Rural Applications of Advanced Traveler Information Systems: User Needs and Technology Assessment

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Research and Development
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6300 Georgetown Pike
McLean, VA 22101-2296

FOREWORD

The User Needs and Technology Assessment Report is one in a series of interim documents for the Rural Applications of Advanced Traveler Information Systems (ATIS) project. The document describes the research design and findings from rural traveler surveys to identify and prioritize traveler information needs in rural and small urban areas (less than 50,000 population). Information was gathered in focus group discussions and telephone interviews with travelers in rural areas, and consultations with agencies engaged in collecting, coordinating, and disseminating information to rural travelers. The report also describes the nature of and quantifies the magnitude of rural traveler information problems. From this quantification, an assessment of information needs is summarized.

This document also examines technologies available or under development which are applicable to rural advanced traveler information systems. The application of technologies to data collection, data aggregation/processing, traveler interface, and communication in a rural environment is broadly assessed. The document also summarizes current initiatives relevant to rural applications of ATIS and presents an overview of project findings to date. A framework for further development of ATIS concepts to meet travelers' information requirements in rural and small urban areas is also presented.

The intended audience for this report is Federal, State, and local officials and others interested in and involved in the deployment of ATIS in rural and small urban areas.

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Director of Office of Safety and Operations
Research and Development

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16, Abstract

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd □ 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2 = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2 = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectares (he) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (Lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp □ 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] ^{o}F □ y ^{o}C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 hectare (he) = 10,000 square meters (m^2) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gr) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliters (ml) □ 0.03 fluid ounce (fl oz)
1 liter (1) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] ^{o}C □ x ^{o}F

QUICK INCH-CENTIMETER LENGTH CONVERSION

INCHES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

CENTIMETERS: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 25.40

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NBS Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. Cl3 10286.

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EXECUTIVE SUMMARY

INTRODUCTION

This report provides a preliminary assessment of "Rural Applications of Advanced Traveler Information Systems (ATIS)" and is the result of an extensive Federal Highway Administration (FHWA) sponsored investigation. The goal of the report is to identify and substantiate rural traveler needs, the technology available or under development which may be incorporated in ATI systems in order to meet these needs, and to begin the process of identifying rural ATIS applications for further development, operational testing, and implementation.

THE PROJECT

This preliminary assessment details the "four points of focus" which will be the basis of the development of ATIS applications for the rural environment. These four points are:

1. Identifying rural traveler informational needs.
2. Identifying the technologies which may support the needs.
3. Having an understanding of the current state-of-the-art in rural ATIS.
4. Recognizing application areas with potentially high benefits for both the traveler and the system provider.

The remaining tasks of the project include:

- Completion of the development and evaluation of system concepts.
- A comprehensive systems analysis of the concepts and their component subsystems.
- Selection of concepts for further development and preparation of a research program plan leading to operational tests.
- Development, installation, and initial testing of one or more of these systems.
- Development of a set of guidelines for selection, design, and implementation of ATI systems in rural and small urban areas and preparation of a comprehensive report documenting the results and findings of the study.

RURAL, ITS

Most intelligent transportation system (ITS) investments to date have been concentrated in major urban areas, where congestion is most severe and population densities are highest. ITS technology, however, also offers substantial potential benefits to both highway users and operators in rural areas.

Traffic fatalities are disproportionally represented in the rural environment; 40 percent of all vehicle-kilometers traveled (VKT) in the United States and 61 percent of all fatal accidents occur on rural roadways. A serious safety issue, motor-vehicle fatalities accounted for approximately 50 percent of all accidental deaths in the United States in 199 1. Thus, safety is a fundamental concern of the rural travel environment.

THE RURAL ENVIRONMENT

The rural environment incorporates rural and small urban (less than 50,000 population) areas and includes local rural travel as well as intercity and interstate travel. Eighty-five percent of the road mileage in the United States is in rural and small urban areas.

Because the rural environment differs greatly from the urban environment, the informational needs of the travelers within rural areas vary from those in urban areas. Thus, the rural environment presents significantly different challenges to ITS deployment than does the typical urban area:

- Congestion is primarily nonrecurrent.
- Fewer alternate routes are available.
- Emergency services take longer to respond to rural incidents on average.
- The provision of cost-effective systems is more difficult in rural areas as there are many more miles of rural highways than urban, and traffic volumes on rural roadways are much lower.
- Rural highways tend to traverse more rugged terrain than urban.
- Rural roadways have fewer multiple vehicle accidents than urban and a high proportion of single vehicle accidents.
- Urban areas tend to be dominated by commuter trips, whereas rural and small urban roadways tend to have a much greater proportion of recreational trips, farming trips, and commercial vehicle tips.
- Trips in rural areas tend to be longer, thus fostering motorist inattention and dozing.
- A higher percentage of older vehicles, commercial vehicles, and slow moving farm vehicles characterize rural traffic.
- Animals wandering on, or bounding across, the roadway present a hazard which is unique to rural settings.
- Lack of existing infrastructure (e.g., electricity, telephone) in sparsely populated areas makes implementation of cost-effective systems more difficult.
- Roadway lighting is not usually provided in rural areas, so visibility is decreased compared to urban areas.
- Rural highways are more difficult to maintain because of the usually large area of coverage, resulting in more problems with the clearance of snow and ice, maintenance of bridges, etc.
- The average speed is typically higher in the rural environment.

PERCEIVED USER PRIORITIES

User Services

An interview process consisting of focus groups, national telephone surveys, and one-on-one interviews was undertaken in order to determine perceived rural travel informational needs. A total of seven user services were anticipated to be needed by travelers in rural and small urban areas.

1. Trip Planning is a pre-trip function which may provide the traveler with information to help decide if the trip will be made and, if so, which route or mode to choose.
2. Routing is a more specific form of route selection than that provided in trip planning and allows the traveler to specify preferences such as road types, route characteristics, and intermediate destinations.

3. Traveler Advisory is a service which provides the traveler with real-time information regarding travel-related conditions.

4. Traveler Services Information includes location and additional descriptive information regarding necessary services such as food, fuel, lodging, car repair services, and hospitals.

5. Safety and Warning systems are both in-vehicle and roadside functions. They monitor vehicle conditions, roadway geometrics and related vehicle activity, and even driver condition.

6. Route Guidance is an en route service providing the traveler with directions for getting from the vehicle's current location to a selected destination.

7. Emergency Services encompass several traveler support functions, such as mayday alarms, mechanical assistance requests, and medical assistance requests.

TRIP STAGES

The information needs of travelers in rural and small urban areas can be categorized by the stage of the tip:

- Pre-Trip Information is basically used for trip planning and is provided to a traveler at the trip origin prior to initiation of the trip. Some examples of this type of information include alternate modes, trip routing, timing, weather and roadway conditions, and en route facilities.

- En Route (Problem Free) is provided en route to the traveler while he/she is not immediately faced with any specific problem. Examples of this type of information include changing roadway and weather conditions, alternate routes, and traveler services.

- En Route (With Problem) is provided while en route, but upon occurrence of special problems (e.g., mechanical breakdown, an incident) which create a need for specific information. Emergency and driver warning are examples of this type of information.

RURAL TRAVEL INFORMATION NEEDS ASSESSMENT

METHODOLOGY

An extensive series of interviews were undertaken to identify the top priorities travelers and transportation and emergency service providers placed on the availability of travel related information in rural areas. The interviews were national in scope and included:

1. Focus group sessions with 15 to 20 members of the general public.

2. Two national telephone surveys of 1,025 households.

3. Focus group sessions with representative highway agency and emergency service provider personnel.

4. Focus group sessions with commercial users.

5. 61 one-to-one interviews with senior highway, police, emergency medical services, tourist, commercial operators, and travel organization executives.

General Travelers' Information Needs and Priorities

Information Needs and Priorities

Not surprisingly, the key information needs of gerieral travelers are focused on obtaining assistance when faced with any problem encountered while traveling. The second priority was determining the preferred trip route during the pre-trip planning stage, and general en route information placed a distant third.

The information most desired by general travelers, in order of importance, includes:

1. The ability to call for help (mayday) in an emergency.

2. Warning of approaching hazard immediately ahead.

3. An alert signal which will sound if the driver falls asleep at the wheel, or the vehicles starts to go off the road.

4. Information concerning road closures and trafftc congestion ahead.

5. Advisories of maximum safe speeds under prevailing conditions.

6. Directions and route selection to get to a given destination.

As stated above, the ability to transmit a mayday signal when faced with a problem en route was the greatest desire. Such a system should have the capability to be activated both manually and automatically, and it must include automatic vehicle location capability. Two-way communication is desirable, so that a stranded traveler could specify the type of problem to an emergency center and could also receive necessary instructions until help arrived.

Technology Perceptions

The general travelers appear open to using advanced technologies to meet their information needs. In-vehicle technologies as a means of information dissemination, such as audio and video, were viewed as potentially useful. However, some concern was expressed regarding the safety of in-vehicle video displays. Accurate information on weather and road conditions was viewed as essential to the adoption of these advanced information systems. Interviewees indicated a willingness to pay for the desired pre-trip planning information if it could be obtained, for example, through a means such as a single phone call or through interactive television.

Other Highway Users' Information Needs and Priorities

Other highway users are represented by the commercial fleet operators, emergency medical services providers, and community and school transportation operators. Their information requirements are influenced by the nature of their operations, such as commercial fleet regulations, scheduling, and vehicular characteristics. Their interest in information is mainly to assist them in meeting schedules or delivery deadlines and making their trips quick, efficient, and safe.

The primary information needs of this group are related to safety and warning and traveler advisory. They include obtaining more accurate and accessible information on weather and road conditions with sufficient advanced warning to avoid any effects on their trip. The information about road conditions was most valuable to a driver when provided en route, since conditions such as these can change rapidly. There are also concerns about regulations and other restrictions en route.

Commercial operators collect information from a variety of sources, and several managers said they would like to be able to consult just one source to get this information. Information on construction was obtained from county governments and State departments of transportation (DOT's). It was stated repeatedly that drivers were the best source of accurate information.

These highway users view AT1 systems as tools which can assist them in doing their jobs more safely and efficiently. However, they are very sensitive to the costs incurred in obtaining information. Any investments in new technology must provide benefits, through cost savings, which outweigh the investment cost.

Emergency medical service (EMS) providers were most interested in those technologies which would facilitate reporting accidents. It was felt that mayday systems would be a good way to reduce accident notification times dramatically in rural areas. However, several concerns were raised. One was that a mayday system would be prone to abuse if the signal could be manually activated. Other concerns were that the system would be too expensive, it would not provide enough information to EMS dispatchers, and would demand more staff resources to monitor mayday signals.

PROVIDERS' INFORMATION NEEDS AND PRIORITIES

As providers of various types of information, this group includes highway and law enforcement agencies, economic development and tourism departments, county governments, the National Park Service, automobile clubs, and other interest groups. Safety and warning information is considered the most important by the providers. They want the information they supply to travelers to be accurate, relevant, reliable, and delivered in real time, thus improving the quality of information supplied. They are also concerned about driver information overload.

Providers identified characteristics of the rural environment which impact transportation, particularly regarding traveler safety:

1. Weather conditions can be unpredictable and change rapidly. Rural travelers must deal with snow, ice, fog, and flash floods, and often with a lack of adequate warning. In the western States, mountain roads can be closed most of the year due to snow.

2. Rural drivers must contend with heavy truck traffic from logging or agricultural operations and slow moving farm vehicles on secondary roads. They must be alert for obstacles in the road, such as animals or fallen rock.

3. Rural roads carry low volumes of traffic. There are fewer motorist services available in rural areas.

4. A combination of large distances and a low volume of traffic in rural areas is a major problem for effective dissemination of information.

Provider groups are enthusiastic about the potential of an ATIS to help them do their jobs more effectively. However, they also identified several issues and barriers to ATIS implementation:

1. The cost and availability of funding for implementation of ATIS.

2. User sensitivity to cost of in-vehicle systems.

3. Liability for both the accuracy of information provided and the performance of in-vehicle ATI systems.

4. Institutional issues and the need for standardization of ATIS technologies and communications.

ESTIMATING THE MAGNITUDE OF THE PROBLEM

While perceived needs are important in the development of informational systems, and will be essential to the public and commercial acceptance of such systems, it is imperative that the magnitude of rural transportation problems related to these needs also be understood. Therefore this study involved a data collection effort in an attempt to quantify, where possible, rural transportation needs. Figure 1 presents illustrative figures of the magnitude of rural travel. Additionally, a generalized summary of both perceived and substantiated needs is presented in figure 2. This summary is the result of a subjective review of the data collected.

TECHNOLOGY ASSESSMENT

A state-of-the-art technology review was conducted in order to identify technologies which may be applicable to rural ATIS. A top priority in evaluating available technologies was not to reinvent the wheel, but rather to piggyback on existing or developing projects and apply them to rural and small urban situations.

Several major conclusions were drawn from the state-of-the-art technology review. Substantial proven technology is available to support basic rural ATIS applications, and there are significant promising innovations, The potential to piggyback rural ATIS applications on other, non-transportation investments, is substantial.

The four functional areas of any rural ATIS are data collection, data aggregation and processing, communications, and traveler interface.

DATA COLLECTION

Much of the data collection in a rural ATIS will be done manually. This is due both to the

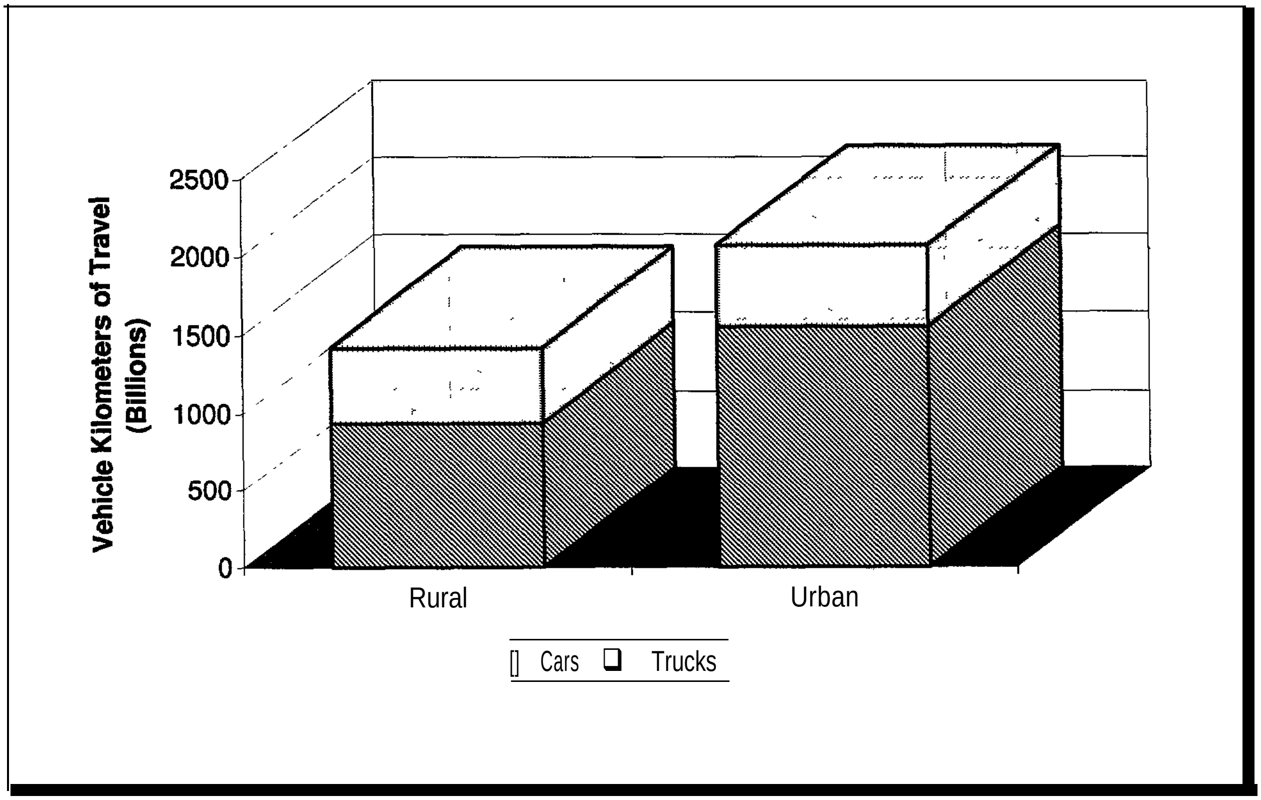


Figure 1: Annual Vehicle-Kilometers of Travel — Rural vs. Urban by Vehicle Type

USER SERVICE	RELATIVE PRIORITY					
	SUBSTANTIATED				PERCEIVED	BOTH
INFORMATION NEED	SAFETY	CONV./EFF.	ECONOMIC DEVLPMNT	TOTAL		
TRIP PLANNING/ROUTING						
Routing	1	4	0	5	6.2	**31.0**
Road Conditions	1	3	1	5	5.2	**25.9**
Weather Conditions	3	4	1	8	5.0	**39.7**
Travel Time	0	4	1	5	5.2	**25.9**
En Route Facilities	1	2	3	6	4.0	**24.0**
TRAVELER ADVISORY						
Recurrent Congestion	1	2	1	4	5.1	**20.4**
Construction & Maintenance	1	4	1	6	5.1	**30.6**
Incidents	2	4	0	6	5.1	**30.6**
Weather & Visibility	3	3	1	7	4.5	**31.2**
Road Closures	1	4	0	5	8.2	**40.9**
TRAVELER SERVICES						
Lodging & Restaurants	0	2	5	7	4.3	**29.8**
Tourist Attractions	0	2	5	7	4.3	**29.8**
Assistance Services	1	3	3	7	4.3	**29.8**
SAFETY & WARNING						
Vehicle Conditions	4	3	0	7	8.5	**59.3**
Vehicle Activity - Collision	5	3	0	8	8.5	**67.8**
Vehicle Activity - Speed	5	3	0	8	8.5	**67.8**
Roadway Geometrics	3	1	0	4	7.8	**31.2**
Driver Condition	4	1	0	5	8.3	**41.4**
ROUTE GUIDANCE						
Diversion	2	5	1	8	4.9	**39.4**
EMERGENCY SERVICES						
Mayday - Medical	5	4	0	9	8.6	**77.1**
Mayday - Mechanical	3	4	0	7	8.6	**60.0**

Figure 2: Relative Priority of Information Needs by User Services

expanse of rural roadways, making fully automated data collection financially prohibitive, and the practicality of manual data collection for construction, maintenance, and special event information.

With regard to automated data collection, many of the technologies available today are applicable for rural information systems. The adoption of in-vehicle sensors will be primarily driven by private industry, and the penetration of these sensors in the country's vehicle fleet will depend on the public's willingness to pay for these instruments. Because of the high incidence of single vehicle and fatal accidents on rural roadways, further development of near-field object and driver alertness sensors, along with vehicle location based mayday systems, are particularly attractive.

Roadway based weather and roadway sensors will be primarily publicly managed. One of the primary barriers to the implementation of these devices on rural roadways will be high costs due to a lack of existing infrastructure. For this reason, it is anticipated that early instrumentation of rural roadways with these sensors will be confined to critical locations.

The applicability of specific technologies must be evaluated on an application by application basis. Of primary importance will be the specific data collection needs. Also of importance will be price and reliability.

DATA AGGREGATION AND PROCESSING

A data base management system will be necessary to provide access control and support due to the variety and volume of data which might be supplied to rural AT1 systems and the variety of sources and users for the data. The compatibility of automatic data collection systems, in terms of both interfaces and protocols, will be an issue in the design of such a system. The transfer of information will require the definition of traffic data requirements, sampling rate, and other information as needed. One approach to this problem is the definition of external data links at a local level, allowing a “node processor” to take the information and convert it to a standard protocol.

Additional concerns regarding the aggregation and processing of traveler information data include who will finance the process and the infrastructure necessary to support it. It will be essential that all travel related information is provided to the traveler in a single, comprehensive package in order to make it convenient and useful. This approach will increase the potential commercial market for AT1 systems and may, as a result, increase the role that private enterprise plays in the provision of information. Additionally, the traveler may be charged a fee to receive the information. This would be similar to the traveler paying for the information and safety benefits of joining an automotive club. If public agencies are to continue the development of ATI systems, the costs of this may be offset by advertising fees paid to the public agency by traveler service providers.

In order to successfully implement a rural ATIS it is essential that both public and private entities take part. Non-safety and non-emergency applications must be commercially viable so that those elements can be privately developed. The legal liability of both public and private components of the system are a key concern. Multi-agency/jurisdiction planning and management is essential for a successful system. All of these concerns must be addressed in order to provide a useful, successful, and workable rural advanced traveler information system.

COMMUNICATIONS

Communications for a rural ATIS will be the major challenge due to long distances, low volume of message traffic, the need for power self-sufficiency, and the limited coverage area. These factors suggest that the communication solutions which are appropriate for heavily traveled urban routes may not be appropriate for rural ATIS.

As with infrastructure based roadway sensors, the limitations of ATIS communications in rural settings are largely financial limitations. The communications approach for any rural ATIS will depend heavily on the type of information needed, how quickly it must be updated, where it must be received, and how it is assembled.

A communications system with standard protocols will be more flexible, and will ultimately have a higher market penetration, than a closed architecture system. This may be an area where the government assists in developing standards or where industry associations **may** need to take a lead.

Due to the significant expense of communications, a localized architecture may be chosen for ATIS implementation in some areas rather than a more extensive communications dependent architecture which provides centralized information.

Additionally, an important issue in the selection of appropriate communication technologies is long-term reliability. Several of the new communications technologies have been developed and are being supported by new companies with unknown financial futures. The development of any system which relies on these technologies may involve risk.

TRAVELER INTERFACE

Traveler interfaces can be categorized as either those that are purchased by individuals or those that are made available to the public by the service provider.Generally, those systems with traveler interfaces that are purchased by individuals will be heavily invested in by private industry. Traveler interfaces which are provided for public use are more likely to have a greater governmental involvement, especially when the interface is roadway based as with variable message signs and highway advisory radio.

The commercial viability of information systems in general is foreseen as very good. Both general travelers and the operators of commercial fleets are realizing the benefits, including potential time and money savings, of having up to date travel information available for trip-making decisions. It is foreseen that this commercial viability will be especially evident in rural areas with high tourist and event driven activity.

Infrastructure costs and the nature of user priorities make in-vehicle systems and targeted roadside systems a high priority. However, the most important issues regarding traveler interfaces may be the requirement that the information presented must be convenient and easily comprehended by the user. This will also require that information systems be integrated and deployed so that a seamless system is effected both within the rural environment and between rural and urban areas.

CURRENT RURAL ATIS INITIATIVES

The study involved an investigation of current projects and initiatives which either directly affect, or have the potential to impact, rural ATIS. Exhibit 3 provides a brief listing of some of the major initiatives currently underway which are expected to advance the development of rural ATIS. These projects represent advances in the areas of each of the previously identified user services as well as in traveler behavior and the development of standards for communications and data processing.

An identification and understanding of current projects is essential, as is an understanding of current initiatives in urban traveler information systems, to ensure that the work undertaken and recommended within this study is founded on previous work rather than duplicating it.

POTENTIAL RURAL ATIS

The early stages of the project have involved establishing and prioritizing the information needs of rural travel, together with assessing the technological opportunities available to rural advanced traveler information systems. The next major task of this project is to develop application concepts for rural ATIS.

The application concepts will be the result of the four points of focus described previously: priority user needs, technological opportunities, ongoing initiatives in rural ATIS and parallel areas, and an assessment of those concept areas with the potential for a high payoff. Application concepts developed based upon the four points of focus will generally fall under one of four categories: proven technology, established technology, emerging technology, or future concepts. Those concepts which currently hold the most potential will primarily be within the established and emerging technology areas. It is within these areas that the continuing work will concentrate on, and from which rural ATIS concepts will be developed.

A number of potential applications concepts have been outlined and will be considered, together with others, for further development under the guidelines of the project. These include:

1. Mayday system.
2. Electronic flares.
3. Railroad crossing warning systems.
4. Telephone/fax information system.
5. Vehicles as probes.
6. Automated kiosks.
7. Dynamic speed signs.
8. In-vehicle safety and warning system.
9. Localized radio broadcast.

Several factors must be considered as the project progresses. Because rural ATIS will cover long distances, areas, and a large number of motorists, hardware cost and cost of installation will be major influencing factors. Lower capital costs will lead to their adoption to a greater extent, rendering them cost effective and achieving higher market penetration.

Administration and operation of AT1 systems must be streamlined, so they will be cost effective. Minimal maintenance and low costs are also desirable for such systems. One of the distinguishing features of any rural ATIS will be its remote location (and consequently its lack of accessibility). This will make the portable nature of equipment very useful in installation, operation, and maintenance. Upgradability of this equipment is an essential feature that will facilitate enhancements to capabilities and functions at a later date.

A desire for standardization requires compatibility of rural ATIS with similar systems in urban areas. This will eliminate any confusion to the rural travelers who are accustomed to urban systems.

CHAPTER 1: INTRODUCTION

In 1993 the Federal Highway Administration (FIIWA) commissioned a research project to find ways to improve safety, mobility and services in rural areas. This project is entitled "Rural Applications of Advanced Traveler Information Systems (ATIS)." The project's objective is to guide Federal programs with respect to intelligent transportation system (ITS) technologies in rural and small urban areas and to provide guidelines for ATIS implementation efforts by State and local government agencies in meeting rural travelers needs.

This report is one of a series of interim documents for the project. It presents the findings from traveler surveys to identify and prioritize rural traveler information needs. It also describes technology available or under development which can support ATIS to meet these needs. The report sets the stage for delineation of alternative rural ATIS concepts in the next phase of the project.

The report is organized into eight chapters. The remainder of this chapter describes the project more fully, discusses the rural transportation environment, and previews possible ITS applications in rural areas.

- **CHAPTER TWO —** describes the research design and findings of surveys completed to assess travelers' perceived needs and traveler information requirements in rural and small urban areas. Findings are presented from focus group discussions, telephone interviews with rural travelers, and consultations with agencies engaged in collecting, coordinating, and disseminating information to rural travelers.

- **CHAPTER THREE —** quantifies rural roadway and travel attributes and other characteristics. The nature and magnitude of rural traveler information problems are identified from which an assessment of the need is summarized.

- **CHAPTER FOUR —** examines ATIS technologies available to address rural traveler services and information needs. Applicable technologies for rural use related to data collection, data aggregation/processing, traveler interface and communications functions are reviewed.

- **CHAPTER FIVE —** discusses the application of technologies to meet rural traveler needs. Broad interpretations and conclusions are presented concerning ATIS applications in rural settings.

- **CHAPTER SIX —** summarizes current initiatives relevant to rural applications of advanced traveler information systems.

- **CHAPTER SEVEN —** presents an overview of the major findings from the work completed to date and discusses the continuing work by presenting a framework for the development of ATIS concepts to meet travelers' information requirements in rural and small urban areas.

THE PROJECT

Most intelligent transportation system studies and investments to date have focused on meeting the needs of travelers in major urban areas where congestion is most severe and population densities are highest. ITS applications to support or assist travelers in rural and small urban areas have received relatively lesser attention. Given the number of States and large geographic areas with rural settings, and recognizing that ITS technologies may offer substantial potential benefits in these areas, the FHWA initiated this project to guide future developments and Federal programs.

The project involves seven major tasks:

- Comprehensive assessment of user needs.
- Review of relevant technology both in existence and under development.
- Quantitative evaluation of rural transportation problems which can be effectively addressed by ATIS technology.
- Development of a range of rural ATIS concepts.
- Selection of a sample of promising concepts and preparation of detailed system specifications.
- Implementation of field tests of these systems.
- Documentation of guidelines for use by State and local government agencies in implementing rural AT1 systems.

THE RURAL, ENVIRONMENT

The rural environment encompasses rural and small urban areas (less than 50,000 population). Eighty-five percent of the road mileage in the United States is in rural and small urban areas (figure 3).

On the order of 1400 billion annual vehicle-kilometers of travel (900 billion annual vehicle-miles of travel) occurs in rural areas, and about one-half billion auto trips are made each year in rural areas of the United States by local rural residents and intercity and interstate travelers (figure 4). Traffic fatalities are disproportionally represented in the rural environment; whereas 40 percent of the vehicle-kilometers of travel (VKT) in the United States is on rural roads, 61 percent of all fatal accidents occur on rural roadways. It is instructive to note the similarities as well as differences between the rural travel environment and the urban environment. Where similarities exist, urban ATIS developments may be equally applicable in rural settings. Where differences exist, in some cases relatively minor adaptations or enhancements to urban ATIS systems may satisfy the rural need. In other cases, needs may be so different that a distinctly separate approach must be pursued. For example, mayday signaling is well suited for low-volume conditions which occur commonly in rural areas but seldom occur in urban areas.

Many travelers encounter both urban and rural environments; therefore, it is also important that technological standards be established and met in order to maintain compatibility between rural and urban systems.

The following is a list of some of the distinguishing features of the rural environment. In many instances these features set the rural condition apart from the urban environment:

- Trip distances are relatively long.
- Traffic volumes are low.
- Congestion is relatively rare; where it occurs, it is generally non-recurrent or seasonal in character.
- Alternate routes are few.
- Many travelers are unfamiliar with their surroundings.
- Highways may traverse rugged terrain in remote rural areas.
- Effect of climate conditions can be extreme.

