Connected and Automated Vehicle Plan

Part I: Background DRAFT

Prepared by the Corporation of the City of London
September 2022

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DISCLAIMER

The Connected and Automated Vehicle Plan was developed through collective input from variety of public and private agency stakeholders. Information was gathered through research, discussions, and presentations. The report does not necessarily reflect the views or opinions of any single agency discussed herein.

INTRODUCTION

This Connected and Automated Vehicle (CAV) Plan will be used by decision makers who are responsible for the implementation and maintenance of public infrastructure which will be impacted by the emergence of CAV technology. This CAV Plan has been prepared in a way that can communicate the City of London's context and unique approach to CAV technology to interested external stakeholders, industry players, and the public.

> **Part I: Background** provides an explanation of the current realities of CAV technology in London and elsewhere and explores anticipated timelines associated with the technology development. It is important to note that given the emerging nature of CAV technology, information provided within this section is subject to change.
>
> **Part II: Detailed Actions** presents the core areas of focus and actions that may be available to the City of London to consider in response to CAV technology. To implement the actions that have been identified, a subsequent Implementation Plan will need to be developed. The future Implementation Plan will consider each action and identify what is needed to proceed with implementation including triggering events, timelines, and required additional staff and financial resources.

This CAV Plan is proactive in nature, based on the needs to prepare the City for the arrival of CAV technologies in a timely manner. The action items identified in this plan will need to be further developed as part of a future Implementation Plan and looked at through a lens of deliverability, resourcing, and sustainability.

The future Implementation Plan and any proposed programs, projects, and sub-projects will need to be carefully considered in alignment with Council's CAV Plan including Corporate priorities and resourcing.

This document, **Part I: Background** is broken down into four primary sections:

> **What are connected and automated vehicles?** provides the basic definitions of what connected and automated vehicle technologies are and how they work.
>
> **The arrival, challenges, and opportunities of CAVs** presents key development factors such as technological, policy, economic, and human behaviour including major development categories for the various types of CAVs anticipated to be available.
>
> **London's local and regional context** provides a snapshot of CAV programs and agencies in both the public and private sectors regionally, provincially, and federally that are currently there to support the emergence of CAV technologies.
>
> **Public opinion** provides a preliminary look of known attitudes – both positive and negative – the public currently holds towards CAV technologies in the London area and more broadly, servicing as a "snapshot" in time where we are today.

The next document in the CAV Plan, **Part II: Detailed Actions** details the strategic areas of focus and related, specific actions for consideration in preparing London for the emergence of CAV technologies.

1 WHAT ARE CONNECTED AND AUTOMATED VEHICLES?

Connected and Automated Vehicles (CAVs) are driverless or self-driving vehicles that can detect the surrounding environment using artificial intelligence (AI), a variety of sensors, connected networks, and a global positioning system (GPS) coordinates among other means to navigate a mobility network successfully and safely with little or no human input.

These vehicles can be broken down into two primary components[1]:

Automated Vehicles

These vehicles make use of sensors and computer analytics to assess their environment and perform varying degrees of driving tasks. There are five levels of automation that range from driver-assistance systems that can help with steering to fully automated, self-driving vehicles in which passengers need pay no attention to the road.

Connected Vehicles

For connected vehicles, there are two types of connected technologies: consumer convenience and infotainment, and vehicle-to-vehicle and vehicle-to-infrastructure communications. Practical examples of this technology could include, your car receiving restaurant recommendations for a given route, getting a countdown for when the next traffic light is turning red, or having the car ahead of you provide a warning that you are following too closely.

For the purposes of this plan, both Automated Vehicles and Connected Vehicles are considered integral with one another, meaning that while automated and connected technologies can operate independently of one another, they are often integrated together in how they operate on a practical level. Therefore, they are referred to jointly as Connected and Automated Vehicles or CAVs for short in this plan.

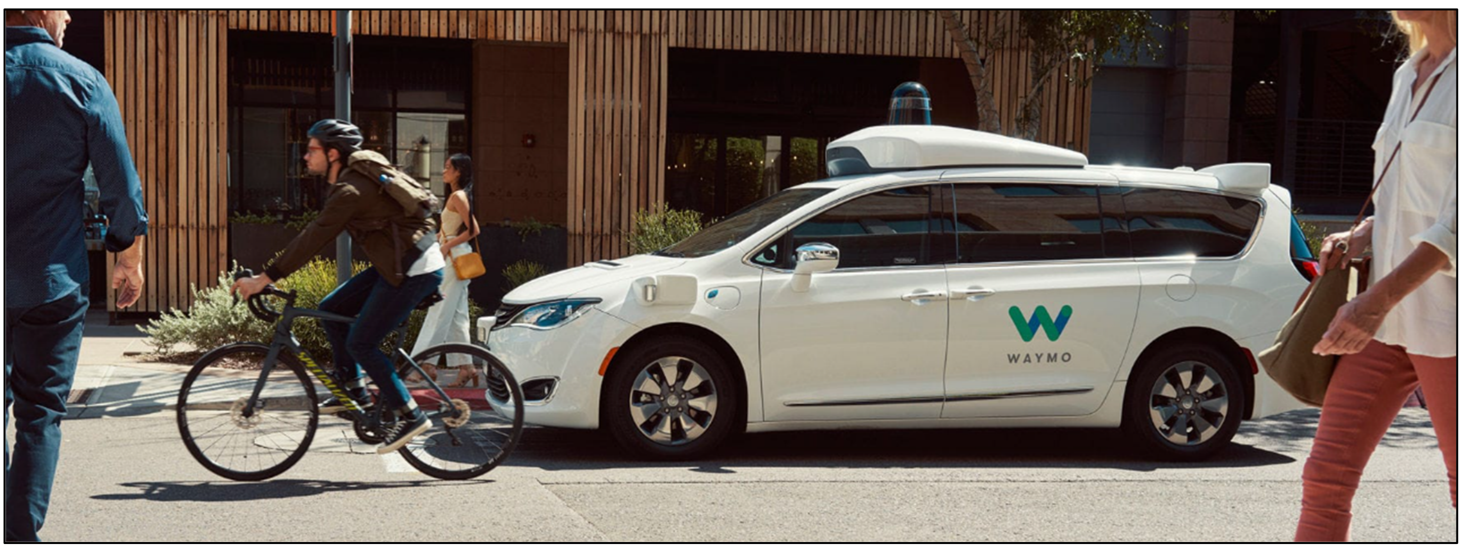
[1] Canada. Parliament. Senate. Standing Committee on Transport and Communications. Driving Change: Technology and the Future of the Automated Vehicle. 2018. P.29. Available from: https://sencanada.ca/content/sen/committee/421/TRCM/Reports/COM_RPT_TRCM_AutomatedVehicles_e.pdf

CAVs have the potential to deliver the following if properly managed:

- Environmental benefits;
- Economic prosperity;
- Societal equity;
- Safety improvements;
- Traffic congestion management; and
- Improved flow of goods and services.

One of the major improvements to road safety is the elimination of human driver error and distraction, due to the CAV technology taking over the driving operation. However, this expectation needs to be tempered with lower levels of vehicle automation where the attention of the human driver to maintain safe vehicle operations remains critical and driver errors remain possible. Further details on levels on automation are discussed in the next section.

Figure 1: Example of Waymo's Automated Vehicle[2]



[2] Waymo. Waymo One. 2022. Available from: https://waymo.com/

1.1 AUTOMATION TECHNOLOGIES

All vehicles exist on a scale of automation, even the ones available on the roads today or from decades past (e.g. basic cruise control). However, as auto manufacturers release new models with different feature packages, it can be hard to know where precisely a vehicle falls along the spectrum of automation.

1.1.1 LEVELS OF DRIVING AUTOMATION

The Society of Automotive Engineers (SAE) has defined the Levels of Driving Automation[3] (see **Figure 2**) that are a widely used set of definitions for indicating the level of driving automation present in a vehicle. There are six levels of automation where the higher the level, the more the vehicle can handle all aspects of driving without human intervention[4].

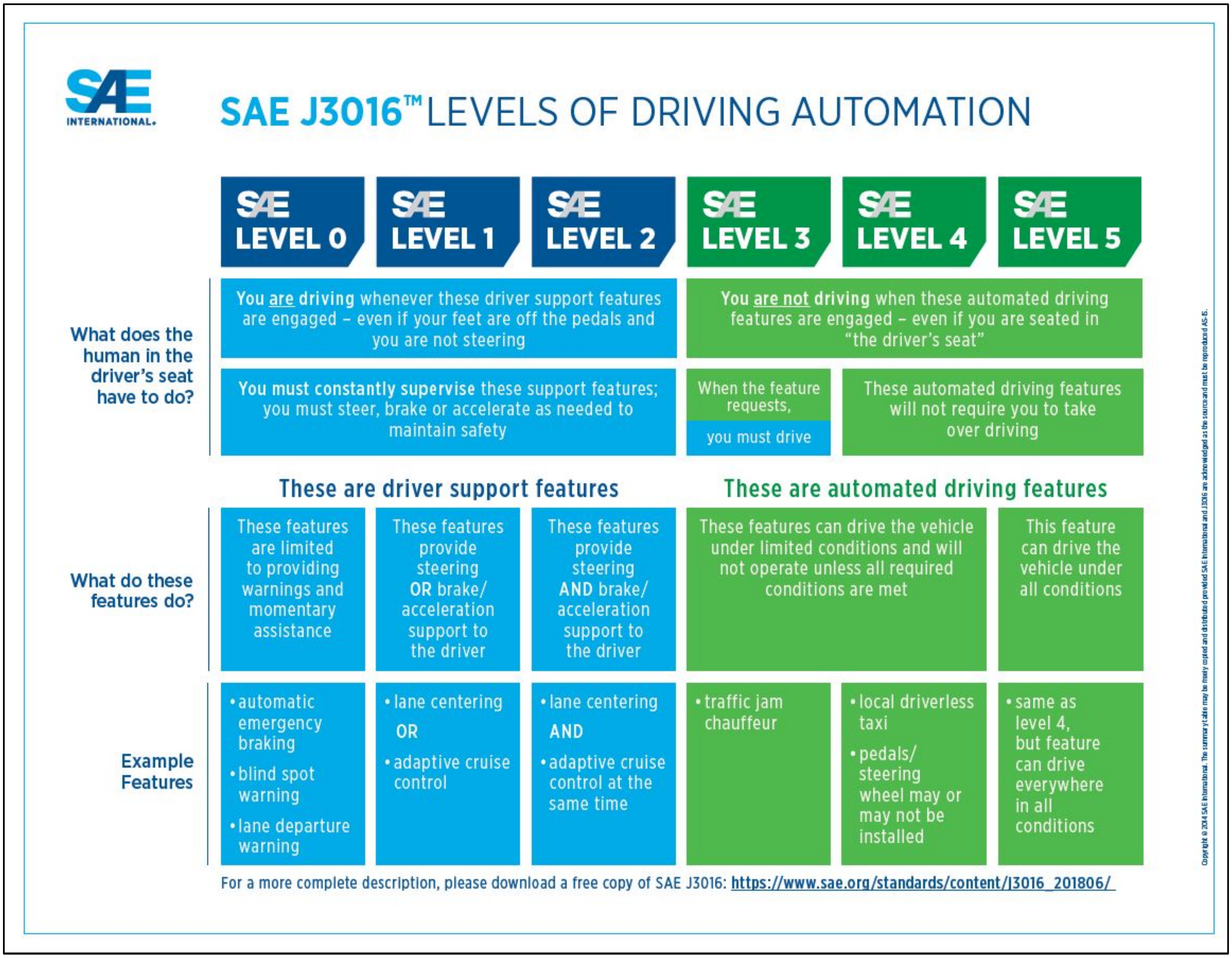
Considering the SAE Levels of Driving Automation, for SAE Levels 0-2 the focus is on driver support features, meaning that the human driver is in control but automated features support and enhance the vehicles operations. In contrast, SAE Levels 3-5 focus on automated driving features meaning that the vehicle itself is generally in control of the driving operation with the support of human intervention, depending on the level of automation.

