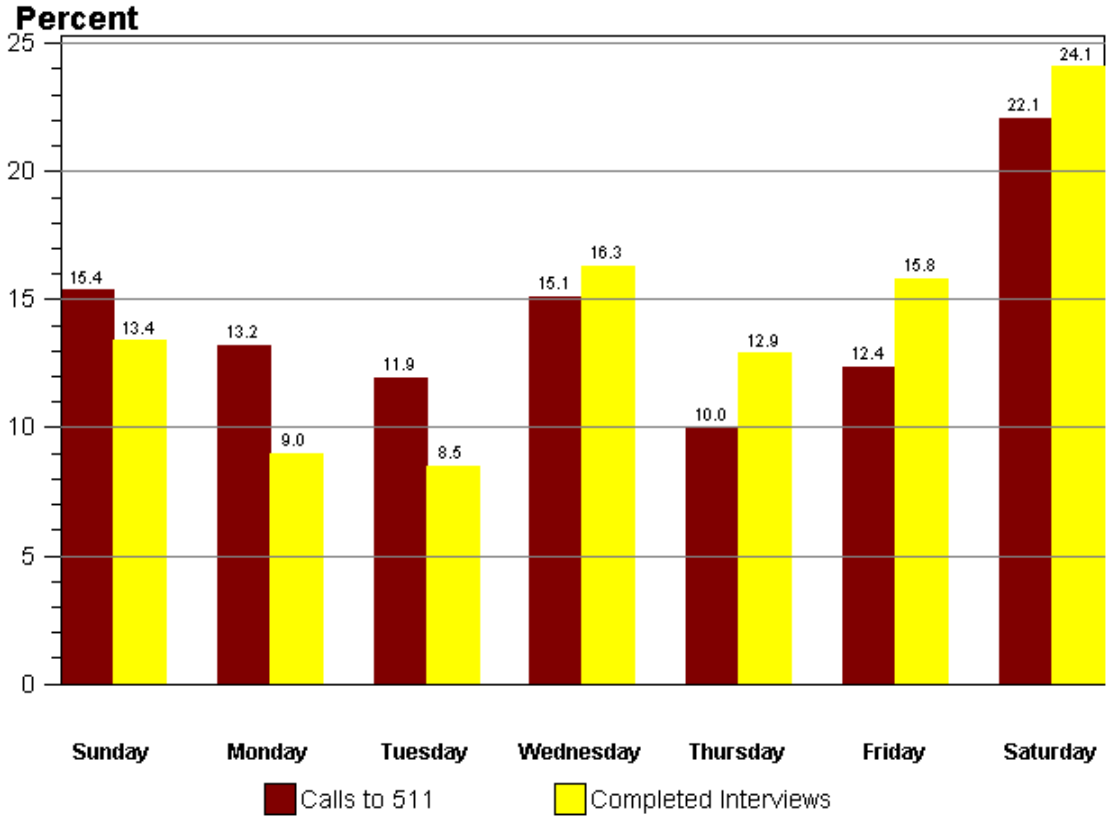


Figure B-2. Distribution of 511 Calls and Completed Interviews by Day-of-Week

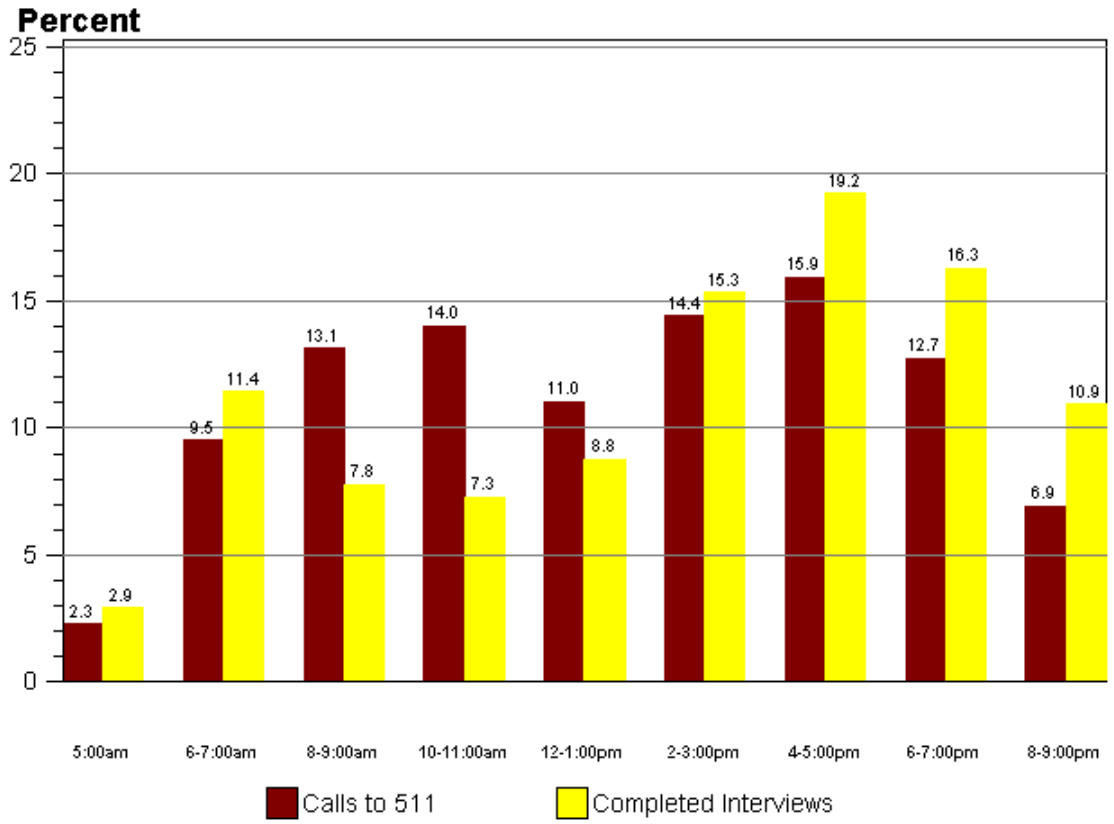


Figure B-3. Distribution of 511 Calls and Completed Interviews by Time-of-Day

Construction of the Weights

Weights for this survey were constructed using a three-step process in which each step modifies an interim weight developed in the previous step. These steps are outlined below.