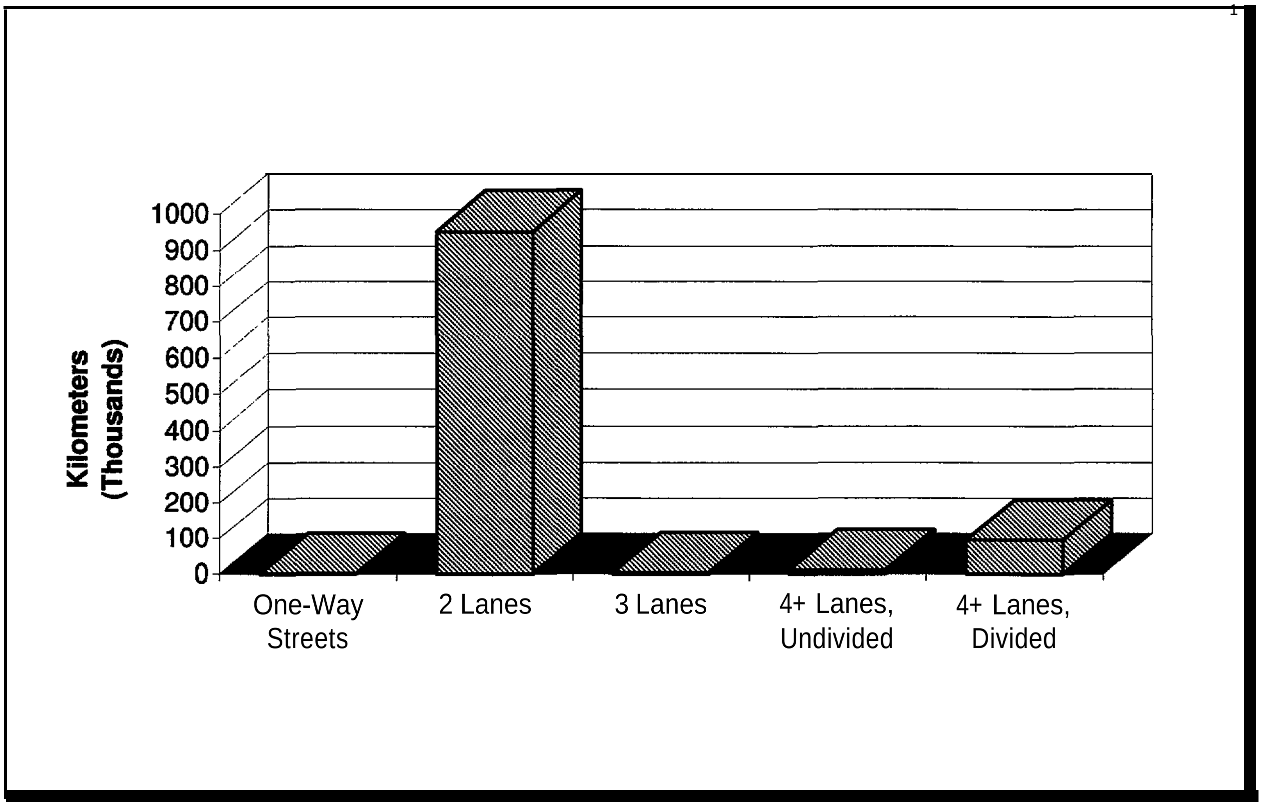


Figure 3: Rural Public Roads and Streets by Traffic Lanes

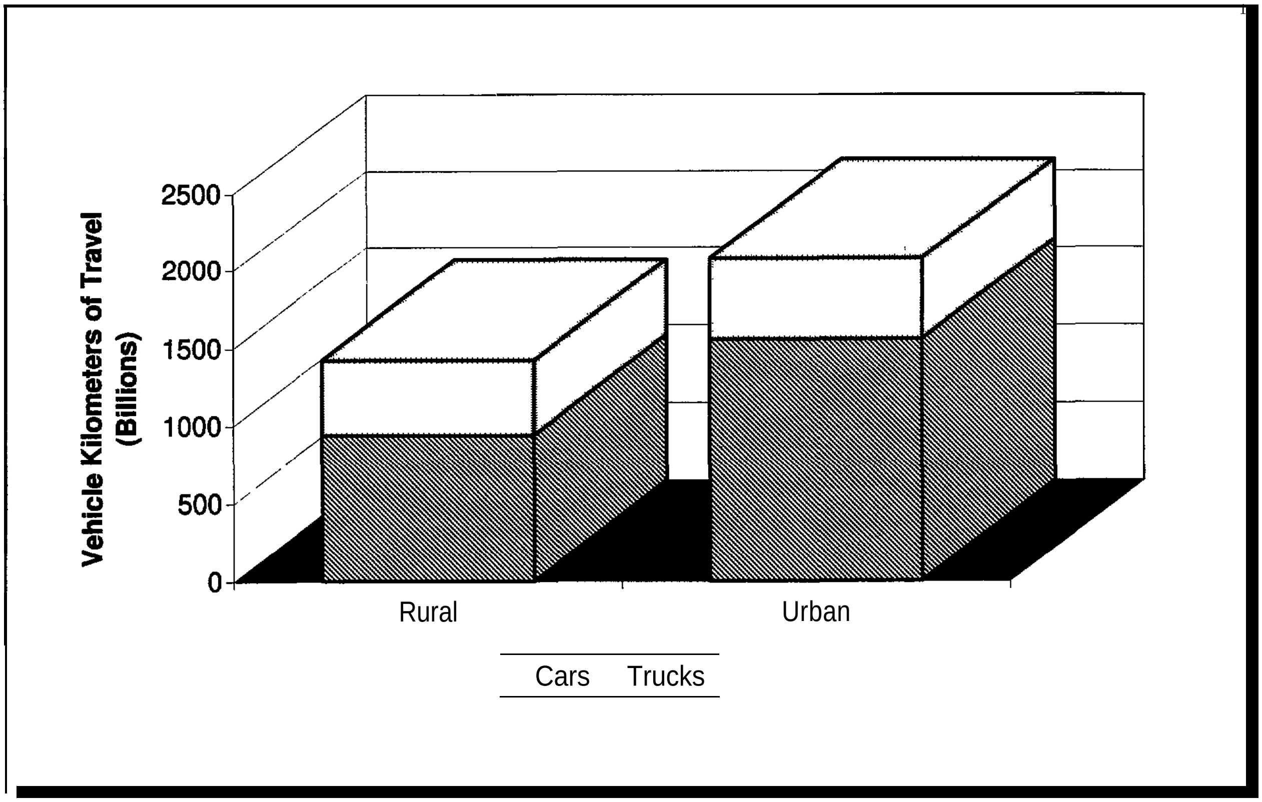


Figure 4: Annual Vehicle-Kilometers of Travel — Rural vs. Urban by Vehicle Type

- Animals wandering onto or bounding across roadways present unique hazards.

RURAL ITS

Rural ITS combines the application of electronic and communication technologies with creative concepts to improve safety, mobility, and services for travelers using transportation systems in rural areas.

Examples of these potential ITS applications abound. The number and severity of accidents may be reduced through utilization of advanced technologies. On-board hazard warning and crash avoidance systems may substantially reduce occurrences of fatalities in rural areas arising from single vehicle accidents involving inattentive or dozing drivers. Similarly, devices outside the vehicle may supplement drivers' vigilance and control and subsequently enhance driver safety.

ITS technologies can markedly improve mobility of rural travelers. Non-recurrent congestion can cause major problems on rural roadways. The vast majority of rural roads are two-lane, increasing the likelihood of a closed travel way in the event of an in-lane incident. ITS technologies can be enabling platforms to update maps and provide up-to-date incident and construction information and necessary route changes. Technologies such as head-up displays of route information, in-vehicle signing in both public and private vehicles, two-way communications, and vehicle systems monitoring are some other examples of ITS applications which could enhance and perhaps extend traveler mobility beyond what is possible today.

ITS technologies can also facilitate traveler services such as trip planning, route guidance, and traveler advisory information in a more efficient and effective manner. Advanced surveillance, detection, and communications technologies could provide ITS services to drivers, whether they are familiar or unfamiliar with their surroundings. Route planning services provided in advance of trips may help travelers to make decisions regarding mode of travel, routing, and departure time. Traveler advisory information could be sent directly to in-vehicle route guidance systems. Enhanced communications and vehicle location capabilities may improve rural emergency response times, as well as improve the quality of rural public transportation services in rural communities and areas.

Developing functional and useful rural ATIS designs require an understanding of the needs of those who will use such systems, as well as of the environment in which these systems will be placed. The next chapter probes rural traveler information needs as the first step toward gaining these requisite understandings.

CHAPTER 2: PERCEIVED USER PRIORITIES

INTRODUCTION

This chapter describes the research design and findings of surveys completed to assess travelers' perceived needs and traveler information requirements in rural and small urban areas. The findings result from focus group discussions, telephone interviews with rural travelers, and consultations with agencies engaged in collecting, coordinating, and disseminating information to rural travelers.

A key objective of this research project is to gain understanding of traveler information needs in rural and small urban areas and how ATIS applications might help those travelers. Accordingly, the research design included surveys of rural travelers to identify and prioritize their information needs. A four step process was used in this work.

First the nature and types of information which could be provided by ATIS services were defined. Six categories of user services were delineated and formed the basis for structuring interviews and data collection.

Next, the conceptual approach for assessing the rural traveler information market was developed. It was recognized that a large survey sample would be required if a conventional market segments approach were attempted (e.g., information needs of elderly rural travelers, vacationers, tourists, foreign travelers, travelers making short, intermediate or long trips, travelers familiar and unfamiliar with their surroundings, commercial vehicle operators). Attacking the problem in this way did not appear attractive or effective. Consequently, a different framework was adopted, one based on examining sequential information stages of every rural trip irrespective of the trip purpose, the tripmaker, or other attributes. This approach led to viewing rural traveler information needs in terms of three "trip stages" — pre-trip planning stage; en route stage under normal conditions, and en route stage encountering problems.

A survey research plan was constructed to obtain traveler needs for each trip stage. It included focus group sessions with general travelers and a variety of interest groups; a national survey of travelers who made "long" trips of 240 km (150 mi) or more; and a national survey of residents of rural areas and communities under 50,000 population.

Finally, the fourth step consisted of analyzing the survey results, ranking information needs and interpreting the priorities which travelers attached to the various information categories and trip stages.

USER SERVICES

For this research the perceived information needs of rural travelers were hypothesized to fall into six user services, as shown below in figure 5. These formed the basis for structuring interviews and dialogues with survey participants. The user services relate very closely to those developed later by the ITS Advanced Rural Transportation System (ARTS) Committee, a committee of ITS America.

- TRIP PLANNING/ROUTING
- TRAVELER ADVISORY
- TRAVELER SERVICES INFORMATION
- SAFETY AND WARNING
- ROUTE GUIDANCE
- EMERGENCY SERVICES

Figure 5: Rural ATIS User Services

1. Trip Planning/Routing provides travelers with pre-trip information

to assist in deciding if a trip will be made, the possible routes, weather and road conditions, travel times, amenities and services en route, and other alternate modes of travel. Additionally, preferences such as road types, route characteristics, and intermediate destinations can be specified. The best route can then be selected based on these preferences and real-time or historical route data.

2. Traveler Advisory services provide travelers with real-time information regarding road conditions, such as construction and maintenance activity, congestion information, and incident advisories, to aid the traveler in making trip-related decisions en route, based on the most current information.

3. Traveler Services Information includes location and descriptive information regarding services such as food, fuel, lodging, car repair services, and hospitals.

4. Safety and Warning systems are both in-vehicle and roadside functions. They monitor vehicle conditions, roadway geometrics and related vehicle activity, and even driver condition.

5. Route Guidance provides travelers with en route directions, including distance and exits or turns required.

6. Emergency Services encompass several traveler support functions, such as mayday alarms, and requests for mechanical or medical assistance.

TRIP STAGES

Traveler information needs are perceived to differ by sequences or stages of a trip; for example, the immediacy of an information need may vary greatly depending on whether the traveler has not yet begun their trip; has started the trip, but has not planned all the details of the route, etc.; or is en route and needs to make a decision at the next interchange. Therefore, in addition to presenting survey participants with categories of user services, it was useful to further classify information need responses by trip stage.

- Pre-Trip — Information is provided to initiate tips. Examples of such information include alternate modes, trip routing, travel times, weather and roadway conditions, and en route facilities.

- En Route (No Problem) — Information is provided en route to the traveler while he/she is not faced with any specific problem. Examples of this type of information include changing roadway and weather conditions, alternate routes, and traveler services.

- En Route (Problem) — Information is provided when a problem occurs en route, either with the user’s own vehicle (e.g., mechanical breakdown, involved in an accident/incident) or outside of the vehicle (e.g., problem with another vehicle, roadway problem). Emergency warnings and driver warning advisories are examples of this type of information.

RURAL TRAVEL INFORMATION NEEDS

METHODOLOGY

To gain insight into the types of information required by different categories of travelers in rural, intercity, and small urban areas, survey participants were grouped as follows:

- General Travelers — includes private travelers on business and pleasure trips. These travelers may be residents of either rural or urban areas.

- Other Highway Users — includes truck operators, school bus fleet operators, and emergency medical service providers.

- Providers — includes public agency suppliers of information, such as highway and law enforcement agencies. (Please note that these interviews did not include any private sector providers).

Information requirements were elicited through a combined strategy using:

- Focus Groups.
- National Telephone Surveys.
- One-to-One Interviews.

The methodology framework for user needs assessment is illustrated in figure 6.

Focus group sessions were used as an exploratory research technique to identify the information needs and priorities of general travelers. Group sessions were led by a moderator who stimulated the discussion without specifically leading the responses of the participants. Focus group discussions helped to obtain general reactions and broad priorities on the subject. Nine locations throughout the United States were visited to conduct focus group sessions. To obtain a broad range of views, a variety of community groups (e.g., PTA's, church groups, chambers of commerce) were interviewed.

The qualitative results of focus groups were then verified through two national telephone

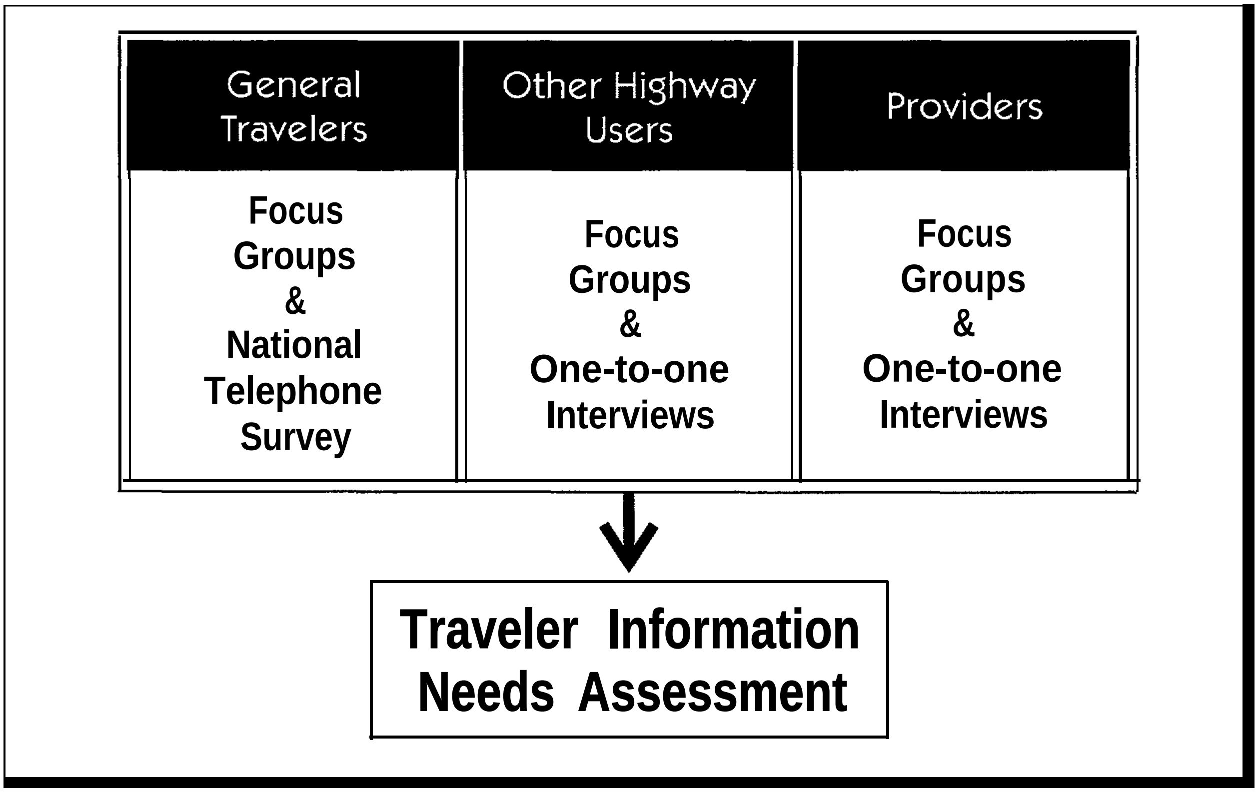


Figure 6: Overall Methodology for User Needs Assessment

surveys. The first national telephone survey interviewed a sample of 525 respondents drawn from stratified national random sampling for both urban and rural residents. The survey instrument was constructed from the experience gained from focus group sessions. Respondents were from households who had made one or more trips of greater than 240 km (150 mi) in the past year. The interviewer elicited rural travel information priorities of respondents. The survey provided an independent comparison with the information needs identified from the focus groups.

A second national telephone survey of 500 respondents was drawn from residents of rural areas and towns of less than 50,000 population; it mimicked the earlier national survey, but addressed only "local travel" of rural residents.

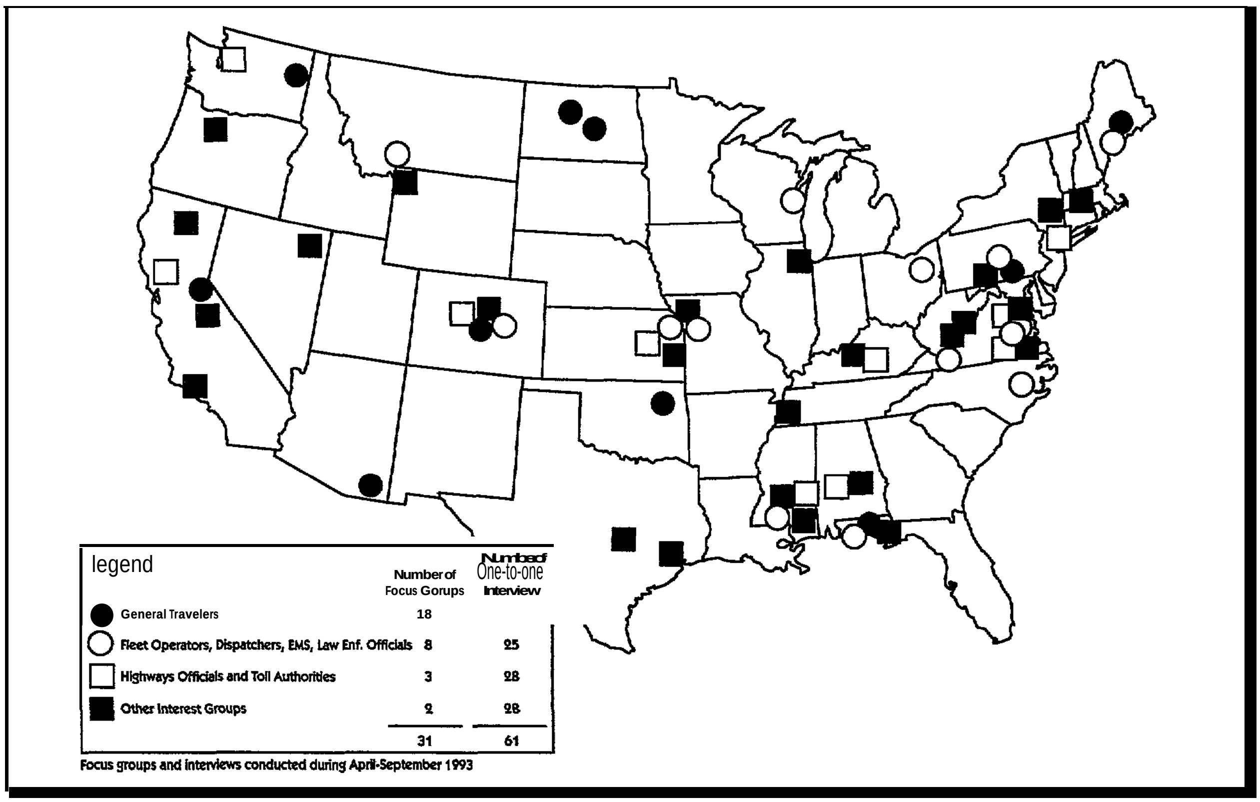
Opinions of other highway users and providers were solicited through focus groups and one-to-one interviews. Their input was solicited to better understand their information requirements and to obtain their perspectives on traveler information needs and technology applications.

In all, 31 focus groups, 61 one-to-one interviews, and 1,025 telephone interviews were completed with various individuals and groups. Participants were from all regions of the country, resulting in a national representation (figure 7). Figure 8 summarizes the broad conclusions of these surveys and a more detailed analyses of the information needs assessment surveys is presented in the following sections.

GENERAL TRAVELERS INFORMATION NEEDS AND PRIORITIES

Key findings of the general travelers' information needs assessment include:

- Place of residence had no impact on the weighting of rural travel information needs as urban and rural



residents responded virtually identically.

- Information needs for the en route (with problem) phase was considered the most important by general travelers.

- A means of communicating with an emergency service center (mayday system) was rated as the most important need when faced with a problem en route. A mayday system with both manual and automatic activation was desired.

- Accurate information concerning trip routes was considered most important during the pre-trip planning phase.

- Driver advisory information on road closures and congestion ahead, and warnings of approaching hazards, such as fallen rocks, animals, icy bridges, and safe speeds under prevailing conditions, were also rated as important information needs.

- Other information needs were also identified by the general travelers. These included locations of automatic teller machines (ATM's), safe stopping (rest) areas, local speed limits and traffic regulations in towns en route.

- Information related to service facilities and the area being traversed were viewed as beneficial, but not as important for rural travel.

Respondents of the first survey, who stated they had taken at lease one trip equal to or greater than 240 km (150 mi) in distance in the past year, were asked to rate the importance of information for travel in rural and small urban areas with respect to trip stage using a scale ranging from "Very Important" to "Not at all Important." The results when segmented into rural and urban resident groups show both

GENERAL TRAVELERS

- Key needs for general travelers
  - Assistance during en route problem
  - Pre-trip planning
- Mayday -biggest en route (problem) concern
- Routing assistance -biggest pre-trip planning need

OTHER HIGHWAY USERS

TRUCKERS

- Weather and road conditions
- Other types of information less critical

PROVIDERS

HIGHWAY AGENCIES

- Information provided be timely, accurate, and reliable
- Emergency, safety, and warning information considered most important

EMS PROVIDERS

- Concerned with getting to the site of a incident as quickly and safely as possible

LAW ENFORCEMENT AGENCIES

- Concerned for traffic management during
  - Highway construction
  - Accidents
  - Adverse weather conditions

Figure 8: Key Findings of the Information Needs Assessment

groups rated information regarding the en route travel with problems stage of a trip as "Very Important" and the remaining two stages, pre-trip planning and en route with no problem, as "Very Important" to "Somewhat Important" (figure 9).

Weighted ranking of information importance was determined by incorporating a scaling procedure with the importance rating. For example, "Very Important" was assigned a weight of 10 and "Not at all Important" was assigned a weight of 0.

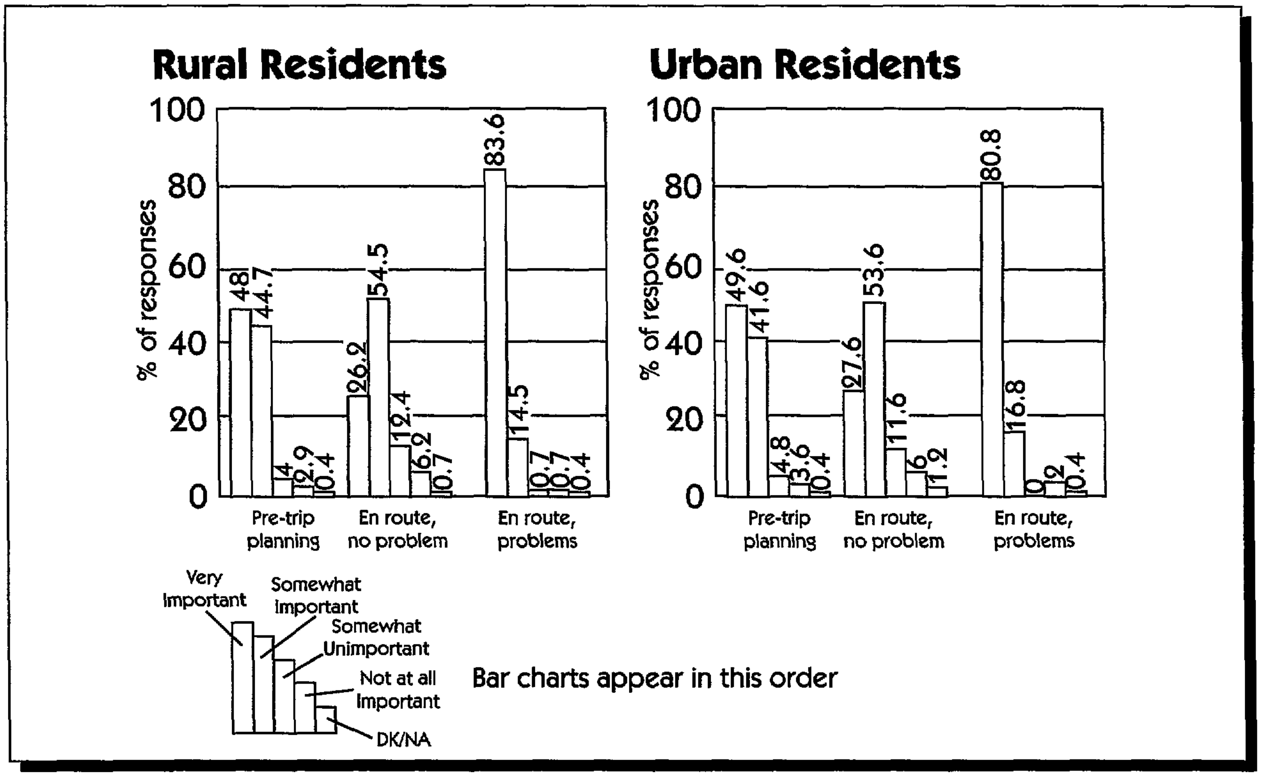


Figure 9: Importance of Information

In addition to rating the importance of information during the various trip stages, respondents were asked to rate the importance of information components within each stage of travel (figure 10). The key information needs of these general travelers are focused on obtaining assistance when faced with any problem en route and determining the preferred trip route during the pre-trip planning stage.

The weighted importance of the information component is shown in figure 11 and listed below. The most desired types of information include:

- Ability to call for help in an emergency (mayday).
- Warning of rapidly approaching hazards immediately ahead.
- Signal to "wake-up" a drowsy driver.
- Information concerning road closures and traffic congestion ahead.

TRIP STAGE/INFORMATION COMPONENT	EXAMPLES OF INFORMATION NEEDS
PRE-TRIP PLANNING	
Trip Routing/Travel Time	Best Routes, Travel Time
Weather/Road Conditions	Snow, Ice Construction
En Route Facilities	Hotels/Motels, Rest Areas
EN ROUTE, NO PROBLEM	
Weather and Road Conditions Ahead	Snow, Ice, Construction
Alternate Routes	Detours, Road Closures
Traveler Services	Hotels/Motels, Rest Areas
EN ROUTE, PROBLEM	
Driver Advisory	Road Closure, Congestion
Driver Warning	Road Hazards, Safe Speeds
Emergency	Mayday Signal

Figure 10: Stages of Travel and Example of Information Needs

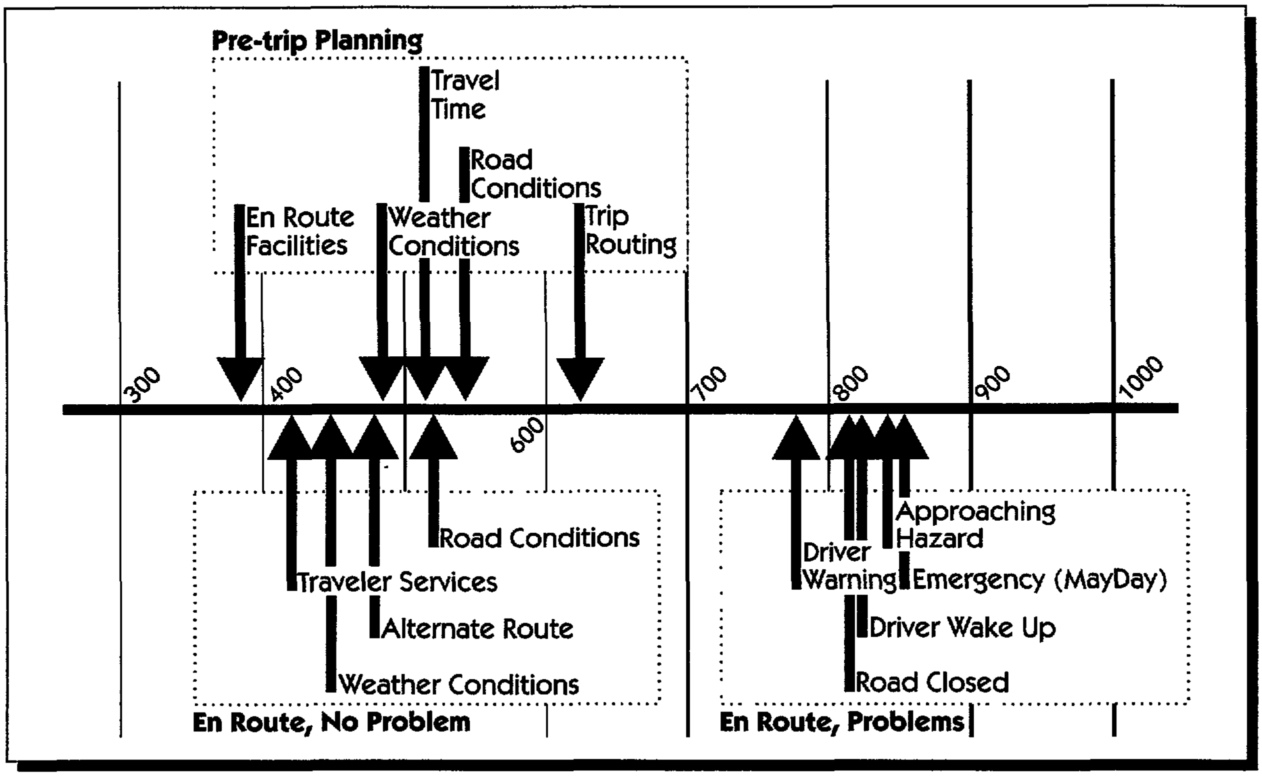


Figure 11: Weighted Importance Ratings

- Information regarding safe speeds under prevailing conditions.
- Pre-trip planning information concerning directions and route selection.

