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Technology in Rural Transportation "Simple Solutions"

US Department of Transportation
Federal Highway Administration

Research and Development
Turner-Fairbank Highway Research Center
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FOREWORD

The Technology in Rural Transportation: "Simple Solutions" report contains the findings of a research effort aimed at identifying and describing proven, cost-effective, "low-tech" solutions for rural transportation-related problems or needs. Through a process of research and interviews with local level transportation professionals throughout the United States, examples of technology applications which have been locally developed to meet local problems were identified and documented.

During phase A of the project, more than fifty "simple solutions" were identified. The categorization of technology applications was made in accordance with the critical program areas, or "rural clusters" developed by the Federal Highway Administration's (FHWA) Rural Action Team as part of its work to develop an Advanced Rural Transportation Systems Strategic Plan. During phase B, a subset of this list of candidate solutions was selected for further investigation. Details documented during this stage included descriptions of the benefits of the technology, the expected implementation process, the potential issues associated with each technology, and each technology's role in larger scale, fully integrated rural intelligent transportation systems.

It is hoped that the resulting simple solution descriptions will be used as a toolbox of information to assist in reaching out to local level transportation professionals to introduce them to intelligent transportation systems (ITS) and their potential benefits. Solutions studied within the project focussed on practical applications of technologies, which could serve as precursors to future applications of more advanced systems.

The intended audience for the report includes Federal, state and local transportation professionals interested in and involved in increasing awareness of the benefits of ITS deployments in rural and small urban areas.

A. George Ostensen
Director of Office of Safety and Traffic Operations
Research and Development

Technical Report Documentation Page

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16. Abstract

The Rural Outreach Project: Simple Solutions Report contains the findings of a research effort aimed at identifying and describing proven, cost-effective, "low-tech" solutions for rural transportation-related problems or needs. Through a process of research and interviews with local level transportation professionals throughout the United States, examples of technology applications which have been locally developed to meet local problems were identified and documented.

During Phase A of the project, more than fifty "simple solutions" were identified. The categorization of technology applications was made in accordance with the critical program areas, or "rural clusters" developed by the Federal Highway Administration's (FHWA) Rural Action Team as part of its work to develop an Advanced Rural Transportation Systems Strategic Plan. During Phase B, a subset of this list of candidate solutions was selected for further investigation. Details documented during this stage include descriptions of the benefits of the technology, the expected implementation process, the potential issues associated with each technology, and each technology's role in larger scale, fully integrated rural intelligent transportation systems.

it is hoped that the resulting simple solution descriptions will be used as a toolbox of information to assist in reaching out to local level transportation professionals to introduce them to intelligent transportation systems (ITS) and their potential benefits. Solutions studied within the project focussed on pratical applications of technologies, which could serve as precursors to future applications of more advanced systems.

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- The ENTERPRISE Consortium.
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1. EXECUTIVE SUMMARY

Transportation professionals face a variety of challenges in meeting the day to day needs of travelers especially in rural towns and cities. Often, innovative uses for technologies are applied to solve such problems. The primary objective of this study was to identify and describe proven, cost effective, simple solutions for rural transportation-related problems or needs. For the purposes of this project, a “simple solution” is defined as a method or technology that a local agency is able to implement, or administer the implementation of, to meet a local need without requiring more than a minimum level of assistance from State or Federal agencies.

During phase A of the project, a national search was conducted to identify and describe a series of simple solutions with potential for meeting the needs of rural transportation users. The purpose of this initial research was to collect and present adequate information about each solution to allow members of the project review team to select a subset of the solutions for further investigation in phase B. The emphasis of this search was on identifying technology-based, effective, practical solutions for existing or impending problems.

Solutions were categorized according to the Critical Program Areas (CPAs) defined in the U.S. DOT Advanced Rural Transportation Systems Strategic Plan. The CPAs are as follows:

- Traveler safety and security.
- Emergency services.
- Tourism and travel information services.
- Public traveler services / public mobility services.
- Infrastructure operation and maintenance.
- Fleet operation and maintenance.
- Commercial vehicle operations.

Within each of these areas, solutions were also grouped according to whether they were appropriate for site-specific, corridor-wide, or region-wide implementation.

Within phase A of the project, 5 1 candidate solutions were identified and described. From the information assembled in phase A, a subset of 14 solutions was selected by FHWA as most probable for transfer to other locations. These solutions served as the focus of phase B of the project. The intent of phase B was to define each solution in sufficient detail to enable transportation professionals in other rural areas to assess the potential for deploying the solution locally. In addition, part of each solution’s definition was a description of its potential contribution to broader rural intelligent transportation systems (ITS) developments.

Following this executive summary, section 2 contains the 14 detailed solution descriptions resulting from phase B. Section 3 presents the brief, one-page descriptions of the remaining 37 solutions created as part of phase A. Following the solution descriptions, section 4 provides further information on the project approach. Additional findings and insights gained during the project are also provided in this section.

2. DETAILED DESCRIPTIONS OF SELECTED SOLUTIONS

This section contains the detailed summaries of the 14 ITS simple solutions that were selected by the FHWA as most probable for transfer to other locations. For each of these technology applications, the following information is provided:

- Name of project or activity.
- Overall goal of solution.
- Description of technical approach.
- Current status, for example, proposed application, research / pilot testing, operational test, full deployment.
- Location and geographic scope.
- Agencies or individuals involved.
- Estimated / actual overall cost of solution, and details of funding sources.
- Key contacts for further information.
- Extent to which goals were achieved.
- Details of the project or activity timeline.

In addition to these basic information items, further analysis of each application was undertaken so that each was defined in sufficient detail to enable transportation professionals in other rural areas to assess the potential for deploying the solution locally. Additional information provided includes:

- Further information on the technologies used within each application, covering any additional technologies that could accomplish similar applications, the estimated costs to develop or purchase the technologies, the estimated costs to operate and maintain the technologies, and the estimated development levels for technologies within each application.
- A summary of the benefits of each application, including the direct and indirect benefits to travelers, the community, and local businesses or industries, where applicable.
- A general description of the expected implementation process, including what must be accomplished to implement the application, both technically and institutionally, the potential roles for agencies involved, potential staged approaches where small scale applications could be implemented quickly and for minimal costs, and any problems encountered in previous implementations.
- A description of potential issues associated with each application. Efforts were focused on identifying technical, institutional, and funding issues.
- A description of each solution's contribution to broader rural ITS developments. The final step involved considering how the application could be an active part of a larger scale ITS deployment.

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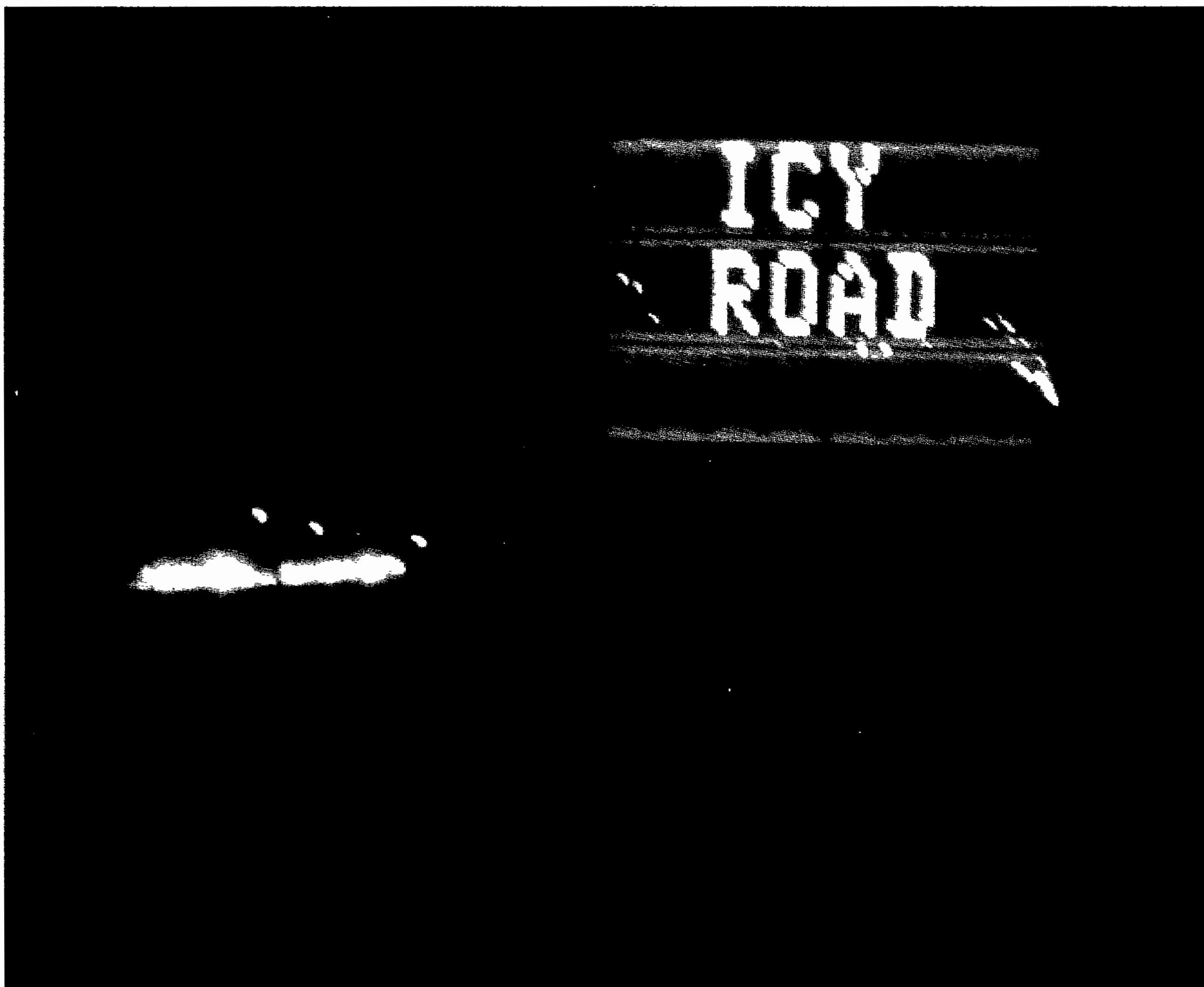
Traveler Warnings for Spot Hazardous Conditions



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2.1 Traveler Warnings for Spot Hazardous Conditions

General Description: Ice tends to form on bridges and overpasses before it does on other portions of the roadway. Given that the main roadway may not be icy, drivers often do not anticipate icy conditions on bridges, etc., and are therefore not prepared. This simple solution equips those sites most susceptible to icing with detectors connected locally to a device that warns drivers to slow down and use caution on the icy surface.

Real-World Example - Washington State Ice on Bridge Warning System

Overall goal: To increase the safety of drivers on a bridge prone to icy conditions.

Technical approach: Ice sensors were installed on the bridge. When these detected ice on the pavement, flashing beacons were activated on a sign reading "ICE ON BRIDGE WHEN FLASHING".

Current status: The system was intended as an experimental system and was used for a limited period. There were concerns over liability should an accident occur on an occasion when the sensors failed to detect icy conditions.

Location / geographic scope: The system was tested on Highway 10 1 near Port Angeles on the Olympic Peninsula in Washington State.

Agencies involved: Washington State DOT

Cost information: None available. The technologies used were widely available and low-cost.

Key contacts: Bill Legg, Washington State DOT. (206) 543-3332
Toby Rickman, Washington State DOT. (360) 357-2670

Have goals been achieved? The technology proved to operate satisfactorily, however, liability concerns may prevent permanent deployment.

Solution timeline: Intended as experimental system only.

Further Description of Application

Additional technologies may include:

Other means of providing traveler warnings include variable message signs, activated by sensors, which could provide more detailed information on conditions. Details on area-wide road or weather conditions could alternatively be communicated to travelers via wireless data broadcast, using AM, FM or HAR subcarriers. Messages could either be provided to travelers using roadside signs or in-vehicle devices, including regular radios. The costs to support this service using radio subcarrier technologies would be prohibitive as a stand-alone service. However, in areas already disseminating data over wireless radio, additional costs to encode and deliver this information would be minimal.

Potential additional uses for this technology may include:

It could be that additional types of potentially hazardous locations, for example, locations prone to flash flooding, high winds, or reduced visibility due to fog, drifting snow or sand could be instrumented with appropriate sensors which could then activate similar stand-alone warning signs or flashing beacons.

Benefits of Application

	Benefits to travelers	Benefits to the community / public sector	Benefits to business / industry
Direct benefits	Increase in driving safety	Increase in local roadway safety	Increase in safety of freight vehicles
Indirect benefits	Less costs incurred in repairs or insurance through avoiding accidents	Less costs incurred in making repairs to accident locations Favorable public perceptions of safety improvement schemes	Less costs incurred in repairs, insurance, and loss of shipments through avoiding accidents

Probable Implementation Process

Step One: Cities or counties should first consider whether the nature of conditions in their jurisdiction warrant such warning systems. As is outlined above, this configuration of sensor and flashing beacons / message sign could be utilized for a number of different conditions, and it is possible that at least one of these types of condition could be experienced in any part of the continent, indicating widespread potential applicability for such warning systems.

Step Two: Accident records should then be investigated to identify which bridges, routes, or other appropriate locations would benefit most from the installation of warning systems. Criteria which could affect the appropriateness of a warning system at a given location could include: the frequency and severity of crashes, the frequency and severity of dangerous conditions, the traffic levels on the affected route, and the number of unfamiliar travelers who use the affected route.

Step Three: The appropriate combinations of sensors and warning signs / beacons should then be specified and procured.

Step Four: Warning systems must be installed and reliability evaluations performed to ascertain that systems are functioning adequately prior to being fully commissioned. Given the liability concerns expressed by the implementers of the Washington State Highway 101 system, it could be advisable to incorporate some type of status logging capability into the system such that data on the performance of the components is available for periodic analyses.

Potential Implementation Issues

The issue of liability which was identified by the original implementers of this technology requires careful consideration. There were concerns over liability should an accident occur on an occasion when the sensors failed to detect icy conditions or if the sensors detected icy conditions but a beacon malfunction prevented activation of the warning. For a simple, stand-alone system, the reporting of malfunctions to a central point for action would severely impact the cost benefits of the application. One potential approach would be to implement systems as part of a wider regional or corridor infrastructure. For this type of configuration, it is more likely that two-way communications with the responsible agency would be more cost-effective. The communications system could be used to report malfunctions to the agency and for the agency to override the system if required.

It may be that the greater investment needed to install such a regional or corridor system would make agencies more likely to consider transferability and expandability issues related to the technology.

Solution's Contribution to Broader Rural ITS Developments

This simple solution is a prime example of a site-specific, stand-alone application of technology, given that it provides warnings of localized conditions which need only be communicated to local travelers who are likely to encounter an occasion of a recurring condition. The potential role of this solution in an integrated rural intelligent transportation system is described below:

Traveler Information - Linking the site-specific application to a regional or corridor infrastructure allows this solution to serve as part of a regional traveler information system, providing real-time information to travelers at isolated locations.

Incident Management - The occurrence of spot hazardous conditions, such as roadway icing and reduced visibility, is often described as an incident. Equipped sites are locations where incidents are likely to occur, hence this solution helps to manage the vehicles in and around the incident site, especially if additional technologies for incident management, such as closed circuit television (CCTV) cameras, are also installed at the affected location.

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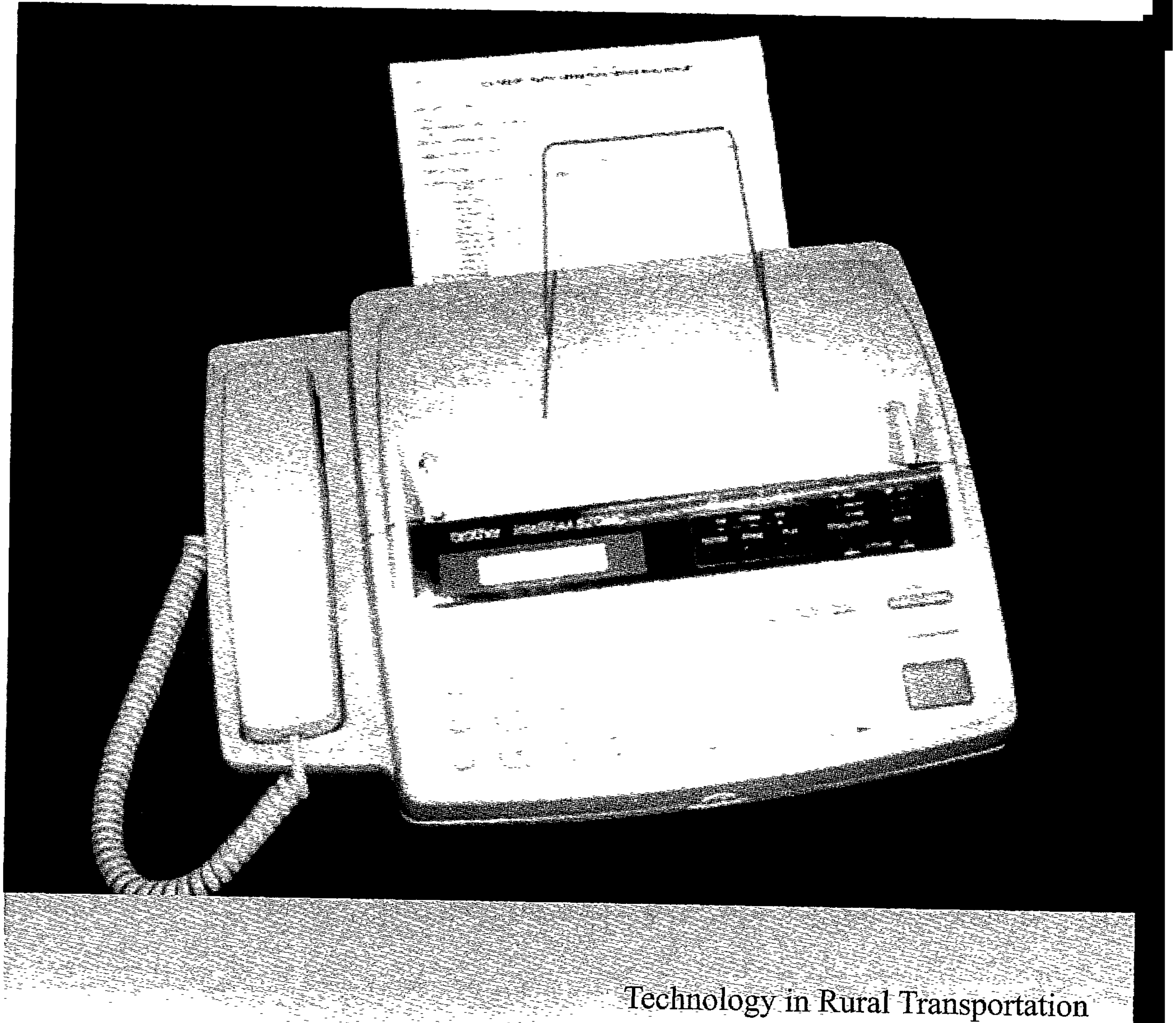
ENTERPRISE

Information Management

Using Fax Machines



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"Simple Solutions"

2.2 Traveler Information Using Fax Machines

General Description: Increasingly detailed and up-to-the-minute information is becoming available concerning road and weather conditions. This simple solution provides a means of providing this information to a wide audience at a low cost. Presuming access to a regular fax machine, road and weather condition information, and other types of traveler information can be received from a central agency. Information can be faxed either on demand, according to a predefined schedule, or on a flexible basis to alert users of changing conditions. Information may be specific to the needs of the receiver or may be general in nature.

Real-world Example - Colorado DOT Weather By Fax

Overall goal: To provide weather and road condition information to a wide range of users in a cost-effective manner.

Technical approach: Current weather and road condition information and short-term forecasts are faxed to a list of approximately 200 user agencies, including freight haulage companies, ports of entry, visitor centers, ski areas, radio stations and television networks. The information, which is around two pages in length, is usually faxed out once a day in the summer months and approximately four or five times a day during the winter. In addition to these regular bulletins, supplementary faxes are also sent to warn of unusual or particularly severe conditions, such as avalanches, the opening and closing of passes, or to advise travelers to put on or remove snow-chains. The information is collated using a variety of sources including Colorado DOT’s 88 weather stations installed around the state, a NOAA terminal situated at the Traffic Operations Center, the Colorado State Patrol, and verbal reports from ports of entry personnel.

Current status: The information used to be sent out from the Traffic Operations Center itself, using a series of six fax machines using pre-programmed broadcast lists. Given the number of recipients and the frequency of faxes, especially in winter, this system was very labor-intensive. Recently, CDOT contracted with a consultant and telecommunications company to provide fax services. The information is faxed from a CDOT PC to the service provider, from where information is broadcast virtually simultaneously to all recipients. Users receive the information in between three and nine minutes from the time of receipt at the service provider depending on the number of “retries” that are necessary to connect with their fax machines.

Location / geographic scope: Agencies throughout the state of Colorado receive the information. In addition, agencies along the I-70 and I-80 corridors into Wyoming and Utah are also provided with the information.

Agencies involved: The system is operated by the Colorado Department of Transportation Traffic Operations Center. The fax services are provided by Expedite through the Ideal Dial service provider.

Real-world Example continued - Colorado DOT Weather By Fax

Cost information: IdealDial charged CDOT $250 for the set-up fee. However, the customary fee for setting up such a service depends on the number of fax recipients, and is usually around $1,000. As CDOT uses IdealDial for other services a discount was applicable. In addition to the set-up fee, a fee of 25¢ a minute for fax transmission is charged. CDOT estimates that this can be equated to 25¢ a page. The costs for transmission also vary by volume of transmissions and would decrease significantly for greater quantities of information.

Key contact: Michele Kayen, Colorado DOT Traffic Operation Center. (303) 239-5808.

Have goals been achieved? The current system has been in operation since the beginning of December, 1996. So far, the system has proved to be a vast improvement over the previous method due to the increased speed with which information is transmitted to the users. In addition, TOC staff time can be better utilized, now that CDOT personnel do not fax the information themselves. No staff positions have been lost as a result of the fax automation.