However, it should be emphasized the SAE Level 3 is of particular interest and concern given that this is the “gap” level of automation between driver support and automated driving features. This makes SAE Level 3 a particular challenge since human drivers may tend to over-estimate the ability of automation and may use this automation in a more careless, less safe manner.

From a level of automation perspective, the main focus of this CAV Plan is on SAE Levels 3-5 where more transformational change is likely and the City will be required to more actively prepare for the emergence of CAV technologies. However, were connected vehicle technologies precede automated vehicle technologies the CAV Plan can be considered where applicable.

[3] Society of Automotive Engineers International [SAE]. SAE J 3016-2018: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. 2018.
[4] Smith BW. Automated Driving Definitions. Law of the Newly Possible. 2018.

Figure 2: SAE J3016 Levels of Driving Automation[5]



[5] Society of Automotive Engineers International [SAE]. SAE Standards News: J3016 automated-driving graphic update. 2019. Available from: https://www.sae.org/news/2019/01/sae-updates-j3016-automated-driving-graphic

The following two subsections further discuss the SAE Levels of Driving Automation.

Driver Support Features

- **Level 0:** The human driver is operating and controlling the vehicle and must constantly supervise steering, braking, and acceleration to maintain safety. Other vehicle systems may provide warnings or support, such as automatic emergency braking or lane departure warnings.
- **Level 1:** The human driver is operating and controlling the vehicle when these features are turned on, but is assisted with either steering or braking and acceleration (e.g. lane centering, adaptive cruise control, etc.).
- **Level 2:** The human driver is operating and controlling the vehicle when these features are turned on, but is assisted with steering, braking, and acceleration (e.g. lane centering and adaptive cruise control).

Automated Driving Features

- **Level 3:** The human driver is not operating or controlling the vehicle when these features are turned on (e.g. traffic jam chauffeur), but must drive if prompted in order to maintain safety.
- **Level 4:** The human driver is not operating or controlling the vehicle when these features are turned on, but will either:
    - Need to drive if prompted to reach the destination (in a vehicle that can be manually driven); or
    - Not be able to reach every destination (in a vehicle that does not have a steering wheel or pedals).
- **Level 5:** The human driver is not operating or controlling the vehicle when these features are turned on and can reach any destination.

The automated driving system (ADS) is engaged depending on SAE level of automation when the vehicle is within a specified operational design domain, e.g. defined by a mapped geographical area, certain weather conditions, etc.

1.1.2 DRIVING AUTOMATION SYSTEMS

Driving automation systems are made possible through numerous sensors that model and respond to the driving environment. Automakers, suppliers, technology developers, and other industry players have developed systems using one or more of the following sensor technologies including:

- Accelerometer (i.e. speed and acceleration);
- Cameras (i.e. monocular, stereo, infrared, or a mix of these);
- Lidar (i.e. laser measurements);
- Radar (i.e. short range, long range, or both);
- Satellite positioning systems (i.e. GPS); and/or
- Ultrasonic Sensors (i.e. sonar).

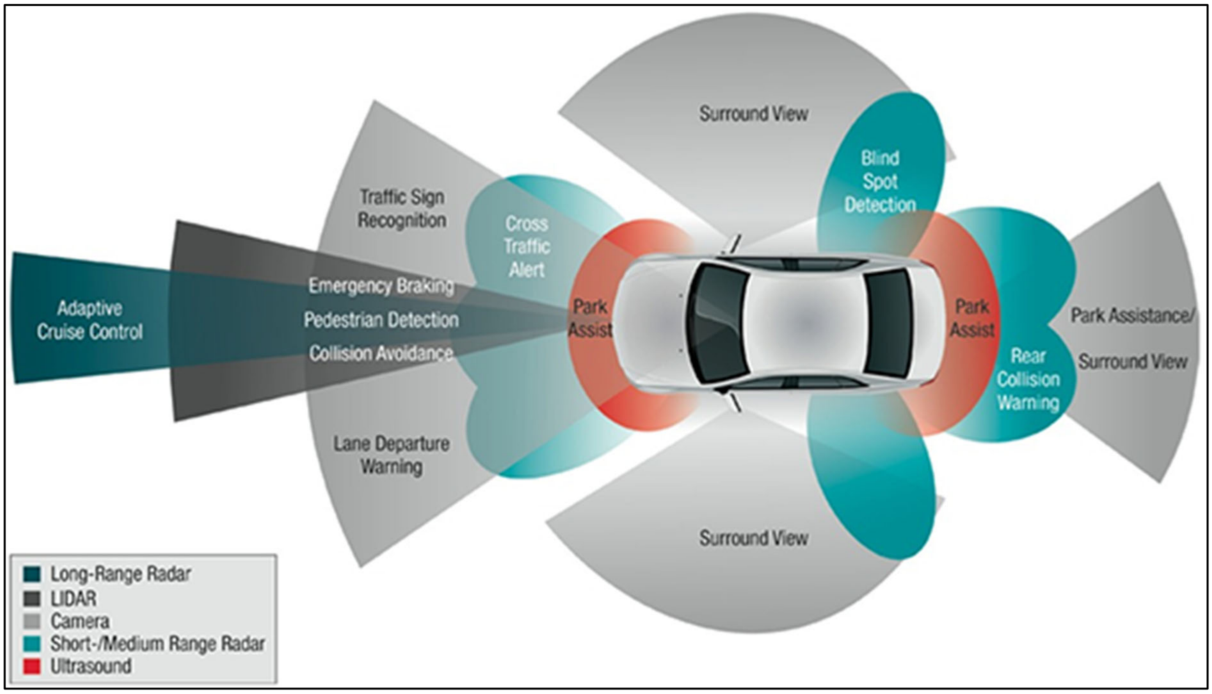
Most CAV system developers utilize a mix of these technologies to ensure that these systems are aware of their surroundings. For SAE Level 4 and 5 ADS, the industry has not yet created a standard understanding of what mix of sensors (illustrated below in **Figure 3**) will be required, and currently develop their technology based on the performance of these sensors (i.e. speed detection, sensitivity to colour, robustness to weather and time of day, resolution, range, etc.), cost, market segment, and visual appeal[6].

1.2 CONNECTED TECHNOLOGIES

Londoners already live with some intelligent transportation technologies – such red light cameras and automated speed enforcement – and the City is in the process of upgrading the traffic signal systems[7] to support rapid transit and eventually CAV technologies. Wireless, connected technologies could further unlock the transformative potential of driving automation by enabling individual CAVs to communicate both amongst each other and with transportation infrastructure.

[6] Michigan Tech Research Institute. Benchmarking Sensors for Vehicle Computer Vision Systems. 2019. Available from: https://www.mtu.edu/mtri/research/project-areas/transportation/sensors-platforms/benchmarking-sensors/
[7] City of London. Intelligent traffic signals. 2020-10-22. Available from: https://london.ca/living-london/roads-sidewalks-transportation/traffic-management/intelligent-traffic-signals

Figure 3: Sensors for Vehicle Computer Vision Systems[8]



1.2.1 TELEMATICS

Telematics refers to telecommunications, sensors, and instruments technology which allow for the sending, receiving, and storing of information to provide driver information and control vehicles on the move. Vehicle-to-Vehicle (V2V) technology allows for the wireless exchange of information about a vehicle's speed and position with surrounding vehicles, helping to avoid crashes and manage traffic congestion[9]. Vehicle-to-Infrastructure (V2I) and Vehicle-to-Everything (V2X) technology uses wireless technology to broadcast and receive information and messages about upcoming road conditions, construction zones, traffic lights, weather, emergency alerts, and more.

[8] Same as previous.
[9] National Highway Traffic Safety Administration. Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application. 2014-08. Available from: https://www.nhtsa.gov/sites/nhtsa.gov/files/readiness-of-v2v-technology-for-application-812014.pdf

There are currently two major communication technologies that make this possible[10]:

- **Dedicated short-range communications (DSRC)** is a wireless communication technology enabling vehicles to communicate with each other and other road users directly, without involving cellular or other infrastructure. Every vehicle broadcasts its location, heading and speed securely and anonymously ten times per second. All surrounding vehicles receive the message, and each estimates the risk imposed by the transmitting vehicle[11]. Similarly, nearby infrastructure (e.g. traffic signals) could communicate with CAVs using these DSRC messages.

- **Cellular V2X (C-V2X)** technology uses mobile networks provided by private carriers just like mobile phones. While cellular communications do not consistently provide high enough transmission speeds required for critical safety applications, they can carry longer-range communications for data transfers to support some mobility and environmental applications, along with supporting data collected and disseminated by transportation agencies, such as traffic and pavement data. The next iteration of cellular V2X technology is 5G communication – which brings promise of greater interoperability, wider bandwidth, increased cybersecurity, and a decentralized network that runs on private cell towers[12].

There is still uncertainty around precisely which wireless communication protocols will be widely adopted, perhaps both DSRC and C-V2X may ultimately completement each other rather than compete. However, the vision of CAVs connected using both V2V and V2I technologies that maximize the safety and efficiency of trips is powerful. Together, telematics technologies could make urban mobility networks more connected and responsive than ever.

[10] USDOT. Connected Vehicle Impacts on Transportation Planning. 2016-06. Available from: https://www.itskrs.its.dot.gov/its/benecost.nsf/ID/6367c692a4c49b85852583a90062c6fe
[11] Autotalks. DSRC technology. 2021. Available from: https://auto-talks.com/technology/dsrc-technology/
[12] Wassom B. DSRC vs. 5GLTE: Which will it be for Connected Vehicles? WardsAuto. 2018. Available from: https://www.wardsauto.com/industry-voices/dsrc-vs-5glte-which-will-it-be-connected-vehicles

1.2.2 DATA COLLECTION AND ANALYSIS

A vehicle equipped with sensors, communication technology, and computing power is a mobile “big data” collecting machine. Big data has five main characteristics, collectively known as the “5 Vs”:

- **Volume:** There are vast numbers of individual data points generated every second;
- **Velocity:** Data entering the system and moving around in both real-time or near-real-time;
- **Variety:** Data about many different objects, individuals, and conditions in numerous formats (e.g. text, audio, picture, video, etc.);
- **Veracity/Validity:** Data quality, credibility of the data source, or trustworthiness; and
- **Value:** Data value that the City can provide to users or vice-versa.

