Technical Report Documentation Page

1. REPORT No.
FHWA/CA/OR-96/30

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Feasibility of Intelligent Transportation System Applications in Rural California
Final Report

5. REPORT DATE
February, 1997

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
Stephen Albert
Patrick McGowen

8. PERFORMING ORGANIZATION REPORT No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Western Transportation Institute
208 Cobleigh Hall
Montana State University
Bozeman, Montana 59717

10. WORK UNIT No.

11. CONTRACT OR GRANT No.
65W692

12. SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
New Technology and Research Program
1227 O Street. 5th Floor

13. TYPE OF REPORT & PERIOD COVERED
Final Report Jan. 1995- Feb. 1997

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Research performed in cooperation with the California Department of Transportation and the U.S. Department Transportation, Federal Highway Administration.

16. ABSTRACT
The purpose of this report was to provide the California Department of Transportation direction for the Program for Advancing Rural Transportation Technologies (PARTT), which is the rural component of the Advanced Transportation Systems Program. This report contains prioritized stakeholder input on problems and advanced technology solutions, based on a workshop conducted in Bishop, CA. The report also examines potential Advanced Rural Transportation System applications in northern California. the study recommends short term and long term deployment strategies; research and development; funding opportunities; and next steps to build a successful Intelligent Transportation System that meets stakeholder needs.

17. KEYWORDS
Rural, Intelligent Transportation Systems, Advanced Rural Transportation Systems, Research, Stakeholder Needs

18. No. OF PAGES:
64

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1997-2001/intelligent.pdf

20. FILE NAME
intelligent.pdf

1. Report No. FHWA/CA/OR-96/30	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **Feasibility of Intelligent Transportation System Applications in Rural California** **Final Report** **Program for Advancing Rural Transportation Technologies**		5. Report Date **February, 1997** 6. Performing Organization Code
7. Author(s) **Stephen Albert** **Patrick McGowen**		8. Performing Organization Report No.
9. Performing Organization Name and Address **Western Transportation Institute** **208 Cobleigh Hall** **Montana State University** **Bozeman, Montana 59717**		10. Work Unit No. (TRAIS) 11. Contract or Grant No. **65W692**
12. Sponsoring Agency Name and Address **California Department of Transportation** **New Technology and Research Program** **1227 O Street, 5th Floor** **Sacramento, California 95814**		13. Type of Report and Period Covered **Final Report** **Jan. 1995 - Feb. 1997** 14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the California Department of Transportation and the U.S. Department Transportation, Federal Highway Administration.

16. Abstract

The purpose of this report was to provide the California Department of Transportation direction for the Program for Advancing Rural Transportation Technologies (PARTT), which is the rural component of the Advanced Transportation Systems Program. This report contains prioritized stakeholder input on problems and advanced technology solutions, based on a workshop conducted in Bishop, CA. The report also examines potential Advanced Rural Transportation System applications in northern California. The study recommends short term and long term deployment strategies; research and development; funding opportunities; and next steps to build a successful Intelligent Transportation System that meets stakeholder needs.

17. Key Words	18. Distribution Statement
Rural, Intelligent Transportation Systems, Advanced Rural Transportation Systems, Research, Stakeholder Needs,	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	51	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

1. Executive Summary

1.1 Introduction

In an effort to improve the efficiency, safety, and mobility of California's transportation system, the Advanced Transportation Systems program was developed to provide innovative solutions to existing transportation problems. In 1992, a rural component to this program was initiated by the California Department of Transportation (Caltrans). This rural program was designed to examine rural concerns with respect to Advanced Transportation Systems and was entitled Program for Advancing Rural Transportation Technologies (PARTT). The importance of PARTT in investigating rural concerns is evident when considering the following national and state rural statistics:

- Rural roads constitute 80% of the national road miles(1) (52% in California).(2)
- While a majority of the road miles are rural, only 40% of the national vehicle miles traveled occurs on rural roads(1) (19% in California).(2)
- 58% of the fatalities caused by automobile accidents occur within this small portion of the vehicle miles traveled(1) (53% in California).(2)
- Emergency response time in rural areas is almost double that of urban areas in California and nationally.(3)

Nationally, rural roads typically also have:

- 150 miles average trip length(4);
- 78% travelers on pleasure trip(2);
- Higher average age driving population than urban centers(5);
- More difficult terrain and changing weather conditions;
- 66% of rural communities have little or no transit service(4);
- 1 in 9 households are without a private vehicle(4);
- Commercial vehicles are essential to economic development;
- Substandard alignment due to limited funding;
- Long, isolated areas with limited services;
- Large number of recreational areas mixing unfamiliar motorists with commuter and truck traffic; and
- Sparse populations.

The purpose of this report was to broadly view the transportation needs and concerns of California's rural transportation systems; identify possible advanced transportation technologies to enhance the safety and efficiency of those systems; review national and California rural research initiatives; identify key issues and potential funding opportunities; and recommend conceptual ideas for further activities. The goal of this project is to provide background for building a successful Intelligent Transportation Systems (ITS) program that meets stakeholder needs.

1.2 Stakeholder Needs

In order to determine rural stakeholder needs a pilot workshop was conducted at the Caltrans District 9 office in Bishop, California. The stakeholder outreach effort consisted of a stakeholder workshop and several mailings, through which stakeholders were educated and transportation problems and solutions were identified and prioritized. At this workshop approximately 17 persons representing 7 stakeholder groups were in attendance. Each problem and solution was rated from one to five (1=unfeasible solution/no problem, 5=very viable solution/severe problem). Based on results of the workshop the most significant problems and solutions identified by stakeholders were as follows:

Problems	Rating
• Lack of funding for rural areas	4.2
• Speed related accidents	3.6
• Long emergency response time in isolated areas	3.5
• Weather and related safety problems with commercial vehicles	3.4

Solutions	Rating
• Improve cellular coverage (to improve mayday applications)	4.0
• Make local road conditions available through cellular phones	4.0
• Real time traveler and advisory information made available	3.9
• Tourist information available at rest stops and on the Internet	3.9

As seen by the solutions identified, stakeholders are most interested in low tech applications in the areas of mayday, travel advisory and traveler information. Additional applications identified by stakeholders include; call boxes, vision enhancement, speed reducing measures, other traveler information and advisory applications, public transit applications, and hazardous materials incident response.

It should be noted only 27% of the invited stakeholders and 17% of the invited stakeholder groups attended the workshop. The workshop was considered a pilot to assist Caltrans in determining how to best solicit input.

1.3 Recommendations

Based on stakeholder input, and nationally identified rural ITS technologies several rural ITS applications were reviewed. For each ITS application this report gives; a description, potential benefits, and possible locations for deployment of demonstration. Based on limited stakeholder input and accident data analyzed, it is the opinion of research staff that the following applications may have the greatest possibility for success in rural California:

- Impaired driver monitoring;
- Safe speed warning;
- Automated speed enforcement;
- Mayday (expanding cellular coverage or satellite);
- Tourist and traveler information supplemented with weather information;
- Rural door-to-door transit initiative;

- Fleet operations and maintenance;
- Commercial vehicle fleet management;
- Commercial vehicle automated safety inspection; and
- Commercial vehicle administrative process.

The applications identified in this report that received second priority by the research staff as having a high probability for success are:

- Vision Enhancement;
- Object in the roadway warning;
- Call boxes;
- Commercial vehicle electronic clearance;
- Commercial vehicle onboard safety inspection; and
- Hazardous materials incident response.

The following recommendations result from this review and funding alternatives identified in this report.

As a result of the findings of PARTT and the pilot Stakeholder Workshop, it is recommended that Caltrans pursue the selection of a rural area to further refine the need and potential application of ITS. The northern California geographical area from SR 36 on the south to the Oregon border and from US 101 on the west to US 395 should be considered as a potential study area. This area is characterized by low volume roads, national and state parks, poor weather, long distances, poor alignment and many other attributes exemplifying rural areas in California.

Based on cursory benefit analysis, limited stakeholder feedback, and Caltrans supplied data, the following short-and long-term research and deployment recommendations are provided. These recommendations are prioritized based on their potential for building a successful ITS program and meeting stakeholder needs.

Short-Term Deployment

Short-term deployment is vital to building support for continued ITS deployment activity in rural California because it will allow the public to realize an early return on their investment . Short-term deployment for this report can be defined as less than five year. Short-term deployment recommendations have been arrayed based on the Advanced Rural Transportation System (ARTS) Critical Program Areas (as identified by the ARTS draft strategic plan) to show parallel between National and California initiatives. For each short-term applications, potentially beneficial areas were identified by research staff and are shown in Figure i.

Traveler Safety and Security

A Traveler Safety and Security project would include two applications (safe speed warning system and automated speed enforcement). Either application may have the potential to reduce the number of speed related accidents.

The safe speed warning system shows great potential and is already used by Colorado and Oregon. The basic system components include a road surface sensor, vehicle sensor, a processor,

and a variable message sign. These systems are generally stand alone and appear to have a comparatively low cost.

Automated safety enforcement systems have the potential to reduce speed related accidents and save enforcement resources. Automated speed enforcement is also relatively low cost, with potentially high benefits, and previously tested.

Emergency Services
Based on the results of the TransCal demonstration which uses satellite communications, widespread deployment efforts should be considered. A second alternative preferred by stakeholders would be the expansion of cellular coverage to allow the use of cellular based mayday. Many rural areas do not have cellular coverage from cellular phone providers. Cellular coverage providers, most likely, will not expand without subsidized funding in these rural areas because of the lack of market potential. The benefits of expanding cellular coverage in rural areas, if proven to be large enough, may afford the subsidizing of expansion.

Tourism and Traveler Information Services
Tourism and travel information systems supplemented with weather and road conditions show a potential benefit to enhance the tourism economy and increase both commuter and recreational driver comfort. In addition, safety benefits may be realized by more informed drivers. To provide for sustainable funding levels, Caltrans should consider advertising as a means to finance the systems. The system could include:

- Internet information. This is a low cost method of providing information for an entire area.
- Touch screen information kiosks at roadside tourist stops. The Yosemite Area Traveler Information Project (YATI), for example, could be patterned as a self supporting system with initial seed capital from state and federal sources.

Public Traveler/ Mobility Services
Caltrans should consider a rural door-to door transit initiative where computer software is used for fleet management, scheduling and routing, and reservations. An additional option could include automatic vehicle location (AVL) system which are integrated with the scheduling and routing software for better fleet management. From the limited stakeholder feedback, the AVL was not a preferred solution; but computer software programs for more efficient management received a high stakeholder ranking.

Fleet Operations and Maintenance
There are many ways in which infrastructure operations and maintenance could be made more efficient. Examples include a remote weather monitoring system to aid in a more efficient deployment of snow plows. In addition robotics for roadwork such as garbage pickup and striping continue to be developed and should be considered for the maintenance of the rural transportation infrastructure. These robotics can improve maintenance safety and efficiency

Commercial Vehicle Operations
Short term commercial vehicle automated safety inspection applications may be implemented at existing weigh stations in rural California. Such applications include the automated brake

adjustment system using video imaging as described in an Automated Roadside Inspection Feasibility Study.(6) This system allows the safety inspector to visually inspect the brakes through video cameras mounted in the scale while the truck is weighed. This and similar applications could be demonstrated at one safety inspection station and, pending results of demonstration, could be deployed throughout rural California.

Long-Term Deployment

Long-term deployment can be defined as applications that: require greater than five years; are potentially beyond the role and responsibility of Caltrans; or require further study on detailing the benefits. For each long-term applications, potentially beneficial areas were identified by research staff and are shown in Figure ii.

Traveler Safety and Security

Driver monitoring system design can be complex and may be more applicable to vehicle manufacturers. This application is being recommended for long-term deployment because additional research may be required to ensure a beneficial system design.

Tourism and Traveler Information Services

The tourist information systems that may be more appropriate for longer term deployment include in-vehicle and portable hand held devices. These applications may be less cost effective because only one person may use the device as opposed to other systems, such as kiosks, were a greater number of persons can access the device. However, for long-term applications, Caltrans may wish to investigate the use of such device to test the benefits of such a system. The portable digital assistant could be rented, or loaned to tourists for their trip at welcome centers or other locations that tourist frequent. These devices may be able to tap into existing databases developed for the early deployment tourist information.

Fleet Operations and Maintenance

For long term deployment, Caltrans should consider continued commercial vehicle fleet management outreach and education. While fleet operations and maintenance ITS applications are proven, technologically feasible and beneficial, the implementation of these systems is carrier dependent. The potential benefit to society through reduced cost of shipping may warrant an outreach effort to the carriers detailing potential system designs, and estimated costs and benefits.

Also, for long-term deployment, Caltrans should consider improvement to commercial vehicle administrative processes. The benefits of electronic purchase of credentials and similar applications to the State and carriers could be significant. Also, this application requires major cooperation, restructuring of existing paperwork processes and coordination of public and private sector organizations. Unlike many of the other projects discussed that can be deployed in specific locations, this application requires statewide deployment to realize the benefits.