Step 1. Calculate Base Weight: The base weight in stratum *i* was calculated as the reciprocal of the probability of selection.

$$Base\ Weight_i = \frac{No.\ of\ 511\ Calls_i}{No.\ of\ Intercepted\ Calls_i}$$

Step 2. Calculate Adjustment for Response Rate: The base weight in each stratum was adjusted to account for differences in the stratum-specific response rates by multiplying the base weight by the reciprocal of its stratum-specific response rate.

$$Adj.\ Weight_i = Base\ Weight_i * \frac{No.\ of\ Intercepted\ Calls_i}{No.\ of\ Completed\ Surveys_i}$$

Step 3. Normalize Weights: In this survey, the true number of unique callers to the 511 system is not known because many callers use the system multiple times. It is not possible to completely identify all of these multiple users through a unique identifier, such as the telephone tag in the 511 server logs, because this information is not available for every call. Thus, it is impossible to align the survey distributions of *individuals* who completed the survey to the overall population of *individuals*. Therefore, the final step in creating the survey weights was to normalize the weights back to the size of the sample (i.e., number of completed surveys) by dividing the calculated weight by the average weight. This maintains all of the relative adjustments for differing probabilities of selection and response, but will result in weighted survey estimates with sample totals instead of population totals. Note that the number of strata is represented by *s* in the two equations that were used to normalize the weights.

$$Weight_i = \frac{Adj.\ Weight_i}{\left(\frac{\sum_{j=1}^{s} Adj.\ Weight_j * No.\ of\ Completed\ Surveys_j}{\sum_{j=1}^{s} No.\ of\ Completed\ Surveys_j} \right)} * \frac{No.\ of\ Appointments\ Made_i}{No.\ of\ Completed\ Surveys_i}$$

$$Final\ Weight_i = \frac{Weight_i}{\left(\frac{\sum_{j=1}^{s} Weight_j * No.\ of\ Completed\ Surveys_j}{\sum_{j=1}^{s} No.\ of\ Completed\ Surveys_j} \right)}$$

APPENDIX C

USER SURVEY RESULTS BY QUESTION

This appendix presents the survey questions along with the responses. The responses list both straight frequency and the weighted frequency along with the standard error. Answers of "don't know" or no response are not included in the frequencies.

A total of 411 individuals completed the survey, of whom 140 were making their first call to 511 when intercepted for the survey. Because some questions were directed at callers who had had previous experience with the 511 service, new callers were not asked questions D1 through E3 below and the wording of some of the questions in section C was adjusted, too. To facilitate administration of the questionnaire, the computer-aided telephone interview system automatically branched to a first-time segment of the questionnaire after section B. Questions for the first-time callers are presented at the end of this appendix and are designated with an initial letter X from XC1 through XG5.

A1. When did you first call 511?

	Frequency	Weighted Frequency	Percent (SE)
It was the first time when recruited for survey	140	133.6	33.1 (3.1)
Within the past month	38	51.8	12.8 (2.6)
Between 2 and 6 months ago	138	133.2	33.0 (3.3)
Between 7 and 12 months ago	39	34.1	8.4 (1.7)
Over a year ago	49	51.0	12.6 (2.5)
Totals:[19]	404	403.8	100.0

A2. How did you first hear about 511?

	Frequency	Weighted Frequency	Percent (SE)
Saw it on electronic sign over the road	125	133.7	34.0 (3.4)
Saw it on a sign beside the road	14	12.9	3.3 (1.2)
From friend/coworker	62	58.4	14.8 (2.3)
Newspaper	17	16.1	4.1 (1.3)
TV	19	17.6	4.5 (1.5)
Radio	35	35.8	9.1 (2.0)
DOT website/Internet*	32	42.3	10.7 (2.5)
Police department*	17	14.2	3.6 (1.0)
Phonebook*	23	25.7	6.5 (1.5)
Map/atlas*	13	10.1	2.6 (0.7)
Arizona DOT*	10	7.4	1.9 (0.6)
Other	23	19.8	5.0 (1.2)
* write-in category Totals:	390	393.9	100.0

[19] Total responses for each question reflect only the number of individuals who actually answered the question.

A3. How many times have you called 511 in the past month?

	Frequency	Weighted Frequency	Percent (SE)
1	43	50.7	18.3 (3.4)
2-3	96	97.3	35.1 (4.2)
4-5	51	53.2	19.2 (3.6)
6-10	41	33.4	12.0 (2.4)
11-15	18	21.2	7.6 (2.5)
>15	22	21.6	7.8 (2.3)
Totals:	271	277.4	100.0

A4. Would you estimate that you place more of your calls to 511 from your cell phone, from a landline, or would you say you call 511 about equally from a cell phone and landline?

	Frequency	Weighted Frequency	Percent (SE)
Most from cell phone	227	223.6	80.6 (3.4)
Most from a landline	27	31.9	11.5 (2.5)
About equally cell phone and landline	17	22.0	7.9 (2.5)
Totals:	271	277.4	100.0

A5. Have you ever called 511 in a different state?

	Frequency	Weighted Frequency	Percent (SE)
Yes	19	3.6	4.9 (1.2)
No	252	263.8	95.1 (1.2)
Totals:	271	277.4	100.0

B1. Where were you when you phoned?

	Frequency	Weighted Frequency	Percent (SE)
At home	122	124.9	30.4 (3.1)
At work	26	24.8	6.0 (1.3)
Driving in a private vehicle	232	231.7	56.4 (3.1)
A passenger in a private vehicle	19	19.0	4.6 (1.3)
A passenger on a bus	0	0.0	0.0 (0.0)
Waiting at a bus stop	1	2.0	0.5 (0.5)
Somewhere else	11	8.7	2.1 (0.8)
Totals:	411	411.0	100.0

B2. Did you call 511 for information regarding a specific trip you were making?

	Frequency	Weighted Frequency	Percent (SE)
Yes	379	382.2	93 (1.5)
No	32	28.8	7 (1.5)
Totals:	411	411.0	100.0

B3. Did you call before a trip or while you were traveling?

	Frequency	Weighted Frequency	Percent (SE)
While traveling	250	248.5	65.2 (3.3)
Within 15 minutes before setting out	33	31.0	8.1 (1.7)
More than 15 minutes in advance of your trip, but on the same day	62	58.6	15.4 (2.4)
A day or more in advance for a trip you were planning	32	42.8	11.2 (2.5)
Totals:	377	380.9	100.0

B4. What type of transportation did you use for this trip (select all that apply)?

