Autonomous Vehicle (AV) & Vehicle-to-Infrastructure (V2I) for Road Transport

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Increasing Travel Demand

Comes from an increasing population, intensification of development and changing lifestyle.

Shortage of Labour

Potential obstacle as we try to improve service delivery & cater for more on-demand PT services to meet changing travel patterns.

Land Constraints

Roads and other land transport infrastructure takes up 12% of our total land area today (as compared to 14% which is devoted to housing), implying a clear need to optimize our road usage.

Ageing Population

The need to tailor more personalized transport modes to suit ageing population's varying travel needs and road safety concerns for elderly drivers.

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concerns for elderly drivers.

Land Transport

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Value Propositions of AV Applications

Increase productivity



Autonomous buses to tackle problem of labour shortage

Increase road safety

• AVs enable ageing population to maintain freedom of mobility while ensuring safe driving





Optimise Road Capacity

• AVs enable ageing population to maintain freedom of mobility while ensuring safe driving

Enable new transport products & services in new towns

- Customized / on-demand PT services could be made available
- AV vehicle-sharing schemes to complement walking and cycling in new towns





Increase R&D Value-Add

- Singapore is a Living Laboratory and is ideal for conducting test-bed for
- AV development and deployment

Singapore Autonomous Vehicle Initiative

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Singapore Autonomous Vehicle Initiative (SAVI) launched on 27 Aug 2014



Driverless vehicles could hit public roads here next year

By LEE JIAN XUAN

IT WON'T slam its brakes, it won't cut into your lane and it won't tailgate. It also won't have a driver.

From January next year, driverless cars could hit Singapore's public roads for the first time.

these fully autonomous cars zipping around buildings in the one-north area. A separate trial involving driverless buses could also see workers being ferried between Fusionopolis and Biopolis

A new 17-member committee formed by the Transport Ministry has set up the two schemes. Headed by the ministry's permanent secretary Pang Kin Keong, it will research, develop and implement driverless technology in Singapore.

Among the members are inter-A year-long trial may see national experts, industry players and personnel from the Land Transport Authority and the Agency for Science, Technology and Research.

> Singapore is still in the early stages when it comes to the use of driverless vehicles, with such

vehicles being tested by the National University of Singapore (NUS) and Singapore-MIT Alliance for Research and Technology (Smart). Nanyang Technological University and engineering firm ST Kinetics are also testing such vehicles.

Two driverless golf buggies could be available for the public to test in Jurong Lake District later this year.

Senior Minister of State for Transport and Finance Josephine Teo said Singapore is about 10 to 15 years away from a full deployment of such vehicles. While that is quite a long wait, when the vehicles eventually hit roads, neighbourhoods will be clean, green and ear-free, she said.

"For longer intra-town commutes, commuters can just hop onto a pod that runs through an underground network, almost like a personalised MRT," she said. In Milton Keynes in Britain.

(From left) Driverless vehicles that are being tested by Nanyang **Technological University, ST Kinetics** and NUS-Smart, respectively. ST PHOTO MARK CHECKS

100 electric-powered driverless pods ferry people around town.

A study by the Massachusetts Institute of Technology (MIT) found that shared driverless vehicles could reduce passenger vehicle ownership here from the current 900,000 to 300,000.

But experts say introducing driverless technology in Singapore may have complications too, such as getting commuters to feel safe in driverless vehicles, and setting out regulations. "One challenge is liability

what if it hits someone? Who pays?" said MIT professor Emilio Frazzoli, who sits on the new committee.

Those who wish to give feedback to the committee can visit www.facebook.com/AVIdeasSG Hanguan@sph.com.sg

SAVI is a technical platform for industry partners and stakeholders to conduct research and development (R&D) and test-bedding of AV technology, applications and solutions.



Committee on Autonomous Road Transport for Singapore (CARTS)

Objective:

To take a holistic approach in charting the strategic direction of **AV-enabled land mobility concepts**, moving Singapore towards being a **sustainable and liveable city**



Chaired by Permanent Secretary, Ministry of Transport

Comprising public & private sector members

Workgroup1 Visioning AV Deployment Workgroup 2 Regulations & Implementation

Land Transport

Authority

AV Possibilities for the Land Transport System



AV automated driving whereby applications can enhance traffic management

AV Mobility-On-Demand for point-to-point travels using a

network of demand responsive shared vehicles

AV automated driving

Autonomous bus for a mass transport service that operates on fixed routes and scheduled timings. This can alleviate Singapore's heavy reliance on manpower.

Autonomous bus

AV Mobility-on-Demand for "Car-lite" oriented town

V2I / V2V communication

"Platooning" of AVs and autonomous freight

AV Freight for movement of goods on expressways during night time. This can alleviate traffic congestion during day time and maximise road capacity

Autonomous Vehicle Testbed @ One-north

Facilitate the wider deployment of AVs on Singapore roads and the review of AV performance, traffic regulations and safety.



Test Bed Environment & Infrastructure



Surveillance



- Real time streaming of video feeds
- Video recording
- Enable remote monitoring



On-going Autonomous Vehicles Activities



Request for Information (RFI)

TITLE: LTA seeks ideas on incorporating autonomous vehicles for public transport

POSTED: 05 Jun 2015 11:59 URL: http://www.channelnewsasia.com/news/singapore/lta-seeks-ideas-on/1894620.html

The Land Transport Authority has issued a Request for Information on how AV technology can be harnessed for mass-transport services such as buses or shared vehicles.

SINGAPORE: A Request for Information (RFI) has been issued by the Land Transport Authority (LTA) on Friday (Jun 5), seeking views on how to incorporate autonomous vehicles (AVs) in mass transport services.

LTA will study if AVs, such as autonomous buses, can be deployed as a mass-transport service that operates on fixed routes and scheduled timings, it said in the press release.

