



# **ITS Guideline**

**for Sustainable Transport  
in the Asia-Pacific Region**

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# **ITS Guideline for Sustainable Transport in the Asia-Pacific region**

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## **Outline of each section**

Section 1 describes the purpose of this ITS Guideline for Sustainable Transport in the Asia-Pacific region. It is intended to provide a reference for policy makers in the Asia-Pacific region to develop or update their own ITS Master Plans. An ITS Master Plan is an essential prerequisite for each region to get consensus of and support from the concerned people and organizations including public sectors, private sectors and academia as well as the concerned international organizations.

Section 2 describes current transportation problems and responses in each country and region and the direction of future measures. Using the measures adopted in other countries and regions as benchmarks is extremely important for effectively undertaking measures in one's own country.

Section 3 describes the fundamental transport problems such as congestion, traffic accidents, environmental problems, and the lack of the lack of multi-modal transport. It also elaborates fundamental ideas on the measures to eliminate the problems. Then, the approaches to the problems are suggested, referring to the effects of ITS. Finally, the necessary perspectives in the implementation of measures are introduced.

Section 4 describes the role and applications of ITS. This section also explains each application of ITS including new or emerging applications such as utilization of probe data and mobile devices corresponding to transport problems such as congestion, traffic accidents and environmental problems

Section 5 describes the type of benefits and also how benefits are evaluated. It exemplifies benefits of each application of ITS shown in Section 3. The benefits include time and fuel savings, prevention of accidents, increased comfort, reductions of emissions and economic effects. It then introduces how to quantify the benefits with the measurement methods.

Section 6 describes the important conditions for the development and deployment of ITS, especially in developing countries. These may include the issuing of financing systems, formulation of national policy on ITS development and deployment such as National ITS Master Plan including establishing national technical standards of ITS, and capacity development.

Section 7 describes the contents of the ITS Master Plan, which includes principles, targets and a roadmap for development and deployment of ITS to request related experts from the public, private and academic sectors for their understanding and cooperation in its implementation.

## **Section 1 Introduction**

### **1.1 Purpose and target reader**

The purpose of this ITS Guideline for Sustainable Mobility in the Asia-Pacific region is to provide a reference for policy makers in the Asia-Pacific region to develop or update their own ITS Master Plans. An ITS Master Plan is an essential prerequisite for each region to get consensus of and support from the concerned people and organizations including public sectors, private sectors and academia as well as the concerned international organizations.

### **1.2 Background**

This ITS Guideline was mainly created from the discussions at the last two Regional Workshops on ITS held in collaboration with the Asian Development Bank Institute (ADBI) and with support by the ITS Asia-Pacific Board of Directors. The first Workshop was held in Tokyo, Japan in March 2010 and the second Workshop was held in Tianjin, China in July 2011. Some additional comments and suggestions were provided by experts in the Asia-Pacific region and discussions at the past ITS World Congress and Asia-Pacific ITS Forum held by ITS Asia-Pacific.

A summary of the discussion of past Regional Workshops on ITS is described as follows:

Common recognition of transportation in Asia

- Rapid growth of traffic demands accruing rapid population and economic growth exceeding that of infrastructure development in many cities and regions of Asia. Although Intelligent Transportation Systems (ITS) have previously been recognized and introduced as vital tools to solve safety and environmental problems in many Asian countries, they have not always been successful.

Important points for introducing ITS in developing countries

- Financing system
- Capacity Development
- To formulate national policy on ITS deployment including establishing national technical standard of ITS (ITS Master Plan).
- To benchmark progress of ITS to facilitate flexible introduction of the system tailored to local conditions.

## **Section 2 Outlook**

The outlook is a description of current transportation problems and responses in each country and region and the direction of future measures. With regard to responses to transportation problems, the outlook describes policies, organizations, targets, projects, ITS introduction technologies, and so on as response policies and measures for addressing those issues. Using the measures adopted in other countries and regions as benchmarks is extremely important for effectively undertaking measures in one's own country.

The details of the outlooks for each country and region are set forth in the Appendix 1.

## **Section 3 Approach to transportation problems**

### **3.1 Transportation problems**

Transportation problems are extremely serious in the major cities of developing countries in the Asia-Pacific region. Among these problems are major roadways where traffic comes to a complete standstill, intersections with vehicles entering from all four directions resulting in gridlock, subjective manual operation of traffic signals, parked vehicles that block traffic lanes, traffic networks without alternative routes, drivers forced to endure traffic congestion without any traffic information, drivers and pedestrians that do not comply with traffic signals and traffic rules, motorcycles with three or more passengers not wearing helmets, vehicles so overloaded that they tilt, lack of public transport such as subways and buses and inconvenient transfers, and so on.

Transportation problems can be broadly divided into problems occurring from the flow of traffic and problems relating to the convenience of transportation. The main problems occurring from the flow of traffic are traffic congestion, traffic accidents, and environmental problems. Problems relating to the convenience of transportation include issues relating to mobility such as lack of access to public transportation and lack of information relating to the use of public transportation, parking, and other facilities. Below, individual problems are discussed.

#### **(1) Traffic congestion**

Eliminating or reducing traffic congestion requires the control of traffic flows through the introduction of traffic rules and compliance with those rules by users.

Traffic congestion is a phenomenon that occurs when traffic demand exceeds road capacity. Means of eliminating traffic congestion can be broadly divided into two approaches: increasing road capacity and controlling traffic demand.

Increasing the capacity of general roads requires improvements to road structures and efficient traffic flows. Improvements to road structures include increasing the number of lanes or lane width and creating intersections with overpasses or underpasses. Means of increasing the efficiency of traffic flows include eliminating illegally parked vehicles, normalizing left and right turn lanes at intersections, and optimizing traffic signal control. Also, constructing bypass routes that avoid city centers and alternate routes between major destinations can be effective, but these are long-term measures, and consequently, it is necessary to coordinate with urban development plans including the construction of public transportation such as subways.

Increasing the traffic capacity of highways requires optimization of the flow of traffic onto highways, ensuring appropriate vehicle speeds, and optimizing traffic capacity as well as eliminating traffic congestion at toll gates and limiting congestion caused by road structures.

In addition, the introduction of public vehicles such as buses as well as car sharing can be an effective means of increasing vehicle ridership compared to private vehicles.



Traffic demand is closely related to economic activity and urban activity, and therefore, it is necessary that future traffic demand forecasts be coordinated with mid- to long-term urban policy.

## **(2) Traffic accidents**

The causes of traffic accidents can be broadly divided into accidents caused by road structures, accidents caused by vehicle problems, and accidents caused by human error. Accidents caused by road structures include a lack of lighting, a lack of lane designations, and the lack of intersections and pedestrian bridges for road crossing. The percentages of accidents caused by road structures, vehicle problems, and human error vary by country, region, and city, but in many cases, the greatest percentage of accidents is caused by human error.

In addition to the measures addressing the direct causes of accidents mentioned above, the development of legal systems and education relating to traffic safety are also important. Legal development includes the adoption of laws relating to traffic safety, the imposition of fines for traffic violations, and the creation of vehicle safety standards.

Also, since human error is a leading cause of traffic accidents, educating drivers on traffic safety and conducting traffic safety campaigns to raise public awareness are effective.

## **(3) Environmental problems**

Among the environmental problems caused by exhaust gas emissions are air pollution caused by nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM) and global warming caused by carbon dioxide (CO<sub>2</sub>) emissions. These components of emissions are produced from fuels. When a vehicle engine cannot operate efficiently because of traffic congestion or other causes, fuel efficiency deteriorates and atmospheric pollutants and carbon dioxide emissions necessarily increase. As a result, eliminating traffic congestion and increasing the efficiency of traffic flows leads directly to improvements in this problem. Also, rapid starts and acceleration consume more fuel than is necessary. Eco-driving that limits such actions can improve fuel efficiency and reduce emissions. The first step in resolving the problem of emissions is improving fuels and vehicles through regulation, but improving traffic flows and practicing eco-driving are also effective.

## **(4) Problems relating to mobility**

Means of land transportation include automobiles as well as public transportation such as buses, railways, and subways, while air and marine means of transportation also exist, forming a multi-mode system. Collaboration among modes and divisions of roles can improve access to transportation including public transportation and raise the efficiency of mobility. Also, in addition to physical collaboration such as terminals that link multiple means of transportation, the provision to users of information concerning related transportation can facilitate choice of the optimal mode to user destinations.

## **3.2 Approaches to resolving transportation problems**

Approaches to resolving transportation problems require analysis of current conditions, proposal

of countermeasures, and application of ITS in areas where its introduction will be effective.

### **(1) Analysis of current conditions and proposal of countermeasures**

Resolving transportation problems requires not a single measure or means, but the parallel implementation of multiple countermeasures. Multi-faceted approaches including long-term and short-term as well as national and municipal measures are necessary, and consequently, collaboration and cooperation among the various related parties is essential.

Origin Destination (OD) surveys are necessary for understanding traffic demand, which is the foundation of the occurrence of traffic. Rather than using survey questionnaires as in the past, probe surveys that use vehicles equipped with GPS are effective for conducting OD surveys. This provides not only OD information, but also route and travel time data, enabling identification of locations and times of traffic congestion, queue length of traffic congestion at intersections, and so on, making it possible to obtain basic data that can be effective for traffic congestion countermeasures.

Analysis of causes relating to actual circumstances is necessary for both traffic congestion and traffic accidents, and in the case of traffic congestion, locations of traffic congestion and impediments to efficient traffic flows are identified. In the case of traffic accidents, statistics are gathered and accident causes are categorized.

Countermeasures include construction of infrastructure such as roads and public transportation, development of legal systems, and the introduction of ITS to increase traffic flow efficiency and help prevent traffic accidents. The provision of information to users by ITS is also effective. As explained in Section 3.3, these measures must maintain overall compatibility, and achieving coordination and the sharing of common objectives among the related parties through the adoption of an ITS Master Plan is important.

### **(2) Effects of ITS**

ITS can be effective in achieving the following objectives relating to countermeasures for and means of solving transportation problems.

- Obtaining and providing information  
Technology for monitoring traffic conditions, processing information, and providing information. In addition to conventional fixed sensors, probe technology facilitates the measurement of traffic flows. In addition, big data processing such as social networks can be used to identify traffic flows and user behavior and conduct patterns.
- Influencing user conduct choices  
The provision of information to users (through various media) can influence conduct choices by users and as a result can have effects on normalizing traffic spatially and in time and between modes.
- Traffic control  
Optimal control of traffic flows through traffic signal control, ramp metering, and optimal

route guidance.

- Electronic payment and electronic control

Reduction of traffic congestion at toll gates through electronic toll collection (ETC) systems, enhanced convenience through electronic parking fee payment, and increased work efficiency through electronic freight information and automated vehicle weight measurement.

The application of ITS to individual transportation problems is discussed in Section3 and the benefits are discussed in Section5.

### **3.3 Perspectives on measures and methods of implementation**

When taking measures to address transportation problems and introducing ITS, it is necessary to proceed from the following perspectives.

- Seamless and sustainable

Measures relating to transportation problems require action from the perspectives of seamlessness and sustainability as seen by users. A seamless and sustainable perspective requires consistency and continuity of measures.

- Organization and standardization

Since ITS involves many different fields, the establishment of partnerships between related organizations is important. The development of system standardization is also necessary from the user's perspective.

- ITS implementation process

Transportation problems include infrastructure as a constituent element, and as a result, change and reform often require time but are also urgent issues. When introducing ITS, it is important to develop introduction scenarios that take into consideration cost effectiveness. Also, maintenance and operation following the introduction of ITS are essential for achieving system performance. Some examples include updating digital maps in conjunction with changes to road networks and revising the number of traffic signal control systems in conjunction with changes to intersection configurations or fundamental attributes.

- ITS Master Plan

Transportation problems encompass multiple modes (land, marine, air), and road transportation is made up of users, vehicles, and roads and involves many diverse parties. It is important that an ITS Master Plan that integrates national policy be adopted, that users share a common awareness, and that the information is disseminated to users. Transportation problems vary in different regions, and for this reason it is necessary to prepare regional ITS plans based on the ITS Master Plan.

## Section 4 Role of ITS and its applications

This section describes the role and typical applications of ITS. This section also explains each application of ITS including new or emerging applications such as utilization of probe data and mobile devices corresponding to transport problems such as congestion, traffic accidents and environmental problems as shown in the following matrix.

**Table 4-1**

	Traffic information	Traffic management	ETC/ERP	Public transport *	Multimodal
Congestion	✓	✓	✓	✓	✓
Accident	✓	✓			
Environment				✓	✓
Mobility	✓	✓	✓	✓	✓

	Freight transport	ASV	----	----	----
Congestion	✓				
Accident	✓	✓			
Environment	✓				
Mobility	✓				

*Sub category	BRT	LRT	----	----	----	----
Congestion	✓	✓				
Accident						
Environment		✓				
Mobility	✓	✓				

### 4.1 Traffic information

Traffic information can be broadly divided into the stages of collection and distribution. At the stage of collection, information is collected from fixed sensors on the road, and more recently it has also become possible to collect dynamic information from moving vehicles. At the stage of distribution, methods include the provision of information by transmitters on the road (infrared, wireless, etc.) and by broadcasting. Traffic information systems process the collected information and provide congestion, accident and other information to drivers via navigation systems, smartphones, etc. These systems utilize human machine interfaces (HMI) that efficiently and effectively communicate important traffic information that is both spatially and temporally accurate to drivers.

### 4.2 Traffic management

Like the provision of traffic information, traffic management is an effective means of easing traffic congestion and reducing the incidence of accidents.

On general roads, signal control has the effect of not only smoothing the traffic flow, but also of reducing the incidence of accidents. The use of dynamic signal control, which responds to the traffic flow, in addition to management based on signal changes at fixed intervals is an effective means of realizing a smooth flow of traffic.

