Study on the safety measures of the Intelligent Transport Systems (ITS) Plan in Japan

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Abstract
This paper studies the safety measures of the ITS plan in Japan, available today or under study. After the successful completion of e-Japan Strategy, Japanese government is now advocating ubiquitous Japan plan, or u-Japan plan, to introduce advanced information and communication technologies. One of the pillar projects of u-Japan plan is ITS implementation. The Japanese concept of ITS encompasses three main aspects: they are comfort, efficiency, and safety. The main issue of this paper is the safety aspects. This paper first breaks down the safety aspects into pre-crash and post-crash safety measures. The findings of the paper are that pre-crash safety measures are well studied and covered by the current ITS plan in Japan on one hand, but on the other hand, the post-crash measures are not covered as much as desirable, particularly when compared with those in the ITS plan in the USA.

1 Introduction
With the advances and proliferation of smaller communicating/computing devices, Weiser\(^1\) predicted in 1991 that communicating/computing would be “invisible”. This concept of ubiquity reflects the trend where computing/communicating devices become increasingly invisible or transparent, embedded, intelligent, and deployed in a variety of settings such as the home, office, and vehicle.

By this definition, the concept of ubiquitous network society was advocated by Japan’s Ministry of Internal Affairs and Communications (MIC). The concept has essentially three components: ubiquitous accessibility to networks, ubiquitous communicating and computing, and offering of ubiquitous services. ITS services can be considered as one of the ubiquitous services. In ITS, wireless technologies are pervasive both within a vehicle and between a vehicle and a supporting infrastructure such as roads and road-side equipment. They are to monitor, sense, manage and com-}

municate among various equipment within a vehicle, between vehicles, and between a vehicle and a supporting infrastructure in and along the roads, to improve comfort, efficiency and safety of drivers, passengers, users of public transport and pedestrians.

More specifically, they are further paraphrased as follows in a document issued in 2003:\(^2\):

1) In terms of convenience and comfort, ITS Japan aims at providing an enjoyable and convenient transportation experience for drivers, passengers, users of public transport and pedestrians alike.
2) As a target for efficiency and environmental preservation, ITS aims at providing a zone of zero traffic congestion.
3) In safety and security, ITS Japan aims at achieving a zone where traffic accident fatalities are reduced to zero.

In a document issued in 2006, with regard to the traffic safety, a more realistic target of “reducing traffic fatalities to 5,000 or below by the end of 2012” is stated\(^3\).

2 ITS plan in Japan
The “Comprehensive Plan for ITS in Japan”, copyrighted in 2004\(^4\), states, in Chapter 1, that:
“ITs is expected to play a primary role in expanding and creating new markets for automotive and data communication-related industries.”

Therefore, the ITS plan in Japan can be summarized to have

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the following two objectives:
1) To find solutions to the problems facing today’s road transport; and
2) To create new industries, as a result of convergence between automotive and data communication-related industries, in light of Japan’s current low economic growth rate, and to develop new markets around the world.

In February 1995, the Advanced Information Telecommunications Society Promotion Headquarters, headed by the Prime Minister, determined the "Basic Guidelines on the Promotion of an Advanced Information and Telecommunications Society", which included a policy guideline for promoting ITS. The guidelines stated a comprehensive and systematic promotion of:
1) Vehicle Information and Communications Systems (VICS);
2) R&D and standardization activities on ITS info-communications-related technologies; and
3) International cooperation concerning ITS.

The “Guidelines” were the first official document to position ITS related projects on the level of a national and multi-ministerial project. It defined ITS as a driving force for “introducing information technology (IT) into the public sector, indispensable for promoting creation of an advanced info-communications society”.

In July 1996, five government bodies got together and compiled a “Comprehensive Plan for ITS in Japan”, presenting a long-term ITS vision for the next 20 years. The names and the organization of the five government bodies were changed in 2001 and their current names are Ministry of Land, Infrastructure and Transport (MLIT), National Police Agency (NPA), Ministry of Internal Affairs and Communications (MIC) and Ministry of Economy, Trade and Industry (METI). The Comprehensive Plan stated that the targets of ITS development and deployment are as follows:
1) ITS can be regarded as a comprehensive info-communications system, dealing with road traffic and transportation;
2) ITS can display a clear example of an advanced info-communications society to the Japanese people, through road traffic/transportation system being closely related to their daily lives. Thus, the ITS plan is expected to play a leading role in creating an advanced info-communications society where every citizen is ensured of leading a happy life through use of state-of-the-art info-communications technologies.

