

HIGHLIGHTS OF 'REIMAGINING URBAN MOBILITY WITH AUTONOMOUS VEHICLES' EXHIBITION

1. Introduction to autonomous vehicles

Autonomous vehicles (AVs) are vehicles that can sense their environment and hence move with little or no human intervention.

How do autonomous vehicles work?

AVs sense their location and surroundings by gathering input from their suite of sensors. Sensors used by AVs include:

- Cameras
- Light Detection and Ranging (LiDAR)
- Radio Detection and Ranging (RADAR)
- Inertial Measurement Unit (IMU)
- Global Navigation Satellite System (GNSS)

By retrieving sensory input from various sources concurrently, the AV's perception system will be able to translate the data into physical commands, taking into account traffic conditions and agents on the roads such as other vehicles, pedestrians, and cyclists. This helps the AV to chart an efficient path towards its destination, while safely avoiding obstacles along its journey.

Smart and connected infrastructure

The capabilities of AVs are enhanced by smart and connected infrastructure such as fleet and traffic management systems and the Vehicle to Everything (V2X) system. V2X is a communication system between a vehicle and any other entity that may affect or be affected by the vehicle (e.g., other vehicles, network, infrastructure). With V2X, the "field of vision" that an AV experiences is extended beyond its immediate vicinity.

2. Potential Benefits of autonomous vehicles

AVs have numerous potential benefits which include:

- **More space in our city**

By optimising routing through intelligent algorithms and moving efficiently, AVs may help to reduce traffic congestion and optimise road space by freeing up land for other uses.

- **Inclusive transport**

AVs can enhance convenience and accessibility of first-and-last mile connectivity for the elderly and those with different transport needs with on-demand and dynamically routed autonomous bus and shuttle services.

- **Safer roads**

AVs have high fidelity sensors to sense their surroundings and navigate accurately in accordance with traffic conditions and rules, which can help to minimise accidents resulting from human error.

- **More optimised urban logistics**

To support increasing delivery volumes, AVs can serve to increase business efficiency and improve customer convenience and experience by enabling contactless deliveries and supporting delivery and utility activities during off-peak hours.

- **Increased job opportunities**

AVs can create new job opportunities such as remote fleet controllers, technicians, and engineers in the AV sector.

3. Enabling the safe development of autonomous vehicles

The safety of AVs for passengers and other road users is of paramount importance, be it during trials, or during actual deployment.

Autonomous Vehicles Deployment Roadmap

LTA and MOT have envisioned an AV deployment roadmap for Singapore. This calibrated and phased approach in trialling and deploying AVs ensures that AVs are safe and publicly accepted before progressing to the next stage of the roadmap.

Centre of Excellence for Testing and Research of Autonomous Vehicles-NTU (CETTRAN)

CETTRAN was established on 1 Aug 2016 by the Government and Nanyang Technological University, to build up technical capabilities and knowledge in testing and certifying AVs in Singapore. A two-hectare AV Test Centre was also set up in 2017 to complement this development. Today, the Test Centre supports the conducting of LTA's testing regime to facilitate safe AV trials on Singapore's roads and public paths.

4. Re-designing towns

AVs present new possibilities for town re-design.

AVs' ability to navigate routes more precisely and optimally can reduce the number of lanes and space needed for roads. Hence, street space could potentially be reclaimed and re-designed for other uses such as bicycle lanes or greenery provision, while taking into consideration the unique site contexts and the need to continue allocating space to facilitate the movement of essential services such as logistics and emergency vehicles.

In addition, streets and crossings, car parks, and pick-up and drop-off (PUDO) locations can be optimised and the space re-purposed. The exhibition showcases possible urban design interventions in an AV-enabled future.

Streets and crossings

A future street layout should respond to the needs of users, prioritising walking, cycling and public transport, with AVs complementing these primary transport modes. Streets and crossings will emphasise a people-first outcome instead of a traditional vehicle-first outcome.

There are two possible approaches to re-designing streets.

Firstly, segregated lanes can be set aside specifically for AVs. This may ease potential safety concerns whilst AV technology proves itself reliable.

Secondly, shared streets can be constructed for AVs, cyclists, and pedestrians, with design interventions put in place to minimise conflict among the different street users. This could reduce the space needed for multiple lanes, hence freeing up space for alternative uses such as for more green spaces.

Car parks

AVs are expected to reduce the space needed for parking, because they can park closer to one another with automated and highly precise access and parking manoeuvres. As AVs can park themselves closer to each other as compared to human-driven vehicles, there will be less need to allocate space for walkways and safety buffers that traditional parking would require, thus making car park layouts more space-efficient. Additionally, space needed for parking is likely to be further reduced if most AVs are fleet-owned and shared.

Good urban design could enable AVs to be stored in a shared “hub”, located away from prime districts, instead of being parked in all buildings across the island. This could free up existing car park space for other amenities that could meet different needs and competing land use demands.

These shared “hubs” will have to be optimally sized and sited, considering factors such as efficient journeys from origins to destinations, traffic congestion and emissions, amongst others. These hubs can also be complemented with on-street PUDOs which will reduce the overall need for numerous dedicated parking spaces.

On-street and off-street PUDOs

When charting a route to one's destination using an AV, traditional factors (e.g., availability of parking or distance between car park and one's destination) will no longer be a concern in the future. This is because AVs can either park themselves or be routed to the nearest shared "hub" for storage.

Instead, passengers, or AV users, will place greater importance on the convenience of their origin and destination points. As such, PUDOs where users board and alight from the AVs may have to be re-designed to provide a more seamless and intuitive experience for passengers, and for the AVs to manoeuvre through smoothly to ensure user and pedestrian safety.

There are two types of PUDOs, on-street and off-street.

- *On-street PUDOs*

AVs could increase the demand for on-street PUDOs. On-street PUDOs can operate on dedicated lanes or have dynamic kerbside management. There is a need to prevent traffic congestion and ensure that the PUDO can cater to vehicles of different sizes, especially in high-density areas and on main streets.

- *Off-street PUDOs*

Off-street PUDOs reduce the risk of creating traffic congestion. These PUDOs can be located as a hub or co-located with other uses such as commercial developments to prevent them from turning into deserted and under-utilised spaces during off-peak hours.

In the future, PUDOs will no longer be just a place for commuters to board and alight but will also turn into lively community destinations with fully integrated public transport services (e.g., Mass Rapid Transit, buses) and amenities to facilitate seamless journeys via AVs.