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The Potential of Intelligent Vehicle Highway Systems For Enhanced Traveler Security

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Abstract

The Intelligent Vehicle Highway System (IVHS) program that was mandated by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) presents a number of opportunities and challenges. While the program primarily is intended to address the problem of traffic congestion, the technologies it will require could also be used to enhance the safety and security of the traveling public. Public transit systems offer the most likely near-term opportunities both for IVHS-type technologies, and for new security measures to be applied. This paper will address some of the possible security functions that could be applied to transit systems by utilizing the availability of Automatic Vehicle Location systems (AVL), broadband digital communication systems, and other IVHS functions.

Introduction

Many countries are developing advanced technology systems to improve traffic flow in congested urban areas or corridors. In the United States, such improved traffic flow is the objective of the Intelligent Vehicle Highway System (IVHS). The responsibility for funding IVHS development lies with the U.S. Department of Transportation through the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). Direction and planning is a shared government/industry responsibility through an organization called IVHS AMERICA. As IVHS is currently conceived, the architecture to allow the efficient implementation of all or parts of the system is a federal responsibity, while implementation will be achieved by local governments and the private sector. Thus the architecture is all important in determining both the limits on services to be provided, and their compatibility across jurisdictions and travel modes.

While the US architecture is still in its early development stages, it is possible to describe some broad outlines of the types of services envisioned. Metropolitan traffic management centers will have access to a broad set of data from sensors, databases, mobile units, etc.to mitigate traffic flow problems. Highway capacity will be increased by providing "pods" of cars traveling very close together, linked by electronic control commands. Public fleets, such as bus fleets, will be equipped with Automatic Vehicle Location (AVL) systems and digital communication systems, permitting much more efficient management of the fleet, while providing real-time schedule information to the public.

Although this paper addresses both public and private vehicle safety and security, the bulk of it will be directed to public travel (transit), because public transportation systems generate more concern for security than do private vehicles. Thus, much of the paper will address the opportunities for security enhancements under the IVHS component for transit, which is called Advanced Public Transportation Systems (APTS), and is managed by the FTA. Nevertheless, great opportunities exist for both the private and public traveler.

Services to private autos

While the need for security services for private autos may not be as apparent as for the public transportation sector, autos constitute the great majority of surface transportation vehicles. Moreover, most of us own one or more, and thus we have a vested interest in technologies that can enhance our safety and security while traveling in them.

As was described earlier, IVHS implementation will require urban areas to set up metropolitan traffic management centers, with tremendous quantities of traffic sensor data flowing into them.

While the exact architecture of the US system has not yet been defined, as noted earlier, it is certainly possible that there will be provision for occasional data transmissions from individual vehicles to the center. At the very least, there will be data communications to and from emergency vehicles. Thus, one possible security enhancement would be to provide an "emergency beacon" service from a car to the center. For maximum usefulness, the beacon should allow for several different types of emergency codes, such as, "accident," "breakdown," and "crime, need police." In order to minimize spoofing and intentional false alarms, a reliable vehicle ID code such as the manufacturer's Vehicle Identification Number (VIN), would have to be included as well. More elaborate options would provide for a short personally-composed alphanumeric message via keyboard entry. As Global Positioning Satellite (GPS) receivers become less expensive, the vehicle could send its location as well. If not so equipped, the center could use a triangulation system to locate the vehicle, using celluar telephone technologies, much like some AVL systems currently being developed. Two-way voice communication, whatever the technology, may be too costly in terms of bandwidth and channel time, and should most likely be left to responding emergency vehicles. That decision can be a local one, and will be related to the total message traffic anticipated.

The system just described could also be employed in an automatic accident reporting mode, by having an airbag, or other high-g senor, initiate an emergency beacon transmission. In heavy urban traffic areas, especially interstate highways, rapid accident reporting is essential to being able to take immediate action to detour traffic and prevent massive tie-ups. Air bags are becoming standard equipment on automobiles, and are proving to be reliable in operation. The air bag's initiating sensor may be used as an automatic method of signaling to central traffic control that a significant accident has occurred.

The physical security of the car left in a parking lot is also important to many people. This aspect of personal vehicle security will be covered in the section on intermodal public transportation, where "park-and-ride" lots are discussed.

Public Transportation Services

AVL Systems

Automatic Vehicle Location systems (AVL) are generally considered to be most useful as bus operations management tools, but they can provide security enhancement features as well. For example, knowing where each bus is at all times could be crucial to responding rapidly to an emergency on a bus, be it a medical emergency, accident, or a criminal situation. Furthermore, with emergency response vehicles all equipped with AVL, the dispatcher can instantly dispatch the closest response unit to the bus location. Compared to current manual dispatching methods, which require two-way radio conversations with both the bus and the response unit, the AVL systems should provide significantly improved response times.

Another security advantage to AVL-equipped bus fleets is that they can provide automatic alerts to the dispatcher of an "off-route" condition, which may indicate a hijacking in progress. (Buses are regularly hijacked!) This acts as a totally passive alarm, in that it requires no action on the part of the driver, and thus is highly reliable.

Finally, AVL systems can provide important evidence in court cases involving incidents on buses, by documenting (time and location) the bus's status during the incident, especially if other data such as radio transmissions from the driver, are also recorded.