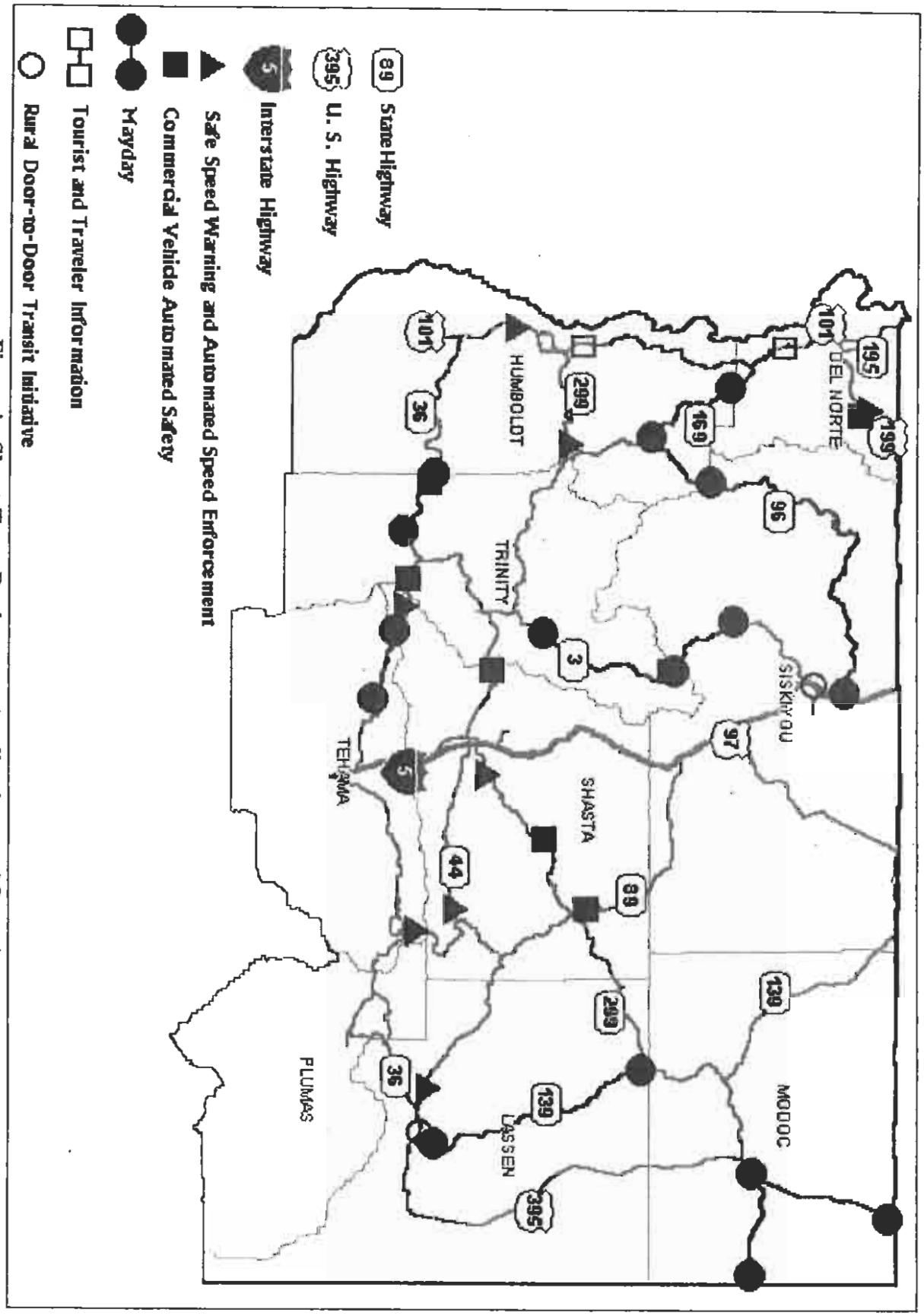

Figure i - Short-Term Deployment Applications and Locations

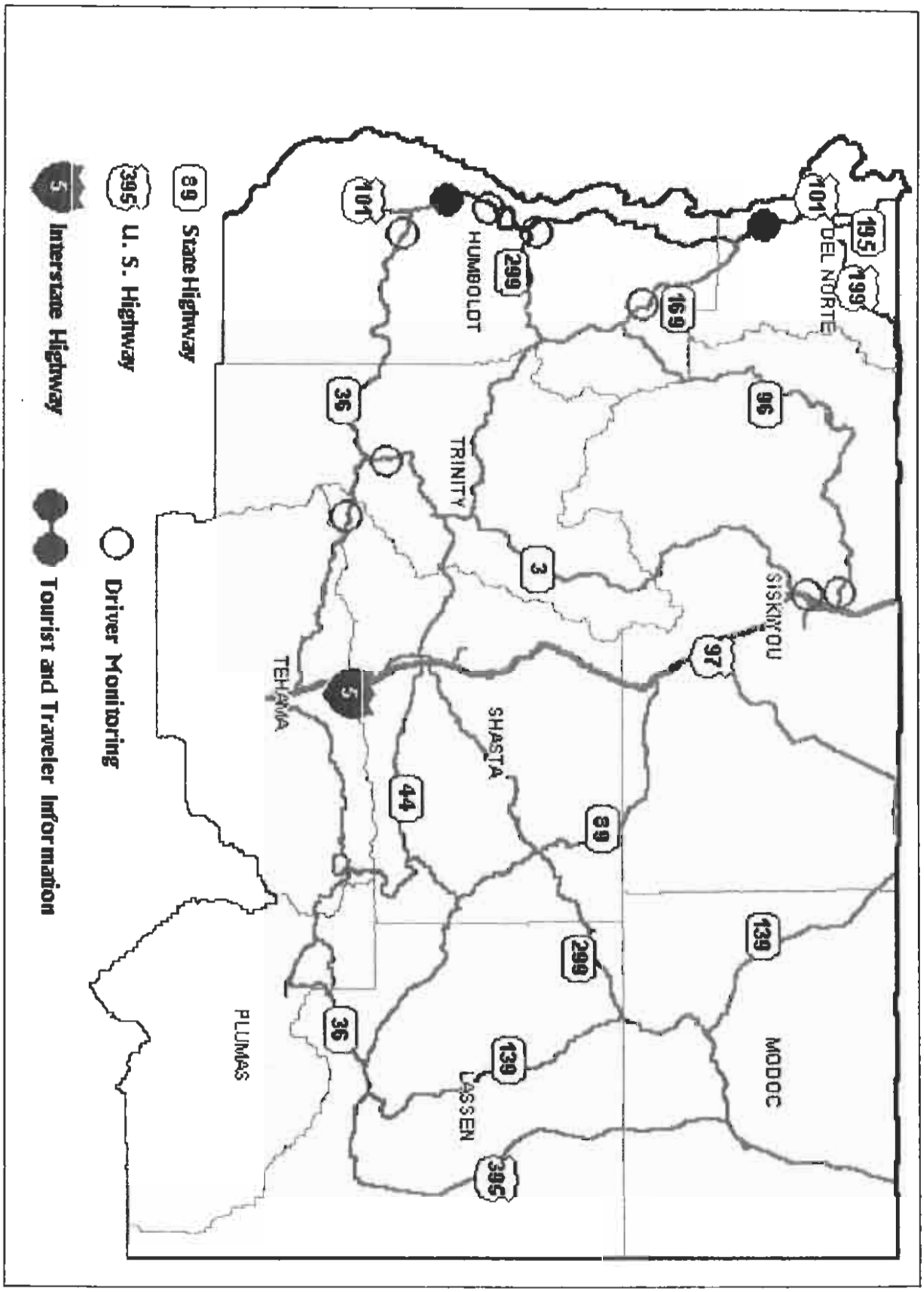

Figure ii - Long-Term Deployment Applications and Locations

Research Initiatives

Based on stakeholder needs, the problem/solution identification in this report and the Intelligent Transportation Society of America (ITSA) Advanced Rural Transportation Systems (ARTS) Committee, Rural Research Sub-Committee, the following research projects have been identified and recommended for continued research. These research and demonstration areas are listed below.

Institutional Issues and Outreach

- Develop an effective outreach program to educate rural stakeholders and to generate a constituency for ITS in rural and small urban areas.
- Research ways to overcome institutional barriers (funding, jurisdictional authority, etc.).

Communication Infrastructure

- Evaluate communication alternatives to enhance area wide coverage in rural environments.

Standards and Protocols

- Identify major rural considerations for the ITS national architecture.
- Evaluate short range communications.

Economic Viability

- Evaluate the impact of traveler information on economic development.
- Perform market research analysis of in-vehicle and portable tourist information systems to determine feasibility.

1.4 Next Steps

While the previous section recommended deployment phasing, the Western Transportation Institute (WTI) realizes that other efforts to assist deployment could be initiated immediately. These next steps relate to outreach, funding, further analysis and deployment prioritization.

Rural ITS Outreach

WTI has organized and conducted a rural ITS workshop in Bishop, CA that determined stakeholder problems and probable solutions. While this workshop was beneficial in educating and facilitating discussion on Advanced Rural Transportation Systems (ARTS), WTI recommends:

1) Revisit the Bishop site and increase the number of stakeholders and groups represented for a broader more significant sampling;
2) Conduct a similar outreach effort in Northern California (Caltrans District 1 and 2) to discuss problems and provide for ARTS education and facilitation; and
3) Present report findings to Districts 1, 2 and 9 of Caltrans and appropriate area stakeholders to determine appropriate prioritization of needs, and ITS route specific improvements.

Funding Opportunities

In the near future, the Federal Highway Administration (FHWA) will be requesting responses to solicitations on two operational test projects. The first operational test includes Tourism and Advanced Traveler Information Systems (ATIS), and the second, Road Weather Information Systems and ATIS. The national solicitations would provide Caltrans an opportunity to leverage state funding to obtain federal dollars for meeting the needs of rural California stakeholders and build on the recommendations of this report.

It is anticipated that in the Spring 1997, the Federal Highway Administration will be requesting responses to solicitations on two national operational test projects. The first operational test includes Tourism and Advanced Traveler Information Systems (ATIS), and the second, Road Weather Information Systems and ATIS. The national solicitations could provide Caltrans an opportunity to leverage state funding to obtain federal dollars for meeting the needs of rural California stakeholders, and build on the recommendations of this report. In addition to FHWA, federal funding opportunities exist within the Federal Transit Administration. Providing a consensus of problems and solutions that meet local needs and parallel national objectives, positions California well for this money.

Prioritization

While this report has recommended possible benefits that may be realized from deployment of ARTS, it was beyond the scope of the study to conduct any detailed cost/benefit analysis. It is recommended that a strategic plan be developed to direct the research, demonstration and deployment of ITS in rural California. Before a detailed deployment plan can be implemented the following actions should be considered:

- Form a regional steering committee to provide policy direction, goals and objectives;
- Estimate cost for each application including capital installation, operation and maintenance, and life cycle requirements;
- Prepare a business plan that details immediate, short term and long term deployment actions and benefits;
- Obtain stakeholder consensus on the business plan and deployment prioritization; and
- Secure public (federal, state, local) and private sector funding.

Table of Contents

List of Tables

List of Figures

Disclosure Section

This study is sponsored by the California Department of Transportation, New Technology and Research Program, in cooperation with the Federal Highway Administration. The major objective of this study is to examine and make recommendations regarding the Caltrans Program for Advancing Rural Transportation Technologies, which is the rural portion of the Advanced Transportation Systems Program. Recommendations will be made based on a cursory benefit analysis and stakeholder needs assessment.

Disclaimer Statement

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the STATE OF CALIFORNIA or the FEDERAL HIGHWAY ADMINISTRATION. This report does not constitute a standard, specification or regulation.

Acknowledgments

Grateful appreciation to the Caltrans, New Technology and Research Program staff, Coco Arriaga, Manager, Advanced Rural Transportation Systems; and John West, Program Manager.

Appreciation is also extended to Katy Walton, District Division Chief-Planning, Caltrans District 9; Kay Hanson, Program Manager, California Alliance for Advanced Transportation Systems; Lisa Flores, Planning, Caltrans District 9; Yusuf Mohamedshah, Lendis Corporation, HSIS; Carol Bittinger, Office of Systems and Computing Services; Joe Armijo, formerly of Montana State University; and John Mounce, Montana State University.

2. Introduction

The purpose of this section is to provide an understanding of national and California rural transportation challenges, the objectives of the Program for Advanced Rural Transportation Technologies, and report content and organization.

2.1 National Significance

In the last 30 years, national vehicle miles traveled (VMT) has doubled from one trillion to two trillion. The resulting congestion has cost the nation an estimated $100 billion annually in delays. In 1991 there were 41,000 deaths and 5,000,000 injuries in the United States resulting from traffic accidents. Traffic related deaths are expected to increase to 80,000 by the year 2010.(7)

To alleviate these problems, there has been an effort to continually improve the quality, safety, and efficiency of the transportation system, while keeping costs to a minimum. To continue pursuing this objective many transportation systems have utilized "advanced technologies" to enhance existing transportation facilities by improving safety, reducing congestion, improving mobility, reducing environmental impacts, increasing energy efficiency, and improving economic productivity.

In December of 1991, Congress passed the Intermodal Surface Transportation Efficiency Act (ISTEA). Within ISTEA there were provisions to establish an Intelligent Vehicle Highway System (IVHS) national program. The IVHS concept has since been broadened to Intelligent Transportation Systems (ITS) to match the intermodal theme of ISTEA. The ISTEA Bill included the following provisions that launched the national ITS program:

- Allocated $660 million in research money;
- Mandated USDOT to develop a national program plan;
- Encouraged states to develop state plans;
- Promoted standards and protocols within ITS;
- Established an information clearing house; and
- Established evaluation guidelines for operational tests.(8)

There are many potential benefits to be realized through ITS. An applicable example of ITS technology benefits is driver warning. It is estimated that if drivers were warned of an impending collision one half second earlier, 50% of rear-end and cross road collisions, and 30% of head on collisions would be avoided. If an extra second were given to the driver, 90% of all accidents would be avoided. It is predicted that ITS will save 11,500 lives, 442,000 injuries, and $22 billion in property damage nationally by 2010.(7)

Because of their magnitude, the congestion and related problems of urban areas tend to overshadow those of rural areas. When developing a program to research, demonstrate, and deploy ITS in the United States, rural areas were initially ignored. It was assumed that solutions to urban area problems would be equally effective in solving problems in rural areas. Rural areas, however, are very different and have unique problems.

Nationwide, rural problem characteristics include:

- 80% of our nation's road miles(1);
- 40% of all vehicle miles traveled(1);
- 150 miles average trip length(4);
- 78% travelers on pleasure trip(2);
- 58% of all accident fatalities(1);
- 2:1 greater emergency response times over urban centers(3);
- Higher average age driving population than urban centers(5);
- More difficult terrain and changing weather conditions;
- 66% of rural communities have little or no transit service(4);
- 1 in 9 households are without a private vehicle(4); and
- Commercial vehicles are essential to economic development.

As can be seen from the above statistics, solutions developed for urban areas will not automatically transfer to rural areas. Rural areas have unique problems and there are many possible benefits of ITS in rural areas.

2.2 California Significance

As shown in Table 1, California's rural transportation system mirrors these national problems in many ways. The accident rates in California between urban and rural areas are similar, but rural accidents are much more severe (53% of fatalities in only 19% of the vehicle miles traveled).

Problems	National	California
Rural road miles	80%;	52%
Rural vehicle miles traveled	40%	19%
Rural fatalities	58%	53%
Emergency medical response time to fatal accidents (rural/urban)	52/35 min	55/34 min

Table 1 - National and State Rural Statistics(1,2,3)

Realizing the benefit of ITS in California, Governor Pete Wilson signed into law a program to establish a multimodal Advanced Transportation Systems (ATS) Program in July of 1992.(9) The program was developed to research, demonstrate and deploy advanced technologies to improve the movement of people, goods, services and information. The ATS program has developed important partnerships to ease the implementation of ITS in California. In addition the plan outlines a fifteen year deployment plan and a five year program plan.

2.3 PARTT Objective

The Program for Advancing Rural Transportation Technologies (PARTT) was initiated in 1992 by the California Department of Transportation (Caltrans) to address rural

transportation concerns. To this end, PARTT has been successful in creating and enhancing the awareness of rural transportation technology in California and the nation. Since its inception, PARTT has influenced national opinion to increase the focus on rural ITS. PARTT has identified five rural research initiatives based on stakeholder input that may be feasible in the rural setting. The five initiatives are listed below.

- Rural weather systems
- Rural mayday systems
- Rural driver alert systems
- Rural commercial vehicle operations
- Rural door-to-door transit systems

The goal of this study was to further define these initiatives and provide some direction to PARTT. The ultimate results of this study are the action recommendations provided in this report.

2.4 Report Content and Organization

This report discusses the activities and results of the current PARTT project ending February 28, 1997. The report is divided into eight sections described below.

1. **Executive summary**
2. **Introduction and Background:** States the project objectives, national and California significance and report content.
3. **Project Methodology:** Describes the scope of work and the analysis methodology followed in the study.
4. **Problem Definition and Stakeholder Needs:** Summarizes the stakeholder outreach effort and results, including problem identification.
5. **Rural ITS Applications:** Gives an overview of rural ITS applications identified nationally, the existing ITS in rural California, and an evaluation of the ITS solutions identified.
6. **Funding:** Discusses potential funding alternatives for the PARTT program.
7. **Recommendations:** Provides a recommended direction of the PARTT regarding research, development, demonstration and deployment of ITS in rural California.
8. **Next Steps:** Summarizes the recommended actions in order to initiate the action plan.

3. Project Methodology

3.1 Scope of Work

The following are brief descriptions of the tasks that were undertaken in this study to complete the current phase of PARTT. These tasks were defined by the scope of work for the project.

Task 1a. Finalize PARTT report and stakeholder outreach.

A report describing the PARTT program and its mission was prepared as part of a previous contract. During this contract, the report was updated and is submitted separately.

A workshop was held with the stakeholders during which a presentation was given summarizing ITS. At this workshop, breakout groups identified existing transportation problems in rural California and potential solutions to these problems. After this meeting stakeholders were requested by mail to rate the problems and solutions identified. The stakeholder outreach is summarized in Section 4 of this report.

Task 1b. Stakeholder evaluation.

The stakeholder response to the outreach described in task one are recorded and summarized in Section 4 of this report. These responses were used to help prioritize solutions.

Task 2 Monitor and support the development of a national rural research agenda.

The status and current results of this effort are summarized in Section 5.1 of this report. WTI staff has been involved in this effort through the Advanced Rural Transportation Systems (ARTS) committee of ITS America.

Task 3a. Research existing and ongoing activities.

In order to proceed effectively with a rural ITS program in California, it is important to identify existing ITS projects in California and important national programs. These are detailed in Section 5.2 of this report.

Task 3b. Identify locations of ITS solutions.

In the prioritization of solutions, possible locations for each solution were identified and listed in Section 5.4. Locations were identified based on roadway sections over-represented by comparable accidents and other measures relating to the potential benefits identified.

Task 3c. Identify funding sources.

Potential national, state, local, and private funding sources for the PARTT elements are discussed in Section 6 of this report.

Task 4. Final report.

This task includes the preparation of this document. This document includes data/information collected, ITS projects with potential locations, and recommendations and next steps to insure a successful program.

3.2 Methodology

To meet the work scope tasks, the Western Transportation Institute (WTI) used a project methodology shown in Figure 1. This process can be easily related to the typical planning process of problem identification and prioritization, solution identification and prioritization, stakeholder feedback, and action plan.