	Frequency	Weighted Frequency	Percent (SE)
Drove private vehicle	327	333.1	87.2 (2.2)
Passenger in private vehicle	28	20.0	5.2 (1.2)
Bus	3	3.5	0.9 (0.6)
Commercial vehicle	28	30.4	8.0 (1.9)
Bike	0	0.0	0.0 (0.0)
Walking	0	0.0	0.0 (0.0)
Some other means	0	0.0	0.0 (0.0)

B5. What was your primary purpose for making this trip?

	Frequency	Weighted Frequency	Percent (SE)
Commuting to or from work or school	128	124.9	33.0 (3.4)
Work- or school-related travel, but not a commute trip	63	56.9	15.0 (2.3)
Family or personal reasons (e.g., shopping or medical appointments)	120	124.1	32.8 (3.2)
Social, religious, or recreational	64	72.3	19.1 (2.9)
Other	1	0.2	0.1 (0.1)
Totals:	376	378.4	100.0

B6. When we interrupted your call you indicated that you called 511 for information on [intercept-stated reason]**. Is that correct?**

	Frequency	Weighted Frequency	Percent (SE)
Yes	367	368.6	96.4 (1.5)
No	12	13.6	3.6 (1.5)
Totals:	379	382.2	100.0

B7. In general, how satisfied were you with the information you got for the trip you were taking?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	173	187.0	49.4 (3.7)
Somewhat satisfied	81	81.9	21.6 (3.1)
Neither satisfied nor dissatisfied	16	14.8	3.9 (1.5)
Somewhat dissatisfied	37	34.3	9.1 (1.7)
Very dissatisfied	69	60.4	16.0 (2.3)
Totals:	376	378.4	100.0

B8a. Did you select the menu option for information about Roads?

	Frequency	Weighted Frequency	Percent (SE)
Yes	336	334.3	90.0 (2.3)
No	36	37.3	10.0 (2.3)
Totals:	372	371.6	100.0

B8b. Did you select the menu option for information about Buses?

	Frequency	Weighted Frequency	Percent (SE)
Yes	2	3.0	0.8 (0.6)
No	375	378.0	99.2 (0.6)
Totals:	377	381.0	100.0

B8b1. Which bus system or systems did you select? (select all that apply)

	Frequency	Weighted Frequency	Percent (SE)
Phoenix Valley Metro	2	3.0	100.0
Tucson Sun Tran	0	0.0	0.0

B8c. Did you select the menu option for information about Airports?

	Frequency	Weighted Frequency	Percent (SE)
Yes	3	1.8	0.5 (0.3)
No	374	379.2	99.5 (0.3)
	377	381.0	100.0

B8c1. Which airport or airports did you select? (select all that apply)?

	Frequency	Weighted Frequency	Percent (SE)
Phoenix Sky Harbor	3	1.8	100.0
Tucson International	0	0.0	0.0

B8d. Did you select the menu option for information about Tourism?

	Frequency	Weighted Frequency	Percent (SE)
Yes	1	1.0	0.3 (0.3)
No	376	380.0	99.7 (0.3)
Totals:	377	381.0	100.0

B8d1. Did you get information for Arizona Office of Tourism? Did you get Grand Canyon tourism information? (select all that apply)

	Frequency	Weighted Frequency	Percent (SE)
Arizona Office of Tourism	0	0.0	0.0
Grand Canyon	1	1.0	100.0

B8e. Did you select the menu option for Quick reports?

	Frequency	Weighted Frequency	Percent (SE)
Yes	29	29.2	7.7 (1.8)
No	346	350.2	92.3 (1.8)
Totals:	375	379.4	100.0

B8e1. What quick reports did you select? (select all that apply)

	Frequency	Weighted Frequency	Percent (SE)
Northwest Valley	3	2.2	7.4 (4.5)
North Phoenix	7	7.2	24.6 (10.1)
Northeast Valley	2	1.6	5.4 (4.0)
East Valley	9	13.3	45.5 (11.9)
Phoenix	7	4.3	14.6 (5.9)
West Valley	2	1.5	5.2 (3.9)
Tucson	1	0.6	1.9 (1.9)

B9a. You selected the menu option for roads. How satisfied are you with the quality of the information you received?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	151	156.6	46.9 (3.7)
Somewhat satisfied	93	94.1	28.2 (3.4)
Neither satisfied nor dissatisfied	9	11.3	3.4 (1.6)
Somewhat dissatisfied	28	24.7	7.4 (1.7)
Very dissatisfied	54	46.8	14.0 (2.4)
Totals:	335	333.6	100.0

B9b. You selected the menu option for busses. How satisfied are you with the quality of the information you received?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	1	2.0	100.0
Somewhat satisfied	0	0.0	0.0
Neither satisfied nor dissatisfied	0	0.0	0.0
Somewhat dissatisfied	0	0.0	0.0
Very dissatisfied	0	0.0	0.0
Totals:	1	2.0	100.0

B9c. You selected the menu option for airport. How satisfied are you with the quality of the information you received?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	2	1.6	87.2 (13.8)
Somewhat satisfied	1	0.2	12.8 (13.8)
Neither satisfied nor dissatisfied	0	0.0	0.0 (0.0)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	3	1.8	100.0

B9d. You selected the menu option for tourism. How satisfied are you with the quality of the information you received?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	1	1.0	100.0
Somewhat satisfied	0	0.0	0.0
Neither satisfied nor dissatisfied	0	0.0	0.0
Somewhat dissatisfied	0	0.0	0.0
Very dissatisfied	0	0.0	0.0
Totals:	1	1.0	100.0

B9e. You selected the menu option for quick reports. How satisfied are you with the quality of the information you received?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	9	8.9	30.3 (10.3)
Somewhat satisfied	10	12.5	42.8 (11.8)
Neither satisfied nor dissatisfied	1	0.8	2.7 (2.7)
Somewhat dissatisfied	4	4.9	16.6 (8.7)
Very dissatisfied	5	2.2	7.5 (3.7)
Totals:	29	29.2	100.0

B10. Did you make any changes to your trip or travel plans as a result of the information you got from 511?

B10a. Did you decide to leave earlier?