Solution timeline: CDOT plans to work with the telecommunications service provider to customize the system to better meet their needs. Additional features CDOT requires are as follows:

- More detailed transmission reports providing details of failed transmissions in a more timely manner so faxes can be sent to these recipients manually by CDOT.
- More flexibility to stop the fax run partway through if new information is received.
- One rather than two retries if a fax number cannot be reached at first in order to speed up the overall process.

Further Description of Application

Additional technologies may include:

Other means of disseminating general traveler information, or specific road / weather condition information, on a low-cost basis using equipment that many users already have access to could include:

- Electronic mail (e-mail) could be used to disseminate information to anyone with access to an e-mail account. E-mail could also allow for transfer of data files, pictures, written text or audio.
- Voice messages could be recorded and sent out over commercial voice messaging systems.
- Voice messages could also be recorded on an agency’s voice mail announcement allowing end users of the system to call up and listen to the announcement.
- Internet information services.

Potential additional uses for this technology may include:

- On-demand directions to and from specific locations.
- Traffic and road condition reports tailored to a specific route, either for a regular commute or for a less frequent trip, such as a vacation or traveling to relatives for holidays.

Benefits of Application

	Benefits to travelers /the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Travelers are better informed about conditions on the roadways before embarking on trips, without requesting information	Fleet operators are mare .- informed about the road conditions and can plan dispatching accordingly	Agencies can provide services at a low-cost
Indirect benefits	Improved safety and efficiency on the roadways.	Greater client confidence in adherence to delivery schedules	Improved public perceptions of value provided by public agencies

Probable Implementation Process

Step One: Interested agencies must determine the extent of the area about which information will be disseminated, for example, a city, corridor, county, or state-wide. This will be determined by the amount and type of data concerning a particular area which can be easily collected and delivered to a central processing area.

Step Two: Agencies must decide what information will be disseminated using the service, being careful not to offer services which are impractical under existing budgets. It also may be appropriate to determine what information services are already being offered by other agencies, including private sector organizations.

Step Three: Agencies should determine whether they plan to charge users for the information provided, and whether this would be on a flat subscription fee basis or whether charges would vary according to the actual amount and frequency of information provided. Fee levels should be determined.

Step Four: Agencies should perform some research into the potential numbers of users interested in receiving information, given the area of coverage, the types of information available, and the fees for receiving information, if applicable. This will determine whether the agency disseminates information itself using the regular fax, voicemail, or email broadcast capabilities offered by off-the-shelf machines (practicable only for smaller numbers of users), or whether the agency contracts with a telecommunications provider to disseminate the information.

Step Five: Appropriate information formats and message descriptions should be developed. Ultimately, all end users should receive a description of message definitions, for example, reduced speed means slower than normal traffic flow.

Step Six: Agencies should advertise the service and begin signing up interested office buildings, companies, and individuals, noting whether those requesting the service have access to fax machines, e-mail accounts, voice mail, or direct telephone numbers.

Step Seven: Delivery of traveler information can begin, following a standard procedure for disseminating the information bulletins at regular times to all subscribing users,

Potential Implementation Issues

When considering implementing the system, agencies should consider the cost implications of future demand by additional users. Although economies of scale should result, if significantly more users wish to subscribe to the service, the costs of providing the service may become too great for the agency if fees were not levied from the outset.

Solution's Contribution to Broader Rural ITS Developments

This solution is an example of a region-wide dissemination system that, when used in conjunction with other data collection and information processing systems, will contribute to the following rural intelligent transportation systems:

Roadway Management - This solution can play a critical factor in the dissemination of information to contribute to the overall management of rural roadway events. Such events may include: road closures, significant delays or hazardous weather conditions.

Regional Traveler Information - This solution can serve as part of a regional information system, disseminating general information or alerting motorists of real-time events.

Incident Management - When coupled with incident notification and verification, this solution can contribute to management of incidents.

United States Department of Transportation
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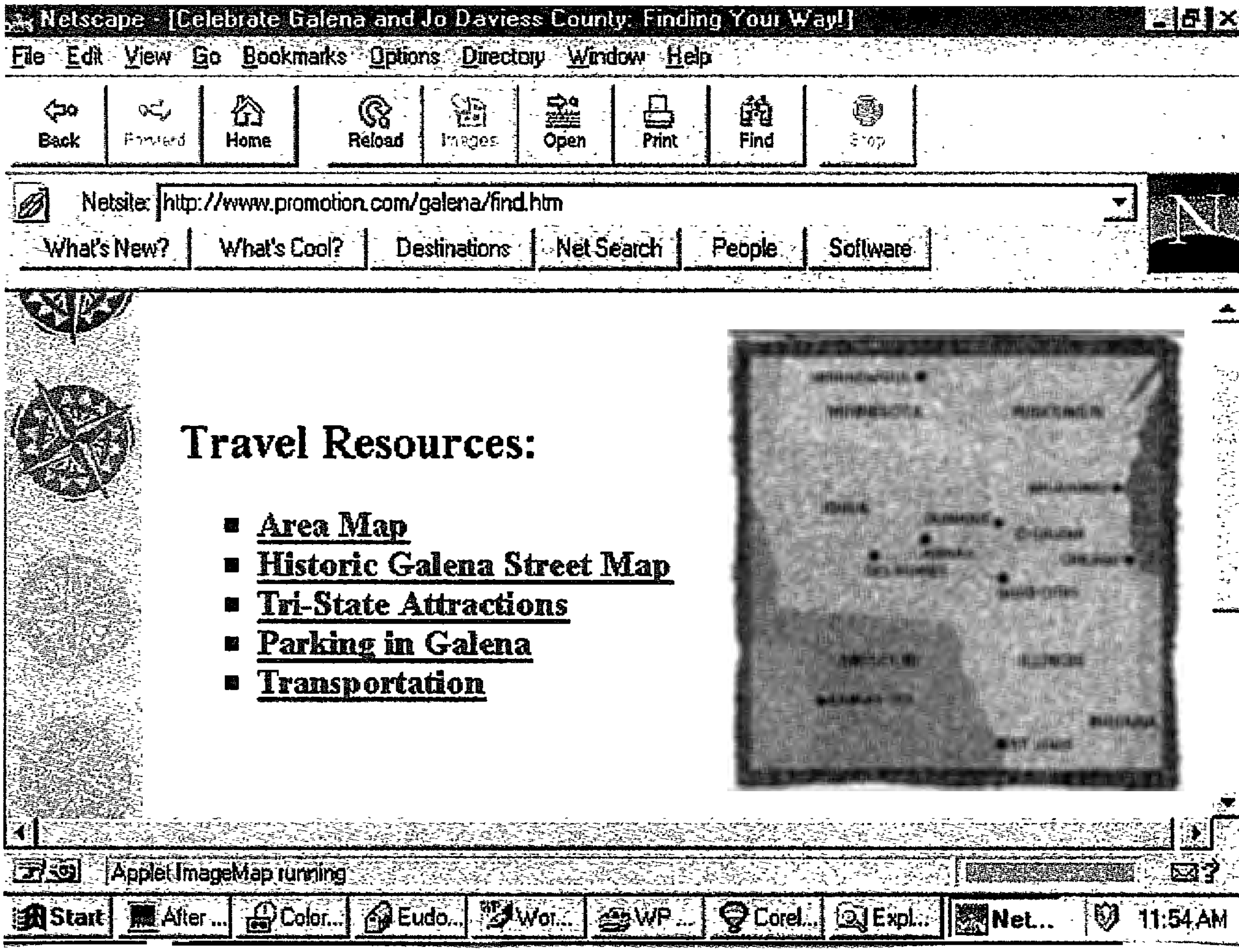
Traveler Information on the Internet



Technology in Rural Transportation
"Simple Solutions"

2.3 Traveler Information on the Internet

General Description: More and more agencies are providing some form of traveler or tourist information on Internet web sites. These agencies include states, cities, counties, Chambers of Commerce, and private organizations, for example, associations of innkeepers. Not only is this type of service relatively cheap to provide and maintain from the agency perspective, it is also available at very low cost to the end user, assuming they have access to a PC, modem, and the necessary software. Information provided varies widely and can range from general information concerning a state or region, through to detailed information about specific accommodations, restaurants, parking facilities, for example.

***Real-World Example* - City of Galena, Illinois, and City of Decorah, Iowa, Web Sites**

Overall goal: To disseminate information about local area attractions to potential visitors and new residents, including, for example, local food and lodging information.

Technical approach: Various small cities have developed web sites to promote local attractions and to provide tourist and traveler information to visitors. The City of Galena, Illinois, web site provides information on restaurants and local historic and natural attractions. The page includes information on how to get to Galena and where to park, as well as information on historic sites and architecture, music and drama, Mississippi river boat cruises and casinos, shopping, outdoor recreation, and guided tours. The Chamber of Commerce of the city of Decorah, in north-east Iowa, has produced a web site that provides information about local weather, businesses, organizations, churches, parks, city offices, and a list of local restaurants and hotels.

Current status: The Galena web site has been operational since August 1995, and can be accessed at http://www.promotion.com/galena. The Decorah web site is currently on-line at http://www.salamander.com/~decorah/. Both are regularly updated.

Location / geographic scope: The pages provide information about Galena and Jo Daviess County and the City of Decorah and its environs. They can be accessed from around the world.

Agencies involved: The Galena / Jo Daviess County Convention & Visitors Bureau site was designed and created by Anne Holmes & Associates. The Decorah Chamber of Commerce also contracted with a service provider to create its site.

Cost information: The City of Galena funds the site by charging a small fee for each business that is promoted on the site. Decorah's site cost just over $2,000 to design, and costs $100 a month to maintain, funded by the Chamber of Commerce itself.

Key contact: For the Galena site, Stephen Holmes, Anne Holmes & Associates. l-800-HOLMES-3. For the Decorah site, Richelle Holsen-Jeremiah, Decorah Chamber of Commerce. l-800-4NE-IOWA.

***Real-World Example continued* - City of Galena, Illinois, and City of Decorah, Iowa, Web Sites**

Have goals been achieved? In the first 12 months that the Galena web site was operational, the Convention & Visitors Bureau reported a 60 percent reduction in the amount of printed informational materials that they mailed to enquirers. This has been attributed to potential visitors accessing the Internet site for information. The site is experiencing an increase in the number of new users of approximately 10 percent each month. At present the number of new visitors to the site each month is around 1,500. The Decorah Chamber of Commerce reports that they have had a good response to the site, both in terms of the numbers of users accessing it and the feedback they have received from users.

Solution timeline: Several new features are scheduled to be available at the Galena site in January, 1997. These include more maps and photographs of Galena and the surrounding area. Features will be added to enable the Convention & Visitors Bureau to update information themselves. In addition, a database search function will be added. This will enable the user to enter a range of dates and types of events of interest to them which will then be displayed.

Further Description of Application

Additional technologies may include:

This type of information service is ideal for providers, as information can be disseminated very cost effectively, lessening the need to dedicate staff to a telephone information service. The system is also very convenient and cheap for existing PC users. However, providing the information via other technologies in parallel could enable non-PC users / owners to benefit also. These technologies could include:

- Information kiosks installed either at rest areas or other locations within the area of interest, or at other regions' tourism offices, including the travelers' home city or state. Information kiosks could also be provided at travel agencies, airports, car rental locations, transit hubs, etc.

Potential additional uses for this technology may include:

Various options exist for increasing the sophistication of services offered via the Internet, including:

- Traveler / tourist information tailored to a specific route, such as a planned or potential vacation route. Users could enter an origin and destination within a state or region and be offered a variety of attractions and activities, accommodations, and restaurant options within a specified distance of their main route.

- Traveler / tourist information tailored to the needs of specific travelers, such as their budget, whether they are looking for a children-oriented vacation, or any special interests or mobility needs they may have.
- Reservation facilities could be offered to travelers enabling them to remotely book and pay for accommodations, special events, excursions, restaurants, for example.

Additional information types could also be provided, if the information is readily available at reasonable cost and if any required inter-agency agreements can be reached, to offer the following information:

- Forecast road and weather condition information.
- Information on construction and maintenance activities likely to affect the traveler on their specified route.

As travelers would mainly consult the Internet information service prior to departing on their trip or vacation, it is likely that real-time weather information and congestion / incident information would not be appropriate due to their time-sensitivity.

Benefits of Application

	Benefits to travelers	Benefits to the community	Benefits to the public sector
Direct benefits	Cheap, easy access to information at any time of the day, week or year.	Stimulates local economies, bringing tourist revenue into a city or region, and promoting local businesses to residents	Cost effective supplement to existing tourism information services
Indirect benefits	Sites often have links to neighboring cities / regions providing easy access to a wide range of information sources		Promotes local transit, traveler services, and parking facilities

Probable Implementation Process

Step One: Interested agencies must determine that sufficient demand exists or could be created for an Internet information service for their area of coverage. If a telephone information service already exists, this could be done by asking each caller a few questions about their access to a PC and Internet software, and whether they would find such a service useful. If no such service already exists, other types of market research could be performed, with varying degrees of complexity depending on the agency and the funds available. For example, agencies could survey other similar agencies on the success and scope of their Internet information services.

Step Two: Agencies should define the type and the level of detail of information that will be provided to users. This is likely to be impacted by the resources that are available to establish and maintain the service and whether local businesses will be charged to be promoted through the service.

Step Three: Depending on the findings of the previous step, the agency should determine whether the expertise required to establish and maintain the service is available within their organization, or whether it would be cost-effective to acquire this expertise in-house. If so, the agency could proceed to Step Five.

Step Four: If the agency does not have the resources to develop the Internet service in-house, or prefers to hire a specialist to create the site, it then needs to identify and contract with an appropriate service provider.

Step Five: Working with the Internet service provider, if applicable, the agency should design, implement and test their service based on the findings of Step Two. In order to ensure maximum visibility and use of the system, the agency should ensure that links to neighboring, regional, or state sites are created wherever possible.

Step Six: This last task involves ongoing operation and maintenance of the Internet service. It may be that once the system is fully functional, routine updating of information could be performed in-house, only calling upon professional Internet services to assist with major redesign efforts. As part of this step, the agency should request and analyze user feedback to ensure that the users' needs continue to be met by the service.

Potential Implementation Issues

The agency should consider existing services which are offered by neighboring cities or regions, as there may be usability benefits from designing a service which is structurally and visually coherent with other services, while not infringing copyright or intellectual property rights.

It is likely that such an Internet service would supplement a parallel telephone-based traveler information service. If this is not the case, the agency should consider supplying a help-line for users who experience difficulties with the service, or for users who would prefer to deal with an operator when needing additional information or assistance.

When deciding to deliver an Internet information service, the agency should be sure not to underestimate the effort required to maintain the service and keep all information current. If the site is not maintained adequately, the service and the agency could lose credibility with users.

Solution's Contribution to Broader Rural ITS Developments

This solution is an example of a region-wide dissemination system that, when used in conjunction with other data collection and information processing systems, will play a role in the following rural intelligent transportation system components:

Personal Mobility Management - This solution can help manage and promote existing systems for increased personal mobility.

Regional Traveler Information - This solution can serve as part of a regional information system, disseminating general information or alerting motorists of upcoming events.

United States Department of Transportation
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ENTERPRISE

Lane Drop Driver Awareness

Technology in Rural Transportation
"Simple Solutions"

Lane Drop Driver Awareness

General Description: Lane drops occur as a result of restricting roadways caused by construction work or other planned or unplanned events. When vehicles fail to merge in a timely fashion, delays or traffic accidents often occur. This simple solution uses advance warnings to calm the traffic and induce smoother transitions into limited lane areas.

***Real-World Example* - The Indiana "Lane Drop Smoothing" System**

Overall goal: To improve workzone safety and traffic operations by encouraging drivers to merge sooner in advance of construction zones.

Technical approach: A series of portable "DO NOT PASS" signs equipped with flashing beacons is placed at the approach to a construction site. Electronic occupancy sensors are placed in the roadway. At the outset of operations only the sign nearest to the workzone has activated beacons. When a certain threshold is detected by these sensors, that is, as the volume of traffic grows more heavy at the approach to the construction, the beacons on the next sign upstream will also be activated, and so on. As traffic flow varies, the signs are activated or deactivated in sequence.

Current status: Five signs comprising one lane drop smoothing system are currently in use. A system specification is currently being developed. The state agency that developed the system then plans to circulate this to contractors.

Location / geographic scope: This is a site-specific application used as necessary in construction zones in Indiana.

Agencies involved: Indiana DOT

Cost information: The current system cost approximately $3,500 per sign.

Key contact: Dan Shamo, Indiana DOT. (317) 232-5523

Have goals been achieved? Anecdotal reports from construction personnel indicate the system is effective in encouraging drivers to merge earlier when approaching a work zone.

Solution timeline: The system is in use. There are no formal plans to commission additional systems.

Further Description of Application

Additional technologies may include:

The alternatives to this system for providing advice to drivers to merge into an alternate lane could be limited due to the very location specific nature of the warnings. It is conceivable that in the future, if roadside instrumentation and vehicle-to-roadside communications were widely deployed, that vehicle specific warnings could be provided to a driver using sensors triggered by a vehicle approaching a lane-drop area. Warnings could be provided to drivers via in-vehicle graphical display units, speech synthesis, or head-up displays. However, the costs associated with such a system would make it viable only if it was incorporated into a system providing wider functionality, such as a traveler information, route guidance, or automated highway system.

More general advice on the location of construction or work zones, or any lane drops needed for special events, could be provided to the drivers of vehicles via wireless data broadcast, using AM, FM, or HAR subcarriers. Messages could either be provided to travelers using roadside signs or in-vehicle devices, including regular radios. Again, the costs to support this service using radio subcarrier technologies would be prohibitive as a stand-alone service. However in areas already disseminating data over wireless radio, the additional cost to encode and deliver this information would be minimal.

Potential additional uses for this technology may include:

Given the portable nature of the signs used for this system, various additional uses for the equipment can be envisioned. These may or may not need to be used in conjunction with the occupancy sensors which are part of the Indiana lane drop smoothing system. Numerous additional uses can be envisioned including:

- Warnings to drivers about construction personnel in or near the roadway ahead.
- Sensors could provide data on current travel times or average operating speeds to maintenance or construction personnel.
- Temporary speed limits - either regulatory or advisory limits.
- Directions to parking facilities with dynamic information on available spaces for special events.
- Diversion advice.
- Warnings of temporary hazardous roadway or weather conditions.
- Temporary vehicle width, height or weight restrictions.

Dependent on the various types of uses suggested above, different communications, additional sensors, or alternate data needs would need to be accommodated. For example, in the case of providing information to drivers on parking facilities with available spaces, appropriate instrumentation at these facilities would need to be installed.

Benefits of Application

	Benefits to travelers / the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Increased safety at the approach to, and within, workzones and other areas where the number of lanes decrease	Less delay due to construction and maintenance work Decrease in vehicle repair and other costs due to fewer accidents	increased safety for-construction and maintenance personnel
Indirect benefits	Less delay due to construction and maintenance work		Smoother traffic flow at construction sites

Probable Implementation Process

Step One: This system is low cost, and signs could be purchased and introduced in a modular fashion, dependent on the needs and finances of the agency. For example, a simplified version of the lane drop system could be implemented in the first instance, using only two or three signs instead of the five that comprise the system as used in Indiana. Nevertheless, the first stage for an agency would be to consider whether the nature of maintenance and construction zones in their jurisdiction would warrant use of this system. Data could be gathered on safety records within work zones and on the delays typically experienced at select zones, for example.

Step Two: In order to gain maximum use of any signs purchased, agencies should also consider what additional functionality, such as what extra types of messages the signs could display, taking into account the associated costs. It could be that for minimal additional financial outlay, multi-function signs could be procured, which due to their wider applicability would be very cost-effective.

Step Three: The appropriate combinations of sensors and portable signs could then be specified and procured.

Step Four: The use of these systems would need to be incorporated into the workzone traffic plans of an agency. Lane drop systems could then be procured and operated as required by the agency.

Potential Implementation Issues

A potential implementation issue associated with this technology is ensuring that construction personnel are given adequate training and guidance as to the appropriate positioning of the signs in the roadway to achieve the desired results. For example, if signs are positioned too closely to the work zone, positive benefits may not be achieved. Indeed work zone safety could even be negatively affected. As was described above, the lane drop system signs could be used for a variety of other messaging purposes. It is likely that different sign sitings would be required depending on the messages being displayed, in which case care should be taken to ensure that personnel are aware of the different sign locations appropriate for each type of message.

As a means of encouraging use of these signs, State DOT could consider purchasing the signs which could then be “rented” by cities and counties or contractors, if appropriate, for their use.

