INTELLIGENT TRANSPORTATION SYSTEMS

Billy Williams
School of Civil and Environmental Engineering, Georgia Institute of Technology, USA

Keywords: Intelligent transportation systems, telematics, system operations, system monitoring, system architecture

Contents

Summary

One of the important innovations in transportation over the past ten years has been the application of advanced sensor, computer, electronics and communications technologies to the operation of the transportation system. These applications, known as intelligent transportation systems (ITS), are primarily intended to improve both the safety and efficiency of travel flows on the transportation system. The types of ITS applications that are found in many parts of the world include regional multimodal traveler information systems, navigation positional aids to motor vehicles and ships, coordinated traffic control systems, freeway and other major road management systems, incident management systems, transit management systems, and electronic toll/fare and freight tagging systems. A major benefit of ITS applications is that information on the current performance of the transportation system can be used to inform system users of bottlenecks and alternate routes or of modal options. ITS technologies can be used as well by the operators of modal networks to respond to incidents or other events needing attention.

The major ITS applications in the world have occurred in Japan, Europe and North America. The USA has developed a national architecture that provides guidance to urban areas and private companies likely to implement an ITS system of what functions and communications technologies are necessary to be compatible with other such

systems. This architecture is specifically aimed at providing interoperability for ITS systems throughout the USA.

The benefits of ITS technologies are associated with increased safety, transportation system efficiency and economic productivity. In order to gain the full advantages of ITS technologies, however, a region-wide, multimodal system consisting of advanced surveillance and control strategies needs to be put in place. The technologies for implementing such a scheme exist, but very few urban areas have developed a system at this level of application.

1. Introduction

In most urban areas, the level of financial resources needed to fund all of the projects that are needed to improve the transportation system often far exceeds the available level of funding. In addition to funding constraints, there has been a growing appreciation worldwide of the negative impacts associated with the construction and use of the transportation system. This has led to efforts to find mobility solutions that are environmentally and economically sustainable. Accordingly, many transportation officials have begun to look at strategies that focus on the efficient utilization of the transportation system that is already in place. As noted in Chapter *Transportation System Organization, Management and Interoperability*, this is referred to as transportation system management.

In recent years, the application of advanced technologies to both the transportation infrastructure and to vehicles has been one of the most important strategies for improving the efficiency and safety of the transportation system. Known as intelligent transportation systems (ITS), the most-used technologies include those relating to sensing, computer control, electronics, and communications. Having up-to-date information on how the transportation system is performing can be useful to those responsible for managing and operating transportation services. Thus, for example, some the early applications of these technologies were on roadway surveillance and incident response. Through the use of cameras, vehicle sensors, or other forms of system monitoring, transportation managers can identify unexpected bottlenecks or breakdowns in traffic flow (such as an accident) and respond quickly. In most major urban areas, this type of system monitoring and response occurs in a centralized traffic control center.

Another early application of ITS technologies was providing information on transportation system performance to system users. When combined with information on the options available to these users in making a trip or in avoiding problems along their route, the traveler information systems that resulted became an important strategy for influencing travel behavior. Examples of this application include variable message signs on major roads informing drivers of roadway conditions ahead, transit information kiosks or message boards that inform transit users of service conditions and arrivals or delays in service, and the use of cable television or paging technologies to warn travelers before they even leave on their trip about conditions that might cause delay.

Other advances in ITS technologies over the past 10 years have resulted in more sophisticated monitoring of freight flows through bar codes and transponders, use of "smart cards" to collect fares or tolls, in-vehicle control strategies that help avoid collisions, and the use of wireless communications to provide real-time control over traffic control devices. The challenge, and perhaps the most important application of ITS technologies, will be in providing travelers with a complete picture of what is happening on the entire transportation system so they can make decisions regarding which mode to take, what route to follow, and even what time to begin the trip.

