# International ITS Program Assessment

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## Executive Summary

This paper attempts to make an updated comparison of worldwide activities in Intelligent Transportation Systems (ITS) and to recommend a strategy for continuing international program assessment for discussion at the Benefits, Evaluation and Costs (BEC) Committee meeting in September 1995. In spite of increasing demand for better demonstration of benefits of ITS projects, centrally provided public funds for ITS in Europe is expected to increase over 50% within the European Commission's Fourth Framework. The Japanese national government is continuing its substantial investment in ITS core infrastructure, which has induced considerable private investment in public-private partnerships in ITS. Through ITS AMERICA, the U.S. has relatively the best organization to involve the private sector in ITS program discussions. However, legislative provisions for stable and continuing support, especially for ITS core infrastructure, are still not in place.

At this point, the U.S. is the recognized world leader in deployment of electronic toll- collection (ETC) and commercial vehicle operations (CVO). However, national standards in ETC and CVO have not been set up, making it uncertain as to how and when the one-tag, one-vehicle objective will become a reality. With nearly one million autonomous navigation units installed in their domestic market, the Japanese is clearly the leader and the dominant international supplier for this application although there has been recent success also from European suppliers. However, the Japanese deployment of dynamic traffic information, though being attempted with vigor, has not met with outstanding success. In Europe, deployment of different approaches to dynamic route guidance has met with repeated delays or less-than-expected success, bringing into question whether this particular user service should remain a practical target in early deployment. Apparently the barriers to the linkage between vehicles and infrastructure are more institutional than technological in Advanced Traveler Information Systems (ATIS).

U.S. top-down approach to the development of a national ITS architecture-has attracted worldwide attention. However, the Europeans-have been taking a *de* facto bottom-up approach to architecture due to political reasons, and the Japanese have been following their traditional approach of market determination. Since the U.S. provides a coherent and rational basis for ITS standards setting, the U.S. involvement in the International Standards Organization (ISO) activities has contributed an intellectual leadership as well as protected the American industry' s interests. In order for the U.S. to maintain its leadership and future international ITS market position, it seems desirable for the federal government to consider a deliberate strategy for supporting U.S. delegates in selected ITS standards working groups.

With industrial globalization, international competition in general has become an increasingly complex issue because competition is no longer drawn necessarily along national boundaries. Also, unlike technology transfer in traded goods (vehicles-side) that could be detrimental to the countries with – advanced technology, international information exchange in non-traded goods (infrastructure-side) can only yield mutual benefits to all countries. Thus, international exchanges in such areas as system architecture and operational tests evaluation would be mutually beneficial. The intertwining relationship among international organizations in the ITS area is such that the justification for public funds to support ITS must stem primarily from the interests of the end users (the taxpayers) in the country. The fact that such support would also help international competitiveness, as well as industrial development, job creation, defense conversion, etc. should be of secondary concerns.

With minor qualifications, the basic conclusions of the French report published in March 1993 are supported by subsequent ITS developments around the world. Two general trends seem common to the ITS programs in all international regions: multi-modalism and the closer coupling between ITS and information networks. To help future international ITS program assessment, it is recommended that we develop a strategy including four aspects: (1) framework, (2) information collection, (3) assessment, and (4) distribution. An outline of such a strategy is offered for further discussion at the BEC Committee meeting in September 1995.

## Introduction

This is the draft of a paper on International ITS Program Assessment with the following objectives:

1) To make a updated worldwide comparison of ITS programs

2) To recommend a way to organize efforts for updating future international program assessment

3) To stimulate discussion at the ITS AMERICA Benefits, Evaluation and Costs (BEC) Committee meeting on September 18-19, 1995.

Note that there was an excellent comprehensive report on “A Comparison of IVHS Progress in the United States, Japan 8c Europe through 1993,” published in March 1994 (prepared by R.L. French & Associates for IVHS AMERICA - hereafter referred to as the French report). The first objective is to be met mainly through updating that report by noting the recent program changes in Japan and Europe and by including ITS activities elsewhere in the world. It has been recognized that ITS is a very dynamic field around the world, and any relevant international assessment will need frequent and periodic updating. The second objective of this paper is to be met through this author’ s recommendation on the, basis of his personal experience, which will need substantial expansion and discussion by knowledgeable people in the ITS community.

The degree to which the third objective will be met depends on the focus and agenda of the ITSA/BEC Committee meeting in September 1995. However, given the, recent Congressional discussion on the ITS program and Congressional concern about international competitiveness versus cooperation in ITS, it is hoped that some of the ideas presented in this paper-will provide a useful framework for general debate on ITS international aspects as well.

## Public Funding

Table 1 summaries the public funding for ITS programs in Europe, Japan, and the United States The table has been adapted from the French report mentioned earlier, the only change being the updated estimate of the DRIVE III budget under the Telematics Directorate General (DG XIII), which has been modified upward from $180M to $275M. The new estimate reported in a newsletter [*The Intelligent Highway*, June 12, 1995] has been confirmed by an official of the European Commission (EC) as the best available quantity at this point. The DRIVE III budget of ECU 205M for the 4-year program, of which ECU 117-125M is expected to fund 40-50 projects in the first two years, is 57% higher than the DRIVE II budget of ECU 130M for the previous four years. (ECU 1 = $1.34) In addition, the EC is supporting ITS projects through its Transport Directorate (DG VII) and Energy Directorate (DG XVII) as well as the Telematics Directorate, making its total support for ITS projects even higher. The numbers in Figure 1 are “centrally provided” public funds as the European numbers exclude national and local government investments; the U.S. numbers exclude state and local government investments; and the Japanese numbers represent funding from national ministries, including funds from their respective public foundations.