On highways, ramp metering (also called ramp signaling) is effective in realizing a smooth flow of traffic by regulating the inflow of vehicles during periods of congestion. When an accident occurs, measures such as stopping the inflow of vehicles are important in addition to the rapid provision of information to drivers.

#### **4.3 ETC/ERP**

The collection of cash tolls on toll roads creates traffic congestion and negatively affects the flow of traffic. Electronic toll collection (ETC) systems are an effective means of avoiding this problem. In addition, the fact that ETC systems collect tolls electronically makes it possible to set the toll rate structure more dynamically, enabling finer control of the traffic flow.

Other systems also exist, for example electronic road pricing (ERP), by means of which the inflow of vehicles to urban areas is regulated electronically by varying tolls. There are also parking and other systems that use identical hardware, software and systems as ETC.

#### **4.4 Public transport**

On the background of limited road capacity, the reduction of the number of private vehicles in use and the transition to public transport that is able to convey large volumes of passengers is an effective means of easing traffic congestion and addressing environmental issues.

It is essential to introduce the optimal public transport system for the specific urban area, buildings, road structures, etc. In addition, the cost of the system, and consequently its cost-benefit ratio, are important factors in the introduction of a public transport system.

Modes of realization of public transportation include bus rapid transportation (BRT) and light rail transportation (LRT).

#### **4.5 Multimodal**

Multimodal transport is an important element in the provision of effective methods of mobility utilizing motor vehicles and public transport networks. Seeking to realize transportation that is more convenient and comfortable for users, multimodal transport systems provide integrated transportation information concerning physical access and connections making it possible to utilize multiple modes of transportation, and enabling the optimal modes to reach the destination to be selected.

#### **4.6 Freight transport**

The proportion of commercial vehicles using the roads, such as trucks being used to ship freight between cities, is high in comparison to private vehicles. Freight transport systems are efficient freight management systems that not only ease traffic congestion and reduce the incidence of accidents, but also make a significant contribution to environmental protection and the efficient movement of goods.

#### **4.7 Advanced Safety Vehicle (ASV)**

Advanced Safety Vehicles (ASV) are vehicles fitted with systems that use advanced technology to support drivers in safe operation. ASV technologies that have been realized to date include collision mitigation braking, Adaptive Cruise Control (ACC), lane-keep assist, lane deviation warning, and Electronic Stability Control (ESC).

## **Section 5 Benefits and evaluation of ITS**

The benefits of introducing ITS and methods of calculating those benefits are discussed.

### **5.1 Types of benefit**

#### **(1) Reduced travel times**

Users can reduce travel times to their destinations by selecting optimal means of transport and routes. The total amount of individual reduction in travel time results in a social reduction of travel time. Such a social reduction of travel time can be thought of as a socioeconomic effect. ITS that can reduce travel times includes easing of traffic congestion through traffic control, selection of optimal routes by drivers through the provision of traffic information, and automated payment of tolls using ETC.

#### **(2) Fuel savings**

Easing traffic congestion and selecting optimal routes can reduce fuel consumption as well as automobile travel times to destinations while the effects on driving from the provision of information concerning eco-driving can also reduce fuel consumption, leading to lower fuel costs. The total of lower fuel costs results in substantial reductions in fuel consumption and fuel costs throughout the society.

#### **(3) Prevention of traffic accidents**

ITS can prevent collisions at intersections, collisions while merging on highways, and rear-end collisions as examples, resulting in less fatalities, injuries and damages.

Losses resulting from traffic accidents can be divided into economical losses and non-economic losses. Economic losses include human losses as well as physical losses and there are other losses from traffic congestions that are caused by accidents. Non-economic losses include declines in the quality of life such as mental losses from accidents.

#### **(4) Comfort**

The provision of information on optimal transfers relating to the use of multiple means of transport (multi-mode transport) to user destinations can facilitate more comfortable mobility. Also, automatic payment of road-use fees and parking fees can also make transportation more comfortable.

#### **(5) Reduction in carbon dioxide (CO<sub>2</sub>) emissions**

Lower social fuel consumption leads to reduced carbon dioxide emissions. Carbon dioxide is one of the causes of global climate change, and lower emissions may contribute to addressing the problem of global warming.

#### **(6) Economic effects from the creation of industry**

ITS can be expected to create products and services in a wide range of fields including the automobile industry and electrical equipment industry, spurring employment and generating

economic effects.

### (7) System evaluation tools

The introduction of ITS will make it possible to efficiently assess the effectiveness and effects of transportation-related systems. For example, surveys of traffic flows, traffic flow improvement assessments, accident cause analysis, and other processes that were previously performed manually can be performed systematically and electronically using information processing. As a result, survey and analysis costs can be reduced.

## 5.2 Relations between ITS applications and benefits

**Table 5-1** shows the relation between the ITS applications in Section 4 and the benefits mentioned above.

**Table 5-1**

	Traffic information	Traffic management	ETC/ERP	Public transport	Multimodal	Freight transport	ASV
Reduced travel time	✓	✓	✓	✓	✓	✓	
Fuel savings	✓	✓	✓	✓	✓	✓	
Prevention of traffic accident	✓	✓		✓			✓
Comfort	✓		✓				
Reduction in CO <sub>2</sub> emissions	✓	✓	✓	✓	✓	✓	
Economic effects	✓	✓	✓	✓	✓	✓	
System evaluation tools	✓						

## 5.2 Methods of estimating quantitative benefits

Some examples of methods of estimating the social benefits of ITS are presented below by way of reference.

### (1) Reduction in travel times

It is possible to calculate the economic effects of reduced travel times for society as a whole and to equate this to a social benefit. When calculating the economic effects of time, units of time



value equivalent to labor costs are used. Units of time value are set for each vehicle type.

## **(2) Reductions in fuel consumption and fuel expenses**

It is possible to reduce motor vehicle fuel consumption (gasoline consumption) in conjunction with the shortened travel times mentioned above. One method of estimating the reduction is to use the correlation between driving speed and fuel consumption. The amount of fuel consumed is calculated from the average travel speed (average vehicle speed) and the travel time. There are variations, however, in the accuracy of this method.

## **(3) Prevention of traffic accidents**

Methods of estimating human and physical losses, which are types of economic loss, are not necessarily the same in different countries and regions, but traffic accident statistics for each type of accident are needed, and it is necessary to organize accident statistics.

Non-economic losses include declines in the quality of life such as mental losses from accidents. One method of evaluating such losses is an assessment method based on the amounts that people are willing to pay to avoid such losses.

## **(4) Reductions in emissions (carbon dioxide)**

One method of estimating reductions in emissions is calculation based on average travel speed and vehicle speed distributions. A simpler method is calculation of carbon dioxide emissions based on average travel speed.

## **(5) Economic effects from the creation of industry**

The creation of industries for ITS products and services can be considered as economic effects. One example of a method of estimating the size of the industry market is estimating the production values of the final products and services. To estimate production values, (i) the ITS field is defined and (ii) statistics concerning product and service shipment volumes in the respective fields and market prices are investigated, and the market size is estimated.

## **5.3 Measurement methods**

To measure the benefits described above, it is necessary to measure the underlying travel times and traffic congestion length. The following methods are used to measure travel times and traffic congestion length.

### **(1) Measuring travel times**

#### **(i) Vehicle probes**

Onboard vehicle equipment with GPS and smartphones can record transit locations and the times of transit, making it possible to survey travel routes, travel times, waiting times at intersections, and other data.

#### **(ii) Automatic vehicle identification (AVI)**

Vehicles equipped with ID transmitters can be traced using multiple roadside receiver antennas based on the same IDs, and travel times can be calculated.

(iii) License plate recognition systems

Imaging systems installed on the roadside of multiple locations can read license plates, and travel times between two points can be calculated based on the transit times of vehicles with the same license plates. Generally, not all digits of the license plates are read from the perspective of protecting privacy. The system does not require onboard equipment.

**(2) Traffic congestion length and congestion waiting times**

(i) Estimates from vehicle detectors and image sensors

Traffic congestion length can be estimated using vehicle detectors and image sensors installed on the roadside. This method does not require onboard equipment.

(ii) Estimates from vehicle probes

Traffic congestion length and congestion waiting times can be estimated based on records from onboard vehicle equipment with GPS.

**5.4 ITS penetration rate and social benefit**

ITS comprises infrastructure systems, onboard systems, and users. Normally, infrastructure and onboard system development does not take place all at once on a national scale, but is implemented gradually. As a result, the social benefits will vary depending on the degree of infrastructure development and the penetration rates of onboard devices. In addition, social benefits will vary depending on the use rates of ITS by users including drivers and the degree to which information is followed. Also, one example of calculating social benefits on a national scale is to calculate the benefits in a standard city or multiple standard cities based on the benefits to individuals and then to calculate the benefit nationwide.

## **Section 6   Conditions for development and deployment of ITS**

This section explains the important conditions for the development and deployment of ITS, especially in developing countries. These may include the issuing of financing support, standardization, capacity development, and policy making.

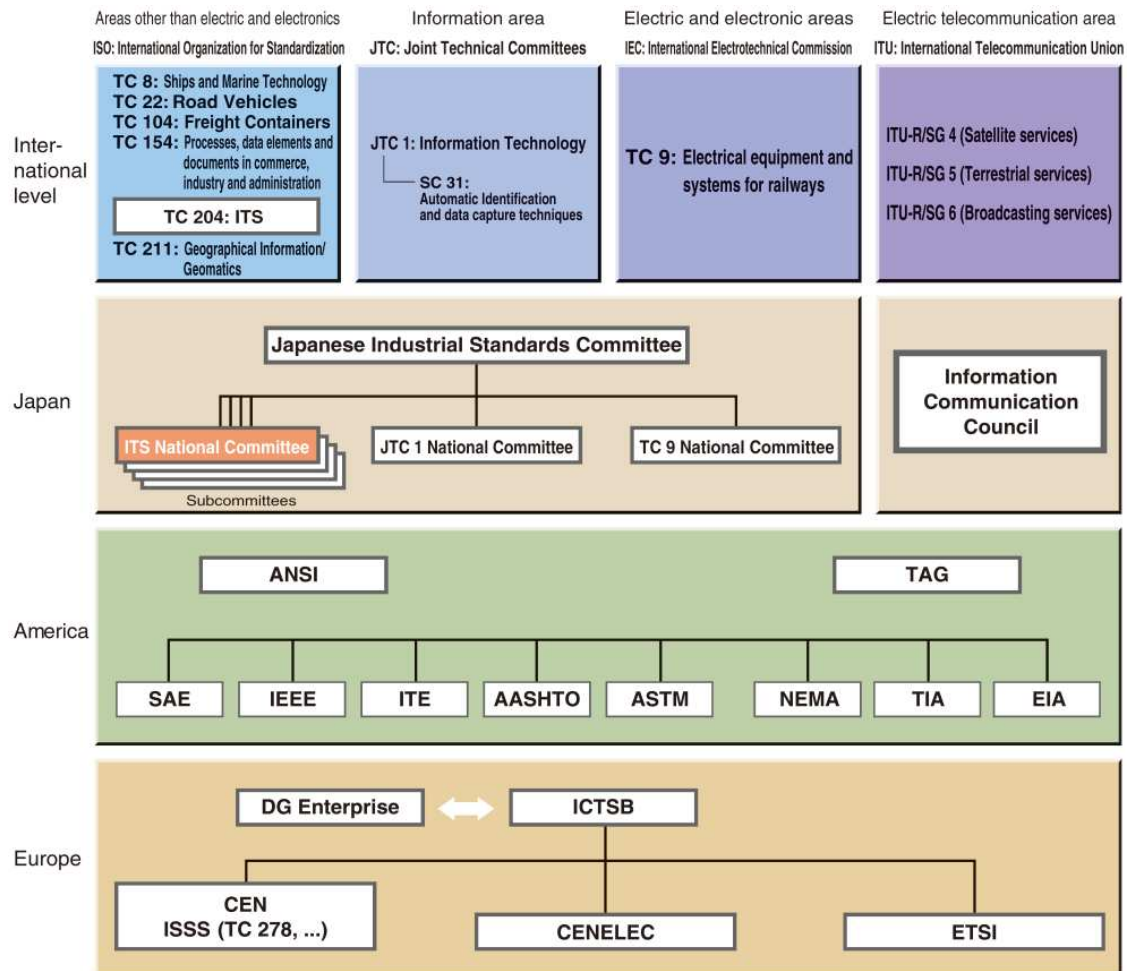
Financing is an issue that includes questions on financial source and on social and economic justification for introducing ITS in developing areas. An ITS Master plan is a policy of introduction of ITS including evaluation of where ITS is missing. This is another reason why developing countries are losing opportunities for ITS investment.

Standardization is an important process to ensure sustainability, compatibility, expandability and also cost effectiveness of introduced ITS. Building required standards is a challenge as it requires vast knowledge on technical options, coordination among stakeholders, and a vision to achieve varying objectives with one standard. Using and seeding international standardization processes such as ISO help countries to build national standards in an effective and fair manner. Dialogue between ITS standardization experts and transport/urban practitioners should occur on a regular basis in order to fill conceptual gaps between the standard and its practical application in fields. As ITS will be experienced and used by people in their daily lives, the ITS community should accelerate outreach efforts to raise their awareness, especially decision makers, on needs to swiftly deploy ITS in addressing imminent urban and traffic challenges. Certification is also necessary for interoperability. Main host organizations (Fig. 6-1) are shown below. And each URL of the website are set forth in the Appendix 2 to refer to their primary focus as well as their main enabling standards for ITS applications.

Capacity development is essential for acceleration of ITS deployment in countries. Although there can be many forms of capacity development, emphasis should be placed on the need to combine bottom-up level of awareness and expertise of urban and transport practitioners as well as broadening the vision of policy- and decision-makers in amalgamating ITS strategy with broader transport and urban development policies. Networking urban and transport practitioners to share experience on ITS was recognized as an effective way to develop capacity.

