Singapore's Autonomous Vehicles Program – An Update

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We Keep Your World Moving

Value Propositions of Autonomous Vehicles

Increase productivity

Autonomous buses to tackle problem of labour shortage

Increase road safety

Enable ageing population to maintain freedom of mobility while ensuring safe driving

Optimise road capacity

Vehicles can move together in a more compact and platoon manner

Enabling new mobility concept in new towns

AV Mobility-On-Demand and vehicle-sharing schemes to complement walking and cycling in new towns

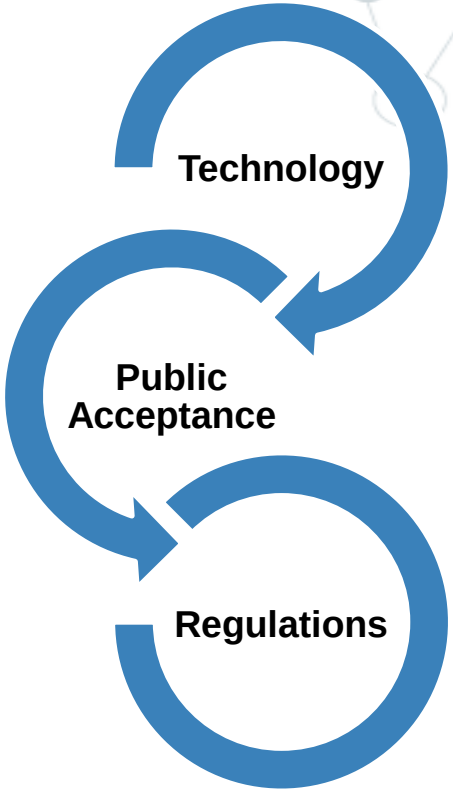
Increase R&D Value-Add

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

Singapore's vision for Autonomous Vehicle deployment

Fixed Route & Scheduled Services	**Mass transport for intra- and inter-town travel on a fixed route and scheduled basis**
Point-to-Point Mobility-on-Demand	**Shared services that are dynamically routed in real-time in response to commuters' demand, for point-to-point or first-mile-last-mile journeys**
Freight	**Carriage of goods**
Utility	**Utility operations (e.g. road sweeping)**

Key Enablers



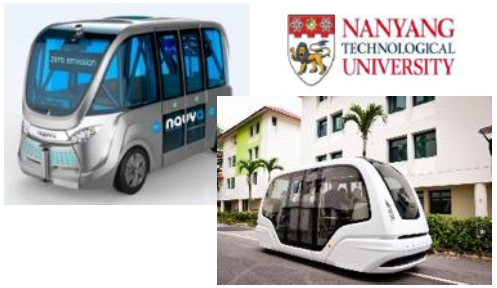
Roadmap for deployment of AVs

Year	Phase 1	Phase 2	Phase 3
Scale	Test-Beds	Town Deployment	Island-Wide
Fixed Route & Scheduled Services Point-to-Point Mobility-on-Demand Freight Utility	**Trials** ▪ Trials in test-beds, controlled environments ▪ Expand to more complex environments, including residential areas, as and when ready	**Limited Deployment** ▪ Roll-out of AVs for commuter service in some of our towns ▪ Operational deployment of truck platoons and utility vehicles in some areas	**Full Operational Deployment** ▪ Full deployment of AVs across all tracks ▪ New towns are designed for AVs ▪ Existing towns to be retrofitted
Enablers	Infrastructure & systems, regulations & standards, public acceptability, manpower and industry development, etc.		