Table 1 Centrally Provided Public Funding for ITS Programs

| EUROPE | UNITED STATES | JAPAN |
|---|---|---|
| • PROMETHEUS spending planned for 1987-93: $770M<br><br>• DRIVE (EC DGXIII) budget for 1988-91: $70M<br><br>• DRIVE II budget for<br>• 1991-94: $160M<br><br>• DRIVE III budget (est) for 1995-98: $275M ($157M for the first two years)<br><br>• EC DGVII (Transport Directorate) RTI/ITS under Framework IV: $25M | Federal Government R&D:<br><br>• 1989-$2M<br>• 1990-$13M<br>• 1991 - $24M<br>• 1992 - $234M<br>• 1993 -$143M<br>• 1994 - $203M<br>• 1995 through 1997<br>•$231 M/yr (est) | 1973-1979:<br><br>• Government funds of $180M for CACS R&D<br><br>1985-1992:<br><br>• Government funds for R&D<br>- $1.9M - NPA & MOT<br>- $5.0M - MOC<br>- $5.4M – MITI<br><br>• Government funds for deployment<br>- $1.875B - NPA<br>- $519.5M - MOC<br>- $17.9M - MOT |

(adapted from the French report published in March, 1994)

While the budget of the DRIVE Program as a whole is increasing substantially, many apparently worthy proposals have been down-sized by as much as 90% or cut off completely. As has happened in the United States, after a period of rapid buildup of central funding, questions have been raised on both sides of the Atlantic regarding the capability of ITS programs to make full utilization of the appropriated funds and regarding the tangible benefits that can be demonstrated to justify the costs of deploying ITS. It has-been said that the European ITS policy makers are asking the same question as their American counterparts: “Where is the beef?”

Although these prudent and legitimate questions need to be raised, there is an increasing concern within the ITS community that the funding pendulum may swing too far to the other side. There is a real fear that the U.S. may forget the lesson learned two decades ago when Congress totally withdrew support for advanced highway technology programs in the 1970s and early 1980s [Saxton, 1993] while the Europeans and Japanese continued to push ahead with their own programs. This difference in public *funding resulted in the large ITS gap which the U.S. had to spend a substantial amount of resources in the past 5 years trying to close. There is also the concern that some ITS policy makers may not fully understand the symbiosis between private vehicles/devices and public core infrastructure in the delivery of ITS services, thus assuming erroneously that future ITS development can be left entirely to the private sector to finance. Even if some of the services provided by the public sector can be privatized, and the deployment of ITS must be decided at the state and local levels, the risks involved in unprecedented public-private partnerships in the ITS area is perceived to be so high that their great potential value may never be realized without some initial pump-priming by the federal government. Since the debate on these issues is still going on with highly uncertain outcome, the federal budget estimate of the U.S. program in Figure 1 has been left unchanged from the French report.

The funding situation in Japan is hard to pin down and quantify. Compared with Europe and the U.S., Japanese funds for ITS R&D 2nd deployment are often combined in ways that are hard to delineate because of differences in jurisdictions and in the definition and classifications of funding [French, 19941. However, it has been pointed out that one of the major characteristics of the Japanese ITS funding has been its continuity over the past twenty years. Each of the multiple Japanese national agencies involved in ITS has its own motivation and justification for substantial and continuing funding of ITS programs [Ervin, 19911. For example, the National Police Agency, with the responsibility for public safety, has provided continuing funding for sensors and traffic management centers under the name of urban traffic safety. The Ministry of

Construction, responsible for building and maintaining expressways, which are all toll roads, has substantial toll revenue to invest in ITS infrastructure as well as R&D for the expressway operations. The Ministry of International Trade and Industry (MITI), responsible for developing and maintaining future Japanese industrial prowess, has provided stable long-term research funding in ITS for decades.

With the continuing financial support from various national agencies, Japan has perhaps the world' s most sophisticated core infrastructure for ITS, and is continuing to invest and upgrade that infrastructure. For example, the National Police Agency (NPA) has announced its intention to replace all of its tens of thousands of ultrasonic traffic detectors with infrared beacons over the next few years. Assuming an average cost of $10,000 per installed beacon, this sensor investment alone would exceed one hundred million dollars over three to four years. This can help explain the large figure of $1.875 billion ITS investment in the recent past by NPA, as shown in Figure 1. The important point is that, although the amount of central public funding for ITS in Japan cannot be determined, its continuation seems to be more assured than in Europe and the U.S.

Note that Europe, Japan, and the U.S. are not the only regions investing in ITS. Elsewhere in the world public funding has been made available for ITS research, development, and deployment. The situation in Canada and Australia is quite similar to that in Europe and the U.S. even though quantitative data are not readily available. Interestingly the newly industrialized countries in the Asian Pacific region are beginning to explore R&D and deployment of ITS, as evidenced by their having sent delegations to the ITS World Congress and to visit Europe, Japan, and the U.S. Reports have been circulated that there are electronic toll collection projects in Korea, Taiwan, and China. The South Korean ITS strategic plan commissioned by the Blue House-will soon be completed. A significant advantage of these countries in ITS funding is that, unlike the industrially mature regions in the world, they still have mammoth road building programs. Instead of building traditional highways, they are aware of their late-comer' s advantage by building smart highways from scratch rather than retrofitting new conventional highways with information technologies at a later stage. And a small percentage of their highway building funds can go a long way toward equipping their roads with ITS core infrastructure.

