TECHBRIEF

The national Intelligent Transportation Systems (ITS) program includes the development and application of advanced systems upon all parts of the transportation network, including rural areas. The U.S. DOT has developed the Advanced Rural Transportation Systems (ARTS) program to meet the needs of travelers in and through rural areas, as well as the agencies responsible for the operation and maintenance of the rural transportation system. The ARTS program complements the ITS efforts in metropolitan areas and commerical vehicle operations (CVO) by studying ways to best implement technologies that address transportation problems in rural areas.

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Advanced Traveler Information Systems (ATIS)

Development and Testing of a Surveillance and Delay Advisory System for Rural Areas

and

Evaluation of Satellite Communications System for Mayday Applications

Publication No. FHWA-RD-99-116
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In early 1993, the Federal Highway Administration (FHWA) initiated a comprehensive study of rural applications of Advanced Traveler Information Systems (ATIS). The study objectives were to guide Federal programs with respect to Intelligent Transportation Systems (ITS) technologies in rural and small urban areas and to provide guidelines for ATIS implementation by State and local governments to meet rural travelers' needs. A series of concepts have subsequently been developed in response to the needs of travelers in rural and small urban areas. Two concepts are highlighted in this TechBrief — Traveler Services Information and Emergency Response.

DEVELOPMENT AND TESTING OF A SURVEILLANCE AND DELAY ADVISORY SYSTEM FOR RURAL AREAS

Background

Travelers in rural areas are often faced with traffic congestion and excessive delays when traveling through construction areas or at approaches to rural attractions. Due to a lack of alternate routes, the impact of traffic congestion in rural areas can be more severe than in urban areas. This can create costly and frustrating delays, especially when travelers have no idea of the extent of the delay until they are part of the resulting congested flow. Therefore, travelers are interested in travel-time information that reflects current conditions through these congested areas. Travel-time information is of value to traffic managers as well, as it enables them to manage the traffic through these areas. Development and initial testing of a Surveillance and Delay Advisory System (SDAS) were conducted as part of the "Rural Applications of Advanced Traveler Information Systems (ATIS)" study sponsored by FHWA.

Project Description

The SDAS was developed to enhance data collection capabilities for travel-time monitoring in congested rural areas. The SDAS employed three different data collection technologies to collect travel-time information — weigh-in-motion (WIM), video-based detection, and spot speed measurement. The system gathered data from a test zone; computed travel times and delays through the zone; and transmitted delay messages, if any significant delay occurred, to motorists traveling through the zone. The test was conducted on a section of State Route (SR) 55 in rural southern New Jersey. This section of SR 55 experiences traffic congestion during weekends in the summer due to heavy travel to the New Jersey beaches.

System Capabilities

Three methods were used to collect data for the SDAS: Two methods—WIM and video-based detection—directly measured travel times through the area, while a third method—radar detectors—involved converting spot speed measurements into travel times. Data from each method were used to independently compute the delay time through the desired area. The communications for the SDAS can be broken down into two types: (1) from the data collection device to the central processor and (2) from the central processor to the dissemination interface. The data processing involved receiving data, performing delay-time computation, and formulating and delivering the appropriate messages to the traveler interfaces. Changeable message signs (CMS) and highway advisory radio (HAR) were used to disseminate information to travelers.

Project Goals/Objectives

The purpose of this work was to develop a travel-time monitoring system using various technologies and to evaluate the system for its application in a rural setting. The system was developed to enhance data collection capabilities for travel-time monitoring in rural areas. The initial testing of the SDAS helped to achieve the following goals:

- The accuracy of spot speed conversion to travel times using three different algorithms was determined under a limited range of operating speeds.
- Travel times computed from spot mean speed versus space mean speed were compared under a limited range of operating speeds.
- It was determined that when certain WIM conditions are met, automatic vehicle identification (AVI) applications are effective in travel-time monitoring.
- It was determined that under free-flow speed operating conditions, less than 2 percent of AVI matches are needed to compute reliable travel times.
- Although the system was designed to be capable of relaying delay information to travelers, this capability was not tested due to lack of extensive delay during the test period.
- The SDAS was cost-effectively prototyped and tested in a rural setting.

Future Activities

The tests conducted under this project provided valuable insight regarding applications of various technologies for travel-time monitoring in rural areas; however, additional work is required prior to actual implementation of such systems. The bulk of this work consists of validating travel-time calculations under a range of operating speeds. With respect to WIM technologies, the following work is recommended:

- Calibrate WIM sensors to peak accuracy.
- Collect a set of data during actual delay conditions and correlate it with data collected by other manual or video AVI methods possibly using specific test vehicles.
- Axle spacing, axle weight, and time window tolerance should be adjusted to optimize matching performance on the test data.
- Test runs should be made with specific vehicles to evaluate matching performance when the vehicle speed differs from one site to the next and to find out the lowest speed at which matches can be reliably made.
- The data for matched two-axle vehicles should be analyzed to see if valid matches are being made for long wheel-base vehicles or if all two-axle vehicles should simply be ignored.