The ability to transmit a mayday signal when faced with a problem en route ranked as the most important. This need was reflected in both the focus groups and the telephone survey. The focus group participants indicated that such a system should be able to be activated both manually and automatically and must include automatic vehicle location capability. The participants also desired two-way communication, so that a stranded traveler could specify the type of problem to an emergency center and also receive confirmation of message receipt and necessary instructions until help arrived.

Traveler advisories on road closures and congestion, and warnings about approaching hazards (safety and warning) during en route (problem) travel were rated as next in importance. Examples of such warnings include falling rocks, icy bridges, drowsy driver alarms, and safe speeds under prevailing conditions.

Information on trip routing was reported as the greatest pre-trip planning need. Accurate information regarding the best routes and the routes with the shortest travel times was desired. Accurate information on weather and road conditions that would be encountered en route was rated as the second most important information need for pre-trip planning.

The results of the second telephone interview, where perceptions of traveler information needs were solicited from rural residents regarding their local travel, supported the findings of the first telephone interview. As with the first interview, information in a mayday situation scored most important with these travelers, followed by safety and warning information regarding such potential hazards as collisions, driver drowsiness, weather, visibility, and road conditions. Differences in the relative weightings of the two telephone surveys arose when evaluating the need for information regarding permanent or semi-permanent infrastructure or fixtures on the roadway. The travelers in the first interview felt information regarding alternate routes, en route facilities, and construction and maintenance, was relatively important when considering long distance rural travel. Alternately, travelers in the second interview, considering local rural travel, placed these information needs lower on their relative scales. This was anticipated as local travelers are usually already familiar with local roadways, including alternate routes and en route facilities.

Focus group participants did emphasize the need for permanent and semi-permanent roadway information when traveling in unfamiliar areas however. Several information needs for pre-trip planning -- all traveler services information -- were identified by focus group participants, including:

- Location of automatic teller machines and the types of cards accepted.
- Location of service providers such as restaurants, motels/hotels, and service stations, including a quality rating and indication of prices.
- Listing of points of interest, types of events available, and pertinent information along the route and at the final destination.
- Information concerning local speed limits and traffic regulations in towns en route.

Additionally, information needs when traveling en route (no problem) were essentially the same as those for the pre-trip planning phase. While advance warning of weather and road condition changes (traveler advisory), problems ahead, and traveler services information were considered important, information concerning the area being traversed (traveler services) was seen as useful in making the trip more interesting.

TECHNOLOGY PERCEPTIONS

In-vehicle technologies providing information disseminated via audio and video devices were viewed as potentially useful. However, some concern was expressed regarding the safety of in-vehicle video displays. The user friendliness of ATIS was viewed as an important factor in the acceptance of the system by users. Focus group participants and telephone survey respondents also indicated a willingness to pay for desired pre-trip planning information, if it could be obtained through a source such as a single phone call or through interactive television.

OTHER HIGHWAY USERS INFORMATION NEEDS AND PRIORITIES

Other highway users are represented by commercial fleet operators, emergency medical services providers, and community and school transportation operators. While many of their information needs are similar to general traveler needs, these groups prioritized them differently. Their information requirements are influenced by the nature of their operations, such as commercial fleet regulations, scheduling, and vehicular characteristics. They are concerned with meeting schedules, delivery deadlines, and making their trips safe, quick and efficient.

The primary information needs of other highway users relate to safety, warnings, and traveler advisories. This includes more accurate, accessible and advance warnings about weather and road conditions that could affect their trips. Because conditions such as these can change rapidly, the information about road conditions was most valuable to a driver when provided en route. There are also concerns about regulations and other restrictions en route.

Although it is common practice for commercial operators to collect information from a variety of sources (e.g., weather service, DOT), several managers said they would prefer to be able to consult just one source. Currently, some information is collected by the drivers, and other information is given to drivers by dispatchers either before departure or en route. Information on construction is obtained from county governments and State departments of transportation (DOT's). Most managers reported using DOT l-800 phone numbers for road condition information. Larger trucking and bus companies subscribe to weather services which provide conditions and forecasts for the areas in which they operate. Truckers use specially adapted truck maps, published by some States, which provide information about restricted roads. It was stated repeatedly that drivers are the best source of accurate information.

These highway users view ATIS resources as tools to assist them in doing their jobs more safely and efficiently. However, they are sensitive to the costs involved in obtaining information. Any investments in new technology must provide cost savings which outweigh the investment cost.

Emergency medical service (EMS) providers stated a high degree of interest in technologies that could facilitate accident reporting. They agreed that a mayday system would be a good way to reduce accident notification times, especially in rural areas. However, several concerns were raised. One was that a mayday system would be prone to abuse if the signal could be manually activated. Other concerns were that the system would be too expensive, would require more staff to monitor mayday signals, and would fail to provide enough information to EMS dispatchers.

PROVIDERS' INFORMATION NEEDS AND PRIORITIES

Providers of various types of information includes groups such as the highway and law enforcement agencies, economic development and tourism departments, county governments, the National Park Service, automobile clubs, and other interest groups. Providers supply diverse types of information to travelers ranging from traffic management to highway safety to economic development. This group's main information goals are to promote safety and make travel more convenient. Safety and warning information is considered the highest priority by the providers. They want the information they supply to travelers to be accurate, relevant, reliable, and delivered in real time, thus improving the quality of information supplied. They are also concerned about driver information overload.

Those providers engaged in economic development functions viewed ATIS applications as highly useful tools to support tourism as well as foster general economic development. ITS traveler information systems were seen as strongly complementary to on-going State and private sector business promotion activities.

The providers identified characteristics of the rural environment which affect transportation, particularly regarding traveler safety:

- Weather conditions can be unpredictable and change rapidly; thus, rural travelers may encounter snow, ice, fog, and flash floods, often without adequate warning. In the western States, mountain roads can be closed much of the year due to snow.

- Rural drivers must contend with heavy truck traffic from logging or agricultural operations and slow moving farm vehicles on secondary roads. They must be alert for obstacles in the road, such as animals or fallen rock.

- Rural roads carry low volumes of traffic and offer fewer motorist services.

- The combination of long distances and low traffic volume makes dissemination of information problematic.

Providers expressed enthusiasm about the potential for an ATIS to help them do their jobs more effectively. While their opinions of these technologies were generally favorable, they did identify several issues and barriers to ATIS implementation:

- Funding for implementation of ATIS is seen as the major impediment.

- User sensitivity to cost of in-vehicle systems is perceived as a major issue in the implementation of such systems.

- Question of liability is seen as an issue from the perspectives of both accuracy of information provided and the performance of in-vehicle ATIS units.

- Resolving institutional issues such as who is responsible for providing and maintaining the information services, and standardizing technologies and communication were also cited as important for ATIS implementation.

CONCLUSION

Rural traveler information needs cover a wide spectrum from emergency and safety to the economic livelihood of commercial businesses. These needs could be met by the applications of advanced traveler information systems. The most important needs are elaborated briefly below:

- <u>Emergency Communication</u> — The need for an emergency mayday system is perceived as the most useful information service by the rural travelers when faced with a problem en route. Three features were reported as desirable for such a system:

  - manual and automatic activation options
  - automatic vehicle location
  - two-way communication

- <u>Guidance in Unfamiliar Situations</u> — This refers mainly to trip routing applications during the pre-trip planning phase. Information was desired, not only on the best routes, but also on travel times. There was also a general willingness to pay for pre-trip information if the required information were available through a single phone call or through interactive television.

- <u>Hazard Warning</u> — Information needs during several hazardous situations were considered important by the general travelers as well as the providers of information such as the highway agencies. Examples of instances for potential applications of ATIS include warnings for fallen rocks on the road, icy roads/bridges, fog, approaching trains at railroad crossings, etc.

CHAPTER 3: IMPORTANCE OF RURAL ISSUES

INTRODUCTION

This chapter quantifies rural roadway attributes, the magnitude of rural travel, safety issues, and other related characteristics. The nature and magnitude of rural traveler information problems are identified from multiple sources, and an assessment of information needs is summarized.

The synthesis of perceived needs presented in chapter 2 is important to the development of informational systems and will contribute essential insight for the public and commercial acceptance of such systems. However, further knowledge and substantiation of rural and small urban area transportation problems is required to determine the scope and magnitude of these various needs.

This chapter provides substantiation of rural transportation needs through quantification of either problems or efforts to fulfill information needs. Figure 12 gives a general statistical overview of rural travel and related characteristics.

Please note that the statistics/quantifications used to substantiate rural transportation needs in the following sections have been obtained from reliable, although limited, information sources. Therefore, the validity and accuracy of this data should not be in question. However, it should be recognized that a further, more in depth data collection effort along these lines could serve to foster a more representative and deeper comprehensive understanding of rural transportation needs and of the nature of the relevant data/information which characterizes them.

VEHICLE-KILOMETERS OF TRAVEL

Twenty-five percent of the U.S. population lives in rural areas and towns with a population of 50,000 or less. However, 41 percent of the total annual vehicle-kilometers of travel (VKT) is driven on rural roads.[1] In 1990, the total annual vehicle-kilometers of rural travel was 1,401.3 billion (870.4 billion VMT). It is estimated that Americans took nearly 500 million long trips [160 km (100 mi) or more] in 1991.[2]

ROADWAY MILEAGE, CLASSES, JURISDICTION AND TRAVEL

The 5 million km (3.1 million mi) of rural roadway in the United States represent 81 percent of the total public road and street mileage; another four percent is located in small urban areas.[1] Only 15 percent is urban

TRAVEL INDICATORS	PERCENT RURAL	QUANTITY
Roadway Kilometers	85% rural & small urban areas	5 million km (3.1 million mi)
Roadway Interstate Kilometers	74% rural	1,148,000 km (713,000 mi)
U. S. Population	25% rural and small urban	
Vehicle-Kilometers Traveled	41% rural	1,401.3 billion km/yr (870.4 billion mi/yr)
Fatal Accidents	61% rural	22,700 accidents/year
Non-Fatal Injury Accidents		733,500 accidents/year

Figure 12: The Magnitude of Rural Travel

mileage, which has been the focus of most ITS applications to date. However, over 2.4 million km (1.5 million mi) — 50 percent of rural roadways — are unpaved. Therefore, unpaved rural roads are unlikely candidates for infrastructure-based ITS application. On the other hand, other applications such as vehicle-based solutions (e.g., collision avoidance) and wide-area traveler information communications (e.g., two-way, broadcast) function independently of the roadway and would work on these roads.

Local, two-lane roadways represent the majority of rural roads (figure 13).[1] Again, a substantial share of these roads may not be priority candidates for ITS services. (Although Interstates are a tiny fraction of all rural roadways, 74 percent of all Interstate mileage is in rural areas).

Figure 13 also depicts the distribution of VKT by functional roadway classes.[1] Travel on Interstate routes represents 23 percent of all rural travel while principal and minor arterials roughly split another 38 percent, and major and minor collectors represent 28 percent; the remaining 11 percent of rural travel is on local roads. This graph shows that rural travel is highly skewed toward a limited portion of the road network. Interstate routes and principal arterials comprise less than 10 percent of rural roadway mileage but accommodate over 40 percent of all rural vehicle-kilometers of travel. Local roads are in sharp contrast with nearly two-thirds of the mileage but only 11 percent of rural travel. ITS application opportunities in rural areas may be skewed similarly.

Jurisdictional control of rural roadways is divided in the following manner: State (22%), Local (72%), and Federal (6%).[3] Widely dispersed jurisdictional responsibilities among many governmental entities mean that rural ITS applications will need to be coordinated across a large number of government jurisdictions.

MOTOR VEHICLE FATALITIES

Despite the fact that only 41 percent of U.S. vehicle-kilometers of travel are in rural areas,

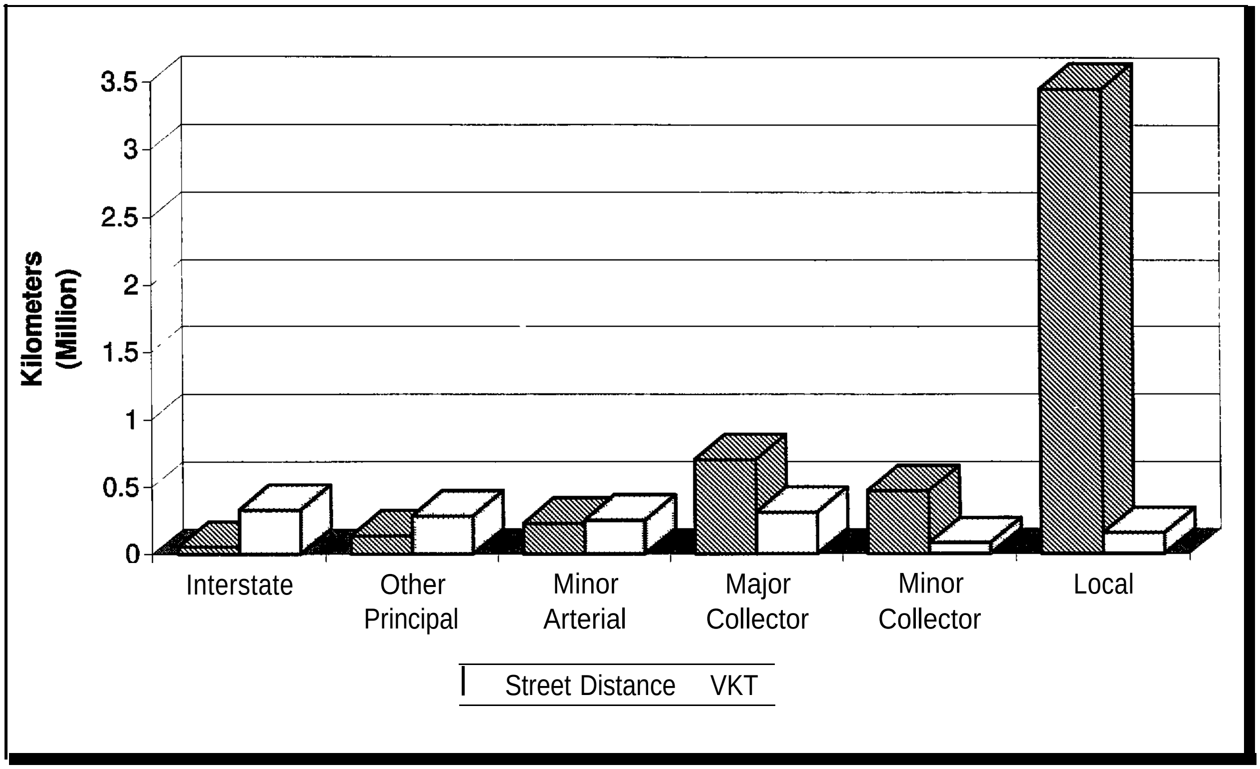


Figure 13: Rural Public Roads and Streets and Rural VKT by Functional System[1]

61 percent of all reported fatal accidents occur in rural areas.[4] In recent years, only heart disease, cancer, and stroke were responsible for more deaths than motor vehicle accidents according to the National Center for Health Statistics.

There were 22,700 rural fatal accidents in 1989 representing a fatal accident rate of 1.68 per 100 million vehicle-kilometers (2.7 per 100 million vehicle-miles). A total of 26,100 people died in rural fatal accidents. In contrast, urban fatal accidents totaled 18,002, representing a fatal accident rate of .87 per 100 million vehicle-kilometers (1.4 per 100 million vehicle-miles); 19,500 persons died in urban fatal accidents.*

SUBSTANTIATION OF USER NEEDS

Traveler problems encountered on rural roadways may be lessened through the ITS applications and ATIS. The following sections examine these problems, using a variety of data sources to estimate their magnitude. The set of user needs identified in the previous chapter is used as a reference base. The following discussion is organized around each of the user services. The user needs are described together with the data which substantiates or refutes them.

TRIP PLANNING / ROUTING

Trip planning and pre-trip routing information services may assist travelers in their trip making decisions — such as if and when to travel, alternate modes and routes, transit schedules, road types, route characteristics, intermediate destinations, directions, distances, and travel time.

* Frequency data contained herein refers to annual totals for either 1989, 1990, or 1991. Likewise, all other material presented refers to data from one, or a combination, of these years.

ROUTING

A number of prototype routing information systems are currently being developed and implemented. The commercial development and usage of these systems is a measure of the need for the information which is disseminated through them.

The Telemap information service conducted a demonstration test in Orlando, Florida. This system provided detailed travel directions when the user entered destination phone numbers. The directions were disseminated via fax or synthesized voice. For the demonstration period the service was available through 2,600 pay phones and 50 fax locations for a charge of $1.95 (billable to any major credit card) for each destination route. During the demonstration period, 2,000 requests per month were received, approximately half from residents and half from non-residents. Ninety-seven percent of the requestors said they would use it again and 43 percent of calls were from repeat users. The service has now been expanded to include the entire Orlando, Florida market and is accessible from any device which emits a touch tone pulse. Telemap is also currently available in Chicago (NW suburbs), Detroit (Flint and Lansing), San Francisco Bay area, Santa Barbara County, and several more U.S. cities.

Another routing service has been developed by the Dallas Area Rapid Transit (DART), one of the largest bus transit systems in the U.S. DART is an advertiser-supported customer information system which provides schedule and route information to bus and rail travelers.

ROAD CONDITIONS

For travelers making trip plans, desired road condition information includes congestion caused by incidents, planned events, or regular occurrences during peak commute hours or seasons, as well as construction, maintenance, or resulting road closures which may interfere with planned travel. Automobile clubs are one good source of information regarding travelers' desire for pre-trip road condition information. In 1992, the American Automobile Association (AAA) prepared 8.3 million “Triptiks” at the request of AAA members.[5] Triptiks provide routing information for member-designated origin and destination pairs, including driving times, construction, detours, and points of interest.

WEATHER CONDITIONS

Many travelers seek out weather condition information, as well as road conditions, prior to travel. This is especially true in rural areas subject to extreme weather conditions.

A telephone weather/traveler information system was implemented for travelers’ use in an area of Wyoming particularly susceptible to bad weather. Eighty percent of the local drivers responding to a survey used the road and travel phone number to receive information regarding adverse conditions. This is consistent with a Washington State Transportation Center study which found most commuters will try to obtain information about traffic congestion conditions before they leave their home or office. In a survey of area travelers, 63 percent stated they would not cancel trips unless the road was closed; however, upon receiving traveler information, alternative routes and earlier departure times would be considered. The majority of truck drivers responding to the survey stated their information came from CB’s (citizen band radios), indicating that there is currently a communication network which attempts to meet some travelers’ needs for advisory information.

The State of Wisconsin provides information to travelers to diminish the adverse affects of weather, construction, and road closures on travel. l-800-ROADWIS, operated by the Wisconsin DOT, received 276,000 calls in 1990, 273,000 calls in 1991, and 338,000 calls in 1992 (926 calls per day). The information service was implemented in order to free State Patrol dispatchers from inquiries about road conditions.

The ROADWIS phone service provides seasonal information including construction, road closure, and detour information in the summer and road conditions as affected by weather in the winter and storming season. The service is used much more heavily in the winter than the summer months, with a December high of 81,000 calls and an August low of 6,900 calls for 1992. Information is also provided to the weather service for distribution and to cable and radio stations that sometimes read it verbatim. A separate media line exists for the media to call in when other lines are busy.

TRAVEL TIME

Travel time appears to be of interest when travelers are seeking trip planning/routing information. Driving time is one of the items often requested by AAA members obtaining Triptiks. Presumably, travelers look for the most “efficient” route, unless they have specific intent to pass through scenic areas or areas with particular attractions, This is the case with travelers who use the cable television presentation of traveler information provided by the Illinois Department of Transportation (IDOT). IDOT began by graphically showing the level of congestion which could be experienced on highway route segments. However, demand from travelers using the system caused IDOT to add estimated travel times along with the congestion information.

EN ROUTE FACILITIES

Information regarding the location of en route facilities would be of greatest interest to travelers in unfamiliar surroundings. This is often the case on long trips [160 km (100 mi) or more]. Americans took 496 million such trips in 1991.[2]

Again, a highly used single resources for trip planning provides a metric for assessing travelers’ interest in information regarding en route facilities. AAA provides the location and descriptive information of restaurants, hotels and motels, camping facilities, points of interest, attractions, etc., which may be found along a traveler's route. This information is provided with the 8.3 million annual Triptik requests. It is also provided in the form of regional and State brochures/books for those travelers who plan their own itinerary and routes with the AAA information.

Additionally, the use of existing traveler service systems substantiates travelers' needs for information. Surveys of vacationers in Virginia in 1988 showed 31 percent of travelers used an available toll-free number to request travel information, and 40 percent of travelers stopped at a Virginia Welcome Center.[6]

TRIP PLANNING/ROUTING REQUIREMENTS

The success of implemented trip planning/routing systems and information in combination with current plans to introduce additional commercially supported systems is evidence that pre-trip travel information service concepts are supported by the traveling public, as well as providers and suppliers of information. The findings also demonstrate that trip planning/routing systems may be either publicly or privately provided; many may potentially be funded through either advertisement revenue or direct user fees. An important design requirement, however, is that advertising information not be so cumbersome as to hinder the traveler from receiving the information they are seeking in a timely manner.

TRAVELER ADVISORY

Traveler advisory information includes real-time information provided en route regarding such problems as congestion, construction and maintenance, incidents, and adverse weather or visibility. This information is essentially the same information provided for trip planning regarding roadway and weather conditions. However, it is provided while en route and therefore may include information updated since the outset of the trip. Further it may be more detailed and immediate advisory information regarding the particular segment of the route being traveled at the time.

RECURRENT CONGESTION

Recurrent congestion, as is prevalent in urban areas, is not a substantial problem on rural roadways. Less than 6,400 km (4,000 mi) of rural roadways (0.1 percent) operate at a volume/service flow ratio greater than 0.95. The great majority of rural roadway operates at a volume/service flow ratio of less than 0.41 (figure 14).[1]

Special note needs to be made of rural attractions which draw large seasonal or cyclical traffic volumes. Examples might include National Parks, seashores, ski areas and similar vacation or recreational sites. Many of these attractions do generate heavy congestion on approach or exit roadways. ATIS applications for such locations may prove especially effective. These sites and their surrounding environs need to be addressed case by case for specific situations.

CONSTRUCTION AND MAINTENANCE

Construction and maintenance on rural and small urban area roadways can present unexpected delay to travelers unaware of the ongoing roadwork prior to arriving on the scene. These work zones also create safety threats for both travelers and work crews. In 1990, a total of 681 fatal crashes (rural and urban) occurred at construction or maintenance work zones; 783 persons died as a result of these crashes. This represents 1.8 percent of all persons who died from motor vehicle accidents in 1990.

INCIDENTS

Incidents, which include motor vehicle accidents as well as planned occurrences, contribute to travel delay. In 199 1, accidents on rural roadways included:

- 600,000 nonfatal injury accidents
- 28,100 fatal accidents

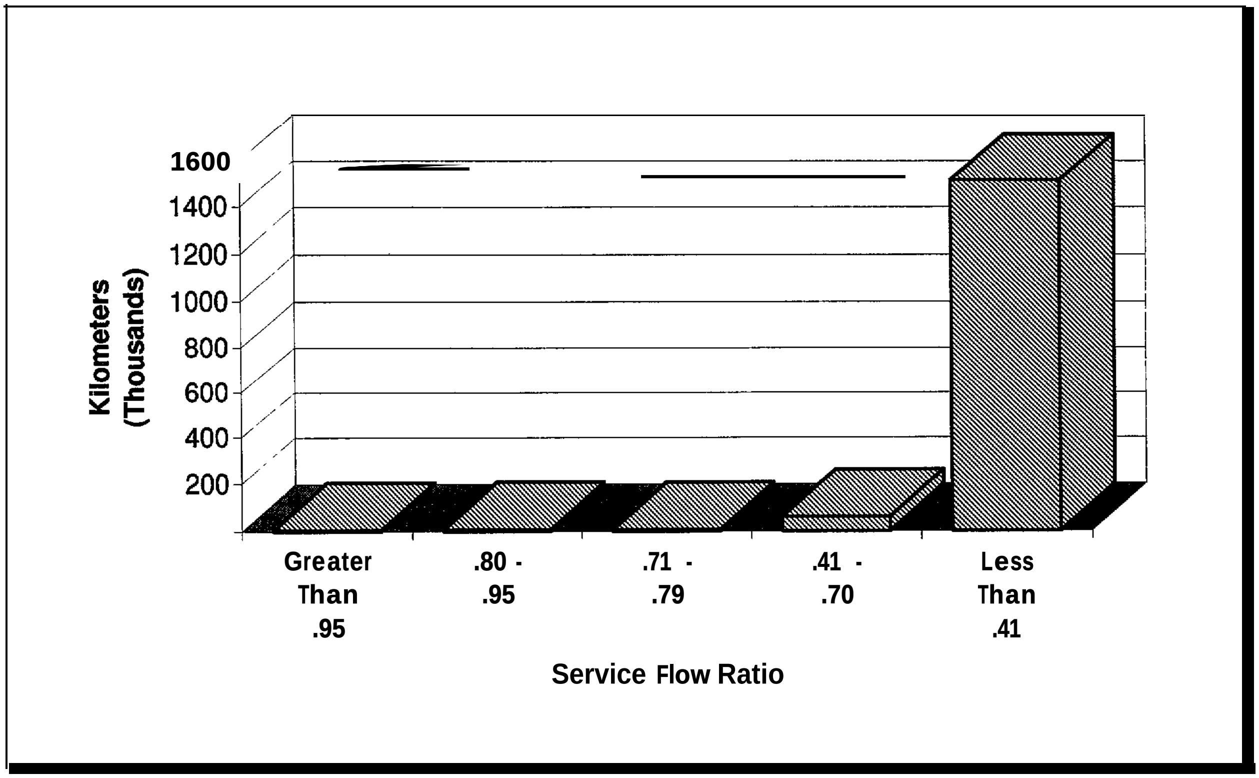


Figure 14: Rural Public Roads and Streets by Service Flow Ratio

With an average emergency response time of 21 min for rural accidents, the potential for related delay is great. In addition to traveler inconvenience, these incidents may cause secondary incidents.

WEATHER/VISIBILITY

Driving problems caused or aggravated by weather have a significant impact on the occurrence of accidents. Weather was a factor in 13.3 percent (5,300) of all fatal crashes in 1990. Of these crashes, 70 percent (3,700) occurred in rain.[7]

Additionally, historical experience in many areas shows a significant increase in the number of accidents during adverse weather and under weather-related visibility conditions. This was exemplified in a study of a 66-km (41-mi) section of Interstate in Wyoming which averaged 193 accidents per year. Sixty-one percent of these accidents occurred during only 10 percent of the time — when the roadway conditions were poor. The result was an average accident rate of 11 vehicles per 1.6 million km of travel (1 million mi of travel), 13 times greater than the accident rate during favorable conditions (0.90).[8]

A second example of the severe problems posed to travelers as a result of weather/visibility problems is a 72-km (45-mi) stretch of Interstate in Idaho where snow and dust cause visibility problems. A 4-year history of accidents shows 19 multiple vehicle visibility-related accidents involving 93 vehicles, 9 fatalities, and 48 injuries. Economic loss was estimated at $3 million. Total average annual economic loss was $770,600. An ITS Storm Warning System field operational test is now underway on this freeway segment.

ROAD CLOSURES

The absence of advance information regarding road closures can cause great inconvenience to both personal and business travelers. Roads may be closed due to any of the problems listed above, including construction and maintenance, planned events, unscheduled incidents, and weather. These closures may also be caused by natural disasters such as rock falls, fires, earthquakes, avalanches, hurricanes, etc. No quantitative information was found regarding the frequency or magnitude of rural road closures.

TRAVELER ADVISORY REQUIREMENTS

Advisory information, at least concerning the specific areas in which delay-causing occurrences are frequent, may greatly improve traveler convenience and efficiency. Similarly, safety benefits may be significant. Anecdotal evidence collected from multiple sources in this study suggest such ATIS advisory services could be highly effective in reducing traveler frustration and delays encountered unexpectedly on rural roadways.

Weather conditions are estimated to contribute to approximately 13 percent of fatal motor vehicle accidents. As illustrated by Wyoming statistics referenced earlier, there are rural areas and environments which may be particularly susceptible to hazards introduced by inclement weather. These areas are good candidates for traveler advisory systems. With roughly three-quarter million rural accidents annually, traveler advisory information systems may decrease the occurrence of secondary incidents and enable travelers to take action to reduce delay and inconvenience which might otherwise be experienced. Additionally, traveler advisory systems which are justified and implemented to mitigate accidents may also be used to advise travelers of the unquantified occurrence of incidents — such as those related to construction and maintenance, road closures, special events, etc. Finally, response to the Wisconsin Department of Transportation's telephone advisory information system indicates that advisory systems could be well used by travelers.

TRAVELER SERVICES INFORMATION

Traveler service information provides information about en route services such as lodging and restaurants, visitor attractions, and assistance services provided by gas stations, car repair shops, hospitals, etc. Such information is currently provided en route through billboards/service logo signs, and at rest areas, visitor centers, and attractions.

Traveler service information may be addressed to both personal and commercial travelers. Commercial truck drivers move 32 percent of our Nation's total revenue ka-km (ton-miles) of freight. Their operation and productivity is dependant upon the traveler services discussed here. Trucks make up a significant share of the traffic on rural Interstate routes — comprising over 30 percent of total traffic in many locations. Combination trucks with five or more axles accounted for 16 percent of average daily traffic volumes in 1990.[3]

TRAVELER DEMAND FOR INFORMATION

The presence of information centers within rest areas and welcome centers indicates that a need for traveler service information has been determined. Every State except Alaska and Hawaii operates 1 or more Interstate highway safety rest area, and at least 44 of the 50 States also operate 1 or more rest areas on non-interstate rural primary highways. In total, there are approximately 2,700 rest areas and 290 welcome centers in the United States. Two States reported offering manned tourist information 24 h/day. Thirty-five States said manned tourist information was offered less than 24 h/day.