Solution’s Contribution to Broader Rural ITS Developments

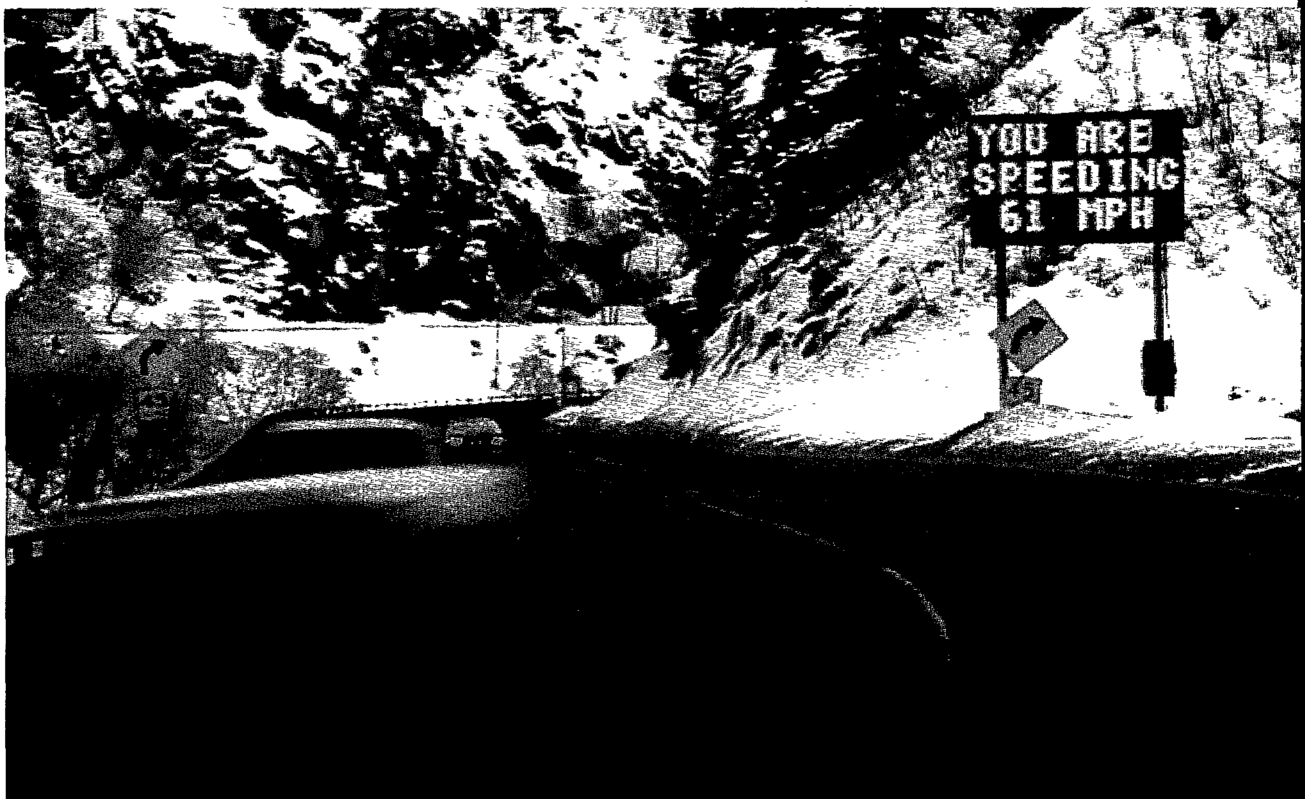
This simple solution is a prime example of a site-specific, stand-alone application of technology, given that it provides information to drivers to encourage merging when approaching restrictions to the number of highway lanes. The potential contribution of this solution to rural ITS deployment is described below:

Roadway Management - By managing the traffic approaching lane-restricted areas, incidents, including delays and crashes, can be avoided and the transportation infrastructure managed more effectively.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Speed Warning Systems



Technology in Rural Transportation
"Simple Solutions"

2.5 Speed Warning Systems

General Description: Vehicles traveling too fast for conditions, particularly on curves or long downslopes increase their risk and hence their likelihood of being involved in an accident. This simple solution is a method for warning these vehicles in real-time to the impending dangers with the expectation that the vehicles will slow down.

***Real-world Example* - Truck Speed Warning System**

Overall goal: To improve safety by lowering the speed of trucks on a narrow curve with a history of severe truck accidents.

Technical approach: A radar gun was installed to determine the speed of trucks approaching the curve. If a speeding truck is detected, a variable message sign is activated which reads "YOU ARE SPEEDING AT [xx] M.P.H. 45 M.P.H. CURVE AHEAD."

Current status: The system has been in place and operational since September, 1996.

Location / geographic scope: The curve, which is on a down gradient and which tightens from seven to five degrees midway, is on I-70 in Glenwood Canyon, Colorado.

Agencies involved: Colorado Department of Transportation

Cost information: The cost of the system is estimated at between $25,000 and $30,000.

Key contact: Jim Nall, Colorado Department of Transportation. (970) 248-7213

Have goals been achieved? The maximum design speed for the curve was 43 mi/h due to limited sight distance. Speed tests were performed before and after the installation of the sign. Prior to installation the 85th percentile of truck speed was 66 mi/h. Following installation this reduced to 48 mi/h.

Solution timeline: CDOT plans to leave the system permanentlyinstalled. At present there are no plans to implement the system in additional locations.

Further Description of Application

Additional technologies may include:

This particular application is of note as it is not infrastructure intensive, that is, it requires minimal permanent equipment installations. Variable speed limiting has a wide range of applications and can be triggered by a number of characteristics, such as geometry, road condition, traffic, weather condition, etc. Thus a number of different sensor systems could be installed as appropriate at a site depending on local characteristics, messages being relayed to drivers by the same message signs.

It is conceivable that in the future, if roadside instrumentation and vehicle-to-roadside communications were widely deployed, then vehicle specific warnings could be provided to a driver using sensors triggered by a vehicle approaching a dangerous curve or down-grade. Warnings could be provided to drivers via in-vehicle graphical display units, speech synthesis or head-up displays. However, the costs associated with such a system would make it viable only if it was incorporated into a system providing wider functionality such as a traveler information or automated highway system.

More general advice on the location of dangerous down-grades or curves could be provided to the drivers of vehicles via wireless data broadcast, using AM, FM or HAR subcarriers. Messages could either be provided to travelers using roadside signs or in-vehicle devices, including regular radios.

Potential additional uses for this technology may include:

The signs in place for the speed warning system could also be used to communicate additional types of information to drivers. Additional communications links and / or sensor systems would need to be installed to enhance current systems in place. If multi-purpose variable message signs, and other sensor technologies, were utilized, information provided could include:

- Warnings to drivers about construction or maintenance occurring ahead.
- Temporary speed advisories / warnings due to construction activities or severe weather conditions.
- Advice to put on or remove snow chains.
- Advice on the status of mountain passes in winter weather conditions.
- Traveler information, including diversion advice.
- Warnings of hazardous roadway or weather conditions.
- Vehicle width, height or weight restrictions ahead.

Interconnection of signs to a regional traffic management or traveler information center may provide maximum flexibility in the messages which could be displayed. Should additional types of information be displayed on the speed warning signs, rules would need to be established for determining how and when a speed warning message should override a more general informational message.

Benefits of Application

	Benefits to travelers / the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Increased safety at dangerous curves down-grades	Increased safety at dangerous curves down-grades	Less costs incurred in making repairs to crash locations
Indirect benefits	Less costs incurred in repairs or insurance through avoiding accidents	Less costs incurred in repairs, insurance, and loss of shipments through avoiding accidents	Favorable public perceptions of safety improvement schemes

Probable Implementation Process

Step One: Presuming that agencies may wish to implement the speed warning system as a stand-alone system and not as part of a wider traffic management or traveler information tool, agencies should first investigate general locations within their jurisdiction that will most benefit from the system. These locations are likely to include accident "black spots" where excessive speed has been identified as a major factor in causing accidents. If the agency is interested in utilizing the signing system for a variety of types of message then additional considerations will need to be taken into account when determining where to locate the signs.

Step Two: For the speed warning system, consideration then needs to be given as to the optimum location for the radar gun installation and specific siting of the sign itself. The speeds at which vehicles currently approach the dangerous section of roadway will need to be assessed. Based on these speeds, the distance required for the vehicles to slow down to the recommended safe speed prior to the dangerous section of roadway can be calculated. Based on these findings, the signs can be placed at the most appropriate points which will allow drivers sufficient time to react to the warning messages.

Step Three: Depending on what conditions the sign will provide warnings for, the message wording to be displayed should be determined.

Step Four: The appropriate combinations of radar systems and warning signs should then be specified and procured.

Step Five: Warning systems must be installed and evaluated to ascertain that all components are functioning adequately prior to being fully commissioned. Providing the systems perform satisfactorily, full operation can then commence. Periodic speed testing should be performed to gauge the effectiveness of the signs in encouraging drive to reduce speeds. Depending on the location of the sign, it may be found that frequent travelers along that route pay less attention to the warnings over time. If this is the case, the agency should consider altering the message wording or visual characteristics of the warning in order to regain frequent drivers' attention.

Potential Implementation Issues

Care should be taken to ensure that speed readings displayed on the warning signs are consistently accurate, as readings that differ from the speedometer readings in vehicles will negatively impact the credibility of the system.

As was described in Step Five above, periodic testing should be undertaken to ensure that drivers are continuing to alter their speeds in response to the warnings.

Solution's Contribution to Broader Rural ITS Developments

This simple solution is a prime example of a site-specific, stand-alone application of technology that could serve as part of a much larger integrated system. The potential contributions of this solution to rural ITS deployments are described below:

Rural Traveler Information - If enhanced with additional information types, this solution could serve as part of a regional traveler information system, providing real-time information to travelers at spot locations.

Rural Traffic Control - Since the messages displayed to travelers are intended to inform them of dangerous situations and advise speed adjustment to prevent accidents or incidents, they could serve as traffic control systems.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Public Service Weather Radio

Technology in Rural Transportation
"Simple Solutions"

2.6 Public Service Weather Radio

General Description: Information on road and weather conditions is of interest to all travelers. In extreme conditions, such as winter snow storms, the timely receipt of accurate information enables maintenance personnel to proactively treat road surfaces, to remove ice or snow, or even to close roads where conditions are most hazardous. Access to appropriate weather information has the potential to improve operations, prevent damage to property and save lives. Increasingly, agencies are looking to improve the sophistication of weather and road condition information collection and dissemination, and to provide reports specific to local areas. This solution is an existing service, which could form the basis of added-value services provided by local agencies to broadcast weather information to travelers and other interested users **in** a cost-effective manner.

***Real-World Example* - NOAA Weather Radio**

Overall goal: To improve safety for the general public by providing current and forecasted weather conditions.

Technical approach: The National Oceanic and Atmospheric Administration (NOAA) Weather Radio information is broadcast from 400 FM transmitters operating on seven frequencies in VHF range, ranging from 162.400 to 162.550 megahertz (MHz). The broadcasts are provided on a continual basis, with information being supplied from local National Weather Service (NWS) offices. The information contained in the broadcasts is tailored to local user needs in the transmitter area. Routine weather updates can be interrupted by NWS personnel to insert special warning messages.

Current status: The system is active, with NOAA Weather Radio available to approximately 70 to 80 percent of the U.S. population. A new alerting system, Weather Radio Specific Area Message Encoding (SAME), is currently being deployed. SAME will use digital coding to activate special receivers which have been programmed for emergency conditions in a specific area, usually a county. As the frequencies are outside the range of normal radio receivers, special radios are required to obtain the information.

Location / geographic scope: The system is operational in fifty states, Puerto Rico, the Virgin Islands, and Guam. It was designed to limit coverage to within 40 miles of a transmitter. This allows for more site specific information to be provided. For example, in coastal areas, information of interest to mariners is provided.

Agencies involved: The National Weather Service is the primary support agency, with responsibilities for system operations and maintenance.

Cost information: No information is available regarding system development and deployment costs. However, weather radios are commonly available, and can be purchased for under $75.

Real-World Example continued - **NOAA Weather Radio**

Key contact: The National Weather Service, Warning and Forecast Branch (attn: W/OMl 1) 1325 East-West Highway, Silver Spring,. MD 209 10.

Have goals been achieved? The system is fully operational. SAME deployments are continuing, and this will be the primary activator for the new Emergency Alert System planned by the Federal Communication Commission.

Soiution timeline: The NWS is currently working on a White House mandated resolution to increase system coverage to 95 percent of the population in the U.S. by the year 2000.

Further Description of Application

Additional technologies may include:

The provision of a basic level of service for road and weather condition information can be considered a public good. Dissemination via some broadcast technology may be the most effective means of ensuring that the widest possible audience is exposed to the information. Although various alternative technologies could be used to transmit information to users, the principle of making the information widely and easily available may be an overriding concern of agencies wishing to implement a service. Therefore, other systems utilizing wireless data broadcast, using AM, FM, or HAR subcarriers, could be the most appropriate mechanisms. Messages could either be provided to travelers using roadside signs or in-vehicle devices, including regular radios. For weather forecasts, information should be available to radios used in the home or at work also. Information could also be provided at kiosks installed at rest areas, parks, or gas stations, for example.

In addition to these broadcast systems, supplementary technologies such as weather-related Internet sites or dial-in telephone services could also be provided in order to widen further the availability of this information.

Potential additional uses for this technology may include:

There is a very wide range of additional information types that could be broadcast via radio subcarriers to in-vehicle or other units, including information on congestion, road construction and maintenance, road or lane closures, incidents, or speed advisories, for example.

Benefits of Application

	Benefits to travelers	Benefits to the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Ability to plan or reschedule trips based on timely receipt of information	Ability to proactively prepare for severe weather conditions, e.g. planning school closures	Ability to plan shipments based on up-to-date information on road and weather conditions	Low-cost dissemination of information, potentially to a very wide audience
Indirect benefits	Safer travel and transportation		Reduced costs and greater reliability of services that rely on transportation or movement of goods	Increased traveler safety and awareness

Probable Implementation Process

As the NOAA weather radio service is already available to much of the U.S. population, in many areas users can access the information immediately by purchasing a standard weather radio. However, should a public agency be interested in disseminating information based on the NOAA service or related messages to travelers, the following steps should be taken.

Step One: Interested agencies should determine the extent of the area for which information will be disseminated for example, a region or state. This will be determined in part by the relevant data collection mechanisms which are in place, whether these be publicly or privately owned or operated systems. In addition, and depending on the type of broadcast system to be used, the availability of suitable broadcast coverage should be assessed. A public or private agency may even decide to establish new broadcast systems, although this will have major cost implications on the overall solution.

Step Two: If the services of private vendors are to be sought by a public agency, the cost implications of purchasing these services should be assessed and determined to be reasonable.

Step Three: Agencies must decide in what format information will be disseminated, taking advantage of established message sets and messaging protocols such as the International Traveler Information Interchange Standards (ITIS). Adherence to the appropriate standards should enable efficient system expansion and transferability in the future.

Step Four: Depending on the broadcast system and receiver units to be utilized, agencies should determine how any fees will be levied for access to the system, if appropriate, and also determine fee levels. If a fee is charged, the amount will depend on the numbers of users willing to pay for the system and what amount they are prepared to pay.

Step Five: The appropriate systems and services should then be specified, procured, and installed or established.

Step Six: In parallel with earlier stages of system development, agencies should market the proposed service and enroll users in the service, if appropriate, or publicize a freely available service.

Step Seven: Once the data collection and delivery system are in place and operating satisfactorily, delivery of traveler information can begin in accordance with the plans and procedures established during previous stages.

Potential Implementation Issues

One potential implementation issue was described above. This is the issue of whether a road and weather information service should be freely available to the travelling public and other users. If a value-added information provision service is to be offered, it may be necessary to delineate what information will be freely available and what information can be sold in order to protect the commercial service.

The adherence to any appropriate standards is an additional implementation issue. Although conforming to standards may require additional investment in the initial stages of system implementation, the benefits of doing so must be promoted.

Solution's Contribution to Broader Rural ITS Developments

This solution is an example of a region-wide weather information collection, processing and dissemination system that currently provides weather information to a large percentage of the nations' population. This solution can contribute to rural ITS developments in the following ways:

Regional Traveler Information - The information can be an integral part of a regional information system, with increased effectiveness when combined with other traveler information.

Incident Management - The emergency warnings provided by the NWS, a part of these broadcasts, are key pieces of information that alert incident managers to potential problems.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Wireless Pagers to Activate Warning Beacons

Technology in Rural Transportation
"Simple Solutions"

2.7 Wireless Pagers to Activate Warning Beacons

General Description: A variety of advisory road signs are accompanied by beacon lights that flash when messages are critical to travelers. The activation of the beacons to flash is either triggered according to the time of day or by manual adjustment. This simple solution enables beacons to be activated remotely using common pager services and low cost receivers on the road signs. This non-infrastructure intensive method could therefore be beneficial in rural regions.

Real-World Example - Pager Activation of School Crossing Beacons (Oregon)

Overall goal: To reduce the costs of installing and operating flashing beacons at schools and to provide greater flexibility and cost-effectiveness in programming the beacons for special events.

Technical approach: Flashing beacons have been installed to warn drivers that they are in a school zone where children are likely to be crossing. The original system used special timers to activate the beacons just before and after school. Any changes in school hours or special events required a special trip to the location to reprogram the clock.

To streamline this process, a pager-controlled system was designed and-built. Each sign installation has a pager, and a 386-PC and paging software are used to control the pager units. Messages are sent from the PC to the pagers. These messages contain the unique ID code of the pager and a code to switch the outputs on or off. The use of unique pager codes allows the. city to use one pager telephone number for a subset of the school installations covered by the system. The central PC schedule is easily modified and allows greater flexibility for handling special school events.

Current status: The system is fully operational at 14 elementary schools.

Location / geographic scope: The City of Portland, Oregon.

Agencies involved: The City of Portland Office of Transportation.

Cost information: The previous system, with individual timers and the necessary overhead cabling, cost about $2,500 per sign to install. The pager-activated system is much more cost-effective, costing around $100 per site for the pager units themselves. As the pagers do not require separate housing, this also reduces costs. The paging service costs $5 per month per number. At present five to six schools utilize one paging number. System software was created in-house.

Key contacts: Bill Kloos, City of Portland Office of Transportation. (503) 823-5382
Paul Zebell, City of Portland Office of Transportation. (503) 823-7300

Real-World Example continued - Pager Activation of School Crossing Beacons (Oregon)

Have goals been achieved? Yes. The system has reduced costs and streamlined the beacon activation process.

Solution timeline: By the summer of 1997, 10 additional schools will be covered by the system. This will represent about half of the elementary schools in the city. As this is a city-initiated solution, there are no plans at present to expand the system to additional cities.

Further Description of Application

Additional technologies may include:

Alternate means of providing such a system include wireless data broadcast on AM, FM or HAR subcarriers. The costs to support this service using radio subcarrier technologies would be prohibitive as a stand-alone service. However, in cities or areas currently disseminating data over wireless radio, the additional cost to encode and deliver this service would be minimal.

Potential additional uses for this technology may include:

Remote beacons could be activated to indicate a series of unpredictable but repeating events. For example, a flashing beacon to indicate ice on a bridge could be remotely activated. Ideally, such a system would be activated by sensors on the bridge. However, as the decision to activate the beacon may be made remotely, at least under the simplest scenario, wireless technology may be needed to communicate with the beacon. The following list includes candidate applications for remotely activated beacons:

- Danger of objects in roadway / falling rocks.
- Flooding possible.
- Trucks entering roadway.
- Children at play.

Benefits of Application

	Benefits to travelers	Benefits to the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	School crossing beacons are less likely to flash when not necessary enabling smoother traffic flow through these areas.	School crossing beacons are more likely to be flashing during unusual times when children are present, creating a safer environment for children.		No manual intervention is needed at the crossing signs to alter the timings.
Indirect benefits	School zones become more efficient for travelers.	Parents may feel more secure allowing children to walk to/from school or after hours school events.	Similar technologies and approaches may be used to warn vehicles of trucks entering the roadway	Improved credibility of advisory systems

Probable Implementation Process

Step One: Rural areas and small cities must first determine if such a system is needed. For those sites that use or intend to use school crossing beacons, the school system should monitor a period to determine how often the beacon activation timing would be altered if available.

Step Two: Pager or other wireless data communication services vary in cost and availability on a local basis. Some exploration would be required to determine such availability.

Step Three: Pager receivers must either be designed and manufactured or purchased by arrangement with the City of Portland.

Step Four: Beacon units must be installed and evaluated to determine that they are functional.

Potential Implementation Issues

Issues associated with the implementation of this system include allowing for future system expansion. Given the potentially high number of schools within an area that could benefit from the system, agencies should ensure that the system is configured so that it can be augmented to cover additional schools in the future with minimum disruption to the school beacons already covered by the system. In addition, the possible expansion of the system to activate other types of signs via paging should also be taken into account when specifying the system.

As this application relies on paging coverage, only those areas with existing terrestrial coverage can take advantage of this system. However, paging services via satellite are also available and offer far greater coverage.

Solution's Contribution to Broader Rural ITS Developments

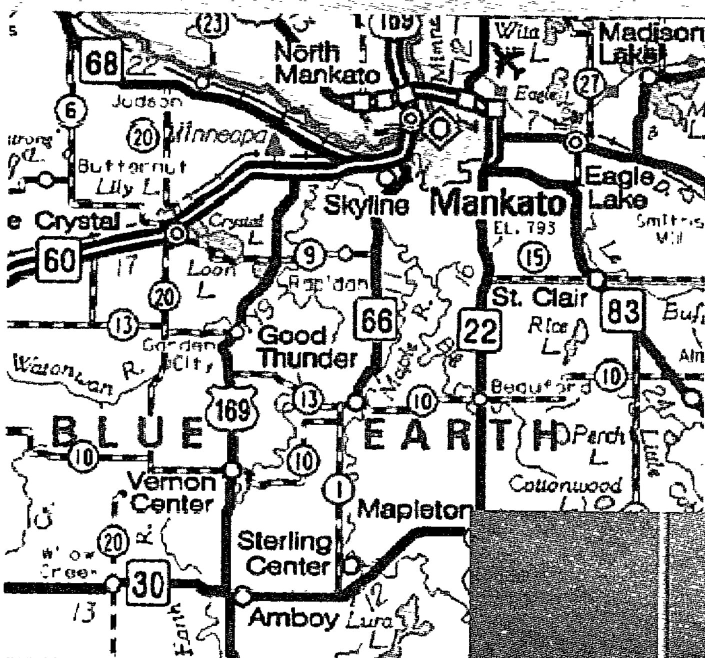
This simple solution is a prime example of a site-specific, stand-alone application of technology, given that it provides a mechanism for activating beacons to emphasize various road signs. The potential contribution of this solution in the rural ITS development is described below:

Integrated Traffic Control - By drawing increased attention to various advisory or instructional traffic signs, this system aids in traffic control.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Coordinate Addressing System



Technology in Rural Transportation
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2.8 Coordinate Addressing System

General Description: In some rural areas of the United States, streets are not named or identified, potentially creating delays for emergency **or** delivery services that must visit private residences. This simple solution is to assign every residence to a coordinate mapping system, enabling easy navigation to specific sites.

Real-World Example – Rural Coordinate Addressing System

Overall goal: To improve emergency services and others' ability to locate rural locations through a low-cost addressing system.