In the case of CAVs, this data is generated from inputs that are both inside and outside the vehicle. Outside the vehicle involves: data on congestion, road safety, street and curbside usage, travel demand, air quality, noise, and more. Inside the vehicle collects data about its own performance, as well as its passengers’ movements and activities – which raises new and unique considerations about data privacy and usage.

This data is mobilized in a variety of ways, such as through data analysis, modelling, visualization, and mapping. For example, instead of a simple count of on-street parking space inventory, location data broadcast by CAVs could allow for the visualization of real-time, historical, and anticipated pickup and drop-off patterns throughout the day, week-to-week, and seasonally, and for all points on a network. Better predicting demand could allow for more efficient management of transportation infrastructure.

As driving automation technology becomes more common on new vehicles, the large amounts of data generated could be valuable not only for improving the vehicle’s operation, but also for gaining more profound insights into urban conditions and helping decision-makers develop evidence-based policy, also known as data-driven decision making[13].

[13] Bloomberg Philanthropies, Aspen Institute. Taming the Autonomous Vehicle: A Primer for Cities. 2017-03. Available from: https://www.planning.org/knowledgebase/resource/9137796/

With the advent of machine learning and artificial intelligence, algorithmically governed systems will be able to continually tweak and optimize themselves without any human intervention. However, this automation creates both opportunities and risks. On the one hand, it can reduce human error, reduce costs, increase productivity, and create openings for new services and products. On the other hand, depending on the quality of data and assumptions used to train the algorithms, automation can increase human error and bias in data outputs.

1.3 ELECTRIC VEHICLE TECHNOLOGIES

While not a central feature of the Connected and Automated Vehicle Plan, electrical vehicle (EV) technologies are worth noting as CAVs could be a potential catalyst for transitioning away from fossil fuels (e.g. through Tesla or similar types of vehicles). The City's recent Climate Emergency Action Plan (CEAP) includes a CAV action item to discourage zero-occupancy use, encourage shared ownership and service models, complements London's public transportation system, prioritizes active transportation road users' safety, and uses zero-emission vehicles[14].

The extent to which CAVs are zero-emissions will in part depend on the extent to which CAVs are shared or fleet vehicles. Ride-hailing and transit vehicles typically drive significantly more kilometres per year than the average vehicle. For this reason, converting fleets to low or zero-emission technologies is essential for maximizing the economic and environmental returns on investment[15]. Passenger and freight CAVs – if powered by low or zero-emission technologies – could significantly reduce GHG emissions and critical air pollutants associated with transportation[16].

Despite this, EVs currently come with challenges including a higher upfront cost for consumers and a lack of charging infrastructure in the public and private domain. Beyond a certain point, the power grid could have further upstream impacts, depending upon how the electricity is generated and how innovation in electricity storage proceeds.

[14] City of London. Climate Emergency Action Plan. A-31. 2022-04. Available from: https://getinvolved.london.ca/climate
[15] Peter Slowik, Pavlenko N, Lutsey N. Emerging Policy Approaches to Electrify Ridehailing in the United States. International Council on Clean Transportation. 2019. Available from:
[16] Bloomberg Philanthropies, Aspen Institute. Taming the Autonomous Vehicle: A Primer for Cities. 2017-03. Available from: https://www.planning.org/knowledgebase/resource/9137796/

Furthermore, CAVs may increase commuter tolerance for longer commutes – as they could watch entertainment or even sleep while the vehicle drives itself. This could lead to energy-intensive urban sprawl, offsetting potential environmental benefits from the vehicles themselves[17]. Additionally, waste streams arising from the disposal of rare-earth minerals used in electric motors and especially lithium-ion batteries may pose new waste management challenges[18].

[17] Same as previous.
[18] Taiebat M, Brown AL, Safford HR, Qu S, Xu M. A review on energy, environmental, and sustainability implications of connected and automated vehicles. Environ Sci Technol. 2018;52(20):11449–65.

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2 THE ARRIVAL, CHALLENGES, AND OPPORTUNITIES OF CAVS

It is anticipated that CAVs will be widely available and market-ready in the coming decades with some lower-level automation vehicles already on the market and in use today (i.e. SAE Levels 1 and 2). Despite all the activity around CAVs, there is still uncertainty around how and when CAV technology at higher levels will be launched (i.e. SAE Levels 3, 4, and 5), and if CAVs will live up to the hype.

2.1 KEY DEVELOPMENT FACTORS

There is uncertainty in the key development factors of CAV technologies from several sources including:

- **Technological factors** may include vehicle performance, security, and infrastructure requirements;
- **Policy factors** may consist of infrastructure investments, liability, allocation of right-of-way, and incentive programs;
- **Economic factors** may include scalability of commercial deployment, changes in the cost of materials and energy, and business case impacts from new regulations and competing innovators; and
- **Human factors** may consist of personal comfort levels with riding in a CAV, willingness to share rides with other passengers, ability to adapt driving skills when both conventional vehicles and CAVs share the road, and individual willingness to share data.

While fully autonomous vehicles (i.e. SAE Levels 4 and 5) are already being tested and in some cases deployed (such as Waymo ride-hailing in Phoenix, Arizona[19]), a 2021 study published last year in AI and Ethics reported that 74% of survey respondents said they do not trust CAVs nor believe CAVs can perform better than a normal driver[20]. The interactions between these factors will affect when highly automated vehicles are launched in the market, how much of the driving task the CAV will perform, the rate of

[19] Waymo. Waymo One. 2022. Available from: https://waymo.com/waymo-one/
[20] Smart Cities Dive. These 3 technologies could make self-driving cars safer. 2022-05-11. Available from: https://www.smartcitiesdive.com/news/av-technologies-self-driving-car-safety/623471/

CAV adoption, cost of CAV technology, and the split between different transportation modes[21].

Recent reports and analyses exploring the impacts of CAVs and their implications for transportation planning have investigated how quickly such vehicles are likely to be deployed based on[22]:

- The previous emergence of vehicle technologies;
- Likely costs and benefits;
- How they will affect travel activity; and
- Their impacts on road, parking, and public transit planning.

This indicates that SAE Level 5 CAVs, able to operate without a driver, may be commercially available and legal to use in some jurisdictions by the late 2020s, but will initially have high costs and limited performance. Some benefits, such as independent mobility for affluent non-drivers, may begin in the 2030s but most impacts, including reduced traffic and parking congestion, independent mobility for low-income people (and therefore reduced need for public transit), increased safety, energy conservation and pollution reductions, will only be significant when CAVs become common and affordable, probably in the 2040s to 2060s, and some benefits may require dedicated CAV lanes, which raises social equity concerns[23].

It has been suggested that while automakers are actively developing automated driving systems (ADS) and advanced CAV technologies are still emerging, automakers will offer limited CAV functionality within defined situations[24]. Driving automation technology exists today (i.e. SAE Levels 2 and 3) in the form of advanced driver assistance systems (ADAS) including adaptive cruise control, blind spot monitoring, forward collision warning, and lane assist.

While SAE Level 2 and 3 driving automation systems may be able to handle certain driving tasks in limited circumstances, they carry the danger that drivers will overestimate the vehicle's abilities, leading to unsafe situations. Significant improvement

[21] United States. Department of Transportation. Benefits Estimation Model for Automated Vehicle Operations: Phase Two Final Report. 2018. Available from: https://rosap.ntl.bts.gov/view/dot/34458
[22] Litman T. Autonomous Vehicle Implementation Predictions: Implications for Transport Planning. Victoria Transport Policy Institute. 2022-08-09. Available from: https://www.vtpi.org/avip.pdf
[23] See previous.
[24] Gartner. Hype Cycle for Connected Vehicles and Smart Mobility, 2018. Report No. G00356056.

will therefore be necessary before full operation of vehicles is passed from humans to artificial intelligence.

Regulatory regimes at the federal and provincial/territorial levels may also require time to ensure the safety of CAV technologies. Even if SAE Level 4 and 5 CAVs appear on the market as they are suggested to do this decade, it will still likely take decades before most vehicles on the road are capable of automated driving.

It should be noted from recent observations and experience that these timeframes are subject to change based on the progress and emergence of CAV technologies. In some cases, breakthroughs can occur quickly and have more immediate impacts whereas other CAV technical challenges continue and limit technological progress.

2.2 MAJOR DEVELOPMENT CATEGORIES

SAE Level 4 and 5 CAVs are anticipated to have the most disruptive impact on urban mobility and associated services, not just in terms of moving people, but in many other applications as well. However, these technologies are currently at different stages in their development, and some may appear on City streets before others.

Here are four major categories of CAVs currently being developed:

2.2.1 PASSENGER VEHICLES

> Passenger vehicle CAVs are smaller-scale CAVs that may resemble one or two person pods or the more familiar four to six person vehicles (i.e. similar to family cars or mini-vans). They may be personally owned, part of a shared fleet, or deployed as part of a larger ride-hailing service.

In contrast to public transit and public service vehicles – for which the timing of deployment is within the control of municipalities – the introduction of CAVs to the general passenger vehicles fleet is subject to much more uncertainty. Companies are setting targets for a “minimum viable product” which may include automated features but could be limited to certain conditions such as well-maintained highways and fair weather. These products could be available for commercial sale but will not have a significant impact on overall mobility networks[25].Anticipated timelines for CAVs are changing year-to-year based on the continuing development of the technology.

Depending upon the balance of CAV ownership models (i.e. how many are privately owned vs. how many are shared ownership), cities could experience a range of disruptive impacts to their infrastructure and built form.

For the time being, Canadian consumers will likely continue to buy cars, although at a reduced rate, as the millennial population cohort opts for a more urban, less car-focused lifestyle. This may lead to the emergence of two parallel vehicle markets: privately owned automobiles with an increasing array of automated features, and higher level CAVs deployed under a shared, on-demand model[26].

Personally Owned CAVs

In the short term, vehicle manufacturers are likely to introduce SAE Level 2-3 features (e.g. traffic congestion chauffeur, highway automated pilot, etc.) first into their premium models and later in their volume models. While SAE Level 2 has become more widely available (e.g. Tesla Autopilot, etc.) to common users over time, SAE Level 3 may not be implemented as readily given the human behaviour to over-estimate the ability of some technologies.

In this scenario, personally owned SAE Level 2-3 CAVs could enjoy market dominance for the foreseeable future until Level 4-5 CAVs are developed and consumer-ready, with sales expected to reach their peak in the mid-2030s[27]. SAE Level 2-3 CAVs could make driving more convenient and free up drivers to do other activities which could lead to longer and more frequent journeys. In this scenario, the status quo is extended – with continued urban sprawl and road congestion – and the positive transformative potential of CAVs has not yet been fully realized[28]. In contrast, this could also significantly improve safety and mobility for a subset of the population including the elderly.