The following work with spot speed detectors is recommended:

- Different manufacturers of radar detectors should be evaluated (given the difficulties experienced doing this test).
- More testing of the spot speed technology is needed. Spacing between detectors should be 1.61 km (1 mi) or less for reasonable travel-time computations.
- Alternate sources of power should be explored to replace gel cell batteries. A standard power drop would be ideal; however, in many rural areas it is not available.
- If daisy-chain communications are not desirable, additional modes of communication should be explored, possibly spread-spectrum radio or telephone lines, if available.

Finally, for video-based travel-time computations, recommendations for future activities are as follows:

- It would be desirable to repeat the testing when seasonal traffic creates congestion. Such a test would provide support to the claims that the use of video in congested traffic might be useful in travel-time computations.
- Enhancements to the matching algorithm include improved robustness over varying lighting and weather conditions. In addition, remote camera control capabilities are planned that would enhance low-light operations.

The technology shows promise for rural areas that experience delays. However, additional testing is recommended.

The project partners are: SAIC, TransCore, New Jersey DOT, International Road Dynamics (IRD), and Nestor Inc.

EVALUATION OF SATELLITE COMMUNICATIONS SYSTEM FOR MAYDAY APPLICATIONS

Background

Approximately 60 percent of all fatal accidents occur in rural areas. Travel speeds are higher and travel density (the ratio of vehicle-miles to highway-miles) is lower in rural areas than in urban and suburban areas. Other factors influencing the disproportionate share of rural fatalities include the additional time required to notify emergency service providers and the length of time for these service providers to respond to the incidents. In fact, data from the Fatal Accident Reporting System (FARS) show that it takes almost twice as long to be notified of rural incidents involving fatalities compared to urban incidents (8.38 min versus 4.35 min). The significant human and monetary losses associated with these accidents could be reduced through an effective "Mayday" system capable of responding rapidly to motor vehicle accidents and other traffic incidents. The reduction in response time achieved by such a system could significantly improve victim survival rates and decrease the severity of injuries by providing victims with more timely medical attention. Recognizing that wireless communications (e.g., cellular telephone) in rural areas are not expected to provide ubiquitous coverage, this project focused on studying satellite communications systems that could provide full coverage in all rural areas, as well as urban areas, and could be integrated into a Mayday system.

Project Description

The project was specifically tasked to evaluate satellite communications systems that may be applied to national/regional Mayday systems. The work included the research into and testing of current and near-future geosynchronous earth orbit (GEO) and low earth orbit (LEO) satellite communications systems. Both voice and data two-way communications were considered. The research effort included the following: availability of satellite communications technology, transmission time for relaying a message from a remote location to a potential response center, estimated initial capital cost to the user, and estimated recurring cost to the user.

Evaluation Approach

Test plans were developed for evaluating systems and equipment tested based on defined functional and performance requirements. Preliminary study and testing of accuracy of vehicle position by communications satellites were also conducted. The delay time for transmission, time to transmit, time to relay transmission from satellite, and transmission/data capacity was determined. In addition, the performance was evaluated in mountainous and level terrain, under a range of geographic locations and high foliage density.

Summary and Conclusions

Satellite communications improvement over the next few years is a key element in the future viability of rural Mayday systems. Other findings determined in the study included:

- As measured in this study, satellite communications times are short enough to support an improvement in notification times to emergency responders.
- Satellite voice and data modes, or a combination of the two, can play a future role in rural Mayday systems. The preferred mode of operation will be driven by operational requirements and may change from region to region. Viable satellite systems to support these modes are available and will be even more so in the future. Mayday processing architectures are somewhat driven by data/voice considerations. Operational requirements that lead to a data or voice decision should be independent of communications carriers.
- The evolving Mayday architecture must be flexible enough to accommodate improvements and changes in the wireless product offerings scheduled for introduction into the 21st century. The wireless industry is one of the most dynamic in the high-tech business sector and no architecture can afford to be dependent on a particular mode of communications. Overall, Mayday functionality must look at communications as a transparent subsystem, with no significant difference between satellite and terrestrial systems.
- Satellite communications offerings are a private venture, and it is logical to conclude that services related to this mode of communications will be largely driven by the private sector. Therefore, it is even more of an imperative to develop a national Mayday architecture that encompasses not only the private sector, but the specialized needs of the public safety community as well.

The need for wireless communications everywhere is essential, especially in rural areas. However, recognizing that cellular coverage still has weaknesses, satellite communications show promise in rural areas. Additional testing is recommended.

For more information

The project partners are SAIC and TransCore. For more information on either of these studies, please contact Tim Penney, Office of Safety Research and Development, HRDS, (703) 285-2174.