Smart Mobility 2030 – ITS Strategic Plan for Singapore

CHIN Kian Keong and Grace ONG

Abstract

Intelligent Transport Systems (ITS) have played an important role to enhance commuters' travel experience in Singapore. The increasing vehicle population, coupled with the changing socio-economic landscape, have brought about new transportation challenges. At the same time, developments in ITS technology have presented opportunities for the city-state to address the challenges and reshape the transportation landscape.

Smart Mobility 2030 is a joint development between the Land Transport Authority of Singapore (LTA), and Intelligent Transportation Society of Singapore (ITSS) - representing the industry. It serves as an ITS strategic plan to coordinate ITS implementation in Singapore systematically as we strive towards a more connected and interactive land transport community.

Introduction

Singapore's demographic and socio-economic landscape has changed considerably over the last decade. Resident population has increased significantly from 3.5 million in the late 1990s to more than 5.3 million today (2015). With an area of just 716km^2, transportation has to compete for land use against other essential needs, such as housing, economic infrastructure and recreation uses. In the face of growing vehicle population and limited land for road expansion, ITS plays an important role to enhance transportation services to maintain delightful travel experiences.

Over the last few years, technological advancements by the ITS industry have greatly changed the public's perceptions of its capabilities. These present opportunities for Singapore to leverage on ITS to address the challenges. As ITS becomes increasingly integrated into everyday life, a well conceived strategy is crucial to coordinate and guide ITS implementations to ensure systems inter-operability.

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Hence, the Land Transport Authority (LTA) together with the Intelligent Transportation Society of Singapore (ITSS) – representing the industry, have jointly developed a revised ITS strategic plan for Singapore – ***Smart***

Mobility 2030. It seeks to provide the strategic leadership, guidance and support for ITS initiatives and programmes to achieve a more connected and interactive transport community. The ITS strategic plan outlines broad strategies and charts key focal areas for the initiatives to meet transport challenges in a systematic and coordinated manner.

The Vision

Singapore's ITS vision - *"Moving towards a more connected and interactive land transport community"*, envisages an integrated transport system of people and transport infrastructure through ITS (*Figure 1*). A wide variety of information services will be easily available to diverse user groups on-the-move for a superior travel experience. This will help shape Singapore into a vibrant and more encompassing community.

Three key broad strategies and four focal areas are identified to provide the leadership, guidance and support to help Singapore achieve this vision (*Figure 2*).

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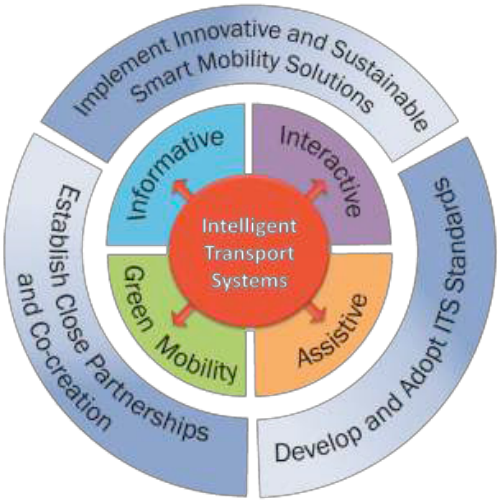
Figure 1: ITS vision for Singapore

Figure 2: The 3 key strategies and 4 focal areas



3 Key Strategies

i) Implement Innovative and Sustainable Smart Mobility Solutions

Innovation in the ITS ecosystem needs to be sustainable to address current and future transportation challenges. This can be achieved, firstly, through cost-effective smart mobility solutions for diverse transport users. Secondly, broader application of big data analytics will provide quick insights into transport trends for better travel planning and transport management (*Figure 3*).

Figure 3: Implement innovative and sustainable smart mobility solutions

ii) Develop and Adopt ITS Standards

Accurate transport data and the provision of reliable, timely and relevant information services are vital to the ITS ecosystem. Data standards and protocols are necessary to ensure overall system efficacy and inter-operability. Effort will go into the development and adoption of ITS standards to facilitate implementation of ITS solutions (*Figure 4*).

Figure 4: Develop and adopt ITS standards

iii) Establish Close Partnerships and Co-creation

Establishing partnerships and collaborations between both public and private sectors allow leveraging on the expertise and strengths of every member (*Figure 5*). This is key to innovation. It also helps align the thoughts and needs of stakeholders and serves as an effective platform to promote ITS awareness.

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Figure 5: Establish close partnerships and co-creation

4 Focal Areas

ITS initiatives and programmes revolve around 4 focal areas, namely, Informative, Interactive, Assistive and Green Mobility (*Figure 6*). These initiatives and programmes lay the foundation to support and steer Singapore towards the ITS vision.

i) Informative

Consistent, accurate and reliable data provides the foundation upon which many ITS solutions and services are built (*Figure 7*).