## Private Sector Roles and Program Organizations

It is generally agreed among all countries that private sector involvement is sine qua non for successful ITS activities. The most obvious reason is that vehicles and devices used by travelers are generally manufactured and owned by private individuals and organizations. Since the public agencies responsible for implementing the ITS infrastructure, especially at the local level, are frequently financially strapped and lack the high-tech expertise for ITS, private involvement on the infrastructure side is also being considered for many public-private partnerships for ITS deployment. In addition, the private sector is expected to play many if not most of the new roles of ITS information service providers (ISPs). However, the way through which the private sector is engaged in ITS programs has been quite different in various countries and merits comparison.

In Europe, the PROMETHEUS Program, conducted from 1987 to 1994 with-over $770M expenditure, was centered around a group of automotive manufacturers headed by Daimler-Benz. Since it was launched under the EUREKA Program, which was set up in 1985 with the objective of strengthening Europe' s competitive position in the world market, the PROMETHEUS Program excluded Ford and Opel (subsidiary of GM) in its early days. However, these restrictions were relaxed toward the end of the program, especially after Jaguar, an original member of the PROMETHEUS Steering Committee, was acquired by Ford. The PROMETHEUS Program preceded the DRIVE Program and, along with the Japanese AMTICS and RACS Programs, jolted the U.S. industry, government and academia into forming the Mobility 2000 group, which later became the U.S. ITS community. Thus, PROMETHEUS may be considered the “Sputnik” of ITS and demonstrated that the spirit of international competitiveness, properly channeled, can be a powerful stimulus for national program development.

Although the PROMETHEUS Program was centered around the automotive industry, traffic-related electronics and communications technologies were not ignored. Thus, the achievements of the program included not just the near deployment of automobile-related applications such as intelligent cruise control but also less automobile-centered applications such as electronic toll collection (ETC) and radio data system/traffic message channel (RDVTMC). After the conclusion of the PROMETHEUS Program near the end of 1994, there was consideration to launch a follow-up program (known as PROMOTE) that would include the European electronics industry as well as automotive industry in the program core. However, for one reason or another, the momentum to launch PROMOTE has not been continued, perhaps because the private industries want to wait and see what specific projects the DRIVE III Program- will end up supporting.

The DRIVE I and II Programs, under the direction of the European Commission, required at least 50% matching funds from the national governments, industry and academia. Thus, its industrial involvement has been strong from the beginning. However, not all industry-supported ITS projects were within the PROMETHEUS and the DRIVE programs. For example, the highly visible Ali-Scout dynamic route guidance system, led by Siemens of Germany, and the totally private project of TrafficMaster to provide congestion information to subscribers, led by General Logistics of UK, were outside PROMETHEUS and DRIVE. Ali-Scout, later upgraded to be known as Euro-Scout, became a part of the DRIVE II Program only in recent years; and TrafficMaster has remained independent of public funds.

A significant move by the Europeans to facilitate private involvement, necessary for ITS implementation, was the formation of ERTICO (European Road Telematics Implementation Coordination Organization). For ITS, ERTICO develops Europe-wide implementation strategies and coordinated the necessary measures. However, final decisions on transport investments, infrastructure development, and taxation are made nationally because the umbrella organizations (like ERTICO) have little power to enforce their recommendations [French, 19941. Furthermore, the membership of ERTICO is not very large, especially in comparison with ITS AMERICA, which has hundreds of organizational members, about half of which are from the private sector.

In Japan, the tradition of close cooperation and coordination between the private and public sectors has been perceived by the outside world to the extent that the term “Japan, Inc.” has sometimes been used to signify their unity. Actually the term is a misnomer as far as ITS programs are concerned. The rivalry among the five national ministries/agencies that have something to do ITS \ has resulted in multiple channels of private sector involvement in ITS that are not always coordinated. Each of the five ministries/agencies uses the mechanism of “third sector organizations", usually known as “associations” in Japan, to interface with industry. Table 2 provides a partial list of such associations and how they are connected with their respective national ministries/agencies.

Table 2 Japanese Associations and Ministries/Agencies

| Ministry/Agency | Name of Association | Acronym of Association |
|---|---|---|
| National Police Agency (NPA) | Universal Traffic Management Society of Japan | UTMS Japan |
| Ministry of Construction (MOC) | Highway Industry Development Organization | HIDO |
| Ministry of International Trade and Industry (MITI) | Association of Electronic Technology for Automobile Traffic and Driving | JSK |
| Ministry of Posts and Telecommunications (MPT) | Research & Development Center for Radio Systems | RCR |
| Ministry of Transport (MOT) | Traffic Safety & Nuisance Research Institute | TSNRI |

It happens often that the same companies are approached for paid memberships in these associations and provide private resources to support competing ITS programs sponsored by the rivaling ministries/agencies. There has been a closer and more harmonious relation among the ministries/agencies for ITS cooperation. For example, the Vehicle Information and Communication System (VICS) Program, overseen by MPT, has combined previously separated programs led by NPA and MOC. The newest association, known as the Vehicle, Road and Traffic Intelligence Society (VERTIS) has provided a focal point for greater ITS cooperation within the Japanese government, involving all the five ministries/agencies. Interestingly VERTIS is headed by Dr. Shoichiro Toyoda from the private sector.