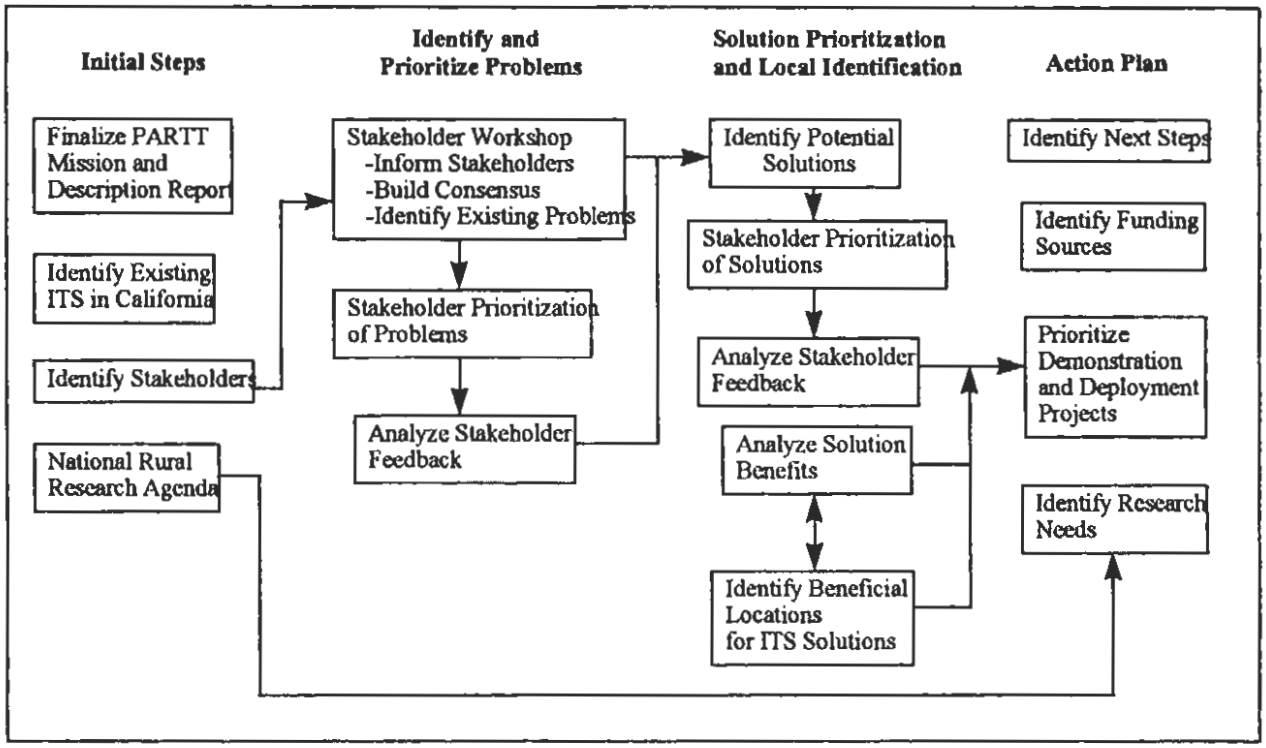

Figure 1 - Project Methodology

4. Problem Definition and Stakeholder Needs

In order to have an effective ITS program where potential solutions meet stakeholder needs, stakeholders (or the customers of these technologies) must be given the opportunity for input. In order to provide California stakeholders the opportunity for input, a pilot outreach workshop was conducted. The outreach effort was intended to build consensus among transportation stakeholders in rural California and to receive feedback concerning PARTT, existing transportation problems, and the application of ITS in general. A workshop was held at the Caltrans District 9 office in Bishop, California and is discussed below.

4.1 Introduction

The purpose of this workshop was to focus attention on transportation concerns of rural California, and examine how Intelligent Transportation Systems (ITS) can assist in solving some specific problems of rural California. This was accomplished by engaging stakeholders in a mutual exchange of information to accomplish the following tasks:

- Inform stakeholders of past, present and planned ITS activities nationally and in California;
- Build consensus among agencies/persons involved in the transportation system;
- Determine problems with the existing transportation system; and
- Identify ITS solutions that may mitigate these problems.

The workshop agenda included the following activities:

- Welcoming of participants by Katy Walton, Division Chief of Planning and Public Transportation for Caltrans District 9;
- Introduction to the workshop, and overview by Coco Arriaga, Manager of Advanced Rural Transportation Systems, Caltrans New Technology and Research program (NT&R);
- Overview of the California Alliance for Advanced Transportation Systems (CAATS) by Kay Hanson (CAATS is a public-private partnership, providing a forum for focusing California's strategic opportunity to deploy advanced transportation technologies);
- Presentation of an overview of intelligent transportation systems, and the program for advancing rural transportation technologies by Stephen Albert and Patrick McGowen, Western Transportation Institute; and
- Small group breakout sessions. Two breakout group sessions were held with each group composed of seven to ten individuals. The first breakout session identified problems with the existing system. The second session identified potential solutions to these problems. The results of the breakout sessions were then presented and discussed with the entire group. The most prevalent problems and feasible solutions were identified.

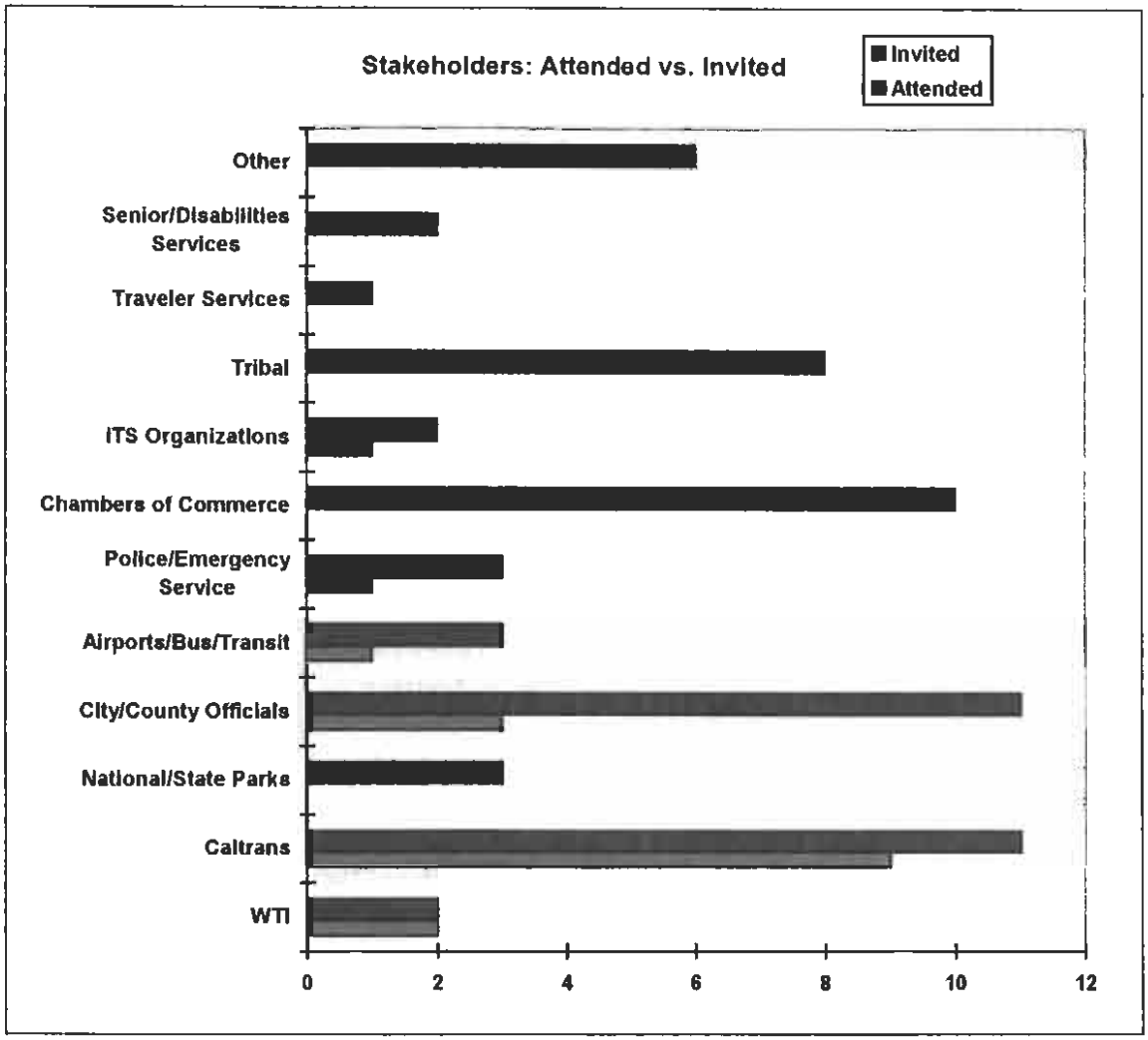

Figure 2 - Invitees and Attendees of Stakeholder Workshop

4.2 Existing Problems

Figure 2 shows the type of groups that were invited to and attended the workshop. As can be seen by Figure 2, the variety and number of stakeholders involved were limited, with approximately 27% of the invited stakeholders attending. In order to broaden input, a follow-up mailing was conducted. However, there were only fourteen respondents (many were the same as those who attended the workshop). The problems, based on the limited stakeholder input, that exist in rural California are discussed as follows:

- **Safety** - Safety was the most important problem identified in rural California, with high speeds topping the list in this area. Accidents caused by drowsy/inattentive drivers, weather conditions, animals in the right of way, and poor geometrics are all concerns in rural California. In addition, all the stated accidents caused by these problems are compounded by the long distances to medical facilities and lengthy emergency response times.

- **Lack of traveler and tourist information** - Lack of traveler and tourist information was also a concern. Much of rural California includes national forests, national and state parks, and other recreational areas. Many rural communities depend on tourism for their local economy. Many stakeholders felt that there was a lack of knowledge of the area by travelers. In addition to tourist information, it was felt that travel advisory information was also inadequate. There was a general lack of information on environmental conditions, and the available information was not always timely and/or reliable.

- **Mobility** - Mobility was also identified as a problem in rural California. Without the population densities of urban areas, communities cannot support a public transit system, leaving many mobility impaired individuals unable to lead a quality lifestyle.

- **Commercial vehicle operations** - Commercial vehicle operations were also identified as exhibiting safety problems. These problems were stated as being due to weather, excessive speeds, and hazardous material spills.

- **Non-commuter congestion** - Non-commuter congestion was also identified as a significant problem. Ski area closing times and large tourist events cause large amounts of tourist traffic at one time. Unfamiliar motorists, compounded by congestion and weather conditions, can lead to safety problems and uncomfortable driving situations.

In addition to these previously highlighted problems, stakeholders raised concerns regarding: funding; communication infrastructure requirements; operations and maintenance requirements; jurisdictional challenges across state and county lines; and lack of backup power for potential ITS applications.

Stakeholder involvement is important to build consensus and reduce jurisdictional challenges. In an effort to broaden stakeholder involvement important potential stakeholders were identified during the small group break-out sessions. These identified stakeholders included:

- National Forest Service;
- California State Parks;
- National Park Service (Yosemite, Death Valley, etc.);
- Council of Governments;
- Bureau of Land Management;
- Private business owners;
- Large land owners;
- Utility companies;
- Sovereign Nations (tribal);
- California Highway Patrol;
- Calex/California trucking industry;

- Chamber of Commerce;
- Inter-agency visitors center;
- Fish and Game Department;
- California Department of Forestry; and
- Air pollution and control district.

4.3 Problem Prioritization

Table 2 shows the existing transportation problems in rural California as identified at the stakeholder workshop. A follow-up mailing was sent to the sixty two (62) stakeholders that were invited to (but did not necessarily attend) the workshop. This mailing included a summary of the workshop proceedings and a questionnaire asking them to rate the existing transportation problems shown in Table 2. Each problem was rated from one to five (1=no problem, 5=severe problem).There were fourteen (14) respondents to the sixty two (62) mailings or 23%. The results of these stakeholder ratings may not reflect the views of all the stakeholders in rural California due to the poor response. The average ratings of the fourteen respondents are shown in Table 2.

The top four problems identified were:	Rating
• Lack of funding for rural areas	4.2
• Speed related	3.6
• Long emergency response time in sparse areas	3.5
• Weather and related safety problems with commercial vehicles	3.4

Existing Problems		Rating
Safety	1. Speed related accidents	3.6
	2. Long response time for emergency services	3.5
	3. Driver awareness/alertness	3.3
	4. Long isolated distances	3.3
	5. Weather (visibility, wind, flooding, ice)	3.1
	6. Stranded motorists (heat and cold)	3.1
	7. Animal-vehicle collisions	3.1
	8. Vehicle mix (i.e. trucks, RV's, trailers, cars, etc.)	2.9
	9. Inadequate shoulders: bicycles, tourists	2.9
	10. Lack of information regarding chain control	2.7
	11. Run off the road accidents	2.5
Traveler Information and Advisory	1. Lack of knowledge of areas by travelers	3.2
	2. Existing traveler information is not reliable and real-time	2.9
	3. Language barriers	2.6
	4. Lack of information on environmental conditions	2.4
	5. Lack of information on tourist services	2.2
	6. Too much commercial advertising along roadside	1.6
	7. Road closures (slow to initiate)	1.5
Public Transit	1. Lack of marketing for transit	2.5
	2. Increasing need for paratransit	2.4
	3. Transit service limited to jurisdictions	2.4
	4. Bus parking (Mammoth)	2.3
	5. Operations	2.3
	6. Institutional issues	2.3
	7. Reservations	2.0
Technology Requirements & Problems	1. Dead areas of radio transmission	3.3
	2. High operation and maintenance costs	3.2
	3. Unaffordable	2.8
	4. Lack of trained personnel to operate and maintain	2.7
	5. Communications infrastructure	2.6
	6. Standards	2.3
	7. Lack of backup power	1.9
Commercial Vehicle Operations	1. Weather and related safety problems	3.4
	2. Speed	3.3
	3. Hazardous materials (spills, tracking)	2.6
	4. Loads	2.5
	5. Night travel to avoid weight checks	2.3
Institutional	1. Lack of funding for rural areas	4.2
	2. Lack of stakeholder involvement	3.2
	3. Jurisdictional across state/county lines	2.4
	4. Insurance	2.2
Other: Congestion /Delays	1. Peak traffic (after ski area closes)	2.5
	2. Delays in construction zones	2.1
	3. High tourist traffic in the town of Bodie	1.8

Table 2 - Existing California Transportation Problems

5. Rural ITS Application

The purpose of this section is to provide Caltrans with the current national rural research needs, contrast those needs against existing Caltrans projects and identify potential ITS applications.

In response to the problems identified in the previous section, potential ITS applications have been identified. This section details the ITS solutions as identified by the national rural research agenda, previous PARTT efforts, and stakeholder outreach efforts of this study. This section also identifies existing ITS applications in rural California. The last portion of this section discusses each application: defining the application, identifying potential benefits, and, where possible, identifying locations that have a good chance of realizing these benefits.

5.1 National Rural Applications

Potential rural applications of ITS have been identified and summarized by the U.S. Department of Transportation's Advanced Rural Transportation Systems (ARTS) Draft Strategic Plan.(10) In addition to identifying applications, this effort organizes these applications into critical program areas or "clusters". The ARTS Draft Strategic Plan defines the following critical program areas:

- Traveler Safety and Security
- Emergency Services
- Tourism and Travel Information Services
- Public Traveler Services/ Public Mobility Services
- Infrastructure Operations and Maintenance
- Fleet Operations and Maintenance
- Commercial Vehicle Operations

Traveler Safety and Security - Safety is a significant issue for motorists on rural highways. Safety on rural roads can be improved with research and development of: vision enhancement systems, weather information systems, animal collision avoidance/warning systems, safe speed warnings (for weather and road geometry), improved commercial vehicle safety inspections, work zone traffic management, remote enforcement and automated highways.

Simultaneously, the concept of incident management will be addressed by resolving unplanned incidents more quickly and by better coordination of planned incidents. This can be achieved through the development of "real time travel advisory", which would inform the traveler of possible delays such as congestion, construction and maintenance, and adverse weather conditions.

Emergency Services - Characteristically rural areas have longer emergency response times and, as a consequence, higher fatality rates. The effects of an accident can be greatly reduced through the development of a fully compatible and operational

communication infrastructure. By expanding cellular coverage or through the use of satellites, emergency response times can be greatly reduced through the development of Mayday systems and call boxes which use cellular and satellite communication.

Tourism and Travel Information Services - Travel on rural roads for tourists and commuters can be more enjoyable by making the traveler more informed. This can be done through the use of pre-trip information via Internet, automated telephone or en-route information systems such as touch screen traveler information booths; read-only portable tourist information systems; highway advisory radio; and changeable message signs. These systems will inform the traveler of ideal travel conditions, alternate modes and routes, transit schedules, route characteristics, distances, and locations of facilities and services along their chosen route.

Public Traveler Services / Public Mobility Services - Public transportation services are limited in rural areas with 38% of the rural population having no access to public transportation and 28% having little access.(5) When public transit is present, there is usually little to no information about the services provided. In addition, service is sometimes limited to weekends, evenings, or certain days. There exists a need to improve coordination between the volunteer, city, county and state entities to increase the efficiency and economy of existing and planned transit systems. Most public transportation systems are demand responsive, which would allow for easy integration of advanced reservation-type systems. This would permit the transportation provider to plan the most efficient routes. Streamlining the operation in this way would result in reduced headways and a cost savings. This may allow the transportation provider to expand operations to serve more of the rural transportation dependent. A component of this critical program area that should not be overlooked is the development of ride-matching services to help reduce the high rate of single occupancy vehicle use in rural areas.

Infrastructure Operations and Maintenance - Approximately $750 billion in time and resources is devoted to travel each year in the United States. Obviously, any improvements in efficiency of the transportation system will result in a tremendous savings to our nation's travel industry. However, due to the vast transportation network in rural areas, operation and maintenance are often both costly and inefficient.

ITS technologies can be used to monitor road conditions and dispatch the necessary information or work crews to problem areas. Areas to be studied are: pavement management systems, better management of work crews, more efficient dispatch of snow removal and salt/sand trucks, and constant monitoring of weather conditions. The development of improved operations and maintenance techniques will provide more efficient use of transportation dollars, allowing excess dollars to be spent on improvements.