Covert Open Mike
A future IVHS-compatible bus would include the capability for direct voice over the digital data channels, or automatically set up separate voice channels using the digital control/data channel. This opens the possibility of providing an emergency listening channel for the dispatcher. A covert open microphone near the driver can be useful to the dispatcher in assessing the seriousness of an incident on a bus. In most cases, the opening of the listening channel to the dispatcher will be initiated by the driver. This procedure has the advantage that it should minimize false alarms. It also protects the driver from dispatcher-initiated monitoring, which seems to be a major concern of drivers. On the other hand, there is the issue of reliability when the open mike is initiated by the driver. If the adversary knows how the system is initiated, he can prevent the driver from doing so, or the driver may be incapaciated and unable to initiate it. The technology allows either mode, however.

Given that the system is initiated, how does it help the dispatcher? Two situations are apparent. One, is a dispute between the driver and a passenger. This is probably the most common case. Generally, the dispute is over the amount of the fare, validity of a transfer, or demands for information that the driver can't supply. By monitoring the conversation, the dispatcher can properly assess the situation and send the most appropriate type of response. The other case is a dispute between two or more passengers. The driver, at least initially, is free to take action himself, or to alert the dispatcher. In that case, it is helpful for the dispatcher to be able to assess the seriousness of the situation through the intensity of the voices. The microphone would need to have a sensitivity adjustment so that disputes in the rear of the bus are heard clearly.

Slow-Scan TV
Another useful security service that is enabled by the presence of a flexible digital data channel, is CCTV from mobile platforms such as buses, commuter rail, or even subways. It seems unlikely that there will be sufficient bandwidth to permit anything like "live" transmissions at 30 frames/ second. More likely, a slow frame rate will be required in order to accomodate the bandwidth available. The CCTV transmission could be triggered by the driver, much like the covert mike system. The transmission of one or more pictures would help the dispatcher assess the seriousness of the situation better than he or she could with just audio. Another useful technique is to transmit two pictures, taken 2-3 seconds apart. The second picture can be compressed considerably by sending only the differences from the first image. The console at the dispatcher's station would store the two frames and repeatedly toggle between them to emphasize motion.

Electronic Fare Collection
A regular source of security incidents on buses is a dispute over the correct fare, the validity of a transfer, etc. Electronic fare collection techniques can enhance security by reducing the potential for fare disputes. Some of these systems already exist and are in use (e.g., the mag stripe "debit card" in the Washington Metro.) The next generation systems are going to "smart cards" which store much more information than just the remaining balance. They can

accomodate special fares (e.g., senior citizen rates), and can be set up to be used in intermodal systems. IVHS implementation will permit an electronic exchange of information between the card and the central dispatch system and central databases to clear up the fare disputes that still remain. Again, by getting the driver out of the loop, the potential flashpoint on the bus is reduced.

Use of Digital Data Links along with AVL
IVHS systems will require data regular transmissions between central control facilities and mobile fleets. In this case, we are speaking of bus fleets and their central dispatching facilities. While many bus fleets are radio-equipped today, two-way voice links with dispatchers are often difficult and slow to establish, and unreliable as well. The advent of IVHS capabilities will provide an opportunity for transit systems to upgrade their communications, but also to tie in their own dispatch facilities to the larger metropolitan traffic management and control centers envisioned under IVHS. By the time IVHS is widely implemented, many bus fleets should be equipped with modern digital communication systems, with two-way voice capability included, Automatic Vehicle Location (AVL) systems, and digital Vehicle Area Networks (VAN) on the buses. These capabilities can be integrated with the metropolitan systems to provide greater safety and security for both the bus passengers and the general public.

Intermodal Facilities
The IVHS program puts considerable emphasis on "intermodalism," i.e., trips that utilize more than one mode of transportation. The objective is to reduce single-occupant vehicle travel to reduce congestion and pollution. Part of the solution in making intermodal transfers "seamless," that is without paying new fares, walking long distances between modes, etc. In some areas of the country, security concerns provide an impediment to increased usage of public transporation for portions of a trip. These concerns can be divided into concerns about personal safety, and concerns about security of personal property, such as a car left in a park-and-ride lot.

Personal Security
Passengers feel insecure any time they perceive themselves to be in a potentially hazardous area with no security personnel watching the area. CCTV surveillance is only a partial answer, as limited security personnel can monitor effectively only a small number of monitors. And it is clearly not cost-effective to provide security guards in all possible hazard sites. However, selective monitoring, and the availability of wide band digital communications from IVHS, either land-line (fiber optics) or over-the-air, will provide new possibilities. Take, for example, a remote Park-and-Ride lot. Bus arrivals in the evening are scheduled for specific times, and thus CCTV could be monitored for a short time as the passengers disperse to their cars, or response units could be on hand or near by at those times. Further security could be provided by providing small portable "security alert" units to passengers desiring them. These would be low-power, limited range units which could communicate an alarm to the local receiver at the lot, which would pass the alarm on to the central control via the IVHS infrastructure. The presence of CCTV would deter false alarms and provide a means of assessing alarms for validity. Similar systems could be provided to passengers on buses or subways. The latter are a particular problem because normally only one subway car in a train is manned, so there is not a reliable, fast way to signal an emergency, or potential emergency, to a motorman or conductor in another

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