	Frequency	Weighted Frequency	Percent (SE)
Yes	12	8.6	2.3 (0.7)
No	365	372.1	97.7 (0.7)
Totals:	377	380.7	100.0

B10b. Did you decide to leave later?

	Frequency	Weighted Frequency	Percent (SE)
Yes	10	8.4	2.2 (0.9)
No	368	373.0	97.8 (0.9)
Totals:	378	381.4	100.0

B10c. Did you take a different bus?

	Frequency	Weighted Frequency	Percent (SE)
Yes	0	0.0	0.0
No	377	379.0	100.0
Totals:	377	379.0	100.0

B10d. Did you decide to take a different type of transportation?

	Frequency	Weighted Frequency	Percent (SE)
Yes	1	2.9	0.8 (0.8)
No	377	378.5	99.2 (0.8)
Totals:	378	381.4	100.0

B10e. Did you decide to take a different route?

	Frequency	Weighted Frequency	Percent (SE)
Yes	60	46.7	12.3 (2.0)
No	316	333.5	87.7 (2.0)
Totals:	376	380.2	100.0

B10f. Did you decide to make stops on the way that you would not otherwise have made?

	Frequency	Weighted Frequency	Percent (SE)
Yes	18	15.4	4.1 (1.0)
No	359	363.5	95.9 (1.0)
Totals:	377	378.9	100.0

B10g. Did you slow down or change speed?

	Frequency	Weighted Frequency	Percent (SE)
Yes	42	35.5	9.3 (1.6)
No	335	345.1	90.7 (1.6)
Totals:	377	380.6	100.0

B10h. Did you change lanes?

	Frequency	Weighted Frequency	Percent (SE)
Yes	48	46.2	12.2 (2.3)
No	327	333.1	87.8 (2.3)
Totals:	375	379.2	100.0

B10i. Did you make another type of change?

	Frequency	Weighted Frequency	Percent (SE)
Yes	4	3.8	1.0 (0.6)
No	374	377.6	99.0 (0.6)
Totals:	378	381.4	100.0

At this point in the survey, a branch in the questionnaire directed the interviewer to skip to XC1 for first-time callers (at the end of the appendix). Questions C1 through G5 that follow were asked of repeat callers only.

C1. For this particular trip, did you speak to the 511 service to select menu options, or did you use the buttons on your phone to make your selections?

	Frequency	Weighted Frequency	Percent (SE)
Voice recognition	211	223.6	81.6 (2.8)
Phone buttons	42	37.8	13.8 (2.5)
Both	16	12.7	4.6 (1.4)
Totals:	269	274.1	100.0

C2. How satisfied were you with the [method used] for making selections from the 511 menu?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	106	97.3	35.5 (4.4)
Somewhat satisfied	70	80.6	29.4 (4.1)
Neither satisfied nor dissatisfied	6	8.2	3.0 (1.3)
Somewhat dissatisfied	38	39.1	14.3 (3.0)
Very dissatisfied	49	48.9	17.8 (3.3)
Totals:	269	274.1	100.0

C2a. How satisfied were you with the phone buttons for making selections from the 511 menu?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	7	5.6	47.1 (16.7)
Somewhat satisfied	4	2.9	24.3 (12.0)
Neither satisfied nor dissatisfied	2	2.2	18.8 (13.2)
Somewhat dissatisfied	1	0.8	6.7 (6.7)
Very dissatisfied	1	0.4	3.1 (3.2)
Totals:	15	11.9	100.0

C3. Voice. Why were you dissatisfied with the voice recognition feature?

		Frequency	Weighted Frequency	Percent (SE)
Did not understand request*		35	31.2	35.6 (6.9)
Gave wrong information*		18	17.6	20.0 (5.1)
Background noise interferes*		25	29.0	33.1 (7.8)
Wanted option to speak to live person*		2	1.6	1.8 (1.3)
Poor menu options*		5	7.9	9.0 (5.6)
Other*		1	0.4	0.4 (0.4)
*write-in category	Totals:	86	87.7	100.0

C3a. Have you ever tried using the voice recognition feature?

		Frequency	Weighted Frequency	Percent (SE)
Yes		34	31.7	77.1 (8.7)
No		10	9.4	22.9 (8.7)
	Totals:	44	41.2	100.0

C3b. How satisfied were you with voice recognition for making selections from the 511 menu?

		Frequency	Weighted Frequency	Percent (SE)
Very satisfied		2	1.3	4.0 (2.8)
Somewhat satisfied		6	3.9	12.3 (5.2)
Neither satisfied nor dissatisfied		0	0.0	0.0 (0.0)
Somewhat dissatisfied		5	5.6	17.5 (9.3)
Very dissatisfied		21	21.0	66.3 (9.8)
	Totals:	34	31.7	100.0

C4. Considering all the calls you've made to 511, would you say the problems with voice recognition seem to happen only when you call from a cell phone, only when you call from a landline phone, or do the problems seem to happen when you call from either a cell phone or a landline?

		Frequency	Weighted Frequency	Percent (SE)
Only on a cell phone		71	66.5	62.2 (6.9)
Only on a landline phone		9	11.6	10.9 (4.2)
Both		23	28.8	26.9 (6.6)
	Totals:	103	106.9	100.0

C5. Do you experience problems with voice recognition when you use speakerphone or handsfree mode, when you are holding the receiver, or both ways?

	Frequency	Weighted Frequency	Percent (SE)
Speakerphone or hands free mode	8	6.5	6.1 (2.4)
Holding the receiver	73	73.6	69.3 (6.7)
Both	22	26.1	24.5 (6.6)
Totals:	103	106.2	100.0

D1. Have you used 511 to obtain road information in the past?