The RFI will also explore if a network of demand-responsive shared vehicles can form a new mobility system for intra-town and inter-town travel. This can potentially serve as a convenient transport mode within towns, resulting in a lower reliance on private cars, LTA added.

Dr Park Byung Joon, head of the Urban Transport Management Programme at SIM University, also noted: "It can relieve some of the manpower issues we have at the moment. That is the kind of very short-term benefit.

"In the long run, the autonomous vehicles potential is really enormous. If we get to the point where every part of Singapore can be linked by autonomous vehicle by on demand, then of course more people have reason not to own a car, and join in the sharing economy. But we are talking about sometime later, because to do that, there is a lot of infrastructure that we have to build to achieve that."

That includes having a detailed database of Singapore roads.

Said Dr Park: "People have some kind of a wrong perception about autonomous vehicles. They think this is only about the GPS system and navigation system using the sensors, so you know the area around.

- RFI was called on **5 June 2015**, under evaluation
- Aim was to seek industry views on incorporating autonomous vehicles in
 - Mass transport services
 - Demand-responsive shared vehicles (mobility-on-demand) services
- Proposers are to propose their:
 - AV R&D technology roadmap
 - Infrastructure and information needs/requirements

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Test-bed program

8 RFI Proposals

LTA has received 8 proposals from both local and international applicants:



The Straits Times, Singapore, 13 Oct 2015

B2 | HOME

Driverless vehicles hit the road in trials around Singapore

Govt-led initiatives seeking to test tech in areas like public transport, freight operations

Christopher Tan Senior Transport Correspondent

From as early as December, visitors to Gardens by the Bay will be able to hop on to driverless shuttles that will take them around the sprawling grounds.

The two Auto Riders can each accommodate 10 people and are wheelchair-accessible, with a motorised ramp that deploys and retracts at the touch of a button. The vehicles, which have been tested in Switzerland, are making their Asian debut here as part of a multi-agency autonomous vehicle trial.

Yesterday, the Transport Ministry signed two memoranda of understanding (MOU).

One MOU is with port operator PSA to jointly develop autonomous truck platooning technology for cargo transport between terminals. In truck platooning, several trucks move together like a train, with only a controller in the first to improve productivity. The other MOU is with Sentosa Development Corp and ST Engineering to test self-driving shuttles across Sentosa.

Meanwhile, A*Star's Institute for Infocomm Research and the Singapore-MIT Alliance for Research and Technology have started driverless trials in one-north, while the Nanyang Technological University has been doing the same on its campus.

Permanent Secretary for Transport Pang Kin Keong said yesterday: "Self-driving vehicles can radically transform land transportation in Singapore to address our two key constraints – land and manpower.

"The trials will help us shape the mobility concepts which can meet Singapore's needs, and also gain valuable insights into how we can design our towns of the future to take advantage of this technology."

Unlike autonomous vehicle trials elsewhere, Singapore is focusing on applying the technology to public buses, freight carriers, autonomous taxis and utility operations such as road sweepers.

In buses, the technology will solve Singapore's perennial bus driver shortage. In taxis, the technology allows for many more journeys with a smaller fleet. Such vehicles are far costlier though, but experts believe that the initial outlay will be offset by manpower savings.

A*Star executive director Lee Shiang Long said: "I'm quite confident that Singapore will be the first city to implement this new technology. This is because unlike trials in other countries, which are left pretty much to the private sector, the Government is behind the efforts here."

A*Star converted a Toyota Alphard Hybrid to run autonomously, equipping it with laser sensors that cost as much as a luxury car.

Elsewhere, the Land Transport Authority has received responses from eight firms to a request for in-

formation to carry out its own trial in one-north. It will evaluate the proposals, and expects to begin trials by the second half of next year.

When asked how much the Government is investing in all these efforts, Mr Pang would only say "quite a fair bit". But given Singapore's land and labour constraints, going autonomous is "a strong imperative".

European, Japanese, US and Chinese companies – including big names like Google, Bosch and Toyota – are researching in this field.

Some, like Daimler and Tesla, are expected to launch autonomous models in the next five years.

SIM University's adjunct associate professor, Dr Park Byung Joon, said: "I think what Singapore should do is to provide a test bed to attract researchers to come here.

"If not, we might be trying to re-invent the wheel."

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THE STRAITS TIMES | TUESDAY, OCTOBER 13, 2015

Auto Riders will take visitors around the grounds of Gardens by the

Bay from as early as December. They can each carry

10 people and are wheelchairaccessible. ST PHOTO: KUA CHEE SIONG

AV Shuttle Service @ Gardens By The Bay

- 2 auto riders from EasyMile will start public trial in Dec 2015
- Route of 1.5km
- Capacity : 10 pax, wheelchair accessible







Land Transport

Authority



Memorandum of Understanding (MoU) signed on 12 Oct 2015

 2-year study on self-driving shuttle trial for on-demand and point-topoint services around the island starting January 2016.





Memorandum of Understanding (MoU) signed on 12 Oct 2015

- Develop autonomous truck platooning technology for cargo transport
 - 10km test route along West Coast Highway between terminals



Vehicle-to-Infrastructure (V2I) Initiatives



V2X Technologies for Safer Roads



V2I Cooperative ITS Applications

Enhancing Junction Safety Through V2I





Proposed Key Phasing Plans

2015 – 2017 Technology Trial

R&D trial of AV buses and shared AVs for first/last-mile travel using one-north as platform for proof-ofconcept 2018 - 2019 Operation Trial

Conduct operational trials of AV buses and shared AVs in onenorth and other testsites > 2020 Deployment

Pilot deployment and service of AV buses and shared AVs at town-scale level



SG 50

Thank You!

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