There is no doubt that the Japanese private sector (including both their automotive and electronics industries) has greatly benefited from the heavy and continuous investment by the national government on ITS infrastructure, as well as contributing new ITS products and services to both their domestic and international markets. Building on its strength in ITS infrastructure, Japan has been able to launch a public-private partnership, known as the ATIS Corporation, to provide dynamic traffic information to travelers and drivers. Thanks mainly to its private sector initiative, with multiple competing suppliers, there are close to a million autonomous (static) route guidance systems installed in Japan. Many similar systems that have appeared recently in the American and European markets have been developed by Japanese firms (with Zexel as the leading international licenser and supplier).

In the United States, the most important focal point for private sector involvement has been the ITS AMERICA. As indicated previously, about half of its organizational members are from the private sector that includes many industries with ITS interests. Through its committee structure, ITS AMERICA has been able to get private companies involved in almost all aspects of ITS activities. Compared to European and Japanese situation, the American private companies should consider it fortunate to have an organization like ITS AMERICA to serve as a single stop to get information and to get involved. Another relatively unique feature of the ITS AMERICA' s structure is its openness to international members, who can serve on the Board of Directors as well as committees at all levels, thus making it available meeting ground for international information exchange. Of course, there are also difficulties experienced by ITS AMERICA in private sector involvement. For example, very few trucking companies ' aye its members even through Commercial Vehicle Operations (CVO) represent an important early target for ITS deployment. However, this does not appear to be an unsolvable critical problem over time and with some policy change. Perhaps a more fundamental issue is its non-profit scientific and educational organization status that, according tax code 501(6)3, prohibits it from lobbying activities. This may require some basic policy considerations, including the formation of an ITS trade association to facilitate private sector inputs to the legislative process.

User Services: Orientation and Deployment

The three regions in the world listed in Table 1 (Europe, U.S., and Japan) have all begun to deploy ITS. Given the vastly different social backgrounds around the world, one can expect that different regions in the world would have different orientation and deployment strategies for ITS user services. This section will discuss the orientation and deployment of a few selected ITS services around the world with relatively salient features and/or experience (both successes and difficulties) that could provide comparative value for ITS deployment consideration and program assessment in any country.

In Europe, serious efforts to deploy several ITS services have been launched -but some seemed to have encountered barriers that resulted in repetitive delays. The prime example is Siemens' Euro-Scout dynamic route guidance system, which is to be launched by COPILOT, a public-private consortium with funding coming mainly from the private sector to finance the beacons on the infrastructure side. The COPILOT implementation plan, with Berlin and Stuttgart as their initial target cities, has been announced since 1992 and the current estimate is for the system to become operational in both cities by late fall, 1995 and, assuming successful experience, to expand to 10 more cities beginning December 1996. The initial market focus is on commercial vehicles that are willing to pay about $1,300 for the on-board equipment plus a $15 monthly fee which would be used to amortize the infrastructure investment as well as to pay for the operational costs. The monthly fee is to be collected from the customers for their use of the COPILOT smart card, which would decode data received from the infrared beacons. Siemens has also announced the dual-mode system through the use of Zexel 7 navigation system to complement Euro-Scout' s function outside the beacon area within the cities.

The repeated postponements of the COPILOT operation and the announcement of dual-mode system have brought to the question whether vehicle-based route guidance is more practical for Europe than infrastructure-based route guidance. Unfortunately, the operational tests of SOCRATES, the best funded DRIVE II project for vehicle-based dynamic route guidance, have shown poor results (equipped vehicles performing worse than the unequipped due to insufficient capabilities of the on-board computer). The combined impact (plus the cutback of the ADVANCE project goals in Chicago) has brought into question whether dynamic route guidance should remain a practical deployment target in the near future.

Other examples of delayed deployment of ITS products in Europe include Volvo' s Dynaguide, which provides blinking icons on in-vehicle digital maps using real-time information received from RDSITMC. The actual launch of Dynaguide on a commercial basis has been postponed repeated (now into fall 1995) after the originally scheduled starting date in January 1995. CARMINAT, an in-vehicle navigation system developed by a France-based consortium led by Telediffusion de France (TDF), using RDS/TMC to provide real-time information to vehicles for traffic information and route guidance is also expected to be delayed beyond the official starting date in December 1996. [Sodeikat, 1995].

On the side of surprising success is the example of Carin, one of the earliest ITS products developed by Philips for in-vehicle navigation. Carin was first made available in January 1995 as an optional-feature incorporated into the so-called board monitor in the new BMW Seven Series at a marginal price of about $2,000. Instead of having 400 expected purchasers of Seven Series models with the Carin option, BMW ended up selling 4,000 Carin units during the first 4 months of 1995 - ten times as expected! [*The Intelligent Highway*, July 10, 1995]. The demand for in-vehicle navigation systems as a part of the high-end automobiles in Europe seems to compare well with that experienced in the U.S. as exemplified by the Zexel units offered as an option of Oldsmobile 88 since mid-1994.

Since Carin is a core technology within CARMINAT (CAR in CARMINAT stands for Carin) but does not rely-on real-time information from the infrastructure, one suspects that unexpected deployment difficulties tend to center around the linkage between vehicles and the ITS infrastructure. In addition, these difficulties are probably more institutional than technological since the basic technology of RDS/TMC used by CARMINAT to provide one-way communication from the ITS infrastructure to equipped vehicles is quite simple and has long been proven in Europe - over half of European broadcasting stations now transmit RDS signals. However, the institutional arrangements to make the RDVTMC services available to the ITS end users are still uncertain. For example, Germany is one of the first countries committed to RDVTMC, making the traffic information on 3,000 kilometers of expressways available for RDS free of charge, and assuming the same level of quality arid-service beyond its national border (in 15 European countries). However, the interface between the German government and the private enterprises is still ill-defined [Sodeikat, 19951. It seems that institutional barriers have proven to be more difficult than expected in Advanced Traveler Information Systems (ATIS).