Survey analyses show that almost all rural freeway travelers on long trips [in excess of 160 km (100 mi)] are potential users of highway rest areas. More than 95 percent of all drivers have used rest areas, and 60 percent prefer them over other stopping opportunities for non-gas, non-restaurant stops. Demographically, the rest area user population closely approximates the driving population, particularly that engaged in longer trips.

As cited previously, Americans took 496 million trips of 160 km (100 mi) or more by auto during 1991. The average distance of auto trips was 955 km (593 mi) round trip, and approximately 80 percent of these trips were for pleasure.[2] The proportion of main-line traffic that enters a given rest area is highly variable — ranging from less than 1 percent to more than 50 percent. The overall average is approximately 10 percent; a somewhat higher proportion of truck and recreational vehicles make rest area stops.[9]

Two 1989 Oregon-sponsored studies of out-of-state motorist visitors support the importance of providing information services which particularly focus on traveler services: 50 percent of visitors plan their overall route but not individual stops, 23 percent do little or no pre-trip planning; 29 percent use roadside signs to determine all or most of their stops; and 10 percent use signs to determine nearly all of their stops.

Welcome Centers in Tennessee are heavily used. An estimated 10 million travelers stop each year, and 1 million of these use the Touch & Go touch screen traveler information system in these centers. Touch & Go is an information system which displays traveler services information with detailed directions. Approximately 21 systems are operated in Tennessee with 175 service providers participating in the advertiser-supported system. Information is updated on a monthly basis. Touch & Go also provides driving safety tips from the Department of Transportation. Touch & Go reports that the most requested information includes:

1. Tourist Attractions.
2. Lodging.
3. Festivals.
4. Restaurants.
5. Shopping.
6. Hiking and Biking Trails.

Construction information was previously offered on some Touch & Go systems. However, it is interesting to note that this information caused complaints from the local tourism industry (the advertisers). Construction was viewed as negative information which encouraged travelers to bypass the affected areas, possibly negatively affecting areas and businesses are dependant upon tourism.

Economic Impacts

Travelers are familiar with logo signs which indicate the location of traveler services on the Nation's Interstate system. Only fuel, food, lodging, and camping services are eligible for logo signs. A study of the economic effects of roadside traveler service signs indicated the logo programs have mainly benefitted the large chains and franchise operations and not the numerous other small rural businesses that offer goods and services desired by the motoring public[10] Because of the desire of these smaller operations, which are generally unable to qualify for the logo program, and other businesses to advertise their services roadside, tourist-oriented directional signs (TODS) have been erected by the States and paid for by these businesses. The signs indicate the name of the business and the direction and distance to the business' location. These signs are authorized on primary and secondary state highways but are not allowed on Interstate highways.

In 1990, 40 States maintained either one or both of the logo and TODS programs. At least six other States had active logo plan evaluations under way.[10] Most of the continuing demand for expansion has come from satisfied motorists who speak favorably of the program. There is also pressure to expand the logo program beyond the Interstate system to other expressways in rural areas.

Interviews with Washington State business operators regarding TODS indicated these businesses felt the signs had a significant impact on their business sales, estimating that as much as 50 to 80 percent of their sales were from highway travelers and they attributed as much as 50 to 70 percent of their total sales to the influence of their TODS. Effects as low as 5 to 8 percent were also estimated. Oregon businesses credited TODS with 30 percent of their highway user sales.[10]

The Manual on Uniform Traffic Control Devices (MUTCD) suggests use of information center kiosks or similar facilities to provide for additional businesses who wish to advertise after the maximum number of TODS have been authorized for an intersection.[10]

The economic effect of information disseminated through rest areas/welcome centers has been previously researched.[9] This research included a request of all state tourism agencies to provide any information concerning the impact of highway rest areas on the State's economy and on tourism. Almost all responses (responses included less than 50 percent of the States) indicated a strong belief that rest area/welcome centers affect the State's tourism industry considerably; however, the effect was difficult to quantify.

Responses from several States to questions regarding the economic effect of rest areas/welcome centers are detailed below. However, as the research noted, for the Nation as a whole, a positive impact of rest areas on tourism can only exist if there is elasticity of demand for tourism services.[9] If the total amount of travelers' time and funds available for tourism is fixed, benefits accrued by one State are simply transfers from another State. Some trends such as increased income, longer lifespans, more travel by older persons, and a reduction in foreign travel, suggest there may be an overall increase in demand for tourist services.

- Colorado — estimates the revenue generated from the Grand Junction and Burlington Traveler Information Centers is $5 million. This is based on 1.4 percent of the directional average daily traffic (DADT) extending their stay an average of 2.4 days. Fifteen percent of the DADT stopped at one of two traveler information centers, and 9 percent of this 15 percent extended their stay by 2.4 days.

- Florida — estimates that, in 1985, 20 percent of the visitors to the welcome centers read, saw, or picked up information about attractions, activities and/or destinations of which they reported they were not previously aware. Due to this information, about 25 percent added 1 or more days to their trip.

- Iowa -- estimated the 1985 economic impact of travelers stopping at the welcome centers was $46 million.

- Kentucky — travelers who stopped and registered at the four welcome centers were responsible for a $59.1 million infusion into the Kentucky economy in 1983. This spending occurred as a result of their travels in and through Kentucky. Over $7.4 million of the expenditures were by tourists who stated that their decisions to travel in Kentucky were influenced by the information obtained at these information centers.

- Michigan — Eleven traveler information centers counseled 1.8 million people, and, because of their counseling efforts, were successful in convincing 9 percent of travelers to stay an additional 4.02 days in Michigan. The direct economic impact to the State was $41.7 million.

- North Carolina — handled over 5.5 million visitors through traveler information centers in 1985.

TRAVELER SERVICES INFORMATION REQUIREMENTS

Travelers exhibit a desire for traveler services information through the support of private information providers such as AAA. Additionally, the target audience is great with almost 500 million automobile trips of 160 km (100 mi) or more per year and truck drivers moving one third of the total US. revenue ton-miles of freight.

Public jurisdictions and the operators of traveler services also recognize the promotional and financial rewards of disseminating traveler service information. As recommended by transportation professionals in the MUTCD, the electronic dissemination of traveler information may eliminate and/or reduce clutter of roadside advertisements competing for travelers' attention. While traveler services information systems may be provided publicly or privately, the economic returns and impacts of traveler service information also almost guarantee that these systems will be financially supported by private interests.

SAFETY AND WARNING

Traveler warning information includes information provided to the en route traveler such as vehicle conditions, vehicle activity, roadway geometrics, and driver condition. Traveler warning information, regarding a variety of situations a driver may experience, is important in regards to safety. The vast majority of fatal crashes in 1990 (87 percent or 34,500) occurred in conditions where the weather was not a factor. Additionally, 46 percent (15,700) of these occurred during daylight hours.[7] From 1990 to 199 1, traffic fatalities decreased in urban areas by 15 percent but in rural areas by only 4 percent.[11]

The main point to retain from the above statistics is that it appears that vehicle crashes can occur at any time, regardless of the present weather conditions: consequently, traveler warning information needs to be provided at all times. In addition, although weather conditions information will have an impact on when to provide such warnings, it should not dictate these transmissions.

VEHICLE CONDITIONS

Vehicle breakdowns or malfunctions on the road are costly to the Nation's drivers. The American and Canadian Automobile Associations (AAA and CAA), with a membership of 34 million, responded to 22.3 million emergency road service calls. The average cost per call to the automobile club is $14.84 or $331 million annually. The average number of calls made per member annually is 0.66."

In 1991, 169 million drivers were licensed in the United States. Presuming that the demand rate of 0.66 calls per driver for emergency road service is consistent for both AAA members and nonmembers, and throughout both urban and rural environments, and assuming a cost of $14.84 per call, 111.5 million emergency road service calls are required per year in the United States at a cost of $1.66 billion. Forty-one percent of the annual vehicle-kilometers traveled in the United States are in rural areas. If, similarly, 41 percent of emergency road service requests are made from rural roadways, the cost of these would be $681 million. In addition to the cost and inconvenience of roadside vehicle breakdowns, safety is a hazard with more than 200,000 serious crimes reported on American highways in 1993.[12]

In addition, vehicle breakdowns and/or malfunctions are "costly" to the Nation's travelers in more than just a monetary fashion. As can be seen from figure 15, the negative effects on roadway efficiency (i.e., reduction in roadway capacity) are clearly illustrated for lane blockages and "shoulder" incidents.

VEHICLE ACTIVITY

Lapses in driver alertness and inappropriate vehicle operation for conditions are two primary safety issues. In rural areas, monotony contributes to inattentiveness, and excessive high speed for prevailing circumstances may leave no margin for error. For ease of analysis, situations which further demonstrate such vehicle activity conditions have been broken down into the following categories:

- Collisions.
- Driving Speed.

NO. OF FREEWAY LANES IN EACH DIRECTION	SHOULDER DISABLEMENT	SHOULDER ACCIDENT	LANES BLOCKED		
			ONE	TWO	THREE
2	0.95	0.81	0.35	0.00	0.00
3	0.99	0.83	0.49	0.17	0.00
4	0.99	0.85	0.58	0.25	0.13
5	0.99	0.87	0.65	0.40	0.20
6	0.99	0.89	0.71	0.50	0.25
7	0.99	0.91	0.75	0.57	0.36
8	0.99	0.93	0.78	0.63	0.41

Source: Lindley, J.A., "A Methodology for Quantifying Urban Freeway Congestion," TRB 1132, 1987.

Figure 15: Fraction of Freeway Section Capacity Available Under Incident Conditions

COLLISIONS

Colliding with another motor vehicle is the most common type of motor vehicle accident in both rural and urban areas (figure 16). Despite the much higher number of total accidents in urban areas than in rural, rural fatal accidents exceed those in urban areas (figure 17). The number of deaths in rural motor vehicle accidents in 1991 by accident type or cause are depicted in figure 18. The total number of deaths was 28,100; 86 percent, or 24,200, were collisions with another vehicle, a pedestrian, or an object.

By comparing the number of accidents by accident type with the number of fatalities by accident type (figures 16 and 18), it is apparent that a disproportionally high number of fatalities occur as the result of rural accidents with another motor vehicle or with a fixed object, relative to similar urban accidents. While a high proportion of rural accidents with another motor vehicle result in fatalities, figure 19 shows that a high proportion of similar urban accidents (with another motor vehicle) result in non-fatal injuries. This difference among urban and rural environments is discussed further in the following section on Emergency Services.

Figure 20 displays rural fatal crashes by roadway function. In descending order, fatal crashes occur most frequently on major collectors, minor arterials, local streets, other principal arterials, Interstates, and minor collectors. Shown in figure 21 are fatal crash rate per 160 million VKT (100 million VMT); local streets have the highest fatal crash rate followed by major collectors, minor collectors, minor arterials, other principal arterials, and Interstates.

The remainder of this section has been broken down into highly visible collision/crash types (after vehicle-to-vehicle) as follows:

- Animal Crossings.
- Railroad Crossings.
- School Buses.
- Slow Moving Vehicles.

Animal Crossings

Animal-vehicle accidents is a collision type which is largely unique to rural settings. In 199 1, accidents involving animals on the road resulted in 100 fatalities (less than 1 percent of all rural motor vehicle deaths) and 4,000 injuries.[4]

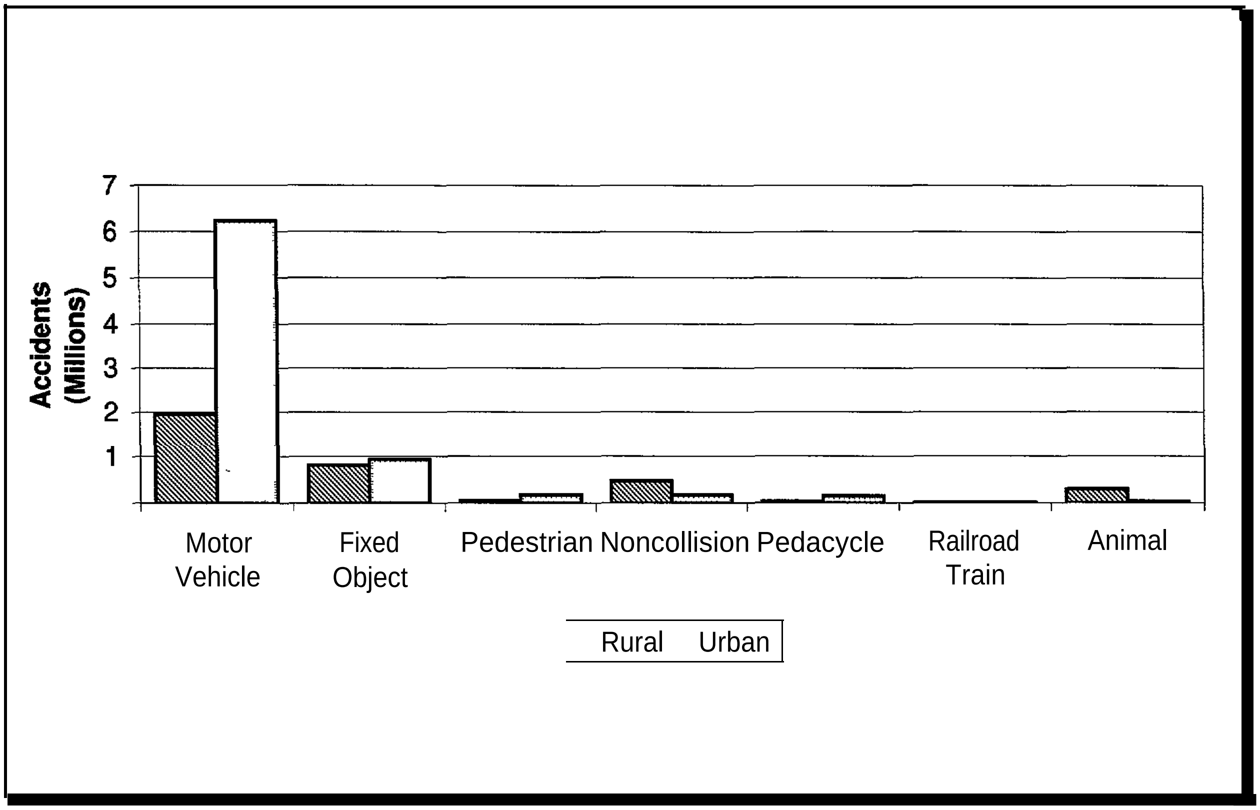


Figure 16: Motor Vehicle Accidents — Rural vs. Urban

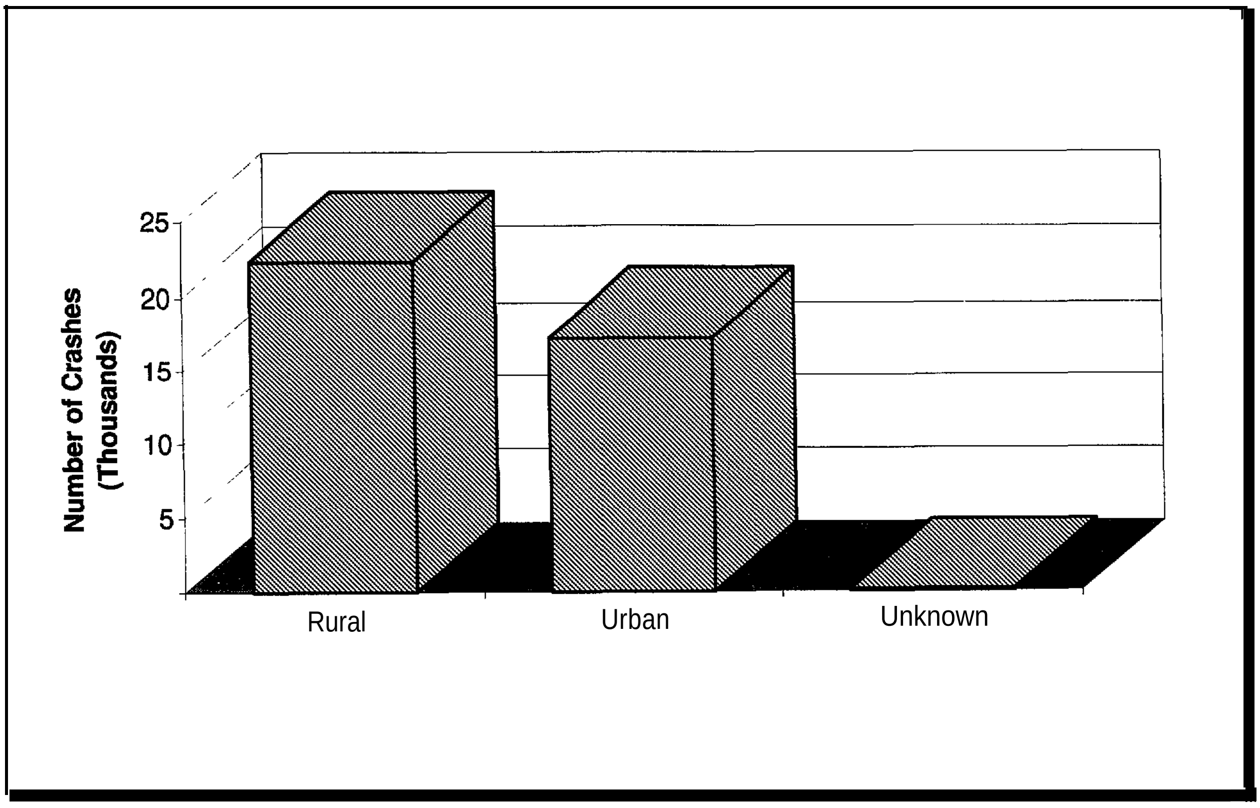


Figure 17: Fatal Crashes — Rural vs. Urban

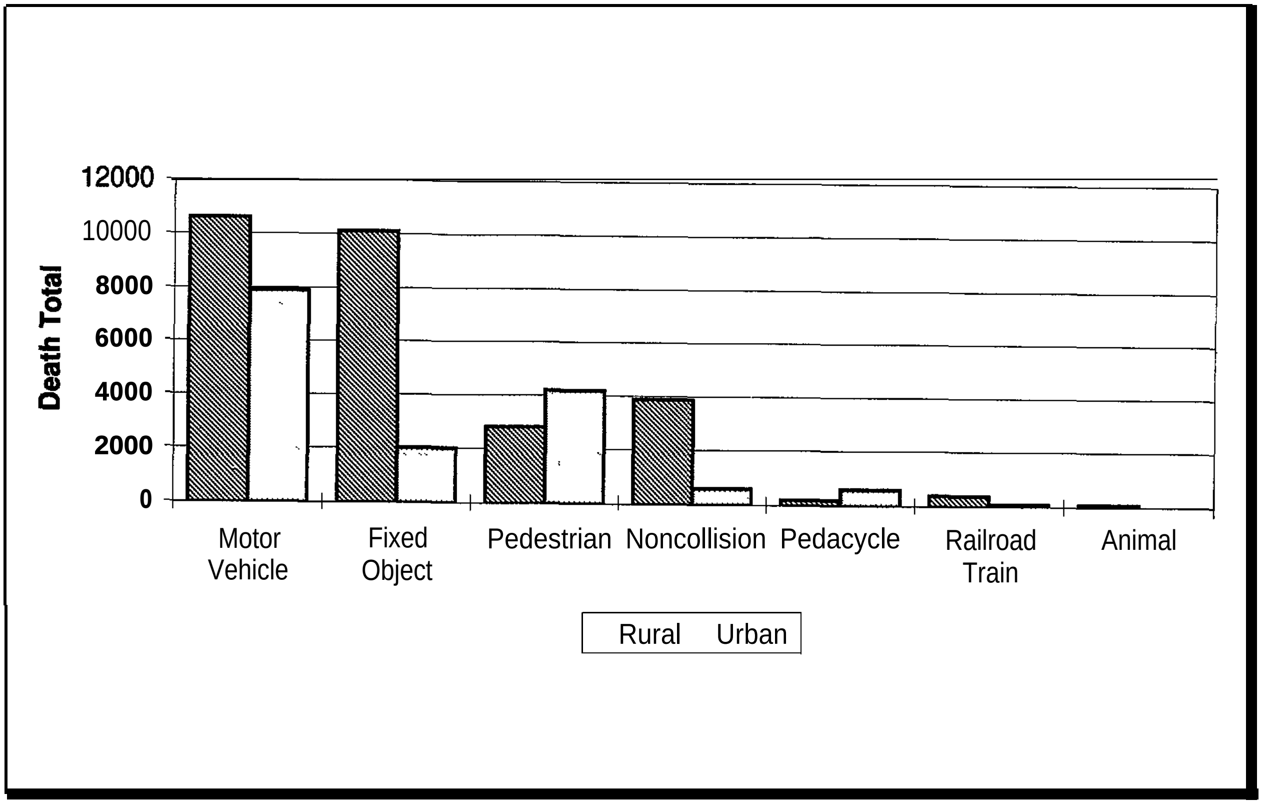


Figure 18: Deaths Due to Motor Vehicle Accidents — Rural vs. Urban

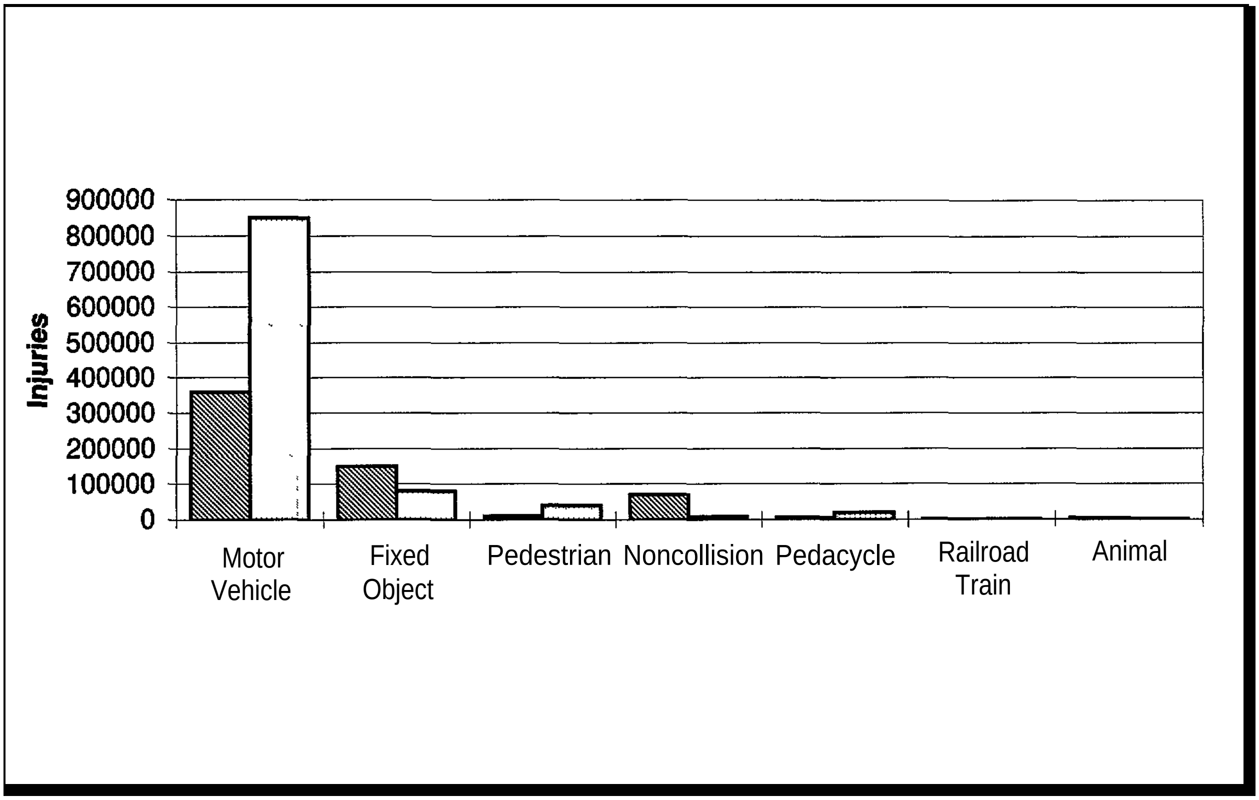


Figure 19: Rural vs. Urban Non-Fatal Injuries Due to Motor Vehicle Accidents

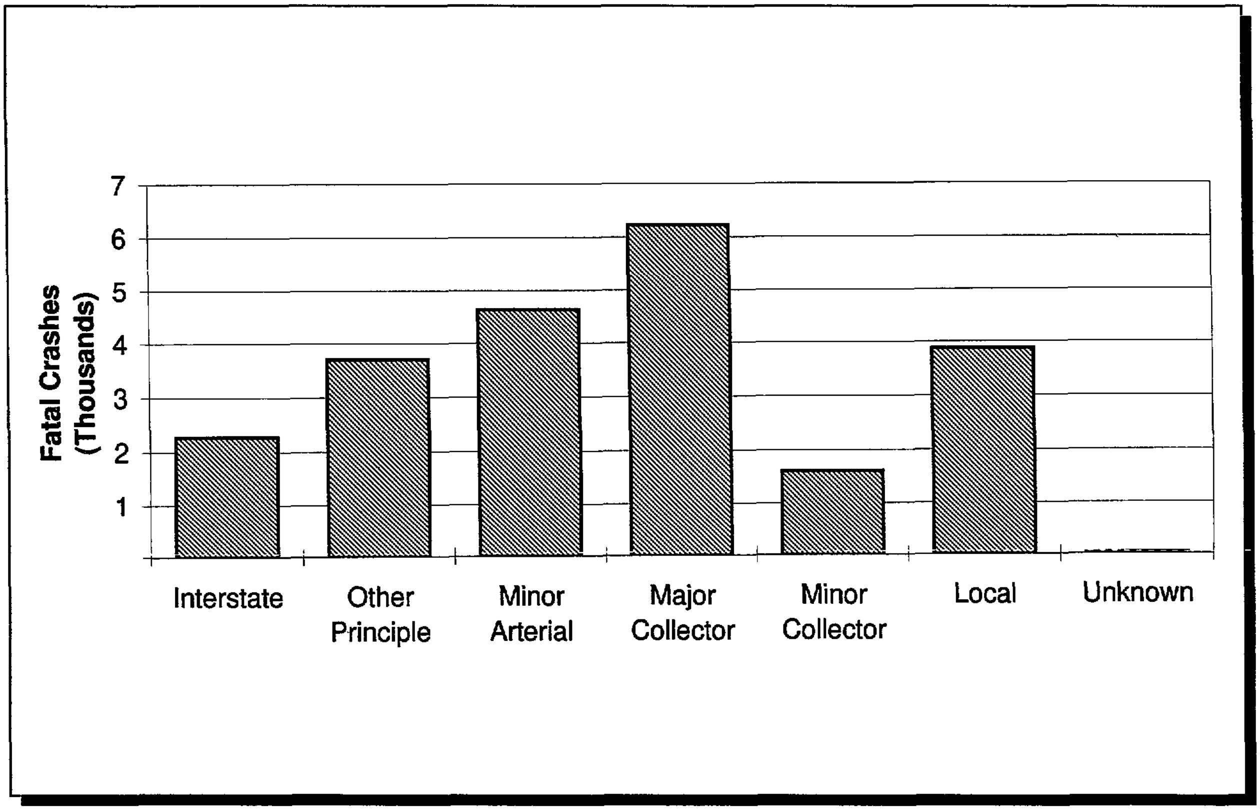


Figure 20: Fatal Crashes by Roadway Function — Rural

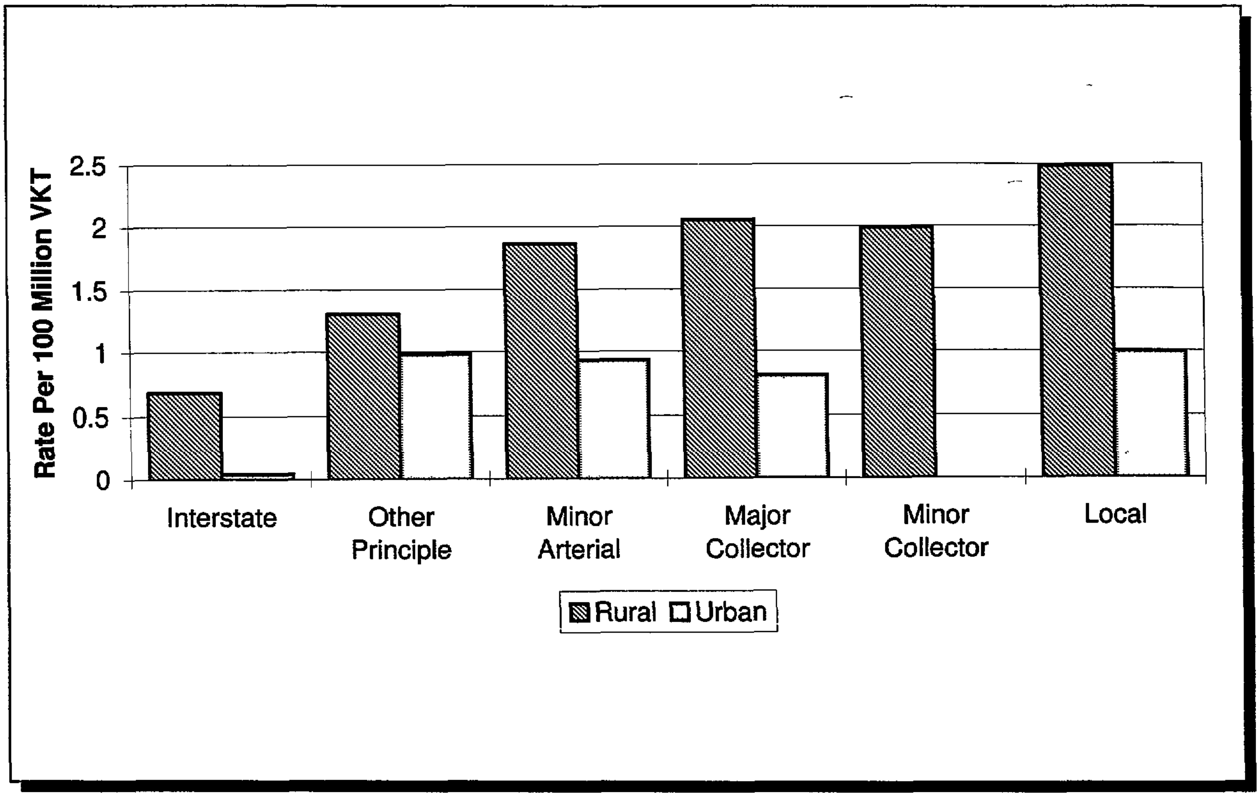


Figure 21: Fatal Crash Rate by Roadway Function — Rural vs. Urban

A Highway Safety Information System Analysis Report for the Federal Highway Administration noted that a study of reported automotive accidents from 1985 to 1989 in five States showed an average of 5.8 percent of all reported accidents involved a vehicle striking an animal.[13] (The States included Illinois, Maine, Michigan, Minnesota, and Utah.) Of these accidents, 95.7 percent resulted in property damage only, 4.2 percent involved non-fatal injuries, and 0.05 percent resulted in fatalities.