Technical approach: **By** truncating state plane coordinates to an accuracy of 100 feet, rural locations in Blue Earth County, Minnesota, were assigned unique addresses consisting of two numbers that are compatible with GIS. These addresses aid emergency services and others in locating the site. The state plane coordinates were collected for each driveway outside city limits using portable GPS units and then input into a GIS database. These addresses were related to phone numbers so that when a 9-l-l call comes in from a rural location, the site appears on a digital map. The database may also be used for creating postal addresses and provided to utilities and delivery companies to help them locate addresses.

Current status: A pilot project that collected data for one township and created the GIS database has taken place. This demonstrated the coordinate addressing system's potential for locating incident sites. The local County Commissioners have requested that an RFP be developed to determine the cost of collecting data and implementing the system countywide.

Location / geographic scope: The system can be used in rural counties that do not have traditional addressing and that cannot afford street signs and street naming.

Agencies involved: The pilot project was developed by the Blue Earth County Highway Department and performed by a team comprised of the highway department, Minnesota Guidestar, the University of Minnesota and Castle Rock Consultants.

Cost information: No information is currently available- on the projected costs for complete deployment in Blue Earth County. The pilot project, which included developing addressing rules and investigating the compatibility of this system with the National Emergency Number Association (NENA) and the US Postal Service, had a budget of $10,000.

Key contact: Al Forsberg, Blue Earth County Highway Department. (507) 625-3281

Real-World Example continued - **Rural Coordinate Addressing System**

Have goals been achieved? The primary goal of developing a low-cost addressing system has been achieved and tested. The system has not yet been implemented on a large-scale basis.

Solution timeline: There is no set time frame, but the County would like to deploy the GIS display system for emergency services by September, 1997. The County hopes to employ this system or find a way to finance a traditional street sign and naming system.

Further Description of Application

Additional technologies may include:

Triangulation off cellular phones or radio would be another application for this simple solution. In some areas, identifying approximate locations by the cell being utilized could also be useful. These options offer ease of use and site identification, however, the tracking method would be less precise.

Potential additional uses for this technology may include:

This technology could also be used to log the locations of a number of different types of objects, such as roadway signs, fire hydrants, and telephone boxes. The locations of some of these objects will already be contained in separate databases used by different organizations. However, the creation of a standard locating and database system for a variety of different objects would aid inter-agency communication and collaboration for maintenance and repair purposes, for example.

This addressing system could also be used as part of a traveler information system, for example, enabling the communication of the precise locations of sites of interest, such as rest stops, gas stations, or unique historic markers, to travelers.

Benefits of Application

	Benefits to the community	Benefits to business/industry	Benefits to the public sector
Direct benefits	Rural residents will have improved service in case of emergencies or when needing home deliveries	Increased efficiency when delivering products or services to residents of rural areas	improved ease and speed of locating rural addresses for the emergency services Significant cost savings over purchasing large quantities of road signs
Indirect benefits	Improved perceptions of accessibility and safety for rural residents	Increased potential customer base	

Probable Implementation Process

Step One: Rural areas and small cities must first determine how their area is currently being impacted by the lack of a such a system, in order to ascertain whether the investment in creating an addressing database will be a worthwhile use of their resources.

Step Two: Agencies should determine what items will be coded within the addressing database. In addition to residences and other structures, various other objects could also be addressed as was outlined previously.

Step Three: The addressing process itself must be carried out.

Step Four: Emergency services, and any other organizations in the area needing access to the addressing information. must be equipped with systems enabling them to receive data and respond to this data to find coded locations.

Potential Implementation Issues

A number of different types of organizations could benefit from a rural addressing system including utility companies, couriers, and store delivery services, for example, in addition to the emergency services. Should a city, county or region decide to proceed with creating an addressing system, the development and maintenance costs of the system could perhaps be offset by selling the addressing information to private companies.

An agency considering creating an addressing system should evaluate not only the cost of the initial development of the database but also the ongoing maintenance costs. Access to a GIS basemap indicating local routes will also be required. As new homes or other structures are built, the database will need updating on a regular basis to ensure that information is accurate and current.

Solution's Contribution to Broader Rural ITS Developments

This simple solution is an example of a low-cost method of improving the quality and accuracy of the locational data required by agencies in pinpointing a rural address. The potential contribution of this solution in the rural ITS development is described below.

Incident Management - This solution will assist emergency and incident response agencies to respond in a timely and accurate manner to citizens requiring their assistance in rural areas.

Roadway Management - This solution plays a fundamental role in managing roadway systems by allowing a universal method for describing locations within the rural transportation system.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Emergency Vehicle Traffic Signal Pre-emption

Technology in Rural Transportation
"Simple Solutions"

2.9 Emergency Vehicle Traffic Signal Pre-emption

General Description: Traffic signals disrupt the progress of emergency vehicles by causing them to slow or stop. Since other vehicles in cross traffic often appear to have the right of way, hazardous situations often occur at intersections. This simple solution pre-empts traffic signals to give equipped emergency vehicles the right of way. Although various types of pre-emption systems are in use in urban areas across the U.S., the solution described below is an example of a low-cost siren-activated system. As it requires minimal additional equipment, it is suitable for small communities. The example described below is a product manufactured by a particular vendor.

***Real-World Example* - Siren Activated Signal Preemption**

Overall goal: To improve emergency response by providing simple and cost-effective signal pre- emption capabilities to emergency service providers.

Technical approach: The Sonem 2000 Digital Siren Detector detects the sirens of emergency vehicles up to half a mile away from an equipped intersection. This activates a signal pre-emption phase, giving a green light to the oncoming emergency vehicle and switching all pedestrian crossings to the "Don't Walk" message. The green light can be held for a pre-set time, of between 5 and 45 seconds. A visual verification system, consisting of a white light and a blue light is installed next to the regular traffic signal. When the white light is activated, this confirms to the driver of the emergency vehicle that it has been given right of way. The blue light indicates that the intersection is being controlled by an emergency vehicle approaching from another direction.

Current status: The system is available for purchase.

Location / geographic scope: To date, the system produced by this vendor has been installed in the Cities of Squamish, Nanaimo, and Whistler, and the University of British Columbia campus in the City of Vancouver, all in British Columbia, Canada.

Agencies involved: The system is manufactured by Sonic Systems Corporation of Vancouver, Canada.

Cost information: The cost of equipping an intersection is approximately $4,000. Discounts for equipping multiple intersections apply. Vehicles do not need to be equipped with any additional equipment, assuming they are fitted with a siren.

Key contact: Robert Scragg, Sonic Systems Corporation. l-800-33-SONIC.

***Real-world Example continued -* Siren Activated Signal Pre-emption**

Have goals been achieved? All the cities where the system has been installed have reported that the system meets their needs very well. The City of Nanaimo has adopted a policy that all new intersections and intersection upgrades will be equipped with the system. Most of the cities refer to Sonem 2000's cost-effectiveness and reliability as their primary reason for selecting the system.

Solution timeline: The product is being actively marketed.

Further Description of Application

Additional technologies may include:

Low powered wireless communication devices in vehicles, similar to garage door openers, could also be used to trigger receivers mounted on the signaled intersections to give oncoming emergency vehicles a green phase. In addition, systems using infra-red technology could perform this function.

Potential additional uses for this technology may include:

Traffic signals may also be pre-empted by other types of vehicles such as snow plows or street cleaners during late night or early morning operations to prevent them from stopping and restarting at intersections unnecessarily. In the case of snow plows, pre-emption capabilities could also be valuable during severe weather conditions at other times of the day. However, in order not to disturb residents, a non-siren based system should be considered. Some form of pre-emption system could also be very useful for allowing public transit vehicles to be given priority at intersections, either on a general basis, or just on occasions when they are behind schedule.

Benefits of Application

	Benefits to travelers	Benefits to the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Improved safety of traffic at an intersection being approached by an emergency vehicle	Safer intersections during high-speed emergency vehicle crossings	Ambulance vehicles more secure when crossing intersections	Fire / police more secure when crossing intersections
Indirect benefits	Overall smoother flow of traffic due to the emergency vehicles controlling intersection signals	Patients transported in emergency vehicles will reach their destinations in more a timely and safe manner	More timely response to emergency calls	More timely response to emergency calls

Probable Implementation Process

Step One: Determine the number of signals requiring pre-emption control.

Step Two: Assess commercially available signal pre-emption products to determine which is most suited to the area's needs and equipment.

Step Three: Install the pre-emption system and verify that it is functioning properly.

Potential Implementation Issues

As no special equipment on the emergency vehicle is required, equipped vehicles could cross jurisdictional boundaries and activate the signals of neighboring cities or counties, if these have also been equipped with the same system.

In Guam, shortly after implementing a siren-activated signal pre-emption system manufactured by another vendor, local drivers discovered that by activating their car alarms equipped signals could be pre-empted. Depending on the frequency of the siren technology, this may occur with other implementations as well.

Solution's Contribution to Broader Rural ITS Developments

This simple solution is an example of a low-cost method for improving safety surrounding incidents and incident response. The potential contributions of this solution to the rural ITS development are described below.

Incident Management - This solution can serve as a fundamental portion of the infrastructure for delivering incident response.

Traffic Control - For coordinated traffic control systems or stand alone signal controllers, this solution can play a key role in the infrastructure delivery.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Low-Cost Vehicle Detection

Technology in Rural Transportation
"Simple Solutions"

2.10 Low-Cost Vehicle Detection

General Description: Vehicle detection to determine traffic volumes or lane occupancy is essential for timing traffic signals, planning roadway expansions and predicting traffic impacts, even on low volume roads or rural areas. Traditional loop detectors require permanent installation and are expensive. This simple solution uses less expensive audio technology to detect the presence of vehicles.

Real-World Example - Smartsonic Sensor for Traffic Applications

Overall goal: To develop a low-cost alternative to loop detectors for monitoring traffic flow and lane occupancy.

Technical approach: The Smartsonic Sensor measures the acoustic energy radiated by passing vehicles to determine the lane occupancy and vehicle count. The acoustic detector can also determine vehicle speeds, types and, when used as part of a network, link travel times.

Current status: Development of the sensor has been completed, and it is now commercially available.

Location / geographic scope: The system is currently in use in Arizona, Texas, Virginia and Massachusetts and can be used where there is a pole, bridge or overpass on which to mount it.

Agencies involved: AT&T developed the sensor in conjunction with the Virginia Tech Center for Transportation Research, sponsored by the FHWA. The system has since been sold to International Road Dynamics Inc. (IRD) for commercial production.

Cost information: One lane equipment cost: $1500. One lane installation cost: $500. Four lane equipment cost: $6000. Four lane installation cost: $1000.

Key contact: Rod Klashinsky, IRD. (306) 653-6600

Have goals been achieved? Yes.

Solution timeline: The sensor is commercially available from International Road Dynamics Inc.

Further Description of Application

Additional technologies may include:

Other vehicle detector technologies include loops, closed-circuit television, infra-red, and the magnometer. All can be utilized to determine vehicle presence, but the appropriate technology depends on the desired application.

Potential additional uses for this technology may include:

Other uses for this type of system could include the detection of incidents. The detectors would need to be connected to some central processing facility, such as a traffic management center. Algorithms could potentially be created to detect when the vehicle speeds or link travel times reported by a network of sensors appear to be unusual for a particular location and time of day. Some verification system is likely to be required.

Some research has been undertaken into using acoustic readings from vehicles passing a sensor to identify varying road and weather conditions, although this research is in the preliminary stages and has met with variable success to date.

Benefits of Application

	Benefits to travelers /the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Less delay for travelers during implementation as opposed to loop detector installation	Less delay for business travelers and commercial vehicle drivers during implementation as opposed to loop detector installation	Wireless technologies often require less and easier maintenance. Traffic lanes would not need to be shut down to provide any maintenance. Not infrastructure intensive.
Indirect benefits			Safer to implement for installation crews. Reliable traffic counts allow for more precise traffic signal adjustment.

Probable Implementation Process

Step One: Identify key sites for implementation. The selection criteria can include high volume locations or areas along a corridor that require additional traffic analyses.

Step Two: Conduct comparisons to select the best vendor and product for the application,

Step Three: Determine adequate mounting structures for the equipment. Some products mounted on standard light poles actually make the structure sway with high winds, as the product functions as a “kite”, making the pole unfit to handle the extra weight.

Step Four: Evaluate the deployed system to determine whether system goals are being met.

Potential Implementation Issues

As this system relies on acoustic information to detect traffic, there may be locations, such as busy intersections or in the vicinity of airports, where the system is unsuitable due to interference from other sources of noise.

As the sensors require mounting on a pole, bridge, or overpass there may be additional locations where this application is unsuitable.

Solution's Contribution to Broader Rural ITS Developments

Monitoring traffic speeds, volumes, etc., is a critical part of any transportation management system. As traffic may need to be monitored at many sites at different times by a single agency, this low-cost, easy to install and remove monitoring system has great potential. This alternative method for vehicle detection provide options for data collection and may be useful in assisting the following developments:

Traffic Control - This solution can serve to collect the information needed to control the traffic system.

Incident Management - This solution can provide a means for detecting incidents or other unplanned events that affect the flow of traffic.

Roadway Management - This solution can be utilized at locations undergoing construction or maintenance, or any site where traffic needs to be monitored.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Coordinated Rural Transit Services

Technology in Rural Transportation
"Simple Solutions"

2.11 Coordinated Rural Transit Services

General Description: Numerous rural residents either do not drive or do not have access to vehicles and therefore rely on the mobility services offered by transit operations. This simple solution combines and coordinates the services of several local agencies to offer a more efficient and effective public transit service using the combined fleets of various operators.

Real-World Example - Multi-Service Provider Dynamic Dispatching System

Overall goal: To combine the separate transportation operations of a variety of providers in order to provide a more cost-effective and higher level of service to users.

Technical approach: Various agencies, including a child development center, a counselling service, two senior centers, a youth home, and a nursing home originally combined their individual vehicle fleets and operations to form a single transit organization. A central dispatching center was created to handle requests for transportation from the clients of all these agencies. The center uses the “Rides Unlimited” dispatching system. The organization has 12 vehicles, and Automatic Vehicle Location (AVL) equipment is fitted to all but two of these vehicles.

Current status: The system has been operational for over six years. At the present time, the center now provides dispatching services for approximately 20 agencies.

Location / geographic scope: The Sweetwater County Transit Authority serves the rural county of Sweetwater, Wyoming. The county is roughly the size of Vermont.

Agencies involved: Sweetwater County Transit Authority, Wyoming.

Cost information: The system used in Sweetwater County originally cost around $15,000 for software supporting three workstations. The authority now runs seven workstations. The computers required to run the software are 486 PCs with upgraded memory. Various other comparable systems are on the market for around $10,000 to $15,000. However, the transit authority stressed that their biggest single cost was in training operators to utilize the software. They invested in a total of six weeks of on-site training and start-up support at a cost of approximately $15,000. Subsequent technical support is performed remotely by a technician dialing into the system via the PCAnywhere program.

Transit Authority income comes from contracts with agencies, various grants, Federal subsidy, state subsidy, fares, and donations, in decreasing order of magnitude.

Key contact: Cindy Johnson, Sweetwater County Transit Authority. (307) 382-7827

Have goals been achieved? Ridership has increased by five times since the organizations-joined forces to form a single transit authority using the centralized dispatching system.

Solution timeline: The Transit Authority hopes to install a communications backbone and also to equip all vehicles with mobile data terminals in order to log rides and streamline payment for services using magnetic stripe cards. They also intend to increase provision of same day service. At present around 14 percent of trips are provided on the same day they are requested.

Further Description of Application

Additional technologies may include:

The use of cellular technology could be utilized to accomplish the same results, however, constant communication with the driver regarding location could be distracting and expensive.

Potential additional uses for this technology may include:

Vans or small buses that regularly travel into specific neighborhoods could also perform deliveries for local businesses.

Benefits of Application

	Benefits to travelers / the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Increased mobility and access to community services and businesses for seniors, younger travelers, and any citizens without access to a vehicle	Increased sales and enlarged service area efficiency of mobility services	Decrease in operating costs and increase in efficiency of mobility services
Indirect benefits	Improved quality of life and vitality in rural towns and communities		

Probable Implementation Process

Step One: This solution is ideally suited to an area which has existing transit and mobility services which could be streamlined. A new organization may need to be established so as to minimize the likelihood of local service providers perceiving the initiative as diminishing their control over their own operations. A key challenge to successfully implementing this solution may be the related institutional issues. Other institutional issues should be explored such as insurance requirements and liability limitations.

Step Two: The existing services offered by those agencies that have agreed to join forces should be inventoried and assessed to ensure that a joint system will, at a minimum, meet existing levels of service and in order to quantify where existing services will be enhanced through implementing the system. This last exercise may be vital in gaining any funding from other sources to establish the multi-service provider system.

Step Three: A system which meets the needs of the various service providers should be specified, taking into account the available funding, and commercially available products should be assessed against these requirements. Should no suitable product already exist, then a custom-built system should be considered, again bearing in mind the available resources.

Step Four: A suitable dynamic dispatching system should be procured, installed, and tested to ensure that it meets the needs of all agencies involved. Due to the critical nature of some of these mobility operations, for example, transporting seniors to medical care facilities, a changeover strategy should be implemented such that users do not experience any loss of service during the transition to the new system.

Step Five: Once it has been determined that the new system operates to the satisfaction of all participants, full permanent operation can commence.

Potential Implementation Issues

This type of multi-agency system may be most effective in areas with a large elderly population, communities in which health care providers are long distances away from the majority of residents, or communities with numerous active agencies providing some form of ride assistance to non-driving members. A high level of cooperation and coordination among mobility service providers will be required for such a system to be a success.

Solution's Contribution to Broader Rural ITS Developments

This solution will contribute to rural ITS developments as follows:

Personal Mobility Management - This solution will play a key role in establishing a mobility management infrastructure and will increase mobility for various types of rural residents.

Automatic Payment - Components of this solution will also be a critical part of any infrastructure that exists to allow for automatic payment for services or products.

Economic Development / Community Enrichment - This solution will improve the "livability" of communities that support non-driving residents. Also, by reducing the number of vehicle trips, community parking and congestion problems may be alleviated.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Mobile Weather Sensors

Technology in Rural Transportation
"Simple Solutions"

2.12 Mobile Weather Sensors

General Description: Winter weather road maintenance constitutes a significant effort, especially in northern states. The objective of this solution is to increase the efficiency and cost-effectiveness of applying anti- and de-icing materials to the road surfaces by monitoring the weather and road conditions on-site with the maintenance vehicles.

Real-World Example - Infrared Pavement Sensors Monitoring

Overall goal: To monitor pavement temperatures at the site of maintenance vehicles to assist in the snow removal process.

Technical approach: An infrared (IR) sensor, which monitors pavement temperatures, is installed on maintenance patrol trucks. As air temperatures and pavement temperatures often differ widely, this enables the operators to concentrate the application of materials on the most appropriate areas. Continuous sensor readings are displayed on a unit inside the truck cab as the vehicle drives at highway speeds. (As implemented by the agencies identified below, there is no communication of these temperatures to a central dispatch / maintenance center.) Application rates are determined manually by the vehicle operator by combining the reported pavement temperature with a visual estimate of the ice or snowpack thickness.

Current status: The system has been in use in at least one site since the winter of 1994-1995. The sensors are commercially available.

Location / geographic scope: Areas using this system include the states of Vermont and Indiana. The system can be used at any location where the application of anti- and de-icing materials to the road surface is required.

Agencies involved: Vermont DOT, Indiana DOT. Vermont's sensor supplier is Control Products, Inc.

Cost information: The IR sensors cost approximately $2,300 each.

Key contact: Control Products Inc. (360) 571-0988

Have goals been achieved? Yes.

Solution timeline: Indiana reports that they are deploying systems on additional trucks as money becomes available.

Further Description of Application

Additional technologies may include:

Various types of sensors are under development which are aimed towards improving the efficiency of winter maintenance activities. However, the costs associated with some of these technologies may make them prohibitive for some agencies.

Potential additional uses for this technology may include:

If a sufficient numbers of maintenance vehicles were equipped with these sensors, data could be relayed to a central collection point and contribute to a regional or state-wide road and weather condition information system. Information collected from sensors could be communicated to other maintenance personnel and, when appropriately repackaged, could also feed into traveler information systems.

Benefits of Application

	Benefits to travelers / the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Safer travel on roads in inclement weather episodes due to quicker and more appropriate application of materials	-Greater reliability in deliveries and provision of services in winter conditions due to quicker and more appropriate application of materials	improved cost efficiency in applying materials to the road surface only where required Quicker coverage of road network as materials application is optimized

Probable Implementation Process

Step One: An interested agency should assess its spending on winter maintenance activities, in terms of operator salaries and overtime payments, equipment investments and depreciation, and materials. If possible, agencies who have already implemented the system should be contacted to determine the savings which they have achieved through using the sensor system.

Step Two: Once it has been determined with reasonable confidence that savings could be gained though implementing the system, resources must be identified and allocated to purchase sensor units. Resources for sensor installation and maintenance will also be required. An implementation schedule should be created. Manufacturer discounts may be available if agencies can commit to purchasing a certain number of units in a given timeframe.

Step Three: Sensors and the required in-vehicle equipment should be procured, installed, and tested.

Potential Implementation Issues

Due to the pressures on winter maintenance budgets, equipping vehicles with such systems may be perceived as a low priority for some agencies. Therefore, the potential savings in time and materials which could be gained from the use of these technologies should be emphasized wherever possible. As has been the case in those areas which are already using the sensing systems, maintenance vehicles could be equipped in an incremental process, as resources become available.