Current AV Trials

Fixed & Scheduled Services

Autonomous Shuttle Trials @ NTU



NANYANG TECHNOLOGICAL UNIVERSITY

Autonomous Bus Trials @ NTU, Jurong Island

ST Engineering Land Systems

NANYANG TECHNOLOGICAL UNIVERSITY

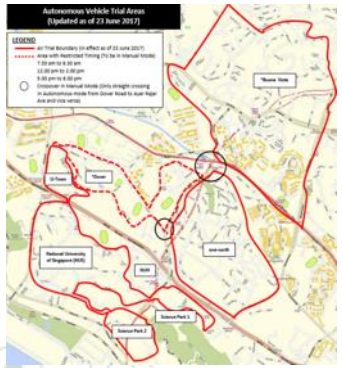
Energy Research Institute @ NTU

Autonomous Shuttle @ Gardens by the Bay, NUS

Gardens by the Bay

NUS National University of Singapore

Point-to-Point Mobility on-Demand Services



Autonomous Mobility-on-Demand Trials @ one-north

APTIV

SMART

Singapore-MIT Alliance for Research and Technology

Autonomous Shuttle Trial @ Sentosa

sentosa

Sentosa Development Corporation

ST Engineering Land Systems

Current AV Trials

Freight

Autonomous Truck Platooning

- Partnership between MOT and PSA
- Autonomous truck platooning concept of 1 human-driven truck with 3 driverless follower trucks
- Trial in enclosed port area and West Coast Highway

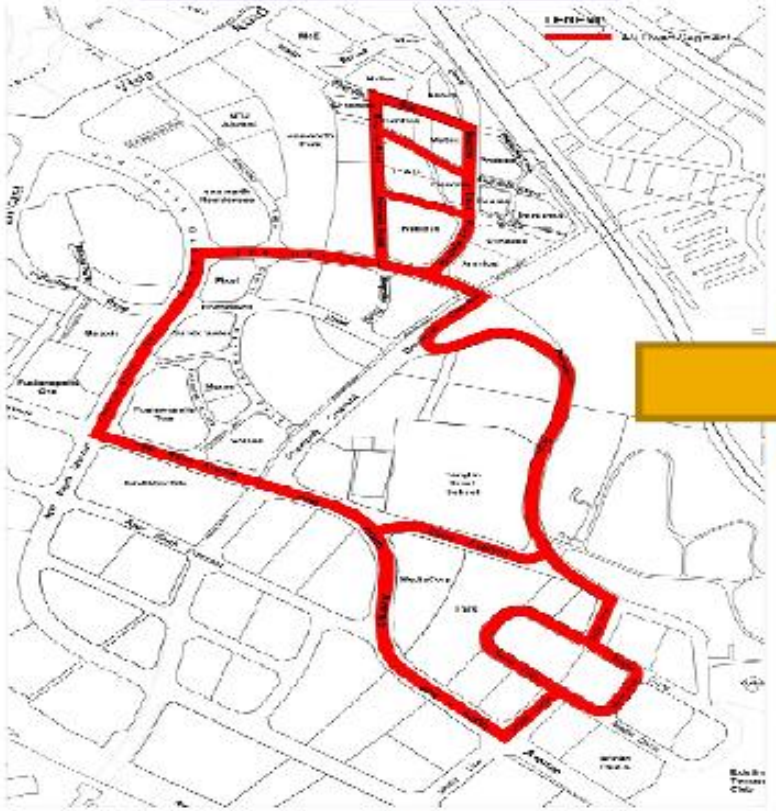
Utility

Road/Pavement Sweeping

- Partnership between MOT and NEA
- 2 consortiums awarded to develop and test the vehicles
- Road trials on public roads in 2020

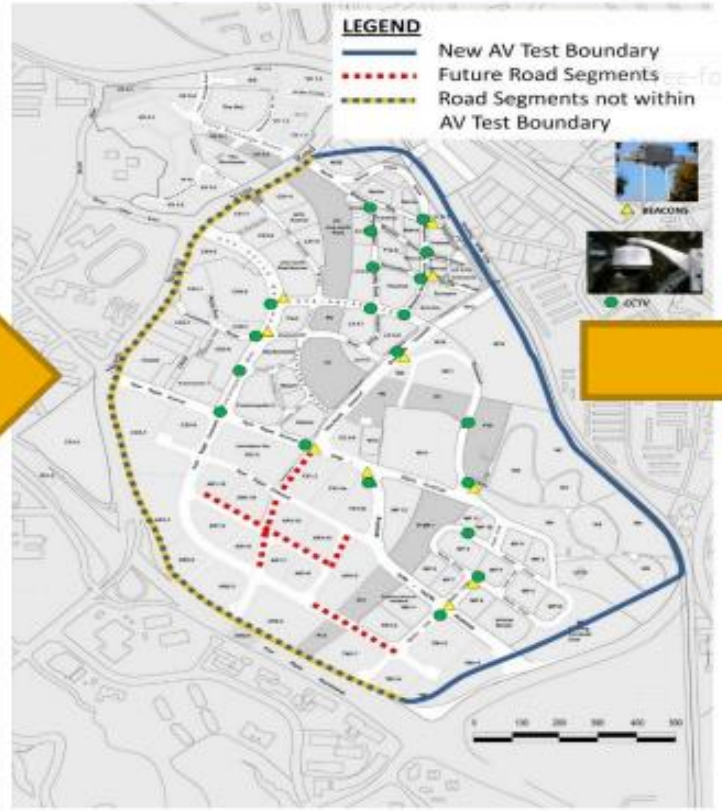
Expansion of test-bed areas through the years

