Policy Implications of Driver Information Systems

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The potential effects of driver information systems (DISs) have strong policy implications for traffic management authorities. Privacy and standardization issues are of major concern when implementing electronic toll collection. Road pricing, a simple technical extension of toll collection, has profound policy implications in terms of political acceptability. Real-time traffic information is being provided by an increasing variety of technological systems with financial viability, and their market acceptance and dominance can strongly influence the future direction of dynamic route guidance. Public authorities must soon make policy decisions about their roles in facilitating multijurisdictional agreements on traffic diversion and in facilitating multimode transport choices to be made by travelers. As for driving assistance, policy decisions may help early implementation of automatic emergency signaling; issues of safety regulations and legal liability should be settled before a host of technologies for driving assistance can become marketable. DIS functions that are to provide business and personal information do not seem to have any direct policy implications for traffic management. However, to the extent that such DIS functions affect the efficiency and regulation of transport, and the marketability and future standards requirements of DIS in general, traffic management authorities cannot ignore such DIS development. The impacts of policy making and technology management are so intertwined that frequent in-depth exchange of views between policy and technology developers should be routinized through joint projects and periodic reviews.

The rapid development and amalgamation of information technology with automobile and road technologies have given rise to new programs in intelligent vehicle-highway systems (IVHSs) in Europe, Japan, North America, and other parts of the world. These programs aim to improve road transport efficiency, safety, comfort, and environment. Driver information systems (DISs) is one of the important components of IVHS that is developing rapidly and is primarily centered on the vehicle to provide motorists with information of interest to them.

The newness and the evolving nature of DIS are such that the potential impacts of these systems and the associated policy implications are difficult to predict. Technology developers and promoters understandably have concentrated on the potential benefits—individual and social—of these systems. Most of the impact assessments typically raised have tried to answer such questions as how much traffic delay can be reduced by dynamic route guidance and how much such reduction would mean economically in tangible terms (*1*). Policy issues were brought up occasionally in these assessments, but only sporadically and for the purpose of considering how to circumvent them by technology (*2*).

There have been some efforts to assess the impacts and policy implications of IVHS in Europe (*3–7*), as well as in the United States (*8,9*). However, most publications have either treated IVHS in general or discussed only a selected issue (e.g., legal liability). The objective of this paper is to provide a comprehensive framework for policy makers and advisors to monitor, assess, and influence the development of DIS from the perspective of traffic management authorities. The work in this paper was based on the author's interviews in late 1990 with a number of organizations in Europe engaged in selected PROMETHEUS and DRIVE projects. However, relevant information was also drawn from the author's knowledge of IVHS activities in Asia (especially through 5-week interviews in Japan in early 1991) and in North America (especially through IVHS activities at the University of Michigan).

In this paper, four categories of DIS will be considered:

1. Toll collection and road pricing,
2. Traffic information and route guidance,
3. Driving assistance, and
4. Business and personal information.

Because DIS is the part of IVHS that involves a great deal of technological development within the private sector that will market DIS products with or without complementary investment by the traffic management authorities, cost estimates of marketable DISs are essential input to the task of assessing realistic policy implications of DIS. Through interactions with a number of private firms, the author has assumed that the mass market for DIS will support low-end in-vehicle units (IVUs) on the order of a few hundred dollars—or the cost of a luxury car radio or an automobile air conditioner. High-end IVUs can probably sell for a few thousand dollars—or 15 to 20 percent of the price of a luxury car. For commercial vehicle operations (CVOs) and for infrastructure investment by the public sector, tangible cost-benefit analyses will be the basis for the necessary justification for DIS investment. However, this may not be sufficient, because there are other policy issues such as privacy and safety, which will be discussed in this paper. The point that should be made at the outset is that many of the policy implications of DIS are intertwined with the specific technologies to be used for DIS and their costs to the users. Therefore, each section of this paper will take a sociotechnological approach by mixing technoeconomic descriptions of DIS with policy-relevant discussions.