In recent years, progress in sensor and data processing technologies has resulted in more accurate and richer transport data. It is important to explore innovative and cost-effective ways of traffic data collection and information dissemination as it will facilitate timely information delivery to diverse user groups.

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Figure 7: The growing importance of information

Figure 6: The 4 focal areas

- **Transport Data Collection Technologies**
  This focuses on the continual pursuit of advanced data collection techniques and systems, as well as, developing sensor deployment strategies to minimise infra-structure while maximising its geographical coverage. It also entails enhancing data quality and accuracies through the use of more intelligent algorithms and to reduce data latency.

- **Dynamic Processing of Big Data and Analytics**
  There is a need to acquire suitable technologies to manage and process this massive data collected (*Figure 8*). It is essential to develop strong analytical capabilities to enhance the transport system's responsiveness under normal and emergency situations. Predictive analytics and data visualisation tools can be sought to provide insights into transport trends, travel behaviours and possible traffic scenarios which can impact transport users.

Figure 8: Leveraging on big data analytics and data visualisation to provide insights

- **Transport Information Delivery**
  Delivering reliable, timely and relevant information is an equally important part of the data/information management strategy. The increasing pervasive penetration of smart mobile devices and integrated in-vehicle systems allows more personalised, contextualised and location-aware information to be delivered to users, based on relevance. It is important to ensure that the information should be simple and intuitive, and delivered in a timely manner, to build public trust. Consequently, there should be greater willingness by the public to act on the information received.

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- **Data Standardisation and Security**
  As ITS become increasingly connected, it is necessary to establish open data/information formats, interfaces and communication protocols. It is in Singapore's interest to adopt or adapt international standards and best-practices for local use to facilitate inter-operability between systems. Proper security frameworks need to be in place to ensure the ITS ecosystem remains robust and safe (*Figure 9*). Likewise, measures to ensure data anonymity and protect users' privacy are crucial to build trust and acceptance of ITS.

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Figure 9: Data standardisation and security

ii) Interactive

Besides spawning enhanced data collection techniques and information dissemination mediums through rapid advancement in info-communication technologies, more opportunities are created for greater integration and interactivity people-to-people, people-to-machine and machine-to-machine.

By riding on the growing pervasiveness of smart mobile devices, transport information services can be more personalised and interactive, tailored to suit the individual's travel behaviour or preference.

- **Intelligent Fleet Management System**

  The intelligent fleet management system aims to integrate and simplify resource management and improve cost-effectiveness, while enhancing service quality and productivity in Singapore's public transport system. Information from different bus operators will be integrated, hence, providing better user experience to the commuters and allowing them to better plan their journey.

  Mobility-on-demand schemes will increasingly become more prevalent and important as we move towards a "car-lite" society. Technologies, such as, intelligent mobile devices, sensors and location-based services can make car-sharing schemes smarter. Users will find it more attractive if they can locate the nearest available vehicles from their smart mobile devices and drive to their destinations without having to return the cars to their original location.

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- **Advanced Road Usage Demand Management**

  Traffic congestions place a downward pull on productivity and the economy. The next generation electronic road pricing system leverages on GNSS (*Figure 10*), communication and other technologies as part of its solution to overcome the constraints of physical gantries. This allows more flexible congestion charging schemes for managing road usage demand and also serves as a platform to catalyse the development of a suite of ITS application services.

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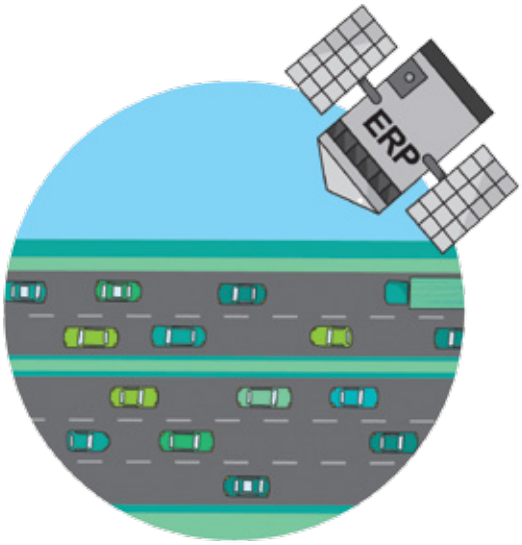
Figure 10: Next generation GNSS-based road pricing sytem



- **Enhancing Integration Between Public Transport and Road Operations**

  Public transport service reliability and road network performance have an effect on travel experience. By having an integrated transport operations and management system (*Figure 11*), transport operators will be better equipped to quickly address any abnormal situation.