Railroad Crossings

Rural deaths which were the result of collisions with a train totaled 400, or 1.5 percent of all rural motor vehicle deaths, in 1991.[4] The lack of respect drivers have for current railroad warning systems may contribute to these collisions, as exemplified in a study of railroad crossing violations in an urban setting. The study showed an average of one violation per hour at each of two test crossings.[14] These study findings and the drivers' unwillingness to take direction from the warning signs may have some long-term implications regarding driver behavior and the design and use of effective warning and advisory type information systems. However, the fact that there were only 100 deaths as a result of train and motor vehicle collisions in urban environments also suggests that differences between rural and urban environments may account for the higher rural fatality rate.

School Buses

School bus transportation accidents killed 100 persons in school year 1990-91 (less than 1 percent of all motor vehicle accident deaths), including 35 pupils and 65 other persons (mostly occupants of other vehicles). Of pupils killed, 5 were passengers on school buses and 30 were pedestrians. About 15 were struck by a school bus. Injuries in school bus accidents totaled 11,000 of which 7,700 were students.

Slow Moving Vehicles

Slow moving vehicles may pose particular hazards in rural settings. The presence of farming vehicles and restrictive roadway geometric features (e.g., narrow, curvy roads) contribute to these hazards. However, no figures were uncovered to identify and quantify the contribution of slow moving vehicles to accident rates.

Driving Speed

Eighteen percent of all rural accidents are due to unsafe speed (662,400 accidents), and 18 percent of rural fatalities are due to unsafe speed (4,282 fatalities). The fatal crash rate per 100 million VMT for rural roadways is greatest on those roadways with a 88 km/h (55 mi/h) speed limit (figure 22).

Recognizing appropriate speeds consistent with prevailing conditions may be especially critical for truck drivers in rural settings. Runaway truck ramps have been implemented by numerous States to mitigate downhill brake problems. For example, I-64 in West Virginia has three runaway truck ramps within a 19-km (12-mi) distance. These were used 278 times during 1990 — 1992 or an average of 93 times per year. Nine injuries and no fatalities resulted from the use of these ramps. Fourteen percent of the 8,700 average daily vehicles on this route are semi-trailers combinations.

Roadway Geometrics

Roadway geometrics concern those aspects of the road's design which may pose safety hazards to the traveler such as blind comers, no shoulder, limited clearance, etc. No figures were identified which directly quantified roadway geometrics' contribution to rural accidents, however, these may be closely tied to the 18 percent of rural accidents which are due to unsafe speed.

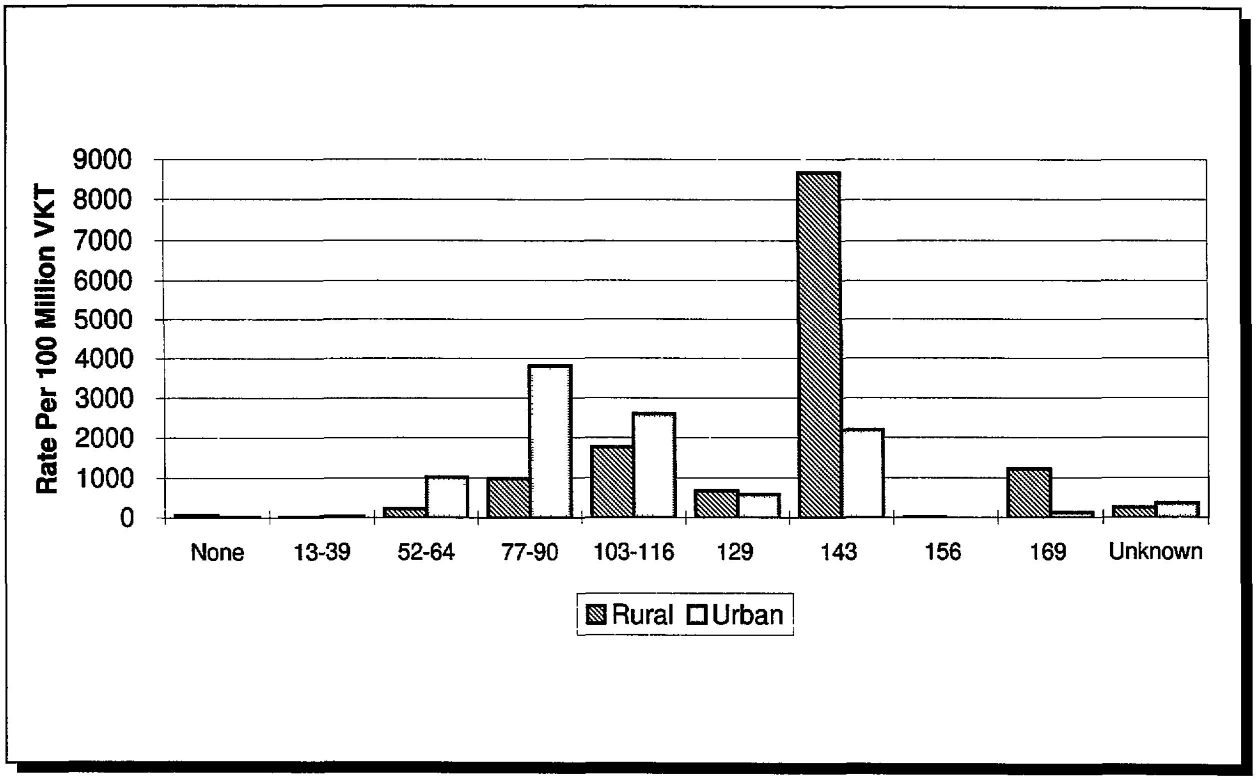


Figure 22: Fatal Crashes by Speed Limit — Rural vs. Urban

DRIVER CONDITION

Improper driving, alcohol impairment, and driver fatigue all contribute significantly to accidents. Figure 23 shows that the majority of rural accidents are caused by improper driving. Figure 24 further shows that speed and failure to yield the right of way are the most common forms of improper driving resulting in accidents in both rural and urban areas. Similarly, these are the most common forms of improper driving which result in fatal accidents (figure 25).

Fifty-three percent of vehicle-related deaths occur at night. This is equivalent to a ratio of 4.25 deaths/100 million VKT (6.8 deaths/100 VMT). Conversely, the daytime fatality ratio is 1.2 deaths/100 million VKT (2 deaths/100 million VMT), which represents 47 percent of rural deaths. The difference in these ratios may be partially due to alcohol use, more inexperienced drivers (e.g., teens) driving at night, etc. The fatal crash rate also increases slightly during the summer months (figure 26), and again, this may be due to the increase of less experienced drivers on the roads during these months.

About 50 percent of all traffic fatalities in 1990 involved an intoxicated or alcohol impaired driver or non-occupant (22,100 fatalities). Twenty-nine percent of serious injury accidents and 7 percent of property damage accidents involve alcohol.[4]

One-third of all single vehicle truck accidents which are fatal to the driver involve driver fatigue. This represents about 20 percent of all fatal truck accidents. The average annual number of accidents involving drowsy drivers as reported by police (data from 1988 - 1990) is 68,000, representing 1 percent of the average annual number of accidents (6.7 million). The National Highway Traffic Safety Administration (NHTSA) believes the real number is closer to 3 percent. Approximately 3/4 of these crashes occurred on open highways (i.e., rural roadways).[15]

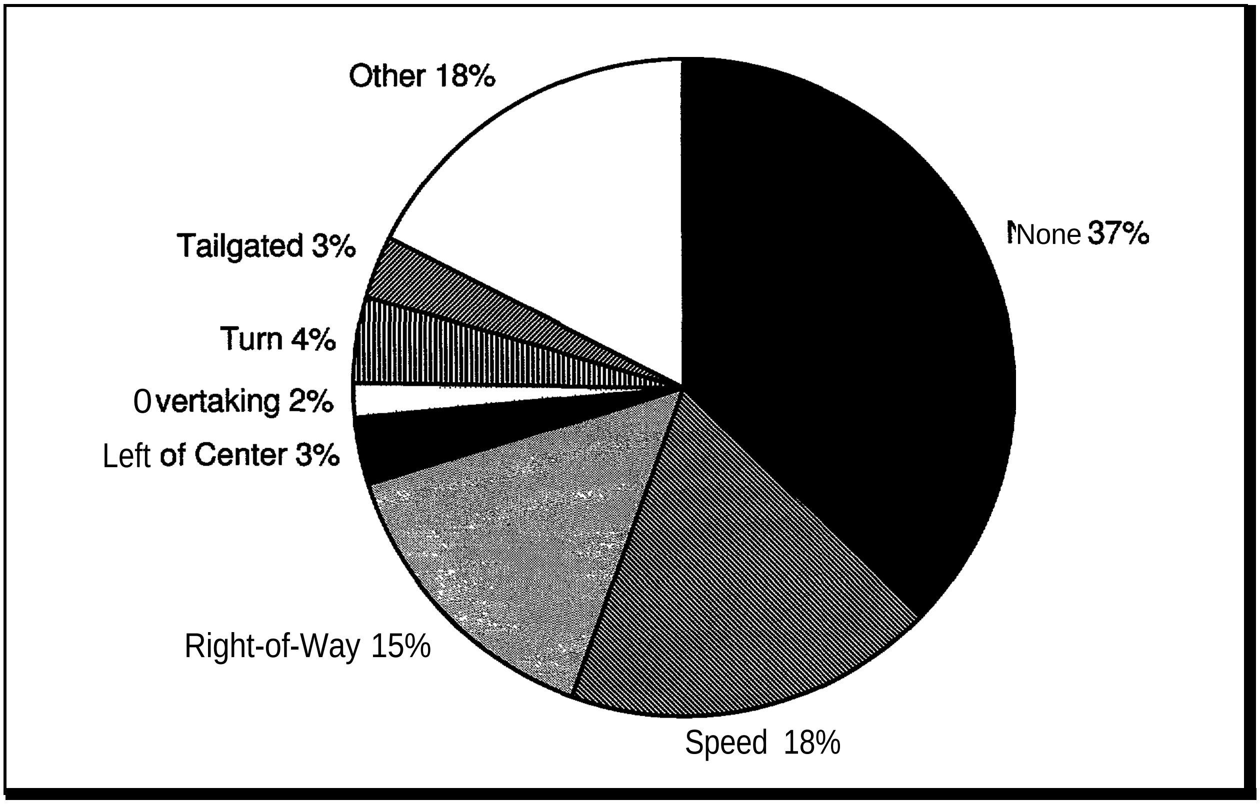


Figure 23: Improper Driving — All Rural Accidents

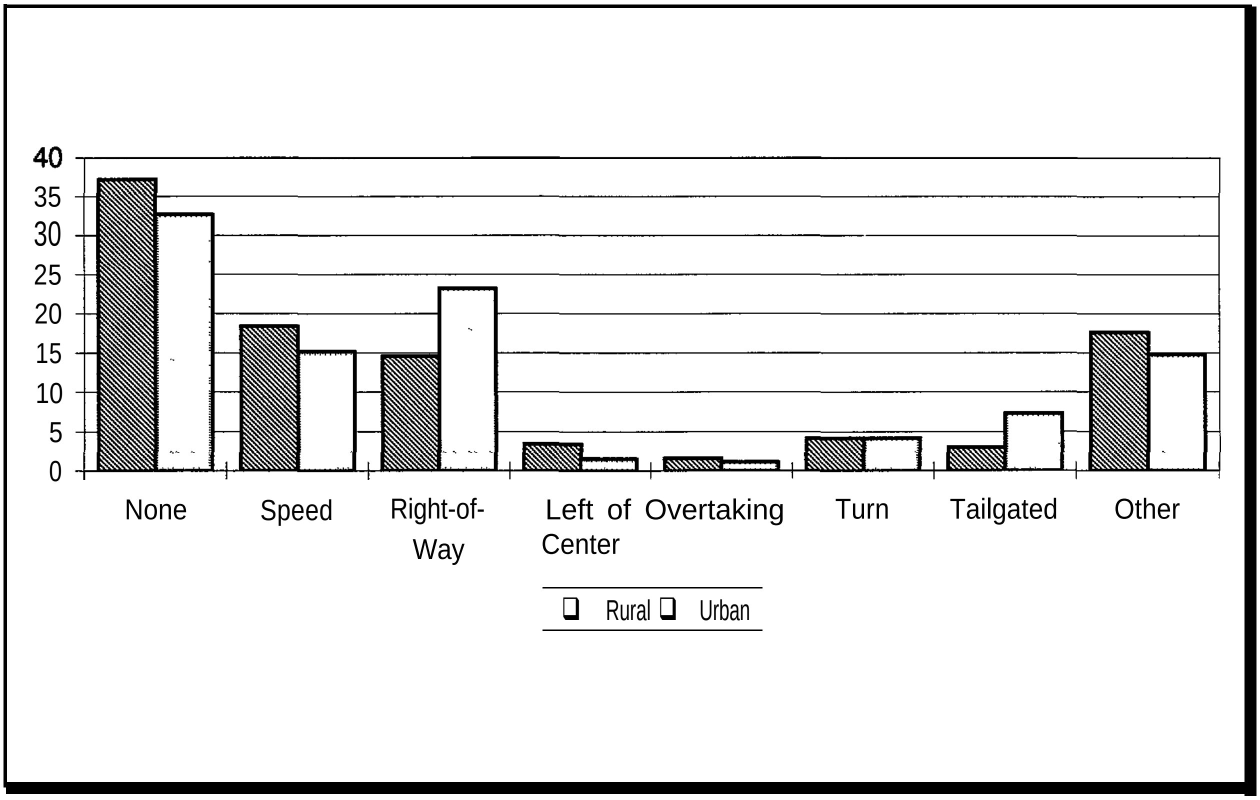


Figure 24: Improper Driving — Rural vs. Urban Accidents

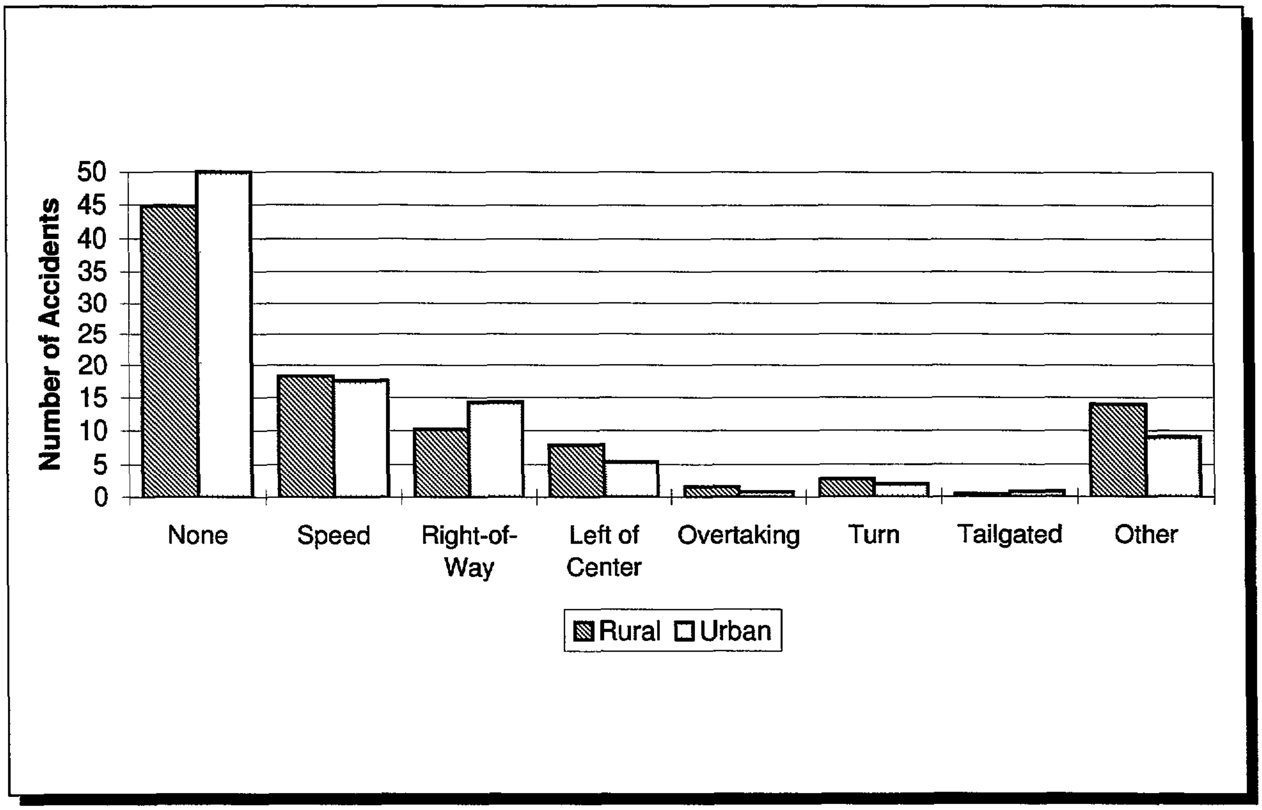


Figure 25: Improper Driving — Rural vs. Urban Fatal Accidents

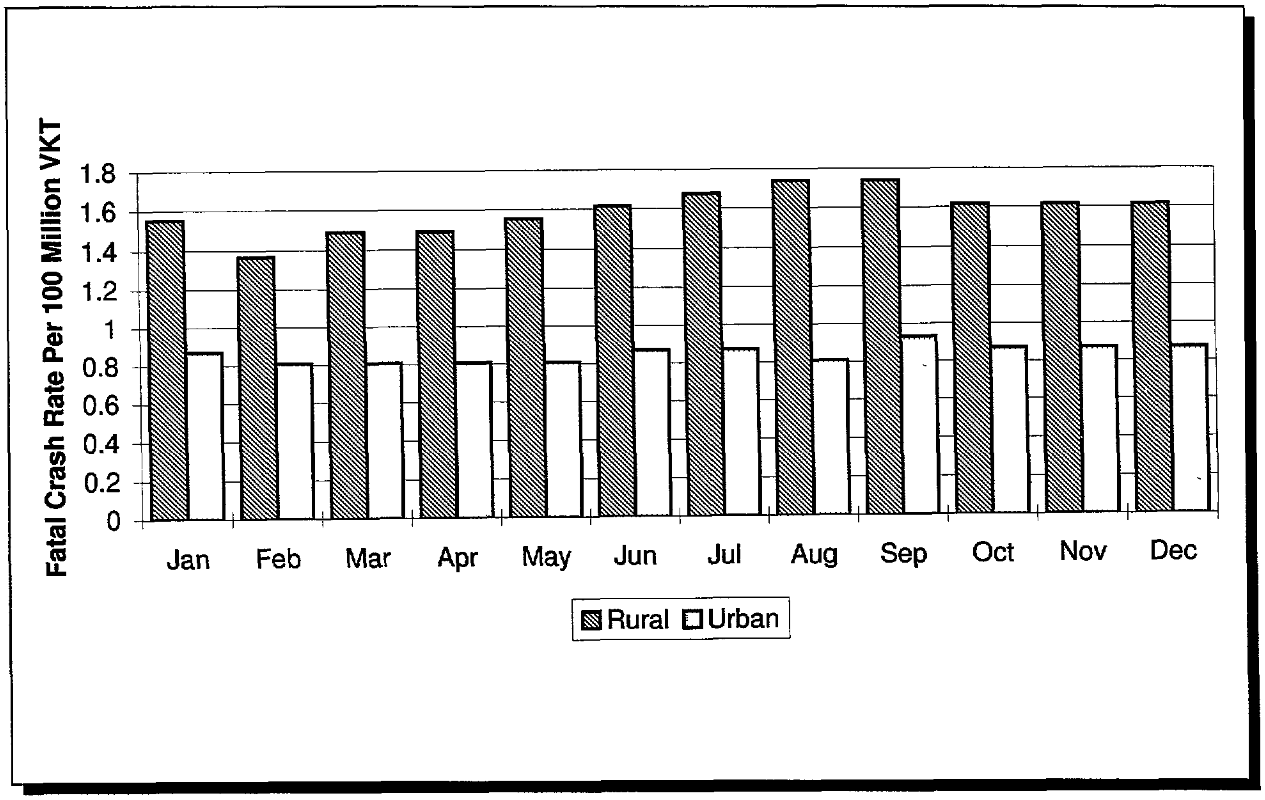


Figure 26: Fatal Crashes by Month — Rural vs. Urban

Safety and Warning Requirements

A variety of safety and warning system devices can potentially contribute considerably to both traveler safety and convenience. AAA/CAA serves over 22 million roadside calls per year. Implementation of warning systems to alert drivers of mechanical deficiencies prior to vehicle breakdown would be of great value. The value is demonstrated by the $331 million annual cost to respond to these calls.

Warning of driver impairment, appropriate speed limits for the conditions, and imminent collisions may substantially decrease the number of accidents and fatal accidents. However, for these systems to positively affect travel safety, the warning will need to provide enough time for the driver to take countermeasures and the driver will also have to choose to take these defensive actions. Some drivers are known to violate railroad crossing safety controls. AAA/CAA emergency roadside calls for running out of fuel in vehicles which have a warning system total 366 thousand calls per year (1.6 percent). These facts suggest that not all travelers would necessarily heed the warnings of ITS devices implemented in the rural environment.

Route Guidance

Route guidance provides the en route traveler with information regarding available routes. Route guidance information may be provided in the form of alternates to a route which is closed or experiencing prolonged delays (due to incidents, construction, special events, etc.). In addition to providing alternate routing instructions, route guidance systems may also simply aid a traveler in finding their way through unfamiliar areas (even if there is no need for alternate routing). The most common means from which route guidance is currently disseminated is via changeable message signs or radio broadcasts (either HAR or commercial broadcasters).

In addition to being useful to drivers who are familiar with the area they are traveling in, but who have not anticipated the need to reroute, routing information would be of particular use to people who are traveling in unfamiliar areas, These include those travelers who were responsible for 496 million trips of 160 km (100 mi) or more in 1991.

Two field tests of in-vehicle route guidance systems have been conducted in the United States in urban areas testing the usefulness of these systems with both travelers familiar with the area (Pathfinder and TravTek evaluations) and with people unfamiliar with the area (TravTek evaluation). The Pathfinder evaluation found that 83 percent of the test drivers found the information provided by the system (primarily congestion levels on alternate routes) useful.[16] Additionally, the TravTek evaluation found that in over 70 percent of the navigation system test trips the system was used by the drivers.[17]

Route Guidance Requirements

Route guidance systems may potentially assist travelers to make routing decisions when faced with unanticipated obstacles. This translates to traveler convenience and efficiency as well as safety in that it will assist travelers in making wise route choices based on the prevailing conditions (e.g., weather). Demonstration services of route guidance systems have found systems to be useful. Improvements in data gathering abilities and communication networks of future systems should enable route guidance to be even more useful to travelers.

Emergency Services

Mayday services for medical and mechanical assistance requests are primary examples of critically important emergency services. These services may be partially met through expanding availability of cellular phone service. Major portions of the United States are well covered with cellular phone service with the exception of the Rocky Mountains region. However, mayday services cannot always be met with cellular systems. Examples include emergency medical calls where the injured traveler is physically unable to place a phone call, travelers who do not want the extended service available with cellular telephone, and for those traveling beyond cellular phone coverage.

MEDICAL ASSISTANCE

Sixty-one percent of all fatal accidents occur in rural areas.[4] There were 22,700 rural fatal accidents in 1989 representing a fatal accident rate of 1.7 per 100 million vehicle-kilometers (2.7 per 100 million vehicle-miles). A total of 26,100 people died. In contrast, urban fatal accidents totalled 18,002, representing a fatal accident rate of 1.4 for a total of 19,500 persons dead. Although the rural fatal accident rate is higher than the urban rate, a higher proportion of urban accidents result in nonfatal injuries. Nonfatal injury accidents totalled 733,455 in rural areas representing an accident rate of 86.4; urban nonfatal injury accidents totalled 1,650,881 or 81.5 accidents per 100 vehicle-kilometers (13 1.2 1 accidents per 100 million vehicle-miles).[18]

Other things being equal, fatality rates tend to be highest where the travel density — the ratio of vehicle kilometers to highway kilometers — is low. Fatality rates are normally higher on lightly traveled segments of the Interstate System than on segments where traffic is heavier.[18] This may be related to emergency response time. The time to notify, respond, and transport accident victims to the hospital is approximately 34 min in urban areas and 51 min in rural areas -- one and one half times as long. Rural notification time is 10 mm compared to 5 min for urban notification. Rural response times is 12 versus 6 mm in an urban setting. Transport time to a hospital is 35 mm for rural areas and 25 min for urban areas (figure 27).[7]

MECHANICAL ASSISTANCE

As detailed under the preceding "Vehicle Condition" section, travelers' need for emergency mechanical assistance occurs relatively often. Of the 22.3 million emergency road service calls to AAA and CAA

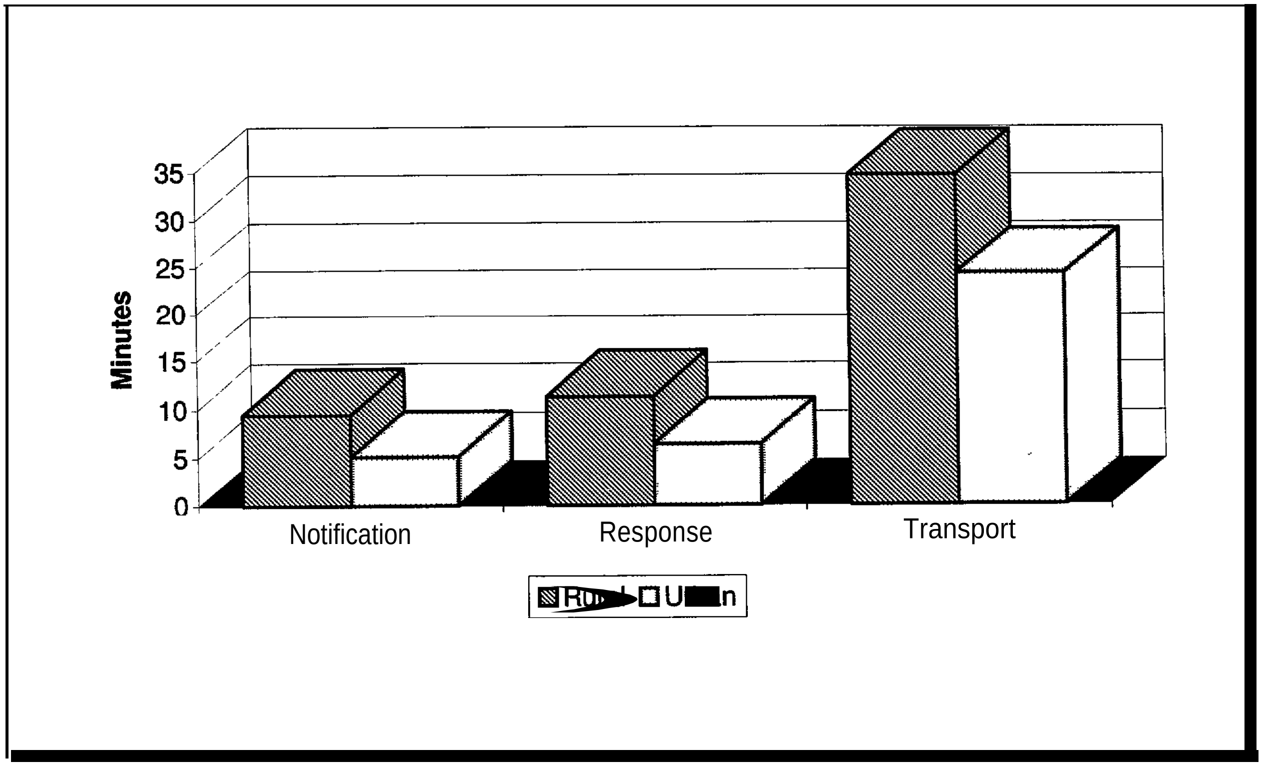


Figure 27: Average EMS Elapsed Times — Rural vs. Urban Fatal Crashes

in 1992, 37 percent requested tow service, 35 percent were responses to "can't start" calls, 12 percent were lock outs, 11 percent were for tire service, and the remaining request were for fuel and other problems. Quick response to mechanical assistance requests may also aid traveler safety in that there were 200,000 recorded occurrences of serious crimes on the Nation's highways in 1993.

EMERGENCY SERVICES INFORMATION REQUIREMENTS

Emergency services encompass those services which are perceived as the most desirable form of information systems to travelers in rural and small urban areas. The data presented in this section, and all preceding sections in this chapter, substantiates the need for emergency services as all the incidents documented in this chapter have the potential to require emergency medical or mechanical services. Additionally, these services, whether publicly or privately provided, are services for which user fees could be charged -just as AAA membership and ambulance service fees are now charged.

RELATIVE PRIORITIES

In order to effectively use the results of the analyses of travelers' information needs in rural and small urban areas some means is required to prioritize these needs. While statistics were cited in reference to many of the needs, a quantitative comparison of accidents to fatalities and to traveler usage of existing information sources would be a comparison of apples, oranges and pears. Therefore, efforts to prioritize the many information needs, and understand the relative priorities once the needs are ranked, necessarily involve some subjective determinations.