Specifically, the Comprehensive Plan has defined goals for government-industry-academia collaboration in each of research and development areas. In 1999, a new user service was added when constructing "System Architecture for ITS in Japan", aiming at coordinating ITS functions with advanced information and telecommunications society.

In 2001, the IT Strategic Headquarters was established, headed by the Prime Minister, to which the responsibilities of the former Advanced Information and Telecommunications Society Promotion Headquarters, set up in 1994, were transferred. The newly created IT Strategic Headquarters took over the responsibility of the promotion of ITS and of the collaboration with the ITS Japan, which is an industry-academic ITS promotion organization, and with the ITS Standardization Committee that promotes international standardization of ITS. By this change of responsibilities, Japan’s ITS has been clearly positioned as a tool to promote the research and development of next generation info-telecommunication technologies to be applied to road traffic safety and efficiency, and to use Japanese market as a test bed for their implementation.

3 Pre-crash Safety Measures of Japan’s ITS plan

Technological advances in telecommunications and sensors have made possible the development of a large number of ITS services such as navigation assistance, remote monitoring, preventive maintenance, and traffic control. All these services are primarily directed towards the key requirements of safety of the occupants of the vehicle. The Vehicle, Road and Traffic Intelligent Society (VERTIS) was the forerunner of the ITS plan in Japan, and set the national safety goal for 2025 as “a 50% reduction of traffic accident related deaths.” The VERTIS plan launched three in-vehicle sensor-based projects aimed at pre-crash safety measures to prevent accidents. They are as follows:

5 Advanced Information Telecommunications Society Promotion Headquarters of Japan, "Basic Guidelines on the Promotion of an Advanced Information and Telecommunications Society" February 1995
9 "ITS Japan" http://www.vertis.or.jp accessed in May 2006
1) Smartway Project / Advanced Cruise-Assist Highway Systems Project\textsuperscript{10} is a road-based concept, which will serve as the platform for Advanced Cruise-Assist Highway Systems (AHS). AHS provides support for drivers in judging driving conditions through combined use of road infrastructure and info-communications systems. For instance, AHS can help the driver to avoid obstacles ahead of the vehicle by controlling the vehicle's cruising via radio communications between the vehicle and devices installed alongside roadways. In addition, the system can detect and report road traffic accidents and disasters automatically, which will facilitate emergency rescue activities and enhance safety in cases of accidents and disasters.

2) Smartcar Project / Advanced Safety Vehicle (ASV) Project\textsuperscript{11} aims at improved safety realized through application of in-vehicle sensor technologies. Research and Development on ASV includes the following six major safety oriented technologies: i) preventive safety technology, ii) accident avoidance technology, iii) fully automatic steering technology, iv) technology for improved safety in collisions, v) technology for preventing expansion of damage and havoc, and vi) fundamental vehicle technology.

3) Smart Cruise System (SCS) Project\textsuperscript{12} aims at allowing drivers to put the car on “cruise” and leave the driving to computers, with cameras and other sensors mounted on vehicles communicating with each other and with roadway systems. The system will prevent cars from straying from their lanes, or colliding with pedestrians or vehicles in the vicinity. Examples of Smart Cruise System services are as follows:

i) \textit{Support for prevention of collisions with forward obstacles}: This support detects other vehicles and objects in the headway and notifies the vehicle. The vehicle then gives a driver information, warning and operational support.

ii) \textit{Support for prevention of right turn collisions}: This support informs a vehicle of intersections where right turns are possible and detect oncoming other vehicles and notifies the vehicle. The vehicle then gives a driver information, warning and operational support.

iii) \textit{Support for prevention of lane departure}: This support receives lateral direction information from lane markers, which are installed in the road. The vehicle gives a driver information, warning and operational support.

As we can obviously notice, all the above pre-crash measures are aimed at the application of info-telecommunications technologies to prevent accidents and to improve the safety and efficiency of vehicles traffic.

4) \textit{Are pre-crash safety measures enough? - Analysis of traffic accidents}

As a result of various traffic safety measures, fatalities caused by traffic accidents are decreasing in Japan, as shown in Figure 1.

The New IT Reform Strategy, issued in January 2006, states that the target is “to reduce traffic accidents fatalities to less than 5,000 per year by year 2012. Since the corresponding number is 2005 was 6,900, a further reduction of some 28% is needed. The view of the author is that, in order to achieve this target, not only pre-crash preventive safety measures, but also post-crash safety measures to take care of injured persons are needed. More specifically, it is

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{yearly_changes_of_traffic_accidents_fatality.png}
\caption{Yearly changes of traffic accidents' fatalities in Japan\textsuperscript{13}}
\end{figure}


necessary to reduce the time from detection of traffic accidents to the admission of the injured persons to medical facilities.