[25] Eno Center for Transportation. Beyond Speculation 2.0: Automated Vehicles and Public Policy: An Update to Eno's Action Plan for Federal, State, and Local Policymakers. 2019. Available from: https://www.enotrans.org/wp-content/uploads/2019/04/4-1-AV-Paper-FINAL-with-Cover.pdf
[26] Grush B, Niles J, Baum E. Ontario Must Prepare for Vehicle Automation: Automated Vehicles Can Influence Urban Form, Congestion, and Infrastructure Delivery. Residential and Civil Construction Alliance of Ontario. 2016. Available from: https://rccao.com/research/files/RCCAO_Vehicle-Automation_OCT2016_WEB.pdf
[27] See previous.
[28] See previous.

Shared CAVs

Ridesharing services (e.g., Uber and Lyft) are making up an ever-increasing share of trips in cities around the world. However, future shared CAVs may not be restricted to company-based models, but may include neighbourhood-based sharing models, whereby one or more CAVs would be shared by multiple households in the same neighbourhood, like residential condo corporation models we see today.

A recent study prepared by the City of Toronto's Big Data Innovation Team in partnership with the University of Toronto found that due to the substantial travel time savings for most trips, ridesharing services may compete with transit, but can also fill gaps in service[29].

Shared CAV fleet companies (i.e. using SAE Level 4-5 vehicles providing either single trips back-to-back or pooled with one or more other passengers) could continue this trend, beginning to provide on-demand service in some urban areas at the same time as SAE Level 2-3 personally-owned vehicles become available in the consumer market. A study from the World Economic Forum and the Boston Consulting Group forecasts that low-cost, convenient CAV Mobility-as-a-Service (MaaS) could account for more than 40% of trips in urban areas by 2030, decreasing personal car and mass transit use by 14% each[30].

Shared CAV fleets could provide a significant return on investment as they can operate and generate revenue around the clock[31]. This business model could see substantial growth, as car ownership continues to decline and ridesharing apps like Uber and Lyft continue to gain in popularity.

Depending upon how quickly shared fleets are deployed and how comfortable people become using them, the popularity of human driven vehicles could begin to decline. With appropriate policies, SAE Level 4-5 shared CAVs could potentially drive down congestion and parking demand, as well as increase mobility choices. However, with the emergence of COVID-19, people may conversely be resistant to shared fleet use until hygienic improvements and comfort levels improve, which could well last several years.

[29] City of Toronto Big Data Innovation Team, UTTRI. The Transportation Impacts of Vehicle-for-Hire in the City of Toronto. 2019. Available from: https://www.toronto.ca/wp-content/uploads/2019/06/96c7-Report_v1.0_2019-06-21.pdf
[30] World Economic Forum and the Boston Consulting Group. Reshaping Urban Mobility with Autonomous Vehicles: Lessons from the City of Boston. 2018. Available from: https://www3.weforum.org/docs/WEF_Reshaping_Urban_Mobility_with_Autonomous_Vehicles_2018.pdf
[31] The Economist. Self-Driving Cars Will Require New Business Models. The Economist. 2018-03-01. Available from: https://www.economist.com/special-report/2018/03/01/self-driving-cars-will-require-new-business-models

In the scenario that CAVs are successful, this technology could contribute to the creation of new business and service delivery models, shifting job markets, transforming industries, altering energy consumption, and reshaping the urban form[32].

2.2.2 TRANSIT VEHICLES

> Transit vehicle CAVs are larger-scale shuttles that could hold anywhere from eight to 25 people or more and may complement more conventional public transit networks and services by providing first-and-last mile connections in lower-demand areas.

Transit vehicles with driving assistance or automation technologies could help improve the safety and efficiency of public transit service. A SAE Level 1 or 2 transit bus with Advanced Driver Assistance System (ADAS) could provide: smooth acceleration and deceleration, automatic emergency braking and pedestrian collision avoidance, curb avoidance, precision docking, narrow lane/shoulder operations, and platooning. Higher level automation packages could be deployed in maintenance and yard operations, as well as shuttle, bus rapid transit, and mobility-on-demand services[33].

CAVs could both support and challenge existing public transit systems. On one hand, a technology that could strengthen transit networks is the low-speed automated shuttle[34]. These vehicles, capable of carrying eight to 25 people at speeds of around 25-30 km/h, could provide feeder service in neighbourhoods and employment areas where higher-order transit service is impractical and providing first-and-last mile connections to major transit routes or other important destinations is a challenge[35]. Automation and platooning of shuttles could lead to a new form of bus rapid transit (BRT) with CAV buses operating on busways or high occupancy vehicle lanes[36].

On the other hand, without proper planning, other CAV services and vehicles could draw away riders from the transit system which would undermine its viability and create more

[32] Grush B, Niles J, Baum E. Ontario Must Prepare for Vehicle Automation: Automated Vehicles Can Influence Urban Form, Congestion, and Infrastructure Delivery. Residential and Civil Construction Alliance of Ontario. 2016. Available from: https://rccao.com/research/files/RCCAO_Vehicle-Automation_OCT2016_WEB.pdf

[33] U.S. Department of Transportation. Federal Transit Administration. Strategic Transit Automation Research Plan. 2018-01. Available from: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114661/strategic-transit-automation-research-report-no-0116_0.pdf

[34] National League of Cities Center for City Solutions. Autonomous Vehicles: Future Scenarios – Weaving a Microtransit Mesh. 2018. Available from: http://avfutures.nlc.org/sustainability

[35] Cregger J, Dawes M, Fischer S, Lowenthal C, Machek E, David Perlman. Low-Speed Automated Shuttles: State of the Practice Final Report. U.S. Department of Transportation. 2018. Available from: https://rosap.ntl.bts.gov/view/dot/37060/dot_37060_DS1.pdf

[36] National Association for City Transportation Officials. Blueprint for Autonomous Urbanism. 2017. Available from: https://nacto.org/publication/bau2/

congestion. In a Toronto area study[37], it was found that increased subway ridership was associated with higher first-and-last mile ride-hailing trips to and from subway stations while "feeder" surface transit ridership declined along corridors where ride-hailing trips increased.

2.2.3 GOODS MOVEMENT, DELIVERY, AND FREIGHT VEHICLES

> On the distribution and long-haul side of CAVs, semi-trucks are being tested to follow one another in platoons (nearly bumper-to-bumper) in a line resembling a train. The close spacing reduces air-drag friction, lowers fuel consumption (and therefore lowers GHG emissions and air pollution), and allows goods to be transported more efficiently. For delivery and short-haul, smaller vehicles could travel on sidewalks, campuses, or indoor commercial spaces, delivering everything from packages to restaurant take-out deliveries right to customers' doors.

CAVs could significantly change how goods are moved between and within cities. CAVs may be a tool for responding to overlapping trends in the goods movement sector that are presenting challenges for the industry: the emergence of crowd shipping; a driver labour shortage, particularly for long-haul operations; increasing congestion, particularly in dense urban environments; increasing volumes of goods to be shipped; and changing consumer behaviour, including a rapid shift to e-commerce and pressure for just-in-time deliveries[38][39]. Since fuel costs represent a significant portion of the cost to deliver goods, any opportunities to reduce fuel use will also be of interest to the industry.

Long-haul tractor-trailers are expected to be among the first vehicles to use CAV technology on a large scale on public roads and are already being tested by various companies in the United States and Europe. Long-haul CAV tractor-trailers could potentially drive in platoons (i.e. like a train) with the driver acting as a "chaperone" rather than a dedicated driver and operator using V2V systems such as cooperative adaptive cruise control. Eventually, the platoons could travel without on-site human involvement through remote monitoring. CAV technology could enable freight services to increase productivity, from 13 hours per day of driving time (the current daily limit for

[37] City of Toronto Big Data Innovation Team, UTTRI. The Transportation Impacts of Vehicle-for-Hire in the City of Toronto. 2019. Available from: https://www.toronto.ca/wp-content/uploads/2019/06/96c7-Report_v1.0_2019-06-21.pdf
[38] Wiginton L, Smith C, Ewing M, Batista G. Fuel Savings and Emissions Reductions in Heavy-Duty Trucking: A blueprint for further action in Canada. 2019. Available from: https://www.pembina.org/reports/freightclimateblueprints.pdf
[39] Lee J, Kim C, Wiginton L. Delivering Last-Mile Solutions: A feasibility analysis of microhubs and cyclelogistics in the GTHA [Internet]. 2019. Available from: https://www.pembina.org/reports/delivering-last-mile-solutions-june-2019.pdf

a human driver in Ontario) to 20 hours with CAVs[40]. However, platooning may also introduce other safety and operational challenges for other non-commercial vehicles and best practices will likely need to be developed and regulated.

On a smaller scale, delivery robots are being designed to travel on sidewalks or in other public and private environments, delivering items such as packages and restaurant takeout deliveries right to customers' front doors. In the United States, companies like Amazon, FedEx, Domino's, and others are actively piloting this technology as a way of reducing costs and increasing convenience for customers[41]. However, consideration will need to be given to pedestrian safety and the impacts of such small-scale CAV technologies sharing sidewalks with pedestrians and vulnerable road users.

2.2.4 PUBLIC SERVICE VEHICLES

> Different levels of automation are being tested in public service vehicles such as waste collection trucks and snowplows to help improve their efficiency and safety.

CAV technologies are being developed not only for the passenger and freight sectors, but also for the delivery of public services. Many companies are exploring how automation can contribute to improved traffic safety, worker conditions, efficiency, and a lower environmental impact. For example, self-driving street cleaning vehicles are being developed internationally that can automatically trace and pick up garbage, as well as trim roadside bushes, while sensing and monitoring the vehicle's vicinity to avoid people and obstacles in its path. These technologies can also be mass produced allowing for significant cost savings in service delivery[42].

CAV features are being tested in numerous types of service vehicles to help improve their efficiency and safety. Waste collection trucks could automatically travel their routes, lifting and emptying bins, and reducing the risk of occupational injuries in workers[43]. CAV snowplows – already being tested at some airports – could be deployed quickly after a major snowfall to clear streets and sidewalks[44].

[40] Ticoll D. Driving Changes: Automated Vehicles in Toronto. Munk School of Global Affairs. University of Toronto. 2015-10-15. Available from: https://munkschool.utoronto.ca/ipl/files/2016/03/Driving-Changes-Ticoll-2015.pdf
[41] Wong JC. Delivery robots: a revolutionary step or sidewalk-clogging nightmare? The Guardian. 2017-04-12. Available from: https://www.theguardian.com/technology/2017/apr/12/delivery-robots-doordash-yelp-sidewalk-problems
[42] Xinhua. Chinese firm develops self-driving street cleaning vehicles. ChinaDaily. 2018-04-27. Available from: http://www.chinadaily.com.cn/a/201804/27/WS5ae2b5e4a3105cdcf651aeb2.html
[43] Volvo Group. Volvo pioneers autonomous, self-driving refuse truck in the urban environment. 2017-05-17.
[44] Mogg T. Daimler aims to bring its self-driving snowplows to airports. Digital Trends. 2017-10-19. Available from: https://www.digitaltrends.com/cars/snowplows-driverless-daimler/

Since many services provided by the City occur along fixed routes (e.g. snow clearing, street cleaning, waste and recycling collection, etc.), there could be an opportunity to deploy non-passenger CAVs to supplement the existing suite of City services. Automating service vehicles to improve the safety and efficiency of public service delivery could consist of just automating certain driving functions or deploying full CAV solutions. For example, the City of Toronto has engaged in initiatives such as the Autonomous Snowplow Competition[45] and the Micro Utility Devices challenge[46].