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TOLL COLLECTION AND ROAD PRICING

Electronic toll collection is an IVHS technology ready for deployment. The current technology centers on automatic vehicle information (AVI) using electronic transponders. It may be considered as the first wave of IVHS technology entering the mass market. At a relatively low cost (about 10 percent of the normal toll) and with high reliability (about 99 percent accurate), the efficiency of road travelers and the efficiency of infrastructure toll collectors can be increased substantially. In some installations, such as the Crescent City Connection bridge in New Orleans, the public authorities share their savings by offering a 30 percent discount on tolls for AVI-equipped vehicles (Paisant, unpublished data, 1991). Nonequipped motorists also benefit from the shortening of the queues as the equipped vehicles zip through the toll booths without stopping. It appears to be a "win-win" arrangement for all major stakeholders.

There are two basic technologies for the AVI transponder. The ones available on the market operate at a UHF. One basic technology uses the surface acoustic wave (SAW) approach. The other basic technology uses an electronically erasable and programmable read-only memory (EEPROM) chip, which can have its code number or message modified electronically. The EEPROM chip may be passive or active.

The existence of several AVI technologies and automatic toll collection system designs gives rise to the issue of standardization, which is getting hotter as this category of DIS application spreads and as the various vendors vie for market share and market dominance. As with other information technologies such as computers, there are two general approaches to standardization. One approach is in the marketplace, in which the market leader sets the de facto standards and compels other suppliers to go along with an obvious disadvantage, since the inner workings of the standards are often opaque and proprietary. The other approach is in the conference room, in which committees consisting of major industrial suppliers, often with the involvement of major users, public authorities, and academics, try to agree on a minimum set of standards that will allow multiple vendors to coexist with mutually compatible hardware and software products. The market-leader approach may be considered an unfair practice to the dominated suppliers, but it is realistic and works as fast as market penetration. The committee approach usually comes up with more-open systems that favor the users, but it is a slow process that often appears wasteful and can be overtaken by the market-leader approach.

Perhaps one important reason that standardization for automatic toll collection has been, and perhaps should be, slowed is the yet-to-be-resolved issue of privacy. The functioning of the toll collection systems that have been described assume that the equipped users have no objection to their identity's being revealed to the system, thus allowing their whereabouts at what time to be known to those with access to the system. One way to reduce this concern is to use a technology similar to that for prepaid phone cards, whose users' identities cannot be known to the telephone system.

Phone cards have been used in Europe with success, but adapting the concept to a "smart travel card" for automatic toll debiting and other such applications is technically not quite straightforward. First, for automatic toll collection, unlike for pay phones, there can be no contact between the smart travel card and the interrogating system. Second, the required two-way communication will be a dialogue, and not a two-way monologue (as in AVI), because the amount to be debited on the smart travel card will depend on the location and the time of the interrogator signal—and the complicated dialogue needs to be completed within a short time if the vehicle is not required to slow down excessively.

As indicated previously, electronic road pricing in its primitive form is technically a simple extension of electronic toll collection. There are two general types of road pricing: (a) the charge for the use of a road, which has long been in practice for toll roads, regardless of whether the toll is collected manually or electronically; and (b) the charge for keeping a vehicle in a particular district, no matter whether the vehicle is in motion or not (analogous to having the vehicle in a large parking structure). It is the second type of road pricing that has recently been proposed to be put into practice and that has been particularly controversial.

The concept of road pricing as a means for demand management is attractive to economists who argue that excessive congestion is a phenomenon of inefficient allocation of scarce resources. An efficient way to reduce congestion is thus to introduce a market mechanism to road transport. Without road pricing, more road building would simply attract more traffic to the new roads, and the previous level of congestion would return as the system seeks a new equilibrium. In the long run, the only way to reduce congestion is to charge the less urgent users—some opponents would say the less affluent users—sufficiently to keep them off the congested routes. This concept is not new at all, but the low-cost electronic means to make road pricing practical is new and has given the concept a new life (*10*).

Road pricing has many opponents. Besides those who believe that road pricing favors the rich, the strongest public sentiment against road pricing is its appearance as another tax. Opponents have also raised the privacy issue as a negative factor. On a rational basis, the proponents of road pricing appear to have answers to all the objections that have been mentioned (*11*). For example, reduced rates may be charged to the poor, privacy may be protected by the use of anonymously prepaid smart cards, and so on.

