AVIN Ontario

AVIN INSIGHTS
Technology Spotlight

DRIVING THE FUTURE OF PUBLIC TRANSPORTATION IN ONTARIO

On-Road Trial of Electric Low Speed Automated Shuttles (LSAS)

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Where Next Happens

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Introduction

Low Speed Automated Shuttles (LSASs)[1] have the potential to provide new transportation options for riders over the first and last mile of their journey and enhance access to public transportation. They could also provide commuters with a seamless and convenient connection to transportation hubs such as airports.

Driven by an overarching vision to develop and implement state-of-the-art mobility solutions at the federal, provincial and municipal levels and create cleaner and more efficient mobility for citizens in urban and rural areas, Transport Canada (TC) launched an on-road electric Low Speed Automated Shuttle (LSAS) trial in Ontario. This trial was conducted in partnership with Area X.O operated by Invest Ottawa, the National Research Council (NRC), the City of Ottawa, and EasyMile (*refer to section Engagement – Trial Partners for full list of contributors*).

The trial operated in various weather conditions in a real-world transportation environment. It is considered the first project of its kind to be approved in the province under the Ontario Automated Vehicle (AV) Pilot Program through Ontario's Ministry of Transportation (MTO).

This insights piece is developed as part of the Autonomous Vehicle Innovation Network (AVIN) technology spotlight insights series. It provides a snapshot of the LSAS trial and highlights its key findings.

Trial Objectives

PLANNING

Gain deep insights into the planning process for low-speed automated vehicle trial testing in Canada from the perspective of a manufacturer and Canadian trial organization.

OPERATION

Understand the LSASs automated driving capabilities, human factors considerations, safety performance, battery efficiency, and viability as a first-/last- mile solution for public transit.

SAFETY

Inform Transport Canada's safety approaches for LSASs to support the development of guidance documents and TC collaboration on international standards.

[1] *LSASs are usually designed to operate as fully automated (Level 4 -High Driving Automation) within a restricted Operational Design Domain (ODD). The operational speed of LSASs are typically limited to 25km/h (or lower) with cruising speeds around 10-15 km/h.*

The Shuttle

Two EasyMile EZ10 second generation automated shuttles were used in this pilot. The shuttle is an all-electric vehicle equipped with an automated driving system that can operate in high automated mode (SAE Level 4) and can carry up to 12 passengers (6 seated and 6 standing) and one operator. For this pilot, to enhance safety against sudden stops, passengers were required to remain seated with their seatbelts fastened. Moreover, to ensure social distancing, passenger capacity was reduced.

The shuttle can provide passengers with audio and visual cues to let them know of stop announcements. It comes equipped with a ramp making it accessible to individuals requiring mobility assistance. The shuttle is also equipped with seatbelts for all seating positions. The EasyMile EZ10 can travel on a two-lane road with on-coming traffic as well as with an adjacent bicycle path.

Shuttle Specs

Length / Width
4050 mm / 1892 mm

Gross Vehicle Weight (loaded)
2,750 kg

Curb Weight (empty)
1,970 kg

Accessibility
Mobility ramp equipped

Electric Motor / Transmission
Propulsion engine (electric asynchronous) / Single Gear

Range
16 hours

Navigational Aids
- 360 view coverage LIDAR
- High precision GPS
- Inertial measurement unit Wheel encoder
- Navigation Version Voyager 8

EasyMile EZ10

LSAS Trial Journey

The project was executed in four phases:

01 | Project Preparation and Stakeholder Workshop

This phase focused on the site analysis and modifications for the on-road trial, a safety assessment report, the track test plan, and a stakeholder engagement workshop. All required documentation was prepared as part of this phase including importation, permits, and insurance for the LSASs.

02 | Technical Orientation to Automated Shuttle Operation

This phase consisted of a two-day technical workshop that trained participants, including first responders, on the operation of the EZ10 Shuttle with a focus on health and safety risks in the operational domain of an AV.

03 | Track Testing of the EasyMile EZ10 LSAS at Area X.O

This phase focused on assessing the automated driving capabilities of the shuttle at the Area X.O private test facility over five days. The closed-track testing evaluated shuttle performance in scenarios that could conceivably be encountered during the on-road trial.