Learning from the Past

Throughout history, successive transportation innovations have enabled humans to reach more places faster. While CAVs could represent the newest wave, it is worthwhile to look back at the lessons learned from the last time North American cities underwent such a transformation: the transition from horse-drawn carriage to the automobile.

The horse dominated nineteenth century urban and rural life in North America and Europe[47]. However, by the end of the nineteenth century new transportation options appeared on the scene and the transition away from the horse began.

Parallel developments in steam power, electricity, and the internal combustion engine led to a "widening up" of new mobility options – the bicycle, omnibus, horse-drawn streetcar, electric streetcar, cable car, railway, steam-powered car, electric car, and the automobile[48].

Of course, not all these options lasted. Public hygiene issues associated with horses, namely manure and carcasses contributed to their decline.

[45] Institute of Navigation. 2019 Autonomous Snowplow Competition. 2019. Available from: https://autosnowplow.com/2019_Event_and_Results.html
[46] City of Toronto. Transportation Innovation Challenge: Micro Utility Devices. 2022. Available from: https://www.toronto.ca/wp-content/uploads/2022/03/8c9b-TSTransportation-Innovation-Challenge.pdf
[47] Nikiforuk A. The Big Shift Last Time: From Horse Dung to Car Smog. The Tyee. 2013-03-06. Available from: https://thetyee.ca/News/2013/03/06/Horse-Dung-Big-Shift/
[48] Dr. Ir. F. W. Geels. The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). Technology Analysis & Strategic Management. 17:4, 445-476. DOI: 10.1080/09537320500357319. 2005.

Figure 4: Talbot Street, north of King Street, circa 1900

Image Source: Western University Archives

Electric streetcar systems were widespread across North America for a time – fostering tremendous growth in “streetcar suburbs” like the neighbourhoods of Springbank, Old North, Wortley Village, and Old East Village – before these lines were largely torn up in favour of new bus fleets.

Early automobiles were specialty items, used only by innovators, the wealthy, racers, and hobbyists, as well as military applications. While the introduction of the Model T Ford made the automobile widely accessible, broader social and scientific developments over the span of about 100 years (1830s to 1930s) played roles in advancing and accelerating the transition to the automobile.

As the complex infrastructure that had developed around the horse-based economy began to decline, a new infrastructure emerged, enhancing the benefit of the automobile. Early barriers, such as buying fuel in cans from pharmacies and cars that required repair on route, were overcome with innovation and development of support networks. New professions and business models began to emerge including mechanics, traffic engineers, parking garages, gas stations, car washes, and taxi companies[49].

Based on historical experience, here is what might be expected with regards to CAVs:

- While there may be an initial explosion in new technologies, not all options in the current mobility marketplace will last.
- Early regulation will be focused on ensuring the safety and effectiveness of CAVs, until the public is sufficiently comfortable with them.
- Later, the regulatory focus will likely shift to removing restrictions and supporting CAVs in reaching their full potential, which could mean restricting older technologies, such as human-operated vehicles.
- Infrastructure lasts for a long time so future-proofing it is essential to avoid a state of technological lock-in.
- The evolution of safety, standards, and formats will be a gradual, iterative process.
- There will be unanticipated uses of CAVs, resulting in unintended consequences (e.g. the development of the drive-through for automobiles).
- The full potential of the technology will not be realized in a mixed environment. CAVs, like conventional automobiles, may require segregation and purpose-built infrastructure to maximize their benefit.

Eventually, everything from what streets look like to how traffic is managed to the types of vehicles used for transporting people and goods may change dramatically, like the early-1900s.

[49] Smith B, Browne CA. The Day the Horse Lost its Job. Microsoft Today in Technology. 2017-12. Available from: https://blogs.microsoft.com/today-in-tech/day-horse-lost-job/

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3 LONDON'S LOCAL AND REGIONAL CONTEXT

London's local and regional context includes entities that support the development of both connected infrastructure and automated vehicles as this technology continues to emerge in the coming decades. **Table 1** below lists a scan of some of the CAV key stakeholders within London's local and regional context but is not an exhaustive list and subject to change. The subsections herein further expand upon some of these key stakeholders.

3.1 GOVERNMENT

In Canada, the regulation of vehicles and road safety is a shared responsibility among all levels of government. Transport Canada establishes safety regulations for the manufacturing, importation, and shipment of motor vehicles and motor vehicle equipment through the Motor Vehicle Safety Act (MVSA)[50]. The provinces and territories are responsible for the licensing of drivers, vehicle registration and insurance, and regulation for the safe operation of vehicles on public roads. For the Province of Ontario, these regulations fall under the Highway Traffic Act[51].

Transport Canada's Guidelines for Trial Organizations encourages those who are testing CAVs in Canada to engage with municipal and provincial authorities regarding local traffic laws, infrastructure, safety considerations, and preparations for local emergency services[52]. Despite the distinct roles and responsibilities of each level of government, all jurisdictions are encouraged to work together to ensure that there is continued learning and knowledge transfer throughout the development of this technology for its safe testing and deployment.

As illustrated in **Table 2** below, the roles and responsibilities of the various levels of government in Canada are broken down as they are related to CAV technologies. Further, while classified under specific sections, it should be noted that through funding,

[50] Government of Canada. Motor Vehicle Safety Act. Consolidated as of 2022-08-08. Available from: https://laws-lois.justice.gc.ca/eng/acts/m-10.01/
[51] Government of Ontario. Highway Traffic Act. Consolidated as of 2022.07-01. Available from: https://www.ontario.ca/laws/statute/90h08
[52] Transport Canada. Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations. 2021-08-06. Available from: https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles/guidelines-testing-automated-driving-systems-canada

partnerships, collaborations, etc. between both public and private entities, there is a lot of “blurring the lines” between these various stakeholders.

Table 1: Key Stakeholders in London’s Local and Regional Context[53]

Government	• City of London • ESCRYPT • London Transit Commission • Middlesex-London Health Unit (MLHU) • Ministry of Transportation Ontario (MTO) • Transport Canada
Academia and Research	• Fanshawe College • National Research Council (NRC) Canada • Western University
Economic Development, Entrepreneurial Accelerators, and Industry	• Canadian Automated Vehicles Centre of Excellence (CAVCOE) • Canadian Urban Transit Research and Innovation Consortium (CUTRIC) • London Chamber of Commerce • London Economic Development Corporation (LEDC) • MaRS Discovery District • Municipal Alliance for Connected and Autonomous Vehicles in Ontario (MACAVO) • Ontario Centre of Innovation (OCI) • Ontario Vehicle Innovation Network (OVIN) • TechAlliance

[53] OVIN. Ecosystem Map. 2022. Available from: https://www.ovinhub.ca/ecosystem-map/

Table 2: Levels of Government and Respective Responsibilities[54]

Federal Government	• Setting and enforcing motor vehicle safety standards for new or imported motor vehicles and motor vehicle equipment. • Investigating and managing the recall and remedy of non-compliances and safety-related motor vehicle defects nationwide. • Public education on motor vehicle safety issues. • Monitoring and developing rules on privacy and cybersecurity. • Setting and enforcing compliance with technical standards related to wireless technologies integrated into vehicles and roadside infrastructure. • Relevant legislation including the Motor Vehicle Safety Act.
Provincial and Territorial Governments	• Testing and licensing human drivers and registering motor vehicles in their jurisdictions. • Enacting and enforcing traffic laws, regulations, and trials. • Conducting safety inspections. • Regulating motor vehicle insurance and liability. • Planning for future transportation projects (e.g., highway management, transit, etc.). • The development, adaption, and use of provincially owned infrastructure to support CAV deployment. • Public education on motor vehicle safety. • Relevant legislation including the Highway Traffic Act.

[54] Council of Ministers Responsible for Transportation and Highway Safety. Automated and Connected Vehicles Policy Framework for Canada: Report of the PPSC Working Group on Connected and Automated Vehicles. 2019-01-21. Available from: https://www.comt.ca/Reports/AVCV%20Policy%20Framework%202019.pdf

Municipal Governments	• The creation and enforcement of by-laws on vehicle movement. • Enforcing traffic laws and regulations. • The development, adaption, and use of infrastructure to support CAV deployment. • Public education on motor vehicle safety. • Transportation planning, operations, and managing passenger transportation including public transit. • Regulation or delivery of passenger transportation in the form of transit, taxis, and ride-hailing services. • Managing and creating new logistics for traffic control and parking enforcement. • Policies to integrate transportation with land use. • Relevant legislation including the Municipal Act, 2001.

3.1.1 CAV TESTING IN ONTARIO

In 2016, Ontario was the first province in Canada to launch a pilot program to allow the testing of CAVs on its roads. This 10-year program allowed for eligible participants (i.e. auto manufacturers, technology companies, academic and research institutions, and parts manufacturers) to apply for a permit to test SAE Level 3, 4 and 5 automated vehicles under strict requirements outlined in MTO's Regulation 306/15: Pilot Project – Automated Vehicles of the Highway Traffic Act[55].

As of the last update in 2019, changes to the pilot program included:

1) Allowing for driverless CAVs under certain testing conditions.
2) Allowing for cooperative truck platoons under certain testing conditions.

[55] Ministry of Transportation Ontario. Automated Vehicle Pilot Program. Updated 2022-04-06. Available from: https://www.ontario.ca/page/automated-vehicle-pilot-program

Select key requirements for participants testing driverless testing of SAE Level 4 and 5 CAVs under the pilot program include[56]:

- Declaring that the technology is safe and effective based on previous testing and testers may be asked for proof of this.
- Accepting full liability.
- Informing the MTO of the environment and limits the CAV is designed to work in (i.e. its operational design parameters).
- Being able to monitor and control the vehicle if required.
- Being able to bring the CAV to a safe stop if necessary and explain how a safe stop will be done.
- Placing a copy of the signed approval form in a visible place in the CAV and keep a copy with the remote operator.
- Providing a "work zone and first responders' interaction plan" to affected authorities, such as law enforcement and municipalities, that explains how the CAV will interact with emergency responders and construction zones.
- Informing affected municipalities where the testing will happen.
- Having signage on the vehicle clearly showing that it is a CAV being tested.

Given the Province of Ontario's roles and responsibilities as listed in **Table 2**, it is important to highlight the importance of the City of London to proactively prepare for CAV technologies on our infrastructure.