In Singapore, a manually operated road pricing system (an area licensing scheme) to keep most of the motor traffic from its central business district has been in operation since the mid-1980s. The scheme was highly successful in reducing traffic congestion in the central business district. In fact, it was so successful that the roads became highly underutilized in the district, and the price was reduced from Singaporean $5 to $3 for any vehicle to enter the restricted zone during peak hours (*12*). Recently, Singapore has planned to convert its road pricing system from manual to electronic.

In Europe, there is a joint manual and automatic toll cordon for Oslo, Norway; similar plans are under consideration for Stockholm, Sweden. In the United Kingdom, serious consideration for road pricing has been coupled with very innovative ideas for its implementation. For example, a "timezone" concept has been proposed for London, which would be ringed with roughly concentric circles representing progressively more expensive tolls as one approached the center (*11*). This approach would prevent traffic diversion at zone boundaries as has happened around the central business district of Singapore, causing congestion around its boundaries. An even more radical concept, known as congestion metering, is being considered by the city of Cambridge (*13*). Unlike the usual road pricing scheme—as in Hong Kong, where a congested zone is predetermined and a fixed fee for entry is charged whether the zone is congested or not—congestion metering will levy a charge only when a vehicle experiences actual congestion (defined by a threshold of vehicle speed and number of stops per unit distance). It is believed that such a scheme will induce a more economically rational behavior from the driver and result in more effective relief of congestion. However, the political acceptability of these schemes is still to be tested.

TRAFFIC INFORMATION AND ROUTE GUIDANCE

For years, real-time traffic information collected by traffic management authorities has been provided to the general public, including drivers on the road, through commercial and public radio and television stations at no incremental cost to the users. However, such information may not be timely and relevant enough to help drivers make strategic route choice decisions. Even dedicated traffic stations (highway advisory radio, or HAR) may give too much irrelevant information, and the driver may not tune to these stations at the critical moments for decision making. On the other hand, the incremental cost to the driver for these services is negligible, since most car radios can tune to dedicated stations just as easily as to other stations. To ensure that the driver does get new significant traffic information when it becomes available (such as after a major incident has been identified), automatic HAR (AHAR) radio has been designed to turn the radio on, or interrupt other audio devices and programs, and automatically tune to the HAR station with the latest information (*14*). However, the added cost of the AHAR has not made it very marketable, and most HAR stations have not been sending out the automatic interrupting signal to make AHAR work.

Recently radio data systems (RDSs) have become available in Europe to provide low-rate (about 1,000 bit/sec, or bps) coded information to properly designed receivers, using the sidebands of the frequency spectrum assigned to the broadcaster. Originally designed to provide program identification and alternative frequencies for better reception of the desired radio program or program type, RDS is now being promoted to provide real-time traffic information through a traffic message channel (TMC), which may provide effectively 74 bps of traffic information codes to specially equipped radios (*15*).

There is an active European project working on the standards of RDS-TMC (*16*). As indicated, the output may be in the form of textual or synthetic voice displays—textual display may be more distracting but it would not interfere with or require interruption of other audio programs. For owners of high-priced (about $300) car radios, the added cost of acquiring the RDS feature is marginal. The cost to the stations to add RDS features would be on the order of a few thousand dollars, and the incentive for them to make the investment could be significant because of competition. To go to TMC, however, there would be additional infrastructure costs for traffic data collection and collation and for message management systems.

The European RDS standards have almost been set, but the Japanese have not been satisfied with them and have been developing and testing new approaches, using more sophisticated digital modulation schemes and error correcting codes. One of Japan's FM multiplex broadcasting approaches has been tested for mobile reception; it promises to provide much higher bit rates than the current European approach—10 to 12 kilobit/sec (kbps) versus 1 kbps (Yamada, unpublished data, 1991). These high bit rates can be used to transmit a great deal more traffic information and even projected link times without the need for additional frequency spectrum. Given the still-fluid situation with RDS in North America, it behooves the traffic management authorities to work with telecommunication policy makers there to review all the competing schemes of RDS before final standards are set.