Multi-lane electronic toll collection (ETC)‘ is considered an important ITS technology in Europe because the northern European countries (Germany, Holland, etc.) are likely to follow the tradition of their southern neighbors (France, Italy, Spain, etc.) by converting all of their motorways to toll roads by 1998, as proposed by the

European transport ministers, subject to the approval of the European Parliament. Since freeways have not been designed to have space for toll plazas, the most attractive way to collect tolls from the converted freeways would be to set up gantries with multi-lane ETC systems. In Germany, ten consortia have been selected for field trials, with results due in the third quarter of 1995. A similar test program was announced in the United Kingdom. According to the responsible official, 30 consortia bid for the UK trials, including 4 U.S. companies. However, no decision has been made in UK, probably due to the political unpopularity of collecting tolls for expressways, which have been free to users. On the research side, a multi-lane ETC systems is the central technology being developed and tested in the ADEPT project under the DRIVE II Program. According to the project director, although smart cards have been tested successfully to function well even when multiple equipped vehicles cross the gantry simultaneously while changing lanes, the current system cannot reliably identify the vehicle(s) which do not respond due to violation and/or system malfunction. In order words, localization is still a technical problem in multi-lane ETC. However, the ADEPT II proposal for DRIVE III funding has been cut nearly 90% in the current evaluation stage [*The Intelligent Highway*, June 12, 1995], making it highly uncertain that any significant work can continue under ADEPT.

Multi-purpose smart cards have been proposed by European experts, not only for intermodal transportation (collection of tolls, transit fares, parking, etc.), but also for non-transport purposes such as medical records, pay phones, small retail purchases, etc. However, the Europeans seem to be ahead of the U.S. in implementing multi-purpose smart cards, partly due to the liaison between two European standardization committees (CEN/TC278 for RTI/IVHS and CEN/TC224 for Machine Readable Cards). Several European banks (e.g., Banksys in Belgium) have launched tests on such smart cards, which would merit careful watching as a linkage between ITS and the European information infrastructure.

In Japan, both the UTMS and VICS systems mentioned previously have been under intensive tests and their demonstrations are open to people from other countries with ITS interests. At the time the UTMS in Yokohama was shown by the National Police Agency at the 1994 VNIS Conference, only one of the five functions (Advanced Mobile Information System) was demonstrated. Currently a year-long test is underway to validate 200 infrared vehicle detectors with 500 test vehicles. In November 1995, VICS wilt be demonstrated to interested attendees of the 2nd ITS World Congress. VICS is becoming operational with $20M capital collected recently from more than 80 domestic and foreign companies. The VICS Center was established on July 1, 1995. Note that VICS does not intend to collect user fees from the vehicles. Instead, it will collect royalty ($25-30 per unit) from the vendors who sell the in-vehicle units to the end users. With the in-vehicle units, the end users will be able to download dynamic traffic congestion and travel time information through microwave beacons, optical (infrared) beacons and FM multiplex broadcasting. The plan is to cover the entire country of Japan with 7 VICS centers over 18 years. Estimated penetration rate is 10% with a cumulative revenue of $89M after 10 years, and 24% with $250M cumulative revenue after 20 years [Noguchi and Sakamoto, 1995].

It appears that Japan is well positioned to provide dynamic traffic information to travelers and drivers, because for years, the Japanese have been ahead of the rest of the world in deploying ITS core infrastructure - Advanced Traffic Management Systems (ATMS), including over 160 traffic control centers, multi-colored changeable message signs, and an enormous number of vehicle detectors and traffic surveillance systems on all their (tolled) expressways and many arterials in their major cities. The most recent significant development is the new Tokyo Traffic Control Center opened in February 1995. This center will control up to 12,500 signals using the advanced algorithm called STREAM. As of June 1995, half of the total 14,000 signals in the Tokyo area are already under this on-line control. Building on the strength of this core infrastructure, a new public-private partnership, known as Advanced Traffic Information Service (ATIS) Corporation, was formed and started operation in May 1994, involving many private companies to utilize and distribute the traffic information made available from the core infrastructure installed by both the National Police Agency on urban streets and the Ministry of Construction on the expressways.

Financially, ATIS Corporation has a total capitalization of $17 million, of which 34% has come from the Tokyo Metropolitan Government and the remaining 66% from over 50 private companies. According to their business plan, cash flow would become positive within 4 years and the initial investment would be paid back within 6 years. For full services including parking as well as traffic information, ATIS collects approximately an initial fee of $300 and a monthly fee of $30 from individual vehicles, and an initial fee of $1,600 and a monthly fee of $500 from commercial vehicle fleets. In addition, the users have to pay for the initial cost of the in-vehicle And/or the home-based equipment; which would cost in the order of 3 to 4 thousands of dollars depending on the equipment quality and capability. This market for in-vehicle equipment is apparently the major motivating factor for private firms to join ATIS Corporation.

The early experience of ATIS Corporation was mixed. The majority of users are commercial fleets. A preliminary survey suggested that individual end users consider the hardware still too expensive even though the initial and monthly fees to ATIS seem reasonable. Furthermore, the general public feels that they have already paid taxes and thus should expect free traffic information. This experience has probably helped shape the VICS pricing strategy as discussed earlier. A good lesson to be learned from the Japanese experience seems to be that substantial investments on ATMS infrastructure and multi-jurisdictional cooperation are necessary but not sufficient conditions for viable ATI-S services. It also shows that the first market segment for ATIS should be the commercial fleets rather than the general public.