[56] Ministry of Transportation Ontario. Automated Vehicle Pilot Program. Updated 2022-04-06. Available from: https://www.ontario.ca/page/automated-vehicle-pilot-program

3.1.2 PROVINCIAL SUPPORTS

The Ministry of Transportation of Ontario is also leading a CAV readiness initiative with funding from Transport Canada. This initiative brings together government and other stakeholders to facilitate capacity building within the Greater Toronto and Hamilton Area (GTHA) and Kitchener-Waterloo corridor and to establish a common and consistent planning horizon and framework for CAVs. Metrolinx, the Region of Peel, the City of Toronto, and WSP are partners in this initiative including the recent development of a CAV Readiness Plan[57].

As part of this plan, Detailed CAV Program Sheets[58] were developed that included scope for regional government involvement in the preparation for CAV technologies. The City of London will likely benefit from the lessons learned through these partnerships and reports prepared by other key implementation areas within Ontario and Canada such as the GTHA and the Ottawa Area that we can apply locally and in our own region.

Further, the CAV Readiness Plan and Detailed CAV Program Sheets may be a useful resource in the development of the City of London's future Implementation Plan for CAVs.

3.1.3 FEDERAL SUPPORTS

The federal government through Transport Canada has similarly made some significant investments in CAVs including $2.9 million through the Advance Connectivity and Automation in the Transportation System (ACATS) program over the 2018-2019 period. The Program aimed to prepare the country for wider use of CAVs on roads through[59]:

- Research, studies, and technology evaluations;
- The development of codes, standards, and guidance materials; and
- Capacity-building and knowledge-sharing activities.

[57] Ministry of Transportation Ontario. CAV Readiness Plan. 2020-04-03. Available from: https://www.ovinhub.ca/wp-content/uploads/2020/05/CAV-Readiness-Plan-Final-Report-2020-04-03-1.pdf
[58] Same as previous.
[59] Transport Canada. Program to Advance Connectivity and Automation in the Transportation System. 2019. Available from: https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles/projects-funded-program-advance-connectivity-automation-transportation-system

Fifteen projects were funded from a variety of partners through ACATS, including: the City of Toronto, the Canadian Automobile Association, the Canadian National Institute for the Blind, the City of Calgary, the City of Vancouver, the Intelligent Transportation System Society of Canada, and the Ministry of Transportation Ontario amongst others[60].

In addition to the funding provided by the federal government, Innovation, Science and Economic Development Canada (ISED) and Transport Canada have established five Vehicle of the Future Advisory Groups to engage experts on issues associated with CAVs and inform a whole-of-government approach for this technology. These advisory groups address topics including safety, innovation, competitiveness, and data privacy and security. Transport Canada, the Standing Senate Committee on Transport and Communications, and the Canadian Council of Motor Transport Administrators have also released a series of guidelines and policy documents for the safe testing and deployment of automated vehicles in Canada including:

- **Driving Change: Technology and the future of the automated vehicle** that outlines the regulatory and technical issues related to the deployment of CAVs[61].
- **Canadian Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles** that provides a series of considerations and recommendations that support Canadian jurisdictions in their planning and rollout of CAVs[62].
- **Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations** that highlights Canada as a destination for research and development, clarifies the role of each level of government for CAV trials, and establishes minimum safety requirements for trial organizations operating in Canada[63].

[60] Same as previous.
[61] Canada. Parliament. Senate. Standing Committee on Transport and Communications. Driving Change: Technology and the Future of the Automated Vehicle. 2018. P.29. Available from: https://sencanada.ca/content/sen/committee/421/TRCM/Reports/COM_RPT_TRCM_AutomatedVehicles_e.pdf
[62] CCMTA. Canadian Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles. 2018-06. Available from: https://ccmta.ca/web/default/files/PDF/CCMTA-AVGuidelines-sm.pdf
[63] Transport Canada. Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations [Internet]. 2018-06. Available from: https://tc.canada.ca/sites/default/files/migrated/19_ah_01_automated_vehicles_layout_en_r13.pdf

- **Safety Assessment for Automated Driving Systems in Canada** that is a voluntary tool to help CAV developers review safety of vehicles equipped with SAE Levels 3-5 features which they intend to manufacture, import, operate, and/or sell in Canada[64].
- **Canada's Safety Framework for Automated and Connected Vehicles** that informs stakeholders of Transport Canada's safety-focused approach to CAVs and sets a stable policy direction for safe deployment on Canada's roads[65].

Further, Transport Canada is leading the way to enhance the privacy and security of CAVs through a 2019 contract award to ESCRYPT valued up to $1.3 million to advance the development of a Canadian Security Credential Management System (SCMS) for CAVs[66].

The ESCRYPT project with Transport Canada sees connected infrastructure and vehicles as a means to improve the safety and efficiency of road transportation by enabling vehicles to communicate with smart infrastructure (e.g. traffic signals, rail crossings, traffic signs, etc.) and other road users (e.g. pedestrians, motorcyclists, cyclists, etc.) in a secure manner.

Potential applications of the SCMS include:

- Traffic signal priority for emergency response vehicles, like ambulances, police, and fire trucks.
- Real-time road condition advisories to warn drivers about potential hazards, like slippery surfaces, accidents, or construction.
- Warnings to advise commercial truck drivers about bicyclists, pedestrians, and motorcyclists.

The SCMS will help ensure that communications are secure and can be trusted. The SCMS incorporates privacy-by-design principles and enables communication without revealing personal information about the vehicle or the driver.

[64] Transport Canada. Safety Assessment for Automated Driving Systems in Canada. 2019-01. Available from: https://publications.gc.ca/collections/collection_2019/tc/T86-52-2018-eng.pdf
[65] Transport Canada. Canada's Safety Framework for Automated and Connected Vehicles. 2019-02. Available from: https://tc.canada.ca/sites/default/files/2020-05/tc_safety_framework_for_acv-s.pdf
[66] Transport Canada. Transport Canada awards contract to ESCRYPT to enhance the privacy and security of connected vehicles. 2019-03-14. Available from: https://www.canada.ca/en/transport-canada/news/2019/03/transport-canada-awards-contract-to-escrypt-to-enhance-the-privacy-and-security-of-connected-vehicles.html

As part of the contract, ESCRYPT is responsible for developing Canadian requirements for the system and recommending an operational model for how the technology may be deployed in Canada.

3.2 ACADEMIA AND RESEARCH

Southern Ontario is home to a wide range of developments in the CAV technology space. Networks among industry, local governments, academic institutions, and research organizations have created an environment in which to learn from one another and grow the next generation of advanced vehicle technologies and services. This network provides an opportunity for the City of London to support and help foster an area that can contribute lessons learned to the successful deployment of CAV technology.

3.2.1 FANSHAWE COLLEGE

Fanshawe College has comprehensive programs serving the greater London region by providing flexible learning arrangements and experiential education opportunities developed in response to labour market needs including the automotive industry[67]. In addition to their more conventional programs, Fanshawe College has other assets to help support the emergence of CAV technologies in cooperation with industry.

Fanshawe College has product testing areas using leading-edge technologies and equipment to help manufacturers discover problems early in the design cycle, which help prevent potential field issues. The creation of realistic, custom test protocols based on the application enables better predictions of product behaviour versus more traditional "test to failure" protocols. Designs are reviewed based on test results and recommendations made for areas of product improvement to ensure product quality[68]. Product testing areas include performance, thermal, mechanical, electrical, and environmental testing regiments.

[67] Fanshawe College. About Fanshawe. 2022. Available from: https://www.fanshawec.ca/about-fanshawe
[68] Fanshawe College. Product Testing. 2022. Available from: https://www.fanshawec.ca/cts/partners/product-testing

In additional, Fanshawe College has an entrepreneur centre, known as Leap Junction. Leap Junction provides services including the following[69]:

- Support start-ups with one-on-one business analysis and mentorship.
- Create and host entrepreneurial-focused workshops, pitch competitions, retail opportunities, and events geared towards networking and skill development.
- Provide co-working space and meeting rooms for clients.
- Act as a link for students and youth to access investors, industry, and other stakeholders in London.
- Integrate entrepreneurial activities into the local community and work with a vibrant ecosystem that supports local entrepreneurs.
- Summer incubator which provides seed funding, mentorship, programming, and co-working space.

3.2.2 NATIONAL RESEARCH COUNCIL (NRC) CANADA

The National Research Council (NRC) has a major research facility located here in London, Ontario and is, in part, engaged in Intelligent Mobility Research. Research activities include advanced driver assistance systems (ADAS), simulation and testing of automated driving hardware and software, 3D simultaneous localization and mapping, and image data classification. Intelligent Transportation System (ITS) research themes primarily focus on connected infrastructure including cybersecurity for vehicles and critical infrastructure, “smart” roads and corridors, Internet-of-Things (IoT) for transportation using V2X technologies, and intelligent systems for the movement of people and goods.

3.2.3 WESTERN UNIVERSITY

Western University is the local, major university within the London area and boasts several research and program areas related to CAV technologies that could be leveraged as CAVs emerge.

[69] Leap Junction. What is Leap Junction? 2022. Available from: https://www.leapjunction.ca/about-leap-junction

These include various relevant departments and research centres such as[70]:

- Fraunhofer Project Centre;
- Institute for Chemicals and Fuels from Alternative Sources (ICFAR);
- Particle Technology Research Centre; and
- Surface Science Western.

Further, Western University has automotive and mobility focus areas and capabilities such as[71]:

- Information engineering research and training;
- Wireless networks and cooperative communications;
- Modern data analysis and processing;
- Cybersecurity;
- Lightweight composite materials development and testing;
- Automotive paint properties, defects, and adherence;
- Advanced coatings and powders;
- Corrosion prevention and modelling; and
- Fuel cells and lithium-ion batteries.

[70] OVIN. Ecosystem Map. 2022. Available from: https://www.ovinhub.ca/ecosystem/ecosystem-map/
[71] Same as previous.

3.3 ECONOMIC DEVELOPMENT, ENTREPRENEURIAL ACCELERATORS, AND INDUSTRY

The development of CAV technology is generally occurring within three different groups of industry entities:

- **Original Equipment Manufacturers (OEMs)** including large automobile manufacturers and part suppliers;
- **New entrants and non-OEM companies** developing their own suite of CAV technology to design vehicles for deployment in a fleet context; and
- **Technology, telecommunications, and logistics companies** such as Amazon, Apple, Google, and others.

These efforts by OEMs, non-OEMs, technology, logistics firms, etc. represent an investment shift within the automotive industry to a focus more on software and services.

Although essential sensor hardware has decreased in cost, CAV technology is still relatively costly for individual consumers and is unlikely to see mass commercialization in the near term. Some companies have already begun to reposition themselves as mobility providers by making large investments and laying the groundwork for developing – and eventually deploying – their own CAV fleets.

Further, economic development organizations and entrepreneurial accelerators play key roles in supporting new industry players to develop a variety of CAV technologies.