The latest technological system on the market for providing real-time traffic information is the TrafficMaster, which has been in operation for the London area since mid-1990 (*17*). Average vehicle speed in the fast lane of the motorways around London (M25 and a limited range of other motorways connecting to it) is automatically measured every 2 mi and reported every 3 min by infrared sensors. When the speed drops below a threshold of 25 mph, the average speed and location of the congested segment are transmitted over a paging service frequency to owners of the TrafficMaster's simple map display unit, which may be carried by the owners or put on top of their vehicle dashboards. Paging service is also available. The price of TrafficMaster is about $500 for the portable unit and about $32/month for the service charge. The paging service option is another $30/month. By late 1990, there were about 300 customers (35 to 40 percent of whom choose the paging option), and the number exceeded 2,000 by the end of 1991. Because the breakeven point is only about 2,500, TrafficMaster's financial viability appears to be very promising (Martell, unpublished data, 1990).

From the perspective of traffic management authorities, at least two policy issues are related to traffic information. The first has to do with the fusion and authentication of traffic information, and the other has to do with the potential risk of a specific traffic information provider's near-term success preempting certain forms of dynamic route guidance that must use real-time traffic information.

As in any private service-providing activities, there is a risk of "cream-skimming" so that the easiest and most profitable services are provided while the more difficult but perhaps much needed services are neglected. For example, TrafficMaster has focused on M25 not only because it is the most traveled motorway, but also because the average speed can be measured most conveniently and the operating company needs to deal with only one public authority, namely, the U.K. Department of Transport. It is encouraging to learn that TrafficMaster has recently considered expanding to the arterials (the A-roads) in the London area (*18*).

If drivers just want to find their way to their destination under normal traffic conditions, they can use static route guidance, which does not require real-time traffic information and thus can be autonomous. Philips' CARIN system and Bosch's TravelPilot system can provide static route guidance through a combination of dead-reckoning and map-matching with the digital map information stored in a magnetic tape cassette or compact disk. To cover a wide area of possible travel (e.g., Western Europe or the entire United States), the most practical way to store the vast amount of map information is through the use of a compact disk system, which has been rather expensive. For example, TravelPilot with compact disks started to sell for about $3,500 in the United States, although the price quickly dropped to $2,500 and is expected to drop with an expanding market. This may be compared with currently available navigation systems with GPS plus dead-reckoning and map-matching for more than $4,000 in Japan, where compact disk drives can be acquired for as low as a few hundred dollars, substantially below the cost of those drives in Europe. In any event, a fully functional navigation system will probably be too expensive in the near future to be accepted in a "baseline" IVHS system for the mass market in the United States (*19*). This is an important point for the public authorities to consider if privatizing IVHS is an important goal.

Because one of the major frustrations in driving is to get caught in unexpected traffic congestion, dynamic route guidance that takes into account real-time traffic information in route guidance is highly desirable. Dynamic route guidance is by no means a new concept. Over the past 20 years, there have been three discernible generations of such systems (*20*). The first-generation systems include ERGS in the United States (*21*), CACS in Japan (*22*), and ALI in Europe (*23*)—all programs in the 1970s—using low-rate inductive loops for communication. For example, CACS transmitted 144 bits of information at each junction at 4.8 kbps (*24*). The second generation is typified by ALI-SCOUT (*25*), whose development began in the early 1980s, using beacons for short-distance communication at major junctions. At each junction, the beacon transmits 8 K of information at 125 kbps. [The next generation of ALI-SCOUT, known as EURO-SCOUT, is to be ready by 1992; it will transmit 30 K at 500 kbps (Sodeikat, unpublished data, 1990)]. The third-generation systems include CARMINAT (*26*) (one-way wide-area communication into the vehicle via RDS), SOCRATES (*27*), and ADVANCE (*28*) (two-way communication via a digital cellular radio link), which are systems under development in the late 1980s and early 1990s. In these systems, information will be transmitted *continuously* at a relatively high rate—about 9.6 kbps in SOCRATES (McQueen, unpublished data, 1991). As we progressed from the first to the third generation, the required number of equipped junctions on the infrastructure decreased while the typical cost of an IVU increased (from $80 to $250, to an estimated $800, hopefully, for the third-generation of IVU at mass production).