Fleet Operations and Maintenance - Private and public fleets can be better managed through routing and GPS/AVL software. Examples may include public sector demand-responsive transit vehicles, or winter fleet maintenance vehicles, (e.g., snow plows,

sanders, spreaders, and emergency response vehicles). Using GPS/AVL software to track and dispatch emergency vehicles could result in significant reduction in response time to an accident scene.

Commercial Vehicle Operations - Legal commercial vehicles can electronically bypass weigh/inspection stations and electronically purchase credentials, thus saving time and money for both the carriers and the enforcement agencies. CVO safety and research issues include; on-board driver monitoring systems, and HAZAMT truck tracking (to help improve incident response times considering the environmental sensitivity of most rural areas).

Research Initiatives - As part of WTI involvement in the ITS America Advanced Rural Transportation Systems Committee, and Rural Research Agenda Sub-Committee, research needs for rural ITS have been identified. Currently these research needs are being ranked by ARTS Committee members . This national effort identified needs include:

Traveler Safety and Security

- Potential rural ITS applications for animal vehicle collision avoidance;
- Potential low cost rural driver awareness and alert systems to reduce run-off-the road accidents;
- Feasibility and effectiveness of low cost intelligent vehicle and highway vision enhancement applications to improve rural safety;
- Feasibility and effectiveness of ITS to reduce high speed farm equipment and vehicle collisions;

Tourism and Travel Information Services

- Potential rural partnerships for traveler information, operations and maintenance;
- Effectiveness of public radio station traveler information systems;
- Development and implementation of traveler and tourism information;
- Corridor coalition;
- Effectiveness of VMS and HAR for rural safety and diversion;

Weather Monitoring and Traveler Advisories

- Prediction of pavement temperature accounting for the influence of the surrounding landscape;

Commercial Vehicle Operations

- Evaluation of pre-pass CVO technologies and marketing initiatives;

Economic Viability

- Evaluate the impact of traveler information on economic development;
- Perform market research analysis of in-vehicle and portable tourist information systems to determine feasibility;

Public Traveler and Mobility Services

- Guidelines for rural public transportation broker services;

Crosscutting Issues:

Institutional Issues and Outreach

- Develop an effective outreach program to educate rural stakeholders and to generate a constituency for ITS in rural and small urban areas;
- Research ways to overcome institutional barriers (funding, jurisdictional authority, etc.);

Communication Infrastructure

- Communication alternatives to enhance area wide coverage in rural environments;

Standards and Protocols

- Identify major rural considerations for the ITS national architecture;
- Short range communications;
- Mayday communications; and
- Standards.

5.2 Existing California Rural Technology Projects

California has several rural technology demonstrations underway. The descriptions are as follows.

Sierra Project(11)

The Sierra project (called "Snow Wars") is a weather, traffic and highway condition gathering and destination system for Interstate 80 between Auburn, California, on the western slope of the Sierra Mountain Range and the Nevada State line.

The Sierra project has several components which are listed below.

- A SCAN roadway weather information system to collect meteorological information.
- Weather radar to track storm cells.
- Pavement sensors to determine pavement condition.
- A traffic monitoring system.
- Changeable message signs, highway advisory radio and the California information network to provide information to travelers.
- The Kingsville snow management (control) center to collect and disseminate information.

Visibility Warning Project(12)

In November 1991, during a period of California drought, a major dust storm blew up on Interstate 5 in a rural area of California between Los Banos and Bakersfield. During the storm 164 vehicles were wrecked, 17 motorists were killed and 119 injured.

The California Department of Transportation (Caltrans) has installed a visibility warning system in that area of Interstate 5. The warning system includes a micro weather forecasting system, wind activated meteorological devices, closed circuit television and changeable message warning signs. The system is operated by Caltrans and the California Highway Patrol from control centers in Fresno, California, 40 miles from the project.

Caltrans District 10 Advanced Fog Monitoring and Warning System Evaluation

An independent evaluation of the Caltrans District 10 Automated Fog/Weather Monitoring System is being conducted under the Program for Advancing Transit and Highways (PATH). This evaluation is taking place during the winters (January - March) of each of the three years of the study. These months were selected because they correspond to the fog season in the respective study area. The following evaluation tasks will be conducted.

- Technical assessment: the objective of this task is primarily to verify and document the system under test.
- Influence on driver behavior during fog conditions: this includes an assessment of the degree to which driver behavior is influenced by the automated fog detection and warning system.
- Net impact on traffic safety: data before and after the installation of the system will be compared to assess, in a gross sense, the efficacy of the system in reducing traffic loss due to inclement weather.
- Visibility sensor output comparison with perceived driver visibility: video images displayed and monitored remotely will be used to manually access visibility at the test locations using visibility targets. Observations will be recorded and compared to correlate visibility readings.
- System reliability: evaluators will analyze collected information to determine unreliability or serviceability problems and suggest remedial actions, if appropriate.

Yosemite Area Traveler Information Project(13)

The Yosemite Area Traveler Information (YATI) project is a $2.24 million demonstration project to better manage Yosemite's four million annual visitors. YATI is a cooperative effort by local, state, and federal agencies to provide current information about the 11,000 square mile, five-county region containing and surrounding Yosemite National Park. By providing current reliable information on transit, activities, parking, accommodations, and attractions, the project gives travelers an array of options for their visit. This will in turn help to reduce congestion, improve air quality, promote tourism and economic growth, and eliminate unnecessary trips. YATI utilizes a network of high-tech communications systems to provide travelers with up-to-the-minute information about traffic and weather conditions, as well as the status of transportation and recreational facilities throughout the entire Yosemite region. Components of the YATI system include.

- Changeable message signs: these specially designed, programmable signs are strategically located throughout the region and are used to inform travelers of current unusual traffic or other conditions (e.g., bad weather, fire, construction, incidents, etc.). They can also direct travelers to other components of the YATI system where they can receive additional information.

- Highway advisory radio: roadway signs and notices on the changeable message signs direct motorists to tune in to a specific radio frequency for information regarding highway conditions and recreational opportunities. These pre-recorded announcements are broadcast on low wattage AM or FM transmitters that cover a small radius. Travelers are directed to the nearest YATI kiosk for further information.

- Multimedia kiosks: allow travelers to access the entire YATI database through a user friendly touch-screen system. Each kiosk contains traveler information for the entire region, as well as local advertising and information of local interest. All of the information available through the world wide web is also available on these kiosks. Travelers have the ability to print out maps and selected subscriber (advertiser) information. Future planned enhancements include both graphics and short video clips, complete with voice-overs and soundtracks.

- Internet website (http://www.yosemite.com): all of the information available on the kiosks is available on this website.

- Traveler advisory telephone: (pending implementation) travel planning information will also be available via a telephone database of audio information.

TransCal

TransCal, a comprehensive interregional traveler information system (IRTIS) for the Interstate 80, US Highway 50 region, integrates roadway conditions, incidents, traffic, transit, weather, travel mode (car, transit, train, air), and traveler services (yellow pages) data. It showcases emerging capabilities in computing, communications, and consumer electronics that can improve the availability and quality of traveler information so that travel decisions can be based upon the most current and accurate information available.

The TransCal project will also design and test a satellite-based emergency notification system to enable travelers to summon aid in emergency situations.

A Tahoe Frequent Passenger Program to encourage greater transit usage in the Tahoe basin by providing incentives to use alternative transportation, will also be initiated by TransCal.

Kern County Early Deployment Plan

The Kern County Council of Governments (COG), the metropolitan planning organization for the Bakersfield metropolitan area, received a federal grant for the preparation of a strategic plan for the deployment of ITS technologies appropriate for Kern County. The COG ITS plan will provide a road map for incorporating consideration of ITS into the transportation decision making process. Since most of Kern County is rural, its planning process can provide useful input for early deployment planning in predominately rural areas.

Sutter County Field Operation Test

This weather detection and reporting demonstration is designed to show that a call box can measure selected weather parameters of interest, automatically determine a pre-set alarm condition, and call the appropriate traffic management facility. The traffic management center (TMC) would then activate one or more traveler information systems to inform drivers of the weather hazard. Additional information such as the expected length of the condition and its location can be broadcast over the highway advisory radio network.

This demonstration will examine the ability of the call box to interface with external sensors that measure various weather parameters of interest. These parameters include ambient air temperature, dew point, wind speed, precipitation and restrictions to visibility (fog and dust). The demonstration will also determine the ability of the call box to automatically report parameters that exceed pre-set thresholds. The TMC will maintain information concerning potential weather hazards as a function of measured parameters and will generate appropriate traveler alerts to be transmitted to changeable message signs or other traveler information systems such as highway advisory radio.

The evaluation factors for this demonstration are listed below.

- Real-time parameter measurement accuracy;
- Ability to remotely load threshold parameters;
- Adverse effects on call box power budget;
- Efficiency of data transmission protocol; and
- Ability to integrate received alarm data into the TMC system.

5.3 Critical Program Area Prioritization

The ITS solutions identified by stakeholders, and previous PARTT efforts were prioritized based on stakeholder feedback. Table 3 shows the solutions identified at the stakeholder workshop. The workshop focused on ITS, however some solutions may not be considered ITS. A follow-up mailing was sent to the sixty-two (62) stakeholders that were invited to (but did not necessarily attend) the workshop. This mailing included a summary of the workshop proceedings and a questionnaire asking them to rate the solutions shown in Table 3. Each solution was rated from one to five (1=unfeasible solution, 5=very viable solution). The average ratings of the fourteen respondents are also shown in Table 3. As mentioned previously only fourteen stakeholders responded to the questionnaire. Because of this the results do not necessarily reflect the views of all stakeholders in rural California.

The top four solutions were:	Rating
• Improve cellular coverage	4.0
• Make local road conditions available through cellular phones	4.0
• Real time traveler and advisory information made available	3.9
• Tourist information available at rest stops and Internet	3.9

Feasible Solutions		Rating
Safety	1. Call box	3.6
	2. Adequate shoulder width	3.2
	3. Rumble strips	3.2
	4. Better testing/training for drivers	2.9
	5. Vision enhancement	2.8
	6. Automated speed enforcement	2.4
Institutional	7. Funding for rural areas	3.8
Traveler Information and Advisory	8. Local conditions through cell phones	4.0
	9. Real-time information	3.9
	10. Tourist info on Internet and at rest stops	3.9
	11. Electronic information kiosks	3.6
	12. Highway advisory radio (improve quality)	3.4
	13. In-vehicle information devices	2.8
	14. Yellow pages services	2.7
	15. Traffic guidance	2.4
	16. Electronic billboard information to reduce use of roadside billboards	2.2
	17. Portable hand held information devices	2.2
Public Transit	18. Public transit communications and automated reservation system	2.4
	19. Fleet management (GPS)	1.9
Commercial Vehicle Operations	20. Hazmat ID and coordination	3.3
	21. Fleet management (GPS)	2.3
Technology Requirements	22. Cellular phone coverage	4.0
	23. Weather data collection	3.3
	24. Ensure reliability/believability of information and technology	3.2
	25. Centralize and increase traffic data monitoring and detection	2.9

Table 3 - Potential Solutions Identified by Stakeholders

5.4 Analysis of Potential Rural ITS Applications in Northern California

This section discusses the potential benefits of the applications previously identified. In addition, locations are determined for each application that seem to have the best possibility for realizing benefits.

To aid in the identification of potentially beneficial locations for each ITS application, data were collected for a specified rural area within northern California. This area, shown in Figure 3, includes the area outlined in the north by the Oregon border, in the south by

Highway 36, in the east by Highway 395, and in the west by Highway 101. This area is characterized by low volume roads, national and state parks, poor weather, long isolated distances, poor alignment, and many other attributes exemplifying rural areas in California.

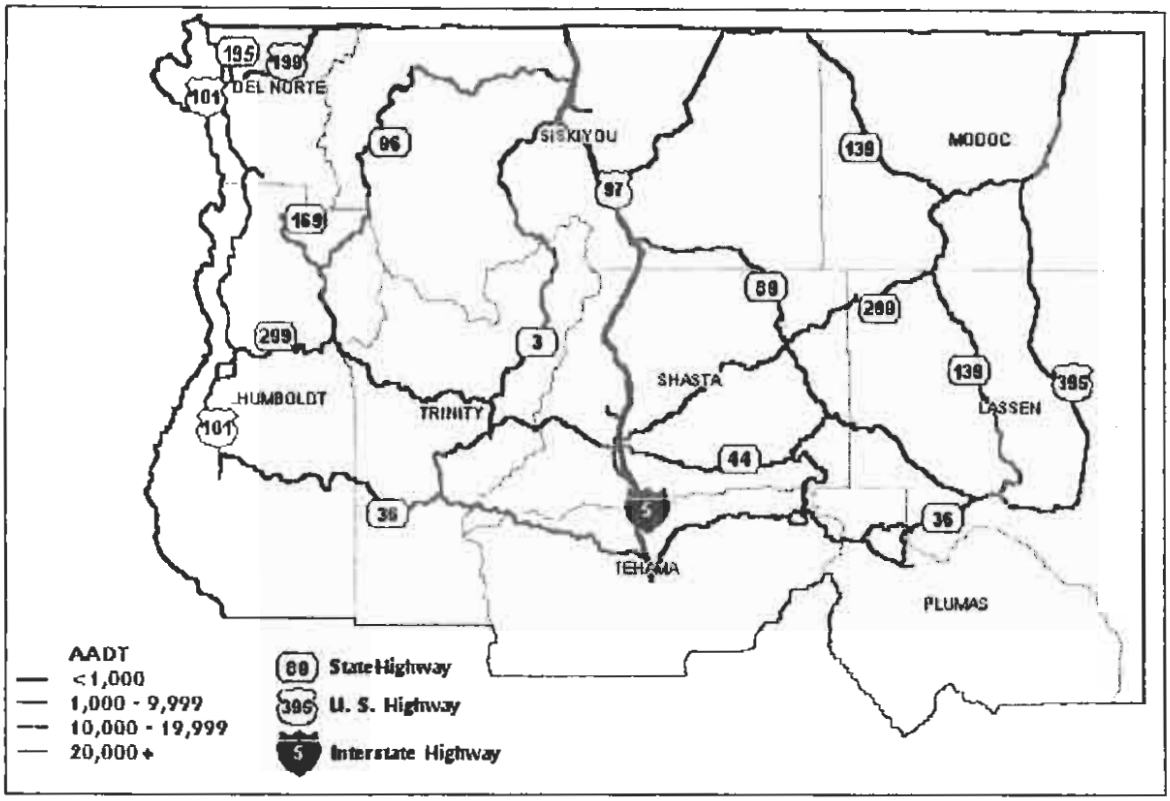

Figure 3 - Northern California Study Area

As discussed previously, stakeholders have identified safety applications as one of the major problems in rural areas. For applications with accident reduction as a potential benefit, locations were determined based on the frequency of a particular type of accident. Accident data from the Highway Safety Information System was examined for the area described above for a three year period from 1992-1994. These locations are chosen based on a statistical overrepresentation of a particular type of accident identified.

High accident locations were determined for each 10 mile segment in northern California using a rate per million vehicle miles traveled determined by the equation below. Average annual daily traffic (AADT) was estimated by averaging the AADT from the traffic counting station within the segment. AADT was taken from the 1995 Traffic Volumes on California State Highways(14). The accident rates for all the segments are compared within each functional class of roadway as defined by the AADT categories in Figure 3. A 10 mile segment is identified as a possible atypical accident site if its accident rate was calculated to be greater than two (2) standard deviations above the average (mean) for its designated class of roadway.

$$Rate = \frac{\#\_accidents * 1{,}000{,}000}{AADT * 10mile * 365days * 3years}$$

For each ITS application; a description is given, potential benefits are specified, and locations are identified. These locations, in the opinion of the research staff, have the highest probability of realizing the possible benefits identified. The applications discussed in this section are grouped by the ARTS Draft Strategic Plan critical program areas.

5.4.1 Traveler Safety and Security

This application is by far the largest and most prominent critical program area within rural ITS. Systems included in this critical program area include: vision enhancement; weather information; objects in roadway warning; impaired driver monitoring; safe speed warning; and automated speed enforcement. The most probable benefit realized by applications within this critical program area is the reduction of accidents.

5.4.1.1 Vision Enhancement

Description

Systems within this application provide the driver with additional or augmented visual information during situations of poor visibility. This safety application could include vehicle based systems, improving the drivers vision by infrared imaging (or similar technology), or infrastructure based systems, like the Minnesota, Mining and Manufacturing (3M) lighted guide tube shown in Figure 4.