3.3.1 ONTARIO VEHICLE INNOVATION NETWORK (OVIN)

The Ontario Vehicle Innovation Network (OVIN) is a Government of Ontario initiative, delivered through the Ontario Centre of Innovation (OCI). A key aspect of Ontario's automation plan, OVIN works to support subject matter experts, post-secondary institutions, and other industry stakeholders to commercialize new products and services in the automotive and transportation sector and support Ontario's readiness for the adoption and deployment of these technologies[72].

OVIN is comprised of funding programs, technology development sites, and a technology demonstration zone in Stratford, Ontario where CAV companies can test,

[72] WSP. Ontario CAV Ecosystem Analysis. 2019-04. Available from: https://www.ovinhub.ca/wp-content/uploads/2021/04/avin-ecosystem-analysis-final-report-2019.pdf

validate, and showcase their products. The technology development sites enable small and medium sized enterprises to develop, prototype, and validate new technologies, access specialized equipment (i.e. hardware and software), and obtain business and technical advice.

There are six OVIN technology development sites across Ontario (see **Figure 5**) to support the development of new technologies in their own unique area of focus[73]:

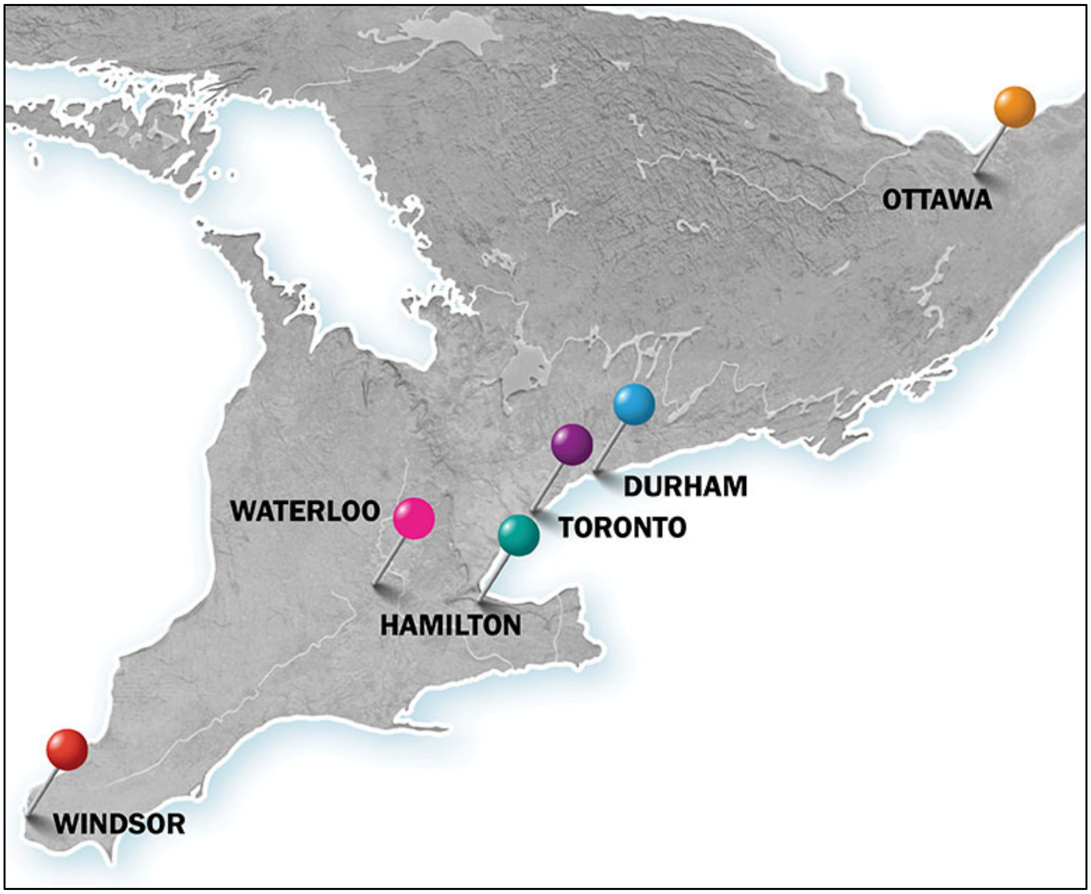
- **Durham Region:** Human Machine Interface (HMI) and User Experience;
- **Hamilton Region:** Multimodal and Integrated Mobility;
- **Ottawa Region:** Vehicle-to-Everything (V2X) Communications;
- **Toronto Region:** Artificial Intelligence (AI) for CAVs;
- **Waterloo Region:** High-Definition (HD) 3D Mapping and Localization; and
- **Windsor-Essex Region:** Cross-Border Technologies and Cybersecurity.

In Ontario, industry members range from Small-to-Medium Enterprises to large Multi-National Enterprises. The province has a well-established automotive and technology sector and has welcomed CAV development in a variety of forms[74].

The start-up space has experienced strong growth in recent years under OVIN with companies developing technologies in many aspects of the CAV sector. More recent examples of companies to watch in 2021 include AutoGuardian by SmartCone, LeddarTech, Sensor Cortek, Untether AI, Waabi, and more[75]. Further, London's proximity to automotive hubs (e.g. Windsor), technology hubs (e.g. Waterloo Region), artificial intelligence hubs (e.g. Toronto), and leveraging local industry potential (e.g. 3M, Brose Canada Inc., Leggett and Platt, etc.) give our community a unique opportunity to be at a crossroads of these hubs and the potential to contribute to their advancement.

[73] OVIN. Ontario's ecosystem. 2022. Available from: https://www.ovinhub.ca/ecosystem/
[74] OVIN. Ecosystem Map. 2022. Available from: https://www.ovinhub.ca/ecosystem-map/
[75] Invest in Ontario. 10 Self-driving companies to watch in 2021. 2021-09-22. Available from: https://www.investontario.ca/spotlights/10-self-driving-vehicle-companies-watch-2021

Figure 5: OVIN Technology Development Sites



Further, Ecopia received nearly $1 million through OVIN to match an industry contribution of over $2 million to develop a high-definition (HD) map for the City of Toronto that will be leveraged to accelerate the deployment of CAVs. This initiative strives to lay the foundation for a digital twin of the City of Toronto. This HD Map of Toronto will serve as a testbed for CAV applications and puts Ontario at the forefront of next-generation transportation systems[76].

[76] Ecopia. Ecopia AI Creates HD Map of Toronto for Autonomous Vehicles through Partnership with Government of Ontario. 2021-08-12. Available from: https://www.ecopiatech.com/news-post/ecopia-ai-creates-hd-map-of-toronto-for-autonomous-vehicles-through-partnership-with-government-of-ontario

3.3.2 ONTARIO CENTRES OF INNOVATION (OCI)

The Ontario Centre of Innovation (OCI) brings together industry, academic, and government stakeholders across Southern Ontario to capitalize on the economic opportunities of CAVs while supporting the province's transportation systems and infrastructure to adapt to these emerging technologies through the OVIN[77]. Specifically, OCI supports the commercialization of academic intellectual property, industry-academic collaborations, and the development of emerging technologies. This includes overseeing the execution of advanced technology platforms, as well as supporting and investing in early-stage projects with a probability for commercial success and return on investment[78].

3.3.3 MUNICIPAL ALLIANCE FOR CONNECTED AND AUTONOMOUS VEHICLES IN ONTARIO (MACAVO)

In late-2016, the Good Roads established the Municipal Alliance for Connected and Autonomous Vehicles in Ontario (MACAVO). The purpose of MACAVO is to provide a forum for municipal and regional staff to collaborate on research, facilitate vehicle testing with industry and academics, and share resources and knowledge on integrating connected, automated, and autonomous vehicles into municipal operations. As of mid-2019, MACAVO had over 80 participating municipalities across Ontario including the City of London.

MACAVO continues working with municipalities to identify and create a seamless, coordinated Preferred CAV Testing Corridor from Windsor to Ottawa[79]. The objective of this initiative – the first municipal coordination of its kind in the world – is to attract and retain talent within Ontario while working in partnership with private corporations, testing critical infrastructure technologies along the preferred corridor and working directly with CAV stakeholder groups to find innovative solutions to problems.

[77] OCI. Ontario Vehicle Innvation Network (OVIN). 2022. Available from: https://www.oc-innovation.ca/programs/ontario-vehicle-innovation-network-ovin/
[78] OCI. About. 2022. Available from: https://www.oc-innovation.ca/about/
[79] Good Roads. Municipal Alliance for Connected and Autonomous Vehicles in Ontario (MACAVO). 2022. Available from: https://goodroads.ca/technical-solutions/macavo/

3.3.4 CANADIAN AUTOMATED VEHICLES CENTRE OF EXCELLENCE (CAVCOE)

The Canadian Automated Vehicles Centre of Excellence (CAVCOE) provides consulting services, analyses, and recommendations to all stakeholders who are involved in the deployment of CAVs, or who will be impacted by their arrival. Stakeholders served include government, public sector agencies, private sectors companies, and industry associations. CAVCOE's expertise is on how CAVs will impact operational, business, and revenue models, allowing the organization to assist in the development of policies, strategies, and plans for CAVs as well as identify potential business models or strategies that can maximize benefits and mitigate consequences from CAV deployment[80].

3.3.5 CANADIAN URBAN TRANSIT RESEARCH AND INNOVATION CONSORTIUMN (CUTRIC)

The Canadian Urban Transit Research and Innovation Consortium (CUTRIC) supports projects that develop the next generation of mobility and transportation technologies for Canadians. These technologies help advance Canada's low-carbon and "smart" technology sectors, supporting job growth and economic development over the long term. CUTRIC's National Smart Vehicle Demonstration and Integration Trial plans to integrate semi-automated and (eventually) fully automated, connected, and electric vehicle shuttles, pods, and buses across up to 12 Canadian municipal jurisdictions as first-and-last mile applications[81]. The primary project objectives are the development of standards for V2V and V2I communication protocols, electric low-speed CAV shuttle (e-LSA) manufacturer equipment, and cybersecurity protocols[82].

The Zero Emission Transit Fund, announced in August 2021, includes $2.75 billion in funding over five years to support public transit and school bus operators' plan for electrification, support the purchase of zero emission buses (ZEBs) and build supporting infrastructure, including charging infrastructure and facility upgrades. This investment is being made in coordination with the Canada Infrastructure Bank's commitment to invest in zero-emission buses as part of its three-year Growth Plan[83]. The London Transit

[80] CAVCOE. Canadian Urban Transit Research and Innovation Consortium. 2022. Available from: https://www.cavcoe.com/

[81] CUTRIC. Automated and Connected Electric Vehicle Integration: Optimization Analysis & Techno-Economic Predictive Analysis. 2022. Available from: https://cutric-crituc.org/funded-projects/automated-and-connected-electric-vehicle-integration-optimization-analysis-techno-economic-predictive-analysis/

[82] CUTRIC. National Smart Vehicle Demonstration and Integration Trial. 2019. Available from: https://uttri.utoronto.ca/files/2019/05/UTTRI_April-26_KristyMlakar_Shareable-compressed.pdf

[83] CUTRIC. Canada's Zero Emission Transit Fund. 2021. Available from: https://cutric-crituc.org/zero-emission-transit-fund/

Commission (LTC) has engaged CUTRIC's Zero-Emission Bus Consulting Services to plan and implement its transit electrification strategy[84].