	Frequency	Weighted Frequency	Percent (SE)
Yes	44	49.1	99.2 (0.9)
No	1	0.4	0.8 (0.9)
Totals:	45	49.5	100.0

D2. How satisfied are you with the quality of 511's information on

D2a. Weather-related roadway conditions:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	66	73.6	37.6 (5.1)
Somewhat satisfied	44	49.6	25.3 (4.3)
Neither satisfied nor dissatisfied	64	62.0	31.7 (4.8)
Somewhat dissatisfied	4	3.0	1.5 (1.0)
Very dissatisfied	7	7.7	3.9 (1.6)
Totals:	185	196.0	100.0

D2b. Traffic incidents and accidents:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	94	97.7	38.4 (3.5)
Somewhat satisfied	86	90.5	35.6 (4.1)
Neither satisfied nor dissatisfied	28	31.9	12.5 (2.9)
Somewhat dissatisfied	20	25.5	10.0 (2.9)
Very dissatisfied	13	8.8	3.5 (1.1)
Totals:	241	254.5	100.0

D2c. Traffic congestion:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	95	100.0	41.5 (4.1)
Somewhat satisfied	81	86.7	36.0 (4.3)
Neither satisfied nor dissatisfied	27	34.0	14.1 (3.4)
Somewhat dissatisfied	16	13.2	5.5 (1.7)
Very dissatisfied	10	6.8	2.8 (1.0)
Totals:	229	240.8	100.0

D2d. Roadway construction projects:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	118	113.4	47.3 (3.9)
Somewhat satisfied	84	92.2	38.5 (4.1)
Neither satisfied nor dissatisfied	23	20.5	8.6 (2.1)
Somewhat dissatisfied	9	9.1	3.8 (1.5)
Very dissatisfied	4	4.4	1.8 (1.0)
Totals:	238	239.6	100.0

D2e. Quick reports providing regional summaries:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	45	43.5	24.3 (4.8)
Somewhat satisfied	37	39.1	21.8 (3.9)
Neither satisfied nor dissatisfied	77	82.8	46.3 (5.4)
Somewhat dissatisfied	6	8.7	4.9 (2.9)
Very dissatisfied	5	4.9	2.7 (1.4)
Totals:	170	179.0	100.0

D3. Have you used 511 to obtain bus information in the past?

	Frequency	Weighted Frequency	Percent (SE)
Yes	3	4.3	1.5 (1.1)
No	267	272.1	98.5 (1.1)
Totals:	270	276.4	100.0

D4. How satisfied are you with the quality of 511's information

D4a. On major bus service disruptions:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	3	4.5	84.7 (15.8)
Somewhat satisfied	1	0.8	15.3 (15.8)
Neither satisfied nor dissatisfied	0	0.0	0.0 (0.0)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	4	5.3	100.0

D4b. When you asked to be transferred to a bus agency for more information:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	0	0.0	0.0 (0.0)
Somewhat satisfied	1	0.8	18.9 (20.1)
Neither satisfied nor dissatisfied	2	3.5	81.1 (20.1)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	3	4.3	100.0

D5. Have you used 511 to obtain airport or tourism information in the past?

	Frequency	Weighted Frequency	Percent (SE)
Yes	8	5.9	2.1 (0.9)
No	263	271.6	97.9 (0.9)
Totals:	271	277.4	100.0

D6. How satisfied are you with the quality of 511's information on

D6a. Airport conditions:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	2	1.1	19.9 (14.0)
Somewhat satisfied	4	3.3	61.0 (20.3)
Neither satisfied nor dissatisfied	1	1.0	19.0 (17.1)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	7	5.4	100.0

D6b. The Grand Canyon:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	1	1.0	19.0 (17.1)
Somewhat satisfied	2	1.8	33.9 (22.5)
Neither satisfied nor dissatisfied	4	2.5	47.0 (21.4)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	7	5.4	100.0

D6c. Tourism information that is available by transfer to the Arizona Office of Tourism:

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	1	1.0	17.5 (15.8)
Somewhat satisfied	1	0.2	3.9 (4.1)
Neither satisfied nor dissatisfied	6	4.6	78.6 (16.1)
Somewhat dissatisfied	0	0.0	0.0 (0.0)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	8	5.9	100.0

E. Do you strongly agree, agree, are neutral, disagree, or strongly disagree that

E1a. The traffic information I get from 511 is accurate and timely:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	65	66.5	24.7 (3.7)
Agree	144	153.8	57.1 (4.3)
Neutral	11	11.1	4.1 (1.5)
Disagree	19	17	6.3 (1.8)
Strongly Disagree	13	8.8	3.3 (1.0)
Aspect Not Used	12	12.4	4.6 (2.0)
Totals:	264	269.5	100.0

E1b. 511 covers the areas and routes I'm interested in:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	131	130.6	47.3 (4.4)
Agree	129	138.4	50.1 (4.4)
Neutral	3	1.6	0.6 (0.4)
Disagree	3	2.2	0.8 (0.5)
Strongly Disagree	2	1.1	0.4 (0.3)
Aspect Not Used	1	2.3	0.8 (0.8)
Totals:	269	276.4	100.0

E1c. I prefer to get information on segments of roads, like I-10 from Phoenix to Tucson, rather than for an entire road, like all of I-10 in Arizona.

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	146	146.8	53.7 (4.5)
Agree	93	83.0	30.4 (3.6)
Neutral	7	17.2	6.3 (2.9)
Disagree	14	20.7	7.6 (2.6)
Strongly Disagree	4	2.5	0.9 (0.5)
Aspect Not Used	3	3.2	1.2 (0.9)
Totals:	267	273.4	100.0

E2a. 511 covers all of the bus services I'm interested in:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	1	0.6	10.9 (11.7)
Agree	1	0.8	15.3 (15.8)
Neutral	1	2.9	54.9 (28.8)
Disagree	0	0.0	0.0 (0.0)
Strongly Disagree	0	0.0	0.0 (0.0)
Aspect Not Used	1	1.0	18.9 (18.9)
Totals:	4	5.3	100.0

E2b. On 511 I can quickly get through to a live operator to help plan my trip:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	0	0.0	0.0 (0.0)
Agree	1	0.8	15.3 (15.8)
Neutral	0	0.0	0.0 (0.0)
Disagree	0	0.0	0.0 (0.0)
Strongly Disagree	1	0.6	10.9 (11.7)
Aspect Not Used	2	3.9	73.8 (20.6)
Totals:	4	5.3	100.0

E3a. It is easy to navigate through the 511 menu to get the information I need:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	76	80.1	29.1 (4.1)
Agree	118	115.5	41.9 (4.7)
Neutral	20	19.5	7.1 (2.0)
Disagree	33	31.1	11.3 (2.7)
Strongly Disagree	22	28.0	10.2 (2.8)
Aspect Not Used	1	1.2	0.4 (0.4)
Totals:	270	275.4	100.0

