Nanyang Technological University, Singapore (NTU Singapore) today announced that it will be working with industry partners to integrate cellular communication into vehicle-to-everything (V2X) technologies, as part of NTU's upcoming research in the smart mobility sector.

Different vehicular communications technology will be studied, including dedicated short-range communication V2X, existing 4.5G and the upcoming 5G mobile networks, to improve the data transmission speed and radio coverage distance for communication between vehicles to infrastructure, paving the way for faster notifications and warnings.

Starting next year, NTU will work with industry partners to study the above-mentioned technologies, how they can synergistically complement each other and be explored for use in autonomous vehicle (AV) prototypes, traffic infrastructure and unmanned aircraft systems. These vehicular communications will be used to relay real-time navigation traffic and hazard information to vehicles in advance.

NTU Vice President (Research) Prof Lam Khin Yong said NTU is well-positioned to advance smart mobility solutions on its Smart Campus together with its industry partners from the communications, electronics, and transport sectors.
"Employing cellular communication and integrating them into existing V2X technologies for mobility can help to reduce travelling time, minimise the risk of serious accidents and optimise road usage for a densely populated urban city like Singapore. The emerging technologies researched today may soon become the norm for our everyday lives, contributing to Singapore's vision to be a Smart Nation," Prof Lam said.

**NTU – a leader in V2X communication technology**

NTU’s decision to carry out further research in V2X and cellular-V2X communication comes after several successful development and tests of transportation technologies using the international car-to-car wireless standard for vehicular use. Known as the dedicated short-range communication V2X communication technology, they were tested at the NTU-NXP Smart Mobility Test Bed.

Launched in 2015, the NTU-NXP Smart Mobility Test Bed turned the NTU campus into a V2X-enabled campus for researching and testing secure, smart connectivity and mobility solutions. These are aimed at improving traffic flow in cities, preventing road accidents, and enhancing the user experience for mobility services.

"Since its set-up in 2015, the NTU Smart Mobility Test Bed has been a valuable contributor to Singapore's innovation ecosystem, bringing together industry partners to co-create and commercialise V2X solutions for a safer and more efficient driving environment. EDB is delighted to support NTU in pushing the envelope on the next generation of intelligent mobility solutions, such as cellular communications for autonomous vehicles and drone air traffic management." said Mr Pee Beng Kong, Director, Singapore Economic Development Board (EDB).

Four completed research projects were showcased today.

**Early warning system for vehicles**

An early warning system for vehicles was demonstrated today. The system gives advance warning to drivers on road hazards such as a car stopping unexpectedly or a passenger suddenly opening a vehicle door.

Such an early warning system requires a smart in-vehicle unit that can tap into the automotive electronics systems to detect the actions of the driver and its passengers and notify other nearby vehicles through a special car-to-car Wi-Fi signal.

**Cellular communication for PMDs**

Also showcased at today’s event is a project by NTU, Continental and Schaeffler that utilises V2X communication to connect vehicles to e-scooters or e-bikes. It allows drivers and users of personal mobility devices (PMDs) to detect one another.

Besides cellular communication technologies for vehicles on land, NTU is also working on the development of drone air traffic management via 4.5G mobile networks. This will give better localisation and positioning to the drones, as well as a smoother stream for high definition video footage.

NTU is a world leader in smart mobility solutions and has partnered top companies like Volvo, BMW Group, Blue Solutions, ST Engineering, and mobilityX, to develop innovative technologies for AVs, electric vehicles and multi-modal mobility solutions.

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**Media contact:**
About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Humanities, Arts, & Social Sciences, and Graduate colleges. It also has a medical school, the Lee Kong Chian School of Medicine, set up jointly with Imperial College London.

NTU is also home to world-class autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Ranked 12th in the world, NTU has also been placed the world's top young university for the past five years. The University's main campus is frequently listed among the Top 15 most beautiful university campuses in the world and it has 57 Green Mark-certified (equivalent to LEED-certified) building projects comprising more than 230 buildings, of which 95% are certified Green Mark Platinum. Apart from its main campus, NTU also has a campus in Singapore's healthcare district.