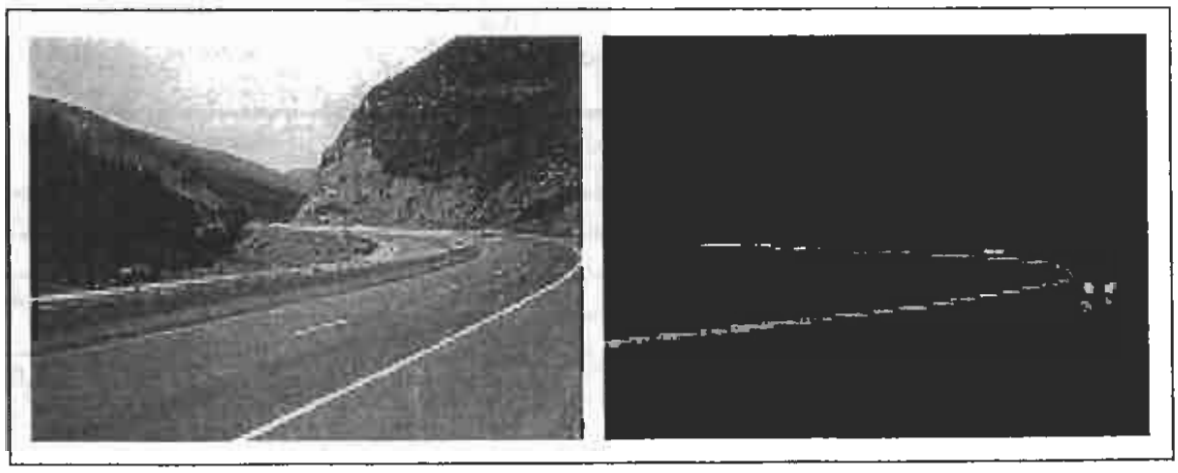

Figure 4 - Lighted Guide Tube

Potential Benefits

Benefits may include a potential reduction of accidents caused by poor visibility and improved driver comfort. For the analysis period, no accidents were identified as caused by vision obscurements. This is not to say that no accidents in northern California are caused by poor vision, just that the investigating officer did not identify vision obscurements as a cause. Because of the apparent lack of accidents caused by poor

vision, further research and demonstration is not recommended for vision enhancement technologies.

5.4.1.2 Weather Information

Description

Information given to the travelers regarding road and weather conditions may potentially help drivers to change their driving behavior (drive more carefully), choose an alternate route that has less severe weather conditions, and/or choose to postpone the trip. In addition, this information may be useful in coordinating road closures when they are required due to weather. The two most important types of information that would be beneficial include road surface slipperiness (and chain requirements) and current weather conditions. This information could be provided to the driver through highway advisory radio (HAR), public broadcast radio, variable message signs (VMS), interactive kiosks, Internet, and/or a 1-800 phone line, hot-line. This application could be implemented in coordination with tourist information using the same information dissemination methods.

Potential Benefits and Locations

Potential benefits may include reduced accidents during inclement weather by changing driving behavior, and improved driver comfort. Other possible benefits may include opportunities for income from advertising on certain information systems such as touch screen kiosks.

Possible accident locations were determined based on accidents that occurred during poor weather and/or road conditions, including snowfall and a snow-packed or icy road surface. These locations are shown in Table 4. It is unknown how much a weather information application will reduce these accidents. However, these roadway sections have the potential to realize benefits from weather information systems.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Total Fatalities	Total Injuries	Rate
5	Siskiyou	0	10	16,300	3	25	0	0	0.14
5	Siskiyou	10	20	17,700	3	28	0	0	0.14
36	Lassen	10	20	2,500	2	23	0	2	0.84
44	Lassen	20	30	1,800	2	23	0	0	1.17
44	Lassen	30	38	1,800	2	16	0	0	1.01
44	Shasta	40	50	1,800	2	27	0	0	1.37
44	Shasta	50	60	1,600	2	17	0	0	0.97
44	Shasta	60	70	1,900	2	18	0	2	0.87
89	Tehama	0	4	490	1	2	0	0	0.93
96	Siskiyou	60	70	900	1	6	0	0	0.61
139	Lassen	40	50	500	1	4	0	0	0.73

Table 4 - Possible Application Locations During Adverse Weather

5.4.1.3 Objects in Roadway Warning

Description

Objects in the roadway could include animals, fallen rocks, mud slides, stopped or parked cars, and debris. Advanced technologies can be used to warn the driver in advance of these objects. An example of such a system could include animal sensors connected to a dynamic sign that would flash when animals were detected within the highway right-of-way, on an approach roadway

Potential Benefits and Locations

By giving the driver an advanced warning of objects in the traveled lane, some accidents may be avoided. A potential benefit from this application is the possible reduction of accidents involving objects and animals in the traveled lane. Table 5 shows possible application locations chosen based on accidents involving objects in the roadway. Object in roadway warning systems in these locations may have a beneficial effect on safety.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Involving Animal	Total Fatalities	Total Injuries	Rate
5	Siskiyou	40	50	14,200	3	15	12	0	3	0.10
36	Trinity	30	40	150	1	1	1	0	0	0.61
44	Lassen	0	10	2,200	2	13	10	0	10	0.54
44	Lassen	20	30	1,800	2	15	10	0	8	0.76
44	Lassen	30	38	1,800	2	7	3	0	3	0.44
89	Shasta	40	44	1,800	2	5	4	0	2	0.63
96	Siskiyou	30	40	500	1	3	0	0	5	0.55
96	Siskiyou	100	106	600	1	3	0	0	1	0.76
139	Lassen	10	20	500	1	3	3	0	2	0.55
139	Lassen	40	50	500	1	3	2	0	0	0.55
263	Siskiyou	40	41	2,000	2	1	1	0	0	0.46

Table 5 - Possible Application Locations Involving Animals & Objects in Roadway.

As can be seen by Table 5, most of the accidents involved animal collisions. System design for this type of application may be geared toward the reduction of animal collisions only and not all objects in the roadway.

5.4.1.4 Impaired Driver Monitoring

Description

This application would monitor the driver either directly, or by abnormal vehicle movements, to detect intoxication, driver inattention, or driver fatigue. A driver could be monitored by eye movement patterns to determine fatigue/intoxication and not allow the vehicle to operate if the driver was not within normal parameters. Traditional (non-ITS) applications could be also be utilized such as rumble strips; however, these applications are infrastructure intensive.

Potential Benefits and Locations

Potential benefits include a possible reduction in accidents caused by drunk driving, falling asleep, and inattention. In addition, enforcement agencies may realize a reduction in the need for enforcement of drivers under the influence of alcohol.

Possible Application locations for accidents involving drunk drivers, driver fatigue and driver inattention were determined and are shown in Table 6. These locations may work well for driver monitoring systems.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Total Fatalities	Total Injuries	Rate
3	Trinity	0	10	1,100	2	8	0	7	0.66
36	Humboldt	0	10	2,600	2	21	2	22	0.74
36	Tehama	0	10	300	1	4	2	5	1.22
96	Siskiyou	100	106	600	1	6	1	5	1.52
101	Humboldt	70	80	25,300	4	69	1	42	0.25
169	Humboldt	20	30	200	1	3	0	5	1.37
200	Humboldt	0	3	1,900	2	5	0	5	0.80
263	Siskiyou	50	57	1,100	2	7	1	5	0.83

Table 6 - Possible Application Locations Involving Alcohol, Inattention, & Fatigue

5.4.1.5 Safe Speed Warning System

Description

Many accidents are caused by excessive speeds for conditions and road alignment. A safe speed warning system could potentially reduce these types of accidents. A safe speed warning system usually consists of road sensors and possibly vehicle detectors that determine weight and axle configurations. These components relay information to a processor that will compute a safe speed for the vehicle based on road conditions and alignment and then activate a variable speed sign to display a suggested safe operating speed.

Potential Benefits and Locations

Benefits from this type of countermeasure may include a reduction in accidents caused by excessive speeds. Possible locations where this application may be effective include curves and downgrades that have an overrepresentation of speed related accidents. Locations that may benefit from such a system were determined based on high speed related accident locations shown in Table 7.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Total Fatalities	Total Injuries	Rate
36	Shasta	0	10	200	1	3	0	3	1.37
44	Lassen	30	38	1,800	2	17	0	15	1.08
44	Shasta	40	50	1,800	2	32	0	25	1.62
89	Tehama	0	4	490	1	6	0	2	2.80
101	Humboldt	70	80	25,300	4	230	0	182	0.83
199	Del Norte	20	30	3,100	2	36	0	23	1.06
299	Humboldt	30	40	3,300	2	38	0	30	1.05
299	Shasta	20	30	14,400	3	173	0	152	1.10

Table 7 - High Speed Related Accident Locations

5.4.1.6 Automated Speed Enforcement

Description

This type of technology would include radar speed detection coupled with a camera and computer. When a speeding vehicle is detected the license plate would be recorded and a ticket would be issued by mail. While these systems are technologically feasible, many states legislative actions may be required before implementation may take place.

Benefits

The benefits are similar to safe speed warning systems. In addition to these benefits, there may be a reduction in cost of enforcing speed control and some extra income may be generated from fines. However, when determining operating costs it is important to include administration of mailing the tickets, court appearances, etc. Locations shown in Table 7 may be best suited for safe speed warning, or automated speed enforcement, depending on further analysis.

5.4.1.7 Traveler Safety and Security Summary

This program area includes applications that have the potential to improve safety. For each of these applications, potential benefits have been identified, and locations have been determined that, in the opinion of the research staff have the highest potential of realizing these benefits. Recommended application locations, as identified above, within this cluster are shown in Figure 5.

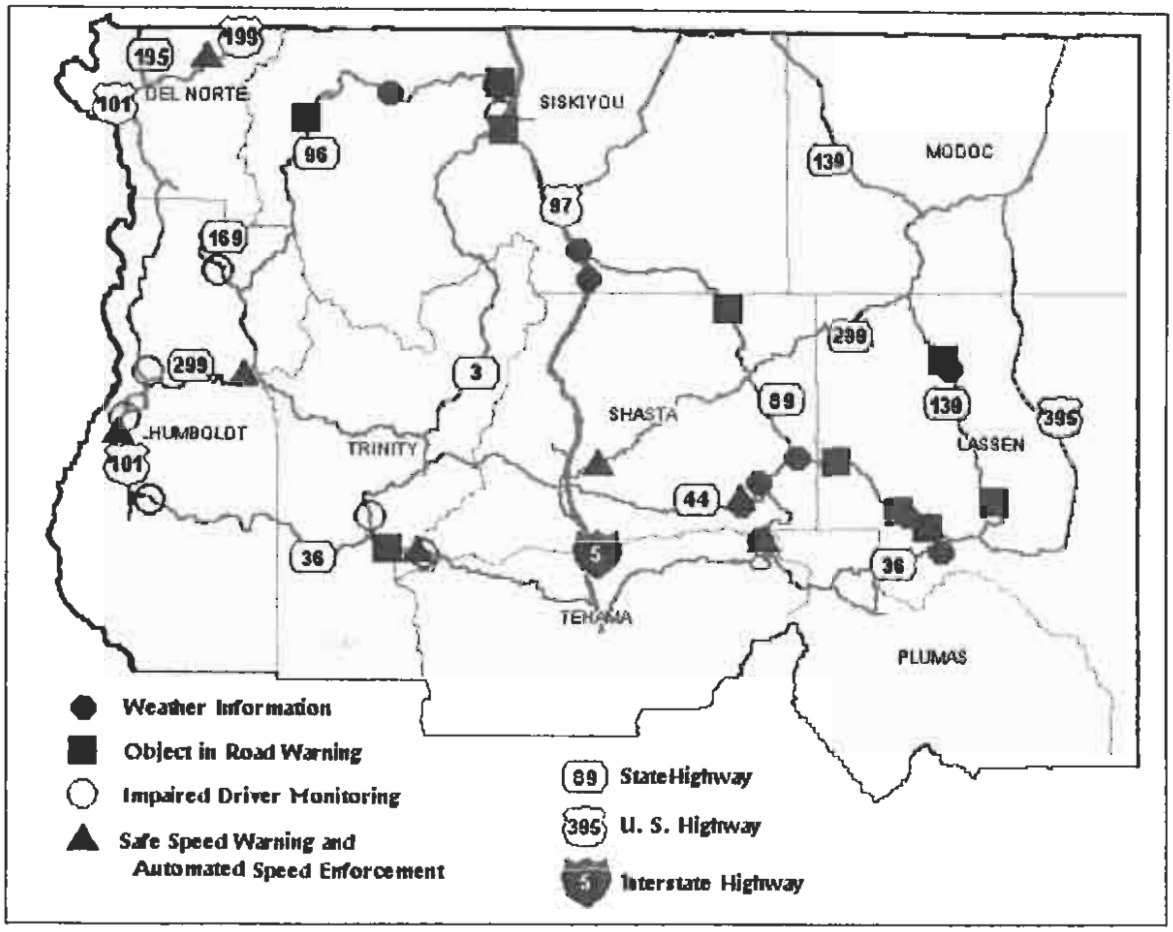

Figure 5 - Traveler Safety and Security: Applications and Locations

5.4.2 Emergency Services

The emergency services critical program area includes rural ITS applications that aid emergency service providers (medical, fire, police) to better manage their vehicle fleets for a faster more efficiently response to emergencies. Applications within this area include mayday and call boxes.

5.4.2.1 Rural Satellite Mayday

Description

One problem identified by stakeholders was vehicle breakdowns and accidents in isolated areas. Rural mayday may reduce the emergency response time to rural accidents. The average time to notification after an accident in rural California is 9.5 minutes.(3) This time may be reduced by implementing a mayday system. One important note is the communication link of the mayday system. The two most common communication media are satellite and cellular phone. Cellular phone communication is usually the less expensive of the two and is currently commercially available. However, cellular phone

coverage is sparse in rural areas as shown by the map in Figure 7. There may be other cellular phone providers in this area besides Cellular One.

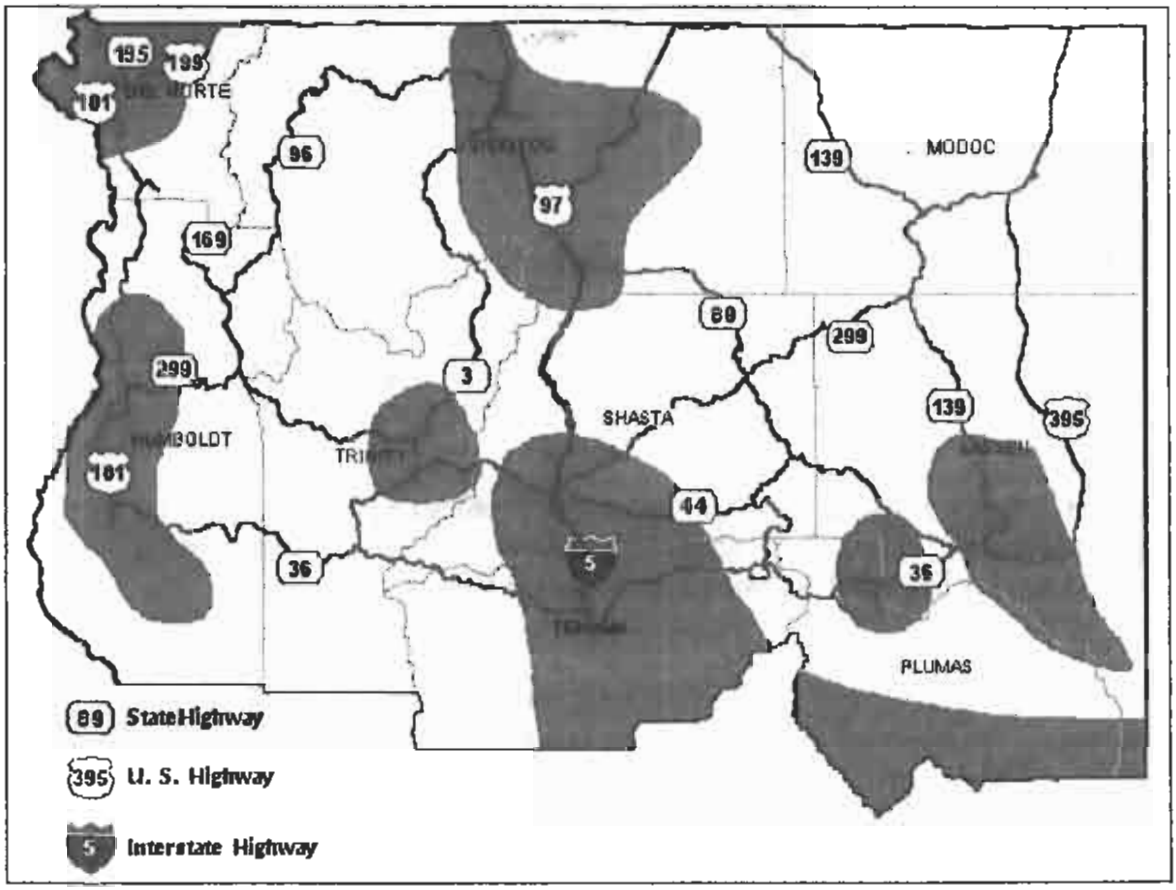

Figure 6 - Cellular One Coverage(15)

Potential Benefits and Locations

Benefits include possible saved lives, less severe injuries due to a faster response time, and time saved by waiting for assistance. These systems are more beneficial in low volume traffic areas. On roadway sections with high traffic volume there is a very good chance that someone will drive by with a cellular phone and call the accident in. Based on this criteria, a location that would appreciate benefits from mayday includes roadway sections with no cellular coverage and low traffic volumes;

Figures 3 and 7 identify locations with less than 1000 ADT and no cellular coverage. These possible application locations are shown in Table 8 along with the number of fatalities and severe injuries.