It is interesting to note that the first two generations of dynamic route guidance systems are infrastructure-based and the third generation is primarily vehicle-based. The former searches for the best routes with equipment on the infrastructure (such as with ALI-SCOUT); the latter does that with equipment on board of the vehicle (such as with CARMINAT). It is important to discuss the policy implications of these two types of system. First is the financial implication, which may affect the system viability. Infrastructure-based systems naturally put major capital investment requirements on the infrastructure side. This may be a slow process, not only because of the magnitude of the investment but also because of the need for multijurisdictional cooperation in both system installation and operation. Drivers who are early investors in the IVUs for such systems may be dissatisfied with their limited usability for a long time. The whole system may then become unacceptable to the users, and the infrastructure costs may be too high for a government or operating company to bear. On the other hand, the vehicle-based systems require expensive IVUs, and the early users are likely to be the more affluent drivers and the commercial vehicles. Second is the question of who is in control. The infrastructure-based systems would be more amenable to the presumption that traffic should be controlled by a central authority (public or a private surrogate) that will guide the traffic to reach a "system optimum" according to a systemwide objective (such as minimum total vehicle hours of delays) subject to centrally determined constraints (such as no traffic diversion to schools and residential areas). Such systems would also make it easier for public authorities to encourage multimode transport options (e.g., park-and-ride). On the other hand, the vehicle-based systems would be more amenable to the presumption that drivers will determine their own objective functions and will search for "user optimum" (such as a weighted average between travel time and tolls paid) subject to privately determined constraints (such as avoiding subjectively perceived high-crime areas).

Regardless of the approach taken, the projection of link time (up to about 90 min into the future) will be needed for dynamic route optimization, and this projection must be done centrally. This implies new tasks and improved technologies to be used by the traffic management authorities. For example, credible and reliable projection of link time will need the speedy and accurate estimation of the duration of an incident after it is detected and verified. Such estimations are being done only haphazardly at present. Some form of simple model based on artificial intelligence is needed to predict incident duration as a function of the link location, time of the day, number of lanes blocked, weather condition, whether bodily injuries are involved, and so on. At present, the projection of link times in the ALI-SCOUT system is done by a sort of moving average of current and historical data with modification through link models, which appear to ignore the interactions between links in a network (Janko, unpublished data, 1990). A more sophisticated real-time simulation model may be needed to provide more accurate link-time projections (*29*).

Another important task in this area for the traffic management authorities is to provide updated information of road changes (construction, reconfiguration, new roads and roundabouts, new one-way and turning lane restrictions, etc.). Autonomous systems that provide navigation and static route guidance would need this updated information. As they get such information from the infrastructure, they might as well get the dynamic route guidance information from the infrastructure, if it is available. Thus there is a strong motivation to explore dual-mode systems that combine the autonomous and infrastructure-based systems (*30*).

With the coexistence of multiple basic approaches to dynamic route guidance, standardization is clearly a very important policy issue. It is interesting to note that the Japanese have abandoned the infrastructure-based approach as a result of the evaluation survey among drivers involved in the CACS program during the 1970s (*31*). The North Americans, notably through TravTek (*32*) and ADVANCE projects, have been working during the last few years exclusively on vehicle-based systems for dynamic route guidance. The substantive progress being made in SOCRATES may lead to a vehicle-based system in Europe that would be more congruent with the trends in Japan and North America. On the other hand, the low-cost IVU is clearly an attractive feature of infrastructure-based route guidance systems. If a sufficient number of cities in Europe and North America are convinced in the near future to make the substantial investment on the infrastructure for them, such systems as ALI-SCOUT may preempt the market for dynamic route guidance.