04 | On-Road Trial Testing at Tunney's Pasture

The fourth phase was the on-road trial testing of two LSASs at Tunney's Pasture campus in Ottawa. During this on-road trial, the EZ10 shuttles were operated on a pre-defined route over a 3-week period.

Track Testing

Phase 3 focused on conducting testing and evaluation of the EasyMile LSASs at the Area X.O private test track. The track testing included setting-up Area X.O for LSAS testing, evaluating the LSAS's automated driving capabilities in hazardous scenarios involving Vulnerable Road Users (VRU) as per Area X.O and National Research Council test plan, and preparation and transport of LSAS to Tunney's Pasture for the on-road trial.

Testing Scenarios

The following vehicle automated driving capabilities were tested:

- Consistency in following a predefined route;
- Detection of hazardous situations and/or obstacles (i.e. VRU target); and
- Initiation of braking to mitigate and/or avoid a collision with obstacles.

VRU scenario testing was performed at two intersections at Area X.O:

1) 4-way signalized intersection with lane markings, pedestrian crosswalks and overhead streetlights; and
2) 3-way intersection with no signalization or traffic signage, no lane markings and no overhead lighting

VRU targets used in this testing are based on the Euro NCAP pedestrian and bicyclist targets. These included a 50% adult male, a 7-year-old child and a 50% adult male on standard average European utility bike. A realistic body-proportioned Canada goose decoy was also used as an obstacle during testing, as the species is prevalent along the Tunney's Pasture trial route during this time period.

On-road Testing

The overall goal of the project was to test, evaluate, and to operate an on-road trial of an LSAS as a first/last mile transit solution. In Phase 4 and following rigorous planning and track testing, the automated shuttles were tested on-road in two phases at Tunny's Pasture:

01 | Set-up phase without riders

No passengers were on-board the shuttles. One of the two shuttles was used to map the route, test the satellite coverage and GPS differential correction age, and evaluate the LSAS path-following and obstacle detection capabilities.

02 | On-road trial with riders

The testing of the LSAS with passengers was performed over a 10-day period November 3 to 8, and November 10 to 13, 2020.

The automated shuttles followed a 1.5 km route throughout the Tunney's Pasture campus, a federal government campus on crown land. The route included four planned stops with access to the Light Rail Transit (LRT) station. The shuttle travelled at an average speed of 8.34 ± 4.07 km/h with each stop taking approximately 20 seconds.

The site has optimal qualities for LSAS testing including **low** motor vehicle **speed limits**, **connection to public transit** and several highly frequented destinations, possibilities for a variety of **low-speed interactions** with other road users, and **proximity to secure overnight storage** with **electric charging**.

Extensive COVID19 mitigation measures were implemented, including physical distancing and frequent sanitization, in order to protect passengers. Participation in the trial was also highly limited, in accordance with the City of Ottawa's Chief Medical Officer's guidance.

Engagement
Trial Partners

This project builds on anchor support from the Government of Ontario through the Autonomous Vehicle Innovation Network (AVIN) and founding industry partners over the last two years. It brings together Area X.O operated by Invest Ottawa; Transport Canada; the Ontario Ministry of Transportation; the City of Ottawa; EasyMile, an industry leader in driverless technology; Ottawa start-ups including AutoGuardian by SmartCone and RideShark; multinational companies such as Accenture; and the National Research Council Canada.

The City of Ottawa also engaged local stakeholders including first responders, emergency services, and public transit operators.

The Autonomous Vehicle Innovation Network (AVIN) is a key component of Driving Prosperity, the Government of Ontario's initiative to ensure that the automotive sector remains competitive and continues to thrive.

The Government of Ontario has committed $85 million in innovative programming to support research and development (R&D) funding, talent development, technology acceleration, business and technical support, and testing and demonstration sites.

AVIN programs support small- and medium-sized enterprises (SMEs) to develop, test, and commercialize new automotive and transportation products and technologies, and cultivate the capacity of a province-wide network to drive future mobility solutions, reinforcing Ontario's position as a global leader.

AVIN, led by Ontario Centre of Innovation (OCI), is supported by the Government of Ontario's Ministry of Economic Development, Job Creation and Trade (MEDJCT) and Ministry of Transportation (MTO).