Route	County	From MP	To MP	Total Accidents	Total Severe Injuries	Total Fatalities
3	Trinity	50	85	15	1	1
3	Siskiyou	0	20	7	0	0
169	Humboldt	0	34	15	0	1
96	Humboldt	20	45	29	3	0
96	Siskiyou	0	105	116	9	3
36	Tehama	0	20	19	0	3
36	Trinity	0	41	26	0	0
299	Modoc	40	67	22	1	1
395	Modoc	30	62	34	2	2
139	Lassen	2	67	59	3	4

Table 8 - Possible Application Locations for Mayday

Stakeholder Rating

The limited stakeholder response indicated that long emergency response times are a problem. Stakeholders preferred expanding cellular phone coverage and using existing cellular based mayday instead of developing a satellite mayday.

5.4.2.2 Call Boxes

Call boxes are telephones along the side of the road, that are directly connected to a response center. The potential benefits are similar to mayday. The benefits realized by call boxes would be on a per mile basis and not area wide like mayday. Possible application locations were determined from the routes identified in Table 8 and are shown in Table 9. These locations have the potential to realize the benefits of call boxes.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Total Fatalities	Total Injuries	Rate
96	Siskiyou	40	50	1,100	2	19	1	20	1.58
96	Siskiyou	100	106	600	1	19	1	14	4.82
139	Lassen	0	10	1,500	2	14	2	21	0.85
169	Humboldt	20	30	200	1	8	1	7	3.65
299	Modoc	40	50	1,000	2	12	1	6	1.10

Table 9 - Possible Application Locations for Call Boxes

5.4.2.3 Emergency Services Summary

For each of the two applications (mayday and call boxes) in this program area, benefits were identified. Based on these benefits, locations were identified that, in the opinion of the research staff, have the highest potential for realizing these benefits. Locations identified for these applications are shown in Figure 6.

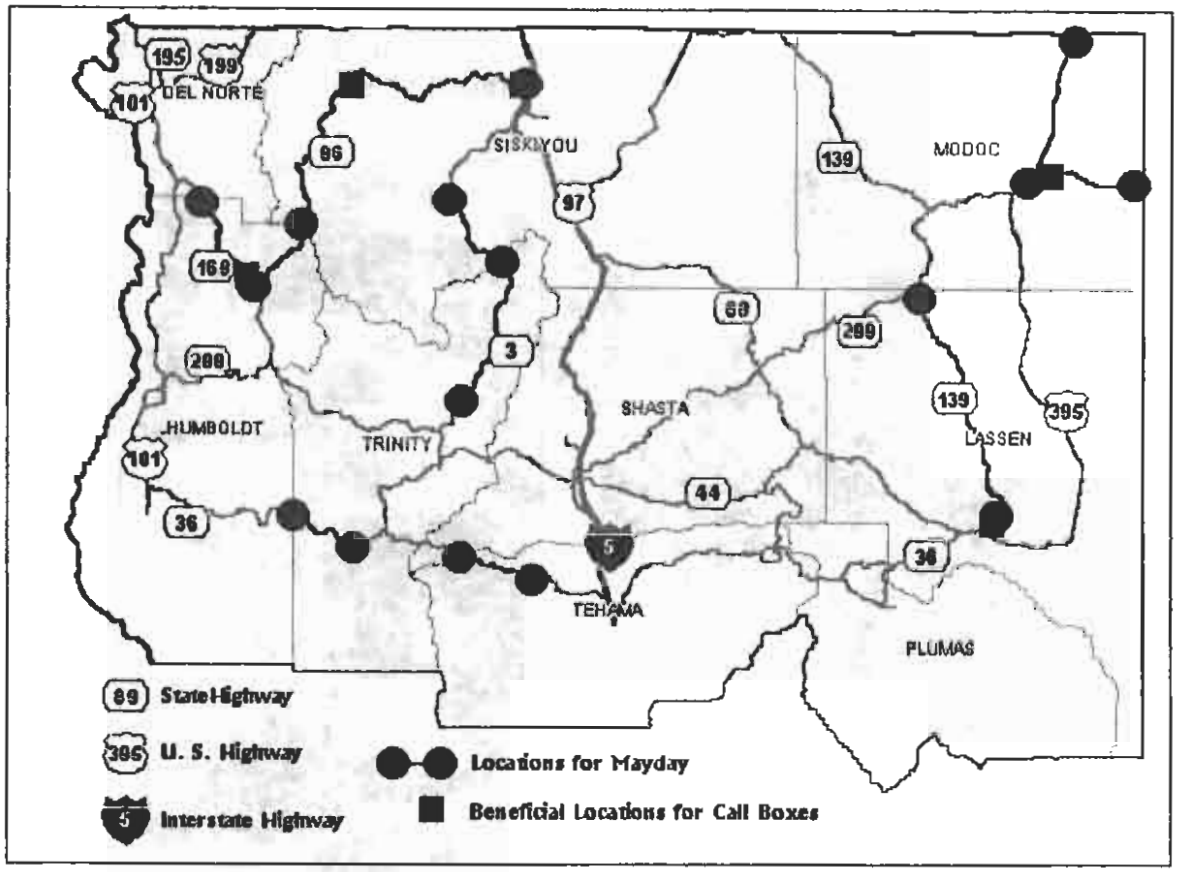

Figure 7 - Possible Locations for Emergency Services Applications

5.4.3 Tourism and Traveler Information Services

Description

Areas of high tourist traffic may benefit from these types of applications. Tourism and traveler information services could provide the following types of information to the traveler through in-vehicle devices, touch screen kiosks, radio, and the Internet:

- Route planning and guidance;
- Tourist attractions; and
- Services (gas, lodging, food, etc.).

Potential Benefits and Locations

These types of applications would give tourists more familiarity with the area, allowing them to concentrate on the driving task. Benefits may include reduced accidents caused by inattention of tourists, and increased convenience to tourists (resulting in increased tourist dollars spent). Of all the accidents in the analysis period, none were recorded as being caused by drivers unfamiliar with the road and only three accidents resulting from inattention. The economic benefit, however, has large potential.

Tourism and travel information systems can provide unfamiliar travelers with needed information relative to state and national parks. State parks and national parks and forests

are shown in Figure 8. A total of approximately two million (mostly from state parks) visitors frequent the study area's state parks and national forests each year as shown in Tables 10 and 11. The large number of state parks and resulting tourist/travelers along all of Route 101 make it an excellent candidate for tourist information applications.

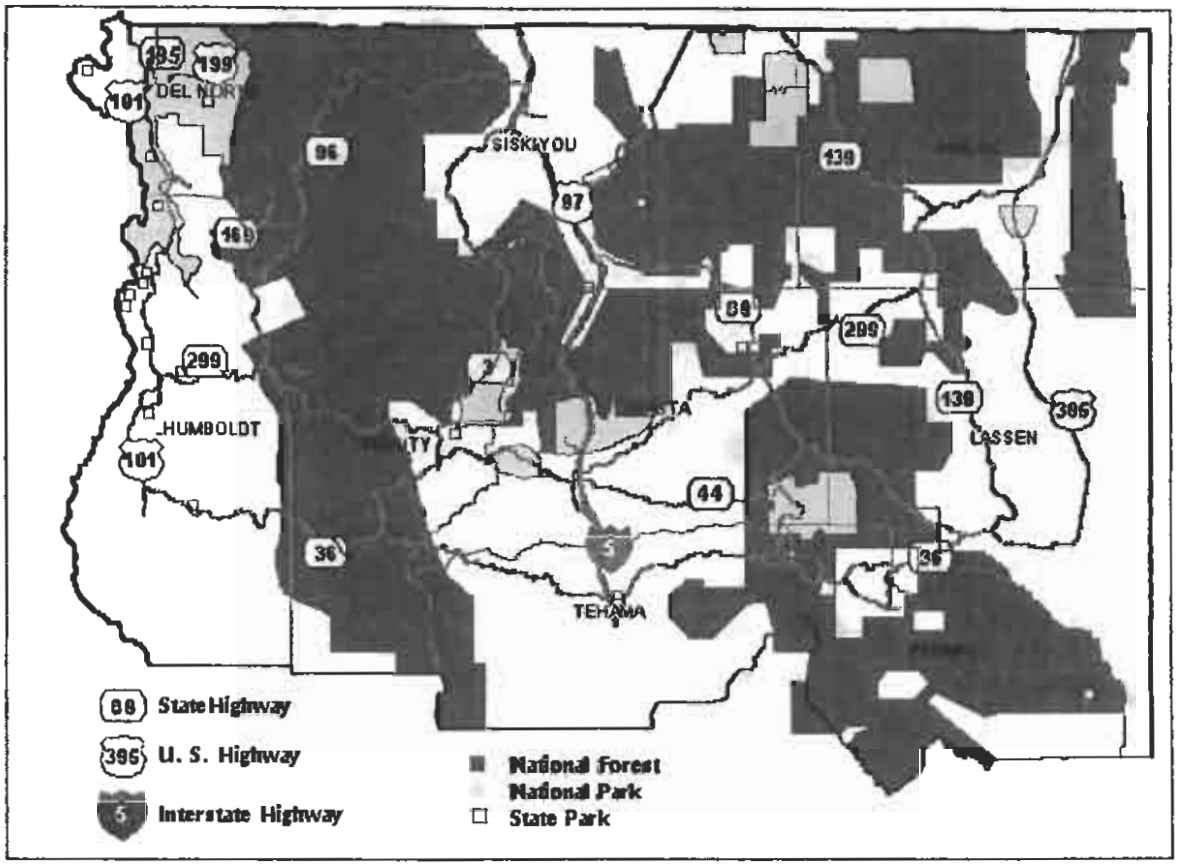

Figure 8 - Recreational Areas in Northern California

Forest	Recreational Visitor Days
Klamath	997
Lassen	1856
Mendocino	1485
Modoc	913
Six Rivers	1463
Plumas	2558
Shasta-Trinity	17,493

Table 10 - Tourist Visitation to National Forests in Northern California

State Park	Day Use	Camping	Total
Jedediah Smith Redwoods State Park	128,548	51,960	180,509
Del Norte Coast Redwoods State Park	41,501	29,184	70,685
Prairie Creek Redwoods State Park	229,725	57,610	287,336
Humboldt Lagoons State Park	325,519	1,404	326,924
Patrick's Point State Park	82,335	60,054	142,390
Trinidad State Beach	34,502	0	34,502
Azalea State Reservoir	26,313	0	26,313
Grizzly Creek Redwoods State Park	17,410	10,805	28,216
Humboldt Redwoods State Park	550,721	87,161	637,882
Fort Humboldt State Historic Park	54,788	0	54,788
Castle Crags State Park	50,152	24,689	74,841
Mcarthur-Burney Falls State Park	125,705	71,141	196,846
Shasta State Historic Park	27,977	0	27,977
Weaverville Joss House State Historic Park	15,659	0	15,659
William B Ide Adobe State Historic Park	31,252	0	31,252
Lake Earl and Talawa	27,269	172	27,441
Mount Shasta Recreational Area	No Data Available		
Little River State Beach	No Data Available		
Frenchman Reservoir Recreational Area	No Data Available		

Table 11 - Total Annual Visitors to State Parks in Northern California

5.4.4 Public Traveler Services / Public Mobility Services

5.4.4.1 Rural Door-to-Door Transit Initiative

Description

Caltrans is currently initiating a door-to-door paratransit system demonstration for the disabled in Santa Clara County. This demonstration includes paratransit vehicles equipped with high-tech automatic vehicle location and navigation systems and a paratransit dispatch center capable of providing real-time and reservation based door-to-door transit service. Caltrans and other partners are also initiating a "personalized" public transportation system providing door-to-door service to the public-at-large in the San Gabriel Valley region. The system will include advanced communications, automatic vehicle location, in-vehicle displays, smart cards and readers, and automated, demand responsive dispatching.

The Rural Door-to-Door Transit Initiative would extend this type of demonstration to a rural setting where fixed transit service is not practical. Vehicles used during this rural demonstration would be equipped with portable navigation devices capable of responding to previously identified visual landmarks rather than street addresses, as well as communication devices to provide the link to the Dispatch Center. Rider-participants

would request rides and receive trip information via a variety of interfaces, including telephones, pagers, and other hand-held devices.

Potential Benefits and Locations

Potential Benefits of such a system may include, a more efficient transit system (resulting in a reduced cost or more coverage with the same cost), and increased service to the public. Also, by increasing the service area and/or number of rides provided, many mobility impaired individuals would experience an improved quality of life. Areas that may benefit from such applications would include:

- Large number of transportation dependent (mobility impaired, persons below the poverty level, and seniors);
- Existing transit/paratransit system; and
- Existing transit systems where current demands exceed service levels.

Table 12 shows some population statistics regarding persons that may be transit dependent. Expanded transit service in these areas would result in a higher quality of life for them.

		Age 16-64		Age 65 +			Households	
County	Pop.	% M. I.	Total	% M. I.	total	% below poverty	% With no vehicle	Total
Del Norte	23,460	2.3	12,496	10.5	2,943	15.7	4.4	7,987
Humboldt	119,118	2.5	75,792	13.4	13,866	17.6	7.9	46,420
Lassen	27,598	2.4	13,796	16.8	2,767	13.3	6.3	8,543
Modoc	9,678	2.6	5,382	12.0	1,615	15.0	4.7	3,711
Plumas	19,739	2.5	11,785	9.8	3,281	11.9	5.4	8,125
Shasta	147,036	2.6	89,397	13.6	20,155	13.7	6.1	55,966
Siskiyou	43,531	2.4	25,584	13.8	6,987	14.0	7.6	17,306
Tehama	49,625	3.2	28,739	15.3	8,136	13.2	6.5	18,704
Trinity	13,063	3.1	7,773	18.5	1,918	11.9	6.4	5,156

M.I. = Mobility Impaired **Table 12 - Transit Dependent(16)**

A transit survey of the study area only identified one transit system that had to refuse riders. Upon a more detailed study of transit providers in rural California, other transit systems may be identified where demand exceeds capacity. The transit service that had to refuse riders based on exceeding capacity is:

- City of Yreka Senior Program
  Contact: Katie Anderson, Program Director
  (916)842-4455

In addition, the following transit agency showed a strong interest in implementing ITS

- Lassen County
  Contact: Scott Moss
  (916)251-8260

5.4.5 Fleet Operations and Management

5.4.5.1 Commercial Vehicle Fleet Management

Description
This application would aid carriers in better management of their fleets by tracking the vehicle's location, itinerary, and fuel usage using cell based or satellite data link. The vehicle may have a processor to interface to its sensors (e.g., fuel and speed) and the data link. The dispatcher can provide the vehicle with dispatch instructions, and can process and respond to requests for assistance and general information from the vehicle.

In addition, this application could support the maintenance of commercial vehicle fleet through close interface with on-board monitoring equipment and automatic vehicle location capabilities. Records of vehicle mileage, repairs, and safety violations are maintained to ensure safe vehicles on the highway.

Benefits
The greatest potential benefit of this system would include increased efficiency of a carrier's fleet. Since this system applies to one carrier at a time, it is left up to the individual carrier as to whether or not to implement such a system. However, since decreased cost of moving goods will benefit society as a whole, the State could help to inform carriers of such systems.

5.4.5.2 Caltrans Maintenance Fleet Management

Description
There are many ways in which infrastructure operations and maintenance could be made more efficient. Examples include a remote weather monitoring system to aid in a more efficient deployment of snow plows. In addition robotics for roadwork such as garbage pickup and striping continue to be developed and should be considered for the maintenance of the rural transportation infrastructure. These robotics can improve maintenance safety and efficiency

Benefits
By automating some maintenance activities and using real time information to deploy snow plows, there are benefits to be realized by reduced maintenance costs and improved safety. A benefit analysis of these types of applications is beyond the scope of this project. Further consideration is recommended for maintenance fleet management applications.

5.4.6 Commercial Vehicle Operations

Commercial vehicle operations include systems that improve the safety and efficiency of commercial vehicle fleets. Possible systems, discussed below, include electronic clearance, automated inspection and onboard safety monitoring, administrative processing, and hazardous materials incident response.

5.4.6.1 Commercial Vehicle Electronic Clearance

Description

This application would allow pre-cleared eligible vehicles to bypass weigh stations at mainline speeds. The Heavy Vehicle Electronic License Plate (H.E.L.P.) system is an example of this technology. There are currently operational sites along Interstate 5.

Potential Benefits and Locations

Carriers who participate in an electronic clearance program may realize a time savings benefit from being able to bypass a weigh station. The state weight enforcement may also realize a savings in scale operating costs by being able to concentrate on violators verses weighing legal vehicles. Implementation of this application may also result in a savings to the State from longer lasting pavements by reducing the amount of wear caused by overweight trucks. Potential locations include existing weigh stations. Further analysis, beyond the scope of this project, is required to determine which, if any, of the existing weigh stations would have an appropriate cost/benefit for this application.