E3b. I am more likely to take the bus due to information on 511:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	1	0.6	0.2 (0.2)
Agree	9	9.1	3.3 (1.3)
Neutral	10	7.2	2.6 (1.1)
Disagree	87	91.9	33.5 (3.9)
Strongly Disagree	64	61.6	22.4 (3.4)
Aspect Not Used	96	104.3	38.0 (3.9)
Totals:	267	274.6	100.0

E3c. I call 511 most often when the weather is bad:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	28	27.4	9.9 (2.6)
Agree	38	47.7	17.2 (3.1)
Neutral	22	18.4	6.7 (1.8)
Disagree	127	130.7	47.2 (4.2)
Strongly Disagree	28	25.8	9.3 (2.0)
Aspect Not Used	27	26.8	9.7 (2.0)
Totals:	270	276.8	100.0

E3d. I am able to get through to 511 without any busy signals:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	165	165.1	59.5 (4.3)
Agree	105	111.8	40.3 (4.3)
Neutral	0	0.0	0.0 (0.0)
Disagree	1	0.6	0.2 (0.2)
Strongly Disagree	0	0.0	0.0 (0.0)
Aspect Not Used	0	0.0	0.0 (0.0)
Totals:	271	277.4	100.0

E3e. I can easily understand the information on 511:

	Frequency	Weighted Frequency	Percent (SE)
Strongly agree	112	116.2	42.2 (4.3)
Agree	140	141.9	51.6 (4.2)
Neutral	7	6.1	2.2 (1.1)
Disagree	7	9.1	3.3 (1.5)
Strongly Disagree	4	1.8	0.7 (0.3)
Aspect Not Used	0	0.0	0.0 (0.0)
Totals:	270	275.1	100.0

F1. What benefits, if any, have you obtained by using 511?

	Frequency	Weighted Frequency	Percent (SE)
Able to change routes*	37	39.3	14.9 (3.1)
Able to receive current road/weather information*	85	85.7	32.6 (4.0)
Helped save on travel time*	54	54.1	20.5 (3.9)
Able to avoid traffic congestions due to accidents/construction*	48	51.6	19.6 (3.7)
None*	17	17.3	6.6 (2.1)
Satisfied – no special benefit*	1	0.4	0.2 (0.2)
More relaxing/easier travel*	6	3.1	1.2 (0.5)
Other*	12	11.8	4.5 (1.7)
*write-in category Totals:	260	263.2	100.0

F2. Please rate each potential improvement as high, medium, or low priority.

F2a. Improvements to the speech recognition feature:

	Frequency	Weighted Frequency	Percent (SE)
High	185	200.0	72.3 (3.5)
Medium	41	35.4	12.8 (2.4)
Low	43	41.2	14.9 (2.8)
Totals:	269	276.6	100.0

F2b. Adding more roads that currently aren't covered:

	Frequency	Weighted Frequency	Percent (SE)
High	73	63.2	24.1 (3.4)
Medium	92	97.7	37.3 (4.3)
Low	97	101.1	38.6 (4.1)
Totals:	262	262.0	100.0

F2c. Providing information on when a bus will arrive at a particular stop:

	Frequency	Weighted Frequency	Percent (SE)
High	21	18.3	7.3 (2.0)
Medium	28	23.9	9.5 (2.2)
Low	206	209.9	83.3 (2.6)
Totals:	255	252.1	100.0

F2d. Providing information on roads in neighboring states:

	Frequency	Weighted Frequency	Percent (SE)
High	49	44.0	16.6 (3.0)
Medium	71	72.8	27.4 (3.6)
Low	144	148.8	56.0 (3.7)
Totals:	264	265.6	100.0

F2e. Providing more detailed information on general traffic congestion levels and delays:

	Frequency	Weighted Frequency	Percent (SE)
High	188	182.2	65.8 (4.0)
Medium	64	69.6	25.1 (3.8)
Low	18	25.1	9.1 (2.8)
Totals:	270	276.9	100.0

F2f. Is there anything more you would like to add to the list of potential improvements?

	Frequency	Weighted Frequency	Percent (SE)
Yes	97	97.7	35.2 (4.2)
No	174	179.7	64.8 (4.2)
Totals:	271	277.4	100.0

F2f. Suggested potential improvements:

	Frequency	Weighted Frequency	Percent (SE)
Menu-related*	9	8.4	8.6 (3.9)
Information on road/traffic conditions*	35	33.9	34.8 (7.0)
Road segment and road names*	6	5.3	5.5 (2.4)
User interface*	25	26.0	26.7 (5.8)
Coverage of more roads*	4	2.6	2.6 (1.4)
Ability to access live person*	3	3.2	3.3 (2.0)
New content*	2	0.9	0.9 (0.8)
Add website*	2	1.6	1.7 (1.2)
Other*	10	15.4	15.8 (6.2)
*write-in category Totals:	96	97.4	100.0

F2f1. In your opinion, should that be high, medium, or low priority change for the 511 system?

	Frequency	Weighted Frequency	Percent (SE)
High priority	86	82.9	84.8 (5.2)
Medium priority	11	14.8	15.2 (5.2)
Low priority	0	0.0	0.0 (0.0)
Totals:	97	97.7	100.0

F3. Are you likely to phone 511 again?

	Frequency	Weighted Frequency	Percent (SE)
Yes	262	269.8	97.6 (1.1)
No	8	6.6	2.4 (1.1)
Totals:	270	276.4	100.0

F4. Would you recommend 511 to a friend?

	Frequency	Weighted Frequency	Percent (SE)
Yes	260	266.0	96.2 (1.5)
No	10	10.4	3.8 (1.5)
Totals:	270	276.4	100.0

F5a. Have you used radio traffic reports as a source of travel information?

	Frequency	Weighted Frequency	Percent (SE)
Yes	193	198.4	71.6 (4.0)
No	77	78.6	28.4 (4.0)
Totals:	270	277.0	100.0

F5b. How many times per month do you use radio traffic reports as a source of travel information?

	Frequency	Weighted Frequency	Percent (SE)
1-10	85	85.5	44.7 (5.5)
11-20	39	41.8	21.8 (4.2)
21-30	50	53.7	28.1 (5.0)
>30	14	10.4	5.4 (1.6)
Totals:	188	191.3	100.0

F5c. Do you think the quality of information provided in radio traffic reports is much better than 511's information, somewhat better, about the same as 511, somewhat worse, or much worse than 511?