To develop a priority scoring rank, the information needs identified from the focus group and telephone interview process were used, in combination with the substantiation of these needs as detailed in this chapter. Three "goals" for traveler information were specified to represent information value:

1. Improve safety.

2. Provide for traveler convenience and efficiency.

3. Contribute to economic development.

These three "goals" of traveler information were chosen to represent the value of the respective information needs as substantiated here because they:

1. Represent the major benefit categories of traveler information.

2. Can realistically be assigned substantiation scores (e.g., if convenience and efficiency were separate categories, they would in all likelihood, be assigned the same score).

Scores were assigned ranging from 0 - 5 based on the substantiated needs and the ability to fulfill each goal. Zero represented a null contribution to the "goal" category and five represented a highly significant contribution. Scores were assigned by a committee made up of representatives of the project's Expert Panel. The committee's scores were determined through a workshop meeting which spanned 2 days and included presentations of the work conducted thus far for this project and group discussions.

Having identified the scores for each of the information goals, a total substantiated score was developed by adding the three goal scores. Finally, the relative priority score was developed by multiplying the substantiated score and the traveler-perceived needs score as reported from interview respondents in the previous chapter.

Figure 28 presents the calculated relative priority scores of individual information needs by user services. The information needs found

USER SERVICE	RELATIVE PRIORITY					
	SUBSTANTIATED				PERCEIVED	BOTH
INFORMATION NEED	SAFETY	CONV./EFF.	ECONOMIC DEVLPMNT	TOTAL		
TRIP PLANNING/ROUTING						
Routing	1	4	0	5	6.2	**31.0**
Road Conditions	1	3	1	5	5.2	**25.9**
Weather Conditions	3	4	1	8	5.0	**39.7**
Travel Time	0	4	1	5	5.2	**25.9**
En Route Facilities	1	2	3	6	4.0	**24.0**
TRAVELER ADVISORY						
Recurrent Congestion	1	2	1	4	5.1	**20.4**
Construction & Maintenance	1	4	1	6	5.1	**30.6**
Incidents	2	4	0	6	5.1	**30.6**
Weather & Visibility	3	3	1	7	4.5	**31.2**
Road Closures	1	4	0	5	8.2	**40.9**
TRAVELER SERVICES						
Lodging & Restaurants	0	2	5	7	4.3	**29.8**
Tourist Attractions	0	2	5	7	4.3	**29.8**
Assistance Services	1	3	3	7	4.3	**29.8**
SAFETY & WARNING						
Vehicle Conditions	4	3	0	7	8.5	**59.3**
Vehicle Activity - Collision	5	3	0	8	8.5	**67.8**
Vehicle Activity - Speed	5	3	0	8	8.5	**67.8**
Roadway Geometrics	3	1	0	4	7.8	**31.2**
Driver Condition	4	1	0	5	8.3	**41.4**
ROUTE GUIDANCE						
Diversion	2	5	1	8	4.9	**39.4**
EMERGENCY SERVICES						
Mayday - Medical	5	4	0	9	8.6	**77.1**
Mayday - Mechanical	3	4	0	7	8.6	**60.0**

Figure 28: Relative Priority of Information Needs by User Services

within the emergency services user service category scored the highest in relative priority with the information needs within the safety and warning user services category following these. This is consistent with the relative scores of both the perceived needs and the substantiation process indicating that these information services are both desired and warranted.

Individual information needs have been sorted by their relative priority scores in figure 29 allowing inconsistencies in the substantiated and perceived relative priorities to be looked at. The need for information regarding recurrent congestion is one area where an inconsistency is apparent. While the relative perceived need is somewhere in the middle of information needs as perceived by rural travelers (scoring 5.1 with other needs scoring from a low of 4.0 to a high of 8.6), the need for information regarding recurrent congestion was not well substantiated. This is due to the fact that recurrent congestion occurs in few rural areas. However, the higher relative perceived priority may represent the desire for information regarding recurrent congestion in those few areas where recurrent congestion may be a frequent problem. These may include tourist-oriented and seasonal recreation areas. Therefore, while the relative priority of some information needs may be low, it will be important when developing rural ATIS application concepts to consider situational issues like recurrent congestion where information needs may not be substantial throughout the country, but they may be substantial in specific areas. This table of substantiated and perceived needs, and the ability to compare these needs, provides the

USER SERVICE	RELATIVE PRIORITY					
	SUBSTANTIATED				PERCEIVED	BOTH
INFORMATION NEED	SAFETY	CONV./EFF.	ECONOMIC DEVLPMNT	TOTAL		
Mayday - Medical	5	4	0	9	8.6	**77.1**
Vehicle Activity - Collision	5	3	0	8	8.5	**67.8**
Vehicle Activity - Speed	5	3	0	8	8.5	**67.8**
Mayday - Mechanical	3	4	0	7	8.6	**60.0**
Vehicle Conditions	4	3	0	7	8.5	**59.3**
Driver Condition	4	1	0	5	8.3	**41.4**
Road Closures	1	4	0	5	8.2	**40.9**
Weather Conditions	3	4	1	8	5.0	**39.7**
Diversion	2	5	1	8	4.9	**39.4**
Roadway Geometrics	3	1	0	4	7.8	**31.2**
Weather & Visibility	3	3	1	7	4.5	**31.2**
Routing	1	4	0	5	6.2	**31.0**
Construction & Maintenance	1	4	1	6	5.1	**30.6**
Incidents	2	4	0	6	5.1	**30.6**
Lodging & Restaurants	0	2	5	7	4.3	**29.8**
Tourist Attractions	0	2	5	7	4.3	**29.8**
Assistance Services	1	3	3	7	4.3	**29.8**
Road Conditions	1	3	1	5	5.2	**25.9**
Travel Time	0	4	1	5	5.2	**25.9**
En Route Facilities	1	2	3	6	4.0	**24.0**
Recurrent Congestion	1	2	1	4	5.1	**20.4**

Figure 29: Relative Priority of Information Needs

means by which these situational areas may be identified.

SYSTEM CREDIBILITY

As this chapter's title suggests, almost no issue could be more important to rural ATIS than the credibility of the ATI system, or rather, the credibility of the information provided by the ATI system. Ultimately, the eventual success of many ATI systems, especially in rural areas, will depend upon the accuracy, reliability, and timeliness of this information service provision.

Within the ITS arena, it is felt that most ATI systems will be championed by private sector interests that envision a commercially-viable product that meets or exceeds the desires of its target audience. In order to address these market interests, chapter 2 of this report presented a summary of perceived User Needs that were identified for rural areas. In turn, chapter 3 saw the identification of rural transportation "problems" that help shape the scope and magnitude of the various needs. However, it may be more accurate to label the results of these chapters as user wants instead of user needs, because the results reflect the information that users say they "want," which is sometimes different from the information that they "need." This is an important distinction to make, because many commercial ventures into rural ATIS may focus on providing only the information that they believe consumers are willing to pay for (user wants) at the expense of what many public agencies believe the consumer needs (user needs). However, it is felt that user wants are the forerunners to user needs, if not one in the same thing. (In this report, user needs and user wants are considered to be the same, because the users' "perceived needs" identified in chapter 2 accurately reflect both wants and needs, with no apparent distinction between the two). In addition, even if wants and needs are considered to be two separate entities, it is unlikely that an ATIS vendor would provide only the information that users' want, and not recognize what users' need, for fear of losing their share of the market.

Therefore, the appropriate resolution of this situation is critical to the success of rural ATIS and AT1 systems in general. A delicate balance must be established (and maintained) between user wants and user needs in order to avoid any negative deployment consequences. It is envisioned that this balance will eventually come about as market forces (over time) determine the products and information that users are willing to pay for. To what level these AT1 systems/products present user wants vs. user needs is unknown at this time (e.g., information provided is 60 percent wants vs. 40 percent needs). From a business perspective, why provide any information if no one is willing to pay for it. Therefore, it seems apparent that, in the final analysis, it will be the user, not the information service provider, who will determine the informational content of proposed AT1 systems by power of their pocketbooks. Determining and providing what the user wants vs. what the user needs will be a productive exercise in AT1 system market penetration for the successful ATIS vendor. The AT1 system vendor must correctly gauge their market based on user preferences (i.e., appropriate split of wants/needs). Because most vendors will generate revenue from providing an information service or selling an information product, the desires of the consumer will be paramount over any other concerns (e.g., potential advertisers complaining that inclusion of construction activities encourage travelers to bypass areas thereby negatively affecting their business).

In the marketplace, it is usually the informed consumer who determines whether a product or service succeeds or fails. Therefore, an ATIS Vendor will need to ensure that their product/service encapsulates enough market share to generate profits. If this means providing construction information to paying customers because users want or need this information, then the ATIS vendor will have to decide if this type of revenue generation exceeds the revenue generated by potential advertisers. If it does, then user needs and wants will be paramount. If not, then advertiser concerns will prevail. If advertiser concerns were to prevail in the above example, it is expected that users who are not informed of construction activities would question the credibility of their AT1 system and its usefulness. Because consumer confidence in a product/service is usually the benchmark for eventual and ultimate success in the economic marketplace, an ATIS vendor who fails to adhere to its customer base and their wants and needs will most likely find themselves out of business.

Because most ATI systems are expected to be wholly or in part operated and maintained by private sector interests, various public agencies now find themselves in the position of trying to ensure that the ATI system is optimized for <u>all</u> users and for all parties that have a vested interest in the movement of people (user needs), not just those who control the data flows (user wants). Unless these public agencies get into the information service provision market themselves, there does not exist any method to ensure a user needs service provision, (if not already provided by the ATIS vendor), short of financially subsidizing this information. Therefore, public agencies either have to rely on the informed consumer and market forces economic models to determine rural ATIS service/product penetration or be prepared to subsidize these ATIS services/products to include the information they deem necessary.

SUMMARY

It is evident that some needs, such as emergency services, are both well substantiated and desired by travelers while others are not so well substantiated. Additionally, several information services may prove to be commercially viable systems supported either through advertising revenues or user fees. One aspect which will affect the desirability of these information systems is the providers' ability to package the various services in one system. During the interview process, fleet operators stated their desire to receive all travel information from one source. Finally, care will need to be taken when conceptualizing information systems that the need to generate revenue through advertising does not dictate the information which is disseminated. At least one such case has been noted with construction status information being pulled from a advertiser-supported traveler services information system.

CHAPTER 4: RURAL ATIS TECHNOLOGY ASSESSMENT

INTRODUCTION

This chapter examines ATIS technologies available to address rural traveler services and information needs. Applicable technologies for rural use related to data collection, data aggregation/processing, traveler interface, and communications functions are reviewed.

The user needs surveys and the assessment of rural transportation issues discussed in chapters 2 and 3 provide quantitative measures of the kinds of information desired by rural travelers and the market for rural ATIS applications. This chapter examines the technology tools which are available and emerging to satisfy the designated needs. A technology assessment task was executed for this project and reported in a separate document; it is summarized in this chapter.

Considering the rapid pace of change in the high tech marketplace, this section represents a snapshot of current technologies as of early 1994. It is fair to assume that many of these products, services, and technologies will continue to evolve, improve, and be superseded by others. Furthermore, technology will continue to be fueled by market demands outside the needs of rural ATIS applications. A top priority in evaluating available technologies is not to "reinvent the wheel," but rather to piggyback on existing or developing capabilities and apply them to rural and small urban area situations.

The rural ATIS functional elements required to provide the user services discussed earlier could be categorized into the following functional areas:

- Data Collection
- Data Aggregation and Processing
- Communication
- Traveler Interface

Each user service has unique requirements in each identified functional area. For example, the communication needs of the trip planning services are quite different from those required for route guidance systems or emergency services. Similarly, the data collection requirements for safety and warning services are different than those required to support routing services.

In the next section, various technologies are described within the four functional areas; the discussion addresses applications to support one or more rural traveler services. For example, automatic vehicle location (AVL) may be used for collecting data (location of a stranded vehicle) to provide emergency services. It could also collect data (travel time) to provide traveler advisory services. Because the supporting technologies may be applicable for multiple user services, the technology descriptions are structured around functional areas rather than user services.

DATA COLLECTION

Data collection systems gather information required to support all the ATIS user services. Automated technologies available for data collection can be divided into the following categories: in-vehicle sensors, weather sensors, and roadway sensors. (Please note that the weather sensors and roadway sensors categories are not mutually exclusive: in other words, some of the weather sensors that provide real-time roadway conditions are embedded in the pavement and the roadway sensors described are strictly used for traffic measuring purposes.) In addition, a good deal of information will be collected and entered into a system manually. This includes static information (e.g., traveler services, public transportation services and schedules) and dynamic information (e.g., construction, special events, incident response).

In-Vehicle Sensors

These sensors gather information about the roadway, the vehicle, other vehicles, the driver, and roadway conditions. The mass of data collected by in-vehicle sensors would be used to fulfill the emergency services and safety and warning functions of a rural ATIS. In-vehicle sensors can be an integral part of the vehicle design or may be add-on items.

Near-Field Object Sensors

Near-field object sensors detect the presence of vehicles or roadside objects near the equipped vehicle, operating much like an airplane's radar system. Similar systems have been impractical for automobiles due to the large number of objects encountered in a roadway environment. However, recently several automotive radar systems have been developed that overcome this limitation. These near-field object sensors would benefit a rural ATIS due to the high incidence of single vehicle accidents and fatal accidents in rural areas. The near-field object sensors are designed to provide important safety-related information about the immediate driving environment to the driver. However, only the VORAD system has experienced a significant amount of real-world use.[19]

MAYDAY SYSTEMS(AVL)

As a data collection function, mayday systems serve to collect information on vehicle location and vehicle conditions information. All automatic mayday systems (as compared to manual reporting methods) rely on some form of automatic vehicle location. There are numerous commercial AVL systems available, many of which were designed for fleet management services, and a few of which were originally intended for stolen vehicle recovery services. Vehicle conditions information is usually obtained from "black boxes" (similar to those used by the airline industry) installed on the vehicles. These are primarily used as a means to collect and capture critical safety data (e.g., data that describes the nature of a crash) and the vehicle's most current operating conditions (e.g., fuel/oil level, engine temperature, lights on/off).

Mayday systems using AVL fulfill a specific niche in a rural ATIS: automatic emergency location service. Several of the AVL systems evaluated in this project could be applied in a rural environment. In a rural area, a GPS-based AVL system would no longer have a problem with tall buildings obstructing the "view" of satellites, but mountainous terrain results in the same phenomenon. Other systems would require modifications for use in rural areas. The expense of the in-vehicle equipment is also an impediment to implementing some AVL technologies into private vehicles, whether for rural or urban environments. For AVL suppliers to operate in a rural environment, there must be the market demand to be profitable. The issue of invasion of privacy has frequently been mentioned as a disadvantage of an AVL system, although this concern was not voiced during the study of user needs as previously discussed.

Weather Sensors

In addition to collecting data about prevailing weather conditions, weather sensors collect information about roadway conditions affected by the weather. The sensors can provide real-time roadway condition and weather data, as well as predict conditions. These sensors provide information which is highly useful and desired for travelers' trip planning, routing, route guidance, and safety and warning advice. Weather sensors are available for both roadway and airport use; most fog detection systems were designed for airport use.

Roadway Sensors

Roadway sensors provide traffic flow data, such as volume, occupancy, and speed, which are parameters traditionally associated with levels of congestion in urban travel environments. However, these sensors also provide useful information for safety and warning applications. Other types of roadway 'sensor yield vehicle length, weight, and number of axles. Three types of roadway sensors were evaluated in the study; figure 30 outlines the capabilities of each type.

SENSORTYPE	TECHNOLOGY	V	0	S	C	L	DETECTION AREA	STATUS
IN-PAVEMENT	Loop	•	•	o	o	1	Size of Loop	Operational
	Magnetometer	•	•	o	o	1	Point	Operational
	Self-Powered Vehicle Detector	•	•	o	o	1	Point	Development
OVERHEAD	Radar	•		•		1	Depends on Distance	Operational Testing (CT)
	Microwave (Forward Looking)	•	•	•	•	1	Minimum 2-Meter Length	Operational Testing (Toronto)
	Microwave (Side Mounted)	•	•	o	o	4-6	Depends on Distance	Operational Testing (Toronto)
	Ultrasonic	•	•		•	1	Point	Used in Japan
	Infra-Red	•	•	o	o	1	Depends on Distance	Used in Europe
	Passive Acoustic	•	•	o	o	4-6	User Defined	Development
	Optical	•	•	o	o	1	Point	Development
MACHINE VISION	Video Image Detection (VIDS)	.	.	.	.	4	UserDefined	Operational

V = Volume
0 = Occupancy
S = Speed
C =Classification
L = Number of lanes covered by single detection unit
. = Parameter can be measured
0 = Parameter can be measured in a paired-configuration

Figure 30: Roadway Sensor Technologies

IN-PAVEMENT DETECTORS

As the name implies, the detection element of these technologies is embedded in the roadway pavement and senses the presence and other attributes of vehicles as they pass over the detection zone. In-pavement detectors are a proven technology for data collection and could be used in a rural ATIS, They would be appropriate in areas where recurrent congestion is a problem, such as popular tourist attractions, or at locations where speed or vehicle classification is needed for safety and warning applications.

OVERHEAD MOUNTED DETECTORS

Several types of overhead detectors have been applied, in varying degrees, in real-world implementation. Radar detectors, located over a single lane, multiple lanes, or at the roadside, measure vehicle speed based on the Doppler effect. Microwave detectors operate much like radar detectors and are currently available. Ultrasonic detectors measure the height profile of vehicles using sound waves. Currently marketed infra-red detectors consist of both active and passive models. Active systems illuminate the detection zone with infra-red energy and detect the energy reflected from vehicles in the zone. Passive infra-red systems detect a vehicle presence by the blackbody radiation emitted from vehicles in the zone. Passive acoustic detection, currently in prototype form, is based on the theory of recognition of a unique acoustic signature of engine noise or tires on pavement. Optical vehicle motion detectors (OVMD) sense vehicle presence by a disruption in an infra-red beam bounced off the pavement from a transmitter to a receiver. OVMD's are also in the prototype stage.

Installation of detectors above or to the side of the roadway allows maintenance activities to be performed with minimal traffic disruption. Roadway reconstruction and rehabilitation activities usually have no effect on overhead detectors, while they usually destroy in-pavement sensors. A drawback of these technologies is that optimum placement is typically directly over each lane. For this type of installation to be cost-effective, an existing overhead structure is required. These are scarce in rural and small urban areas. Another concern is that most of these technologies have not been completely proven in terms of accuracy or long-term reliability. However, operational tests involving many of these surveillance technologies are in progress. An FHWA-sponsored research effort to field test and evaluate these detectors also is underway. It is anticipated that many of these devices will be viable and proven candidates by the mid-1990's.[20]

Machine Vision

Machine vision technology — also widely known at video image detection systems (VIDS) — uses microprocessor hardware and software to analyze video images of the roadway. VIDS may be considered a "proven technology," but its applicability to rural ATIS is constrained by current cost and some of the same factors as for in-pavement and overhead detectors. Video image systems may be well suited for use at spot locations, perhaps near National Parks or other congested areas, where the type of data collected by VIDS is desired.

DATA AGGREGATION AND PROCESSING

The data aggregation and processing components of a rural ATIS must be able to handle data from a wide variety of sources. Data handling may take place on an individual vehicle or may occur at a regional or central processing center. In either case, many types of data will be involved. Network data, representing the road network, will be fundamentally static, changing only when the road network changes. Dynamic network data changes as roadway conditions change. Other data types include incident/event data, traveler services data, public transportation data, automatic vehicle location (AVL) data, and weather data. The transfer, processing, and configuration of these various data types are critical to a successful ATIS.

The variety and volume of data that could be supplied to rural ATIS, together with the variety of sources and users, require that a data base management system be instituted to provide access control and support. While the technological capabilities to implement such a system exist, compatibility of existing data collection systems may complicate the design of such a system.

One of the main emphases of data management will be reading and translating data to a form that is appropriate for the data base. With the potential for several different agencies to provide similar information (e.g., State and several local agencies may all provide roadway detection data), difficulties may arise due to the lack of standardized interfaces and protocols. Several projects involving urban and corridor-based ATIS are presently grappling with this problem. This is an area of development that is currently being pursued by public interests to ensure that the rural information systems can share information and that rural and urban systems are compatible.

Additional concerns regarding the aggregation and processing of traveler information data include the question of who will fund the process, and the infrastructure necessary to support it, and be liable for the dissemination of incorrect information. The burden of aggregating and processing information may be taken on by either public agencies or private service providers. Private service providers may include, for example, those companies involved in the provision of yellow page information or existing motorist services, such as auto clubs, map providers, etc. However, it will be essential that all travel-related information be integrated and presented to the traveler in a single, comprehensive package, making it convenient and useful. This approach will also increase the potential commercial market for ATIS and, as a result, may increase the role that private enterprise plays in the provision of information.

COMMUNICATIONS

The communications function provides for the transmission of all information between vehicles and the infrastructure and within the system infrastructure. The communication network is an integral part of a rural ATIS design; it affects, and is affected by, system architecture, configuration, and operational strategies.

FHWA's Communications Handbook provides detailed information on communications media, system architecture, decision-making processes, and trade-off analysis for traffic control systems.[21] This section briefly discusses communications network of rural ATIS.

The communication network for rural ATIS can be divided into the following three elements:

- Vehicle to/from Infrastructure Communication.
- Within Infrastructure Communication.
- Vehicle to Vehicle Communication.

VEHICLE TO/FROM INFRASTRUCTURE COMMUNICATIONS

These systems can be divided into the following four types, depending on their communications range:

- Short Range Communications Systems.
- Local Area Communications Systems.
- Regional Communications Systems.
- Wide Area Communications Systems.

Figure 31 shows areas of coverage provided by each of these communications systems.

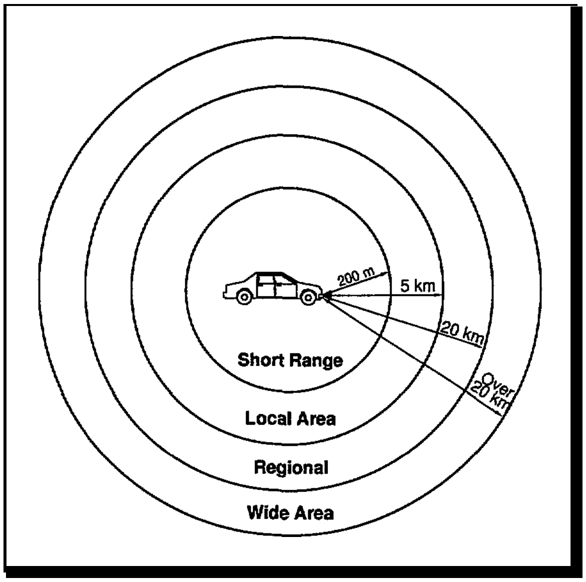


Figure 3 1: Communication System Ranges

Figure 32 shows the types of information which could be provided by each system.

As used here, Short Range Communications references vehicle to immediate roadside communications (as opposed to the more general "vehicle-to-roadside" communications term used throughout ITS literature, meaning all communications with vehicles).

Regional Communications refer to systems with a range up to 20 km (12.4 mi). Wide Area Communications refer to systems with a much greater than 20 km (12.4 mi) radius of coverage.

COMMUNICATION SYSTEMS	AREA OF COVERAGE	TRAVELER INFORMATION						
		Roadway Conditions	Weather Conditions	En Route Services	En Route Attractions	Traffic Conditions	Advance Warning	Emergency Warning
Short Range	< 200 m (<655 ft)	X		X	X	X	X	X
Local Area	< 5 km (< 3 mi)	X	X	X		X	X	
Regional	< 20 km (<12.4 mi)	X	X	X	X	X		
Wide Area	> 20 km (>12.4 mi)		X	X	X			X

Figure 32: Vehicle To/From Infrastructure Communications System

Both one-way broadcast and bidirectional communication technologies are considered here, as rural ATIS systems will certainly use both.

SHORT RANGE COMMUNICATIONS SYSTEMS

Short range systems, such as infra-red, microwave beam, inductive loop radio, and low power radio, with operating ranges of less than 200 m (655 ft), are best used to provide site specific advance information to travelers as they approach a dangerous area or hazard. Roadside infrastructures would be installed in advance of these areas to communicate warnings to travelers. Most of the intelligence and functionality of the short range communications systems are centralized in the roadside infrastructure, thus reducing the cost of the in-vehicle equipment.

LOCAL AREA COMMUNICATIONS SYSTEMS

Local area communication systems have great potential for providing traveler advisory information in a rural ATIS. In many rural areas, AM radio frequencies are more readily available than in urban areas, so lo-watt (licensed) highway advisory radio (HAR) is feasible. The limitations of HAR include the “voice only” nature of the license and the fact that FCC requires that no commercial messages be transmitted over HAR, in effect, requiring that HAR be fully publicly supported.

REGIONAL COMMUNICATIONS SYSTEMS

Regional systems provide the two-way communications necessary for emergency services as well as route guidance using VHF or UHF radio. Cellular telephone use has seen phenomenal growth since its introduction. Rural ATIS services using cellular telephone, as well as cellular radio technologies would undoubtedly be viable.

CB radios are a familiar and proven communication technology. They are applicable for personal use concerning travel, security, and emergency road and traffic condition information, as well as business calls. FCC now allows broadcasting of information via CB; therefore, general information could be relayed to users.

WIDE AREA COMMUNICATIONS SYSTEMS

Subcarriers on FM, AM, and TV broadcast stations are examples of wide area communication systems than cover areas greater than 20 km (12.4 mi). These broadcast subcarriers have several unique features which make them an attractive option for wide area communications:[22]

- They are currently available and do not require regulatory approval.

- Subcarriers are a mature technology.

- Much of the hardware needed is already available.

- Radio and TV stations provide existing, in-place infrastructures and have vast coverage area.

- Incremental cost of adding a subcarrier to a broadcast station is low ($4,000-$6,000).

In theory, wide area communication systems could provide traveler information in rural settings, whether for traveler advisory, route guidance, or emergency services. The long range broadcast capabilities of these systems would mean fewer infrastructure installations.

WITHIN INFRASTRUCTURE COMMUNICATIONS

This category provides all communication among the roadside infrastructure, various control centers, and agencies that support the rural ATIS. The technologies identified to support these communications can be classified as:

- Bounded.
- Unbounded.
- Leased Media.
- Developing Technologies.

Bounded media include fiber, copper pair, and coaxial cables; unbounded media includes all airwave transmission technologies. Leased media are systems or networks that are commercially available and are offered by telephone companies and private communications companies. Developing technologies are systems still in experimental stages.

BOUNDED MEDIA

Bounded media are proven elements of urban and small-scale traffic management and ITS projects. However, in a rural environment, their use is not economical because of the long distances between infrastructure elements. Installing conduit and cable throughout a rural ATIS network is unlikely to be practical except in special circumstances, such as linking infrastructure elements in a small urban area or unique local situations.

UNBOUNDED MEDIA

Unbounded media, such as microwave, commercial two-way radio, spread spectrum radio, and satellites, have the potential to overcome the range and installation problems of other communication methods. Microwave transmission ranges could allow for data exchange between information centers and other elements of the rural infrastructure. Spread spectrum radio, with a range of up to 8 km (5 mi) in some configurations, could be (and has been) applied for communication between control centers and variable message signs. It might also be applied to control HAR and other roadside elements. Satellite communication has such large coverage that it could be used for any long range application, either from one information center to another or from field units to an information center. Microwave and satellite communications are the most widely used private unbounded media. Industry experience with and market penetration of these technologies are important considerations.

LEASED MEDIA

The infrastructure available for lease in rural areas, while not as omnipresent nor competitive as in urban areas, is increasing constantly as common carriers install the new bounded and unbounded transmission technologies described above. The market-based reality is that availability of leased media for consideration in rural environments will depend on factors other than ATIS needs and therefore leased media will probably be only a partial solution. When leased media services are available, however, they should be considered for data transmission as they are all quite capable of carrying the type of data required for rural ATIS.

Developing Technologies

The communications industry is undergoing a period of significant change, growth, and technology infrastructure investment. These developments suggest a period of rapid technology development and implementation is to come; a number of new technologies will be available soon.

Several commercial entities have taken cellular telephone technology and applied it to special mobile radio (SMR) systems. This gives all the functionality of cellular phones over a very wide "cell" — that is, the large areas covered by commercial two-way radio. This will have significant impact if it gives rural areas the equivalent of cellular phone coverage.

The FCC radio frequency auctions in May 1994 can be expected to have major effects on developments in the communications field. The market directions of many companies and, therefore, the type and commercial availability of radio systems, will be determined by the auction outcome.

Low earth orbit satellite (LEOSAT) systems could be viewed as examples of developing wide area communication systems. Although in limited use to date, LEOSAT systems are being used by some in the long-haul trucking industry. Deployment could be expensive for personal vehicles but installation in vehicle fleets may be realistic.

Vehicle to Vehicle Communications

These systems support vehicle to vehicle relay capabilities for safety and warning services. Communications of this type are very appealing for a rural ATIS because the elements of the ATIS would be contained in each vehicle, eliminating the use of roadside infrastructure. This technology is rife with liability and has not been put into practical application at this time. However, tests have been performed for systems in which vehicles traveling in opposite directions transmit collision avoidance information and also for systems in which leading and following vehicles transmit distance and speed information.

TRAVELER INTERFACE

Traveler interface technologies enable travelers to receive information regarding travel conditions, request assistance, inquire about roadside services, etc. This information may assist travelers in planning trips, selecting optimum modes of travel, and determining routes. During trips, this information can aid travelers in decision making regarding travel events. The extent to which travelers access the available information depends not only on the timeliness and accuracy of the information, but also on its worth, cost, reliability, and ease of access.

Traveler information must be timely, complete, and accurate. Advice must be credible, and it must be perceived by each traveler as providing some definite advantage when followed. Traveler interface devices disseminate this information to travelers using a variety of audio and visual techniques, but the options generally can be divided into the following four broad categories:

- Trip Origin Interface.
- Roadside Systems.
- In-Vehicle Systems.
- "On-Person" Systems.