January 2015



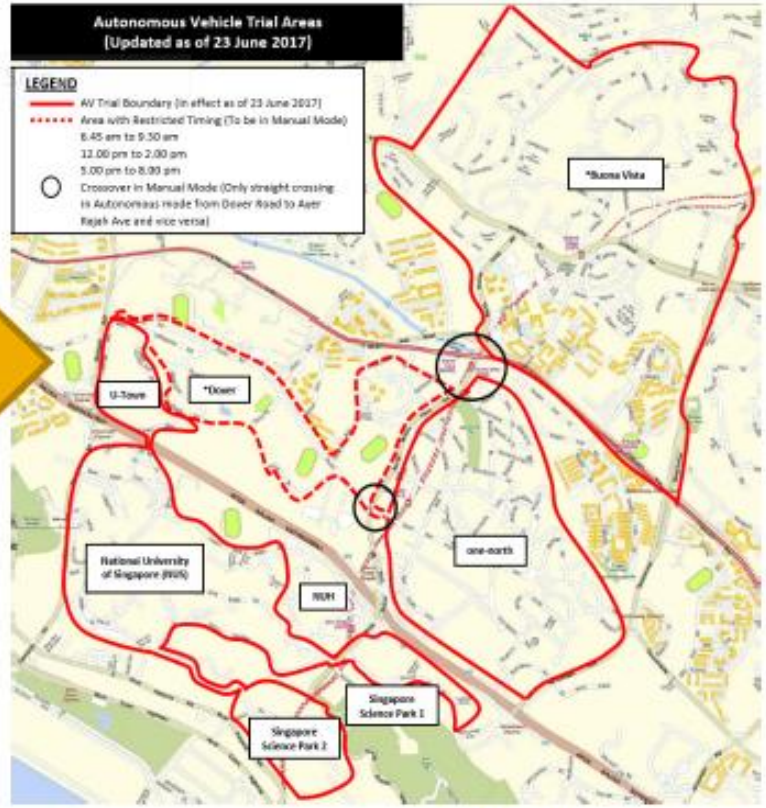
In collaboration with JTC, announced 6km of demarcated one-north roads

September 2016



Doubled the length of roads from 6km to 12km

June 2017



Announced expansion of trial areas to include NUS, Singapore Science Park 1 and 2

Expansion of test-bed areas through the years

Oct 2019 : Announced expansion to Western Singapore provides a wider range of traffic scenarios and will be gradual