5.4.6.2 Commercial Vehicle Automated Inspection and Onboard Safety Monitoring

Description

Both of these systems help to improve the safety monitoring of commercial vehicles. With the help of computers and advanced vehicle diagnostics, safety inspection could be made faster and more thorough. Onboard vehicle diagnostics could monitor critical vehicle components, such as the braking system, and warn the driver before a vehicle component failed.

Potential Benefits and Locations

Potential benefits include a possible reduction in the number of accidents involving trucks, as well as faster more efficient safety checks.

Possible application locations involving heavy vehicles were determined and are shown in Table 13. These locations and existing weigh/safety inspection stations have the potential to be effective locations for the implementation of commercial vehicle safety systems.

Route	County	Milepost From	Milepost To	Average AADT	Class	Total Accidents	Total Fatalities	Total Injuries	Rate
3	Trinity	80	85	200	1	1	0	1	0.91
36	Trinity	0	10	400	1	3	0	1	0.68
36	Trinity	30	40	150	1	1	0	0	0.61
89	Shasta	20	30	1,700	2	6	0	1	0.32
199	Del Norte	20	30	3,100	2	20	0	0	0.59
299	Shasta	0	10	3,900	2	23	0	1	0.54
299	Shasta	50	60	3,700	2	14	0	1	0.35

Table 13 - Possible Application Locations based on Commercial Vehicle Accidents

5.4.6.3 Commercial Vehicle Administrative Processes

Description

Commercial vehicle administrative processes refers to an electronic paper free vehicle. Carriers would be able to electronically purchase credentials for their trucks, thus reducing the administrative costs for the State and the carriers. Since this would apply to the entire State, a detailed cost benefit analysis, beyond the scope of this project, would be required for this system. Possible benefits include reduced overhead costs to commercial vehicle carriers and the State.

5.4.6.4 Hazardous Materials Incident Response

Description

This application would include systems that would aid hazardous materials (HAZMAT) response teams to have a faster more effective response to hazardous materials. An example is Operation Respond. This is a pilot program to maintain a database of hazardous cargo. Carriers are involved in order to keep the database current and accurate. Emergency 911 centers would be equipped to use this database in order to better inform the Hazmat response teams and produce an adequate response. Operation Respond would be inexpensive and simple to implement.

Benefits

Table 14 shows all fifteen accidents involving hazardous materials (not necessarily spilled hazardous materials) for the analysis area for the three year period(1992-94). Possible benefits may result from a faster reaction time by the HAZMAT response teams. Resulting benefits include: time savings by the commercial vehicle carrier, cost savings by the HAZMAT response team from a more efficient clean up, less environmental damage, and less deaths/injuries caused by the spread of the spilled hazardous materials.

Route	County	Milepost	Fatalities
005	Shasta	22.344	0
005	Shasta	32.11	0
005	Siskiyou	0.98	0
005	Siskiyou	2.84	0
005	Siskiyou	11.47	0
005	Siskiyou	22.99	0
036	Humboldt	0.01	0
036	Humboldt	2.36	0
097	Siskiyou	23.8	0
097	Siskiyou	52.91	0
101	Humboldt	53.33	0
101	Humboldt	118.75	0
139	Siskiyou	5.042	0
199	Del Norte	12.22	0
299	Shasta	49	0

Table 14 - Hazardous Materials Accident Locations

5.4.6.5 Commercial Vehicle Operations Summary

For CVO applications, benefits have been identified. Based on these benefits locations have been identified that, in the opinion of the research staff, have the highest potential of realizing these benefits. Recommended application locations, where identified, within this cluster are shown in Figure 9.

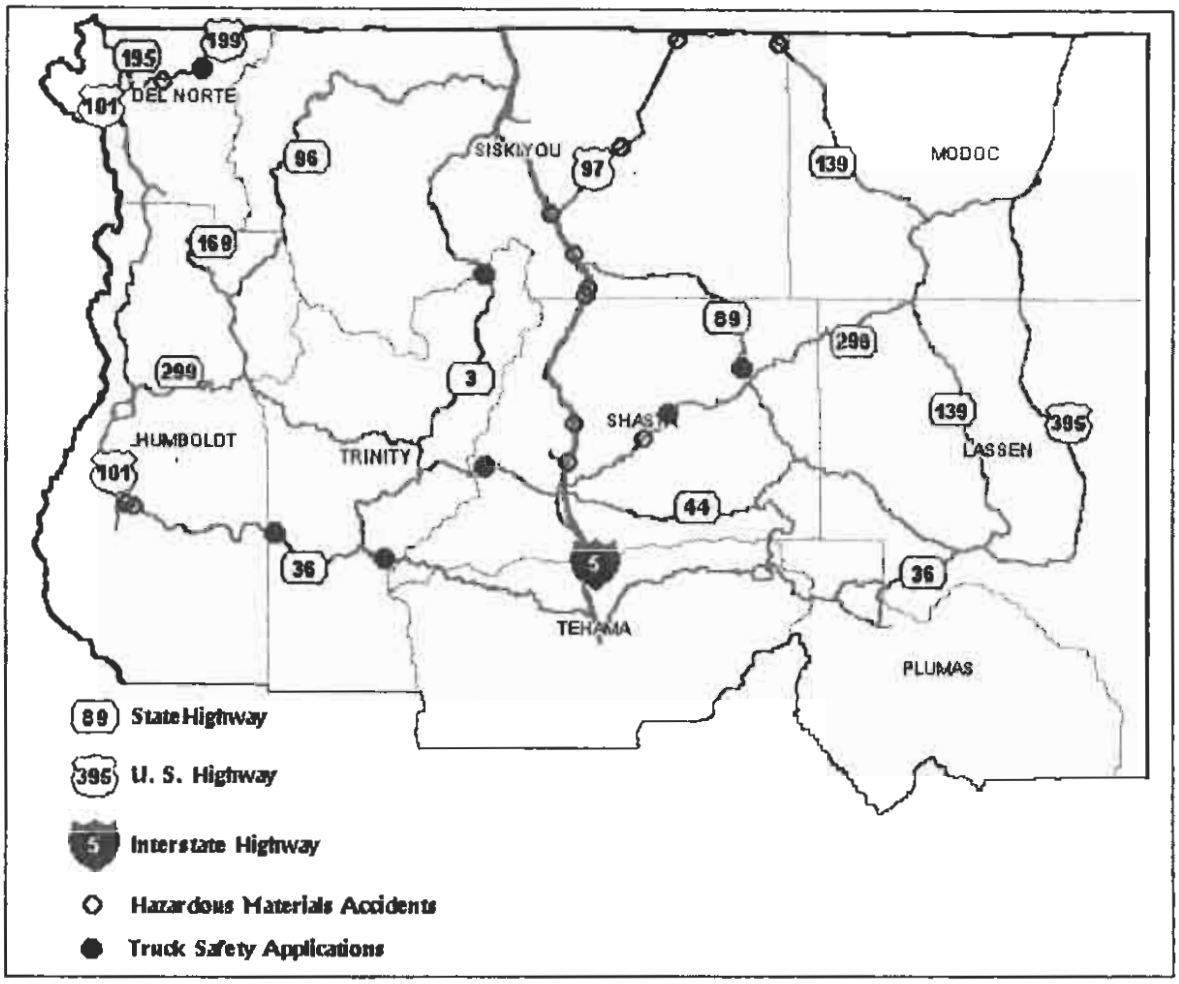

Figure 9 - Possible Applications for Commercial Vehicle Operations Applications

5.4.7 Summary

In an effort to determine potential benefits of ITS applications for rural northern California roadways, a variety of data has been assembled and analyzed including stakeholder perceived problems and solutions; California ITS initiatives; and national research. Based on limited stakeholder input and accident data analyzed, it is the opinion of research staff that the following applications may have the greatest possibility for success in rural California:

- Impaired driver monitoring;
- Safe speed warning;
- Automated speed enforcement;
- Mayday (expanding cellular coverage or satellite);
- Tourist and traveler information supplemented with weather information;
- Rural door-to-door transit initiative;
- Fleet Operations and Maintenance;

- Commercial vehicle fleet management;
- Commercial vehicle automated safety inspection; and
- Commercial vehicle administrative process.

The applications identified in this report that received second priority by the research staff as having a high probability for success are:

- Vision Enhancement;
- Object in the roadway warning;
- Call boxes;
- Commercial vehicle electronic clearance;
- Commercial vehicle onboard safety inspection; and
- Hazardous materials incident response.

Potential locations identified by this study for the applications identified as having a reasonable probability for success are shown in Figure 10. Commercial vehicle administrative process and fleet management are not shown in Figure 10 because they are area wide applications and not site specific.

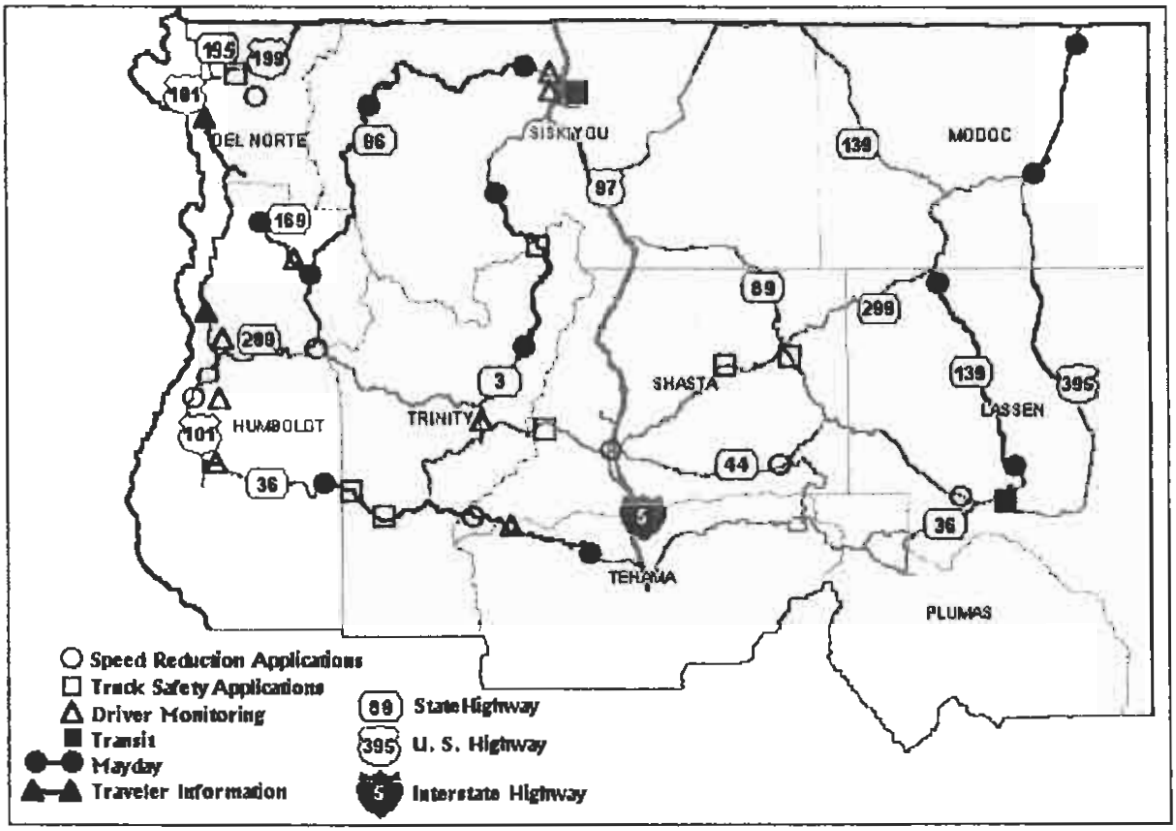

Figure 10 - Potential Deployment Projects

6. Funding

Intelligent Transportation System projects can be funded through a variety of public and private sector opportunities. These funding mechanisms include ISTEA, the reauthorization of ISTEA and private sector partnerships.

Under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) the U.S. DOT allocated over $660 million for Intelligent Transportation Systems (ITS) research, development and deployment. While rural ITS funding was limited, funding opportunities are available under the FHWA Priority Technologies Program, and Operational Test categories.

The Priority Technologies Program is under Section 6005 and is "set up to stimulate and provide incentives to develop partnerships for accelerating the application of advanced technologies."(17) Program funds (FY 97 $ 3,000,000) are usually regionally competed for by state DOTs. For the Caltrans region this years funds will be approximately $250,000. A local match of twenty (20%) percent is required for this funding category under ISTEA.(17)

Operational Tests are another funding opportunity. While these opportunities have decreased in recent years, the FHWA will be releasing two nationally competed solicitations for 1) Road - Weather Information Systems and Advanced Traveler Information Systems(18); and 2) Tourism and Advanced Traveler Information Systems.(19) An undetermined amount of funding will be available for the RWIS and ATIS Operational Test and approximately $600,000 for Tourism and ATIS will be eligible for two to three $ 200,000 to $ 400,000 projects, according to FHWA representatives.

Additional federal funds may also be available from the Federal Transit Administration for rural door-to-door transit initiative and other similar projects. These funding categories may include but are not limited to:

- FTA Section 5311 (formerly section 18) Rural and Small City Transit - reimburse public transportation system operating and capitol costs up to 80%.
- FTA Section 5313 - planning and research for rural areas.

Also, because rural ITS projects provide for increased safety, funding is available through the Highway Safety Act of 1996, Section 402.

While it is uncertain the level of funding for rural ITS by USDOT, at the 1997 Transportation Research Board Annual meeting in January, the Joint Program Office announced a three segmented program initiative targeted at metro, commercial vehicle operations, and rural needs. It is anticipated that the ISTEA reauthorization will provide some rural ITS funding opportunities, but the exact levels are unknown at this time.

In addition to public funds, the private sector is a potential source of funding. Some systems may be entirely implemented and managed by private industry. These companies

may recover their costs through user fees, advertisements in the system, or other means. In the infancy of some technologies, vendors could sometimes loan equipment for a period of time to promote their product, or in exchange for field testing their product.

Caltrans may wish to consider deploying ITS through cooperative partnerships, too. An example of this type partnership is the Heavy vehicle Electronic License Plate (H.E.L.P) Inc., an organization funded by user fees, and private and public organizations. The State should continue to examine future contractual rules to allow and encourage such cooperative partnerships.

7. Recommendations

The purpose of this report was to provide rural California stakeholder input and feedback on problems and potential ITS applications; review on-going California initiatives; investigate national rural research needs; and make preliminary recommendations to the Caltrans Program for Advancing Rural Transportation Technologies.

As a result of the findings of PARTT, it is recommended that Caltrans pursue a selection of a rural area to further refine the need for potential application of ITS. The northern California geographic area from SR 36 on the south to the Oregon border and from US 101 on the west to US 395 should be considered as a potential study area.

Based on a cursory benefit analysis, limited stakeholder feedback, and Caltrans supplied data, the following short and long-term research and deployment recommendations are provided. These recommendations are prioritized based on their potential for building a successful ITS program and meeting the stakeholder needs.

7.1.1 Short-Term Deployment

Short-term deployment is vital to building support for continued ITS deployment activity in rural California because it will allow the public to realize an early return on their investment . Short-term deployment for this report can be defined as less than five years. For each short-term application, potentially beneficial areas were identified by research staff and are shown in Figure 11. Short-term deployment recommendations have been arrayed based on the Advanced Rural Transportation System Critical Program Areas to show parallel between National and California initiatives.

Traveler Safety and Security

A Traveler Safety and Security project would include two applications (safe speed warning system and automated speed enforcement). Either application may have the potential to reduce the number of speed related accidents. Determining which, if either, of the two systems would have an effect on reduction of accidents in the areas identified would require further analysis beyond the scope of this effort. Areas with a high number of speed related accidents are shown in Figure 11.

Safe speed warning system shows great potential and are already used by Colorado and Oregon. The basic system components include a road surface sensor, vehicle sensor, a processor, and a variable message sign. These systems are generally stand alone and appear to have a comparatively low cost.

Automated safety enforcement systems have the potential to reduce speed related accidents and save enforcement resources. Automated speed enforcement is also relatively low cost, potentially high benefits, and previously tested.

Emergency Services
Based on the results of TransCal demonstration which uses satellite communications, widespread deployment efforts should be considered. A second alternative, preferred by stakeholder, would be the expansion of cellular coverage to allow the use of cellular based mayday. Many rural areas do not have cellular coverage from cellular phone providers. Cellular coverage providers, most likely, will not expand without subsidized funding in these rural areas because of the lack of market potential. The benefits of expanding cellular coverage in rural areas, if proven to be large enough, may afford the subsidizing of coverage expansion. Areas with no cellular coverage, and low AADT have the potential of realizing the benefits of these types of systems and are identified in Figure 11.