Following is a brief discussion of these systems.

Trip Origin Interface

Traveler information, especially trip planning information, can be provided to travelers at trip origin locations, which might be homes, workplaces, or shopping centers and other activity nodes. Televisions, personal computers, telephones, and radio receivers are all available options for trip origin interfaces. Television is very cost-effective in that most homes already have a set. Real-time travel information can be disseminated through teletext or cable television channel access. Cable television, though, is not available in many rural areas.

Personal computer applications for trip routing are currently available. Interactive services such as the Internet, the World Wide Web, Prodigy, CompuServe, etc. hold great potential for dissemination of real-time travel information. Telephone call-in services for routing (in urban areas) and other traveler information are available in several parts of the country. Similarly, a portable radio receiver operates like a pager for timely receipt of information.

Roadside Systems

These interfaces, located at or near the roadways, usually provide advisory and safety and warning information to the traveler, although some (e.g., kiosk, TRIPphone™) provide more information. Variable message signs (VMS), automated kiosks, HAR, and call boxes, all forms of roadside systems, have been applied to traveler information systems. VMS could be used in rural ATIS applications to provide dynamic information regarding road blockages, unsafe conditions, or alternate routes. Stationary or portable VMS could be applied, depending on the situation.

Automated kiosks and telephone-based information services (e.g., TRIPphone™) are currently in use around the country. They typically provide traveler services information (e.g., food, service, lodging, attractions, special events) as provided by advertisers/subscribers to the system. As their use is expanded to more and different locations, kiosks can be an integral part of rural ATIS implementations.

HAR, or local area broadcasting, provides localized traveler information broadcasts to vehicles in the vicinity of the roadside transmitters. Information such as road closures, incidents, special events, safety warnings, road hazards, safe speeds, and traveler service information can be provided by HAR relatively economically. The critical factor in using HAR in any system is educating the traveler to tune to the specific HAR radio frequency.

Telephone call-boxes are being used in lightly traveled rural areas and are available as solar powered cellular phone systems. They could serve as communication links between travelers and emergency services as well as links between data collection stations and data processing centers.

In-Vehicle Systems

In-vehicle systems relay advisory, safety and warning, and emergency information via voice, text, or video display inside the vehicle. These systems will most likely be purchased by individuals, either as a design feature of the vehicle or as an add-on accessory. Many in-vehicle systems are currently available, although not all are applicable in rural and small urban areas.

Hazard Warning Systems

Hazard warning systems alert drivers that they are approaching potentially dangerous situations. Application examples include warnings for low clearance, speed too fast for a curve, speed too fast under existing weather conditions, or approach to a blind spot. In addition to warning drivers, the system might also function as a data collector, relaying hazard information to an ATIS information center.

Bad Weather Driving Assistance Systems

Bad weather driving assistance systems are also known as all weather/night vision (AWNV) systems. AWNV systems are under development by both Ford and a Japanese consortium, but neither system has yet seen practical application.

Navigation Systems

A navigation system combines a vehicle location system with a guidance system to create an electronic navigator. Navigation systems have been tested in the United States and Europe, and U.S. automakers are now marketing such a system. There is no doubt that the technology is applicable to a rural ATIS as they fulfill the route guidance need as well as facilitating vehicle location.

Collision Warning Systems

These warning systems detect a possible collision and warn the driver to avoid the collision. Some form of radar is the most common technology used for object detection, and several radar systems have been developed and tested. Only one of these systems is commercially available at this time and liability issues are a significant issue in their evolution.

Technologies For In-Vehicle Information Transmission

The information communicated to a traveler using an in-vehicle system can be either an audio or visual format, or a combination of both. Head-up display is currently an option in several production automobiles and could be applied for hazard warning systems, collision avoidance and warning systems, or AWNV systems. Using audio output to provide information is not new and is it not an ITS-related development. However, recently tested navigation and route guidance systems include synthesized voice which provides route guidance directions. This same application could be used in a rural ATIS.

Cellular telephone could be used as a traveler interface as well as a method of communication. A traveler could obtain current information about roadway conditions for en route planning. A screen display in-vehicle system would be an important element of a route guidance system in a rural ATIS. This type of interface could also provide traveler advisory information, feedback from a mayday call, and safety and warning messages. Human factors considerations in screen design are very important for an in-vehicle system and are being evaluated as more screen displays are included in production vehicles and as after market add-on accessories. In addition, equally important are the human factors issues which surround the processing, integration, and display of the information upon these devices.

An existing system called TrafficMaster operates in London. It provides real-time congestion information via infrared beacons which provide one-way communication. Additionally, both General Motors and Sony Electronics are planning to introduce in-vehicle navigation systems to the California market in 1994.

"On-Person" Systems

On-person systems can provide much of the same information as the three systems discussed previously. The portability and accessibility of on-person systems are their unique and appealing features. Personal communication devices (PCD) are small, portable, wireless devices for sending and receiving information. The most common example of a PCD is a pager which is a one-way (receive only) device. Another example of PCD is Personal Digital Assistant (PDA) which is a hand-held unit with two-way (transmit and receive) RF communications link. While the pager has no processing capability, PDA's have varying degrees of processing capabilities depending on the design and the model.

AT&T's EO, Apple Computer's Newton, and Motorola's and GTE's personal digital communicators are more advanced types of PCD's. These devices could provide user interface for most trip planning, routing, traveler advisory, route guidance, and emergency services of a rural ATIS. As technology develops further, all of these applications may become practical. Currently available PCD technology, though, can serve trip planning functions (a portable personal computer), traveler advisory functions (a cellular telephone), and emergency services functions (a cellular telephone).

SUMMARY

As is evidenced by the technology assessment presented here, substantial technology which is applicable to ATIS is both currently available and actively being developed. Perhaps one of the most interesting technological developments which pertains to ATIS is the widespread acceptance and integration of telecommunications in virtually every aspect of our daily lives. This is demonstrated by the likes of the multimedia interactive devices being presented to consumers and businesses, the development of the National Information Super Highway, and the growing competition within the telecommunications industry itself (e.g., the baby Bells). In addition, the constant changes/technological improvements that are taking place within these areas have direct ties and potential impact on the ITS National Systems Architecture (currently under development). In the next chapter, the potential application of these developments to rural ATIS is further discussed.

CHAPTER 5: APPLICATION OF TECHNOLOGIES TO RURAL ATIS

INTRODUCTION

Each functional area of a rural ATIS data collection, data aggregation/processing, communications, and traveler interface contributes to fulfillment of the various user service needs, as is detailed in figure 33. There are sufficient proven tools and technologies available, in addition to products in development, to fulfill anticipated user needs. Their potential applications are discussed in the remainder of this chapter.

DATA COLLECTION

It is felt that data collection within rural ATIS will primarily involve manual reporting activities. This belief is held for the following reasons:

- Scope of Coverage — The geographic size of rural areas within the United States is quite large. Therefore, trying to obtain "complete" coverage of the entire rural roadway network using automated data collection efforts (e.g., uniform spacing for roadway detector stations, CCTV, environmental sensors) does not appear to be feasible, primarily due to the associated high costs involved with such dense instrumentation.

- Existing Resources — Manual reporting methods are quite practical, and currently in use in most rural areas. Many types of information required/desired for rural ATIS applications involve up-to-date incident reporting, construction/maintenance activities, special event information, and roadway/weather conditions. In a lot

	FUNCTIONAL AREAS															
	DATA COLLECTION				DATA AGGREGATION/ PROCESSING			COMMUNICATIONS			TRAVELER INTERFACE					
		Automated														
POTENTIAL USER SERVICES	Non-Automated	Roadway Sensors	In-Vehicle Sensors	Weather Sensors	Information Centers	Roadside Systems	In-Vehicle Systems	Veh. to & from Infrastructure	Within Infrastructure	Vehicle to Vehicle	VMS	In-Vehicle Systems	Automated Kiosks	Cable TV	P.C.	Telephone
Trip Planning	•			•	•				•				•	•	•	•
Routing	•	•		•	•			•	•			•	•	•	•	•
Traveler Advisory	•	•	•	•	•	•	•	•	•		•	•	•			•
Traveler Service Information	•				•	•	•	•	•	•	•	•	•		•	•
Safety & Warning	•	•	•	•	•	•	•	•	•	•	•	•				•
Route Guidance		•	•		•		•	•	•		•	•				•
Emergency Services			•		•	•	•	•	•	•		•				•

Figure 33: Technology Review

of these instances manual reporting methods such as motorist cellular telephone call-ins, DOT maintenance/construction radio communications, regular telephone call-ins, CB reports, and law enforcement dispatching/radio communications already exist and are being utilized to some extent.

Basically, manual reporting activities appear to provide the type of information desired/required and the appropriate coverage area for rural ATIS applications. This is not to say that there will not be any automated data collection efforts in these instances. Automated systems of this nature should be used where appropriate (e.g., CCTV at interchanges and/or toll facilities, roadway detectors near entrances to National Parks and/or attractions, roadway/weather sensors at known problem/hazard areas and/or representative locales) and when funding is available for the scope of coverage required. Therefore, many of the technologies available today for automated data collection, as well as those being developed, are applicable to rural information systems. The adoption of in-vehicle sensor technology will be driven by private industry, particularly automobile manufacturers who will market their vehicles with factory-installed sensors. The commercialization of in-vehicle sensors will depend upon the public's acceptance, their cost and perceived value. Acceptance in transit and commercial vehicle fleets will depend on the benefits and the fleet owners' willingness to pay for the devices and installation. Because of the high incidence of single vehicle and fatal accidents on rural roadways, vehicle-based mayday systems are particularly attractive, as is further development of near-field object and driver alertness sensors.

Weather and roadway sensors can provide invaluable information to rural travelers in terms of safety and awareness of possible travel delays. Because these sensors are infrastructure based, instrumentation of the roadways will be primarily publicly managed. One of the main barriers to device implementation on rural roadways will be high costs, which is primarily due to lack of an existing infrastructure. It is anticipated that early instrumentation of rural roadways with these sensors will be confined to critical locations.

Instrumentation of both vehicles and roadways suggests the possibility of integrating these devices to allow data collected in vehicles (e.g., speed) to be transferred to the central system. Weather and roadway information and resulting safety and warning information would be transferred to vehicles. While the communications necessary to support such a system may be developed publicly, privately, or by a combination of each, it is important to ensure that communication and protocol are standardized to allow for universal transfer of data. This will also ensure the compatibility of rural and urban systems. It is likely that the government will play a significant role in the adoption of communication and protocol standards; however, private industry associations may also be instrumental in the implementation of such standards.

The applicability of specific technologies, or technology types, must be evaluated on an application by application basis — and related to the specific data collection needs. Price and reliability will be major factors in the selection of data collection technologies for specific rural applications. Technologies within each of the data collection areas are being developed and today's prices and reliability ratings may not reflect those of the coming year. Additionally, prices and reliability will depend on the specific application. The reliability of a technology will also depend on the circumstances under which it will function: inclement weather, night time, heavy or light traffic, single or multiple lanes.

DATA AGGREGATION AND PROCESSING

The variety and volume of data which might be supplied to rural ATIS systems, together with the variety of sources and users for the data, require that a data base management system be instituted to provide access control and support. While the technological capabilities to implement such a system exist, compatibility of existing automatic data collection systems may complicate the design.

An important data management activity for any rural ATIS will be reading and translating data to a form appropriate for the data base. With the potential for several different agencies to provide similar information (e.g., State and several local agencies may all provide roadway detection), difficulties may arise because of the lack of standardization of interfaces and protocols. Many international standards for open systems are now being developed with the support of the Institute of Electrical and Electronics Engineers (IEEE), who are working toward the elimination of interface variances. Transferring information will require the definition of traffic data requirements, sampling rate, and other information as needed. One approach to this problem is to define external data links at a local level, allowing a “node processor” to take the information and convert it to a standard protocol. An alternative, and less likely solution, would incorporate the adoption of standard protocols by manufacturers. This development area may be pursued by public interests to ensure that rural information systems can share information and that rural and urban systems are compatible.

Additional concerns regarding the aggregation and processing of traveler information data include questions about who will:

- Finance the process.
- Finance the infrastructure necessary to support it.
- Incur liability for dissemination of incorrect information.

The burden of aggregating and processing information may be taken on by either public agencies or private sector providers. Private service providers may include companies that process yellow page information or provide motorist services, such as automobile clubs, map provider, etc. Access to all travel-related information in a single, comprehensive package will increase its convenience and usefulness. This approach will also increase the potential commercial market for ATIS systems and, as a result, may increase the role that private enterprise plays in the provision of information. For example, traveler services alone may not be sufficient to warrant the purchase of a personal communications or in-vehicle device. However, traveler services combined with real-time weather, construction, and event information may entice the traveler to invest in such items. In this example, a private service provider collects and disseminates traveler information, and charges fees to travel service advertisers, the traveling public, or both. The concept of user fees is not new. It is, in fact, similar to paying for information and safety benefits by joining an automobile club. What may be difficult, however, is administering a fee-based service beyond any fees assessed at the time of purchasing the user interface. Alternately, public agencies may continue to develop rural ATIS applications, taking on the role of data aggregator and processor. The costs may be offset by advertising fees paid to the public agency by traveler service providers.

The liability for distributing traveler information via advanced technologies will be similar to that of distributing information via more traditional media, such as billboards and radio. This liability is anticipated to be minimal because it is not envisioned that disseminating information through advanced technologies will replace static regulatory signs, at least in the currently defined long-term (the next. 20 years). Exceptions may be variable speed limit information, where a definite liability will exist. Another potential component of an ATIS is a mayday system using AVL. The liability potential in an emergency situation will undoubtedly receive critical attention. Maintenance of the system’s components will be of prime importance to managing that liability. What may be the greatest liability of disseminating incorrect information would be the loss of credibility with the traveling public. If the system depends upon commercial marketability for financing, a loss of credibility might represent a significant setback.

COMMUNICATIONS

Long distances, low message traffic volume, the need for self-sufficient electrical power, and limited coverage area suggest that communications solutions appropriate for heavily traveled urban routes may not be appropriate for rural ATIS. For example, the installation of a fiber network or a cellular radio infrastructure would prove too expensive to provide economical communications in rural areas.

As with infrastructure based roadway sensors, the limitations of ATIS communications in rural settings are largely financial. Communications media, whether bounded or unbounded, require infrastructure investments with costs dictated by the expanse of the area to be covered. Thus, selection of communication technologies should be made after analysis of the desired function, the geography, and the area's existing infrastructure. The communications approach for rural ATIS will depend heavily on the type of information needed, how quickly it must be updated, where it must be received, and how it is assembled.

The selection of communications technologies to support communications between vehicles and the infrastructure should be based upon:

- Whether one-way or two-way communications is desired.
- Necessary range of communication.
- Urgency of the communication.
- Whether generalized or selective messages are distributed.
- Availability of receiving units or user interfaces.

If user interface costs are high, and it is ascertained that the potential audience for information will not expend that amount for in-vehicle equipment, the best selection for a communication medium may be highway advisory radio, which utilizes a standard radio, currently existing in almost every vehicle. However, the potential market for specialized user interfaces bears attention. The public's willingness to pay for communication capabilities is evident from purchases of CB's and cellular telephones.

Also of importance when analyzing vehicle to/from infrastructure communication is recognizing that any system with standard protocols will be more flexible, and ultimately have a higher market penetration than a closed architecture system. Again, this may be an area where the government might assist in developing standards or where industry associations may need to take a lead. Similarly, the need for standardization of vehicle-to-vehicle communication protocols are obvious. Without such standards, Fords will only be able to communicate with Fords.

Within-infrastructure communications costs contribute significantly to the expense of an ATIS system. For this reason, a localized architecture may be chosen rather than the more extensive, communications-dependent architecture which provides centralized information. The alternatives are those applications where the benefits of an integrated information system with a comprehensive central data base outweigh the costs of communication. Communications must be chosen based upon reliability, desired range, topography of the area, cost-effectiveness in relation to the existing infrastructure, and availability of media.

Another important issue in selecting appropriate communication technologies for rural ATIS is the long-term reliability of these technologies. Several new communications technologies (e.g., ORBCOMM, T-NET) are available, developed and supported by new companies with unknown financial futures.

Therefore, a great deal of risk may be involved in development of rural ATIS systems which rely solely on new technologies for communications.

TRAVELER INTERFACE

Traveler interfaces can be categorized by those purchased by individuals or those made available to the public by service providers. Generally, those systems with traveler interfaces that are purchased by individuals will be heavily invested in by private industry. Because private industry will most likely develop, manufacture, and market the traveler interface, private industry will also be involved in the development and distribution of the information to be received by that interface. Exceptions to this may be interfaces purchased by the public primarily for other purposes, such as televisions and personal computers.

Traveler interfaces that are provided for public use are more likely to have a greater governmental involvement in information dissemination, especially when the interface is roadway-based, as with VMS and HAR. However, it is possible that private service providers could sponsor the implementation of such interfaces, much as commercial information is currently disseminated to travelers via billboards. For example, the Shell InfoCentre in Ontario, Canada is wholly supported by commercial interests. Also, a number of "good samaritan" service patrols operating on the country's freeways are privately sponsored. The sponsorship of travel information could also be undertaken as a good samaritan effort.

Expansion of commercial information systems is proceeding broadly in this era of the Information Super Highway. Metro Traffic Control, who markets their radio traffic reports to 50 cities in the United States, and in Canada the United Kingdom, and Mexico, has recently branched out and is providing current traffic information to commercial trucking companies, corporations with existing in-house communications systems, etc. These companies are realizing benefits, including potential time and money savings, of having up-to-date travel information available for trip-making decisions. It is foreseen that this commercial viability will also be evident in some rural areas — specifically those with high tourist and event-driven activity. Early implementation of these systems will also lend some insight into the market for ATIS in other rural areas.

A key issue regarding traveler interfaces may be the requirement that the information presented be convenient and easily comprehended by the user. This may discount some interfaces for specific applications, because some information may be more effectively presented in a graphical, textual, or audible format. The information provided, and its format, must be designed to meet the needs of the specific audience. This design must also include an analysis of how much time is available to deliver a message. If that time is significant, say at a transit stop or in the user's home, there may be opportunity to include advertising. However, if the user has a limited amount of time to absorb the information, it must be delivered quickly and efficiently. In this situation, the inclusion of advertising may only serve to reduce the audience size rather than increase the value of the service.

MAJOR CONCLUSIONS OF TECHNOLOGY ASSESSMENT

The challenges of applying these technologies to a rural ATIS are two fold.

Five major conclusions were derived from the technology assessment:

- Substantial, proven technology is available to support basic rural ATIS applications.
- Communications is the major challenge.

- There are significant promising innovations including PDA, GIS/GPS, LEOSAT, conditions sensors, pager technology, and RBDS which could be used in future rural ATI systems.

- There is significant potential for piggybacking rural ATIS applications on other, non-transportation investments.

- Infrastructure costs and nature of user priorities make in-vehicle systems and targeted roadside systems a high priority.

Integrating and deploying a seamless system which makes use of the existing technologies will require a creative solution, incorporating the most effective elements of ITS technology. The solution must be cost effective to justify installing ATIS systems in enough locations for them to be of value to the traveler.

In addition, five major points can be made regarding further development of rural ATIS:

- A combined public/private role is essential:

  PUBLIC
  - Emergency Response
  - Safety
  - Roadside Infrastructure
  - Standardization
  - Data Collection
  - Major Management Role

  PRIVATE
  - Traveler Services
  - Communication Infrastructure
  - In-Vehicle Technology

- Non-safety/non-emergency applications must be commercially viable.

- Multiagency/jurisdiction planning and management are essential.

- Ubiquitous application is essential if certain applications are to be effective; less critical for others.

- Legal liability is a key concern.

All of these concerns must be addressed to provide a useful, successful, and workable rural advanced traveler information system.

CHAPTER 6: CURRENT RURAL ATIS INITIATIVES

Presented here are brief overviews of some of the major initiatives currently underway that are expected to advance the development of rural ATIS. Additionally, figure 34 provides a listing of many of these projects. This information is current as of April 1996 unless otherwise noted.

GENERAL PROJECTS

A number of projects have been undertaken to advance the understanding of human interaction with traveler information systems and the technological state-of-the-art of ATIS. These are described below:

- Institutional and Legal Issues — Currently ongoing studies are addressing management and administrative issues regarding ATIS and ITS in general. Included are areas such as educational and staffing needs, environmental issues, institutional issues, overcoming barriers to ITS deployment, public acceptance of ITS technologies and services, ITS in relation to privacy laws, alternative procurement models, potential tort liability upon ITS technologies, and identification of legal issues.

- Human Factors in ATIS and CVO Design Evolution is addressing the impacts of driver interfaces, information type, behavioral factors, and user demographics on the development of specific information subsystems. Applications specific to commercial vehicle operations (CVO) focus on the information requirements of commercial vehicle operators. The estimated total cost of the project is $5.25 million and the project is anticipated to be complete in early 1997.

- ITS Radio Frequency Spectrum Planning is an ongoing project to identify the emerging radio frequency needs of ITS and to take the necessary steps to ensure that spectrum is available when needed. FHWA Research and Development is sponsoring the project.

- Ontario ITS Strategic Plan, a mission to develop an ITS Strategic Plan for Ontario is currently being undertaken by the Ministry of Transportation of Ontario's (MTO's) "in-house" staff. This program assesses the implications of implementing and operating advanced technology projects and provides practical guidelines for their design and deployment. This program's focus includes the entire Province, with strong emphasis on Ontario's northern and rural areas. At this time, the MTO has prepared a "draft" ITS Strategic Plan for internal review and anticipates a "final" release by the end of 1996.

USER SERVICES

The remaining projects are best described with respect to the user services they fulfill: tip planning, routing, traveler advisory, traveler services information, safety and warning, route guidance, or emergency services. Projects fulfilling multiple user services are presented first.

MULTIPLE USER SERVICES

USER INTERFACES

Projects which focus on the traveler's interface have the potential to provide a variety of user services dependant upon the information that is disseminated through them. In-vehicle

PROJECT				RURAL ATIS USER SERVICES					
	NAME	AGENCY	STATUS	TRIP PLANNING/ ROUTING	TRAVELER ADVISORY	TRAVELER SERVICE INFO.	SAFETY & WARNING	ROUTE GUIDANCE	EMERGENCY SERVICES
1	Dynamic Truck Speed Warning for Long Downgrade	Col. DOT	Operattonal 7/95		x		X		
2	Intelhgent Runaway Truck Ramp	Col DOT	Proposal				X		
3	I-70 Rural IVHS	Col. DOT	In-Progress	X	X	X			
4	ITIS	ENTERPRISE	In-Progress		X	X			
5	MAY DAY	ENTERPRISE	Operational						X
6	HERALD	ENTERPRISE	FHWA Operational Test		X	X			
7	RUN-OFF-THE-ROAD	ENTERPRISE	Proposal				X		
8	ARTIC (Advanced Rural Transportation Information and Coordination)	MN DOT	Phase 1 Anticipated Operational 9/96 Phase 2 Operational 1/97	X					
3	ODYSSEY	MN DOT	Concept Funding Allocated	X	X	X			
10	RWIS (Road Weather Information System)	MN DOT	In-Progress	X	X				
I1	WIVIS (Weather Identifier & Visibility Sensor)	MN DOT	Operational		X				
12	TRAVEL AID	WA DOT/FSI	In-Progress		X				
13	YATI (Yosemite Area Traveler Information)	Caltrans	In-Progress	X	X	X			

Figure 34: Current Rural ATIS Activities

PROJECT				RURAL ATIS USER SERVICES					
	NAME	AGENCY	STATUS	TRIP PLANNING/ ROUTING	TRAVELER ADVISORY	TRAVELER SERVICE INFO.	SAFETY & WARNING	ROUTE GUIDANCE	EMERGENCY SERVICES
14	ARTS (Dust-Fog)	Caltrans	Operational 7/94		X		X		
1.5	RWIS (Roadway/Weather Information System)	Caltrans/NV DOT	Operational Early 1994	X	X				
16	Cal. Smart Traveler	Caltrans, FTA	In-Progress	X	X				
17	FM Subcarrier project	FHWA, MITRE	Completed		X		X		
18	In-Vehicle Crash Avoidance Warning System (Human Factors)	FHWA, COMSIS, CRC, Univ. Central, FL	Under Study Anticipated Completion Late 96				X		
19	IVSAWS	FHWA, Hughes	Complete				X		
20	Automated Collision Notification System	FHWA, NHTSA, John Hopkins University	Complete						X
21	I-75 Fog Warning System	TN DOT	Operational		X		X		
22	REACH-75	GDOT/FDOT	Operational		X				
23	Solar Powered HAR	GDOT	Operational		X				
24	RWIS for Snow & Ice Control	NY DOT	Budgeted for 94/95 spot Operational Locations		X				
25	Kiosk-Based Traveler Information Systems	ADOT	Pre-Proposal Stage	X	X	X			
26	Storm Warning System Test (l-84)	Idaho DOT	Operational 10/93		X		X		
27	Branson Ozark Highroad	MS DOT	In-Progress	X	X	X			
28	I-526 Fog Mitigation Project	SC DOT	Operational		X				

Figure 34: Current Rural ATIS Activities (Continued)

PROJECT				RURAL ATIS USER SERVICES					
	NAME	AGENCY	STATUS	TRIP PLANNING/ ROUTING	TRAVELER ADVISORY	TRAVELER SERVICE INFO.	SAFETY & WARNING	ROUTE GUIDANCE	EMERGENCY SERVICES
29	Maryland (KIOSK)	MD DOT	In-Progress	X	X	X			
30	HAR Rural ATIS	Fairfax County, VA	Operational 12/95		X				
31	ROADWIS (I-800-ROAD-WIS)	WI DOT	Operational	X	X				
32	Travel Guide	Ministry of Transportation Ontario	In-Progress	X	X	X			
33	RAPP (Regional Automated Permit Process)	Utah, Idaho, Oregon, Iowa DOT's	In-Progress			X			
34	PASS(Port-of-Entry Advanced Sorting System)	OR DOT	Operational		X				
35	Drowsy Driver Monitor	V.P.I., NHTSA	In-Progress				X		
36	SAFER ((Sound/Light Alarm for Extra Reaction Time)	Gulf Coast Commuter Services, FL	Operational				X		
37	Touch & Go	Touch Information Inc.	Operational	X		X			
38	Truck Warning System	W. VA. DOT	Proposal				X		
TOTALS				I3	26	11	12	0	2

Figure 34: Current Rural ATIS Activities (Continued)

interfaces may also have the ability to provide route guidance and emergency services if vehicle location capabilities are used in conjunction with the system.

The MTO's TravelGuide project focuses on the development of a portable, "on-person" navigational and route guidance system. With work currently in progress, development goals concentrate on integrating a portable computer with a map data base, digital radio/data receiver, graphical and text displays, and a synthesized voice unit to provide route guidance instructions. This personal travel communications/information device will receive real-time travel time information when within the range of the appropriate FM transmitter in order to improve the route selection process. The TravelGuide device could be used by pedestrians, cyclists, automobiles, commercial vehicles, and transit vehicles. The $500,000 CAN (approx. $350,000 US) TravelGuide project successfully demonstrated that a portable route guidance system with real-time traffic data/information links has potential application as a commercially viable product. Throughout the Summer of 1995, 3 full months of testing were conducted to assess system operations and credibility, perform market surveys, and generate interest in TravelGuide-type applications.

The State of Washington DOT's Federally-funded Travel Aid operational test project is being designed to improve safety along a 64-km (40-mi) stretch of I-90 across Snoquahnie Pass, a rural area prone to ice, snow, rain, and poor visibility. First, Travel Aid will use environmental sensors to determine road surface and weather conditions data/information. From this information, a safe travel speed will be calculated and relayed to travelers through variable speed limit signs, VMS, and in-vehicle signing equipment. This low-cost in-vehicle device provides an "alert" signal to inform the motorist that a message is available and then displays a relevant text message. Currently, the first components of this $5 million project are being installed on the roadway.

The DIRECT (Driver Information Radio Experimenting with Communication Technology) program is a Federally-sponsored Operational Field Test that will deploy and evaluate four low-cost methods of communicating advisory information to motorists. These approaches include radio data systems (RDS), automatic highway advisory radio (AHAR), HAR using AM, and cellular phone call-ins. A metropolitan transportation center will collect traffic information from various sources and provide traffic updates to travelers on an exception basis. In April 1996, the $5 million DIRECT program's initial experimental testing saw 25 vehicles become specially-equipped with DIRECT equipment (subsequent testing will involve additional vehicles). The DIRECT evaluation is scheduled for completion in October 1998.

COMMUNICATIONS/STANDARDS

Due to the lack of existing infrastructure and the expanse of the area to be covered, system development might be financially limited by the communications necessary to implement rural information systems. Advancements in communication technologies will be crucial to the widespread use of rural information systems and will also have the potential to assist in delivering a number of user services.

The Colorado DOT, through ENTERPRISE — a consortium of several States and other agencies working in the ITS area, is involved in the international traveler information standard (ITIS). ITIS is a project that seeks to establish preliminary, open protocol standards for a digital radio broadcast service (for traveler information) using existing AM/FM broadcast infrastructure. In fact, one ENTERPRISE project — the HERALD project — is a Federally-sponsored operational test in Colorado and Iowa that is testing the utility of providing traveler information (via the ITIS format) in rural areas by employing a subcarrier on commercial AM radio. In particular, HERALD will test the suitability of the draft ITIS AM-bearer applications protocol for low data rate transmissions over wide areas of rural America. This test will assess the performance of AM data in a rural environment and its potential to serve as an ITIS bearer. The main focus of HERALD involves characterizing the AM channel and determining the most appropriate methods of modulation, error detection, and data structuring for this new medium's message generation, transmission, and reception components. At this time, Phase 1 (Prototype Testing) of HERALD is nearing completion with a Summary Report due out shortly.

FHWA is sponsoring the development of an FM/SCA prototype for traffic information broadcast. The project involves the testing of a prototype system to broadcast traffic information to mobile receivers via the subsidiary communications authorization (SCA) traffic information channel. This system will allow the use of commercial FM broadcast stations' subcarriers to transmit traffic and other information at rates higher than previously achieved. The data rate for this system will be high enough to support broadcast of individual link travel times (e.g., for routing applications). At least one urban and one rural broadcaster have expressed interest in participating in field tests.