Solution's Contribution to Broader Rural ITS Developments

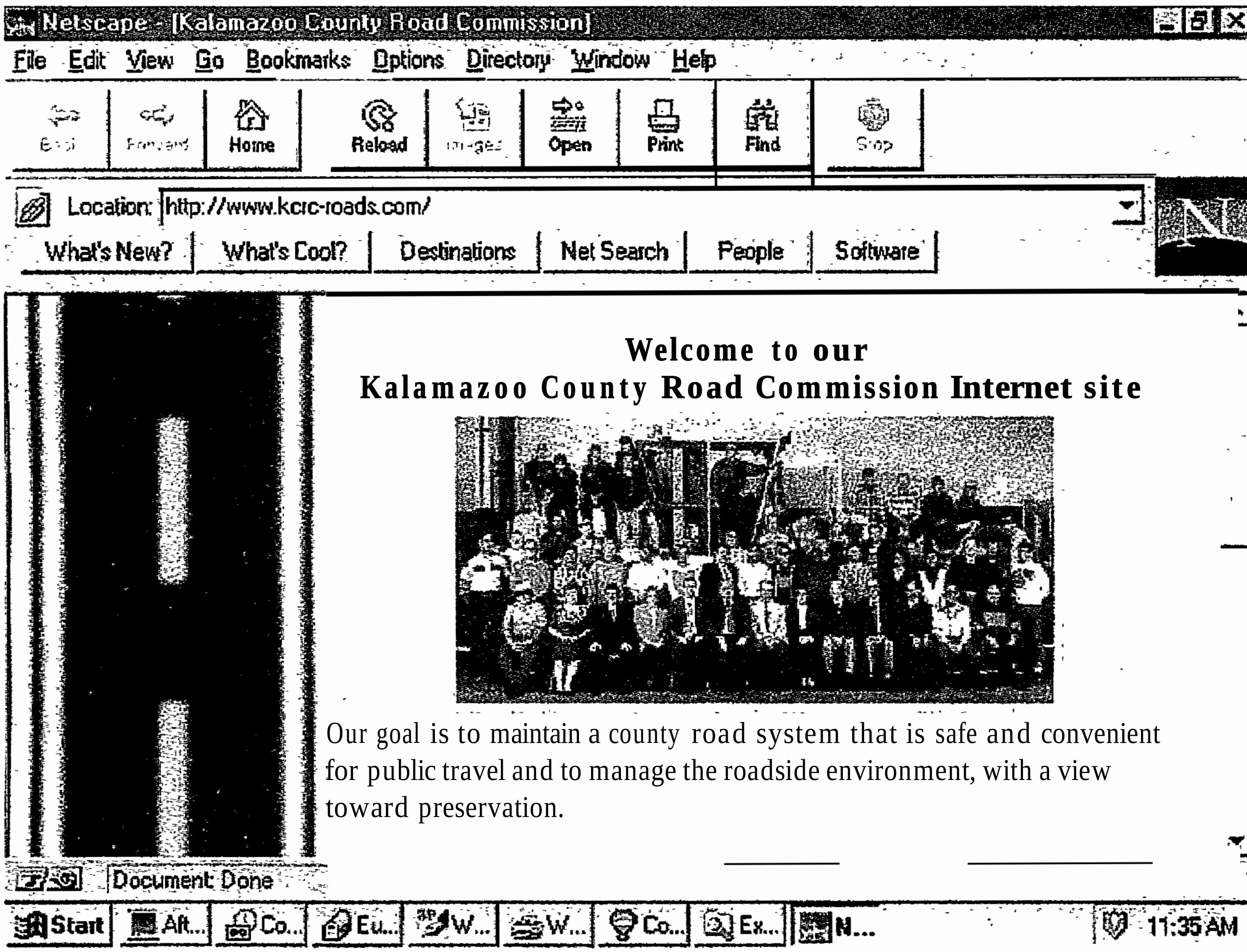
While this solution would not provide the only pavement temperature source, it could provide invaluable supplemental information to a Road / Weather Information System (R/WIS) by providing "roving" information concerning a far broader portion of the road network than a fixed R/WIS is able to, thus extending the scope of the pavement condition data beyond the current micro-scale. This solution could play a key role in rural ITS as follows:

Roadway Management - Improved roadway maintenance during inclement weather will contribute to an overall management system for the roadway.

United States Department of Transportation
Federal Highway Administration
Federal Transit Administration

ENTERPRISE

Public Agency Outreach for Transportation Management



Technology in Rural Transportation
"Simple Solutions"

2.13 Public Agency Outreach for Transportation Management

General Description: The roles of public sector transportation agencies are often misunderstood or misinterpreted at many levels by citizens. This solution builds upon an agency's outreach activities by promoting communications between the public sector and residents on various issues. This type of communication link provides easy access to residents, travelers, and businesses on the issues of public interest dealt with by various government agencies.

Real-World Example - Kalamazoo County Road Commission Internet Site

Overall goal: To allow interaction between the residents of Kalamazoo County, Michigan, and the County's Road Commission.

Technical approach: An Internet site has been developed which provides the road commission's mission, goals, policies, county and local township maps, road and bridge closures and detour information, bids for services and goods, and news releases on vehicle weight restrictions, road project hearings, budget hearings and approvals and board elections.

Current status: The web site is fully operational and can be accessed at http://www.kcrc-roads.com.

Location / geographic scope: Kalamazoo County Road Commission is responsible for nearly 1,200 miles of county roads. The Internet site offers information relating to this network of roads.

Agencies involved: Kalamazoo County Road Commission

Cost information: Costs include the cost of developing the web pages and purchasing space on a web server to house them. Keeping the pages up to date requires further maintenance cost.

Key contact: Kalamazoo County Road Commission. (616) 38l-3171

Further Description of Application

Additional technologies may include:

Various other options exist for communicating information on local road initiatives, construction, or closures, for example, including:

- Dial-in telephone recorded messages.
- Dial-in operator-based information services.
- Circulation of newsletters, or advertisement of road projects in the local press.

- Broadcast fax service to information service subscribers.
- Informational billboards or signs at the sites of future construction or maintenance activities.

None of the above systems can offer the breadth and depth of information, and comparable ease of manipulation of information, that is offered by the web site example described above. In addition, most of these sources, although they will be used as supplementary mechanisms, are likely to be less cost-effective from the agency's perspective.

Potential additional uses for this technology may include:

A road information web site could be enhanced to provide many other services including the following:

- Current and forecast road and weather condition information.
- Information on possible detours to avoid construction or maintenance workzones.
- Information on local special events, including parking options, locations and pricing, and suggested routes.
- Information on other local attractions.
- Links to neighboring region's information sites or to state-wide information sites.

Benefits of Application

	Benefits to travelers / the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Easy and cheap access to local roads information at any time of day current available contracts	Easy and cheap access to local roads information and freeing up agency resources	Information is disseminated in a cost-effective manner, freeing up agency resources
Indirect benefits	Residents are better informed of local initiatives		Positive public perceptions of information dissemination activities

Probable Implementation Process

Step One: Agencies should consider their existing information provision services and determine what cost savings or other efficiencies would result from implementing an Internet information site. Alternatively, if the agency is not primarily interested in improving existing operations but aims to start providing new information, then the various options available to them for doing so should be assessed.

Step Two: The agency should determine whether the expertise required to establish and maintain the Internet site is available within their organization, or whether it would be cost-effective to acquire this expertise in-house. If these are not possible options, the agency should identify and contract with an appropriate service provider.

Step Three: Working with the Internet service provider, if applicable, the agency should design, implement, and test their service. In order to ensure maximum visibility and use of the system, the agency should ensure that links to neighboring, regional, or state sites are created wherever possible.

Step Four: This last task involves ongoing operation and maintenance of the Internet site. It may be that once the system is fully functional, routine updating of information could be performed in-house, only calling upon professional Internet services to assist with major redesign efforts. As part of this step, the agency should collect and analyze user feedback to ensure that the users' needs continue to be met by the service.

Potential Implementation Issues

It is likely that such an Internet service would supplement a parallel telephone-based information service. If this is not the case, the agency should consider supplying a help-line for users who experience difficulties with the service, or for users who would prefer to deal with an operator when needing additional information or assistance.

When deciding to deliver an Internet information service, the agency should be sure not to underestimate the effort required to maintain the service and keep all information current. If the site is not maintained adequately, the service and the agency could lose credibility with users.

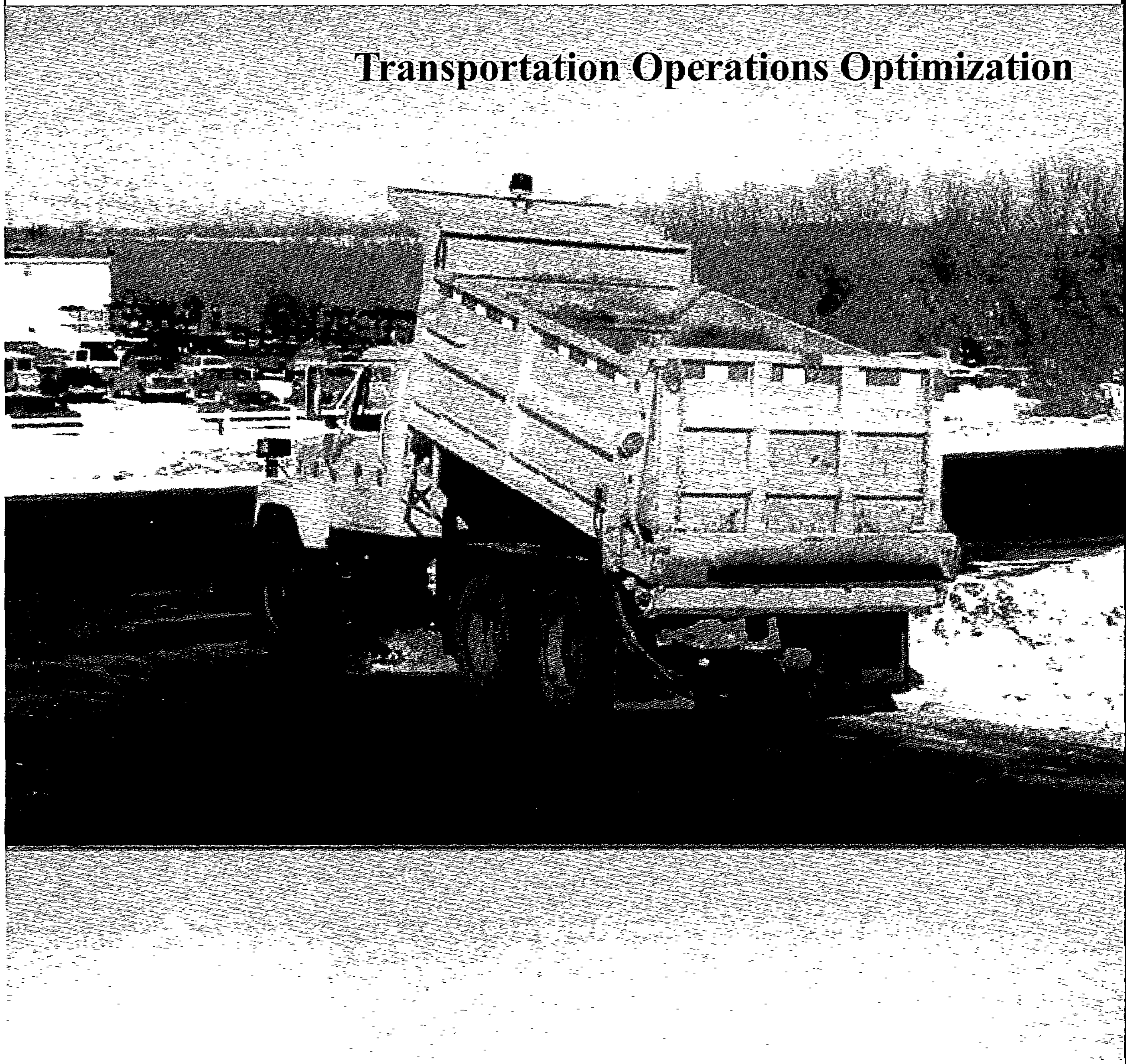
Solution's Contribution to Broader Rural ITS Developments

The information dissemination achieved through this solution will play a significant role in virtually every component of rural ITS developments. Improved communications between the transportation providers and the residents, especially in rural areas, will contribute to decisions about which products and services are most important and interesting to residents.

United States Department of Transportation
Federal Hughway Administration
Federal Transit Administration

ENTERPRISE

Transportation Operations Optimization



Technology in Rural Transportation
"Simple Solutions"

2.14 Transportation Operations Optimization

General Description: The various operations and maintenance activities, involving the dispatching of resources, that are provided by local and state governments were largely designed many years ago using manual processes. With new technologies becoming available, and the ever evolving combination of resources and needs, these operations may often be re-engineered with new optimization technologies and techniques.

***Real World Example -* Snow Route Design Optimization Software**

Overall goal: To re-design snow routes in order to optimize the plowing process.

Technical approach: A Computer Aided System for Planning Efficient Routes (CASPER) has been completed for the use of maintenance engineers. This software was designed to assist in the design or re-design of network service routes — snow plow routes in the first instance: Each district within a state performs its own optimization.

Current status: The system was piloted in two districts in Indiana, now all districts have access to the program to re-design their routes. It is estimated that by the winter of 1996- 1997, new routes will have been designed for approximately 80 percent of the state's service area.

Location / geographic scope: All districts in Indiana.

Agencies involved: Purdue University, Indiana DOT.

Cost information: Precise costs for software development are currently not available.

Key contact: Dan Shamo, Indiana DOT. (3 17) 232-5523

Have goals been achieved? Yes. The developers have documented a reduction of approximately 8 to 10 percent in the total number of routes needed to service the road network in addition to improved service levels for the remaining routes. Developers claim total cost savings of $11 to $14 million in reduced equipment and operating costs for winter maintenance activities.

Solution timeline: All districts now have access to the system. The system developers are considering enhancing the system to provide more functionality, such as pavement marking maintenance planning, etc.

Further Description of Application

Additional technologies may include:

This particular system was created to optimize existing snow plow routes designed in previous years, and so is a means of rationalizing and improving upon existing practices and techniques. Other computerized database systems could be designed to offer the same functionality, and it is likely that all such computerized systems would offer more convenience and efficiency over any manual techniques.

Potential additional uses for this technology may include:

As outlined above, there are many other services besides snow plowing that could benefit from this solution. The state agency is investigating enhancing the system to incorporate maintenance management schedules for other highway-related activities such as re-painting pavement markings and replacing road signs. In theory, the system could be expanded to form a master system enabling the planning, management, and scheduling of all road maintenance activities.

Benefits of Application

	Benefits to travelers /the community	Benefits to business / industry	Benefits to the public sector
Direct benefits	Roads will be cleared more effectively in winter conditions, resulting in safer travel	Roads will be cleared more effectively in winter conditions, resulting in safer travel	Cost savings for snow removal and maintenance activities
Indirect benefits	Taxpayer's money can be optimized of the levels of service		Improved public perceptions provided

Probable Implementation Process

Step One: Agencies should consider their winter maintenance budget, in terms of operator salaries and overtime payments, and equipment investments and depreciation. In addition, the local road network, in terms of the number of miles, density, network structure, etc., should be analyzed. Projected cost savings from implementing the optimization system should then be calculated based on these findings.

Step Two: Once it has been determined with reasonable confidence that savings could be gained though implementing the system, resources must be identified and allocated to either develop custom software or to purchase software from the original developers.

Step Three: Once the snow route optimization software is available, the system can be distributed for the use of local agencies as appropriate.

Potential Implementation Issues

Due to the development costs of such a system, it is likely that a state agency would build and maintain a system such as this, which would then be provided to districts, counties, or cities at low or no cost for them to perform their own optimization of routes.

If designing a system, agencies may wish to ensure that any additional functionality that they may require in the future can be easily added to the initial system.

Solution's Contribution to Broader Rural ITS Developments

This solution will contribute to the rural ITS development as follows:

Roadway Management - Improved services delivery will enhance the management of roadway systems.

3. SHORT SUMMARIES OF IDENTIFIED SIMPLE SOLUTIONS

The U.S. Department of Transportation developed the Advanced Rural Transportation Systems (ARTS) program in 1996 to address the application of ITS in rural areas. Since the range of rural transportation systems was so broad, the program was organized into seven Critical Program Areas (CPA). Those program areas were developed around "major needs" and "services" as follows:

Traveler Safety and Security

Traveler safety and security is one of the key focus areas for ITS in rural applications. Due to the increased severity of accidents in rural areas - caused by factors such as high operating speeds, accident response time, and distance of emergency facilities - travelers' needs focus on:

- Improving operation of vehicles in a safe and responsible way.
- Reducing other factors that cause accidents, such as poor road conditions and visibility.
- Preventing accidents.
- Reducing the severity of accidents.
- Increasing the security of travelers along their trip.

Emergency Services

As accidents occurring in rural areas often occur in isolated or remote areas, timely and appropriate response is critical. Technology is assisting delivery of response in the following methods:

- Determining appropriate services required to provide emergency assistance.
- Assisting emergency vehicles in reaching their destinations.
- Coordinating activities of different services, such as ambulance, emergency rooms, and the state patrol.
- Sharing of critical and appropriate information on emergencies.

Tourism and Travel Information Services

Numerous rural areas attract large numbers of tourists who may be are unfamiliar with the area and who require additional information and different types of information than residents. Technology applications can serve as delivery mechanisms for information such as details of accommodation and restaurants, medical facilities, sites of interest, scenic routes, and state parks. In addition, many travelers pass through remote areas as part of a longer trip to a further destination.

Ensuring that tourists and travelers have transportation and area information is also in the best interests of local residents and businesses, as tourist income can contribute greatly to local economies.

Public Traveler Services / Public Mobility Services

Public transit services in rural areas are often limited or non-existing. As a result, the mobility of non-drivers can be restricted. Potential roles of technologies in improving mobility are as follows:

- Identifying those in need of increased mobility and providing a mobility "safety net" for them.
- Determining how to provide services in an efficient manner.
- Establishing information sharing among providers to optimize routing and coordinate delivery.
- Finding coordination and communication links between providers of the services and the social service providers.

Infrastructure Operating and Maintenance

Transportation professionals in rural areas face the difficult challenge of operating and maintaining a large network of roads with limited resources. Technology applications can assist these professionals in the following ways:

- Contributing to the automation of highway pavement management systems.
- Creating provision of services to help reduce the costs of operations and maintenance while maintaining or improving quality of service.

Fleet Operating and Maintenance

Fleet operations and maintenance are subject to inefficiencies resulting from isolation, expansive road networks, and low traffic volumes, for example. As a result, difficulties arise in combining destinations for efficient routing. The focus of fleet operation and maintenance concerns that may be addressed by technology solutions is as follows:

- Coordination and provision of services for rural fleet operations and maintenance.
- Management of services, for example, vehicle location and routing, maintenance scheduling, and rural addressing.

Commercial Vehicle Operations

Commercial vehicle operators experience many of the same issues and concerns that rural travelers experience. Additionally, commercial operators encounter increased inefficiencies at border crossings and inspection sites. While technologies applied to commercial vehicles frequently are not considered "simple," some non-complex systems do exist to help streamline the movement of goods in rural areas.

Keeping in accordance with these categories, the 37 simple solutions summarized in this section are classified into the same Critical Program Areas.

3.1 Radar Detector Activation (Safety Warning System)

Critical Program Area: Traveler Safety and Security

Overall goal: To improve road safety by providing drivers with advance warnings of hazards.

Technical approach: The system activates any current, commercially available radar detector to warn of a hazard. The basic system emulates the effect of approaching a police vehicle, sounding the detector's K-band alert. It is intended to encourage drivers to slow down prior to encountering a hazard or potentially hazardous situation, such as railroad grade crossing. A more advanced system is being developed which will require enhanced radar detectors and transmitters. The transmitter will be able to issue a variable text message to the detector or activate any of a series of fixed text messages which have been pre-stored in the "smart" detector, giving more precise details of a hazard.

Current status: Transmitter testing began in November, 1995. Discussions with various state departments of transportation regarding field testing are currently underway. Patents have been filed for the Safety Warning System, and FCC approval to use police radar frequencies is being sought. Marketing of the "smart" detectors commenced in the fall of 1996.

Location / geographic scope: The system could potentially be deployed in any state where use of radar detectors is legal. Deployment could take place either at site-specific locations, such as at railroad grade-crossings, or on a corridor or region-wide basis.

Agencies involved: The Safety Warning System is a cooperative effort involving the Radio Association Defending Airwave Rights (RADAR), a national non-profit organization representing those who make, sell, and own radar and laser detectors, and other private organizations. Research and development is being conducted by Georgia Tech Research Institute.

Cost information: Information is not currently available on costs incurred during the development of the system. It has been estimated that the cost of "non-smart" transmitters for a site-specific application, such as a railroad grade crossing, would be approximately $500, plus installation costs. Given that the system is capable of activating any of the estimated 10 to 15 million radar detectors currently in use, the system can provide basic warning capabilities at no additional cost to a driver already owning a radar detector.

Key contacts: Gene Greneker, Georgia Tech Research Institute. (770) 528-7744
Janice Lee, Safety Warning System, L.C. (941) 473-1555

Have goals been achieved? The system has been developed and successfully tested in non-live situations. Ultimate success of the system depends on FCC approval and market uptake.

Solution timeline: The implementation time frame depends on the system being granted the necessary FCC approval for use of radar frequencies. Both the "smart" transmitters and receivers are said to be market-ready.

3.2 Work Zone Signage using Changeable Message Signs (CMS)

Critical Program Area: Traveler Safety and Security

Overall goal: To notify the traveling public of upcoming or existing construction and maintenance activities.

Technical approach: Mobile CMS are being deployed that can be controlled remotely via telephone lines. A telephone call to the CMS changes the message being displayed. There is no fixed message set for the CMS-any appropriate text message can be programmed for display. The CMS are portable and are utilized at either end of a construction, maintenance, or road closure zone.

Current status: Two CMS, comprising one workzone advisory system, have been in use for two years.

Location / geographic scope: The system is utilized in Dane County, Wisconsin, which has an area of approximately 1,200 square miles.

Agencies involved: Dane County.

Cost information: The CMS cost $25,000 each. The National Highway Transportation Safety Administration (NHTSA) provided funding for one unit and Dane County purchased the other unit.

Key contact: John Nor-well, Dane County. (608) 266-4011

Have goals been achieved? Yes. The county has received excellent feedback from in-house personnel, including maintenance workers and field supervisors, as well as from the traveling public. Travelers like and respond well to the advance notification of construction and maintenance activities. Dane County would like to expand the program to include more CMS purchases for stationary sites in high density travel areas. These new units would be used for event information, incident management, and construction zone notification.

Solution timeline: Currently, the county is competing against Capital Improvement Projects in the state Department of Transportation's (DOT) budget for Federal Highway Administration (FHWA) funds to expand this program.

