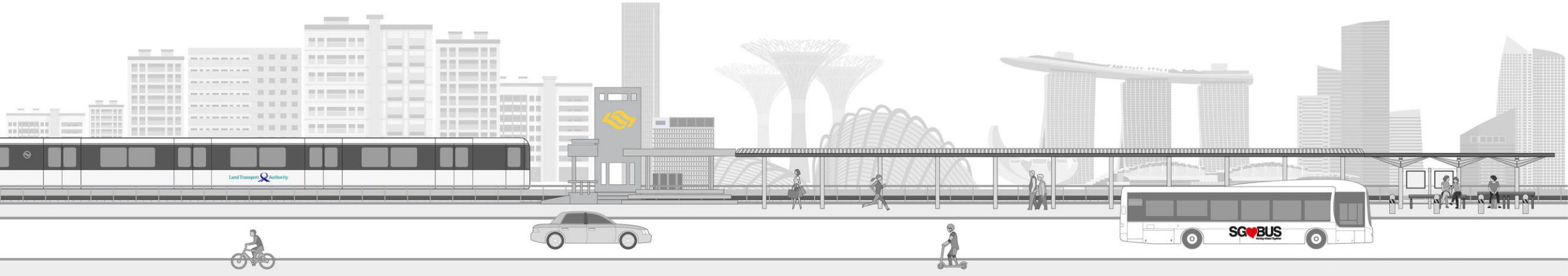
Autonomous Vehicles Programme in Singapore

LAM Wee Shann

Chief Innovation & Transport Technology Officer
Land Transport Authority, Singapore



Vision for Urban Mobility

Urban Mobility Challenges

- **Rising Travel Demand**
- **More Diverse Needs and Wants**
- **Limited Land Area**
- **Increasing Manpower Constraints**

Vision

To create a Car-Lite Singapore where people choose to walk, cycle and ride public transport, and where urban mobility (the movement of goods and people in cities) can be achieved in the most resource efficient manner

Why AVs

Reduce traffic congestion and land take

By optimising traffic flows and reducing demand for car ownership through more convenient and comfortable public transport, especially at first/last mile.

Reduce reliance on manpower

Reducing operating cost; allowing job up-skilling and redesign to address other demands.

Improved road safety

By eliminating human-related error. Reduced economic losses from deaths, injuries and traffic jams that may arise from accidents.

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.		

Ongoing AV Trials

Fixed & Scheduled Services

Autonomous Bus Trials @NTU-CleanTech Park, Jurong Island

ST Engineering Land Systems

NANYANG TECHNOLOGICAL UNIVERSITY

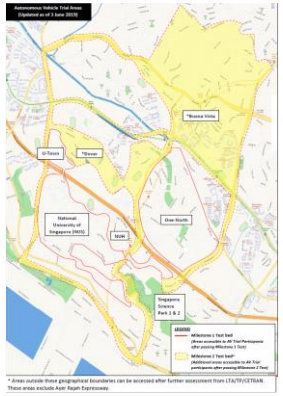
Autonomous Shuttle @ Gardens by the Bay

Gardens by the Bay

ST Engineering

Point-to-Point Mobility on-Demand Services

Autonomous Vehicle Mobility-on-Demand Trials @ one-north



Motional

SMART
Singapore-MIT Alliance for Research and Technology

Autonomous Shuttle @ NUS

easyMile

NUS National University of Singapore

Inchcape

COMFORTDELGRO

Examples of Non-People Mover AV Trials

Phase 1: Test-bedding

Freight

Autonomous Truck Platooning

MINISTRY OF TRANSPORT
CONNECTING SINGAPORE

PSA
The World's Port of Call

TOYOTA TSUSHO

SCANIA

- Partnership between MOT and PSA
- Autonomous truck platooning concept of 1 human-driven truck with 3 driverless follower trucks