It is generally known that autonomous navigation systems have a huge market in Japan. At this time, over one million units may have been installed since 1987, supplied by quite a few competing vendors. It is also generally felt that the house numbering system as well as the Japanese drivers' penchant for new technology may account for this unusual demand which may not be applicable to other parts of the world. However, the experience and economy of scale derived from the domestic market should put the Japanese suppliers of navigation systems in excellent competing positions around the world. (Note the particular success of Zexel in both the United States and Europe mentioned earlier in this paper.)

While Japan is way ahead of U.S. and Europe in autonomous navigation systems, it is way behind the others in electronic toll collection (ETC). This is hard to understand since all Japanese expressways are toll roads arid the Japanese electronics industry has been nimble in creating domestic and international markets. In fact, Japanese electronic companies are heavily involved in the Singaporean program to automate its road pricing system. The reasons offered to explain Japanese tardiness in ETC applications range from labor concerns of toll collectors to traffic congestion on expressways being so bad that speeding up toll collection would have little impact on travel delays. All these seem to be excuses. Nonetheless, the Japanese Ministry of Construction has finally announced in June 1995 that it has selected 10 consortia from 25 applicants to participate in a joint ETC research project (known as Automatic Toll Collection System or ATCS in Japan). Four U.S. firms are involved in these 10 consortia. Experimental operation will not begin until 1997.

In the U.S., electronic toll collection (ETC) and commercial vehicle operations (CVO) have been the first two waves .of ITS deployment, each requiring the close cooperation between public and private sectors. These are also the deployment areas in which the U.S. is recognized as world leaders. Practically all major highway toll facilities have either deployed or are planning to deploy ETC. After ten years of research and operational tests, the first public-private partnership in CVO was set up in the West as HELP, Inc. which began its operation (collecting revenue) in the State of California in early summer 1995. The next CVO network, Advantage 75, is going through intensive development and testing. However, national standards in ETC and CVO have not been set up, making it uncertain as to how and when the one-tag, one-vehicle objective will become a reality.

## System Architecture and Standards

While the U.S. ITS Program has put a major initial emphasis on the development of a national system architecture in the past three years, the European and Japanese have not been doing nearly as much even though they have been following the U.S. architecture effort with intense interests. It appears, that while the U.S. is taking a top-down approach to develop a system architecture to assure interoperability and to help attract private investment in ITS products and services, the Europeans have been taking a de facto bottom-up approach due to political reasons, and the Japanese have been following their traditional approach of market determination. Another way to put it is to say that while the U.S. approach is top-down, the European approach is project-driven and the Japanese approach is product-driven [Rumbaugh, 1995].

Under the European DRIVE II Program, there is a “Topic Group

10" which has held regular discussions on European system architecture. Under the leadership of ERTICO, the SATIN (System Architecture and Traffic Control Integration) task force has adopted. an architecture framework which is summarized under six headings. As shown in Table 3, these headings have close correspondence to the U.S. architecture framework.

Table 3 Architecture Framework Correspondence

| Europe | United States |
|---|---|
| Reference Model | Top Level Architecture Diagram |
| Functional Architecture | Logical Architecture |
| Information Architecture | Data Structure |
| Common Data Dictionary | Data Dictionary |
| Data Communication Architecture | Communication Architecture |
| Physical Architecture | Physical Architecture |

Note that SATIN' s Information Architecture corresponds to the Data Structure, which is the next level of detail in the U.S. Physical Architecture. It appears that the major difference between the European and the U.S architectures is not so much in their development methodologies as in their implementation policies. While both architecture approaches intend to be open, to accommodate many different system designs, to support different user goals across many regions, and to Allow system evolution that would accommodate new products/functions, the U.S., takes a complete system approach with fairly detailed outputs while the Europeans only provide architecture requirements described in the relevant background notes. While the U.S. architecture is expected to be specific enough to serve as a basis for testing whether any locally proposed ITS subsystems do or do not comply with the national architecture, the European project proposals are required only to allow for supporting the program integration activities concerning system architecture. The use of systems and concepts that do not fit within the architecture requirements need only be "fully justified." [DRIVE, 1994] A minor difference between the two architectures is the inclusion of air transport within the European architecture whereas, in the U.S. architecture, air and other transportation modes are at present outside the architecture though they can be connected, and can be even included in the future.

The Japanese profess that they do not fully understand system architecture though they are quite keen on standards that are supposed to be derived from the architecture. It is interesting to note that in the ITS Grand Design for developed by VERTIS does not mention anything about system architecture. The Grand Design is more like a strategic plan rather than a system-design. It is also interesting to note that WCS includes both microwave beacons and optical (infrared) beacons for 2-way communications between vehicles and the infrastructure. The Japanese seem to be quite willing to let competing and even incompatible systems (and standards) to coexist, assuming that, eventually and if necessary, the selection of one or the other will be done by the market and other (e.g., political) forces.

Standards, of course, are of practical interests to all organizations engaged in product design, marketing strategy, and equipment purchase. It is generally agreed that international standards and protocols should lead to much larger international markets which will be more attractive to manufacturers, and the increased volume will result in economic growth and lower prices [French, 1994]. However, traditionally standards are set for products, which already have established a market. ITS presents both a challenge and an opportunity for identifying standards before product introduction.