Tourism and Traveler Information Services
Tourism and travel information systems supplemented with weather and road conditions show a potential benefit to enhance the tourism economy and increase driver comfort. In addition, safety benefits may be realized by more informed drivers. A potentially beneficial area identified by research staff for deployment includes Route 101 in Humboldt and Del Norte counties. To provide for sustainable funding levels, Caltrans should consider advertising as a means to finance the systems. The system could include any or all of the following elements depending on design.

- Internet information - this is a low cost method of providing information for an entire area.
- Touch screen information kiosks at roadside tourist stops. The YATI system, for example, could be patterned as a self supporting system with initial seed capitol from state and federal sources.

Public Traveler/ Mobility Services
Caltrans should consider a rural door-to door transit initiative where computer software is used for fleet management, scheduling and routing, and reservations. An additional option could include an automatic vehicle location (AVL) system that is integrated with the scheduling and routing software for better fleet management. From the limited stakeholder feedback, the AVL was not a preferred solution, but computer software programs for more efficient management received a high stakeholder ranking. Two candidate existing paratransit systems for this demonstration identified by research staff are:

- City of Yreka Senior Program
  Contact : Katie Anderson, Program Director
  (916)842-4455

- Lassen County
  Contact: Scott Moss
  (916)251-8260

Commercial Vehicle Operations
Short term Commercial vehicle automated safety inspection applications may be implemented at existing weigh stations in rural California. Such applications include the automated brake adjustment system using video imaging, as described in an Automated Roadside Inspection Feasibility Study.(6) While the truck is weighed, this system allows the safety inspector to visually inspect the brakes through video cameras mounted in the scale. This and similar applications could be demonstrated at one safety inspection station and, pending results of demonstration, could be deployed throughout rural California. Potential locations include existing safety inspection stations near the high truck accident locations identified in Figure 11.

7.1.2 Long-Term Deployment

Long-term deployment can be defined as applications that: require greater than five years; are potentially beyond the role and responsibility of Caltrans; or require further study on detailing the benefits. For each long-term applications, potentially beneficial areas were identified by research staff and are shown in Figure 12.

Traveler Safety and Security
The design of a driver monitoring system impacts benefits, cost, and reliability. This application is being recommended for long-term deployment because additional research may be required and because this application may be more applicable to vehicle manufactures. Locations with a high number of accidents caused by drunk driving, driver inattention, and driver fatigue are shown in Figure 12.

Tourism and Traveler Information Services
The tourist information systems that may not be currently beneficial for early deployment include in-vehicle and portable hand held devices. These applications may be less beneficial and cost effective because only one person may use the system as opposed to other systems, such as kiosks, were a greater number of persons can use the application. However, for long-term, Caltrans may wish to investigate the use of such device to test its benefits. The portable digital assistant could be rented, or loaned to tourists for their trip at welcome centers or other locations that tourists frequent. These devices may be able to tap into existing databases developed for the early demonstration tourist information. As with the early demonstration, tourist and traveler information services, a potentially beneficial route identified by research staff includes route 101 in Humboldt and Del Norte counties.

Fleet Operations and Maintenance
For long term deployment, Caltrans should consider continued commercial vehicle fleet management outreach and education. While fleet operations and maintenance ITS applications are: proven technology, feasible, and beneficial, the implementation of these systems is carrier dependent. The potential benefit to society through reduced cost of shipping may warrant an outreach effort, to the carriers, detailing potential system designs, and estimated costs and benefits.

Also for long-term deployment, Caltrans should consider improvement to commercial vehicle administrative processes. The benefits of electronic purchase of credentials and similar applications to the State and carriers could be significant. Also, this application requires major cooperation, restructuring of existing paperwork processes and coordination of public and private sector organizations. Unlike many of the other projects discussed that can be deployed in specific locations, this application requires statewide deployment to realize the benefits.

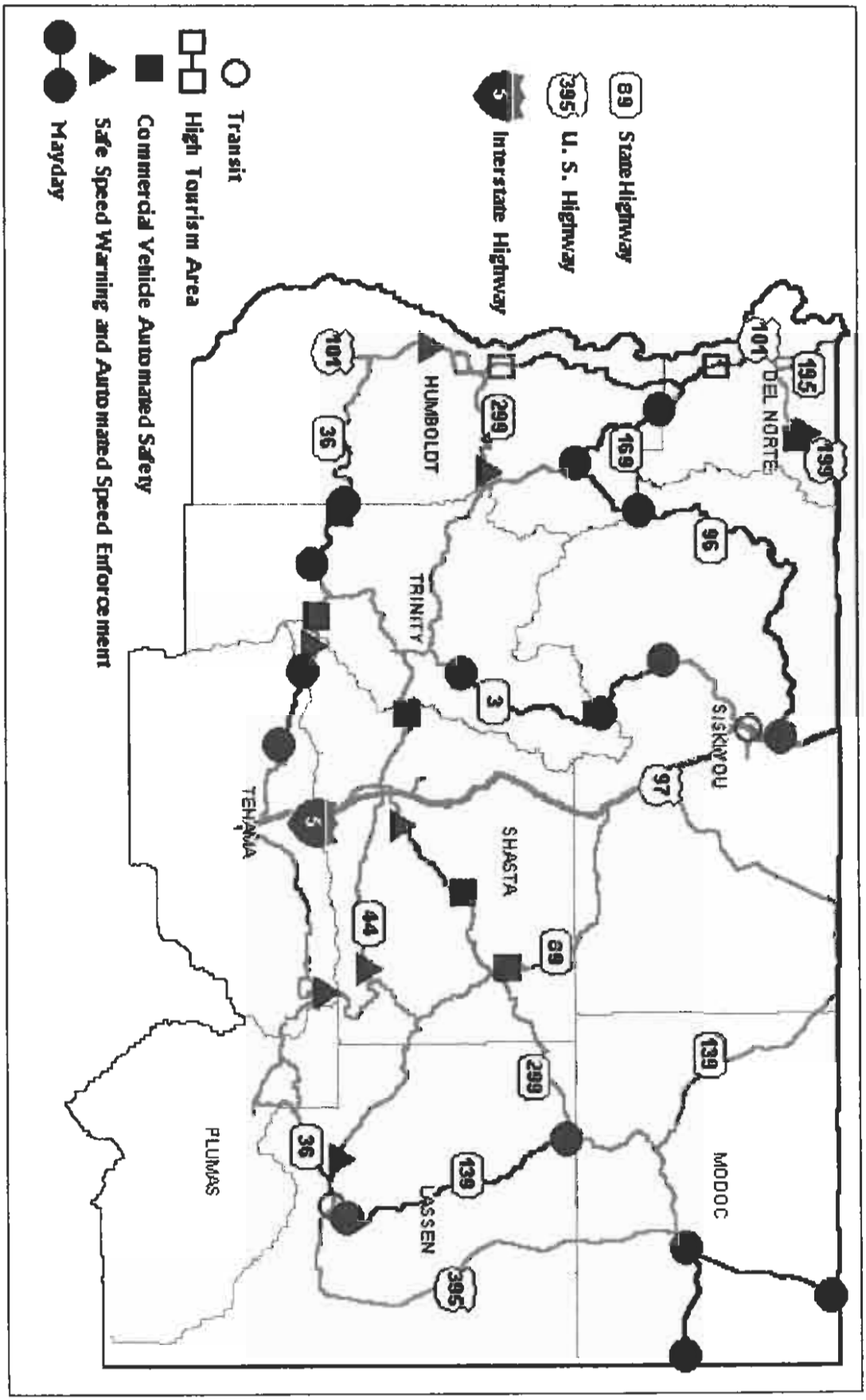

Figure 11 - Short-Term Deployment Applications and Locations

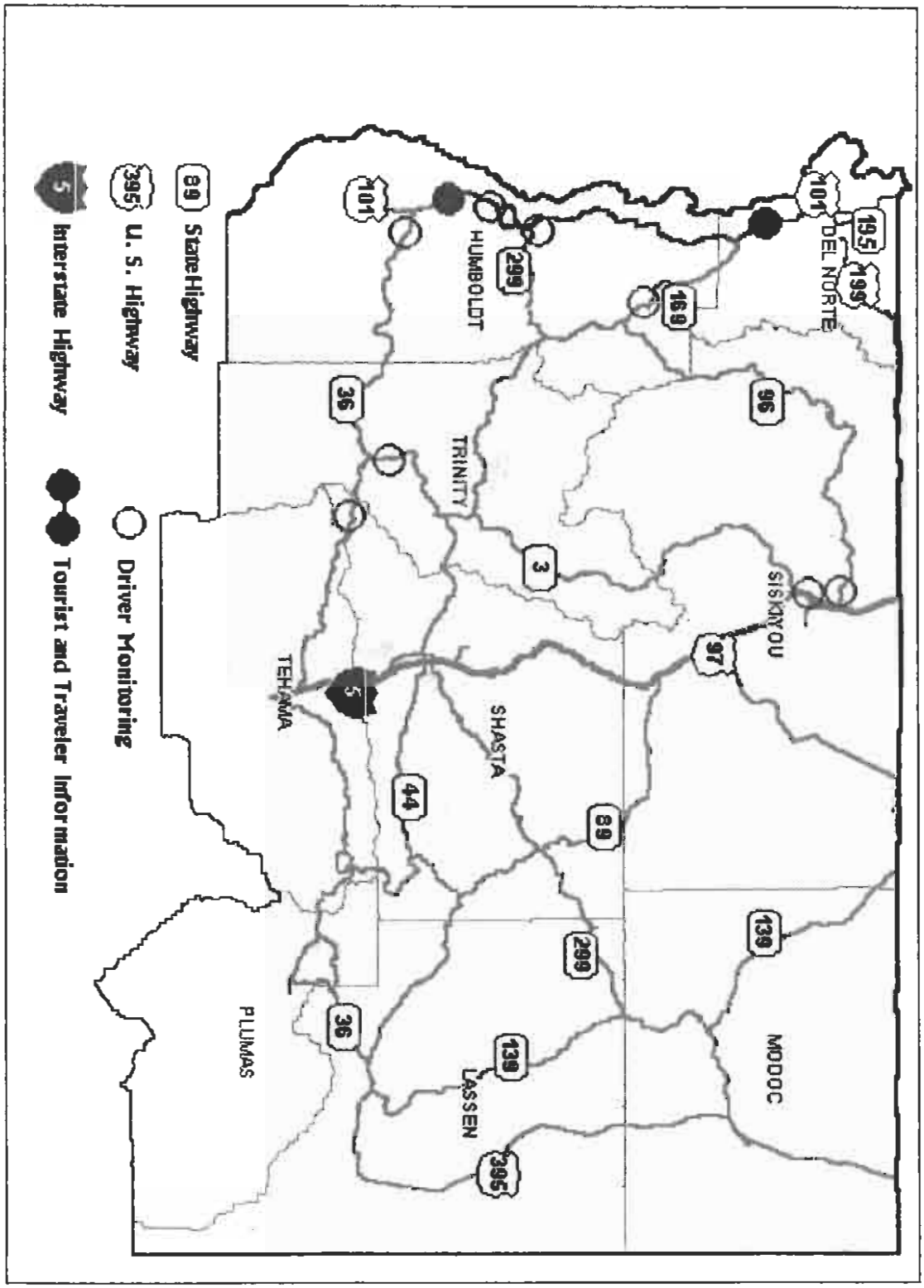

Figure 12 - Long-Term Deployment Applications and Locations

7.1.3 Research Initiatives

Based on stakeholder needs, the problem/solution identification in this report and the ITSA ARTS Committee, Rural Research Sub-Committee, the following research projects have been identified and recommended for continued research. These research and demonstration areas include:

Institutional Issues and Outreach

- Develop an effective outreach program to educate rural stakeholders and to generate a constituency for ITS in rural and small urban areas.
- Research ways to overcome institutional barriers (funding, jurisdictional authority, etc.).

Communication Infrastructure

- Communication alternatives to enhance area wide coverage in rural environments .

Standards and Protocols

- Identify major rural considerations for the ITS national architecture
- Short range communications

Economic Viability

- Evaluate the impact of traveler information on economic development.
- Perform market research analysis of in-vehicle and portable tourist information systems to determine feasibility.

8. Next Steps

While the previous section recommended deployment phasing, the Western Transportation Institute (WTI) realizes that other efforts to assist deployment could be initiated immediately. These next steps relate to outreach, funding, further analysis and deployment prioritization.

8.1 Rural ITS Outreach

The WTI has organized and conducted a rural ITS workshop in Bishop, CA that determined stakeholder problems and probable solutions. While this workshop was beneficial in educating and facilitating discussion on Advanced Rural Transportation Systems (ARTS), WTI recommends:

1) Revisiting the Bishop site and increase the number and representative stakeholder groups for a broader more significant sampling;
2) Conducting a similar outreach effort in northern California (Caltrans District 1 and 2) to discuss problems and provide for ARTS education and facilitation; and
3) Presenting report findings to Districts 1, 2 and 9 Caltrans offices and area stakeholders to determine appropriate prioritization of needs and ITS route specific improvements.

8.2 Funding Opportunities

In the next six (6) months, the Federal Highway Administration will be requesting responses to solicitations on two operational test projects. The first operational test will be for Tourism and Advanced Traveler Information Systems (ATIS), and the second, for Road Weather Information Systems and ATIS. The national solicitations would provide Caltrans an opportunity to leverage state funding to obtain federal dollars for meeting the needs of the rural California stakeholders and building on the recommendations of this report.

8.3 Prioritization

While this report has recommended probable benefits that may be realized from deployment of ARTS, it was beyond the scope of the study to determine any benefit and cost analysis. It is recommended that a strategic plan be developed to direct the research, demonstration and deployment of ITS in rural California. Before a detailed plan can be implemented, the following actions should be considered:

- Form a regional steering committee to provide policy direction, goals and objectives;
- Determine cost for each application including capital installation, operation and maintenance, and life cycle;
- Prepare a business plan that details immediate, short term and long term deployment actions and benefits;
- Obtain stakeholder consensus on the business plan and deployment prioritization; and
- Secure public (federal, state, local) and private funding

9. Conclusion

The goal of this project was to further develop the Program for Advancing Rural Transportation Technologies (PARTT) and make recommendations to direct continued action required to move PARTT forward successfully. This was accomplished through stakeholder needs assessment, monitoring of national rural ITS activities, identifying existing rural ITS activities in California, identifying solutions based on stakeholder feedback, previous PARTT efforts and national activities, determine potentially beneficial locations for implementation of these solutions, identify potential funding sources for the PARTT, and based on these results make recommendations and identify next steps. These items were accomplished as described in this report. The final result of this project is manifest in the action items outlined in this report's recommendations and next steps.

References

1. Federal Highway Administration, (1994). Highway Statistics.

2. California Department of Transportation, (1996). Assembly of Statistical Reports-1994.

3. National Highway Traffic Safety Administration, (1994). Traffic Safety Facts.

4. Federal Highway Administration, (1994). Preliminary Assessment of Rural Applications of Advanced Traveler Information Systems (Draft Report). JHK & Associates.

5. ITSA Conference, Houston, Texas, (1995), FTA Presentation

6. Weppner, M., Rogova, G., Alexander, P., (1996). Automated Roadside Inspection Feasibility Study for Commercial Motor Vehicles. Proceedings of the 1996 Annual Meeting of ITS America, 777-781.

7. The Diebold Institute for Public Policy Studies, Inc., (1995). Transportation Infostructures, the Developments of Intelligent Transportation Systems.

8. U.S. Department of Transportation Joint Program Office for ITS and ITS America, (1995). National ITS Program Plan, 1st edition.

9. California Department of Transportation, New Technology and Research Program, (1995). Advanced Transportation Systems Program Plan.

10. U.S. Department of Transportation, (1996). Advanced Rural Transportation Systems (ARTS) Draft Strategic Plan.

11. Evans, M., (1996). Chief of Division of Operations, California Department of Transportation, District 3 [Telephone Conversation]. (916) 324-1165.

12. Gomez, D., (1996). Associate Transportation Electrical Engineer, California Department of Transportation, District 6 [Telephone Conversation]. (209) 488-4163.

13. Loveland, C., (1996). Chief of California Advanced Public Transportation Systems, California Department of Transportation, New Technology & Research Program [Telephone Conversation]. (916) 654-9970.

14. California Department of Transportation, (1995). Traffic Volumes on California State Highways.

15. Cellular One, (1996). Local/California Coverage, [on-line], http://www.cellone-sf.com/calif.html.

16. Bureau of the Census, U.S. Department of Commerce, (1990). Census of Population and Housing [CD-ROM]. Summary Tape File 3-A.

17. Burkhardt, R., (1996, November). Priority Technologies Program-Guidelines and Funding for FY 97 [Memorandum to Bob Garber, Research Manager, Montana Department of Transportation].

18. Resendes, R., (1997, February). ARTS Program Coordinator, U.S. Department of Transportation, Joint Program Office for ITS [Personal Communication].

19. U.S. Department of Transportation, Rural ITS Program (1996, November). Tourism and Advanced Traveler Information Systems Field Operational Test [Draft-Notice and Request for Proposal].