**Fig.6-1 Relationship of ITS Standardization Organizations**

(ITS Standardization Activities in Japan 2012 ; JSAE)



## **Section 7    Template for ITS Master Plan**

### **7.1 Role of the ITS Master Plan**

The government sets basic principles and targets relating to transportation, and after identifying current issues, an ITS Master Plan that sets forth approaches to achieve those targets is adopted. Based on the national master plan, individual regions formulate regional ITS Master Plans based on regional issues and in line with the national master plan.

The ITS Master Plan includes principles, targets and a roadmap for development and deployment of ITS to request related experts from the public, private and academic sectors for their understanding and cooperation in its implementation.

### **7.2 Main items included in the ITS Master Plan**

#### **(1)Basic principles**

- Clarify the type of transportation society that we seek, as well as the temporal and spatial spans in which that transportation society is to be achieved.

#### **(2)Traffic Status**

- Specify the status of traffic networks, mobility and information technologies nationally or regionally when considering the introduction of ITS; specifically, the number of vehicles registered and total road length as well as the development of basic traffic management systems such as traffic signals and traffic control systems and typical ITS technologies that have already been introduced.

#### **(3)Issues that should be addressed**

- Clarify the status and analysis results of traffic-related problems such as traffic accidents (number of accidents, number of fatalities, etc.), traffic congestion, pollution from exhaust emissions, and carbon dioxide.

#### **(4)Targets for each issue**

- Set the specific targets (quantitative targets and timing for achieving them) for each issue.

#### **(5)Means and technologies for achieving targets**

- Specify the ITS technologies and services that are identified to be introduced for each issue to be resolved.
- Clarify the scheme of related legal and institutional policies and the system for securing standards and interoperability.

#### **(6) Implementation systems (plan proposal and implementation organizations) and capacity building**

- Clarify the responsibilities and organizations for planning and implementation.
- Determine the scheme of capacity building & training for planning and implementation.

**(7) Roadmap (schedule for achieving targets)**

- Specify what approaches will be used and how much will be invested to achieve targets.
- For example, the schedule from plan proposal to basic infrastructure development, selecting projects, moving from trials to practical use, deployment and conducting further development.
- Incorporate into the plans processes for evaluating whether the expected results including higher safety, reductions in traffic congestion, increased convenience, improvements in the environment, and economic benefits were achieved.

**(8) Updated plans and processes**

- Incorporate into the plans reviews and plan updates in response to environmental changes, development of new technologies, and results of assessments of effects.

## **Appendix 1 Outlook**

**Australia**

**China**

**Japan**

**Malaysia**

**Singapore**

### **Australia**

#### **1. The History of ITS in Australia**

ITS in Australia, as in many parts of the world, had its origins in the humble and not-so-intelligent traffic signals. Mechanical and gas lit signals were first used in Europe and the US in the early 1900s. In 1928 the traffic signals in Baltimore<sup>1</sup> (USA) could be activated by sounding the horn. Electrically powered traffic signals were in use in Melbourne in 1928 and vehicle activated signals were installed<sup>2</sup> in Sydney in 1933. These were amongst the first to be activated by the now ubiquitous inductive loops.

Traffic signals progressively became more widespread and sophisticated as Australia's cities grew rapidly in the 1950's and 60's.

In the major cities the more critical inner-city sites and arterial routes were hard-wired to central systems, called Area Traffic Control. These were predominately fixed-time but trimmed by local vehicle actuation. By the late 1960's these systems were barely coping. Firstly, the morning and evening peak traffic demand was at the systems' capacity so they needed to be made even more efficient. Secondly, Australia's outdoor lifestyle highlighted the inability of fixed-time systems to cope with rapid and unpredictable changes in traffic demand. Two common examples are; the dramatic exodus from the beaches as a cool change envelops the whole city on a summer's day, and, the impact on transport networks as sports-mad fans travel to several 75,000-plus venues across a city each weekend. (In July 2013 Liverpool Football Club (UK) played before its largest-ever crowd of 95,000 at a mid-week friendly game in Melbourne. Non-finals events with 90,000 attendees are not uncommon).

Australia has consistently been at the vanguard of traffic planning, design, operation and management. In the late 1960s to early 70s this was evidenced by the development of three major computer controlled traffic signal systems, SCATS in Sydney, BLISS in Brisbane and TRACS in the wider Queensland. The latter has progressed to the STREAMS system and the former remains one of the World's most widely used traffic signal systems. In the 1970's these systems used the recently developed computer's real-time communications capabilities to measure and analyse traffic flows and determine optimum operation on a cycle by cycle basis.

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<sup>1</sup> M.G.Lay, "Ways of The World", 1992.

<sup>2</sup> M.G.Lay, "Strange Ways", 2010.

They expanded to include essentially every urban, and many rural, traffic signal sites in Australia – approximately 9,000.

Public transport was becoming increasingly vital in Australia's car-centric cities. Governments were committed to increasing patronage and services and by 1986 all 660 trams in Melbourne had priority at each of the 650 traffic signals they passed through. Bus priority systems were developing in Melbourne and Brisbane and later in Perth, Adelaide and Sydney.

Australia has also been an early adopter of comprehensive Transport Management Centres where sophisticated systems support operators to effectively manage many transport modes including cars/trucks, buses, trams, and in some cases, ferries.

Australia's six states and 2 mainland territories have, since Federation in 1901, developed and deployed their own traffic systems. Each State and Territory had (and has) its own transport department and was virtually totally responsible for funding the design, deployment and operation of transport systems via its own road and public transport authorities. The federal government provided a supporting and coordinating role but did not provide significant direct funding for systems. It did contribute direct funding to major construction and safety projects. Major cities, notably, Brisbane, Sydney and Melbourne each implemented their own systems so that Melbourne had about 5 different traffic signal coordination systems using different hardware and techniques, Brisbane had two but Sydney City Council had largely devolved its systems to the state road authority.

By the late 1980's the institutional arrangements were beginning to become critical to Australia's traffic management systems. Whilst standardisation of traffic signs, traffic signal hardware and road rules were well advanced they were not complete (fully uniform national road laws were not achieved until late 2000). There was a very real risk that with many diverse agencies developing and deploying increasing complex systems that incompatibilities would lead to wasted resources and lost opportunities.

Other issues were also becoming apparent.

Firstly, technologies were advancing rapidly and commercial enterprises were becoming increasingly involved in developing and selling transport related products. Examples include, GPS systems were advancing towards deployment (in 1990 one US hire car company was considering its own GPS system to locate vehicles "lost" by hirers in car parks), telecommunications companies were undergoing significant changes due to competition and were seeking markets other than fixed land lines. It was apparent that some means to channel this effort into positive directions may be necessary as would mechanisms to discourage any unwanted products. Standards would be important.

Secondly, driver distraction was emerging as a major potential safety issue with new technologies. Whilst speed, alcohol, and increasingly, drugs were the major road killers it was becoming apparent that any positive benefits of in-vehicle systems would be jeopardised if they were not sensitive to distraction issues and good ergonomic design.

Thirdly, many potential systems may impact what the community regarded as a personal or private right. One example occurred in Hong Kong where, as part of a cordon pricing scheme, transponders were fitted to vehicles to detect their entrance into the cordon and charge the owner. The proponents had not adequately considered community concerns such as "user pays/tolls",



“informed consent”, “protection of privacy” nor sought to engage in open two-way dialogue. The scheme was abandoned after sustained community outrage. It was clear that any “new technology” systems, as it began to be called, would have to fully consider community expectations and rights and that benefits would have to be shown to outweigh any negatives.

On 16 August 1990 an agreement was signed by one of the state road agencies and Telecom Australia, the sole telecommunications provider in Australia (now Telstra), to jointly investigate new technologies in transport. The project was called the Transport Information Management System (TRIMS).

After making strong progress in identifying and addressing issues such as those identified above and having concluded a highly successful trial of transponder and detection technologies on freight vehicles at the Port of Melbourne a meeting of national stakeholders agreed to form the Intelligent Vehicle Highway Systems (IVHS) society of Australia.

IVHS Australia continued to receive strong support from counterparts in Asia, Europe and the Americas and a number of meetings and exchange visits were undertaken.

Whilst it is true that IVHS had its roots in the road transport sector it was widely recognised that the benefits of new technologies apply across all transport modes and are certainly not restricted to “vehicles” nor “highways”. So, in keeping with practices overseas, the name IVHS was changed to Intelligent Transport Systems Australia (Incorporated) on November 9, 1992

ITS Australia had been born.

## 2. ITS Timeline

1902 Radio signals across the Atlantic\*\*

Note:

\*\* World first

1910

First coordinated traffic signals\*\*

1920

Experimental TV\*\*

First overhead lane control\*\*

First vehicle-actuated traffic signal\*\*. First traffic signals in Australia

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1930

First traffic signals in Sydney.

“Marshalite” (clock face) traffic displays deployed - last used on Nepean Hwy ~1975

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1940

Early computers - government owned

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1950

Computers sold commercially

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1960

	Sydney area traffic control (hard wired)
	Embryonic WWW at UCLA**
1970	DEC PDP 11 released** (only computer able to run SCATS until ~1990) First microprocessors** Intel 8080 microprocessor (required for SCATS traffic signal controllers)
	Eagle area traffic control system - St Kilda Junction SCATS installed in Sydney. Apple home computer released Ericsson area traffic control systems - Port Melbourne, Prahran, Malvern
	Mobile phone network in Japan**
1980	IBM PC** Early ATMs and telephone banking. Johnston St Bus Lane signals replace manually placed cones IBM XT (286). CRB SCATS central computer located at Kew IBM AT (386). Apple Macintosh. RTA (Vic) Traffic Control and Communications Centre - Hawthorn. CCTV cameras used for traffic - 23 ex CHOGM cameras (1981) Windows released**. School Zones (static signs) in ACT**. SCATS & tram priority** throughout Melbourne (SCRAM project). Tram & bus tracking (MTA) Fuel minimisation pilot** (first major use of LEDs for traffic in Australia). Ice/Wind rural warning signs.
	Fibre optic CCTV on SE Arterial then progressively to all freeways. New Traffic Control Centre - Camberwell.
1990	WWW available to the public**. SCATS on PCs.
	Quartz Halogen traffic signal lanterns.
	Antilock brakes in passenger cars. West Gate Freeway truck height warning. DriveTime** on SE Arterial and then progressively on all freeways (includes incident detection and management). VMS on freeways.
	Dynamically variable speed limits on M4 Sydney.

2000	<p>Multi-lane free flow tolling (CityLink)**. LED traffic lanterns.</p> <p>Next bus/tram/train information. Ramp metering trialled. School zones (dynamic signs**) trialled. Dynamically variable speed limits on Western Ring Road. SmartBus (priority) trials. Traffic Management Centre - Kew. Emergency vehicle pre-emption.</p> <p>GIS-based traffic information via WWW.</p> <p>GPS navigation systems in cars. Intelligent cruise control. IAP on freight vehicles (not in Victoria). Travel time on arterials via WWW.</p> <p>Commercialisation of real time traffic information.</p> <p>Electronic stability control in cars.</p> <p>Real time congestion avoidance advice. Ignition alcohol interlocks. CCTV &amp; real time traffic information to mobiles. IAP in Victoria. IP communications and battery backup for signals.</p>
2010	<p>Next generation ITS/freeway management system (eg M1 project).</p>

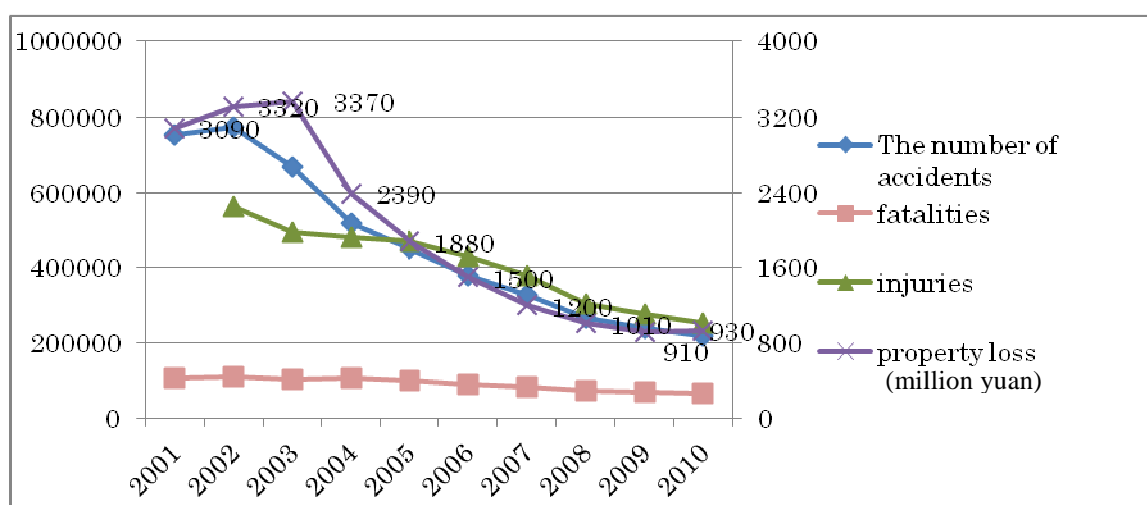
## China

### 1 .Current transportation problems

#### 1.1 Road safety problems

In recent years, the average number of traffic accident fatalities in China are around 70,000 per year, and the number of injuries are about 300,000, which lead to 1 billion yuan direct economic loss. The rapid development of road traffic has caused a sharp contradiction among people, vehicles; the road transportation security is still grave.

**Number of injures, accidents and direct economic loss in China**



#### 1.2 Public transportation service need further development

The operation dispatching management of public transportation service providers is still in a low level; Efficient emergency cooperation mechanism has not been established; And the cooperation among different urban passenger transportation modes need to be enhanced; Public transportation website information need to be enriched.

#### 1.3 Demands on freight transportation are not fully met

The overall operational efficiency of logistics in China is still in a low level, and the logistics cost is quite high. What's more, the information sharing and the informatization of freight transportation are still in its primary stage.