TRIP PLANNING

The University of Michigan has been involved in the development of specifications for designing, implementing, and evaluating a computerized information system to aid telephone operators in rapidly identifying useful itineraries for passengers in a mass transit system. The project is estimated to cost **$70,000.**

The ARTIC (Advanced Rural Transportation and Information Coordination) operational test is a Minnesota DOT project that will coordinate the communication systems of several public agencies in order to improve response times to accidents and road condition emergencies, eliminate redundant communication systems, provide real-time vehicle status and schedule information, and better coordinate/improve rural transportation/transit services to customers. ARTIC will employ a toll-free telephone information system featuring audiotext capabilities and "live" phone operators. Phase 1 of the $1.5 million ARTIC program implementation includes construction of a dispatch center (June '96), installation of the dispatch/radio system (July '96), radio system "de-bugging" (August '96), and dispatch operations (September '96). Phase 2 will integrate ARTIC's transit component and related functionality (December '96) and then become fully operational (January '97).

The Boston SmarTraveler project tested public acceptance and potential traffic impacts of a telephone-based audiotext traffic information service. It also assessed the quantity and quality of information obtained from the various data collection methods used to support the service in order to gauge the potential market for full privatization of information provision to users. This project, which was funded as an operational test at $3 million, is now being supported for a second year with monies allocated by the State of Massachusetts and private participants. The additional testing is intended to answer how many travelers will make use of real-time travel data provided by phone for free and how such information influences their behavior.

The Wisconsin DOT is utilizing a toll free phone number (l-800-ROADWIS) to provide real-time weather condition information during the colder, stormy months and construction information during the periods when weather is a lesser factor in travel decisions.

The California Smart Traveler operational test refers to a series of operational test efforts in the State of California. The emphasis to provide travelers with current information on traffic conditions, transit routes and schedules, congestion type and location, carp001 and

Vanpool options, recommended navigation and alternate routes. Federal funding in the amount of $1 .l million, allocated through 1997, is being matched with non-Federal funds resulting in a total expenditure of over $4 million.

ROUTING

The Arizona DOT is developing a prototype kiosk-based rural ATIS that will be installed at the newly-constructed Painted Cliffs Welcome Center on I-40 near Lupton. The kiosk will include a microcomputer-based system with multimedia capabilities, interactive touchscreen interface, dial-up access, bilingual information capabilities (English and Spanish), print-out capabilities, real-time travel advisory information, pre-trip planning, and routing information services. Travel advisories such as weather warnings, major traffic incidents, construction activities, and height/weight restrictions will be available. Trip routing support will include suggested origin-destination pairs, alternate routing information, and scenic detours. In addition, information on the type(s) of roads the traveler will encounter, travel distance and times, major points of interest, and travel support facilities/services will also be available. This $70,000 project is currently in the pre-proposal stage and will see the development and installation of one (1) prototype kiosk.

TRAVELER ADVISORY

Currently operational, the Florida and Georgia DOTs' REACH (Rural Evaluation of Advanced Concept Highways) for I-75 was established to facilitate major rehabilitation and expansion work that is underway. REACH disseminates real-time information on traffic conditions and construction activities to passing motorists via VMS and HAR. As part of this project, the Georgia DOT is evaluating the use of solar-powered, portable HAR's.

The Tennessee DOT's Fog Detection/Warning System provides advanced warning to travelers in a high fog incidence area along an 13-km (8-mi) section of I-75 crossing the Hiwassee River 48 km (30 mi) north of Chattanooga. A central control center gathers and monitors traffic flow data via roadway sensors and weather conditions (including collection of visibility information) via meteorological stations and visometers in and around the fog-prone area. VMS, variable speed limit signs, HAR, fixed overhead signs, and several fixed warning signs with activated flashers serve as its information dissemination outlets. In addition, swing gates positioned at several on-ramps are "closed" when unsafe travel conditions are determined. This $4.3 million project is currently up and running.

West Virginia will provide grade and speed advisories to truck drivers through the Truck Warning System, Sandstone Mountain Interstate 64 project.

The Colorado DOT is advancing a Dynamic Downgrade Speed Warning System for "large" vehicles [i.e., over 13,620 kg (30,000 lb)] on I-70 just west of the Eisenhower Tunnels. The Federally-sponsored operational test uses weigh-in-motion (WIM) technology and loop detectors to measure vehicle weight and speed. Maximum "safe" speeds are then calculated and displayed to drivers via roadside VMS. Downstream sensors are used to evaluate the effectiveness of the system. This $250,000 project has been tested, is operational, and currently under evaluation,

The I-70 Rural ITS Corridor Planning and Feasibility Study, sponsored by the Colorado DOT, was undertaken in order to develop solutions to the transportation problems inherent to the mountainous regions between Denver and Glenwood Springs. A number of Early Action Projects (EAP's) were approved for implementation including the following:

- Installation of five VMS signs.
- Implementation of six HAR stations using 530 kHz AM band.

- Improvements to the communications system.

- Implementation of roadway sensors/detectors and CCTV at selected critical locations.

- Implementation of a Courtesy Patrol/Incident Management Program on selected portions of the Corridor.

- Implementation of a call box program at selected interchanges (where there is currently no way to call for emergency help).

This $1.65 million study was completed in February 1996 and several of the EAP's are currently being implemented.

ENTERPRISE is pursuing a project involving highway-based activated advisory/warning signs to prevent run-off-the-road accidents.

The FHWA's In-Vehicle Safety Advisory and Warning System (IVSAWS) program is developing a nationwide vehicular information system that provides drivers with advance, supplemental notification of dangerous road conditions. These warnings occur at a point sufficiently upstream from the hazard to enable the driver enough time to take the appropriate action. IVSAWS provides additional safety by enhancing the real-time interaction between the motoring public and professional deployment agencies (e.g., law enforcement, fire department, paramedics, railroad operations). In addition, human factors testing is being conducted to evaluate various driver alert warning systems. At this time, the $924,000 program has been completed.

ODYSSEY is a Minnesota DOT project which will use detectors to collect weather information. This information will then be disseminated through rest area kiosks. The concept is currently being further developed and funding has been allocated for this project.

Caltrans is in the process of installing a Visibility Warning System along a stretch of I-5 between Los Banos and Bakersfield to combat adverse dust and fog conditions. This warning system includes a micro weather forecasting system, wind activated meteorological devices, and CCTV to collect relevant data/conditions and uses VMS to display advisory warnings to passing motorists. This system is operated by Caltrans and the California Highway Patrol from control centers in Fresno [over 64 km (40 mi) away]. This $235,00 project has been operational since July 1994.

The New York DOT is in the process of implementing a Road-Weather Information System (RWIS) for Snow and Ice Control to warn motorists of adverse weather conditions along I-8 1. This system acquires radar observations from Buffalo, Albany, and Binghamton, obtains weather information from a private weather service in Rochester, and uses an 8-channel VHF weather radio receiver to pick-up additional information. These components form the basis for developing a real-time short-range forecast system. The ultimate system will incorporate Doppler radar information, satellite imagery, fine time scale predictions of low-level wind, and the numerical depiction of the evolution of lake-effect storms by 3-D mesoscale computer models. Motorists will be advised of these adverse environmental conditions via VMS installed at four strategic locations.

The Idaho DOT is advancing the Idaho Storm Warning System along I-84, a Federally-sponsored operational test program. The purpose of this program is to investigate sensor systems that could provide accurate and reliable visibility and weather data, and use that data/information to provide general warnings, speed advisories, and possible road closure and routing information. Sensors located at two weather stations collect environmental and visibility data (with video verification). This information is then relayed to a local weigh station (via telephone lines) for computer analysis. If the visibility falls below 365 m (1,200 ft), operators are alerted to post advisory messages via VMS installed at four strategic locations. This project started in October 1993 with the installation of the environmental sensors and two VMS. However, the '931'94 and '94/'95 winters were mild and did not produce any relevant data. The '95/'96 winter produced 12 environmental "events." Currently, the evaluation team is correlating the data (visibility range, vehicle speeds, TOD, etc.) in order to assess the system's performance. In addition, bids are being received in June 1996 for the remaining two VMS signs (to be installed prior to the '96/'97 winter). This project currently maintains a $1.2 million budget.

In the Lake Tahoe Basin, a joint effort between the Nevada DOT and Caltrans is implementing a RWIS program along State Road 431. The purpose behind this initiative is to help maintenance forces better respond to winter storms and inform motorists of adverse environmental and roadway conditions. This system uses several remote weather stations to monitor environmental conditions and transmits advisory messages to travelers via VMS and HAR. At this time, the RWIS is up and running, with plans for further implementation in the region.

The South Carolina DOT has implemented a Fog Mitigation System along a bridge section of I-526. This project will provide travelers with advance warning of reduced visibility arising from fog and other adverse weather conditions via VMS. Weather sensing equipment has been installed at this bridge site that monitors visibility and illuminates nearby street lights and the airport landing lights when visibility falls below 137 m (450 It). This $4.5 million project has been operational since June 1993.

Applications of the state-of-the-art in mobile environmental systems in ITS are primarily in the development stage; there are not any known, practical, commercially available systems on the market at this time. Vision enhancement systems for operation during nighttime and inclement weather are also known as all weather/night vision (AWNV) systems. The focus of this type of system is to assist the driver by enhancing the visibility of other objects in conditions when visibility would otherwise be poor (e.g., rain, fog, snow, dust, smoke, sandstorm, night/darkness). Equipping motor vehicles with such AWNV systems has the potential to reduce/prevent related accidents and is the interest of research and development efforts in the United States, Europe, and Japan as follows:

- United States — The Ford Motor Company is currently developing a concept for an AWNV system using millimeter wave radar technology, capable of detecting objects from a distance of almost 500 m (1,640 ft). Any data collected by the radar would be processed, and the relative location of objects would be transmitted to a head-up display on the vehicle windshield. In addition, this display provides an image of the roadway, including signs and traffic, ahead of the driver.

- Europe — Volkswagen is in the process of developing a visibility monitoring system based on an infrared laser beam. Back scatter signals from the beam are processed to derive the visibility range. The driver is then presented with the recommended speed appropriate for the prevailing condition(s).

- Japan — One AWNV system is under development ny Nissan, Nissan Diesel, and Kanto Seiki. This system is made up of an infrared lens, a scanner, infrared detection element, and a cooling element. The image is picked up by the infrared camera and displayed on a CRT monitor. Another AWNV system under development is mounted on a vehicle to provide a motorist's eye-level view of visibility conditions during blowing snow. This AWNV sensor system's transmitter projects a light beam which is reflected by airborne snow particles and measured by the receiver (which is mounted on an angle). The intensity of the measured light is in proportion to the snow concentration and visibility distance.

TRAVELER SERVICES INFORMATION

The Missouri DOT is in the process of planning and installing several ITS components in association with the Branson Ozark Highroad project. The City of Branson is located along US 65 and receives a high number of tourists due to its scenic beauty and entertainment industry. The project is currently installing conduit to house fiber optic cable to support local HAR at intersections, erecting towers for long-range HAR, installing VMS and CCTV at strategic locations, placing kiosks at key information distribution points, and establishing a traveler information center at the north entrance to the corridor in cooperation with interested parties. This $163 million program is currently in various stages of planning and hardware/software installation.

Caltrans is advancing the Yosemite Area Traveler Information (YATI) system, a Federally-sponsored operational test. The YATI program is an AT1 system for Yosemite National Park and the surrounding region (including five county agencies) that provides real-time travel information on road/traffic conditions, transit alternatives, tourist attractions/activities, parking information, churches, special events, and lodging and camping information. This information will be provided to travelers through VMS, HAR, and a multimedia data base accessible through information kiosks, bulletin boards, PC's, and touch-tone telephones. This $680,00 project has been in operation since December 1995.

The Iowa, Wisconsin, and Minnesota DOT's have implemented an automated mileage and stateline crossing operational test (AMASCOT), a Federally-sponsored program. This CVO project is testing a system that tracks vehicle mileage and State border crossings for faster and easier reporting to State regulatory agencies of fuel tax records. An on-board GPS system automatically tracks and updates vehicle positions information that is translated into a map data base. Interstate border crossings are recorded to automatically apportion actual mileage to the appropriate State. This project is operational and a Final Report was published in February 1996.

In Tennessee, a private sector initiative — Touch & Go — utilizes a touchscreen, menu-driven computerized information system that supports 21 installations, most of which are located at State Welcome Centers. This system can provide information on tourist attractions, lodging, festivals, restaurants, shopping, hiking/biking trails, driving safety tips, and some limited navigation/routing capabilities (e.g., Welcome Center to registered advertiser). Approximately 175 advertisers support Touch & Go through annual subscriptions and update their information on a monthly basis. Tennessee's Touch & Go program has been in operation since 1984 with a similar operation in North Carolina starting-up recently.

The Idaho, Utah, and Oregon DOT's, and the Iowa Transportation Center are in the process of implementing a Regional Automated Permit Processing (RAPP) program for oversized vehicles to reduce procedural delays at enforcement checkpoints. This project will create a "one-stop" corridor from Salt Lake City (UT), through Idaho, to Portland (OR). This project will create a seamless, regional network that incorporates AVI transponders, WIM (at State border crossings), and a shared informational data base. The $280,000 RAPP project is being led by the Utah DOT. Currently, RAPP has completed drafts of the data base requirements and communications protocol to be used. In addition, a draft of the permit form is under development.

The Oregon DOT's Port-of-Entry Advanced Sorting System (PASS) project uses WIM and 2-way AVI transponders at port-of-entry truck weigh stations to allow mainline, high-speed sorting of commercial vehicles. The PASS system weighs trucks to check for violators and electronically-reads license plate information to verify tax, safety, and other vehicle data records. If PASS determines that a vehicle is in violation, it is instructed to exit at the next weigh station. PASS currently tracks approx. 270,000 vehicles for 40,000 companies. This $500,000 project began testing system operations in October 1995.

The DOT's of Wisconsin and Illinois are planning the automation of commercial vehicle checkpoints with the use of high speed weigh-in-motion technology. This project, which is located on the Gary-Chicago-Milwaukee ITS Priority Corridor, will also employ area specific traveler information and vehicle identification.

The HELP (Heavy Vehicle Electronic License Plate) program and subsequent Crescent Demonstration was a cooperative effort between the FHWA, various State DOT's (Washington, Oregon, California, Arizona, New Mexico, Texas, Colorado, Utah, Iowa, and Minnesota), Canadian Province of British Columbia, commercial vehicle/trucking firms, and a permitting service vendor. The HELP program's primary goal is to prequalify commercial vehicles for electronic screening of relevant data (e.g., weight, tax, safety, permits) at ports of entry and weigh stations. HELP relies upon WIM and two-way AVI transponders to perform these operations. This electronic credential application and issuance system provides a "one-stop shopping" concept that allows for remote terminal access and electronic funds transfer for fee collection. The Crescent Demonstration evaluated the HELP program at a number of locations along I-5 and I-40 from Washington to Texas, verifying the technology used and systems/operational approach taken. After the successful completion of the HELP/Crescent demonstration, HELP Inc. (a not-for-profit organization) was established which operates the PrePass electronic clearance system. Currently, California (July 1995) and New Mexico (February 1996) are operating PrePass with Arizona (July 1996) and Oregon (November 1996) prepared to go on-line.

The ADVANTAGE I-75 Motor Carrier Project is a multistate/province initiative along the I-75 Corridor (Florida to Michigan) and Highway 401 (Ontario). The primary goals of this project are to improve safety and reduce the delays encountered due to multiple truck weigh station stops. ADVANTAGE I-75 encompasses 40 weigh stations and integrates AVI, AVC, WIM, computer and communications networking, and data base management in order to automate carrier enforcement and mainline vehicle clearance. This system is currently operational as it held its official "Grand Opening" in December 1995. In addition, efforts are already underway to establish interoperability between HELP Inc.'s PrePass system and ADVANTAGE 1-75's electronic clearance system in order to promote a seamless transportation/CVO system, set-up equipment/communications standards, and promote a uniform direction to the CVO industry/market.

SAFETY AND WARNING

In-Vehicle Crash Avoidance Warning Systems: Human Factors Considerations, will identify driver requirements for effective warning systems to help drivers avoid crashes. This project is estimated to cost $757,000 and is expected to be complete in 1996.

In Florida, the SAFER (Sound/Light Alarm For Extra Reaction Time) program is comprised of two major components. The first part is an in-vehicle warning unit with a sound/light alarm and the second part is composed of magnets embedded in the road (at appropriate locations). The SAFER system operates in the following manner:

- Two in-road magnets are located in advance of a potential "trouble" spot (e.g., sharp bend/curve, limited sight distance intersection, construction zones).

- The magnets are installed in such a manner that the specified distance between them corresponds to the predetermined safe speed for the specific hazard.

- The first magnet start a timer on a SAFER-equipped vehicle and the second magnet will turn the timer off.

- If the travel time preset in the in-vehicle device exceeds the actual travel time, the device will sound an alarm and/or warning light to allow the driver enough time to slow the vehicle to a safe speed before encountering the hazard.

A commercially-available product, SAFER is also investigating methods to adjust the in-vehicle device's "safe distance time constant" to take individual human and environmental factors into consideration.

ROUTE GUIDANCE

The ADVANCE (Advanced Driver And Vehicle Advisory Navigation Concept) program is a Federally-sponsored operational test in the northwestern suburbs of Chicago. The Illinois DOT leads this public/private partnership in developing a dynamic in-vehicle navigation and route guidance system. ADVANCE is comprised of four (4) primary subsystems: an in-vehicle navigation device, RF communications, a traffic information computer processing center, and traffic-related software algorithms. ADVANCE was "re-scoped' in September 1994 and subsequently reduced its deployment target from 5,000 to 75 equipped vehicles. However, all "core" ADVANCE functionality (e.g., probe vehicle travel time reports, dynamic trip planning, traffic predictive algorithms, route guidance instructions, etc.) have been maintained. From June-December 1995, ADVANCE underwent a number of evaluation tests to determine the progress/performance of the program as well as the statistical validity of the information generated/utilized. A report on these findings/lessons learned should be available in October 1996. From a financial perspective, ADVANCE is a $31 million program that maintains a 68 percent FHWA ($21.1 million), 20 percent State ($6.2 million), and 12 percent Private Sector ($3.7 million) split. Of these monies, $24.5 million is for ADVANCE-specific activities and $6.5 million for the "evolution" of the traffic information computer processing center into a corridor wide information/control center as part of the Gary-Chicago-Milwaukee ITS Priority Corridor.

EMERGENCY SERVICES

The ENTERPRISE group leads a Federally-sponsored operational test known as the Mayday program. Located over a 3 1,000 km2 (12,000-mi2) area in north central Colorado, Mayday seeks to evaluate the impact of an infrastructure-based GPS system and response network on emergency service activities/time in order to assist motorists in-need and improve public safety. Utilizing approximately 2,000 vehicles, Mayday will integrate GPS technology, TIDGET location devices (low-cost, NAVSYS-manufactured GPS location "decoder"), cellular phones (for 2-way communications), in-vehicle units, and a dispatch/help center. The $3.8 million project is currently underway and scheduled for completion in December 1997.

Mayday systems are common features of transit vehicle radio systems with silent alarms. Some also include automatic vehicle location (AVL) systems.

CHAPTER 7: SUMMARY AND FURTHER DEVELOPMENT

The development of ATIS applications for the rural environment necessitates:

1. Identifying rural traveler informational needs.

2. Identifying the technologies which may support these needs.

3. Having an understanding of the current state-of-the-art in rural ATIS.

4. Recognizing application areas with potentially high benefits for both the traveler and the system provider.

This report represents the first three steps outlined above. The next task within this project will concentrate on the fourth area, the development of rural ATIS applications.

SUMMARY

RURAL TRAVELER INFORMATION NEEDS

Rural traveler information needs were identified through both a series of interviews and a data collection effort. A national representation of general travelers, other highway users (commercial, fleet, and emergency service vehicles), and information providers were interviewed regarding information needs. Both rural residents and urban residents who travel in rural areas rated the need for information when en route and experiencing problems as very important. Informational needs were also rated high for pre-trip and en route travel with no problems.

A weighted analysis of specific informational needs found that general traveler needs are focused on safety and security and pre-trip determination of the preferred route. The ability to transmit a mayday signal when faced with a problem was reported as the greatest informational need. The weighted analysis resulted in the identification of the following key needs:

1. The availability and usefulness of an in-vehicle distress signal.

2. Information concerning approaching hazards within the next mile or so.

3. Availability and usefulness of an in-vehicle system to activate an alarm if the driver falls asleep at the wheel, or the vehicle starts to go off the road.

4. Information concerning road closures and traffic congestion ahead.

5. Information warning a driver concerning maximum safe speed under prevailing conditions, such as rain or construction ahead.

6. Pre-trip planning information concerning directions and route selection to get to the destination.

Up to the minute information about road and weather conditions, provided en route in order to take into consideration the possibility of rapidly changing conditions, is of the greatest importance to other highway users.

Emergency medical service providers felt that mayday systems could dramatically reduce accident notification times in rural areas. However, concerns were raised regarding abuse of the system and false alarms, system expense, and availability of resources to monitor the signals.

Information providers, while enthusiastic about the potential of rural ATIS, identified issues which create barriers to ATIS implementation: funding, user sensitivity to the cost of in-vehicle systems, liability with respect to the accuracy of information and performance of systems, and the standardization of technologies and communication.

Overall, the rural travel infrastructure warrants upgrades which parallel those of the urban infrastructure; rural travel represents 40 percent of all vehicle-kilometers traveled in the United States, contributing significantly to mobility, commerce, and economic development within the Country. Additionally, 85 percent of road mileage in the United States is in rural and small urban areas.

The data collection effort undertaken corroborated general travelers' safety concerns by showing that 61 percent of all U.S. traffic fatalities occur on rural roadways. A serious safety issue, motor-vehicle fatalities accounted for approximately 50 percent of all accidental deaths in the United States in 1991. The need for information regarding road closures, maintenance, and non-recurrent congestion was also substantiated in that the vast majority of rural roadways are two-lane roads; resulting in the potential to severely limit mobility when faced with an incident which closes one, or both of these lanes.

TECHNOLOGY

Several major conclusions were drawn from the state-of-the-art technology review. Substantial proven technology is available to support basic rural ATIS applications, and there are significant promising innovations. There is also a significant potential for piggybacking rural ATIS applications on other, non-transportation related investments. Not all existing technologies are suitable for the rural ATIS environment due to the expanse of the area to be covered and the lack of existing infrastructure beyond the roadways themselves. However, there is no need to create new technologies to meet the rural ATIS needs.

Communications for a rural ATIS will be the major challenge, and infrastructure costs and the nature of user priorities make in-vehicle systems and targeted roadside systems a high priority. The rural environment will require both short-range and long-range communications and have the potential of utilizing both bounded and unbounded media. Emerging and developing technologies for communications may have a place in rural ATIS because most of these technologies are long range and unbounded which are ideal for the transfer of data from the data collection point to travelers for pre-trip planning purposes.

The other challenges facing the application of technologies to rural ATIS include integrating and deploying a seamless system which is also cost-effective in order to justify the installation of AT1 systems in enough locations for them to be of value to the traveler. The deployment of a seamless AT1 system will require the development of standards for the various ITS technologies and the transfer of data from one system component to another. The standardization of communication protocols will also serve to bolster the commercial viability of ATI system elements as standards will ensure that a developed product won't be made obsolete by the market's adoption of an incompatible element or system.

In order to ensure the cost-effectiveness of these systems, it will be important to automate the systems' operations. Staffing, operations, and maintenance needs of an ATIS have the potential to prohibit the implementation of, or severely disable an already implemented system. A rural ATIS is even less likely than an urban system to have the local support of a transportation department experienced in the management of advanced systems making this an even more critical issue in rural than in urban implementations.

For the successful deployment of a rural ATIS it is also essential that both public and private entities take part. Non-safety and non-emergency applications must be commercially viable so that those elements can be privately developed. The legal liability of both public and private components of the system are a key concern. Multiagency/jurisdiction planning and management is essential for a successful system. All of these concerns must be addressed in order to provide a useful, successful, and workable rural advanced traveler information system.

CURRENT INITIATIVES

Current initiatives were investigated in order to determine the current state-of-the-art in rural ATIS. Projects are currently planned or are underway which would support each of the seven rural ATIS user services. These include trip planning systems which are capable of providing weather and roadway information over the telephone, the provision of traveler advisory information in order to avoid run-off-the-road accidents and provide weather and visibility conditions, systems at welcome centers which provide traveler service information, and mayday services for emergency situations, among others. Also, projects are underway which will affect the management and administration of rural AT1 systems, the testing and analysis of various user interfaces, and analysis of the availability of radio frequencies for ATIS purposes and the human factors which come into play with these systems.

This knowledge and understanding of current initiatives will affect the development of rural ATIS application concepts. The concepts developed under this study will either contribute to and expand the work currently being done or will represent the development of new application concepts. In the first case, the findings of current initiatives, including the application of technologies, the assessments of user interfaces, and the ability of the concept to meet the identified needs will all contribute to the design of the newly developed concept applications.

FURTHER DEVELOPMENT

The work presented thus far has involved establishing and prioritizing the information needs of rural travel, together with assessing the technological opportunities available to rural ATIS and reviewing ongoing initiatives. A major task which is being undertaken following these initial tasks is the development of potential application concepts.

The applications concepts will be the result of four points of focus (figure 35). The first three being the priority user needs as identified previously, the technological opportunities, and current initiatives in rural ATIS and parallel areas. The additional factor contributing to the development of possible concepts is an assessment of those concept areas with the potential for a high pay-off.

Application concepts developed based upon the four points of focus will generally fall under one of four categories: proven technology, established technology, emerging technology, or future concepts (figure 36). Proven technologies are those which are already being deployed in rural applications. Established technologies may have been deployed in urban settings and are now ready for immediate deployment within the rural area. Emerging technologies have not yet been proven and may be candidates for operational tests or proof-of-concept demonstrations. Future concepts are those which will require long-range research and development.

Those concepts which currently hold the most potential will primarily be within the categories of established and emerging technology. It is within these areas that the continuing work will concentrate and from which rural ATIS concepts will be developed.

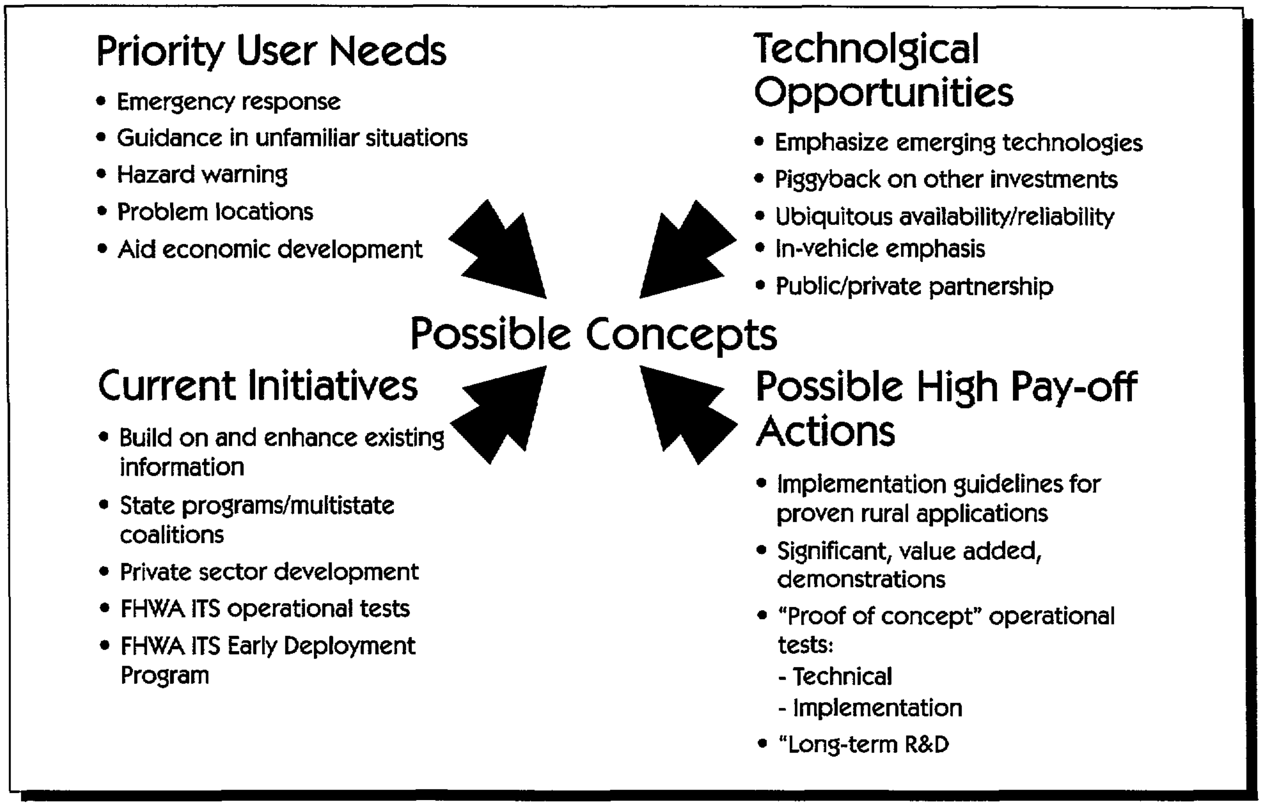


Figure 35: Four Points of Focus

Proven Technology	**Established Technology**	**Emerging Technology**	**Future Concepts**
Established Rural Applications	Limited of no Rural application	Little or no application to date	Potential high pay-offs
• Document successful situations • Implementation guidelines • Implementation assistance	• Proof-of-concept: implementation focus • Working real-world illustrations • Build on existing State/private initiatives • Major institutional focus • Major opportunity but significant effort to make worthwhile	• Proof-of-concept: technical • Demonstrate workability or value of technology • Utilize part(s) of existing initiatives • Highly focused • Formal evaluation	• Long-term technical R&D • High risk High pay-off • Push technological frontier

Figure 36: Four Categories of Concept

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