  Data from various ITS can be aggregated and analysed at the integrated transport operations and management system. This allows a more complete situational picture and enhances operational efficiency through coordinated response to crises or incidents.

- **Smart Junction Management**

  Beyond real-time adaptive traffic signal controls, predictive and pre-emptive capabilities with integrated pedestrian detection are key to the future for more optimal traffic network distribution and management. Through pre-emptive actions at distributing traffic, delays and unnecessary stoppages can be minimised, therefore, a more constant travelling speed ensues.

Figure 11: Integrated transport management

Bus arrival times at bus stops can be improved through prioritised movement at junctions and reduces bus bunching (*Figure 12*). This system can also be extended to benefit other vehicle types, such as, emergency vehicles.

Figure 12: Prioritised bus movement at junctions

- **Spatial Contextual Awareness**

  Rapid advancement and adoption of smart mobile technologies have allowed traffic information to be delivered in a cost-effective manner through smart mobile devices. ITS mobile applications can be developed to process users' information, such as, location, frequently travelled routes, traffic conditions, etc., in real-time before presenting only information relevant to users. This prevents information overload, which otherwise would hamper motorists' cognitive ability and judgement on the roads.

- **Crowdsourcing**

  Crowdsourcing through smart mobile devices provides a cost-effective means to gather anonymised data with minimal infrastructure (*Figure 13*). These data can then provide insights into public transport service quality and users' commuting patterns.

  Likewise, social media platforms provide ground sensing of commuters' sentiments, which serves as a good indicator of transport service quality.

Figure 13: Crowdsourcing information

iii) Assistive

Effort has been vested over the years to reduce traffic congestion and mitigate the impact of accidents on the roads. Instead of addressing issues in silo, systems and vehicles of tomorrow will be more integrated. Information can be shared among nearby vehicles and transport infrastructures, facilitating assistive solutions for safer travel.

- **Connected Vehicles and Infrastructures**

  As vehicles become increasingly connected through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, greater information will be shared, creating exciting possibilities to leverage on ITS for enhancing road safety.

  Often, accidents occurring near traffic junctions could possibly have been averted through advance warnings to motorists. Through integrating detection sensors, wireless communication and traffic light controls, impending accidents can be detected early. Affected motorists can be quickly warned via their in-vehicle devices and the accident averted.

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Furthermore, traffic calming measures through early safety alerts and digital warning signage will enhance road safety at school zones, which is beneficial for the vulnerable user groups.

- **In-vehicle ITS Telematics**

  In-vehicle ITS telematics have been evolving and its gradual convergence with smart mobile device technologies is evident (*Figure 14*). Together with V2V/V2I communication technologies, these allow advanced telematic applications, such as, road safety related traffic advisories, traffic aware dynamic routing, intelligent parking guidance, etc., to be developed.

Figure 14: ITS telematics

As vehicles come in various makes, the adoption of open communication standards between smart mobile devices and in-vehicle command panels is essential. These include machine-to-machine interface (*Figure 15*), data exchange formats,

Figure 15: Man-to-machine interface

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communication protocols, etc., to ensure interoperability and sustainable in-vehicle ITS telematics development.

- **Autonomous Vehicles**

  With the ability to self-drive, autonomous vehicles have the potential to optimise road capacity by moving in a compact, systematic manner. They can also provide greater connectivity for first and last mile travel or facilitate the efficient sharing of cars, thereby opening up the possibility of transforming the way we view car-ownership. To bring these possibilities closer to reality, it is important to create an open platform where the industry, research institutions and the authorities can jointly conduct trials to provide the basis for future deployment.

  The Singapore Autonomous Vehicle Initiative (SAVI) was launched in August 2014 as a technology platform to explore the opportunities and challenges of harnessing vehicle technology for our land transport use. A 6-km long network of public roads in one-north at Buona Vista has been carved out to conduct autonomous vehicle (AV) (*Figure 16*) testing since 2015. A roadmap has also been developed for the AV initiative,

starting from the current technology demonstration in one-north to conducting operational trials, to be followed by pilot deployment from 2020 onwards.

Figure 16: Autonomous vehicle

iv) Green Mobility

In Singapore, 20% of the total carbon emission is caused by land transport and 75% of air pollution from motorised traffic. Importance should be placed on green, sustainable transport systems to minimise the impact of carbon emissions on the environment.

Transportation is one of the major contributors of harmful emissions which pose significant health risks and social cost. It is imperative and in our interest that our transportation system is designed to be energy efficient and sustainable.

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- **Promoting Higher Usage of Public Transport and Active Mobility**

  Promoting public transportation as the choice mode will help reduce the amount of carbon emissions as public buses and trains are more efficient mass people movers compared to private vehicles (*Figure 17*). This also means more land can be preserved for other economic infrastructure and recreational uses. Greater effort will be placed on promoting public transport to reduce reliance on private vehicles.