1.4 Various kinds of systems are not sufficiently integrated and the sharing of data is not adequate, overall effectiveness and economies of scale still cannot be realized.

1.5 Innovations are insufficient, key technology and products with independent intellectual property right are still lacking.

**1.6** The pace of standardization is far behind the increase of demand for development of ITS.

**1.7** The value chain and industrial chain of ITS have not yet come into place, and the mechanism to promote the market-orientation of ITS is still absent.

## **2 Measures to resolve problems**

**(Policies, organizations, targets, projects, introduction of ITS technology, and so on)**

China attaches great importance to the development of ITS, and has clearly brought forward support to ITS development by the following measures.

### **2.1 Development Plans**

**The 12<sup>th</sup> Five-Year plan of Highway and waterborne transportation** indicates one of the requirements in traffic information development in the “12<sup>th</sup> five-plan” is “striving to develop ITS to guarantee the efficient and unimpeded operation of the transportation system, reduce the energy consumption and pollution caused by traffic congestion.”

“Accelerating the development of ITS, improving transport efficiency and reducing transport cost” have been clearly put forward in the **12<sup>th</sup> Five-Year plan of Highway and Waterborne Transportation**.

### **2.2 Intelligent Safeguard of Traffic Safety**

Key tasks in this field include: application of active warning and driver assistance systems based on cooperation between vehicles and road; refined weather forecast and warning on express ways and key waterways; realizing network control and emergency response directed on commercial vehicles and vessels and achieving national full tracking and network control on the waterway transport of dangerous goods; improving intelligent monitoring and control on significant source of risk, detection on dangerous goods and emergency response capability against pollution; promoting the establishment of collaborated emergency response and rescue service by different departments of transportation, police and medical care.

### **2.3 Intelligent Operation and Services of Public Transportation**

Key tasks in this field include: applying and promoting intelligent coordination system of buses, Bus Signal Priority Systems and control systems on exclusive bus lanes; improving coordination and services of passenger terminals; carrying out intelligent coordination system and services of taxis and bicycles in connection with bus stops and metro stations; gradually establishing an intelligent urban passenger transport system that covers buses, subways, taxis and bicycles.

### **2.4 Advanced Freight Transport Management**

Key tasks in this field include: promoting the application of intelligent coordination technologies on freight transportation and improving management in drop-and-pull transportation; promoting the integrated application of intelligent technologies and equipment at ports and storage yards; promoting the national services system that focuses on the intelligent coordination of inter-modal transportation of containers; applying booking services for the parking and unloading of cargo

transportation and promoting regional logistics information sharing platform and services to accelerate the effective connection of different modes of transport.

### **2.5 Intelligent Control and Management of Transportation**

Key tasks in this field include: coordinated management of urban transportation that covers urban road network, multiple modes as well as hubs; improving capability in monitoring and emergency response of national and provincial highway networks; carrying out evaluation of the operation status of wide range regional highway network and decision-making support applications; Realizing control and management of freeway traffic flow; Enhancing decision-making support for national waterway management, monitor on waterway environment and operation status; digital identifications of vessels, navigation aids for vessels and dynamic tracking on vessels.

### **2.6 Comprehensive Transportation Information Services**

Key tasks in this field include: carrying out transportation information services based on Dedicated Short Range Communication (DSRC), Next Generation Internet and broadband mobile communications network; applying and promoting push-delivery transportation broadcast services on express ways and intelligent waterway information services in inner river waterways; establishing a comprehensive transportation information service system that covers both urban and rural areas and different modes of transportation.

### **2.7 Technological Breakthroughs in ITS**

Key tasks in this field include: enhancing researches on the real time acquisition and processing of transportation data, the exchange of traffic information, intelligent safeguard of traffic safety, and intelligent management and control; prioritizing breakthroughs in key technologies, such as identity authentication of key transport elements, real time traffic status sensing technology based on collaboration of multi-sensors, information exchange technologies based on DSRC either between vehicles, between vehicles and (road or waterway) infrastructure, traffic collision alert and active anti-collision technologies based on the collaboration between vehicles and road surface, traffic status analysis and regional intelligent decision-making and coordination technologies.

### **2.8 Standardization of ITS**

Key tasks in this field include: Sponsoring research and establishment on fundamental and key standards, such as the marks of ITS, illustration and exchange of data, exchange of traffic information, and security authentication; enhancing research and establishment on the standards of traffic monitoring, intelligent operation of public transportation, and transportation information; taking an active part in the research and establishment of international standards of ITS; founding testing platforms for the consistency and conformity of ITS standards and establishing market entry systems as well as certification and accreditation system of ITS products.

## **2.9 Initial Formation of ITS Industry**

A few prominent key enterprises and a number of Small and Medium-sized Enterprises (SMEs) with technical expertise in ITS should be gathered and nurtured. Large-scale applications and services in the field of integrated information service, traffic operation management and transportation electronic payment will be achieved. An industrial chain of ITS covering product manufacturing, systems integration and operational services will be preliminarily formed.

## **3 Direction of future measures**

### **3.1 Institutional Innovation on ITS**

A better institutional environment for ITS should be cultivated by carrying out favorable policies that encourage the cooperation between government authorities and enterprises, opening up the market, specialized division, and franchising. In this way, the motivations for developing ITS will be strengthened. Government authorities should encourage the publicity, sharing and exploration of traffic information according to the government information publicity policy, and improve the institutional management concerning ITS.

### **3.2 Overall Planning of ITS Development**

Overall coordination mechanisms among provinces, departments and regions should be established to achieve complementary advantages, specialization and cooperation, resources sharing, and coordination. To provide support for the interconnection, information sharing and application among intelligent transportation systems, ITS architecture needs to be constantly updated and maintained. Regulation on the management of ITS and the overall planning and coordination of key ITS projects should be improved.

### **3.3 Multi-channel Fund Raising in Support of ITS**

Funds should be raised through multiple channels and more support should be directed to the construction and maintenance of ITS with fundamental significance and in public interest. Funds of various informatization construction programs, and technological programs should be fully utilized for the research and development of key technologies, demonstration projects, standardization systems and platform building of ITS. The profit model of ITS should also be developed to attract investment from private sectors and to boost the prosperity of the industry by taking advantage of the market-oriented mechanism.

### **3.4 Safeguard of ITS Information**

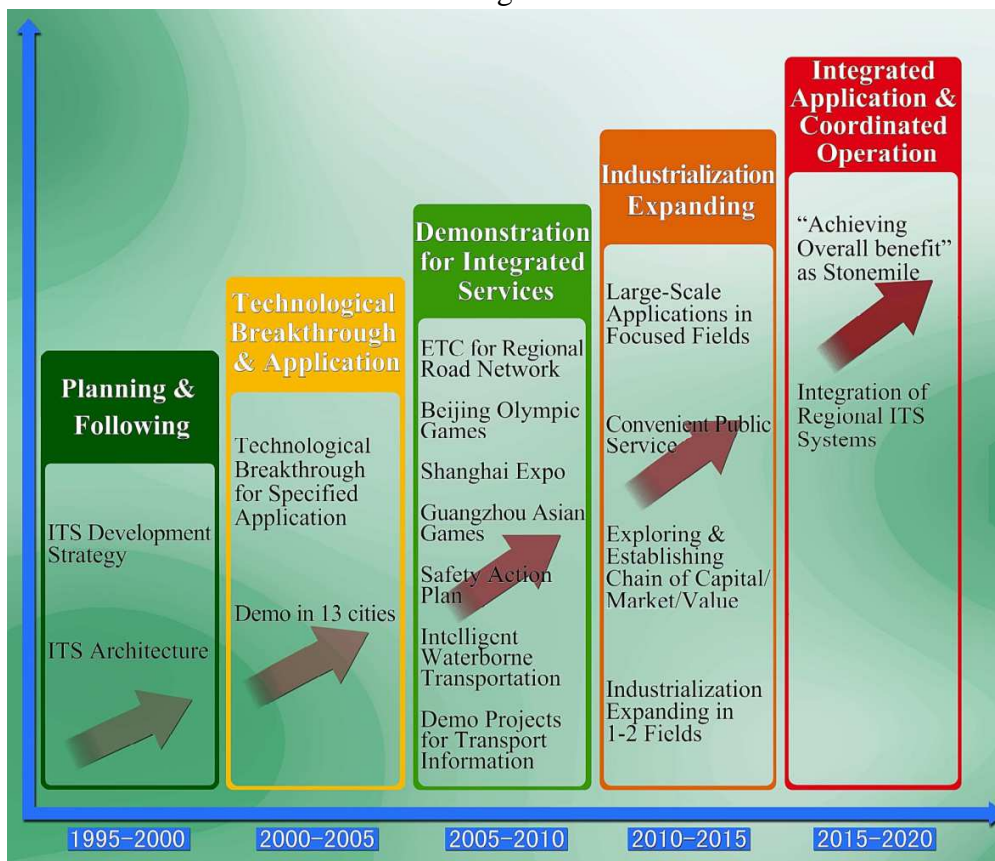
Strategic design ITS information security should be carried out. To guarantee the information security of ITS, an uniform information key management and security authentication system should be established. To ensure the security and reliability of data acquisition, transmission, process and application of traffic information, alert mechanisms on the safety of information should be set up, and safety evaluation, risk evaluation and security protection of important ITS should be strengthened.



### 3.5 Education, Training and Publicity

To cultivate professional and technical personnel in ITS, courses on ITS should be established in institutions for higher education and vocational schools. To improve the professionalism of employees in the industry, well-planned training on ITS should be provided to them. International exchange and cooperation should be promoted in the field of ITS, and overseas students should be attracted to participate in national development of ITS. ITS technologies and applications should also be popularized, publicized and promoted among the general public.

Fig.1



## Japan

### 1 Current status of road and transportation problems and response policies

#### (1) Total road length and number of vehicles owned

As of April 1, 2010, the total road length in Japan was 9,126.8 km of highways, 67,237.7 km of general national roads, 142,407.8 km of prefectural roads, and 1,049,970.8 km of municipal roads, for a total of 1,268,743 km. In addition, vehicle ownership has peaked and has been in the range of 75 million vehicles for the past several years. At the end of 2012, vehicle ownership was 75,595,763 vehicles.

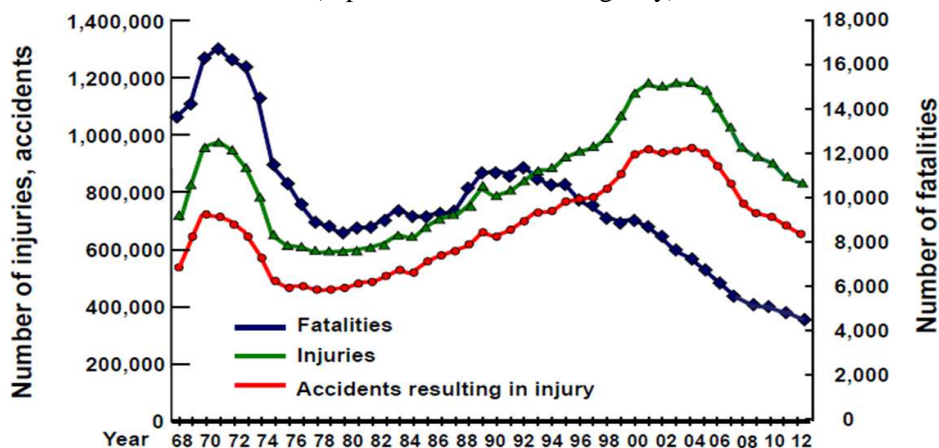
#### (2) Transportation safety problems

The number of traffic accident fatalities peaked in 1970 and subsequently declined rapidly as a result of road infrastructure development, traffic education, and stronger enforcement. There was a gradual increase in the 1980s, but the number of fatalities is again falling as a result of the introduction and spread of vehicle safety equipment and ITS. In 2003, the government adopted a policy of cutting the number of traffic accident fatalities to less than 5,000 in 10 years. This target was achieved early, and consequently, a new goal of reducing fatalities to no more than 2,500 by 2018 was set. The long-term objective is to achieve zero traffic accident fatalities.

According to a National Police Agency announcement released in January 2013, the total number of traffic accident fatalities nationwide in 2012 was 4,411, a drop of 201 (4.4%) from the previous year and the 12th consecutive decline. The number of injuries was 824,539, down 3.5% from the previous year, and the number of traffic accidents was 664,907, down 3.9% from the previous year, and both figures were down for the eighth consecutive year. The number of traffic accidents peaked in 2004 at 952,191 (Fig.1). Looking at the ages of persons killed in traffic accidents, seniors aged 65 years or older numbered 2,264, which is 51.3% of the total. Although the number of fatalities is declining, the incidence of serious accidents along routes to and from schools and the percentage of fatalities involving seniors aged 65 years and older are increasing, and it is necessary to adopt measures to address accidents involving seniors.