Western S'pore set to become test bed for self-driving vehicles

Over 1,000km of roads will be involved gradually; safety to remain top priority

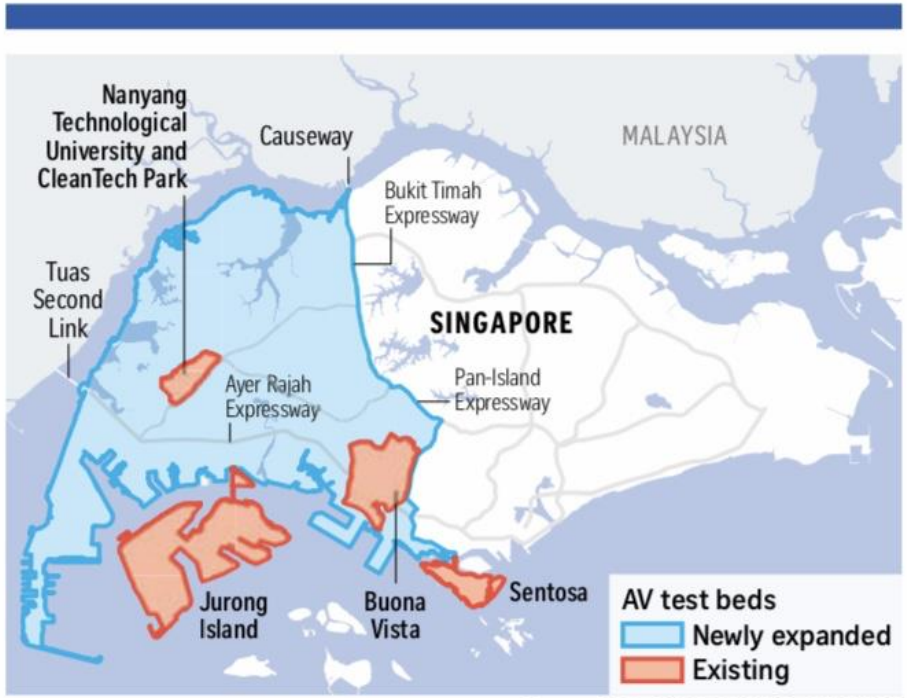
Toh Ting Wei

All of western Singapore will become a test bed for self-driving vehicles as the move towards autonomous mobility goes into overdrive.

This sets the stage for companies to test their autonomous vehicles (AVs) in neighbourhoods such as Bukit Timah, Clementi and Jurong, with the expanded test bed covering more than 1,000km of public roads.

The expansion is expected to take place gradually over the next several years, and public safety will continue to be the top priority, Senior Minister of State for Transport Janil Puthucheary said yesterday.

Public acceptance of self-driving cars is key, Dr Janil said at the Intelligent Transport Systems World Congress at the Suntec convention centre, and this could be eroded if accidents were to occur