Because the social benefits of DIS are supposed to be relieving of traffic congestion and increase of driving safety, not just helping a small group of users to reduce their travel times, it is important for traffic management authorities to evaluate the traffic and safety impacts of DIS. Fortunately, such projects have been launched in several countries, including the United Kingdom (*33*). Preliminary assessment of dynamic route guidance has indicated that the typical reduction of vehicle hours of delays would be in the range of 7 to 15 percent (*34*). Recently more detailed evaluation using computer models has indicated some interesting but problematical results. For example, the user benefits have been shown to decrease—they may even become negative—under certain circumstances as the percentage of cars equipped with the ALI-SCOUT system increases beyond about 15 percent (McDonald, unpublished data, 1990). This was based on the assumption that drivers of equipped cars would follow the routes along the main roads determined by the traffic center while the drivers of unequipped cars who know the local geography would "rat race" through the small urban streets. On the other hand, research at the University of Michigan has shown that the benefit to users in a vehicle-based route guidance system (*29*) can continue to rise for the equipped drivers as the penetration rate increases from 0 to 100 percent. There is an important policy issue here regarding the degree and the means of control that the traffic management authority should exercise to discourage rat race and to make dynamic route guidance attractive to those who have invested in the system.

DRIVING ASSISTANCE

The DIS application category of driving assistance consists of new electronic devices and subsystems that will augment the functions of driving tasks. From the perspective of communications, they may be subcategorized as autonomous, vehicle-highway, and vehicle-vehicle systems. Vehicle-high way systems involve modification of the highway infrastructure, so they are of obvious and immediate concern to traffic management authorities. However, significant public policy issues exist in the other subcategories as well.

Autonomous driving assistance includes, first of all, new electronic display panels that have been designed to show only the key information of interest to the driver at the moment, thus reducing information (output) overload to the driver and saving the very limited space on the dashboard. Similar arrangements have been designed to reduce the number of driver (input) control knobs through a hierarchy of touch-screen commands. The safety and human-factor merits of these devices, under various external lighting conditions and driving situations, are yet to be proven by extensive tests.

Head-up displays of key information on the windshield, a technology borrowed from military aircraft, are generally considered to be desirable because they can provide information without requiring much eye movement from the driver. The technology is still expensive [about $300 (Spreitzer, unpublished data, 1991)] and is only beginning to be offered as an option on some of the most luxurious cars. Vision enhancement through infrared or ultraviolet system is another example of autonomous driving assistance DIS. Still another autonomous system that is attractive is to superimpose a red bar on the side mirror when a sensor detects a vehicle on the driver's blind spot to caution him about changing lanes; this is shown in the PROMETHEUS video tape. Such a system provides only warning signals with the responsibility of vehicle control remaining entirely with the driver. However, there may still be questions of legal liability if collisions occur because the warning red bars malfunction.

In the subcategory of vehicle-highway communication for driving assistance is the example of in-vehicle safety advisory and warning system, in which some of the radio-frequency warning signals—such as hidden stop sign, dangerous curve, and construction ahead—may come to the vehicle from ground points. To receive such active signals at a close distance requires relative low cost receivers on the vehicle—no more than several hundred dollars (*35*). They can be implemented soon on the presumption of willing cooperation between traffic management authorities to provide the active signals and private manufacturers to make the receivers. Another vehicle-highway system that the traffic management authorities may wish to promote is the automatic emergency calls (or distress signals) to be transmitted by vehicles in trouble. This would require three elements: (a) an automatic as well as a manual triggering device for transmitting the signal, because the driver may be unconscious in an emergency situation; (b) an automatic indication of the vehicle location with sufficient accuracy for the rescue crew to find the vehicle; and (c) cooperating traffic management authorities to take up the rescue mission. In a recent survey among American truck drivers and operators, this was considered the highest-priority function of IVHS (*36*). To speed up such applications, some government leadership is in order to get the system set up and maintained in full operation, at least in those segments of the motorways and arterials where accidents have occurred frequently and where emergency calls from telephones or from motorists are either impractical or unsafe.

In the subcategory of vehicle-vehicle communication for driving assistance, the examples are fewer but interesting. The PROMETHEUS program seems to have emphasized communication between vehicles moving in opposite directions. The Handshake project features fog warning by vehicles just coming out a fog zone to oncoming vehicles that are about to enter the fog zone. Similar communication schemes have been proposed so that vehicles, after observing a traffic jam on the other side of the motorway, can send signals to vehicles in the opposite direction upstream of the jam so that they may make a timely diversion. Another recent idea that achieves similar functions, but uses vehicle-highway communication rather than direct vehicle-vehicle communication, is to rely on an electronic transponder installed on the middle strip of a divided motorway as a mailbox for vehicles moving in opposite directions to deposit and pick up messages for driving assistance.