Ontario's Autonomous Vehicle Innovation Network (AVIN)

Engagement
Trial Partners

TRANSPORT CANADA
Transport Canada was the project authority leading this research project. Results will help to inform Transport Canada approaches for low-speed automated shuttles, including the development of guidance documents for connected and automated vehicle testing in Canada.

EasyMile
EasyMile was responsible for providing, operating, and maintaining electric LSAS, all regulatory elements pertaining to the vehicle manufacturer, insurance, compliance, and regulatory filings, supporting track testing at Area X.O and on-road trial testing at Tunney's Pasture with engineers on site for the duration of testing.

Ontario's Ministry of Transportation (MTO)
Ontario Ministry of Transportation (MTO) provided advice and guidance as appropriate with regard to Ontario's Automated Vehicle Pilot Program and supported the project during the Ontario AV Pilot Program application and vehicle permitting processes.

Accenture
Accenture supported in reviewing the testing plans at both the Area X.O test facility and Tunney's Pasture and provided recommendations throughout planning and delivery phases and ideation of future use cases and recommended pilots.

National Research Council (NRC)
NRC provided feedback and expertise in the development of the LSAS test plan and the alignment of the testing to the ISO standards. They also provided support for the instrumentation and gathering of data and test results, analyzed the test data from Phase 3 and Phase 4, and prepared a final test report for Phase 3 and Phase 4 detailing the findings.

Invest Ottawa
Invest Ottawa is the founder, leader, and manager of Area X.O. Invest Ottawa was contracted as the principal project manager to deliver this innovative automated shuttle research project.

City of Ottawa
City of Ottawa was engaged to ensure access to the site and required infrastructure modifications, assist the creation of the emergency preparedness plan, take an active role in all communications, public relations and events and assist with integrating the LSAS with the light rail transit stop at Tunney's Pasture.

AutoGuardian by SmartCone
SmartCone provided technology at each station which was connected to an on-board unit installed in the EasyMile vehicles. These SmartCones communicated to passengers as the shuttle was approaching the station.

RideShark
RideShark is an Ottawa-based transportation technology company providing a market leading mobility platform for customers around the world, including the City of Ottawa. Rideshark developed the API interface to book trips and display real time shuttle information.

Health and Safety

addressing COVID-19

The project team worked closely with Ottawa Public Heath to preserve the health and safety of the community with strict COVID-19 protocols in place throughout the trial.

One shuttle was dedicated to scheduled bubble rides (up to six family members under the same roof) and the second shuttle was used partially as a metro (up to four riders) version, as well as scheduled rides. Both shuttles were cleaned after every ride.

Moreover, all riders were required to complete a COVID-19 self-assessment, use hand sanitizer prior to boarding the shuttle and wear masks during the trip. The EasyMile operators were required to wear N95 masks.

The self-assessment as well as the rider's survey, were administered through quick response (QR) codes to limit the risk of exposure from circulating documents. Touch points were also reduced through other means such as having the shuttle's doors automatically open and close.

RideShark Booking Platform

RideShark leveraged the city's OttawaRideMatch.com site to provide a customized trip booking app that enabled individuals to quickly reserve their scheduled ride on the LSAS with members of their social bubble. The participants were able to view live, real-time vehicle locations and received confirmation emails with key information about their ride.

RideShark provided this app in both English and French while making sure to support any community members that might use an assistive device or need further assistance. The app enabled 500+ people to experience a scheduled ride during the 2-week pilot at Tunney's Pasture.

Smartcone Safety Measures

SmartTorch bollards were placed to provide traffic segmentation and visual and audible communication of when a shuttle is approaching to help protect and alert vulnerable road users (VRU).

These devices were preprogrammed with a message that notified the riders "Shuttle approaching in 2 metres, please clear path and keep a safe distance." It also reminded riders of the COVID-19 risk and that a mask must be worn while on the shuttle and to keep a safe distance of 2 metres apart.
The shuttles were equipped with SmartCone onboard units communicating wirelessly with the bollards.