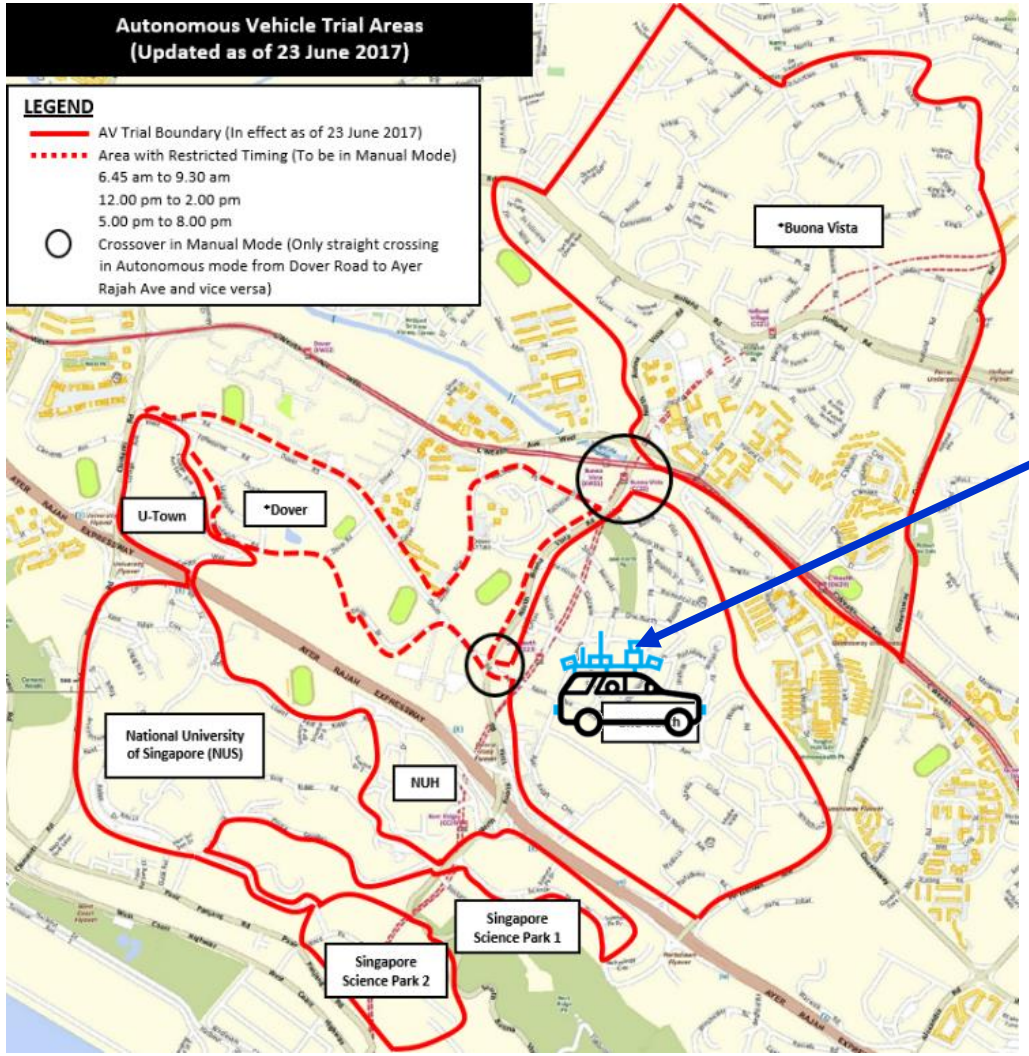


Source: LTA STRAITS TIMES GRAPHICS

Infrastructure and Systems to support AV Trials

Surveillance Cameras

- CCTV placed at strategic and critical locations
- Real time streaming of video feeds
- Video recording
- Enable remote monitoring



Dedicated Short Range Communications (DSRC) beacons

- Traffic light signal status
- Position augmentation
- V2I information dissemination

AV Performance Evaluation System

- AV Monitoring and Evaluation
- Manage V2I information dissemination

Development of Testing Regime for AVs

Testing Centre (CENTRAN) launched on 1 August 2016 to:

- Provide a safe environment to test AVs for various traffic scenarios
- Develop testing & certification methodologies
- Develop milestone tests for (1) limited small-scale test-bed, (2) more complex densely populated environment and (3) removal of safety operator in the vehicle

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jtc
Breaking New Ground

NANYANG TECHNOLOGICAL UNIVERSITY

Vision:
To position Singapore as a renowned AV Knowledge and Research Centre to catalyse the testing and certification of AV Technology for urban cities

4-part Technical Reference (TR68) for AVs launched on 31 Jan 2019

Basic Behavioural Guidelines

Safety Guidelines

Cybersecurity, Principles and Assessment Framework

Vehicular Data Types and Formats

Training of Bus Drivers to Handle AVs

MoU to facilitate existing bus drivers to be trained to handle Avs

Stakeholders include the LTA, Transport Workers' Union, bus operators

100 drivers to be trained to handle autonomous buses

Pact signed to raise their skills to prepare for potential roll-out of such vehicles

Toh Ting Wei

About 100 public bus drivers will be trained to handle autonomous buses to prepare for the potential deployment of the vehicles in Singapore.

More drivers will progressively be trained as autonomous technology improves, the Land Transport Authority (LTA) said yesterday.

The move to train the drivers comes as a result of a memorandum of understanding (MOU) signed by the LTA and eight industry stakeholders – the National Transport Workers' Union, ST Engineering, SBS Transit, SMRT Buses, Tower Transit Singapore, Go-Ahead Singapore, Workforce Singapore, and the Employment and Employability Institute.

The LTA said: "The MOU demonstrates the commitment of all parties to work together to raise the skills and competencies of public bus captains to enable them to take on new roles when autonomous buses are eventually deployed in Singapore."

The training programmes for drivers will be developed by the LTA together with the industry stakeholders. One new role the drivers can be trained for is that of the safety operator for an autonomous bus,

ST PHOTO: KELVIN CHNG

SCARED AT FIRST

I was very scared initially because we were used to holding the steering wheel but now they told us we don't need to do so. But after we got used to it, it was okay... the autonomous system was quite effective.

SBS TRANSIT BUS DRIVER ELIZABETH LIM (left), 60, one of the drivers who learnt how to handle an autonomous bus.

to ensure public safety.

The initial batch of about 100 trained drivers is expected to be deployed to operate autonomous vehicles in Punggol, Tengah and the Jurong Innovation District, likely from 2022. These three areas were identified in 2017 by the Government as places where residents and workers can take self-driving buses and shuttles for their first- and last-mile com-

brand of tripartism.

The LTA said yesterday that leveraging technologies such as autonomous and dynamically routed vehicles is key to realising its vision of having a 45-minute city with 20-minute towns, as stated in the Land Transport Masterplan 2040.