**Fig.1 Number of Traffic Accidents in Japan**

(Japan National Police Agency)



### (3) Environmental and traffic congestion problems

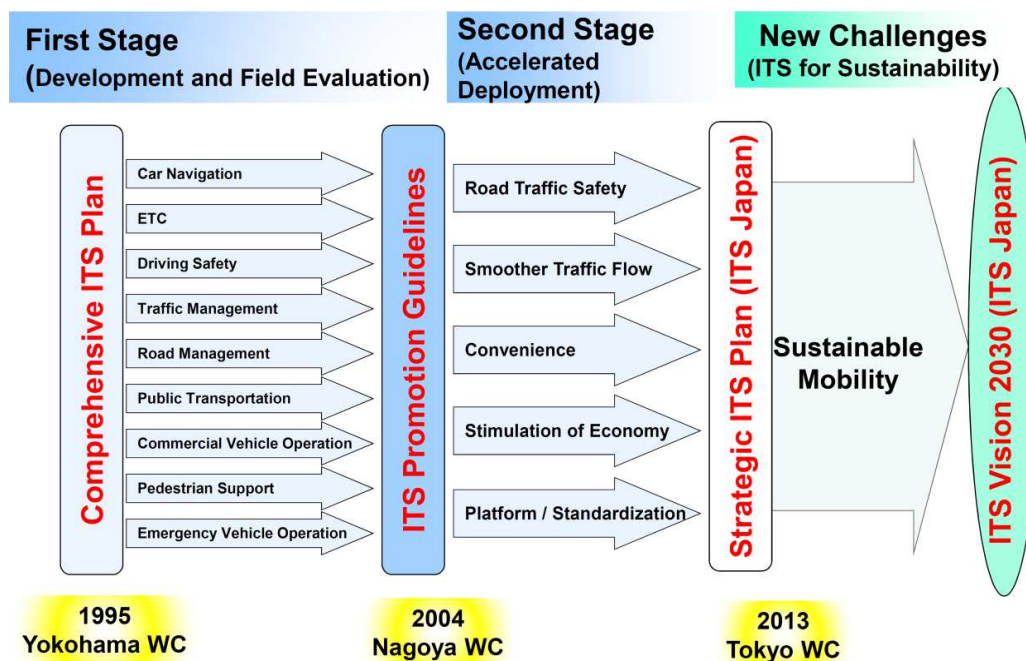
In Japan, the transportation sector accounts for approximately 20% of total carbon dioxide emissions, a leading cause of global warming, and of that percentage, approximately 90% is accounted for by automobile emissions. In addition, lost time caused by traffic congestion in Japan is 3.81 billion person-hours annually (as of 2002), which converts to approximately 12 trillion yen. The government seeks to reduce losses from traffic congestion and completely eliminate traffic congestion over the long term from the perspective of environmental considerations. The government adopted the New Strategy in Information and Communications Technology in May 2010. The strategy emphasizes safety as well as environmentally friendly transportation of people and goods using ITS. Measures are now being implemented to achieve the objectives of using ITS to cut traffic congestion on major roads nationwide to accelerate reductions in automobile carbon dioxide emissions and cut levels to half those in 2010 by 2020.

## 2 Measures to resolve transportation problems

### (Policies, organizations, targets, projects, introduction of ITS technology, and so on)

At the time of the 2nd ITS World Congress held in Yokohama in 1994, development of individual ITS technologies was actively undertaken through collaboration by industry, government, and academia, and since then, the foundations for ITS development in Japan have been laid. This period was the first stage of development. In the following second stage, on the occasion of the 11th ITS World Congress held in Nagoya in 2004, the second time that Japan hosted the Congress, individual systems were integrated and measures were undertaken with a focus on promoting the spread of and practical use of ITS as social tools (Fig.2).

Fig.2 R&D, Deployment and New Challenges

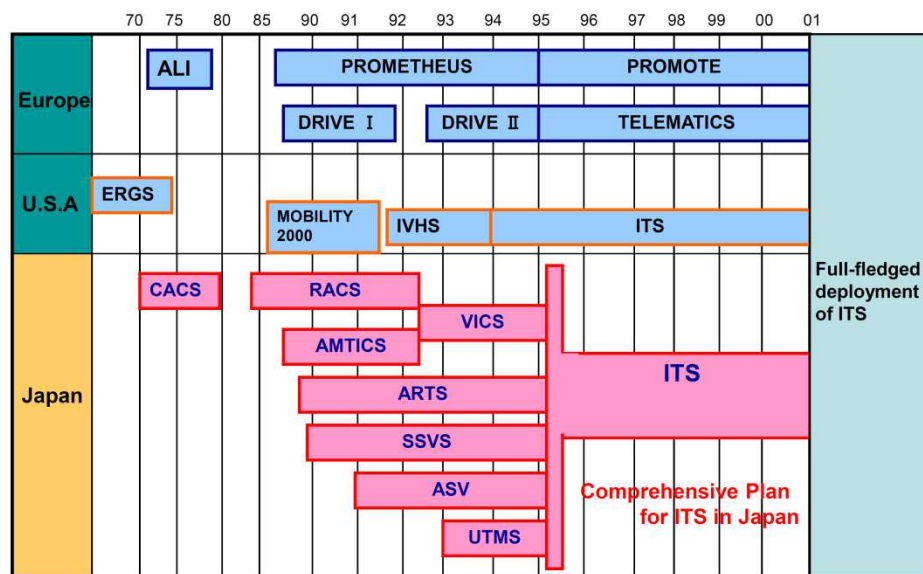


The Vehicle, Road and Traffic Intelligence Society (VERTIS) was established in 1996 to promote the use of ITS in Japan and to prepare for the second ITS World Congress in Yokohama. VERTIS incorporated as a nonprofit organization and changed its name to ITS Japan in 2001. As a representative of the private sector including industry and academia as well as ITS-related organizations, ITS Japan serves as a coordinator for collaboration between government ministries and agencies involved in ITS and has played an important role in the implementation of national ITS projects through collaboration by industry, government, and academia.

### (1) First stage

Research and development in the ITS field in Japan began in the early 1970s. A groundbreaking ITS system in Japan was the Comprehensive Automobile Control System (CACS), a dynamic route guidance system that employed road-to-vehicle communications. In the late 1980s, many public-private sector development projects involving vehicles, road infrastructure, and traffic control were implemented (Fig.3).

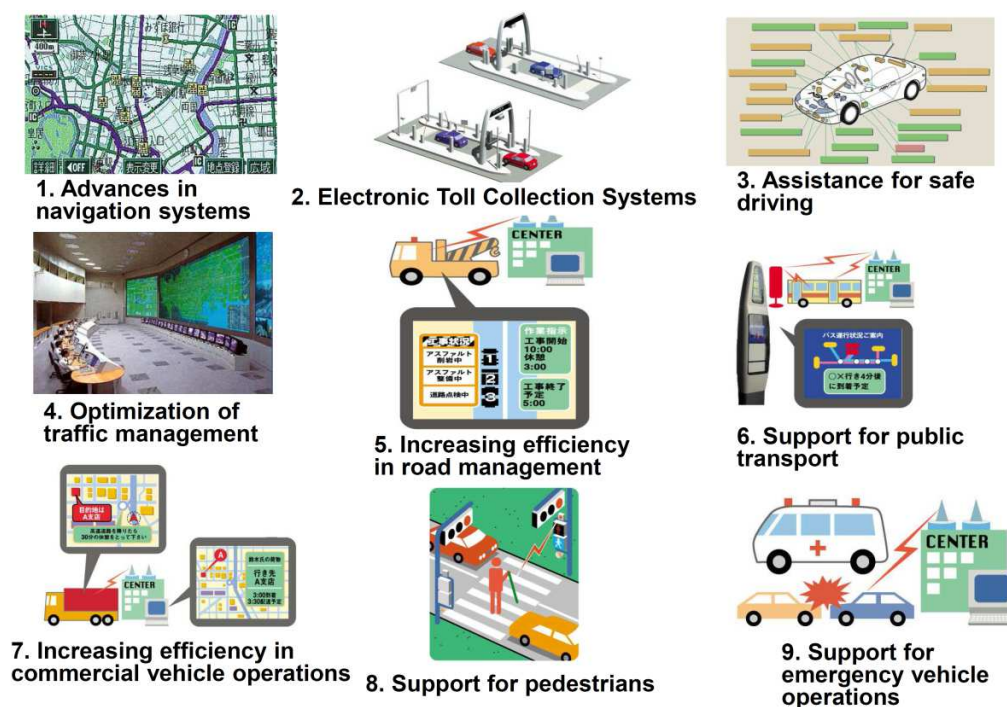
**Fig.3 ITS Developments in Japan**



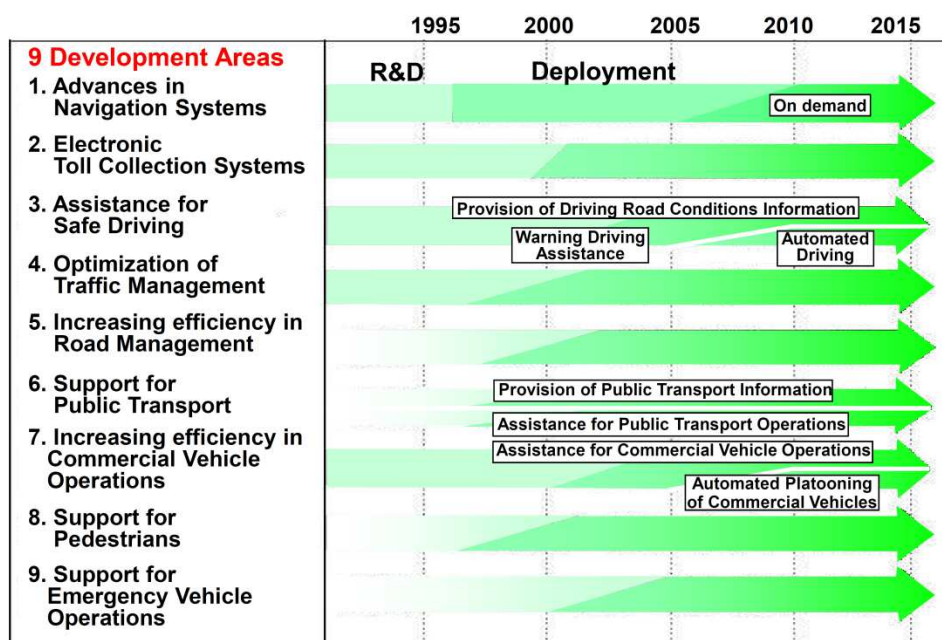
Starting with the 2nd World Congress in Yokohama in 1996, the term ITS was used in the name of the world congress, and the spread of ITS began to accelerate. Comprehensive Plan for Intelligent Transport System (ITS) in Japan was adopted in July 1996 as a policy for promoting ITS by relevant government ministries and agencies, and the actions of those ministries and agencies were integrated. The concept defined ITS development in nine fields (Fig.4), presented a roadmap for the development, practical application, and widespread adoption of ITS, and promoted ITS as a national project through cooperation by industry, government, and academia (Fig.5).



**Fig.4 9 Areas of ITS Development and Deployment**



**Fig.5 Comprehensive ITS Plan in Japan (1996)**



During the first stage, research and development of car navigation systems, VICS, ETC, ASV, and other individual ITS technologies was actively conducted in line with the ITS Overall Concept, and Japan became an example of successful ITS use.

Cumulative car navigation system shipments reached approximately 54.28 million units in

February 2013 and their use increased. Advances have been made such as providing diverse traffic information in the form of probe information and adding safe driving support functions (the ITS page of the Ministry of Land, Infrastructure, Transport and Tourism Website can be found at: [http://www.mlit.go.jp/road/road\\_e/index\\_e.html](http://www.mlit.go.jp/road/road_e/index_e.html)).

In conjunction with the recent spread of smartphones, in addition to installation-type car navigation systems, systems that use smartphones have also started to appear.

Cumulative shipments of Vehicle Information and Communication System (VICS) onboard devices, service for which began in April 1996, reached 35.68 million units in September 2012. Also, cumulative shipments of electronic toll collection (ETC)-compatible onboard devices, service for which began in March 2001, reached 53.14 million units in March 2013, and the rate of ETC use among Highway users exceeded 88% (February 2013), greatly improving traffic congestion at toll gates. In addition, the widespread use of ETC has urged the development of ITS spot systems that use DSRC, a basic technology, including smart interchanges and parking fee collection systems (a comprehensive portal site for ETC can be found at: <http://www.go-etc.jp/english/index.html>).

In the area of advanced safety vehicles (ASV), various advanced technologies have been put into practical application in recent years including nighttime driving support systems, lane-keeping assist systems, pre-crash safety systems, and forward obstacle detection systems using radar. During the fourth phase of the ASV project from 2006 to 2010, a comprehensive ASV strategy was adopted, the adoption of practical technologies was promoted, and development and practical use of communications systems was encouraged. In the fifth phase, which covers the period from 2011 to 2015, an ASV support plan was launched. The objectives are to make rapid advances in ASV technology that has been put into practical use and to encourage the development of driving systems that utilize next-generation communications.

## **(2) Second stage**

On the occasion of the 11th ITS World Congress held in Nagoya in 2004, The Japan ITS Promotion Conference was established by persons involved in ITS in industry, government, and academia and the Executive Summary of ITS Promotion Guideline was adopted. The focus is on addressing how past achievements can be widely adopted and put to practical use as social tools. Areas mentioned as being particularly important to ITS include safety, user peace of mind, the environment, efficiency, comfort, and convenience.

This policy was reflected in the New IT Reform Strategy adopted by the government in January 2006. The strategy positioned ITS as a key technology that can contribute to safety, the environment, and convenience.

Based on the New IT Reform Strategy, the ITS Promotion Conference, made up of representatives of relevant government ministries and agencies and industry, was established and began implementing measures to develop and put to use safe driving support systems based on integrated public-private sector policies intended to achieve the world's safest road transport society.

A number of projects were implemented including a new traffic control system that uses bidirectional communications with individual vehicles through optical beacons (UTMS; Universal

Traffic Management System)) by the National Police Agency, ubiquitous ITS by the Ministry of Internal Affairs and Communications, Energy ITS by the Ministry of Economy, Trade and Industry, Smart Way system that provides safety information to drivers in real-time using 5.8 GHz band DSRC, and Advanced Safety Vehicle (ASV) project by the Ministry of Land, Infrastructure, Transport and Tourism that supports safe driving by exchanging information concerning position, speed, and so on among vehicles using communications. Large-scale Field Operational Tests were conducted for these projects under the guidance of the Japan ITS Promotion Council.

Regional trials were conducted in 2008 and 2009 in eight regions nationwide concerning Driving Safety Support Systems (DSSS), ASV, and Smart Way system, and joint trials were conducted in Tokyo from January to March 2009 to confirm the compatibility of the different systems. In addition, ITS-Safety 2010 public demonstrations were conducted at the new Tokyo waterfront subcenter in February 2009 to increase awareness of the contributions that ITS can make to safety among the general public.