Although the importance of the post-crash safety measures is well recognized and emphasized in the New IT Reform Strategy document, the author found, after consultations with a number of appropriate sources, that currently, as of July 2006, no specific project is being performed under the umbrella of the ITS plan in Japan, on the post-crash safety measures. The New IT Reform Strategy document does say that "a joint committee from the public and private sectors in early 2006 to work towards the realization of Cooperative Safety Support Systems, investigate the best form of effective services/systems ...." Therefore, one can conclude that the ITS plan in Japan would soon start working intensively and extensively on the post-crash safety measures as well.

Current ITS plan lacks visible coordination with the so-called emergency medical services (EMS) community. This is proved by the absence of such organizations in the list of government bodies involved in the ITS plan, as the Ministry of Health, Labor and Welfare (MHLW), responsible for healthcare, and the FDMA (Fire and Disaster Management Agency), responsible for ambulance services, or by the lack of any visible coordination mechanism between the ITS plan and any medical professional organization.

5 Post-crash safety measures

5.1 Automated Collision Notification (ACN) in Japan

ACN, often called "Mayday systems" or Helpnet in Japan, is intended to reduce collision notification delay. In many collision incidents, the fatality increases due to delay between the time of the collision and the time of an arrival of an emergency medical services (EMS) crew at the site of the collision. The shortening of this delay can dramatically improve a collision survivor’s prognosis and treatment. ACN, using mobile communications networks, reduces the delay in collision notification and response time, especially in cases where the driver and passengers become unconscious. When an airbag is deployed, a wireless voice channel opens automatically to notify operators at an ACN call center that a collision has taken place. The ACN sends the location information of the accident by the use of the location information supplied by the Global Positioning System (GPS). Thus, an emergency call center can transmit the location information to an ambulance service center, which can dispatch an ambulance quickly to the site of the accident. The ACN is already implemented in Japan. As of May 2005, some 70,000 automobiles were served by the system. Compared with the total number of automobiles operating in 2005, which is some 79 million in Japan, the number of automobiles subscribed to the ACN service is only a fraction (0.09%) of the total number. Measures are needed to improve the service and enhance the subscription.

No other post-crash safety measures are currently under study, as of July 2006, as extensively and intensively as in other areas, including pre-crash safety measures in Japan.

5.2 Automated Crash Notification Systems in USA

In addition to the functions provided by the ACN in Japan, such as the quick notification of an accident and of its location information to an emergency call center, the Automated Crash Notification Systems in USA has the function of detecting the collision force and the angle of impact to assist responders in determining what type of help to send, such as basic life support or advanced life support, and where to transport the injured, e.g. nearest local hospital or regional trauma center.

In addition, the video camera inside the ambulance enables emergency department and trauma center doctors to view the patient, monitor vital signs, assess the extent of injury and determine possible treatment options while the patient is on the way. Ultimately, the collision data could help doctors determine what kind of treatment may be needed and enable them to ready an appropriate medical team, e.g. neurosurgeons, orthopedists, etc, and other hospital resources, such as an operating room. At the vehicle owner’s option, medical information about the vehicle owner and/or the owner’s family might be stored in the system for wireless release in the event of a collision or other medical emergency.

In USA, the Advanced ACN was put under field trial test since 1999, for example, in the State of Minnesota.

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15 Japan Automobile Manufacturers Association, "Introduction to the Helpnet, an emergency notification system (original in Japanese)", http://www.jama.or.jp/lib/jamagazine/200505/03.html, accessed in July 2006
5.3 Collaboration between emergency medical services (EMS) and ITS community in USA

A main player in the coordination of EMS and ITS in USA is a not-for-profit organization called Communications for Coordinated Assistance and Response to Emergencies, or ComCARE, Alliance\(^{19}\), a broad-based national coalition of more than 90 organizations representing physicians, emergency medical technicians, emergency (911) call directors, automotive companies, consumer organizations, telematics suppliers, wireless technology companies, transportation companies, law enforcement groups, and others. The stated objective of the ComCARE Alliance is "to encourage and facilitate cooperation across professional, jurisdictional, and geographic lines, seeking to break down the walls that separate these agencies and professions and limit their effectiveness. Our goal is to promote a coordinated approach to emergency services."\(^{20}\)

In 2000, the US Department of Transportation (USDOT), ComCARE and OnStar, a telematics service subsidiary company of General Motors, co-sponsored the National Mayday Readiness Initiative (NMRI)\(^{21}\) to "encourage effective, efficient, and seamless integration between ITS and EMS providers". NMRI is a public-private partnership of more than twenty national organizations which have been meeting to develop and address issues that arise in the dealings between Mayday service providers (such as OnStar) and the nation’s public emergency response agencies. NMRI is supported by USDOT funds and a grant from General Motors/OnStar. National Highway Traffic Safety Administration (NHTSA) recognizes GM/OnStar as the leading force in ITS safety based services and integration with other EMS players. The ComCARE Alliance did as well recognize OnStar for its leadership in the field of ITS safety.