A 20-minute town is one where all door-to-door journeys to the nearest neighbourhood centre us-

within that time.

"In the longer term, LTA will continue to work with industry stakeholders to prepare other public bus employees, such as technicians and operations personnel, to take on a range of other roles that would be essential to the deployment of autonomous buses in Singapore," the authority said.

In a speech at the MOU signing

hicles on Sentosa.

The trial, involving a fleet of four autonomous shuttles, started in August and will end next month.

SBS Transit bus driver Elizabeth Lim, 60, one of the drivers who learnt how to handle an autonomous bus, said: "I was very scared initially because we were used to holding the steering wheel but now they told us we don't need to do so.

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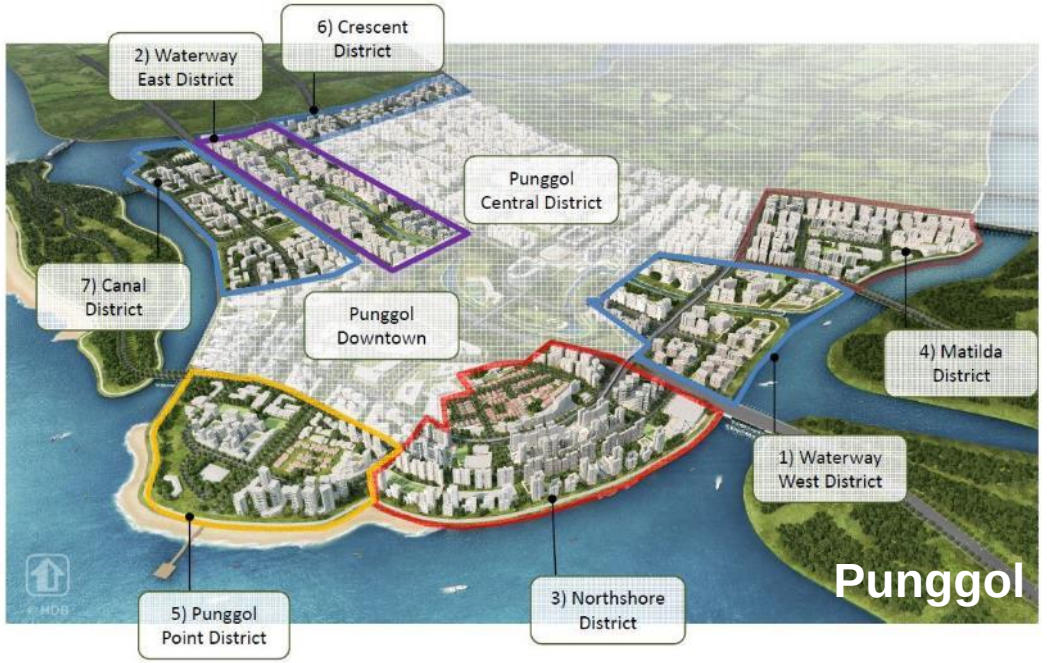
Freight			
Utility			
Enablers	**Infrastructure & systems, regulations & standards, public acceptability, manpower and industry development, etc.**		

Plans for pilot town deployments in early 2020s

Plans for pilot deployment of AVs as public transport in 3 new towns – Punggol, Tengah and Jurong Innovation District (JID).