3.3 Low-Cost Visibility Sensor

Critical Program Area: Traveler Safety and Security

Overall goal: To accurately model visibility images provided via CCTV cameras to improve safety operations along roadway networks.

Technical approach: This project is building on previous studies conducted to investigate detecting and categorizing reduced visibility conditions using data received through closed circuit television (CCTV) monitors. This is accomplished by analyzing the contrast or amount of white color present within an image. By comparing this contrast value against a predetermined set of limits, which have been established for various visibility threshold levels, appropriate warnings can be issued and preventative safety measures taken. By utilizing existing CCTV cameras, it is anticipated that low visibility conditions such as fog or snowstorms can be accurately tracked at a relatively low cost,

Current status: Initial field testing is scheduled to begin in November, 1996. All equipment has been procured and is being deployed at the test site. Preliminary analysis of existing data from a previous study has identified a definite correlation between contrast levels and visibility levels.

Location / geographic scope: The field test is taking place near Duluth, Minnesota. The system could potentially be deployed in any location where CCTV cameras are in use for another application.

Agencies involved: The project is being lead by the Minnesota Department of Transportation (Mn/DOT) and the University of Minnesota-Duluth (UMD). Additional support is being provided by the Ontario Ministry of Transport (MTO) and the Aurora Consortium, a Federal pooled-fund study charged with the investigation and development of Road and Weather Information System (R/WIS) technologies.

Cost information: The preliminary testing and evaluation efforts approved by Mn/DOT has an estimated budget of approximately $29,000.

Key contact: Edward J. Fleege, Minnesota DOT. (218) 723-4850, Ext. 3540

Have goals been achieved? Further details will be available when the field study is completed.

Solution timeline: At the time of writing, the participants are three months into the twenty month project. Initial findings should be available in approximately twelve months.

3.4 Portable Speed Detection

Critical Program Area: Traveler Safety and Security

Overall goal: To slow drivers in residential areas.

Technical approach: The system uses a photo radar device installed in a mobile unit and operated by a specially trained staff person. The device photographs the drivers and license plates and records the speed of vehicles. Offenders are then contacted by mail.

Current status: A four month trial of the system finished in June, 1996. The analysis of this trial suggested continuing the trial for another eight months.

Location / geographic scope: In San Jose, the system is being used exclusively on low volume, low speed roads in neighborhoods that have requested the speed monitoring. The system could be deployed in any community with a need for speed monitoring.

Agencies involved: San Jose Traffic Engineering Office

Cost information: Approximate estimates for the cost of the system, including the vehicle, hardware, and software are around $100,000. Additionally, there is the cost of employing a staff person to monitor the system, as well as additional labor for processing violation notices.

Key contacts: James Helmet-, San Jose Traffic Engineering Office. (408) 277-4304
Larry Moore, San Jose Traffic Engineering Office. (408) 277-3072

Have goals been achieved? The results of the four month trial have shown that the maximum speed has dropped dramatically in areas monitored by NASCOP. Furthermore, the trial showed that the NASCOP system has not slowed vehicles that were already observing the speed limit. The system has been very popular in the neighborhoods in which it was tested.

Solution timeline: The NASCOP system has been tested for four months. After negotiating a new lease with USPT, the producers of the system, the City of San Jose will continue the trial for another eight months.

3.5 Safe Bicycle / Auto Road Sharing

Critical Program Area: Traveler Safety and Security

Overall goal: To enable bicyclists to share the road safely with other vehicles.

Technical approach: A push-button system, activated by a bicyclist, triggers flashing beacons above a fixed sign which reads "BICYCLES ON HIGHWAY". The sign activation times out after a period of time.

Current status: The system has been in place for approximately one year

Location / geographic scope: The system is located on Highway 40 between Craig and Steamboat Springs in Colorado.

Agencies involved: Colorado Department of Transportation.

Cost information: Precise costs not available, however, due to the simplicity of the technologies used, this is a very low-cost system.

Key contact: Jim Nall, Colorado Department of Transportation. (970) 248-7213

Have goals been achieved? Much positive anecdotal feedback has been received since the installation of the system. No formal evaluation of accident rates or user perceptions of the system have taken place.

Solution timeline: CDOT plans to leave the system permanently installed.

3.6 Site Management During Avalanches

Critical Program Area: Traveler Safety and Security

Overall goal: To prevent traffic from driving into the paths of avalanches.

Technical approach: This NCHRP-Idea project is researching the use of various sensors to detect when an avalanche occurs. Two types of sensors are being tested - motion detection sensors and sensors which use ultrasonics to measure the depth of the snow pack. When the sensors detect the onset of an avalanche, gates at either side of the avalanche path installed on the roadway below will automatically close to prevent vehicles from traveling into the danger area. The system is intended for use at locations where avalanches have relatively predictable paths and where the avalanche typically has a long descent time of between 90 and 180 seconds. The system is designed for sites where avalanches usually affect particular stretches of road of between 100 to 200 feet in length.

Current status: System components are currently being installed.

Location / geographic scope: The system **is** being tested on a 200 yard stretch of roadway on State Route 2 10 in Utah, in the Little Cottonwood Canyon. This steep two-lane road has 22 established avalanche tracks and experiences numerous avalanches each winter.

Agencies involved: Utah DOT, Idaho DOT, FHWA, University of Utah

Cost information: The various types of sensors range in cost from around $500 to $2,500 each. A preliminary estimate of the cost of all the required hardware, including a suite of sensors and the roadside gates, is approximately $30,000. In addition, a power supply would also need to be installed in what would usually be a remote area. However, the alternative of building avalanche sheds is many times more costly.

Key contact: Rand Decker, University of Utah. (801) 581-3403

Have goals been achieved? The project is not yet completed.

Solution timeline: The one year project commenced in August, 1996.

3.7 Speed Advisory on Curves

Critical Program Area: Traveler Safety and Security

Overall goal: To increase the safety of drivers at a specific sharp curve.

Technical approach: Radar detection equipment was installed to detect the speeds of vehicles approaching a sharp curve. A "BEWARE OF SHARP CURVE" sign is located prior to the curve. When the radar equipment detects that a vehicle is traveling too quickly to safely negotiate the curve, beacons on the sign flash to alert the driver.

Current status: The system is in place and operational.

Location / geographic scope: The curve is near the intersection of Lynn Street and 19th Avenue in the city of Seattle.

Agencies involved: City of Seattle

Cost information: No precise cost information is available. However, the detection and signage equipment installed is widely available and not costly.

Key contacts: Bill Legg, Washington State DOT. (206) 543 3332
Brian Kimber, City of Seattle. (206) 684-5096

Have goals been achieved? There is anecdotal evidence that in general drivers have reacted positively to the system and have slowed down prior to the curve.

Solution timeline: The system is intended to be a permanent installation.

3.8 Bicycle in Tunnel Warning System

Critical Program Area: Traveler Safety and Security

Overall goal: To increase the bicyclists' perception of safety while travelling through tunnels.

Technical approach: Prior to the entrance to a tunnel the shoulder was widened sufficiently to allow bicyclists to pull off the road safely and activate a push-button which triggered flashing beacons on a fixed message sign further upstream of the tunnel entrance. The sign reads "PEDS / BICYCLES IN TUNNEL WHEN FLASHING". The flashing beacons operate for a period sufficient for the bicyclist to pass through the tunnel before timing out.

Current status: The system has operated since its installation in 1979.

Location / geographic scope: This system is installed at a tunnel on Highway 971 in Washington State near the city of Chelan.

Agencies involved: The system was installed and funded by the North-Central region of Washington State DOT.

Cost information: The system cost $5,000 to build and install in 1979. These costs were relatively low as a power supply was already in place to provide lighting on the tunnel. Had this not been the case, installation costs would have been significantly higher.

Key contact: Janine Ring, North-Central Region, Washington State DOT. (509) 663-9638

Have goals been achieved? No information has been gathered on accidents involving bicycles in the tunnel either before or after the system was installed. It is believed that no serious accidents took place prior to the system being installed, rather the system was put into place in response to reports of bicyclists feeling unsafe in the tunnel environment.

Solution timeline: Fully installed since 1979. No plans exist for installing the system elsewhere in the area.

3.9 Speed Advisories During Fog

Critical Program Area: Traveler Safety and Security

Overall goal: To provide speed advisories to traffic in fog conditions.

Technical approach: The ADVISE project is installing a series of technologies which will detect traffic and sense adverse weather conditions. Detection equipment include six sets of loop detectors which will provide data on speeds, headways, and vehicle classifications based on length, and a machine vision system which will provide traffic counts. The motivation for installing such a wide variety of detection equipment is to collect before and after data relating to driver behavior in normal and restricted visibility conditions, and to ascertain how the activation of the VMS affects driver behavior. It has already been observed that auto drivers and heavy truck drivers react differently in these conditions, hence the need for vehicle classification information.

Four fog sensors, which measure conditions based on refracted infrared light, have also been installed. Two high intensity incandescent VMS will provide speed advisories to drivers based on safe stopping distances calculated using input from the various detection components. Systems have been installed to monitor surface temperatures and snow / ice conditions on the roadway.

Current status: The system components are all installed. It had been intended to activate the system last year but no severe fog conditions were experienced. The message set for display on the VMS has not yet been finalized.

Location / geographic scope: The system is being tested where I-215 crosses the Jordan River in Utah where there is a history of severe accidents during fog conditions. The freeway often experiences congested stop-and-go traffic conditions in all lanes.

Agencies involved: Utah DOT Maintenance Planning Region 2, FHWA.

Cost information: The project is receiving significant levels of Federal funding. However, a whole range of technologies is being implemented from which agencies with less funding could select appropriate components to meet their individual needs.

Key contact: Chris Glazier, Utah DOT, (801) 965-4381

Have goals been achieved? No results are yet available.

Solution timeline: The system is scheduled to be activated in November 1996. If the system proves to be effective, then the DOT plans to implement similar systems elsewhere in the state.

3.10 Automated Visibility Warning System

Critical Program Area: Traveler Safety and Security

Overall goal: To improve traveler safety through areas subject to severe low visibility conditions through the use of advanced warning messages and speed advisories.

Technical approach: This system monitors visibility conditions as well as traffic patterns along a five-mile segment of roadway. When either type of condition or a combination of both reaches a series of predetermined thresholds, alerts are automatically posted at changeable message signs located upstream from the site. These messages notify travelers of conditions ahead and provide speed advisories. At the same time, DOT and law enforcement personnel are notified of conditions at the site to aid decisions regarding road closures and identification of alternative routes.

Current status: The system is currently fully deployed and operational. Testing has been underway since 1995 and is scheduled to be completed shortly.

Location / geographic scope: This system is located along I-75 in southern Georgia. Due to the limited range of the visibility sensors, deployment activities tend to occur only on a site-specific basis. However, multiple sensors can be linked together to monitor conditions along a designated corridor.

Agencies involved: The project is being lead by the Georgia Department of Transportation and Georgia Tech University.

Cost Information: No information is currently available on the system development and deployment costs. However, in general, sensor prices are continuing to decrease at a significant rate as more manufacturers enter the market. For example, over a period of 12 months, one manufacturer has reduced retail cost of sensors by approximately 50 percent. If these trends continue, comparable systems could become a viable option for local agencies.

Key contact: Gary Gimmestad, Georgia Tech University. (404) 894-34 19

Have goals been achieved? The system has proven to aid significantly the alerting of motorists to reduced visibility conditions.

Solution timeline: The system comprises mainly of off-the-shelf technology, such as visibility sensors and changeable message signs. Thus, similar systems could be assembled with little lead-in time. Additional site deployments have already been identified within Georgia.

3.11 Corridor Management During Avalanches

Critical Program Area: Traveler Safety and Security

Overall goal: To improve the safety of drivers in areas prone to avalanches.

Technical approach: This NCHRP-Idea project aims to test technologies along a 16 mile stretch of roadway where there are 57 established avalanche paths. Traffic logging stations at either end of the corridor and avalanche sensors at the roadside are being installed. Based on readings from the roadside sensors, automatic gates will prevent drivers from entering the corridor during avalanches. As traffic counts will be made at the entry and exit of the corridor, it can be calculated if any vehicles remain in the corridor at the onset of the avalanche. This will facilitate better informed rescue operations if necessary.

Current status: It is hoped to have all systems installed for the 1996 1997 winter season.

Location / geographic scope: The test corridor is located on State Route 2 1 in Idaho.

Agencies involved: Utah DOT, Idaho DOT, FHWA, University of Utah.

Cost information: Precise costs not yet available for this test. Costs would vary widely based on the scope and configuration of any one site.

Key contact: Rand Decker, University of Utah. (801) 581-3403

Have goals been achieved? Results are not yet available.

Solution timeline: Implementation plans will depend on the results of the testing.

3.12 Emergency Managers Weather Information Network (EMWIN)

Critical Program Area: Traveler Safety and Security

Overall goal: To provide a low cost weather information access system for emergency management personnel.

Technical approach: EMWIN is a non-proprietary weather information dissemination system. It provides a continuous, dedicated low speed data broadcast which may be received by a number of mechanisms including radio, the Internet, and satellite. The EMWIN datastream consists of real-time weather warnings, watches, advisories, and forecasts; a subset of alphanumeric products for each state; a limited suite of non-value-added graphical products; and some satellite imagery. The EMWIN data may be viewed on a personal computer using software developed by the NWS. This software is available free of charge through the Internet. Commercially supported software is also available at low cost.

It should be noted that various private sector agencies provide value-added weather information via the Internet. The National Weather Service (NWS) has created a list of these agencies which is available at http://www.nws.noaa.gov/im/more.htm#vendors.

Current status: The system has been operational since May, 1994.

Location / geographic scope: EMWIN is currently available on a region-wide basis throughout North America for both Internet and satellite users. Radio access is limited to a 30 to 60 mile radius of those areas where EMWIN transmitters are located. At present, transmitters are located throughout the states of Oklahoma and Texas as well as the Washington, D.C. area.

Agencies involved: The system was developed and is supported by the National Weather Services - Office of Systems Operations (NWS-OSO), in partnership with the Federal Emergency Management Agency (FEMA).

Cost information: NWS designed and implemented EMWIN for less than $50,000. User costs vary according to the data reception method used, ($500 for a satellite system to approximately $250 for a radio receiver and demodulator). Internet access is free. subject to set-up and monthly connection rates, which vary by service provider. Additionally, a personal computer is required to display and interpret data. Total user costs should be less that $2,500, including computer procurement.

Key contact: Kevin Kay, National Weather Service. (301) 713-0191, Ext. 172

Have goals been achieved? The system is operational with real-time data being provided to multiple user groups. EMWIN contributes to meeting the NWS goal of protecting life and property.

Solution timeline: The system is deployed and available to users. NWS is working with FEMA and other organizations, public and private, to deploy additional radio transmitters.

3.13 Weather by Telephone

Critical Program Area: Traveler Safety and Security

Overall goal: To provide an alternative mechanism to acquire weather updates and forecasts.

Technical approach: In order to allow access to National Weather Service (NWS) forecasts and current weather information, individual NWS field offices offer telephone announcement systems. These messages are site-specific in nature and also provide special interest information, such as marine or agricultural data. Many of these systems also feature ring-through for direct contact with NWS personnel to obtain additional information.

Current status: Since the mid-1980s the NWS has been phasing out its participation in this effort in favor of private sector service provision, at the time when it is proven that the private sector can offer equal or better service.

Location / geographic scope: The system is operational at all 300 field stations currently in operation by the NWS, with information provided on a regional basis. No information is presently available regarding the impact of the closing of approximately 150 of these stations on the Weather by Telephone system.

Agencies involved: The National Weather Service has partnered with the Weather Radio Network Corporation (WRN Corp.) to maintain and operate the system.

Cost information: No information is available regarding the system development and deployment costs. Costs for individual calls vary depending upon the location status (NWS or private sector maintained) and the information requested.

Key contact: Weather Radio Network Corporation. (900) 884-6622

Have goals been achieved? The system is a key element of the NWS multi-layered information dissemination program, designed to ensure that the general public can have ready access to weather information.

Solution timeline: The system is fully operational, with no plans for further expansion.

3.14 Private Sector Internet Weather Information Providers

Critical Program Area: Traveler Safety and Security

Overall goal: To provide transportation agency personnel with a low-cost source of weather and road condition information.

Technical approach: The National Weather Service (NWS) has identified a number of private sector meteorologists, who for a fee provide site-specific forecast and real-time weather information. This list has been complied from the membership lists of the American Meteorological Society (AMS), the National Weather Association (NWA), and the Commercial Weather Services Association (CMSA). The providers acquire raw data from the National Weather Service which is run through proprietary models to produce user friendly information.

Most of these vendors provide, at no cost, detailed weather information including generic forecasts, radar and satellite imagery, and graphical representation of conditions. Most of this data is on average 15 minutes old.

Current status: Weather information is currently available through more than 35 private sector meteorological firms, all of whom have World Wide Web (WWW) home pages.

Location / geographic scope: Presently, data is available on a region-wide basis throughout the United States. As meteorological models continue to advance, corridor-wide and even site-specific information should be available at the cost of subscribing to an information provider.

Agencies involved: A list of the service providers is available at: http://www.nws.noaa.gov/irn/more.htm#vendors.

Cost information: The principal costs involve the establishment of an Internet account with a provider. These can typically be obtained for a single user at a rate of approximately $20 per month. Additional costs may include a modem and personal computer, if not already available.

Key contacts: See agencies involved above.

Have goals been achieved? The NWS is in the process of implementing a next generation system capable of providing real-time information and short-term forecasts for 10 km grid spaces. Current technology produces similar information for 100 km or larger grid spaces, allowing for a significantly higher proportion of inaccurate forecasts than the new models.

Solution timeline: As more private sector firms establish WWW sites, the competition for users will increase and should result in additional and higher quality data being freely available.

3.15 Grade-Crossing GIS Database

Critical Program Area: Traveler Safety and Security

Overall goal: The goal of this application is to efficiently determine where safety-related improvements should be made to roadways and at rail-road grade crossing sites.

Technical approach: A video log of track-side and roadway characteristics at grade-crossings and a log of the numbers of vehicles and trains per day at crossings is being created. The mileposts on rural roads assist in identifying, tracking, and documenting specific areas that need maintenance through the use of a Geographic Information System (GIS) database, coupled with a video log of the number of grade-crossings.

This system utilizes an in-vehicle video camera to document on film roadway and track-side conditions for early detection and examination of possible problem areas. The video camera is mounted to facilitate filming fifty feet ahead of the vehicle, and automatically records to disk for downloading onto a database. Multiple users access the database for various purposes including traffic counts, railroad crossing measures (i.e. crossings per day) and projections. Users that access the information include the legal department, statistical analysis specialists, general administration, infrastructure inventory personnel, and maintenance districts. Eight transportation districts throughout the state currently use the database.

Current status: The Nebraska DOT started using video in 1975.

Location / geographic scope: The system is expanding and will be applied statewide.

Agencies involved: Nebraska Department of Roads.

Cost information: The current budget for the video log is $125,000.

Key contact(s): Dick Gingrick, GIS, Nebraska Department of Roads (402)479-4550

Have goals been achieved? Yes. The goals have been achieved and in some cases exceeded. New uses for the information are continuing to be discovered .

Solution timeline: This project is on-going. As this project progresses, its technology is being applied throughout the Department of Roads.

3.16 “Total Stations” for Accident Investigation

Critical Program Area: Emergency Services

Overall goal: To reduce the amount of time it takes to do on-site accident investigation, thereby clearing accidents quicker for congestion and air quality mitigation.

Technical approach: Tri-pod mounted survey equipment is utilized to shoot coordinates at accident sites, allowing the accident to be cleared sooner than with traditional investigative techniques. Officers are able to record all pertinent accident data, such as distances, and turning angles, and recreate the accident scenario at a later date. Upon returning to the office, the “total station” data reduces the amount of paperwork and time required to tile incident reports.

Current status: Police officers are currently being trained on the surveying equipment, however, some units are already operating in the field.

Location / geographic scope: Total stationing is being conducted in the Dallas metropolitan area.

Agencies involved: Department of Public Safety, Texas Department of Transportation, Texas Transportation Institute (TTI).

Cost information: The costs are not available, however the total stationing equipment was purchased with Intermodal Surface Transportation Efficiency Act, Congestion Mitigation/Air Quality funds by the local Council of Governments (COG), and disbursed through Texas Department of Transportation to various city Department of Public Safety agencies for testing.

Key contact(s): Carol Walters, TTI. (817) 261-1661

Have goals been achieved? Yes. To date the accident clearance rate is approximately the same as before the use of total stations. However, it is anticipated that clearance time reductions will occur as the surveyors become more accustomed to the equipment. Paperwork and turn-around time on accident report filing has been greatly decreased through the use of the survey equipment in the field.

Solution timeline: Currently, officer training is taking place and more units are being deployed in the field. It is projected that more units may be purchased if this initial effort proves successful.

3.17 Automated Field Reporting

Critical Program Area: Emergency Services

Overall goal: To increase the efficiency of police field reporting.

Technical approach: Police vehicles will be equipped with laptop computers and in-car portable printers to automate crash accident related reports and traffic citations. Field data will be transmitted using Radio Frequency (RF) transmission, disk transfer and modem. GPS technology will be integrated into the system so that each incident is geo-coded.

Current status: At present an RFP is being drafted for the provision of system software. A bid will be issued later for system hardware.

Location / geographic scope: The pilot test will take place in the Twin Cities metro, Mankato, and Virginia areas in Minnesota.

Agencies involved: Minnesota State Patrol (MSP), FHWA, Minnesota DOT.

Cost information: It is anticipated that the in-vehicle hardware, including a laptop computer and an in-vehicle printer, will cost between $8,000 to $10,000 per vehicle. The software costs are likely to be significant, although with the RFP yet to be issued and responded to, the MSP prefers not to provide an estimate of these costs. The MSP is planning to buy a software solution to meet the needs of police throughout Minnesota, as far as possible, and then allow police forces to utilize the software at no cost when they have purchased the required hardware.