For years, international standards setting within Europe has been coordinated by the European Committee for Normalization (CEN) and that for the whole world has been coordinated by the International Standards Organization (ISO). For ITS, CEN has set up the technical committee CEN/TC278 corresponding to the worldwide committee ISO/TC204 (Technical Committee on Transportation Information and Control Systems). The duplicate effort between CEN and ISO is considered necessary by the Europeans not only for historical reasons but also because, within Europe, the compliance to CEN standards is mandatory while the compliance to ISO standards is voluntary. This difference may also account for the fact that Europeans working on international standards are often supported by their respective national governments while most of their U.S. counterparts are volunteers (supported by their respective employers.) This may create a problem in the case of ITS where many future products have not established a market and therefore U.S. “volunteers” cannot get their employers’ support easily.

Since the U.S. top-down approach to system architecture provides a coherent and rational basis for ITS standards setting, the U.S. involvement in ISO/TC204 has contributed an intellectual leadership as well as protected the American industry’ s interests in

ITS international standards activities. In order for the U.S. to maintain its leadership and future international ITS market position, it seems desirable for the federal government to consider a deliberate strategy for supporting U.S. delegates in selected ITS standards working groups. Note that, for the sake of international harmonization for ITS standards, CEN and IS0 have agreed to cooperate through a number of working groups as shown in Table 4.

Table 4 International Harmonization between CEN and ISO

| Working Group | Lead | Cooperating WGs |
|---|---|---|
| Architecture | ISO | CEN WG12, 13 |
| Quality & Reliability | ISO | |
| Map Database | ISO | CEN WG7 |
| Fee & Toll Collection | CEN WG1 | |
| General Fleet Mgmt | ISO | CEN WG2 |
| Comml Fleet Mgmt | ISO | CEN WG2 |
| Public/Emergency Fleet | ISO | CEN WG2, 3 |
| Traffic Mgmt Infr & Ctrl | ISO | CEN WG5 |
| Traveler Information | CEN WG4 | |
| Route Guidance | ISO | CEN WG4 |
| Human Factors/MMI | ISO | ISO/TC22/SC13/WG8 |
| Veh/Road Warning & Ctrl | ISO | |
| Short Range Comm | CEN WG9 | |
| Wide Area Comm | ISO | CEN WG11 |

(from Max E. Rumbaugh, Jr., SAE International)

## International Cooperation and Competition

With industrial globalization, international competition in general has become an increasingly complex issue because competition is no longer drawn necessarily along national boundaries. True, economists are still doing theoretical and empirical research on the basis of international competition among industrial countries. Some of the recent research results have apparent applications to ITS area. For example, it has been found that technology transfer from a technology-advanced country to a less advanced country on traded goods (e.g., vehicles and on-board equipment) could result in not only relative, but absolute, lowering standard of living of the technology-advanced country. On the other hand, technology transfer of non-traded goods (e.g., highway infrastructure) can only be mutually beneficial to both countries [Johnson and Stafford, 1994]. However, these findings are based on data and assumption that each technology is developed and produced within a single country. This assumption is no longer true in the past decade - e.g., IBM ownership is very international and the IBM microcomputer is said to include many more foreign parts than American parts. In the ITS area, the line of international competition-seems to be even less along national boundaries.

Within Europe, an international alliance was announced among Philips of the Netherlands, with Siemens and Bosch of Germany, to provide dual-mode route guidance - using beacon-based technology in the urban area and vehicle-based technology in the suburban area. In the map database area, the two major commercial consortia in Europe are EGT and EDRA, the former involving Navigation Technologies and the latter involving ETAK, both based in California (although ETAK now has an Australian parent.) As mentioned previously, the Japan-based Zexel has become a dominant supplier of autonomous navigation systems in the U.S. and has recently allied with Siemens in Europe even though Zexel is not a dominant supplier within Japan. These are all examples of international strategic alliances, which transcend national boundaries.

Many of the ITS operational tests in the U.S. involve foreign technologies: e.g., European RDS/TMC in Minnesota; Leica collision warning system in Michigan; Seiko watch with traffic information in Washington; Siemens Ali-Scout route guidance and Australian SCATS signal control system in Oakland County, Michigan. As mentioned previously, a number of U.S. firms have provided electronic toll collection (ETC) technologies to be tested in Europe and Japan. In addition, it has become common for U.S. universities to receive foreign companies' support for ITS research; and the benefits to the U.S. universities are not just financial but more importantly the substantive information from the foreign sponsors.

The intertwining relationship among international organizations in the ITS area is such that the justification for public funds to support ITS must stem primarily from the interests of the end users (the taxpayers) in the country. The fact that such support would also help international competitiveness, as well as industrial development, job creation, defense conversion, etc., should be of secondary concerns. Since ITS core infrastructure is the basic enabling element for practically all ITS user services, public support for the core infrastructure must be provided and 1 maintained. In addition, since infrastructure is a, non-traded good, international information and technology exchange in this area should be mutually beneficial.

There have been dialogs between the DRIVE Program and the USDOT on potential information exchange that would be mutually beneficial. Three ITS-related topics were' initially identified for such exchange: (1) system architecture, (2) operational tests evaluation, and (3) human factors. All three areas are remote from product development. Since human factors are close to the vehicle-driver interface, recent decisions have left this topic to the vehicle manufacturers on both sides of the Atlantic. The other two topics are close to infrastructure and public program management (both being non-traded goods), and have become topics for possible exchange visits in the foreseeable future. The similarities and differences between European and U.S. system architecture approaches have been mentioned previously. As to operational tests, there have been over 300 tests conducted in U.S., Europe and Japan. Sharing experience in the evaluation of these tests should help mutual learning among international regions.