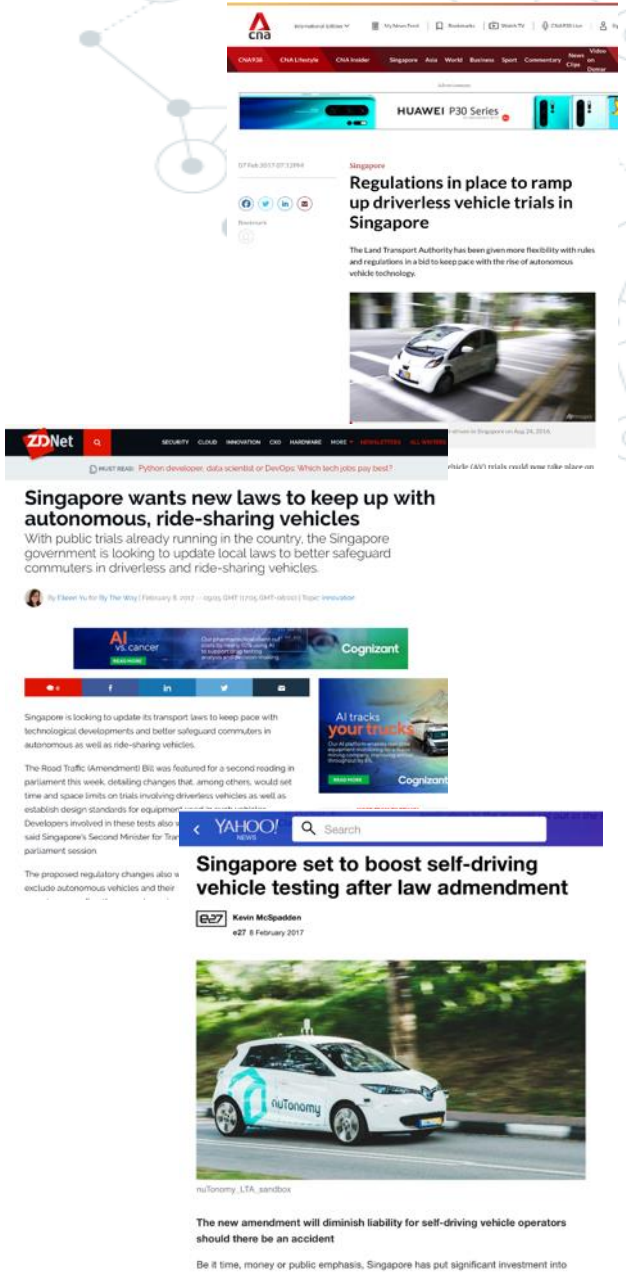
AVs will provide both fixed route, scheduled bus services, and shared, on-demand shuttle services within geofences



Review of Regulatory Regime

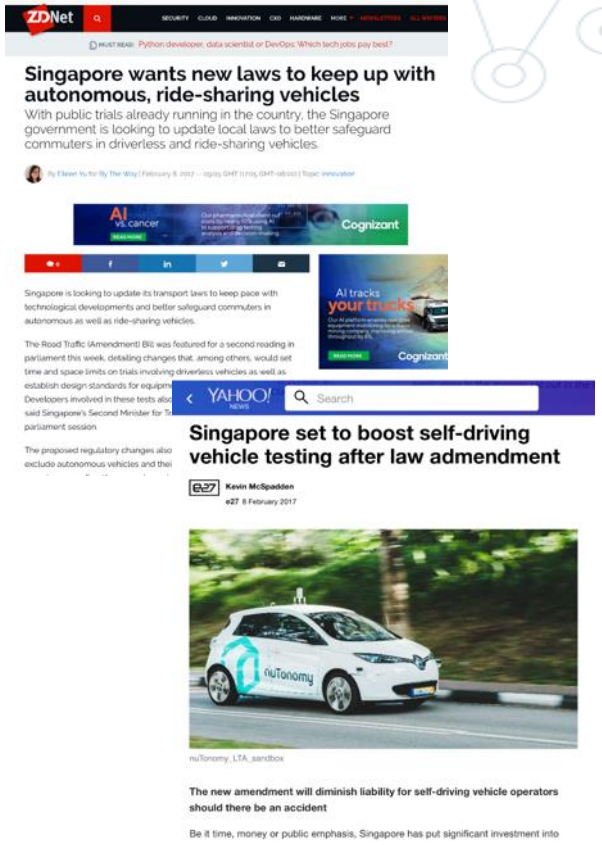
Road Traffic Act amended in Feb 2017 to put in place a regulatory sandbox to facilitate AV trials and deployment

- Provides the Minister for Transport with the power to make subsidiary legislations to regulate the use of AVs
- These powers include the ability to exempt or modify existing provisions



Authorisations for AVs Issued with Conditions

- Requires I**nsurance coverage for third party liability** against death of or bodily injury to any person, and property damage
- **Safety driver** have to hold a valid local driving license, have a clean driving record and training in AV operation given by AV technology developer
- Each AV have to maintain a **blackbox recorder** and log of AV testing activities



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Realising the future of Autonomous Vehicles

Thank You!

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