Key contact: Captain Craig Hendrickson, Minnesota State Patrol. (6 12) 215-l 768

Have goals been achieved? The pilot system has not yet been implemented

Solution timeline: Three different regular laptop units will be purchased in early 1997 to test their ruggedness and temperature sensitivity in police vehicles. A pilot test of the actual reporting system, using 25 to 50 vehicles, is scheduled to be operational by January, 1998.

3.18 Automation of Radio Communications Paper Logs

Critical Program Area: Emergency Services

Overall goal: To automate the recording of information received by radio communication operators by entering it directly into the computer

Technical approach: Currently, most of the information received by radio communication officers via radio or telephone is handwritten on paper logs. Minnesota State Patrol (MSP) has plans to develop computer software to enable radio communication officers to enter information directly into a computer at the time of the call, enhancing information access among radio operators, and integrating data into the MSP's Wide Area Network (WAN). The software would allow operators to attach information from the radio log and queries to the report forms. There would also be a series of customized reports developed for radio operators, districts, and central office to access targeted information.

Current status: A prototype has been developed, but plans for implementation have been put on hold as the MSP hopes to obtain funding for a CAD 9- 1 - 1 system for the Twin Cities metro area which would meet the same need as this automated logging system.

Location / geographic scope: Initial plans were to pilot test the system in the metropolitan area of the cities of Minneapolis and St. Paul in Minnesota. The system could be applied to any police force needing to streamline their call logging and response.

Agencies involved: Minnesota State Patrol.

Cost information: There are some commercially available packages which perform these functions, varying in price. It is estimated that having a customized package developed would cost in the region of $40,000 to $60,000. This application is of interest as it could provide a lower cost alternative to a CAD 9- 1- 1 system.

Key contact: Captain Craig Hendrickson, Minnesota State Patrol. (6 12) 215-1768

Have goals been achieved? System has not yet been implemented.

Solution timeline: N/A

3.19 Interagency Dispatch / Reporting Coordination

Critical Program Area: Emergency Services

Overall goal: To share data more efficiently between police, fire, ambulance, and state agencies through the use of a centralized common, comprehensive crash reporting database.

Technical approach: In -vehicle digital cameras and pen-based notebook computers with in-car printers are mounted in all police vehicles for crime scene and accident data collection, input and downloading to a central database for immediate availability to other vehicles responding to the scene, including emergency management personnel. Information is sent via radio frequency to Dane County and then transmitted along fiber to the in-house computer system. Dane County will soon be installing Global Positioning Stations (GPS) in vehicles to provide more information regarding specific accident location.

Current status: All police vehicles have notebook computers installed. The software development is being completed and tested. The database information is available and shared throughout Dane county.

Location / geographic scope: All marked vehicles in Dane County, Wisconsin have the notebook computers.

Agencies involved: Emergency Management System agencies, such as ambulance and police, Sun Prairie City Police and the Office of Transportation Safety.

Cost information: The cost is approximately $3,400 per notebook computer. Software development is on-going, so no dollar amount is currently available. Seed money to establish this program came from Sun Prairie City Police with additional funding for development and implementation coming from Federal Highway Administration and the National Highway Transportation Safety Administration.

Key contact(s): Frank Sleeder, Chief of Police, City of Sun Prairie. (608) 837-7336

Have goals been achieved? Yes, the program in its initial stage is meeting expectations,

Solution timeline: Sun Prairie is the test site for this effort, and if successful, will be deployed throughout Wisconsin. The end of test period for this project is August, 1997.

3.20 Incident Management using Variable Message Signs (VMS)

Critical Program Area: Tourism and Travel Information Services

Overall goal: The primary goal is to enable corridor incident management.

Technical approach: The Colorado Department of Transportation is installing 23 VMS on an interstate corridor. The signs will be controlled from a central hub, with an on-screen visualization of the network being available to the operator. This corridor experiences heavy seasonal traffic and the objective is to place signs at intersections where alternate routes can be taken to enable travelers to bypass congested areas and any incidents that occur.

Current status: CDOT is currently installing the first signs.

Location / geographic scope: The signs are located on the I-70 corridor between Utah and Vail Pass, Colorado.

Agencies involved: Colorado Department of Transportation.

Cost information: $15,000 per sign plus communications and integration costs.

Key contacts: Jim Nall, Colorado DOT. (970) 248-72 13

Have goals been achieved? The system is not yet fully implemented, therefore no results are available at this time.

Solution timeline: It is hoped to eventually enhance the system to provide additional traveler / tourist information.

3.21 Radio Controlled Crosswalk Push-Buttons

Critical Program Area: Public Traveler Services / Public Mobility Services

Overall goal: To make crosswalk signal activation easier for disabled pedestrians

Technical approach: The system uses a hand-held radio device similar to a garage door opener. When a button on the device is pressed in the vicinity of an equipped crosswalk, the request for the "walk" signal is activated.

Current status: Prototype devices have been successfully tested in a laboratory environment.

Location / geographic scope: City of Colorado Springs, Colorado.

Agencies involved: City of Colorado Springs.

Cost information: It is estimated that it would cost less than $500 to equip a crosswalk with the necessary receiver, Costs for the hand-held devices should also be very low.

Key contact: John Merritt, City of Colorado Springs. (719) 578-6663.

Solution timeline: The City of Colorado Springs is considering handing over the project to local college students as an engineering project. No specific target dates for system implementation have been set.

3.22 Talking Signs for Visually-Impaired Pedestrians

Critical Program Area: Public Traveler Services / Public Mobility Services

Overall goal: To develop signs for visually impaired pedestrians that help orient the pedestrians without disturbing other people in the vicinity.

Technical approach: The talking signs transmit recorded messages via infrared light waves which are decoded by a small receiver held by the pedestrian. Because of the directional nature of infrared light, messages can be focused in one direction, so a receiver will only decode the message if it is pointed in the correct direction.

Current status: The system is being piloted at present. Fourteen signs have been installed at one intersection and between 70 and 80 signs identify ticket booths, boarding areas, and exits in a subway station.

Location / geographic scope: The pilot system is highly localized but could be used at any intersection where a crossing light is installed.

Agencies involved: San Francisco Department of Parking and Traffic, Talking Signs, Inc., Baton Rouge, LA, Smith-Kettlewell Eye Research Institute.

Cost information: The system is expected to cost $400 per transmitter and $100 per receiver.

Key contacts: Bond Yee, San Francisco Department of Parking and Traffic. (415) 554-2300
Dr. Bill Crandall, Smith-Kettlewell Eye Research Institute. (4 15) 561- 1657

Have goals been achieved? No results of the pilot testing are yet available.

Solution timeline: A second pilot site is due to become operational in late 1996. Further implementation plans will depend on the success of these pilot tests.

3.23 Smart-Key Payment for Parking Meters

Critical Program Area: Public Traveler Services / Public Mobility Services

Overall goal: To raise parking meter revenues by providing more payment options, to improve the enforcement and service of meters, and to provide more payment flexibility to users.

Technical approach: New parking meters accept coins, tokens and electronic keys. The keys work like a debit card: they are programmed with a certain value when purchased which is decremented as they are used for parking. The amount of money deducted from the key each time it is used is determined by the number of times the key is turned in the meter. The keys can be reprogrammed at a kiosk. A microchip in each meter tracks the amount and rate of collection, allowing pick-ups to be conducted only when needed, as well as the times when parking enforcement is most critical.

Current status: In West Hollywood, 500 smart-key meters were initially installed to replace traditional coin and token meters. The city had intended to replace the remaining 1,200 meters over a period of several years but accelerated the process due to the popularity of the meters. All of the meters have now been replaced.

Location / geographic scope: The meters could be used in any area where parking meters are used. A kiosk for purchasing keys and parking time must be easily accessible.

Agencies involved: The City of West Hollywood chose to purchase the meters from Duncan Industries.

Cost information: The meter mechanism, not including the housing, costs about $190, about $25 more than a coin-only meter. Other components include hand-held computers for downloading information from the meters and a kiosk for dispensing and reprogramming keys.

Have goals been achieved? Revenues from parking meters rose about 5 percent in the first year of operation, although this is partly attributable to more coin options - the previous meters only accepted quarters. The program was immensely popular with local businesses, which requested that all the meters be replaced to allow key use.

Solution timeline: This solution has been implemented.

3.24 Self-Drive Dynamic Van Pooling Program

Critical Program Area: Public Traveler Services / Public Mobility Services

Overall goal: To see if partially full Vanpools can be filled to capacity with short distance riders.

Technical approach: Via in-vehicle radio/cell phone technology equipment (Teletrack, part of an Air-touch telecommunications system), the vanpool operator is able to communicate en-route with a dispatcher by sending numerical message packets that relay a variety of information including: time and location of departure; number of available seats; and the need for emergency assistance.

Current status: The project was active for a year, but is now complete.

Location / geographic scope: Anaheim, California.

Agencies involved: Anaheim Transportation Network and the City of Anaheim.

Cost information: The $50,000 grant was used primarily for marketing, and the purchase and installation of Teletrack equipment in five City of Anaheim vans. The grant was issued by the South Coast Air Quality District.

Key contact(s): Diana Kotler, Anaheim Transportation Network (714) 254-5277.

Have goals been achieved? No, this program was not financially feasible for short distance vanpooling.

Solution timeline: The program ran for one year and has been completed.

3.25 Community Transit / Car-Pooling Internet Site

Critical Program Area: Public Traveler Services / Public Mobility Services

Overall goal: The goal of this Internet site is to improve the accessibility of transit service information to potential users. A secondary goal of the car-pooling service offered by this transit authority is to track the patterns of ride-share travel requests. The authority uses this information when considering where to introduce new routes.

Technical approach: The Community Transit Agency of York County provides fixed-route service scheduling information, paratransit service information and a car-pool / ride-share matching service on an Internet site. The agency sees this as a long-term business investment as they can trace where patterns of travel are occurring then introduce bus services there in the future if economical. Individuals interested in the ride-share matching service fill out an on-line form. Information is added to a database that is surveyed by people providing rides. In addition, the authority also offers services tailored to the travel needs of the employees of local businesses. Shuttle services are provided for various groups of night-shift workers, for example, often partially subsidized by the employer.

Current status: The web site has been active since May, 1996. The site can be accessed at http://www.cyberia.com/communitytransit/.

Location / geographic scope: The web site provides information for residents of York County, Pennsylvania. The county has an area of approximately 900 square miles. The transit authority operates fifty vehicles at present. The majority of these travelers use transit to commute to York City, Baltimore, or Harrisburg.

Agencies involved: York County Transit Authority

Cost information: The precise costs involved in running the Internet site not yet available.

Key contact: Steve Bland. York County Transit Authority. (7 17) 846-5562

Have goals been achieved? The authority reports that it is pleased with the response to the Internet site. 139 people had accessed the page from August 29 to October 22, 1996.

Solution timeline: The site is fully operational. No expansion of services is currently planned.

3.26 Smart Parking Meters

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To increase parking meter revenue by resetting parking meters when each car leaves a parking space.

Technical approach: Meters contain sensing technology to determine when a vehicle has left a parking space. It then resets the meter to zero, requiring each new driver to put money in the meter. Programming options can also enforce the maximum amount of time allowed in a parking space and will record when the meter last expired. A hand held computer is used to collect information from **the** meters. Information is then downloaded to a PC, which is used to process information about the meters, including the average duration of parking, most popular times for the meter and duration of unpaid parking. To defray criticism of the meters, mostly from local retailers, drivers are given five free minutes when they enter the space and five grace minutes after their paid time expires.

Current status: Fifty-eight meters were converted to include sensor technology and tested for a one year trial.

Location / geographic scope: The system has been piloted in the Borough of New Hope, Pennsylvania. Meters with sensors can be used anywhere a parking meter is appropriate.

Agencies involved: Borough of New Hope Police Department.

Cost information: The equipment cost $2,200 per quarter for all 58 meters for a 5-year lease. The meters can be purchased for approximately $4,000 to $5,000 each.

Key contacts: Chief Robert Brobson, Borough of New Hope. (215) 862-3033
Vince Yost. (610) 584-8830

Have goals been achieved? Meter revenues have increased by more than 50 percent since the new meters were installed, which more than covers the increased cost of the meters.

Solution timeline: Approximately one sixth of New Hope’s meters have been converted. The Borough of New Hope has long term plans to replace the remaining 250 meters.

3.27 Pagers Replacing Photo-Cells for Highway Lighting

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: The goal of this concept is to reduce the cost of highway lighting.

Technical approach: The concept involves activating highway lighting using pagers rather than photo-cells. Researchers calculate savings of between 15 and 30 minutes of lighting per day per circuit, which applied over a whole network could result in substantial energy savings.

Current status: Laboratory testing has taken place, and plans are being made to install approximately six pilot systems to test in the real environment.

Location / geographic scope: Testing will take place in Indiana. The concept would be applicable nationwide.

Agencies involved: Indiana DOT

Cost information: It is estimated that it would cost approximately $100 per pager unit and $5 per month per number for the paging service costs, though multiple units can be triggered by one paging number. Software to govern the system will also be required - in the case of the pilot testing this is being developed in-house.

Key contact: Dan Shamo. Indiana DOT. (317) 232-5523

Have goals been achieved? Pilot testing has not yet taken place.

Solution timeline: Implementation plans will be based on the results of the pilot testing.

3.28 Automated Anti- / De-Icing on Underpasses

Critical Program Area: Infi-astructure Operating and Maintenance

Overall goal: The goal of this NCHRP-Idea project is to enable remote application of anti- and de-icing fluids to an underpass.

Technical approach: This system uses a variety of atmospheric and pavement sensors to detect when anti- and de-icing fluids should be applied to an underpass. The application is performed automatically when required using spray equipment mounted on the bridge parapet above. The system reports to maintenance personnel when fluids have been applied. Maintenance personnel can call into the system using cell-phones to override the sensors and activate the fluid application. It is also possible to call into the system to monitor its current status and to obtain readings from the sensors.

Current status: The hardware was installed in the fall of 1996 for system pilot testing during the 1996- 1997 winter season.

Location / geographic scope: The system is being tested on an underpass on I-2 15 in Utah.

Agencies involved: Utah DOT Maintenance Planning Region 2, FHWA, University of Utah

Cost information: The cost of the system hardware is between $20,000 and $25,000.

Key contact: Doug Anderson, UDOT Research. (801) 965-4377

Have goals been achieved? Results are not yet available.

Solution timeline: This one year project should be completed in mid-1997. Plans for implementation will be based on the results available at that time.

3.29 Cable TV for Signal Coordination

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To control traffic signals and revise timing plans remotely via cable television to address any changes in the traffic flow efficiently and cost effectively.

Technical approach: Cable television is used to communicate signal timing schemes to 98 percent of the City's on-line signals. The City has two-way communications with signal controllers utilizing the cable company's fiber system. The system allows for readjustment of signal timing for incidents, monitors preemption, and notes any incoming communications from the signal regarding broken signal head or other malfunction. Further, the system provides confirmation that appropriate data has been received and implemented at the signal site.

Current status: City traffic engineers have been changing signal timing via cable television for 10 years.

Location / geographic scope: The cable franchise provides coverage for the City of Richardson, Texas.

Agencies involved: Richardson, Texas.

Cost information: There is no cost involved, the cable company utilizes the City's right-of-way in exchange for fiber service to the traffic signals.

Key contact(s): Paul Purvis, Traffic Engineer. (972) 238-4277.

Have goals been achieved? Yes, this program has been successful for 10 years.

Solution timeline: This project is on-going.

3.30 Inter-Agency Signal Master System

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To improve the operations of local traffic signal systems and to increase the options interagency signal control.

Technical approach: A micro-computer based traffic signal control system has been developed which interfaces type 170 intersection controllers. The system, which operates in a Windows environment and can monitor over 10,000 intersections, can store up to 15 years of data on a single optical disk. The system can transmit data simultaneously over a variety of communications media including voice grade telephone lines, fiber optic cable, and cellular, packet, and spread spectrum radio. The system can also automatically page a standby technician to report intersection and equipment failures. Technicians can then access the main computer with a notebook computer via cellular phone. The system is able to monitor the signals of multiple agencies, such as city, county, and state systems.

Current status: In 1993, a DOS version of the system was initially implemented, which was followed by a Windows version. The system is scheduled to be upgraded to Windows NT in November, 1996. 280 intersections are currently covered by the system, and an additional 220 intersections are due to be added to the system in the near future.

Location / geographic scope: The system is being used to operate intersections in Colorado Springs, Colorado.

Agencies involved: City of Colorado Springs, Traffic Engineering Department.

Cost information: The system cost approximately $500,000 to develop and implement.

Key contact: John Merritt, Principal Traffic Engineer, City of Colorado Springs. (719) 578- 6663

Have goals been achieved? The system has proved highly successful, and plans are in place to implement it elsewhere in the state.

Solution timeline: The system will soon be implemented in Boulder and Loveland, Colorado.

3.31 Interfacing Information for Highway Safety

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To identify and analyze high-accident locations and determine appropriate measures to improve safety.

Technical approach: Database software links accident information provided by the New York State Centralized Local Accident Surveillance System with site-specific local traffic counts. Accident rates for individual intersections are then compared with average rates for the appropriate road classification, such as urban, suburban, or rural roads. Intersections with higher than normal accident rates for their classification can then be identified. Investigators use this data to consider accident patterns and recommend suitable road improvements.

Current status: The system has been in operation in Monroe County, New York for seven years.

Location / geographic scope: As this system relies on the New York State Centralized Local Accident Surveillance System for accident information on Monroe County, this system would only be applicable to areas in New York State. Other areas, however, could probably perform this tracking themselves, allowing transfer of the system to other localities.

Agencies involved: Monroe County Department of Transportation, New York State Department of Transportation.

Cost information: No precise cost details are presently available. The cost of implementing the system includes the cost of a traffic engineer and / or technician, a computing system capable of running Paradox, and the Paradox database application.

Key contact: Alan Stiehler, Monroe County Department of Transportation. (716) 274-7927

Have goals been achieved? Since the introduction of the system, around 300 high accident locations have been identified and engineering improvements have been made to about 75 percent of these sites.

Solution timeline: No plans exist at present to transfer the system to other locations.

3.32 Sign Inventory

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To maintain a computerized database of the city's signs. This allows the city to track the maintenance and lifetime of the signs, predict which signs will need replacements, and make cost projections.

Technical approach: A list of all signs, along with information such as location, age, and cost is kept in a spreadsheet.

Current status: The system is fully operational.

Location / geographic scope: The sign inventory has been implemented in the city of Bryan, Texas, which has a population of 55,000. It is believed that the solution could be transferable to any similar sized municipality.

Agencies involved: The City of Bryan, Texas,

Cost information: Precise cost details are not available. This system requires the use of a spreadsheet and a staff person to maintain it.

Key contact: J.W. Chism, Texas A&M. (409) 845-4457

Have goals been achieved? Yes.

Solution timeline: This system is in operation. No plans exist at present to implement the system elsewhere.

3.33 Electronic Engineers' Estimator

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To reduce data entry errors and streamline the process of preparing and submitting an Engineers Estimator Worksheet, which is required for every transportation project in the state of Michigan, by computerizing the worksheet.

Technical approach: In the past, this worksheet has been completed by hand and then submitted to Michigan DOT, where it was then entered into a computer. A mistake or modification meant that the entire worksheet had to be completed again and resubmitted. The worksheet can now be completed by an engineer using a computer program. The system pulls up work numbers and units of measure automatically, to ensure that data is consistent. Arithmetic is also automated to minimize errors. When the worksheet is finished, it is exported to BAMS, a software program developed by AASHTO. This program modifies the data into the appropriate format, after which it is submitted electronically to MDOT, removing the opportunity for data entry errors. The worksheet can be submitted by various methods, including magnetic disks or as an attachment to an electronic message.

Current status: Prototype screens were shown to engineers in Oakland and Washtenaw Counties to get feedback on how the worksheet should look and function. A prototype worksheet is in development and is scheduled to be distributed to Oakland, Washtenaw, and Bay Counties in December, 1996.

Location / geographic scope: The electronic worksheet has been developed specifically for Michigan. It may be adaptable for other states.

Agencies involved: Oakland County, Washtenaw County, Bay County, Michigan Department of Transportation, Michigan Technological University

Cost information: The worksheet will cost $18,000 for development and pressing of 1,000 CDs. The electronic worksheet is available free to local agencies in Michigan from the Department of Transportation.

Key contact: Terry McNinch, LTAP Program Manager. (906) 487-2102

Have goals been achieved? The system is in the final stages of development. Oakland and Washtenaw Counties will use the prototype in December, 1996 to determine its usability.

Solution timeline: The worksheet should be available for distribution in January, 1997. The worksheet will be part of a CD containing publications, including standards documents and construction guides. Later versions are likely to contain additional publications.

3.34 Roadsoft Software

Critical Program Area: Infrastructure Operating and Maintenance

Overall goal: To inventory road conditions, determine pavement deterioration rates, and prepare cost estimates for road maintenance.

Technical approach: The system uses legacy and crash data for all roads in a county to determine road surface quality, deterioration rates, and accident rates for different types of road. The system was developed by surveying local agencies to determine what tools were needed.

Current status: The software is available free for local agencies in Michigan. The current referencing system is county based; in 1998 referencing will be updated to GIS. This upgrade will include tools to evaluate the safety of different surface types.

Location / geographic scope: The software was developed for use anywhere in Michigan. Currently, 8 1 of the 83 counties in Michigan, 40 cities, and 5 municipal planning organizations are using the software.

Agencies involved: County Road Association of Michigan, Michigan Department of Transportation, Office of Highway Safety Planning, and Michigan Technological University.

Cost information: The software is free to local transportation agencies in Michigan. MDOT is spending approximately $400,000 per year to maintain and upgrade the system.

Key contact: Derek Calomeni, Director of Technology Development Group. (906) 487-2981

Have goals been achieved? Yes.

Solution timeline: The solution has been implemented. Software is constantly being upgraded to incorporate new features.

3.35 Computerized Maintenance Fleet Inspection Process

Critical Program Area: Fleet Operating and Maintenance

Overall goal: To facilitate the fleet vehicle inspections and reduce input redundancy.