For more information, visit http://www.ntu.edu.sg

Annex A: Successful industry trials on NTU-NXP Smart Mobility Test Bed

First announced in 2015, the $22 million NTU-NXP Smart Mobility Test Bed was launched in partnership with NXP Semiconductors, the world-leading automotive semiconductor supplier in secure connected cars.

It evolved over the last four years to form a 14-member consortium consisting of global automotive and electronics companies such as Panasonic, Schaeffler, Denso, Chemtronics and ST Engineering Land Systems, to name a few.

Technology commercialisation by the NTU research team led by Assoc Prof Guan Yong Liang from the School of Electrical and Electronic Engineering includes four technology disclosures and two patents licensed to NXP; more than 60 conference and academic papers as well as the training of over 80 scientists and engineers who graduated with bachelor, master and PhD degrees.

These smart mobility technologies were developed using a campus-wide V2X network, which consists of 70 vehicles equipped with a smart on-board unit, and 35 roadside units with 82 video cameras mounted on street lamps throughout the NTU campus. They are connected to a 24/7 "always on" data centre capable of handling live street-view video and V2X data collection.

At the showcase event, there were four live demonstrations of V2X technologies trialled and developed in partnership with industry consortium members namely NXP, Cohda Wireless, Continental, and Panasonic, showcased to over 220 industry and academic participants.

Annex B: NTU-NXP Smart Mobility Test Bed V2X Demos

1. Early warning system for vehicles
By tapping into the car’s electronic systems through the onboard diagnostics (OBD) port, NTU and NXP scientists demonstrated how OBD data collected and interpreted could help make the road safer for all users using the V2X network.

In 20-minute live demo along NTU roads, the vehicle showed how it could notify fast-approaching vehicles if its doors were being opened, or if it had an engine fault and was disabled along an expressway, or when there is a car coming out of a side road.

The nearby vehicles would receive such warnings in real-time wirelessly, via the smart onboard unit (OBU), which gives the driver more time to react and avoid.

Another function shown was a combined Green Wave and GLOS A (Green Light Optimised Speed Advisory) system in which vehicles receive data from upcoming traffic lights to inform the drivers how fast or slow they can drive in order to catch the green wave – where all traffic lights on his route are green.

2. Continental and Schaeffler’s PMD and Car anti-collision alerts

With the increase in PMDs on pedestrian walkways and on the roads, automotive parts giants Continental and Schaeffer worked with NTU scientists to integrate a V2X smart unit into PMDs.

Vehicle drivers and PMD riders can now be alerted via the V2X technology when a PMD is in the blind spot of a reversing vehicle.

Such an early warning system heightens awareness for all road users and would lower the risk of an accident when visibility is low or blocked.

3. Cohda Wireless’s V2X-Locate system beats GPS black spots

A novel positioning system developed by Cohda Wireless, it uses the V2X radio signal to determine vehicle locations where the GPS has difficulty locating satellite signals in areas with tall buildings, underground or under sheltered car parks.

Using the onboard unit in the vehicle to communicate with roadside units installed in car parks, the V2X-locate system uses the known locations of the roadside units and the V2X radio signal in a way. It is similar to a GPS navigator that uses the GPS satellite signals, allowing the vehicle to know its location down to a 1m accuracy 95 per cent of the time.

4. Panasonic 60GHz ultrafast V2X communication for intelligent transportation systems

While conventional V2X systems use a 5.9GHz frequency to communicate, Panasonic has developed a futuristic 60GHz V2X system that can download extremely large files in split seconds. This is even while the moving vehicle is within range of the 60GHz base stations installed on lamp posts or bus stops.

This allows for ultra-fast real-time high definition video streaming and file downloads in future intelligent transportation systems, such as for autonomous vehicles (AVs). They need to be monitored by a central system, or for wireless downloading of high-definition maps to the AVs.

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