  Facilitating walking and cycling is another way to encourage the use of public transport and as alternative modes of transport, thereby reducing our carbon footprint. More than 200km of sheltered walkways are being planned for 2018 under the Walk2Ride programme to improve the walking experience of commuters to MRT (Mass Rapid Transit) stations, bus interchanges and some bus stops. The Government is also building a comprehensive network of cycling paths across the island that will extend over 700km in 15 years' time.

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Figure 17: Energy efficient public transport mode

- **Green Vehicles**

  Electric-powered vehicles (*Figure 18*) or alternative energy sources, such as, diesel-hybrid systems are more energy efficient and less harmful to the environment. Industry players and research institutions shall be key drivers for the development and promotion of such environmentally-friendly "green" vehicles.

Figure 18: Electric vehicles

Plans on test-bedding fleet-based electric car sharing programmes and operations are underway as they have potential to reap greater economies of scale with higher daily mileage and possibly lower running cost. Studies on optimal charging infrastructure to facilitate such widespread usage of EVs are also important as it lays the foundation for a nation-wide infrastructure necessary to support the proliferation of EVs.

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- **Green ITS Infrastructures and Alternative Energy Sources**

  Existing ITS infrastructures tend to use extensive materials, energy and require regular maintenance. These stress the environment and there is a need to explore energy-efficient equipment or clean alternative energy to minimise their impact.

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  Examples include the deployment of smarter street-lighting systems and the use of solar panels to power field equipment. Another example is the use of cloud computing whose applications have expanded into many areas, including transportation. Traditional backend systems often need to be sufficiently designed to handle future and peak period data processing. However, an overtly designed system will not be cost effective or energy efficient to maintain. Cloud computing provides an attractive option as it is easily and quickly scalable, when required, through resource sharing.

  Increasing demands on the backend processing and services inevitably increase power consumption. Reducing air-cooling and power requirements at the servers and data centres is integral to achieve a green data centre standard.

Realising The ITS Vision

As we move towards a more people-centric land transport system, the application of advanced ITS is critical to facilitate smarter urban mobility and also as we move towards a Smart Nation. ***Smart Mobility 2030*** outlines the vision, key strategies and focal areas of Singapore's ITS for the next 15 years. It would facilitate different stakeholders in Singapore to dovetail their efforts and culminate in innovative and cost-effective solutions to address transportation challenges.

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Public Agencies

Public agencies will play a continual role at driving key ITS initiatives and programmes. Gathering ground sentiments and understanding end-user requirements allow insights into how public transport can be made more attractive through appropriate ITS. Public agencies will also be instrumental in coordinating stakeholders to launch smart mobility solutions and services. These will empower commuters and motorists with the ability to plan their trips for a more delightful journey.

Industry Players

Industry players, ranging from start-ups and small-medium enterprises (SMEs) to multinational companies (MNCs) will be key technology drivers in the ecosystem. Sensory technologies, in-vehicle telematics, location-based services and autonomous driving are some key technological areas where expertise lies with the industry. Through strengthening technological competencies and innovative solutions, it will help position Singapore as an ITS technology leader on the global map.

Academic and Research Institutions

Academic and research institutions will play an integral role through their strong research and experimentations to support and promote technological development. Their contribution will strengthen and steer local ITS research in addressing transportation challenges, as well as, promoting Singapore as a key transportation "living" laboratory.

Collaboration and Co-creation

Through these active participation and close collaborations by all stakeholders (*Figure 19*), there are alignments of strategies, ideas and collective efforts from all parties, accelerating ITS development for a sustainable land transport system in Singapore.

Figure 19: Tripartite collaboration

Acknowledgement

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Chin Kian Keong is Group Director, Transportation & Road Operations, and Chief Engineer, Transportation, in the Land Transport Authority (LTA) Singapore. Dr Chin is an engineer by training, and has been involved in the planning, designing, implementation and construction of various road and traffic management projects in Singapore. He was involved in the Electronic Road Pricing (ERP) project which started full-scale operations in 1998. He is currently responsible for road and traffic management issues in Singapore, including the management and implementation of Intelligent Transport Systems and the next-generation ERP system.

Grace Ong is Director, Transportation Technology, at Singapore's Land Transport Authority (LTA), where she plays a leading role in planning and implementing Intelligent Transport Systems. She is responsible for charting strategic directions to meet LTA's vision to provide a people-centred land transport system. She leads a number of flagship projects, such as, the Certificate Of Entitlement (COE) and Electronic Road Pricing (ERP) system, amongst others. She has spearheaded the formation of Singapore's ITS Strategic Plan, ***Smart Mobility 2030***, that shapes the future of ITS in Singapore to better meet the needs of commuters.