Under Innovation 25, the national long-term strategy and policy (adopted by the cabinet on June 1, 2007), projects to accelerate the incorporation of results back into society are being implemented (2008 to 2013), and road traffic systems using ITS are being included in those efforts. Specific long-term targets include the early development of model cities and model routes and, as means of deploying those results nationwide, halving carbon dioxide from traffic, substantially reducing traffic congestion, eliminating traffic accident fatalities, and encouraging the use of multi-modal transportation. Many ITS-related national projects including the development and large-scale trials being conducted under the New IT Reform Strategy mentioned above are also being implemented as projects for giving back to society.

### **3 Direction of future measures**

The 20th ITS World Congress, which will be held in Tokyo in 2013, is taking place at an important time for the dissemination of optimal next-generation ITS based on the results achieved in the first and second stages, and looking ahead to conditions in Japan in the future. To achieve the mobility society of the future, it will be important to address societal issues, verify ITS that has been developed to date from various perspectives, and achieve sustainable mobility.

One important perspective is changes in information systems. Advances in telecommunications technology have been rapid in recent years, and mobile phones, smartphones, smart grids, the Internet, cloud computing, and other technologies have had an impact on mobile communications networks, making it necessary to create ITS systems that incorporate these technologies. In addition, measures to save energy and use electricity in transportation are accelerating, and the contributions of ITS in achieving a sustainable mobility society will be significant. With regard to reducing carbon dioxide, measures are being undertaken to address the automobile environment, including making advances in gasoline and diesel engine systems and increasing the use of electricity. At the same time, diverse investigations are being conducted such as trials in model cities, citizen participation, and automated driving. As measures for creating a next-generation mobility society, in addition to promoting the electrification of automobiles, using electric vehicles for mobility sharing, introducing personal mobility, and expanding technologies such as vehicle battery management that collaborates with smart grids, the contributions of ITS to

creating transport systems compatible with innovative energy supplies will be important. Also, smart community trials are being conducted at model cities in various regions. Rather than measures that address only transport systems by themselves, measures to build and integrate energy and information communications networks that make up cities and communities are needed.

Due to the effects of the major earthquake that occurred in March 2011 and responses to global warming, environmental and energy problems are becoming increasingly severe. It is no exaggeration to say the environmental and energy fields are broad and influence every aspect of our lives. In addition, with the occurrence of widespread flooding in Thailand, approaches to disaster resiliency as a type of strength that can quickly restore overall functioning even if social systems and some business functions are interrupted as a result of the occurrence of risks are becoming increasingly important, and it is believed that ITS can make important contributions from the perspectives of logistics and mobility.



## **Malaysia**

### **1. Status of Current Transportation**

#### **(1) Road length (km)**

106,075 km State Roads (2009)

18,580 km Federal Roads(2009)

1,820 km Toll Highways

Total = 126,475kms

Total = 111,378 kms(2010)

#### **(2) Vehicle ownership number :**

No. of registered vehicles (2010) = 20,188,565 ; of which motorcycles account for 9,441,907

Note; however that cumulative no. of passenger and commercial vehicles registered from 1980 to June 2013 (excluding motorcycles) = 5,651,625

#### **(3) Transportation safety problems**

Number of traffic accidents : 414,421 (2010)

Number of traffic accident fatalities: 6,872 (2010)

Number of traffic accident injuries: 28,269 (2010)

#### **Characteristics of traffic accidents:**

The tremendous increase of motorised vehicles on the roads has invariably led to significant rise in the number of traffic accidents. The number of traffic accidents in 2007 almost doubled as compared to the number of traffic accidents that occurred in 1997. Sixty percent of total fatalities reported over the years involved motorcyclists. This high accident rate has led to road accidents being the 5th leading cause of death in Malaysia (Department of Statistics, 2008) and caused 9.3 billion ringgit of losses to the country in the year 2003 (ADB-ASEAN, 2003) . In the list of world rankings, Malaysia is ranked 46th of 172 countries with regards to occurrence of deaths in registered vehicles due to road accidents (WHO, 2009).

### **Road fatality statistics of Malaysia in relation vehicle and population are as follows**

(ref. derived based on population, registered vehicles and road fatalities information from

<http://www.miros.gov.my/web/guest/road>)

Year	Population	Registered Vehicles	Road Fatalities	Road Fatality for Every 10,000 vehicles	Road Fatality for Every 100,000 population
2006	26,640,000	15,790,732	6,287	3.98	23.6
2007	27,170,000	16,813,943	6,282	3.74	23.1
2008	27,730,000	17,971,901	6,527	3.63	23.5
2009	28,310,000	19,016,782	6,745	3.55	23.8
2010	28,910,000	20,188,565	6,872	3.40	23.8

#### **(4) Traffic congestion and environmental problems**

Many cities in Malaysia, and in particular in the Klang Valley, face mounting challenges to long term sustainable transport systems. High rates of urbanisation, high vehicular ownership and rapid growth of development inevitably lead to increase in travel demand. This is compounded by:

- constraints in the public transport system, in terms of coverage, service quality, integration with other modes of transport, service reliability, and poor public perception further encourages private vehicle ownership and use
- less prioritisation towards planning for and the provision of facilities, amenities and pathways that encourages non-motorised transports such as bicycle lanes, pedestriaways etc.
- lack of enforcement of road traffic rules, e.g. illegal kerbside parking, red-light running
- lack of parking
- tolerances for high traffic mix,
- high percentage of private vehicles and in particular, motorcycles
- poor driver attitudes, e.g., frequent lane changes, poor observance of basic road rules
- lack of traffic information (including parking information) to allow drivers to pre-plan trips

Between 1985 and 1997, the modal share of public transport decreased from 34.3 percent to 19.7 percent. This represents a major shift away from public transport and in particular bus transport, which is partly attributable to higher personal affluence leading to an increase in car ownership and also to deficiencies in the bus services. The increasing reliance on private transportation, in particular private cars, has created considerable pressure on the road network which has contributed to the problems of traffic congestion.

In the year 2000, the per capita CO<sub>2</sub> emission of Malaysia was 5.4 metric tons which is above the global average (3.9 metric ton per capita) and average in Asia (2.2 metric ton per capita) (World Resource Institute, 2007). In 2008, the per capita CO<sub>2</sub> emission increased to

7.7 metric tons. Increasing CO<sub>2</sub> emissions and the contribution from motor vehicles (estimated at 21% of total CO<sub>2</sub> emissions in 2000) is a worrying trend. Nonetheless it is much anticipated that the National Automotive Policy, due to be announced by the Government in 2013 will provide significant impetus towards use of “green” or energy efficient vehicles (EEVs) vehicles which would undoubtedly help in reduction of CO<sub>2</sub> emissions.

## **2. Policies for Transportation problems**

### **(1) Principle on and approaches to addressing transportation problems**

Resolution or mitigation of transport issues is well accepted as being a holistic issue that requires broad based support from Government, road users, commuters and various stake-holders. No one solution fits all. Presently, there are 11 million vehicles and 9 million motorcycles on the road, with about 500,000 new cars added every year. Building more roads, unless these form links as part of a larger strategic network, is therefore not a sustainable option for our cities. In recent years, the Government has identified Urban Public Transport as one of six principal National Key Results Areas (NKRA) that focuses on delivering immediate impacts to the public. Recent key efforts have focused on the following:

- Increasing bus fleet sizes (owned and operated via Government linked companies)
- Introduction of Bus Expressway Transit (BET) routes
- Increasing number of carriages sets for commuter rail services
- Construction of Integrated Transport Terminals at city fringes to de-congest CBD from inter-urban urban buses
- Expansion of Light Rail Transit (LRT) lines
- Construction of a new Mass Rapid Transit System (MRT)

Additionally, City Hall Kuala Lumpur, is also completing in stages the “Skywalk”, which is a series of connected elevated walkways to inter-link various key public transport terminals (LRT, buses, etc) and various points of interest in the city.

In tandem with Government’s renewed emphasis on urban public transport, the Land Public Transport Commission (LPTC) was set up in June 2010 with the goal of ensuring that the people have access to reliable, efficient, integrated and safe public transport. LPTC is developing the National Land Public Transport Master Plan which provides a long term programme to address the current deterioration in public transport with plans to execute high impact, effective delivery initiatives for 20-year sustainable quality public transport service for the nation. It is the goal of public transport to drive forward the ambition of Vision 2020 and 1Malaysia. These have the vision for Malaysia to achieve industrialized and fully developed nation status by sustaining growth of 7% per annum. It is expected that ITS and in particular Advanced Public Transport Systems (APTS) will play a large role in

the roll-out of such future services and capabilities. Presently LPTC is embarking on the deployment of a Performance Monitoring Hub whereby stage buses would be fitted with the GPS for real time tracking and monitoring of bus services; including the delivery of ETA information at key stops.

## **(2) Traffic policies and relevant laws**

There are presently no laws or policies governing ITS, although guidance can be sourced from the ITS Strategic Plan (2000), ITS Master Plan (2003) and ITS System Architecture (2007). The ITS Master Plan and ITS System Architecture were initiated by the Ministry of Works, Malaysia.

In regards to climate change, it is noted that Malaysia became a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) when it ratified the UNFCCC in 1994. Malaysia ratified the Kyoto Protocol in 2002 and the country is fully cognizant of its progression towards a sustainable growth path in a carbon constrained world. It is expected that the new National Automotive Policy, due to be announced and launched soon (2013), will continue or promote emphasis on “green technology” and enhanced environmentally friendly vehicles (“EEVs”), with focus on not just hybrids, but also conventional internal combustion engines that meets a multi-tiered fuel economy and exhaust emission target.

## **3. Status of ITS Introduction**

### **(1) History of ITS introduction**

ITS Malaysia was formally established in July 2007 with its first pro-tem committee, under the patronage of the Secretary General of the Ministry of Works, Malaysia. The first elected council members of ITS Malaysia came into office at the inaugural Annual General Meeting of the Association in 2008. The primary objectives of ITS Malaysia are as follows.

1. To facilitate knowledge and information exchange among members, industry players, trade professionals, engineers, consultants, system developers, solution providers, etc through various networking and information sharing such as via workshops, conferences, seminars, technical talks.
2. To represent the industry in assisting and providing inputs to various Government agencies on standardization, harmonization, policy, funding, deployment and other issues that may impact on the industry and/or Government.
3. To facilitate and foster greater cross-disciplinary collaboration between the academia, public and private sector in various ITS efforts, initiatives and programmes.
4. To serve as a bridging point between the local ITS players with other international ITS

related organizations, agencies, and/or trade associations.

5. To identify, encourage and nurture new areas of research and development in ITS that have specific importance to the country and the region.

The Association's mission is to spearhead, encourage and embed ITS holistically into the research, planning, design, deployment, operations, maintenance and management of transport and carrier systems in Malaysia for safe and sustainable mobility of the future.

ITS in Malaysia has traditionally been championed by the Ministry of Works; and membership of ITS Malaysia has been drawn largely from professionals, vendors, suppliers from the road engineering fraternity. Recent efforts have sought to expand the membership for a more inclusive representation from the public transport sector, automobile industry players and telecommunication service providers. The ITS Malaysia Council currently includes representatives from the Malaysian Highway Authority, Ministry of Works Malaysia, City Hall Kuala Lumpur, LPTC, the Malaysian Communications and Multimedia Commission (MCMC), Multimedia Development Corporation (MDec), local academia, and various private sector representatives.

ITS Malaysia has participated in all ITS World Congresses and ITS Asia Pacific Forums and Exhibitions. ITS Malaysia was also the host organization for the recently concluded 12th Asia Pacific ITS Forum and Exhibition in Kuala Lumpur in April 2012.

ITS Malaysia presently cooperates and collaborates with the following organizations in many of its activities:

- Ministry of Works
- Public Works Department
- Malaysian Highway Authority
- The Institution of Engineers Malaysia
- The Road Engineering Association of Malaysia (REAM)
- Road Engineering Association of Asia and Australasia (REAAA)
- The Chartered Institution of Highways and Transportation (CIHT, Malaysian Branch)
- Transportation Science Society of Malaysia
- Local Academia

## **(2) Deployment of ITS technologies and services:**

Following are some of the key ITS studies, projects and deployments:

### **ITS Strategic Plan**

Realising the increasing loss of opportunities due to lack of integration between different ITS projects, the Road Engineering Association of Malaysia (REAM) took the proactive

initiative of formulating the ITS Strategic Plan in 1999. The key objectives of the Plan were as follows:

- Propose a systematic approach for ITS implementation
- Identify key ITS application sectors that were most relevant to Malaysia
- Provide strategic directions for research and development
- Suggest a working framework for system integration at National level
- Make a case for ITS as a means for supporting sustainable economic development in key transport areas

The Plan identified four initiatives that could be implemented by both public and private sectors as follows:

- Demonstration projects of selected ITS user services
- Research and development programme
- Professional development and training
- Outreach programmes

In September 2000, the Government of Malaysia endorsed the ITS Strategic Plan as a guide for the development and deployment of ITS in Malaysia within the broad implementation policies and strategies outlined in the Plan.

### **ITS Master Plan**

In 2003, the Government embarked on the National ITS Master Plan Study. The key outcome of this was to progress the work of the ITS Strategic Plan and to establish in greater detail the key strategies, direction and framework for the development and deployment of ITS in Malaysia. The Master Plan identified among others, a structured deployment programme for various priority ITS strategic projects in key sectors such as Advanced Traffic Management System, Advanced Traveler Information System, Advanced Public Transport Systems, Commercial Vehicle Operations, Safety Systems, Electronic Payment Systems, Advanced Vehicle Control Systems, Emergency Management Systems and Information Warehousing Systems.

### **ITS System Architecture**

The ITS System Architecture Study was a progression of the ITS Master Plan, and was completed in the period 2006 – 2007. The System Architecture provided a unified framework for the coordinated deployment of ITS in Malaysia by providing detailed descriptions of interactions between travelers, vehicles, roadside devices and control centers. The Architecture also described the information and communication requirements, the data structures to be shared between interacting systems, and the standards required for data exchange.