	Frequency	Weighted Frequency	Percent (SE)
Much better than 511	18	14.7	5.9 (1.6)
Better than 511	43	44.7	17.8 (3.8)
About the same as 511	66	60.9	24.3 (4.0)
Worse than 511	58	63.9	25.5 (3.9)
Much worse than 511	24	28.1	11.2 (3.1)
Have never used	32	38.5	15.4 (3.7)
Totals:	241	250.8	100.0

G1. Gender of respondent.

	Frequency	Weighted Frequency	Percent (SE)
Male	137	144.3	52.0 (4.1)
Female	134	133.1	48.0 (4.1)
Totals:	271	277.4	100.0

G2. What is your age?

	Frequency	Weighted Frequency	Percent (SE)
18 to 24	29	25.9	9.4 (2.6)
25 to 34	63	76.8	27.9 (3.8)
35 to 49	116	111.1	40.4 (3.8)
50 to 64	51	55.9	20.3 (3.4)
65 and over	9	5.1	1.9 (0.7)
Totals:	268	274.8	100.0

G3. What is the highest grade of school or year of college you completed?

	Frequency	Weighted Frequency	Percent (SE)
Less than HS grad	2	2.0	0.7 (0.6)
HS graduate	62	62.2	22.6 (3.8)
At least two full years of college	81	84.3	30.6 (3.3)
Bachelor degree	83	86.9	31.6 (4.2)
Postgraduate degree	40	39.9	14.5 (3.0)
Totals:	268	275.3	100.0

G4. What was your family income from all sources before taxes during the last twelve months?

	Frequency	Weighted Frequency	Percent (SE)
Less than $14,999	11	12.7	5.4 (2.3)
$15,000 to $24,999	7	4.9	2.1 (0.9)
$25,001 to $39,999	32	34.0	14.4 (3.5)
$40,000 to $59,999	57	63.8	27.0 (3.1)
$60,000 to $99,999	72	87.4	37.0 (4.1)
$100,000 and over	46	33.6	14.2 (2.4)
Totals:	225	236.4	100.0

G4a. Could you tell me if your total annual household income above or below $50,000?

	Frequency	Weighted Frequency	Percent (SE)
Below	7	4.3	20.0 (7.9)
Above	16	17.1	80.0 (7.9)
Totals:	23	21.3	100.0

G5. What is the zip code where you currently reside?*

	Frequency	Weighted Frequency	Percent (SE)
Out of state	6	5.4	2.0 (0.9)
Phoenix metro area	226	230.6	84.8 (3.3)
Tucson metro area	2	1.1	0.4 (0.3)
Other part of Arizona	32	35.0	12.9 (3.2)
*zip codes grouped into specific geographical areas Totals:	266	272.1	100.0

Questions XC1 through XG5 were asked only of first-time callers.

XC1. Did you speak to the 511 service to select menu options, or did you use the buttons on your phone to make your selections?

	Frequency	Weighted Frequency	Percent (SE)
Voice recognition	82	80.6	62.3 (5.3)
Phone buttons	37	32.1	24.8 (4.6)
Both	17	16.7	12.9 (3.8)
Totals:	136	129.3	100.0

XC2. In general, how satisfied were you with [method used] for making selections from the 511 menus?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	42	39.9	31.0 (4.8)
Somewhat satisfied	33	30.9	24.0 (4.9)
Neither satisfied nor dissatisfied	6	4.2	3.2 (1.4)
Somewhat dissatisfied	20	18.5	14.4 (3.8)
Very dissatisfied	34	35.4	27.5 (5.3)
Totals:	135	128.8	100.0

XC2a. In general, how satisfied were you with the phone buttons for making selections from the 511 menus?

	Frequency	Weighted Frequency	Percent (SE)
Very satisfied	10	6.4	38.6 (13.7)
Somewhat satisfied	5	5.7	34.4 (15.3)
Neither satisfied nor dissatisfied	0	0.0	0.0 (0.0)
Somewhat dissatisfied	2	4.5	27.0 (17.1)
Very dissatisfied	0	0.0	0.0 (0.0)
Totals:	17	16.7	100.0

XC3Voice. Why were you dissatisfied with the voice recognition feature?

	Frequency	Weighted Frequency	Percent (SE)
Did not understand request*	25	28.1	55.2 (9.1)
Gave wrong information*	15	16.0	31.6 (9.0)
Background noise interferes*	2	1.1	2.2 (1.7)
Wanted option to speak to live person*	0	0.0	0.0 (0.0)
Poor menu options*	2	1.3	2.5 (1.8)
Other*	6	4.3	8.5 (3.8)
*write-in category Totals:	50	50.9	100.0

XC4. Our records indicate that you were calling from a [cell phone / landline phone]. **Is that correct?**

	Frequency	Weighted Frequency	Percent (SE)
Yes	35	41.5	87.3 (4.2)
No	11	6.0	12.7 (4.2)
Totals:	46	47.5	100.0

XC5. Did you experience the problem when you were using a speakerphone or hands free mode, when you are holding the receiver or both ways?

	Frequency	Weighted Frequency	Percent (SE)
Speakerphone or hands free mode	1	1.0	2.1 (2.1)
Holding the receiver	38	37.2	82.0 (9.8)
Both	3	7.2	15.9 (9.8)
Totals:	42	45.3	100.0

XF1. What benefits, if any, have you obtained by using 511?

	Frequency	Weighted Frequency	Percent (SE)
Able to change routes*	4	6.1	4.9 (2.9)
Able to receive current road/weather information*	31	35.2	28.4 (5.4)
Helped save on travel time*	9	7.1	5.8 (2.0)
Able to avoid traffic congestions due to accidents/construction*	4	2.3	1.9 (1.0)
None*	47	38.8	31.3 (4.9)
Satisfied – no special benefit*	16	12.1	9.8 (2.6)
More relaxing/easier travel*	5	3.7	3.0 (1.4)
Other*	18	18.5	15.0 (4.0)
*write-in category Totals:	134	123.8	100.0

XF2. Please rate each potential improvement as high, medium, or low priority.

XF2a. Improvements to the speech recognition feature.

	Frequency	Weighted Frequency	Percent (SE)
High	77	75.9	60.0 (5.0)
Medium	27	24.2	19.1 (3.6)
Low	25	26.3	20.8 (4.1)
Totals:	129	126.4	100.0

XF2b. Adding more roads that currently aren't covered.