Technical approach: A pen-based computer is used for maintaining routine fleet vehicle information (i.e. identification numbers, and previous year's facts and figures) and updating current conditions (i.e. mileage) in a table format for tracking purposes. This fleet management application allows for convenient access to the vehicle's (i.e. trucks, snowplows, cars, front-end loaders) history and easy input capabilities via a table based software for the updating vehicle data.

Current status: The program is implemented and revisions are being implemented to make it an even smoother operation.

Location / geographic scope: This program is currently active at the Indiana Department of Transportation district level.

Agencies involved: Indiana Department of Transportation.

Cost information: The costs were not available.

Key contact(s): Dan Shamo, ITS Program Engineer. (3 17) 232-5523

Have goals been achieved? Yes, the district level deployment is successful.

Solution timeline: This project will be fully deployed statewide by Fall, 1997.

3.36 GPS Location System for Maintenance Vehicles

Critical Program Area: Fleet Operating and Maintenance

Overall goal: To locate vehicles and deploy to incident sites for congestion mitigation, or special applications, such as salting and snow plowing, thus maintaining smooth traffic flows.

Technical approach: The installation of Global Positioning Station (GPS) equipment on all fleet vehicles allows for quick location identification and deployment.

Current status: This project is in the planning stage, as negotiations with the state department of transportation are on-going to obtain funding for this endeavor.

Location / geographic scope: Currently, this project is planned utilizing Dane County as a test site. Upon successful completion, GPS will be applied on a statewide basis.

Agencies involved: Dane County and the Wisconsin Department of Transportation.

Cost information: Costs are not yet available because it has not yet been determined which system to invest in (i.e. system costs range between $300 and 2,000 per unit).

Key contact(s): John Norwell, Dane County. (608) 266-4261

Have goals been achieved? The goals have not been achieved yet as this application is still in the planning stage.

Solution timeline: This project has not yet been funded. However, officials are hoping to implement in 1997.

3.37 Electronic Proof of Insurance System

Critical Program Area: Commercial Vehicle Operations

Overall goal: To facilitate and increase the efficiency of processing of motor carrier liability forms.

Technical approach: An electronic form has been developed to replace the paper form used for filing motor carrier liability coverage forms. Insurance companies can now submit either the paper or the electronic form, which is based on the Electronic Data Interchange (EDI) standard.

Current status: An operational test of the electronic form system has been in progress for eight months.

Location / geographic scope: The system is being tested throughout Minnesota and may be expanded to include other insurance agencies and other states.

Agencies involved: Great West Casualty Insurance, Minnesota Department of Transportation, and the ATA Foundation.

Cost information: No precise costs are currently available on the cost of developing the system. The cost to an agency that wants to begin using the electronic form includes the cost of programming the mapping and a transaction charge.

Key contacts: Chris Conway, MnDOT. (612) 296-0267
Dan Murray, ATA Foundation. (612) 64l-6162

Have goals been achieved? The results of the operational test are not yet available.

Solution timeline: The operational test is scheduled to commence in December, 1996 with one insurance company participating. Mn/DOT is actively pursuing other insurance companies to join the project.

4. PROJECT OVERVIEW AND APPROACH

This section provides further details on the approach taken to identify and document the simple solutions. Some additional findings that resulted from the research process are also outlined.

4.1 Identification of Candidate Simple Solutions

During phase A of the project, a national search was conducted to identify and describe a series of simple solutions with potential for meeting the needs of rural transportation users. The purpose of this initial research was to collect and present adequate information about each solution to allow members of the project's review team to select a subset of the solutions for further investigation in phase B.

The emphasis of this search was on identifying technology-based, effective, practical solutions for existing or potential problems. Identifying these solutions involved three primary steps, described as follows:

Step One - Identify focus areas, potential sites and contacts

The first step in identifying the simple solutions comprised desk-research to define the project focus areas and to identify a set of candidate locations and/or contact names for follow-up investigation. The key focus areas for this project were based on the Critical Program Areas (CPAs) defined in the U.S. DOT Advanced Rural Transportation Systems Strategic Plan. Table 1 illustrates the seven CPAs used to define rural ITS against three types of site configurations (site specific, corridor-wide and region-wide). The focus of this project was to identify solutions that were compatible with the resulting cells in Table 1.

In addition to the focus areas, Step One of the research also identified candidate locations and contacts that may be used to perform the national search. A contact list was assembled that included individuals from each FHWA region. Examples of the types of individuals who formed these key contacts included local level transportation professionals, district engineers, city and county engineers, and state ITS coordinators. The following list identifies some of the publications that were used in this step:

- State DOT directories and mailing lists.
- Publications of state DOTs and Web pages maintained by these agencies.
- Publications of the State Chapters of the Intelligent Transportation Society of America and Web pages maintained by these organizations.
- Proceedings of the annual Rural ITS Conferences, up to and including the 1996 Conference in Spokane, Washington.
- The Rural ITS Conference attendance list.
- Technology transfer / local technical assistance program (LTAP) monthly newsletters.
- National LTAP Conference attendance lists.

- Proceedings of the annual meetings of the Intelligent Transportation Society of America.
- Proceedings of the ITS World Congresses.
- The ITS America Clearinghouse.

Table 1 Simple Solution Categories

CRITICAL PROGRAM AREAS	SITE CONFIGURATIONS		
	SITE-SPECIFIC	CORRIDOR-WIDE	REGION-WIDE
Traveler Safety and Security			
Emergency Services			
Tourism and Travel Information Services			
Public Traveler Services / Public Mobility Services			
Infrastructure Operation and Maintenance			
Fleet Operation and Maintenance			
Commercial Vehicle Operations			

Step Two - Initial contact and investigation

Individuals identified in Step One were contacted via individual telephone calls, broadcast e-mails, broadcast fax letters, and in-person visits. Appropriate professionals in at least one state from each FHWA region were contacted. In addition to contacting individuals, outreach was performed at the following events which are attended by local level transportation professionals:

- 1996 Annual Conference of the Local Technical Assistance Programs / Technology Transfer Centers in New Orleans, Louisiana.
- 1996 Rural ITS Conference in Spokane, Washington.
- Highway Visibility Conference in Huntsville, Alabama.
- ITS America Rural ITS Outreach Working Group's rural tour.

Secondary contact names provided by those individuals or agencies initially contacted were also utilized. Upon completion of this step, 5 1 candidate simple solutions were identified and documented.

Step Three - Follow-on investigations

The third step involved researching the candidate applications by following up leads provided by initial contacts, and using tools such as the Internet and literature searches in order to learn as much as possible about applications of potential interest. The data collected for each simple solution identified within phase A were as follows. It should be noted that, dependant on the status and scope of the individual projects studied, some of these items were not applicable in all cases.

1. Name of project or activity.
2. Overall goal of solution.
3. Description of technical approach.
4. Current status, for example, proposed application, research / pilot testing, operational test, full deployment.
5. Location, and geographic scope if applicable, road class.
6. Agencies or individuals involved.
7. Estimated / actual overall cost of solution, funding sources.
8. Key contacts for further information.
9. Extent to which goals were achieved.
10. Details of the project or activity timeline. This could include the implementation time frame, the duration of project or activity if a finite deployment is planned, or details of the anticipated life span of a project or activity if intended as a permanent implementation.

4.2 Detailed Analysis of Selected Solutions

From the information assembled in phase A, a subset of 14 solutions was selected by FHWA as most probable for transfer to other locations. These solutions served as the focus of phase B of the project The intent of phase B was to define each solution in sufficient detail to enable transportation professionals in other rural areas to assess the potential for deploying the solution locally.

The descriptions of each solution contain the following information.

1. Brief descriptions of each application. To develop complete descriptions of the applications, the knowledge gained from the outreach activities was supplemented with research into various proceedings, technical journals and specifications. The following information was sought for each application:

- Technologies used within each application.
- Additional technologies that could accomplish similar applications.
- Estimated costs to develop or purchase necessary technologies.
- Estimated costs to operate and maintain necessary technologies.
- Estimated development levels for technologies within each application.

2. A summary of benefits of each application. The direct and indirect benefits that can be expected of each application were identified. Whenever appropriate, the following types of benefits were identified for each application:

- Benefits to travelers.
- Benefits to the community.

- Benefits to local businesses or industries.

3. ***A general description of the expected implementation process.*** The anticipated process required to implement each solution was outlined. Naturally, these processes varied for each individual solution, however the following types of issues were considered:

- What must be accomplished to implement the application, both technically and institutionally.
- Potential roles for agencies involved.
- Potential staged approaches where small scale applications can be implemented quickly and for minimal costs.
- Problems encountered in previous implementations.

4. ***A description ofpotential issues associated with each application.*** Various issues that could surface in the implementation of the solutions were documented. Although the study did not attempt to solve any issues, this step was intended to inform the audience about what issues could potentially prevent full-scale implementation. Efforts were focused on identifying technical, institutional, and funding issues.

5. ***A description of each solution's contribution to broader rural ITS developments.*** The final step involved considering how the application could be an active part of a much larger scale ITS deployment. For purposes of this study, the following framework was used to describe a potential role for each solution in the nationwide ITS program.

Rural Traveler Information. When deployed, traveler information systems will make real-time or static information available to the rural traveling public to assist them in travel decisions and to enhance their individual trips. These systems may be regional, corridor-wide, or site-specific, and may offer pre-trip or en-route information. Because the amount of information that is available for rural areas is often limited or non-existent, rural traveler information systems may support mechanisms for data collection and information processing, or interface with one or more of the limited information sources.

Rural Traffic Control. Traffic control systems will control drivers' actions by advisory or regulatory signs, signals, or systems. Where traveler information systems provide information to allow travelers to make decisions, control systems advise specific activities based upon current conditions, situations, or events.

Rural Roadway Management. Rural roadway management systems describe all devices and operations that are directed towards maintaining effective operations along roadways. This involves road maintenance, infrastructure design, and construction. The uses for these systems aim to assist the available staff within the transportation agencies in providing a useful road network that meets the needs of the traveling public.

Personal Mobility Management. The personal mobility systems function to increase the mobility of rural residents who either are not able to or choose not to drive single occupant vehicles. While these solutions will not necessarily deliver transit services to rural residents, the function is to help manage and maintain the viability of any infrastructures that exist to provide such services, and to ensure that residents are able to make use of such systems.

Rural Emergency and Incident Management. The term incident management implies detection, response to, and/or removal of those events causing operational problems or endangering motorists. Traffic accidents are not the sole contributors to such scenarios - various recurring or non-recurring events constitute incidents. Beyond the obvious, incidents can include such non-recurring events as stalled vehicles, double or illegally parked cars, signal malfunctions, inclement weather; or such recurring events as commuter-peak periods, sporting events, or other major crowd attractions. In a rural environment, incidents could also include farming related events or accidents, and natural disasters requiring evacuation or other support. The emergency and incident management systems will help transportation professionals detect and respond to such incidents in rapid fashion.

Automatic Payment. The automatic payment applications will assist travelers in obtaining a variety of services by offering mechanisms for automatic payment of services.

4.3 Summary of Results

Phase A:

The results of the phase A - Identification of Candidate Simple Solutions, resulted in 5 1 candidate solutions. The following table identifies the names of each solution and places each solution into one of the seven rural ITS program areas and into one of three site configurations.

Table 2. Overview of Candidate Solutions.

REPRESENTATIVE MARKETS	SITE CONFIGURATIONS: SITE-SPECIFIC	CORRIDOR-WIDE	REGION-WIDE
Traveler Safety network and Security	Work zone signage using CMS Low cost visibility sensor Pager school-crossing beacons activation Site management in avalanches Bicycle tunnel warning system Bicycle / auto roadway sharing Ice on bridge warning system Radar detector activation Speed advisories during fog, Speed advisory on curve Portable speed detection	Automated visibility warning system Corridor management during avalanches	Emergency managers weather information Weather by fax Weather by telephone NOAA weather radio Private sector Internet weather providers Grade-crossing GIS database
Emergency Services	Rural coordinate addressing system Siren-activated signal pre-emption		Automated field reporting Automation of radio comm. paper logs Interagency dispatch / reporting coordination Total stations for accident investigation
Tourism and Travel Information Services	City food / lodging / attractions information web pages	Incident management using VMS	
Public Traveler Services / Public Mobility Services	Radio-controlled crosswalk push-buttons for handicapped Talking signs for visually impaired pedestrians Smart-key payment for parking meters	Self-drive dynamic van pooling program	Community Transit / Car-pooling Internet site Multi-service provider dynamic dispatching system

Table 2. Overview of Candidate Solutions (continued).

Infrastructure Operating and Maintenance	Smart parking meters	Smartsonic sensor for traffic applications Pagers replacing photo-cells for highway lighting Automated anti- / de-icing on underpasses Dynamic "lane drop smoothing" using CMS	IR pavement sensor monitoring Sign inventory County Road Commission Internet site Interagency signal master system Interfacing information for highway safety Electronic engineers estimator Roadsoft Software Cable TV for signal coordination
Fleet Operating and Maintenance	Computerized maintenance fleet inspection process		Snow route design optimization software GPS location system for maintenance vehicles
Commercial Vehicle Operations	Truck speed warning system		Electronic proof of insurance system

Phase B:

The conclusion of phase B resulted in detailed definitions of fourteen simple solutions. Part of each solution's definition was a description of its potential contribution to broader rural ITS developments. Figure 1 illustrates theoretical categories for such developments and identifies where each solution may play a part.

In the process of identifying and investigating candidate simple solutions, very many Federal, state and local transportation practitioners were interviewed. This process enabled the interviewers to gain valuable insights into the organizational, institutional and financial perspectives of numerous types of agency concerning the application of new technologies. Of particular interest in this study were perspectives of local agencies, who in many cases took the initiative to develop their own, local, solutions to meet their local needs.

In terms of the process of solution identification, it was found that in order to identify applications qualifying as simple solutions it was necessary to use the contact list as merely the first stage of the survey process. In the case of state level DOT contacts, for example, the interviewer was frequently referred to a district level contact and then subsequently to a city or county engineer.

The roles of agencies in technology development and implementation, and the form of cost- sharing during systems development, was different in almost each case investigated. In some cases, technology research and pilot testing had been performed at the state DOT level, and then systems had been adopted by districts, counties or cities either wholly or partly subsidized by the state, or after systems were purchased at cost by the local agencies.

In other cases, an agency such as a district, a county, a city, a police force, a private organization, an academic institution, or a consortium consisting of these types of agency had actually conducted its own research and development. Covering the costs of these activities had been achieved in a variety of ways. Some projects had obtained seed money from the state to perform research. Subsequent funding to further develop and implement systems was then generated locally. In other projects, a private organization working with a local public agency had funded proof-of-concept activities, after which subsequent funding for development was provided by the local agency. In this latter scenario, private companies were sometimes developing new systems to solve a local problem, and were sometimes adapting an existing product to meet a local need.

In yet another case, seed money had been generated locally, then once initial research had yielded positive results, state and federal funds were secured to develop the system. At the other end of the funding continuum, many simple solutions had been created solely with local funds, from initial concept development through to deployment and continuing operation and maintenance of the system.

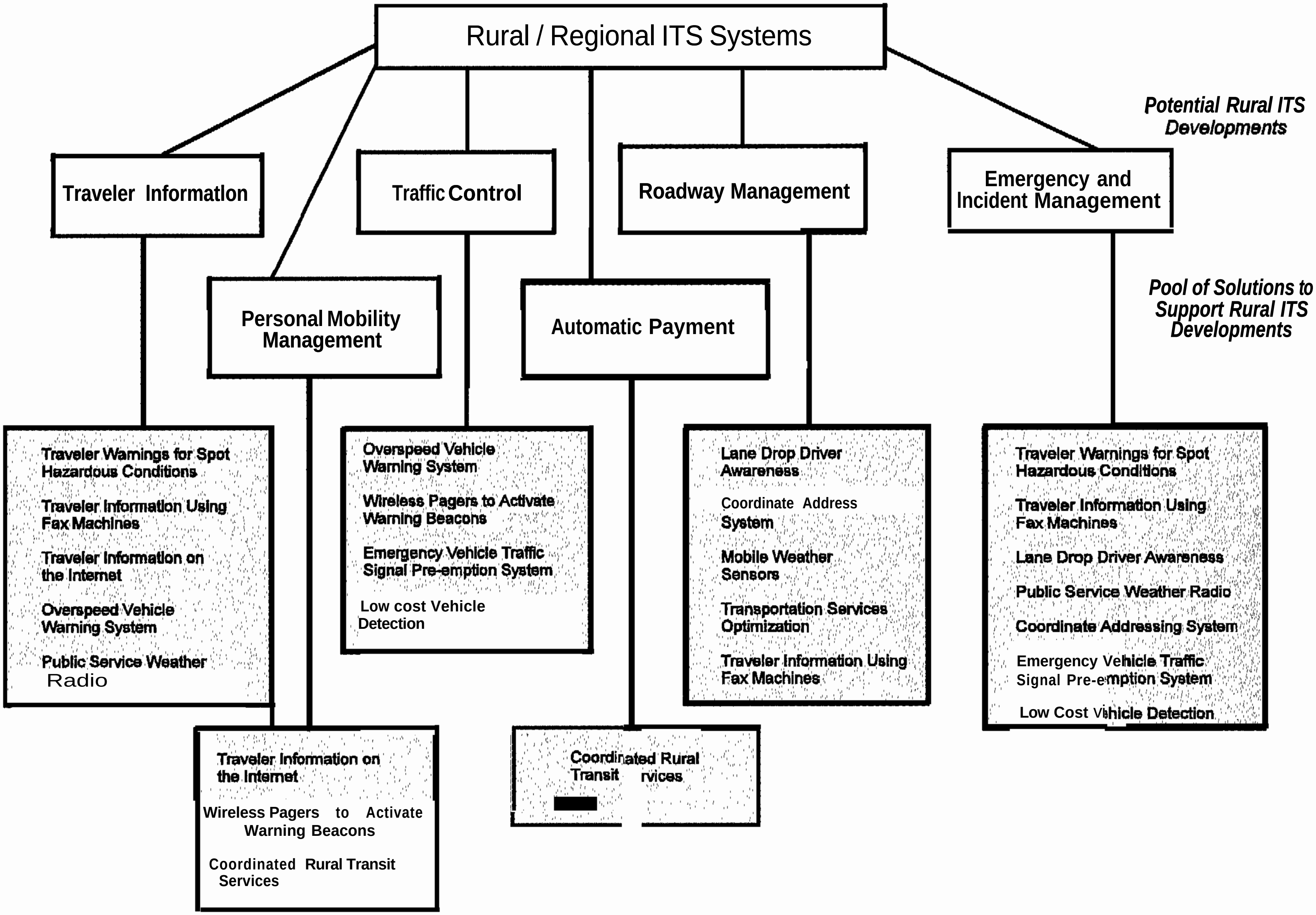


Figure 1. Illustration of Selected Solutions in Overall Rural ITS Development.

The roles that advanced transportation technologies play in rural communities may go further than meeting the primary objective of, for example, improving safety at a particular location, or streamlining a certain maintenance operation. Rural communities can often face low economic stability that directly impacts the livelihood of local businesses. In many situations, the nation's interstate network draws travelers away from routes that pass through local communities. The establishment of "strip mall" developments along the same interstate may further deplete the community of potential income. Within these rural communities, residents often face difficulties in obtaining information about nearby services or traveling to nearby businesses without owning their own vehicle. It is hoped that the implementation of simple solutions such as those described in this report will help contribute to the economic development and community enrichment of rural areas in addition to fulfilling their respective primary functions.

One interesting finding of the Rural Outreach Project concerns the perceptions of ITS of the majority of the local transportation professionals surveyed. During the initial survey process, many of the local level interviewees assumed that the focus of the study was on highly advanced "space age" technologies. A typical first reaction to the interviewers' introduction to the project was a statement that no applications existed in their area that could be of interest to the project. This was specially noteworthy, as it had been a conscious decision during the design of the telephone survey process that the term "ITS" would not be used in conversations with interviewees unless they themselves introduced it. This decision was made as it was correctly assumed that use of the term could dissuade some survey participants from describing their more low-tech applications which were, nevertheless, still of interest within the project.

Early in the initial interview phase it became apparent, first, that local level transportation professionals assumed that the project solely concerned ITS - which they interpreted as being blue sky ideas far removed from the daily lives of rural Americans, and second, that the small-scale technology implementations in which they were involved could not be considered ITS. Once this pattern emerged, interviewers were careful to persist when first told that the interviewee knew of no appropriate systems implemented locally. It appeared as though local level practitioners believed their own systems to be too modest to be associated with the ITS label.

A related conclusion that can be drawn from the experience of speaking with local agency personnel is that the anticipated future phases of the Rural Outreach Project will be extremely valuable. Using the findings documented in this report, it is hoped that follow-up activities can be performed to undertake outreach and education on the benefits of technology applications in general, and ITS in particular. The recipients of this outreach will, in some cases, be the individuals contacted as part of the research phase, as information on peers' initiatives is shared.

It is hoped that the documentation resulting from the Rural Outreach Project will be effective in communicating to local agencies that their solutions can be applied in alternative geographic locations, and that maybe they can benefit from the simple solutions put into place by similar agencies elsewhere. The value of these activities being undertaken under the auspices of the Rural Outreach Project cannot be overemphasized as, in general, the individuals who are working to develop and implement simple solutions do not necessarily consider producing papers, journal articles, or otherwise publicizing their local successes.

In essence, the project established that numerous low-cost, small-scale, localized implementations of technology are in place across the country. Many of the agencies responsible for developing and implementing these systems did not perceive them to be "intelligent transportation systems" as such, nor as being precursors to ITS. It is believed that this finding is significant, as it indicates that intelligent transportation systems are not only being implemented in a "top down" manner in response to nationally-led programs, but that a "bottom up" process is also underway, as local agencies take the initiative to design and deploy systems that meet their own needs.

In addition to the many specific examples of simple solutions that were unearthed during the study, a noteworthy finding was the ingenuity of local agencies in working around the issue of how the development and deployment of their local solutions could be funded. Agencies revealed great flexibility and adaptability in obtaining and maintaining funding for local projects, entering into a wide variety of cost-sharing models with private or other public agencies.