Conclusions and Recommendations

Developments around the world in the past year and half since the French report [French, 19941 was published still support the major findings and conclusions of that report, with only a few minor exceptions. Thus, the updating of those conclusions need only slight modification and paraphrasing as follows:

1. The U.S. now leads in ITS by several important measures (e.g., overall organization and top-down planning, long-term research and operational tests, and deployment of electronic toll collection, commercial vehicle operations, etc.), while Europe and Japan remain ahead in other areas (e.g., Europe in broad-based R&D and Japan in ATMS and ATIS deployment).

2. Overall levels of federal funding for ITS development in the past few years are generally appropriate, notwithstanding earmarking that limits flexibility in their application. However, legislative provisions for stable and continuing support, especially for ITS core infrastructure that will enable deployment of a wide range of ITS user services and that will induce confident commitments and investments by the private sector and the state/local agencies are still not in place.

3. After spending the equivalent of $180M for underlying research during the 1970s, the Japanese national government' s principal funding for ITS in the order of billion of dollars in ITS has been for infrastructure deployment. Japanese industry has been motivated to largely pay its own way in developing ITS products for a market that is now blossoming after years of clear government policy support. The U.S. has not yet demonstrated a comparable commitment to deployment.

From the standpoint of potential cooperation among the three international regions in technological cooperation (through the private and academic organizations as well as the public sector), it would be desirable to identify the core competences of the three regions. For example, the Japanese are particularly strong in consumer electronics manufacturing, which underlies their competence in developing and marketing autonomous navigation systems. Many knowledgeable observers see the vehicle control area as a core competence for European vehicle manufacturers and suppliers. The U.S. unsurpassed experience in combining system engineering and organizational skills with advanced technologies in the defense and space industries has certainly relevance to ITS (e.g., global positioning system has been applied to vehicle positioning 911 around the world). A better understanding and inventory of the ITS-relevant core competences in the international regions, including their specific technologies, programs, and organizations, would help future consideration and negotiation in international cooperation in both the public and private sectors. .

Another observation worth mentioning is a couple of common trends in the changing characteristics of the ITS programs among the three regions in the past year and half. These are the trends toward multi-modalism and toward coupling ITS with information networks. In the U.S. ITS system architecture, nodes are included for future coupling with rail, air and maritime transportation. The European architecture structure has gone a step further by embracing air transport in their Framework IV guidelines, as has been mentioned previously [DRIVE, 19941. The U.S. has begun to consider the intersection between ITS and the National Information infrastructure (Nil) [Schopp, 1994]. In Japan, the VICS Program is considered an important facet of the “road, traffic and vehicle intelligent system” component in the Advance Information and Telecommunications Society promoted by the Japanese government. As mentioned previously, the European multi-purpose smart card is a beginning of the linkage between ITS and information network in Europe. In February 1995, as a part of G7 Conference in Brussels, ITS was portrayed as an important part of the Information Superhighway-Exhibit. The point is that, ITS is no longer restricted as an integrated system between vehicles and the roadway infrastructure. Its scope has been expanded by a number of external forces.

Given the rapid development and changing characteristic of ITS around the world, the question naturally arises as to the most appropriate way of monitoring and assessing its worldwide development. Some may even question whether critical information might not be available in the international arena. Actually, at least in the ITS area, a great deal' of information is quite open internationally. The major problem is not the availability but the systematic organization and processing of the information. To help future international ITS program assessment, it is recommended that we develop a strategy including the following aspects:

1. Framework

There is a need to develop a framework so that international information may be sought and organized systematically in accordance with the framework. The table of contents in the French report has provided a starting point for the, such a framework:

Funding
Organization
Research and Testing
System Architecture and Standards
Marketing and Deployment
Institutional and Legal Issues
Planning

This is a set of individual measures which should stay as invariant from year to year to facilitate continuing assessment. Perhaps a new *ad* hoc category of information should be included that may become important for a particular year or period that reflects special events or forces that may impinge upon the ITS activities in one region or another. A case in point is the new European policy to make all expressways tolled in the foreseeable future that may provide a special impetus or challenge to ETC.

2. Information Collection

There is a need for both systematic and cost-effective way to collect international ITS information that would use a combination of staff (at the ITS Joint Program Office and/or ITS AMERICA), consultants, and volunteers. The staff and consultant' s time could be spent in systematically sifting information available in the open literature (program reports, conference proceedings, newsletters, etc.) according to the framework in 1. Volunteer' s inputs could .be obtained from those who have taken overseas trips, visited foreign organizations, attending international meetings and exhibits, taking technical tours such as those offered at the ITS World Congress.

3. Assessment

As a part of the ITS AMERICA' s Benefits, Evaluation and Costs (BEC) Committee meetings and/or workshops, small groups of international experts can be organized to discuss the implications and assessments of the information that has been collected under 2. Such discussion should be facilitated by white paper(s) written according to the invariant and ad hoc measures developed under 1. The assessment could consist of two parts: a summary portion that would fit into the overall ITS program assessment chapter in the National Program Plan (NPP); and a detailed portion that could either be an appendix to the NPP or an independent document.

4. Distribution

Naturally periodic (annual) international program assessment would be widely distributed as a portion of the National Program Plan. However, in order to help timely decision in both the private and public sectors, the staff of JPO and/or ITSA should maintain interim international information in order to respond to serious inquiries. Occasionally, distribution of new critical information should be active in the sense that the staff may send the newly available information to selected parties who have a need to know, instead of just sending them a report at the end of each assessment period.

The above outline of an international program assessment strategy is based on this author' s individual experience in the past two years as a consultant to the USDOT ITS Program Office. It is hoped that the BEC Committee will help making the recommendation more realistic and effective.

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