	Frequency	Weighted Frequency	Percent (SE)
High	63	60.5	51.6 (5.8)
Medium	38	40.1	34.2 (5.7)
Low	21	16.6	14.2 (3.4)
Totals:	122	117.3	100.0

XF2c. Providing information on when a bus will arrive at a particular stop.

	Frequency	Weighted Frequency	Percent (SE)
High	14	13.3	11.1 (2.4)
Medium	18	17.3	14.4 (3.9)
Low	94	89.7	74.5 (4.5)
Totals:	126	120.4	100.0

XF2d. Providing information on roads in neighboring states.

	Frequency	Weighted Frequency	Percent (SE)
High	33	26.2	21.0 (4.6)
Medium	35	33.6	27.0 (4.8)
Low	64	64.9	52.0 (5.6)
Totals:	132	124.7	100.0

XF2e. Providing more detailed information on general traffic congestion levels and delays.

	Frequency	Weighted Frequency	Percent (SE)
High	75	70.2	55.8 (5.8)
Medium	46	44.5	35.3 (5.4)
Low	11	11.2	8.9 (3.4)
Totals:	132	125.9	100.0

XF2f. Is there anything more you would like to add to the list of potential improvements?

	Frequency	Weighted Frequency	Percent (SE)
Yes	53	54.4	40.8 (5.8)
No	87	79.1	59.2 (5.8)
Totals:	140	133.6	100.0

XF2f. Suggested potential improvements:

		Frequency	Weighted Frequency	Percent (SE)
Menu-related*		8	9.8	18.0 (6.9)
Information on road/traffic conditions*		9	8.0	14.7 (6.1)
Road segment and road names*		4	6.2	11.4 (6.1)
User interface*		4	7.0	12.9 (8.3)
Coverage of more roads*		1	0.6	1.2 (1.2)
Ability to access live person*		14	13.4	24.5 (7.0)
New content*		4	3.0	5.5 (2.7)
Add website*		1	0.6	1.1 (1.2)
Other*		8	5.9	10.8 (4.1)
*write-in category	Totals:	53	54.5	100.0

XF2f1. In your opinion, should that be high, medium, or low priority change for the 511 system?

		Frequency	Weighted Frequency	Percent (SE)
High priority		51	53.3	97.7 (1.7)
Medium priority		2	1.3	2.3 (1.7)
Low priority		0	0.0	0.0 (0.0)
	Totals:	53	54.5	100.0

XF3. Are you likely to phone 511 again?

		Frequency	Weighted Frequency	Percent (SE)
Yes		129	126.5	94.7 (1.7)
No		11	7.1	5.3 (1.7)
	Totals:	140	133.6	100.0

XF4. Would you recommend 511 to a friend?

		Frequency	Weighted Frequency	Percent (SE)
Yes		122	119.6	90.5 (3.1)
No		16	12.5	9.5 (3.1)
	Totals:	138	132.0	100.0

XF5a. Have you used radio traffic reports as a source of travel information?

	Frequency	Weighted Frequency	Percent (SE)
Yes	73	69.8	52.6 (5.9)
No	66	63.0	47.4 (5.9)
Totals:	139	132.8	100.0

XF5b. How many times per month do you use radio traffic reports as a source of travel information?

	Frequency	Weighted Frequency	Percent (SE)
1-10	42	38.9	57.7 (7.8)
11-20	9	15.2	22.6 (8.1)
21-30	15	10.0	14.8 (4.1)
>30	4	3.3	4.9 (2.5)
Totals:	70	67.5	100.0

XF5c. Do you think the quality of information provided in radio traffic reports is much better than 511's information, somewhat better, about the same as 511, somewhat worse, or much worse than 511?

	Frequency	Weighted Frequency	Percent (SE)
Much better than 511	6	5.2	4.5 (1.9)
Better than 511	17	13.8	12.1 (3.8)
About the same as 511	38	37.8	33.2 (5.4)
Worse than 511	17	17.9	15.7 (4.4)
Much worse than 511	5	4.6	4.0 (2.0)
Totals:	114	113.8	100.0

XG1. Gender of Respondent

	Frequency	Weighted Frequency	Percent (SE)
Male	73	71.5	53.5 (5.5)
Female	67	62.1	46.5 (5.5)
Totals:	140	133.6	100.0

XG2. What is your age?

	Frequency	Weighted Frequency	Percent (SE)
18-24	12	13.5	10.1 (3.3)
25-34	22	18.5	13.9 (3.5)
35-49	36	33.0	24.8 (4.7)
50-64	38	36.6	27.5 (4.9)
65 and over	31	31.4	23.6 (4.5)
Totals:	139	133.0	100.0

XG3. What is the highest grade of school or year of college you completed?

	Frequency	Weighted Frequency	Percent (SE)
Less than HS grad	4	5.5	4.1 (2.4)
HS graduate	42	40.6	30.8 (4.8)
At least two full years of college	32	34.2	25.9 (5.2)
Bachelor degree	47	42.1	31.9 (5.2)
Postgraduate degree	13	9.6	7.2 (2.1)
Totals:	138	131.9	100.0

XG4. What was your family income from all sources before taxes during the last twelve months?

	Frequency	Weighted Frequency	Percent (SE)
Less than $14,999	16	15.8	15.0 (4.1)
$15,000 to $24,999	7	6.6	6.3 (2.8)
$25,001 to $39,999	20	20.8	19.8 (5.0)
$40,000 to $59,999	30	20.1	19.2 (3.9)
$60,000 to $99,999	18	18.9	18.0 (5.4)
$100,000 and over	23	22.7	21.6 (5.4)
Totals:	114	105.0	100.0

XG4a. Could you tell me if your total annual household income above or below $50,000?

	Frequency	Weighted Frequency	Percent (SE)
Below	5	9.2	79.8 (12.6)
Above	3	2.3	20.2 (12.6)
Totals:	8	11.6	100.0

XG5. What is the zip code where you currently reside?*

		Frequency	Weighted Frequency	Percent (SE)
Out of state		28	29.7	22.7 (5.2)
Phoenix metro area		69	63.0	48.2 (5.9)
Tucson metro area		7	8.1	6.2 (2.8)
Other part of Arizona		33	30.1	23.0 (4.4)
*zip codes grouped into specific geographical areas	Totals:	137	130.9	100.0