## **Key ITS Deployments and Developments in Malaysia**

As our Malaysian Government takes the inevitable path towards greater e-Government using ICT as a leverage to propel our nation towards greater competitiveness, ITS deployments can also be expected to becoming more pervasive in the coming years.

Our Prime Minister has set very clear set of goals encapsulated within the National Key Results Areas (or NKRAs) and have used these to define the larger Government and Economic Transformation Programmes. The core objectives of these programmes are to create more adaptive and timely delivery of services and to technologically advance Malaysia to higher standards of living in line with our Vision 2020 towards developed nation status.

The Government of Malaysia is investing about USD 500M to upgrade public transport services; and a further USD 2.3B for the extension of the light rapid transit system. The Government has also recently started tenders for the various packages for the USD 12B, new 150km long Mass Rapid Transit system which is targeted for operations in 2016/2017.

The next several years will indeed be very challenging for Malaysia. Our Government is embarking on many projects in the area of advanced public transport systems in ITS as well increasing emphasis on sustainable transport development strategies that require greater optimization of resources, and therefore increasing leverage on ITS technologies and systems. The following are some recent developments toward this path.

### ***1. Integrated Transport Information System (ITIS)***

The Government embarked on a pilot ITS project to manage traffic congestion along major key roadway corridors in the Klang Valley. The "Integrated Transport Information System" or ITIS costing some US \$100 million was completed in 2005 and has now been operating successfully by the City Hall Kuala Lumpur for two years. Key objectives of the system are the early detection of disruptive traffic incidents and, in to collaboration with first responders, to clear the blockages so that normal traffic flows can be restored expediently. The system operates 140 variable message signboards (VMS) and a wide array of automated traffic counters to provide a real time view of the overall traffic network. The system leverages heavily on ATMS and ATIS platform technologies. The success of ITIS has enabled Government to take a stronger long term view of the sustainability of ITS applications for the country. The Government is now studying options for adopting similar systems to other cities in Malaysia to assist in the management of urban traffic congestion.

### ***2. Electronic Payment Services Interoperability***

A problem currently plaguing the country is the use of disparate electronic payment systems and, in particular, for electronic toll collection, bus ticketing and parking collection. The Government is keen to harmonise the various use of "smart" cards or

electronic payment schemes so that the commuting public can enjoy a common “one-card” system.

### ***3. Intelligent Enforcement***

The Government continues to be deeply concerned over road accident fatalities, and in particular, where these are due to aggressive driver behaviour with scant regard for road and traffic regulations. The Master Plan has identified Intelligent Enforcement as a way to help the various agencies to enforce road and traffic regulations without the need to re-deploy valuable human resources to the field. The Government has recently approved and commenced the roll-out of the Automated Enforcement System (AES), with the hope that stronger, more effective and consistent enforcement would help reduce road accidents.

### ***4. SMART (Storm Water Management and Road Tunnel)***

This is the world’s first combined storm water management and road tunnel (SMART), one of Malaysia’s finest engineering showcase. The project was featured in Discovery Channel’s Extreme Engineering, and ITS was innovatively deployed for the 5km motorway tunnel linking the city center with the southern gateway. SMART is also equipped with a state-of-the-art operations control room with the latest systems in operations management, surveillance and maintenance.

### ***5. PLUS Traffic Monitoring Center***

PLUS, prior to a recent privatization exercise, was Asia’s largest public listed tolled expressway operator; with close to 1000kms of tolled expressway in Malaysia alone. Dubbed as the most sophisticated traffic monitoring centre in the country, the PLUS TMC operates 24x7 to provide traffic and incident reporting, and driver assistance.

### ***6. Malaysia Highway Authority***

MHA collates and coordinates traffic information for various toll operations at a national and regional level. As the regulator of tolled highways, MHA also underpins the scoping and specification for ITS related works including traffic control and surveillance systems and toll collection systems. Over the last couple of years, MHA has been formulating its plans for the rollout of the multi-lane free flow system for toll collection.

The MHA also operates its own Traffic Management Center which is linked to various toll concessionaires. Via the MHA TMC, various integrated services related to traffic advisory and information will be rolled-out to road users.

### ***7. Integrated Transport Terminals (ITT)***

The ITT is a new generation of high-tech multi-modal integrated transport terminals. The ITT in Bandar Tasek Selatan commenced operations in 2011 and serves buses plying the southern connectors to the city. The ITT also serves as a main interchange for



heavy rail, commuter and express rail, and light rapid transit systems. Various applications in ITS enables the use of an integrated ticketing system and bus arrival information in enhancing passenger comfort and security.

#### **8. *Mass Rapid Transit System***

The MRT, now called My Rapid Transit, is the main component of the Greater Klang Kuala Lumpur/Klang Valley National Key Economic Area and will be the largest infrastructure project in the country. It will significantly improve the coverage of rail-based public transport in the Greater Kuala Lumpur/Klang Valley area and will spur us towards a 50% public transport modal share by 2025. The current modal share is 17%. The Government approved the execution of the MRT in December 2010 and construction of the first 51km line, which will run from Sungai Buloh in the northwest of Kuala Lumpur, to Kajang in the southeast of the Federal capital, was officially launched in July 2011. Various construction packages are being tendered and awarded in stages, with overall completion and start of operations targeted by 2016 / 2017.

#### **9. *Land Public Transport Commission***

The Land Public Transport Commission (LPTC) was set up in June 2010 with the goal of ensuring that the people have access to reliable, efficient, integrated and safe public transport. LPTC is developing the National Land Public Transport Master Plan which provides a long term programme to address the current deterioration in public transport with plans to execute high impact, effective delivery initiatives for 20-year sustainable quality public transport service for the nation. It is the goal of public transport to drive forward the ambition of Vision 2020 and 1Malaysia. These have the vision for Malaysia to achieve industrialized and fully developed nation status by sustaining growth of 7% per annum. It is expected that ITS and in particular Advanced Public Transport Systems (APTS) will play a large role in the roll-out of such future services and capabilities. Presently LPTC is embarking on the deployment of a Performance Monitoring Hub whereby stage buses would be fitted with the GPS for real time tracking and monitoring of bus services; including the delivery of ETA information at key stops.

#### **10. *Establishment of Special ITS Unit, Ministry of Works***

In recognition of the increasingly pervasive deployments of ITS in Malaysia, the Ministry of Works had recently in 2011, formed a special unit to provide oversight of ITS development, scoping, planning and integration with relevant and impacted projects under the Ministry of Works in Malaysia. This is an important first step towards greater harmonization of forward planning, execution, management and operations of ITS components in various state and national level projects.

### **4. Policies and Plans relating to Transportation and ITS Introduction in the Future**

It is expected that in the near to mid-term; continuing emphasis, mainly driven by

Government, will continue along the following lines:

- Expanding and enhancing the urban public transport sector. In particular, this involves the completion of the MRT, extended LRT lines, additional carriages for commuter rail, and expanded bus fleets.
- Completion of selected strategic highway links within the Klang Valley (primarily by way of privatization) for improved traffic dispersal; and continuing push for greater adoption of electronic (toll) payments, and in the long term, multi-free flow tolled system.
- Integration of rail, bus, pedestrianisation (e.g., “Skywalk”) and park-ride facilities as encouragement towards a more sustainable split of public: private modes of transport.
- De-congestion of urban centers from inter-urban buses via establishment of outer city transport hubs (“Integrated Transport Terminals”).
- Deployment of real time monitoring and fleet management tools for public buses (and perhaps commercial fleets) such as the Performance Monitoring Hub System (by LPTC).
- Improved real time enforcement of road rules such as via the Automated Enforcement System.
- Establishment of traffic data warehousing as a platform for spurring and the creation of web-based tools and applications for deploying real time travel conditions for better journey planning across different transport modes.
- Policies to encourage and increase adoption of EEVs for reduced CO<sub>2</sub> footprint within a carbon constrained eco-system.

## **Singapore**

### **1. Current Transportation in Singapore**

Statistics taken from LTA Annual Vehicle Statistics 2012

#### **(1) Road Length (km)**

Arterial Roads : 652

Collector Roads : 561

Local Access Roads : 2,051

Expressways : 161

#### **(2) Vehicle Ownership Number**

Cars & Station Wagons : 605,149

Rental Cars : 14,862

Taxis : 28,210

Buses : 17,162

Goods & Other Vehicles : 160,417

Motorcycles & Scooters : 144,110

ALL MOTOR VEHICLES : 969,910

#### **(3) Transportation Safety Problems**

Number of Traffic Accidents : 7,168

Number of Traffic Accidents Fatality : 168

Number of Traffic Accident Injuries : 9,106

### **2. Key ITS Timeline**

1980    Area Traffic Control (ATC) of Traffic Signals  
        Green Link Determining System (GLIDE)

1990    Central traffic control center  
        Radio broadcast of traffic information via TrafficWatch  
        Expressway Monitoring and Advisory System (EMAS)  
        Electronic Road Pricing System (ERP)  
        Electronic Regulatory Signs (ERS)  
        TrafficScan System using Taxis' GPS probes

2000    i-transport Platform  
        Revamped of ITS Operations Control Centre (ITS OCC)  
        Junction Electronic Eyes (J-Eyes)  
        One.Motoring web portal  
        Electronic Parking System (EPS)

Enhancement of TrafficScan System  
Unified Maintenance Hub (UMH)  
ITS Masterplan  
Pedestrian Green-Man Countdown Timer  
Parking Guidance System (PGS)  
Green Man Plus (GMP)  
Your Speed Sign (YSS)  
Traffic Information Platform (TRIP)  
Bus Arrival information Display

2010 -today

Traffic Message Channel Location Table (TMC-LT)  
Traffic Message Channel (TMC) standard adoption  
EMAS on Major Arterial Corridors  
Achieve Contactless e-Purse Application Standard (CEPAS)  
Live Traffic on LTA Twitter  
EMAS enhancement  
MyTransport.SG mobile application on iOS and Android  
Radar-based traffic collection system  
Transport DataMall  
Expansion of Green Man Plus  
Traffic Data Quality Assurance Program and Analytics  
Next Generation ERP system evaluation test  
GLIDE Digitisation  
ITS Masterplan 2.0

### **3. History of ITS Introduction**

With just a land area of 715m<sup>2</sup>, Singapore's resident population has increased significantly from 3.5 million in the late 1990s to more than 5.3 million today. Vehicular population has also increased from 700,000 in 2002 to slightly over 960,000 in 2012. The inherent issue on land constraints have placed public and private transport under strain as they compete with other essential sectors such as housing, industrial and recreational purposes for available land use. Given the changes in Singapore's demographic and socio-economic landscapes and a growing vehicle population, Singapore adopts a holistic approach in managing and optimizing road usage. This includes leveraging on traffic management tools and providing motorists with real-time traffic information.

Singapore started its ITS journey in the 1980s with a modest area-wide computerised traffic light signal system and adopted a step-by-step approach in implementation of ITS after monitoring the effectiveness of each new ITS in improving road safety and traffic efficiency.

### **Green Link Determining System (GLIDE)**

To catch up with changes in traffic condition due to rapid infrastructure development in Singapore, the modest area traffic control (ATC) system was upgraded to a traffic-adaptive system called the GLIDE (Green Link Determining System) in 1988. The GLIDE system detects traffic flows via vehicle detector loops that are embedded in the ground near the stop-line of the junction. The GLIDE program works out the required cycle times, allocate green times and works out the required offsets to provide linking between junctions automatically to meet the dynamic changes in the traffic condition and hence, providing motorists with “greenwave” from one junction to another with minimal stops. Due to its adaptive capability, this system is able to cater for unusual change in traffic flow and demand.

### **ITS Operations Control Center (ITS OCC)**

About 55% of average daily traffic flow in Singapore is on the expressways/highways. Any incidents such as vehicle breakdown and accident can cause a rapid built up of traffic and eventually lead to congestion on the expressways if not responded to promptly. In 1991, a traffic central control center was set up to monitor our first expressway tunnels of a total length of 2.4km. The humble traffic control room has expanded to what is now called the ITS Operations Control Center (ITS OCC) that monitors entire Singapore road networks, including more than 161km of expressways and road tunnel systems.

The ITS OCC operates 24/7 throughout the year, monitoring and managing traffic flow based on information gathered by the various ITS. Once traffic incidents are detected, traffic controllers at the OCC will initiate and coordinate efforts to remove obstructions from expressways and major arterial corridors such as dispatching recovery crew and Traffic Marshal to the site and assist to remove the incidents and control the traffic so that traffic flow can resume in the shortest possible time.

### **Expressway Monitoring and Advisory System (EMAS)**

The control room was expanded to monitor all the expressways in the mid 90s using an Advance Traffic Management System (ATMS) called the Expressway Monitoring and Advisory System (EMAS). Using video analytics, the video detection cameras with virtual loops were also extended to count traffic and determine vehicle occupancy. The information can be used to obtain traffic counts, measure speeds and detect congestion. With enhanced incident detection capability, the incident detection is almost instantaneously with the average response time of the towing crew to the incident site being less than 10 minutes.

The EMAS also serves as a mean to disseminate traffic and incident information to motorists via the electronic message signboards strategically located along expressways and roads leading to the expressways. Besides enhancing road safety, timely information also enables motorists to make more informed decision on the choice of routes available, and more importantly allows congestions on incident road to be better managed. The pre-designed messages are stored inside a message library of the EMAS system for prompt implementation of the messages by the operator. Today, the EMAS system assists to manage an average of over 3,400 cases of incidents and road works on our expressways each month.

### **TrafficScan**

In the mid 90s, GPS based Taxi Booking System was launched. With the successful implementation of this system, many taxis in Singapore were tracked with GPS locations and travelling speed. This gave birth to the innovative use of moving taxis as mobile speed sensors throughout Singapore roads. To have a better feel of ground conditions throughout Singapore, the TrafficScan system was introduced in the late 1990s. It is a system that makes use of GPS-equipped taxis as probes on the roads to capture the associated speed information as they ply the roads. These data, together with the other speed data collected from cameras and other sources were collated in real time to provide useful information on the traffic conditions and average travelling speed of the road networks.

