

## NTU Singapore and Volvo unveil world's first full size, autonomous electric bus



*First of two Volvo Electric buses will soon begin trials at the NTU Smart Campus before being extended to public roads*

Nanyang Technological University, Singapore (NTU Singapore) and Volvo Buses have launched the world's **first full size, autonomous electric bus** today. The single-deck Volvo Electric bus is 12 metres long and has a full capacity close to 80 passengers.

This is a key milestone in NTU and Volvo's development programme under the university's partnership with the Land Transport Authority (LTA) to develop and conduct autonomous vehicle bus trials for fixed route and scheduled services, which was announced in October 2016.

The Volvo 7900 Electric bus is equipped with numerous sensors and navigation controls managed by a comprehensive artificial intelligence (AI) system.

Ensuring maximum safety and reliability, the AI system is also protected with industry-leading cybersecurity measures to prevent unwanted cyber intrusions.

The Volvo bus is the first of two that has undergone preliminary rounds of rigorous testing at the Centre of Excellence for Testing and Research of Autonomous vehicles at NTU (CETRAN).

Plans are in place to test the bus at NTU and to subsequently extend the route beyond the NTU campus.

**NTU President Professor Subra Suresh**, said, “This fully autonomous electric bus will play a role in shaping the future of public transportation that is safe, efficient, reliable and comfortable for all commuters. It will soon be tested on the NTU Smart Campus, which has been home to a number of innovations as a living testbed for technologies that impact the human condition and the quality of life.

“This research project not only involves cutting-edge science, technology and AI, but is also an excellent example of close partnership among academia, industry and government agencies in translating basic research into products and services for the benefit of Singapore and beyond. And we have a top team of local and international partners in this multi-disciplinary collaboration.”

The electric bus has 36 seats and provides a quiet operation with zero emissions. It also requires 80 per cent less energy than an equivalent sized diesel bus.

This is Volvo’s first fully autonomous and electric bus in public transportation anywhere in the world. For this trial of a full size single deck bus, Volvo has chosen NTU Singapore as its global partner.

**Håkan Agnevall, President Volvo Buses**, said, “We are very proud to be showcasing our electric bus featuring autonomous driving technology. It represents a key milestone for the industry and is an important step towards our vision for a cleaner, safer and smarter city. The journey towards full autonomy is undoubtedly a complex one, and our valued partnership with the NTU and LTA is critical in realizing this vision, as is our commitment to applying a safety-first approach.”

The NTU and Volvo partnership is part of the collaboration between the University and LTA under NTU’s living lab platform. The platform assesses technology maturity and road-worthiness, including the certification of technologies for deployment on public roads.

**Lam Wee Shann, Chief Innovation and Technology Officer, Land Transport Authority**, said, “The launch of the autonomous bus for on-road trials marks an important milestone in the joint project between LTA and NTU Singapore to develop autonomous buses for fixed routes and scheduled services. It is in line with Singapore’s vision of deploying autonomous vehicles to improve accessibility and connectivity for commuters. We will continue to work closely with NTU to facilitate the safe and robust testing of the autonomous vehicles.”

The bus is undergoing rigorous tests at CETRAN. Jointly set up by NTU, LTA and JTC, CETRAN is a centre dedicated to research and testing of autonomous vehicles. It replicates various elements of Singapore’s urban road condition, such as traffic signals, multiple bus stops and pedestrian crossings, and tropical conditions such as driving through heavy rain and partially

flooded roads. Operated by NTU scientists, CETRAN is located on the NTU Smart Campus in the Jurong Innovation District.

### **Advanced sensors and AI technology protected with cybersecurity measures**

The bus comes with a Volvo Autonomous Research Platform software that is connected to key controls such as its navigation system, as well as multiple sensors.

This includes light detection and ranging sensors (LIDARS), stereo-vision cameras that capture images in 3D, and an advanced global navigation satellite system that uses real-time kinematics. This is like any global positioning system (GPS), but uses multiple data sources to give pin-point location accuracy of up to one centimetre.

The system is also hooked up to an “inertial management unit”, which acts like a two-in-one gyroscope and accelerometer, measuring the lateral and angular rate of the bus. This will improve its navigation when going over uneven terrain and around sharp bends, ensuring a smoother ride.

These sensors and GPS platforms will be managed by a comprehensive AI system that was developed by NTU researchers. It not only operates the various sensors and GPS systems on the bus, but also enables it to navigate autonomously through dense traffic and tropical weather conditions.

The AI system is protected with industry-leading cybersecurity and firewall measures to prevent unwanted intrusions for maximum safety and reliability.

### **Multi-industry collaboration with partners**

As part of the public trials, Singapore’s public transport operator **SMRT** will play a key role in determining the roadworthiness of autonomous vehicles on public roads.

While plans are in place to test the first bus on the NTU campus, a second autonomous 12-metre Volvo 7900 Electric bus will undergo tests at a bus depot managed by SMRT.

It will provide a real-world environment to assess the vehicle’s ability to autonomously navigate into vehicle washing bays and park safely at charging areas.

**Mr. Tan Kian Heong, Managing Director, Buses & Roads Services and Senior Vice President, Human Resources**, said, “SMRT is pleased to support the research and development of these eco-friendly autonomous electric buses. As part of the Autonomous Electric Bus trial, we will leverage on our expertise in operations and maintenance of buses, and work closely with our partners to test the command and control system required to operate a fleet of autonomous vehicles. This will help us to stay future-ready with the latest urban mobility solutions to enhance the accessibility and connectivity of our public transport network.”

Another partner, **ABB**, a pioneering technology leader in digital industries and world leader in fast-charging infrastructure for electric vehicles, will develop a smart fast-charging solution. Based on the OppCharge concept, ABB's HVC 300P fast charge system is ideally suited for autonomous charging in bus depots as well as in running traffic.

Offering a charge power of 300kW via a pantograph mounted on the infrastructure, the fast chargers will recharge a battery in just three to six minutes. This will enable charging during the layover times at the end of the bus route, without impacting normal operations.

**Tarak Mehta, President of Electrification Products division**, said: "ABB is committed to pioneering technological innovations for a sustainable future. We are extremely excited to collaborate on such a landmark project which marks a positive step toward the electrification of public transport across the region and beyond."

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**Media contact:**

Nur Amin Shah  
Manager, Media Relations  
Corporate Communications Office  
Nanyang Technological University  
Tel: +65 6790-4714  
Email: aminshah(a.t.)ntu.edu.sg

Helena Lind  
Manager, Media Relations  
Volvo Buses  
Tel: +46 765 53 62 57  
Email: helena.lind(a.t.)volvo.com