Utility

MINISTRY OF TRANSPORT
CONNECTING SINGAPORE

National Environment Agency
Safeguard · Nurture · Cherish

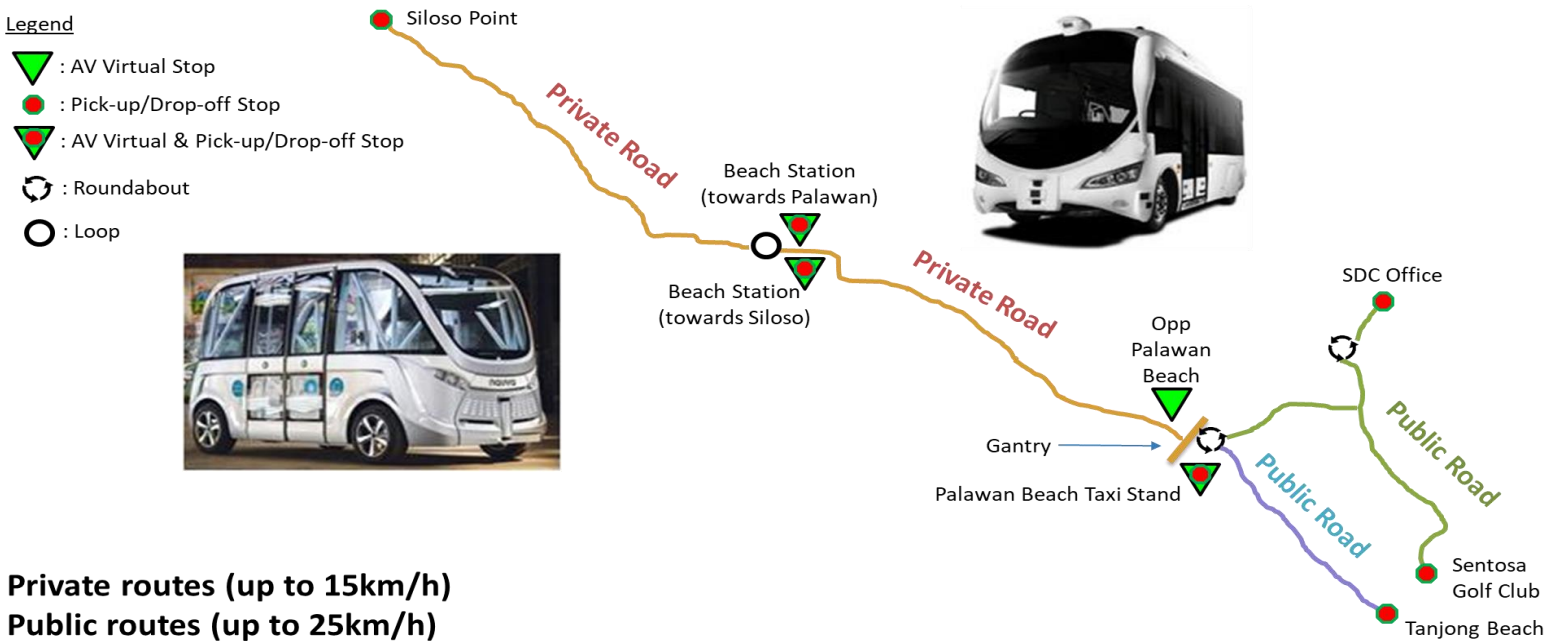
Road/Pavement Sweeping

ST Engineering
Land Systems

NANYANG TECHNOLOGICAL UNIVERSITY
Energy Research Institute @ NTU

- Partnership between MOT and NEA to develop Autonomous Environmental Service Vehicle (AESV) for roadside cleaner
- Developments and trials ongoing

MOT-ST Engineering Trial at Sentosa (Completed)



Private routes (up to 15km/h)
Public routes (up to 25km/h)

ST Autobus – at Sentosa's Beach Station

ST Autobus – travelling in Sentosa

MOT-ST Engineering Trial at Sentosa (Completed)

Basic Milestone

- Conducted Basic functional testing
- Performed basic demo of AVs to MOT, SDC and DSTA in Sentosa

Intermediate Milestone

- Conducted safety assessment
- Performed intermediate demo of AVs in Sentosa at speed of 15km/h

Advance Milestone

- Conducted speed test of up to 40km/h
- Performed advance capability demo of AVs to in Sentosa

Proof-of-Value

- Successfully conducted public on-demand trials in Sentosa

Technical Challengers Faced

- Insufficient data set
- Unpredictable weather
- Narrow routes
- False trigger of sensors
- Challenging road junctions and blind spots

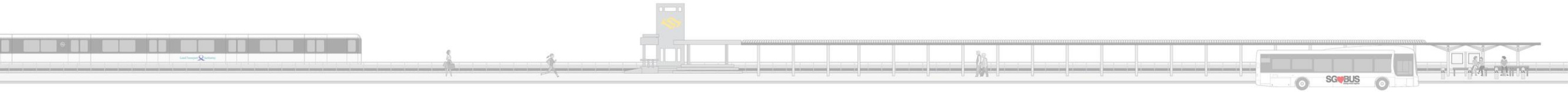
MOT-ST Engineering Trial at Sentosa (Completed)

Completed Bookings	1967
Total number of passengers ferried	5905

Rating	5	4	3	2	1	
Number of Ratings	643	130	85	6	18	Total feedbacks: 885
Rating Percentile	73%	15%	10%	1%	2%	Average Rating: 4.55

Data collected from 26th Aug to 15th Nov 2019

- 12-week public on-demand trials conducted from August to November 2019
- Mobile application and booking kiosks used to hail bus
- Successfully ferried ~5900 passengers and garnered positive rating (4.55 out of 5.00) based on public feedback/survey



MOT-ST Engineering Trial at Sentosa (Completed)