### **Electronic Road Pricing (ERP) System**

In September 1998, Singapore implemented the world's first electronic road pricing system as part of the congestion management strategy. The Electronic Road Pricing (ERP) system replaces the previous manual road pricing system scheme that has been in operation since 1975. The ERP system uses a dedicated short-range radio communication system to deduct ERP charges from smart cards which are inserted in the In-Vehicle Units (IUs) of the vehicles. Each time the vehicles pass through an ERP gantry when the system is in operation, charges are deducted from the smartcards automatically.

### **Electronic Parking System (EPS)**

The success of ERP has led to the subsequent implementation of the Electronic Parking System (EPS) that allows the automatic deduction of parking fees based on the same technologies achieved in ERP and replaces the manual settlement of parking fees via paper coupons and cash at carparks. The same IU and smart contactless cards are put into practical use to bring convenience to motorists. Motorists can enter and exit any EPS enabled car park without having to go through the hassles of handling parking tokens/tickets or ensuring adequate parking coupons being available and displayed in the car.

### **i-transport System**

The i-transport system was implemented in 2004 to integrate all the various ITS to achieve system interoperability and harmonising data transfers to offer an effective and efficient traffic monitoring & control via a single, congruent transport platform. This platform also enables the monitoring of the condition of road tunnels (including the current Kallang Paya Lebar Expressway (KPE), the Southeast Asia longest underground expressway).

Island-wide traffic data and information are gathered via a wide variety of sensors such as those from the detector loops, video detection cameras (with image processing capability) and in-vehicle GPS devices. These enable good measures of the traffic flow condition on the road network that include the traffic volumes, speed, travel time, etc.

These traffic data collected are pushed into the i-transport system whereby it collates and fuses them for operations and disseminations to the public. Besides displaying road advisory messages and travel time information on the variable message signboards, the traffic information such as

traffic speeds, travel times and incident information are also made available to motorists via multiple channels such as the internet website ([www.onemotoring.com.sg](http://www.onemotoring.com.sg)), mobile phones and radio broadcast via TrafficWatch. The traffic information are also shared with the industry where they are in turn disseminated through their products and services such as navigation systems and smartphone applications.

### **Junction Electronic Eyes (J-Eyes)**

Junction Electronic Eyes (J-Eyes) are surveillance cameras mounted near major road intersections on arterial roads and serve as remote eyes for the traffic operations in the ITS OCC. They are used to spot and rectify causes of traffic congestions, thereby allowing operations to implement appropriate action plans to enhance traffic flow at major road intersections.

### **Parking Guidance System (PGS)**

To manage the congestion at car parks' entrances and circulating traffic to look for alternate parking space, a Parking Guidance System (PGS) was introduced. Motorists now can be informed of the availability of parking lots in parking facilities near to them when they approach their destinations through display on strategically placed road-side panels. The PGS has successfully helped to reduce the cruising time of motorists to search for parking lots and this in turn reduces circulating traffic at these areas. At present, the PGS are set up at key strategic shopping stretches such as our Marina Centre, Orchard and Harbourfront areas.

### **Public Transport System**

As part of the initiatives to develop a commuter-centric public transport system, real-time bus arrival information system is implemented at bus stops to help commuters better manage their waiting time and make informed travel decisions.

In addition, Key Bus Services Maps have also been installed at selected bus stops in the Orchard Road area. Designed primarily for tourists and infrequent public transport users, each map provides pictorial information on key bus services calling at the bus stop and the routes they cover. It also indicates the MRT stations along the routes, significant buildings and locales such as places of interests, tourist attractions and major shopping malls.

To enhance the public transport experience and to empower commuters to make informed decisions when using our public transport system, LTA expanded the outreach of the public transport information through various other channels such as the MyTransport.SG mobile app and webportal as well as the PublicTransport@SG portal.

### **Green Man Plus (GMP)**

Green Man Plus (GMP) is one of the latest initiative undertaken to address the needs of elderly pedestrians who may require more time to cross the road. This is done by tapping the CEPAS-compliant senior citizen concession card on the reader mounted at selected traffic light pole. The system will then extend the green man time and allow elderly pedestrians to cross the roads at a more comfortable pace. The system has now been extended to the use by mobility challenged group of road users.

## **Standards Adoption**

The adoption of internationally recognised and established transport standard in disseminating traffic information will encourage and spur greater innovations and researches locally into products that will be compliant to international standards to be used internationally.

Singapore developed and achieved certification on its Traffic Message Channel Location Table (TMC-LT) from the Traveller Information Services Association (TISA) in July 2010 based on the internationally recognized and widely adopted TMC standard. Currently, TMC services are commercially available in Singapore and motorists can enjoy access to real-time traffic information through TMC-enabled navigation devices.

Singapore also developed the Contactless e-Purse Application Standard (CEPAS) national standard that enables different card issuers to offer cards and services that are compatible with the ERP system without any modifications. This allows greater competition and promotes innovations through services. The same card can be used to pay for ERP charges, and other transport-related transactions, including parking, buses and Mass Rapid Transit (MRT) charges. More products and services are being made available to consumers, not just in transportation but also in the service sectors. With continued innovation and competition, more people will be encouraged to pay through this cashless mode.

## **Traffic Data Quality Assurance and Analytics**

Massive amounts of traffic data are collected from the wide variety of ground sensors everyday for monitoring, controls and dissemination. Thus, it is important that these data collected and disseminated are consistently of high quality. A traffic data quality assurance program was established to provide the governance and guidelines to provide the strategic guidance for a highly reliable and accurate traffic data is achieved on a regular basis.

The importance of analysis to process and assimilate the data to yield greater insights into transport trends and travelling behavior should not be undermined. Traffic data analytics with good visualisation allows for added visual impact to better understand and interpret data and trends from different perspectives. Having such insights ensures that traffic applications (for information delivery) perform to expectations in allowing better decision making and planning.

Mobilephone data are also collected from a smartphone traffic application called “traffichlah” that can intelligently self-learn the motorist’s regular travel route and push down relevant, personalized traffic information based on the users’ frequent travel route. These anonymous crowd-sourced travel data allows LTA to gain more in-depth and meaningful analysis on the travel patterns and provides useful insight for enhance traffic management and planning purpose.

## **OutReach via Social Media**

Drivers who try to catch those all-important radio traffic announcements about highway accidents or traffic jams can follow @LTAsg on Twitter for traffic news introduced in 2011. Not only can they get traffic news on their Twitter timelines via their computer but also via the Twitter applications on their smart phones while on the move. Today, there are close to 20,000 followers @LTAsg on Twitter.

News releases and road announcements from LTA is also regularly made available on LTA's



official Facebook page. So far, there are more than 35,000 likes on the Facebook page. It also serves as a mean of gathering ground feedbacks and sentiments on transport-related matters and policies.

### **Active Industry Engagement & Collaborations**

It is also essential to leverage on the industry's strengths and innovations in technology and customer service, to package and disseminate traffic information in the best possible medium to a wider public audience in a seamless fashion. An industry Engagement Framework was thus established to ascertain key areas of focus, identify industries to actively pursue collaborations to proliferate traffic information as well as potential studies on new transport technologies.

In line with the growing demand for traffic data, DataMall@MyTransport.SG was launched to share LTA's rich repository of land transport dataset such as public transport, traffic and geospatial data. Since its inception, the initiative has garnered strong interest from business partners, research institutions and 3rd party developers, generating 2 million data downloads per month. This in turn supports more than 8 million monthly hits from 35 new, innovative transport-related applications created on mobile devices.

DataMall@MyTransport.SG marks the synergetic collaboration between LTA, Industry and community to create an ecosystem that encourages the development and co-creation of innovative transport applications, which empower the public with timely and relevant travel information for smarter travel choices.

### **Singapore ITS Masterplan 2.0**

Given the many constraints in road expansion, managing and optimizing road usage will remain as one of Singapore's topmost priority. Furthermore, Singapore's social and economic landscapes are changing rapidly.

To meet these challenges, LTA together with ITS Singapore developed the Singapore ITS Masterplan 2.0 in 2013 to respond to the changing needs and to provide the necessary strategic leadership, guidance and support to facilitate an era of highly connected and interactive transport community with innovative and integrated mobility solutions in the coming years. Emphasis will also be placed on more public-private collaborations so as to leverage on the industry's innovation, technical expertise and marketing capability to reach out to a wider audience.

Through all the above initiatives and efforts, Singapore hopes to bring to all commuters a smoother journey with smarter choice.

## **Appendix 2 URL of the main ITS Standardization Organizations**

AASHTO (American Association of State Highway and Transportation Officials):

<http://www.transportation.org/Pages/default.aspx>

ANSI (American National Standard Institute):

<http://ansi.org/>

ASTM (ASTM International)

<http://www.astm.org/>

CEN (European Committee for Standardization):

<http://www.cen.eu/cen/pages/default.aspx>

CENELEC (European Committee for Electrotechnical Standardization)

<http://www.cenelec.eu/>

EIA (Energy Information Administration)

<http://www.eia.gov/>

ETSI (European Telecommunications Standards Institute)

<http://www.etsi.org>

ICTSB (ICT Standards Board)

<http://www.icts.org/>

IEC (International Electrotechnical Commission)

<http://www.iec.ch/>

IEEE (The Institute of Electrical and Electronics Engineers, Inc.)

<http://www.ieee.org/index.html>

ISO (International Organization for Standardization)

<http://www.iso.org/iso/home.html>

ISSS (International Society for the Systems Sciences)

<http://iss.org/world/index.php>

ITE (Institute of Transportation Engineers)

<http://ite.org/>

ITU-R (International Telecommunication Union Radiocommunications Sector)

<http://www.itu.int/ITU-R/index.asp?category=information&rlink=rhome&lang=en>

JISC (Japanese Industrial Standards Committee)

<http://www.jisc.go.jp/eng/index.html>

NEMA (National Electrical Manufacturers Association)

<http://www.nema.org/Pages/default.aspx>

SAE: (Society of Automotive Engineers)

<http://www.sae.org>

TIA (Telecommunications Industry Association)

<http://www.tiaonline.org>

## **ITS Asia-Pacific**

### **Purpose**

ITS Asia-Pacific seeks to facilitate Intelligent Transport Systems (ITS) cooperation and coordination between countries/areas in the Asia-Pacific region, taken to mean Asia and Oceania, irrespective of political, industrial, cultural or institutional barriers.

ITS Asia-Pacific offers its members opportunities for networking and information-sharing through assistance in the coordination of the region's involvement in the World Congress on ITS, and hosting the ITS Asia-Pacific Forum.

ITS Asia-Pacific plays a key facilitation and liaison role for its members within the Asia-Pacific region and with related organisations in other regions.

Member countries/areas are encouraged to develop ITS for application across the Asia-Pacific region and to assist each other with information to enable this.

The objectives of ITS Asia-Pacific are

- To support economic growth and better quality of life by solving transport problems of a modal or multi-modal nature through the developing and deploying of ITS;
- To establish the framework for cooperation by building a foundation on which ITS Asia-Pacific members can share and find solutions for common problems; and
- To support other international organizations by linking organizations in various sectors.

### **Roles and Activities**

The roles and activities of ITS Asia-Pacific are

- (1) To identify common problems and find solutions to each problem with a view to the following;
  - Awareness of Asia as a fast-growing region, with megacities emerging;
  - Recognizing and sharing of the current situation and subjects; and
  - Finding solutions and coordinating concrete plans.
- (2) To develop human resources for the next generation through:
  - Personnel exchanges between member organizations to strengthen propagation of information and experience; and
  - Internships to foster leaders of the next generation.
- (3) To collaborate with related international organizations such as:
  - Government agencies in each country/area;
  - Financial sectors such as the World Bank, Asian Development Bank, Asia Pacific Economic Cooperation; and
  - Academic societies such as EAST (Eastern Asia Society of Transportation Studies).

## **Policy Direction**

The policy direction for ITS Asia-Pacific includes

- Application of ITS technologies in conjunction with transportation infrastructure development;
- Focusing on transportation problems of transitional countries including mixed traffic, traffic safety, energy, environmental problems, and ITS applications in rural areas;
- Establishment of master plans for ITS and ITS organisations;
- Facilitation of ITS special interest groups;
- Encouragement of the use of ITS to improve road traffic operation, public transport; and
- Emphasis on the implementation of pilot projects and model deployment initiatives.

The intention of ITS Asia-Pacific is to bridge the gap between transitional and industrialised economies. This extends to countries outside the Asia-Pacific region.

## **Structure**

ITS Asia-Pacific consists of the General Assembly, the Asia-Pacific Board of Directors and committees as determined from time to time.

Each member country/area is encouraged to:

- Develop an ITS organization;
- Develop and deploy ITS-related technologies and services on a continuing basis;
- Support and promote the ITS Asia-Pacific Forum, including representation at the event, development of the program, and encouragement of exhibitions; and
- Host the ITS Asia-Pacific Forum when appropriate.

## ITS Asia-Pacific Board of Directors

Country/Area	Name	Organization
<b>Members</b>		
Australia	Dean Zabrieszach	ITS Australia
China	Xiaojing Wang	China National ITS Center/ITS China
Chinese Taipei	S.K.Jason Chang	ITS Taiwan
Hong Kong,China	Paul Cheng	ITS Hong Kong
India	Arosha Bajpai	AITs India
Indonesia	Elly Sinaga	ITS Indonesia
Japan	Hidehiko Akatsuka	ITS Japan
Korea	Dubo Shim	ITS Korea
Malaysia	Siew Mun Leong	ITS Malaysia
New Zealand	Mohammed Hikmet	ITS New Zealand (Chair)
Singapore	Mong Kee Sing	ITS Singapore
Thailand	Passakorn Prathombutr	ITS Thailand
<b>Secretary General</b>		
Japan	Hajime Amano	ITS Japan