Summary

Trial Highlights

Shuttle Performance

321
1.5km Laps Completed

~13min
average route completion time

~8.34 ± 4.07 km/h
Average shuttle speed

6 passengers
limit due to COVID-19
(LSAS capacity =12 passengers)

14
Emergency stops[2]

1.9 sec
Average time to stop

[2] *Main reasons for emergency stops are birds, leaves, improperly parked vehicles and vehicles cutting past the shuttle. There were no serious incidents involving any stops throughout the trial.*

Summary

Trial Highlights

Riders Perceptions

670
riders

182
Survey responses

88%
trusted the shuttle's ability to transport them safely

92%
experienced a smooth or good quality ride

Key reasons to ride an automated shuttle

1 Convenience

2 Environmentally friendly

Ontario Smart Mobility Readiness Forum

AVIN, through the Smart Mobility Readiness Forum, offers a platform for municipalities and public sector agencies to discuss their transportation objectives and collaborate in their goal of preparing for the adoption and implementation of smart mobility technologies.

Knowledge sharing is crucial in readying the province for its mobility transformation. As such, outcomes of this trial (access full report here) and other similar smart mobility pilot projects will support the Forum in its goal to address the challenges and identify the needs related to the adoption and readiness of C/AVs and smart mobility technologies in Ontario.

Smart Mobility Readiness Forum focus areas are:

- C/AV Development
- Pilot Project Program Management
- Regional Mobility Platform Strategy
- C/AV Modelling Tool
- Data Needs and Management

The Forum is managed by the Autonomous Vehicle Innovation Network (AVIN) through the Ontario Centre of Innovation (OCI), with support from the Ontario Ministry of Transportation (MTO) and Metrolinx.

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Acronyms

AV	Automated/Autonomous Vehicles
AVIN	Autonomous Vehicle Innovation Network
C/AV	Connected and Autonomous Vehicles
Euro NCAP	The European New Car Assessment Programme
LRT	Light Rail Transit
LSAS	Low Speed Automated Shuttle
MEDJCT	Ministry of Economic Development, Job Creation and Trade
MTO	Ontario Ministry of Transportation
NRC	National Research Council
OCI	Ontario Centre of Innovation
R&D	Research and Development
SAE	SAE International, previously known as the Society of Automotive Engineers
SME	Small and Medium Size Enterprises
TC	Transport Canada
VRU	Vulnerable Road User

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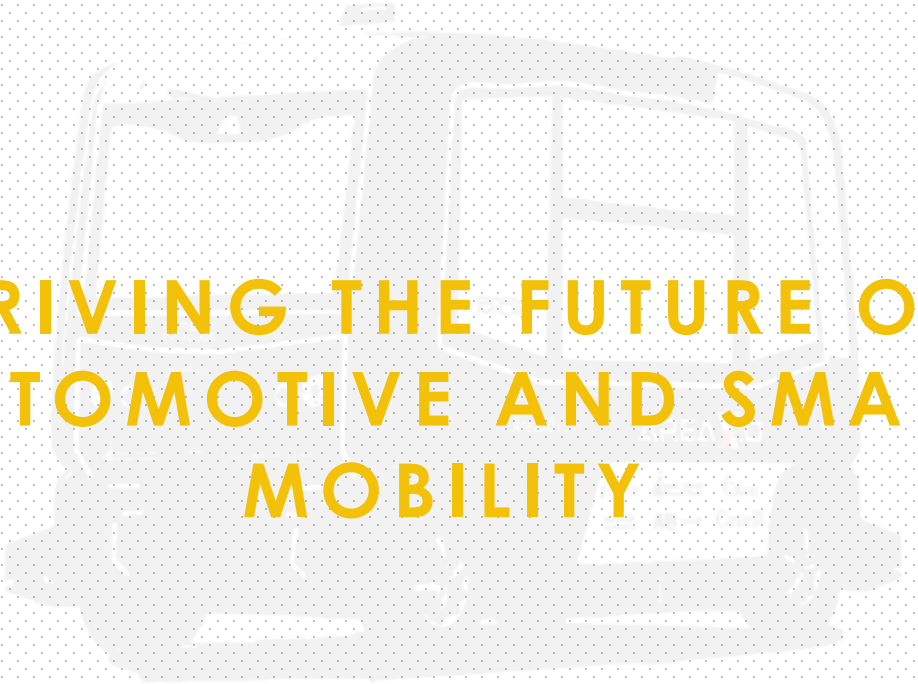

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