Intelligent Transportation Society of America, or ITS America\(^{22}\), is a not-for-profit organization promoting ITS in the USA. It was founded in 1991 and has, as members, private corporations, public agencies, academic institutions and research centers. The medical subcommittee of the ITS America public safety advisory group issued a set of recommendations for emergency medical services (EMS) to the U.S. Department of Transportation that ITS technologies cannot be realized "without immediate and substantive input from the EMS community". ITS America believes that the EMS community must be involved long before technology is introduced to the marketplace, in order to assure its seamless integration into the existing EMS system. Indeed some EMS members of ComCARE took the initiative to ask the automotive industries to study and implement crash sensors, as a part of the Automated Crash Notification Systems, aiming at recording data of a vehicle at the time of a crash.

ITS America’s plan includes the following pre-crash and post-crash safety measures\(^{23}\):

**Pre-crash safety measures:**
- **Intersection Collision Avoidance Systems** which monitor a vehicle’s speed and position relative to the intersection, along with the speed and position of other vehicles in the vicinity, advising the driver of appropriate actions to avoid a right-of-way violation or impending collision.
- **Rear-End Collision Avoidance Systems** which sense the presence and speed of vehicles ahead, and provide warnings to avoid collisions.
- **Road Departure Collision Avoidance Systems** which could prevent vehicles run-off-road crashes. These systems track the lane or road edge and suggest safe speeds for the road ahead.

**Post-crash safety measures:**
- **Automated Crash Notification Systems** transmit crash information such as collision force and angle of impact to assist responders in determining what type of help to send and where to transport the injured.
- **Incident Management Systems** provide traffic operators with the tools to allow quick and efficient response to accidents, hazardous spills, and other emergencies. Communications systems link data collection points, transportation operations centers, and decision support software into an integrated network that can be operated efficiently and intelligently.
- **Telemedicine Systems inside ambulances and medical helicopters** enhance the ability of emergency physicians to direct the medical care of crash victims in route to the hospital or trauma center.

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20 Comments of the ComCARE Alliance to the Federal Communication Commission No. 94-102 regarding Enhanced Emergency Calling Systems 2003
Comparison of safety measures between ITS in Japan and USA

As a summary of Sections 3 to 5, safety measures of ITS in Japan and USA can be compared as follows:

1) Safety measures of ITS in Japan are mostly focused on pre-crash accident prevention measures, using advanced information-telecommunication technologies, such as Advanced Cruise-Assist Highway Systems project, Advanced Safety Vehicle project, and Smart Cruise System project. Post-crash measures are limited to Automatic Collision Notification System. This system is one-generation behind when compared with the Automated Crash Notification System of the USA, in the sense that it does not have the capability to detect and transmit the collision force and the angle of impact. Collaboration and coordination with emergency medical services (EMS) community are virtually non-existent under the ITS plan in Japan.

2) On the other hand, ITS plan in USA focuses not only on the pre-crash accident prevention measures, but also on the post-crash safety measures, such as Automated Crash Notification Systems, Incident Management Systems and Telemedicine Systems inside ambulances and medical helicopters. Furthermore, a not-for-profit organization ComCARE Alliance provides active coordination between emergency medical services (EMS) community and ITS community. This difference in approach seems to arise from the fact that Japan’s ITS is positioned as a tool to promote research and development of new technologies for road traffic safety, “to expand and create new markets for automotive and data communication-related industries.”

One of the two objectives of the ITS plan clearly states that the objective is “to create new industries, as a result of convergence between automotive and data communication-related industries, in light of Japan’s current low economic growth rate, and to develop new markets around the world.”

Conclusion

This paper studied the safety measures of ITS plan in Japan and found out that pre-crash accident prevention measures based on the use of advanced information and communication technologies have been strongly promoted and many projects have been undertaken. On the other hand, post-crash safety measures, especially in the area of collaboration with emergency medical services community, had not been promoted in the past as much as desirable, especially when compared with those in the USA. However, the author takes note that a new initiative under the leadership of the IT Strategic Headquarters in Japan has been implemented under the ITS plan in early 2006 a joint committee to tackle the issue on a more comprehensive basis, including the post-crash measures.

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