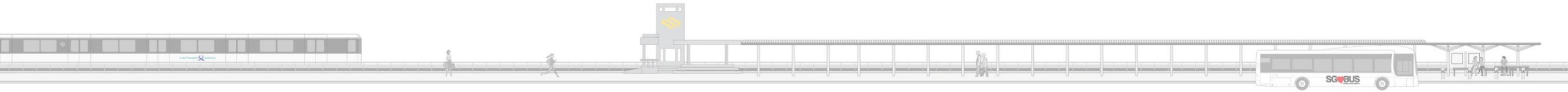
Lessons Learnt:

- For MOT / LTA, trial enabled lessons learnt on shuttle capacity (both seated and standing) to meet demand, shuttle operations, system requirements, public reaction to AV service

- For ST, trial enabled them to test their R&D on AV shuttle in controlled, real-world situation; understand market for such services; and understand customer requirements

- For Sentosa, trial allowed them to appreciate how AV could provide shuttle service; and facilities required to support such AV service

- For public (commuters and other road users), trial allowed them to appreciate how AV operates



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Point-to-Point Mobility-on-Demand			
Freight			
Utility			
Enablers	**Infrastructure & systems, regulations & standards, public acceptability, manpower and industry development, etc.**		

Pilot Deployment of AVs in early 2020s

- Pilot deployment of AVs as public transport in 3 new towns: Punggol, Tengah and Jurong Innovation District (JID)
- Provides fixed route/scheduled bus services and shared/on-demand shuttle services within these new towns
- Collaborate with industry to (i) develop, test and commercialise AV public transport solutions for Singapore; and (ii) field-test solutions developed at fleet and town scale

Punggol - brown-field site with a good mix of residential and commercial/industrial areas

Tengah - green-field residential area

Jurong Innovation District - largely a green-field commercial/light industrial site

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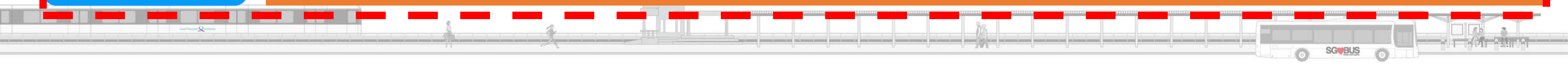

Development of Testing Regime for AVs

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

- Provide a safe environment to test AVs for various traffic scenarios
- Develop testing and certification methodologies, including milestone tests for (1) limited small-scale test-bed, (2) more complex densely populated environment and (3) removal of safety operator in the vehicle
- New development: testing regime for utility AVs and AVs on public paths, to evaluate safety before they can be trialed in public spaces

Autonomous Environmental Service Vehicle (AESV)

Autonomous Mobile Robot (AMR)

Land Transport Authority
We Keep Your World Moving

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

Regulation and Standards: Updating TR68

- Updating TR68 (Singapore standards on AVs) in line with technological and standards developments around the world, in collaboration with industry
- Some areas of focus:
  - **Chapter 1** on situations/scenarios should the AV enter Minimum Risk Conditions (MRC) where the AV will perform a safe stop
  - **Chapter 2** to review of proposed Concepts of Safety, Technical & Operation for autonomous vehicle to enhance the safety of AV
  - **Chapter 3** on AV Cybersecurity Principle, Cybersecurity Testing & OTA
  - **Chapter 4** on data format for Traffic Signals, Charging Stations & Infrastructure

Public Awareness:
Public engagement since 2019 in tandem with trials & deployment

Oct 2019

Announcement on expansion of trial area to Western region

ITSWC Floating Platform Demo

Nov 2019

Buona Vista Community Roadshow

Nov/Dec 2019

Smart Nation + U Roadshow

Manpower & Industry Development: Preparing bus captains for future with AVs

- Public bus drivers participate in AV trials as safety operators
- MoU signed to train existing bus drivers to handle AVs
- Keeping technology developments abreast with stakeholders including Transport Workers' Union, bus operators

A6 | TOP OF THE NEWS | THE STRAITS TIMES

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.

Safety operators take over immediate control of the bus should the need arise. They are also trained to remotely monitor the operation of the 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 2023. 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 commutes, under a pilot programme.

In a blog post, National Transport Workers' Union executive secretary Melvin Yong said the MOU reflected Singapore's unique 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 using walk-cycle-ride modes can be completed within 20 minutes.

In a 45-minute city, nine in 10 peak-period journeys using walk-cycle-ride modes can be completed 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 ceremony, LTA chief executive Ngien Hoon Ping noted that 15 bus drivers have been trained by ST Engineering and SBS Transit for the ongoing trial of autonomous vehicles on Sentosa.

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

SBS Transit bus driver Elizabeth Lin, 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.

"But after we got used to it, it was okay... the autonomous system was quite effective."

twtoh@sph.com.sg

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.

Source from: The Straits Times – 25th Oct 2019

Thank You!

www.lta.gov.sg

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