It should be pointed out that all such vehicle-vehicle communication applications, no matter whether they are for vehicles moving in the same or opposite directions, would not be practical until the percentage of vehicles with appropriate and compatible communication equipment becomes significant. The implementation would be difficult if everything were left to the free market because of the lack of incentives for early investment. Perhaps the way to bootstrap the market is for the traffic management authorities to install the electronic mailboxes discussed previously and provide plentiful information for driving assistance (e.g., icy bridge ahead, etc.) so that early as well as late investors can receive immediate benefits.

TABLE 1 Matrix Summary

Policy Impacts	Toll & Rd Price	Route Guidance	Driving Assistance	Business & Pers Info
Privacy	XX	X		
Standards	XX	XX	X	X
Financing	X	XX	X	X
Political Acceptance	XX			
Multijurisdiction	X	XX		
Multimode	X	XX		
Safety		X	XX	X
Legal Liability			XX	

BUSINESS AND PERSONAL INFORMATION

The provision of business and personal communication to drivers on the move used to be considered a luxury, at least for noncommercial vehicles. However, with the decreasing cost of information technology and the increasing demand for such services in our information society, provision for business and personal information is deemed highly desirable if not essential for long-distance commuters, tourists, high-level executives, and drivers of commercial vehicles—such as trucks, taxis, ambulances, and police cars, some of which are not strictly commercial.

From a policy perspective, the regulation and frequency allocation for business and personal communication appears to be entirely in the domain of telecommunication authorities. However, to the extent that the technology and communication media for this application category of DIS share and overlap with those for the other three application categories that are of central concern to traffic management authorities, the latter cannot ignore the policy implications of this fourth category of DIS as well. Driving safety issues in the use of some of business and personal information systems also would require evaluation and regulation activities of the traffic management authorities.

Personal information can now be conveyed to the motorist (driver and passenger) by car phone, facsimile, or paging—some luxury cars, especially in Japan, even have commercial television for the passengers, or for the driver while the car is standing still. Clearly some of these communication channels may be used for traffic information and route guidance as well. As mentioned previously, TrafficMaster provides real-time traffic information by way of paging service frequency (*17*). The cellular car phone system may be used to provide link-time information for on-board route optimization, especially after the cellular system becomes digital as in the future GSM in Europe (*27*). With the expected advent of personal communication service, which may one day replace the home phone and the car phone, its continuing development should be monitored by the traffic management authorities as well as the communication regulatory authorities.

Tourist and other "Yellow Page" information is expected to be provided to drivers on the move as a feature of DIS. TravTek, one of the major American IVHS demonstration projects involving 100 test vehicles in Orlando, Florida, will feature the provision of tourist information around Disney World. The automobile clubs (both the AA in Europe and AAA in the United States) have libraries rich in tourist information that can be made readily available. There are strong commercial interests in making Yellow Pages available in digital form to facilitate information search and to make two-way communication for Yellow Page transactions such as hotel reservation practical. This growing business may have policy implications in both financing and technical decision making on the basis of safety and human factors.

SUMMARY AND CONCLUSIONS

The matrix shown in Table 1 summarizes the potential prominent policy impacts of the four categories of DIS that have been discussed in this paper. The double X's indicate the policy implications that demand the most critical attention. It should be clear from the matrix that policy implications are quite different for the various categories of DIS and that the relative significance of policy implications may vary from one country to another. However, this author has one general observation that is common to all the countries he has visited in Europe and Asia as well as North America: the DIS researchers in the private industry have not thought very much about policy implications except in a haphazard way, yet they are making technological choices and developmental efforts that may have profound policy implications. Similarly, the policy makers are not familiar with exactly what DIS technologies are being planned for deployment because they have been under development mainly in the private sector. Both sides can save time at the later stage of implementation and can be synergistic if they work more closely and frequently at the developmental stage. Therefore, the author suggests that frequent in-depth exchange of views between policy and technology developers be routinized through joint projects and periodic reviews.

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