2. ITS Defined

As part of a strategy to improve the performance of the transportation system, ITS can be generally defined as the application of advanced telecommunications, computing, and sensor technologies to improve the safety, efficiency and sustainability of the transportation system. Technologies that allow users to locate themselves anywhere on the earth, known as geolocation technologies, are also playing an increasingly important role in ITS applications. In particular, they are of great use for location-specific information services and for emergency call (or mayday) systems that automatically contact the appropriate emergency medical service center in the event of a vehicle crash. The phrase "intelligent transportation systems" was officially sanctioned by the U. S. Department of Transportation (U.S. DOT) in 1994 as a replacement for the earlier title "intelligent vehicle highway systems". This action reflected the multimodal nature of emerging applications and the de-emphasis on technologies for vehicle guidance. In Europe and Asia, the preferred designation has become "intelligent transport systems", thus providing a common global acronym, ITS.

Telematics, a related term with increasing use in the field of ITS, is used inconsistently around the world. The term originated in Europe where its usage is analogous to the phrase "information technologies" and where it is often accompanied by a qualifier, the phrase "health telematics" being an example. Therefore, in this article, the European phrase "transport telematics" will be considered to be synonymous with the application of advanced information technologies in ITS strategies. In the USA, there is an emerging usage of "telematics" to describe wireless information services using in-vehicle communications and geolocation technologies.

The application of ITS technologies to improve the performance of the transportation system is a very important departure from traditional transportation decision making. Table 1 shows the difference in perspective between transportation investment decision making that focuses on capital projects as compared to the operations focus of ITS. As shown, the ITS strategies attempt to gain increased efficiencies out of the existing transportation system by providing better information to the user, as well as better coordination of transportation service provision. This new focus on system management requires an understanding of what the system users desire in terms of performance; a system-wide, interoperable operations infrastructure that allows coordinated responses to system breakdowns; an integrated approach to information sharing among not only transportation service providers, but also other key public services such as emergency response agencies; and a real-time control of system operations so that changes can be made in response to changing demand characteristics.

3. History of ITS Applications in the World

The concept of a fully controlled road system can be traced to the General Motors' Futurama exhibit at the 1939 World's Fair in New York. In this "City of Tomorrow" exhibit, visitors were shown how vehicles of the future (1960) would be electronically controlled, moving smoothly and swiftly along superhighways and surface streets. This concept, later labeled the automated highway system (AHS), was the initial focus of ITS programs in the 1960s and 1970s, with emphasis given to centrally controlled route guidance. Although AHS research activities are still being carried out, the concept of automatic vehicle control has assumed a lower profile as the field of ITS has developed over the last three decades.

The evolution of ITS has followed similar paths in Europe, Asia and North America. Highlights of ITS development in these three regions are briefly summarized below.

-
-
-

Bibliography

Institute of Transportation Engineers (2000) Intelligent Transportation Primer, Washington, D.C. (Broad overview including the historical forces that led to the development of ITS. Covers the included technologies and the issues and challenges ahead. Individual chapters written by world experts in the various aspects of ITS.)

Intelligent Transportation Society of America (2002) National Intelligent Transportation Systems Program Plan - A Ten-Year Vision, Washington D.C. (Strategic vision for ITS research and deployment in the United States prepared in cooperation with the United States Department of Transportation).

Klein, L. (2001) Sensor Technologies and Data Requirements for ITS, Boston, Artech (Highly technical presentation of requirements for the application of ITS technologies).

Papacostos C.S. and Prevadouros, P.D. (2001) Transportation Engineering and Planning (3rd edition), Upper Saddle River, New Jersey, Prentice-Hall (An up-to-date text that includes a discussion of intelligent transportation systems focused primarily on US developments, but including brief coverage of ITS in Europe and Japan.)

Biographical Sketch

Billy Williams is an assistant professor at North Carolina State University engaged in research involving the rigorous application of traffic flow theory and statistical modeling to transportation management and control. Dr. Williams received an NSF CAREER grant to study state estimation and forecasting for intelligent transportation systems and was the 2000 recipient of the Milton Pikarsky Award for the outstanding technical dissertation in transportation in the United States.