3.3.6 MARS DISCOVERY DISTRICT

The MaRS Discovery District provides a range of services from connections to talent, capital, and customers, to advisory services, and more. MaRS supports over 1,200 Canadian science and tech companies by providing them with tailored resources at every stage of their growth. The MaRS Solutions Lab works with Canadian cities to develop solutions for a range of complex challenges. This is done through three main service offerings – innovation labs, innovation procurement, and learning-by-doing. MaRS has produced several reports and provided support for the development of the future of cities – including involvement in OVIN, and research on CAVs, data interoperability, and the sharing economy[85].

3.3.7 LONDON CHAMBER OF COMMERCE

The London Chamber of Commerce is a politically independent, membership based, volunteer driven, not-for-profit organization whose mission is to lead and serve the London business community. The Chamber offers insightful and meaningful policy contributions, leading initiatives that positively influence London's social and economic landscape.

The Chamber facilitates opportunities for member businesses to promote themselves locally and regionally, do business with one another, enjoy savings and value through benefit programs, and gain knowledge through dozens of events and seminars each year. These events range from networking events such as quarterly speed networking events, monthly Business After Five events, Business between Business networking groups, annual Past President's Golf Tournament, annual Mayor's State of the City Address, annual Summit event, assorted seminars, special speaker events, and recognition events like the Business Achievement Awards gala[86].

[84] CUTRIC. London Transit Engages CUTRIC to Guide Zero-Emission Bus Rollout. 2021-04-29. Available from: https://cutric-crituc.org/news/london-transit-engages-cutric-to-guide-zero-emission-bus-rollout/
[85] MaRS Discovery District. MaRS. 2019. Available from: https://www.marsdd.com/
[86] London Chamber of Commerce. About the London Chamber of Commerce. 2022. Available from: https://www.londonchamber.com/about-us

3.3.8 LONDON ECONOMIC DEVELOPMENT CORPORATION (LEDC)

The London Economic Development Corporation (LEDC) provides free economic development services to existing companies and foreign companies across five key sectors including food processing, manufacturing, digital media and tech, professional services, and health[87].

The LEDC provides leadership in the following areas:

- Attracting new business and foreign direct investment to London;
- Retaining existing business and assisting with local expansions;
- Advocating for improving the business environment in London;
- Providing workforce development leadership to connect businesses with education institutes and employment sector agencies;
- Marketing and promoting London for business opportunities in overseas markets;
- Establishing business support partnerships throughout the community; and
- Developing strategic plans.

3.3.9 TECHALLIANCE

TechAlliance supports Ontario's most promising start-ups and fastest growing tech companies, empowering world-class ventures that fuel growth in Canada's innovation economy. We champion and coach entrepreneurs and amplify businesses to foster a vibrant technology community. In pursuit of creating spaces where innovation thrives, TechAlliance engages with tech talent, industry leaders, and founders to drive economic prosperity and support the region's ventures to advance London's growing innovation economy[88].

[87] LEDC. About. 2022. Available from: https://www.ledc.com/about
[88] TechAlliance. Home. 2022. Available from: https://techalliance.ca/

4 PUBLIC OPINION

Public opinion on the arrival of any new, disruptive technology is challenging to understand and measure. In the case of disruptive innovations, individuals have no previous experience on which to base their expectations and opinions can be greatly influenced by marketing and advertising (especially during the early stages of adoption) as well as word-of-mouth among peers and broader social networks.

Despite research efforts in other jurisdictions – including the Greater Toronto and Hamilton Area (GTHA) – public opinion on the use of CAV technologies is still preliminary as most individuals are currently unlikely to have first-hand experience with more fully automated driving features (i.e. SAE Levels 4 and 5). Therefore, it is likely that public opinion will shift in attitudes towards CAV technologies as they emerge and become more prevalent in the coming decades.

More research and understanding is required on this topic and the potential, future educational approaches to help the public better understand CAV technologies.

4.1 GENERAL

A 2018 study from the University of Memphis found that, in general, the more barriers a person perceives around CAVs, the farther into the future they are likely to estimate both the availability of the technology and their willingness to adopt it[89]. Perceived negative impacts of CAV adoption include practicalities (e.g. inadequate infrastructure, perceived low value-to-cost ratio, safety concerns, etc.) and psychological barriers (e.g. disruption of routines and norms, perceptions and beliefs associated with the product, loss of control over driving, etc.). Perceived benefits include travel time and cost, social image among peers, environmental impacts, and greater mobility for those with mobility challenges. Taken together, these factors mean that public opinion regarding CAVs can be difficult to accurately measure at this time.

A study from the World Economic Forum and the Boston Consulting Group shows that willingness to adopt CAV technology varies depending on demographic factors and built environment factors (e.g. neighbourhood type, traffic, density of mass transit, etc.). Residents of countries with a strong, established car culture had the lowest level of

[89] Talebian A, Mishra S. Predicting the Adoption of Connected Autonomous Vehicles: A New Approach based on the Theory of Diffusion of Innovations. Transportation Research Part C: Emerging Technologies. 2018;95(August):363–80. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0968090X18307939

acceptance of CAV adoption, while residents of countries with rapidly developing economies with higher levels of congestion were most likely to accept CAVs[90].

An Emerging Transportation Technology (ETT) survey revealed that, in general, a high percentage of people have reservations about CAV technologies in reducing collisions. Further, some preferred owning lower-level CAVs (i.e. SAE Level 3 or lower) even though they trusted higher level CAVs to prevent collisions. The post-survey interview revealed this is because people viewed current CAV technology as not having undergone enough testing for general driving. Additionally, negative media reports were found to have exacerbated their discomfort and provoked fears about CAV technologies[91].

However, the results also showed that people were not only more comfortable with owning vehicles at higher CAV levels, but also more trustful of them in reducing the likelihood of a collision as their understanding about CAV technologies increased. These findings highlight the value of increasing public understanding of CAVs through a variety of education and training channels.

4.2 GTHA SURVEY RESULTS

In 2016, the City of Toronto partnered with Metrolinx to support a public opinion survey conducted by Toronto Metropolitan University's (TMU's) School of Urban and Regional Planning. The survey was intended to provide a base level of understanding around public support for CAVs and potential behaviour change associated with the adoption of CAVs. TMU re-administered this survey in 2018 with 3,200 residents of the Greater Toronto and Hamilton Area (GTHA) and added questions to reflect an updated context[92].

[90] World Economic Forum and the Boston Consulting Group. Reshaping Urban Mobility with Autonomous Vehicles: Lessons from the City of Boston. 2018-06. Available from: https://www3.weforum.org/docs/WEF_Reshaping_Urban_Mobility_with_Autonomous_Vehicles_2018.pdf

[91] Kim W, Kelley-Baker T, Yang CYD. Public Understanding, Comfort, and Trust of Automated Vehicles. ITE Journal, Vol. 94, No. 1. 2021. P. 43. Available from: https://www.ite.org/ITEORG/assets/File/ITEJ%20Published/2021/ITE_ITE_Jan2021.pdf

[92] Olsen T, Laidlaw K, Sweet M. Automated Vehicles in the Greater Toronto and Hamilton Area: Overview from a 2016 Consumer Survey. Prepared for Metrolinx and the City of Toronto. 2018-03-09. Available from: https://transformlab.torontomu.ca/wp-content/uploads/2018/03/Laidlaw_Sweet_Olsen_Report3_scenarios_20180309.pdf

4.2.1 AUTOMATED VEHICLE ANTICIPATED ARRIVAL

Respondents were asked to anticipate when certain CAV milestones would take place and were asked the following:

Do you expect driverless cars to ever be available for use or purchase in Toronto at any time in the future?

- Approximately one-third of respondents (31.7%) answered "no." The remaining two-thirds (68.3%) who answered "yes" were asked three further questions and to select what year they expected it to become a reality.

There is a high degree of alignment between public expectations and expert forecasts, in the short-term horizon. On average, GTHA residents predicted they might be able to ride in a driverless car by 2025. Estimates for events occurring farther in the future are bound to be subject to a higher margin of error. With that in mind, looking to the market saturation of CAVs, where most vehicles in the GTHA would be CAVs, the public was slightly more optimistic in projecting 2035 compared to many industry experts, who forecast this may occur by the 2050s. Similarly, the public anticipates that human driving will be relegated to a hobby by 2040, which is more optimistic than expert forecasts.

4.2.2 KEY FINDINGS

Other key findings from the 2018 survey include:

What benefits and consequences do respondents expect from CAVs?

- Respondents (63.9%) expected distracted and impaired driving would be reduced because of CAVs.
- Of the potential impacts of CAVs, respondents were most unsure or neutral (49.4%) regarding the impacts on hacking and cybersecurity.
- Data privacy was cited by almost a third (31.8%) of respondents as being the most negatively impacted.

How might respondents' travel behaviour change, should CAVs be available?

- There is significant variation in CAV interest amongst consumers. While interest in CAVs remained largely the same between 2016 and 2018 (i.e. 48% vs. 52%), more respondents indicated they would be willing to pay more for a fully driverless vehicle in 2018 (48%) than in 2016 (25%).
- Younger respondents were significantly more interested (63%) in using CAVs than older respondents (i.e. aged 35-55: 47%; aged 55 and over: 35%).
- Many respondents did consider changes in their travel behaviour if CAVs became commercially available:
  - In 2018, approximately one-third of respondents indicated interest in extending their commutes if they did not have to drive, down from two-thirds in 2016.
  - When asked if respondents were willing to ride different forms of public transit (including small shuttle bus, regular-sized or articulated bus, streetcar, light rail train, subway train, commuter train) should they be driverless, willingness ranged from 50.4% for light rail and subway trains, to 37.9% for regular-sized buses, and 44.1% for shuttles.
  - Although not specific to CAVs, 20% more respondents had indicated that they had used ride-hailing services in 2018 (44.3%) compared to 2016 (24.9%).

How do CAVs relate to respondents' public policy priorities?

- Like 2016, half of all 2018 respondents (50%) indicated that the government should monitor the implementation of CAVs.
- A quarter of respondents reported that they were aware of provincial and municipal CAV planning initiatives.
- Road safety was most the most highly supported policy objective (81.3%) followed by unobstructed movement of emergency vehicles and better traffic management.

Overall, TMU researchers summarized their findings in that most consumers are still learning about CAV technology and ongoing CAV planning initiatives; and, largely due to an uncertain value proposition and evolving understanding about the technology, most consumers are reluctant to commit to using CAVs.

4.3 INITIAL LONDON PUBLIC CONSULTATION

Between December 18, 2019 and February 21, 2020 during the City's initial public consultation period, Londoners were asked three key questions regarding the arrival of CAVs in our neighbourhoods and roadways. During this period, 236 Londoners contributed to the conversation in the initial public feedback phase in the development of this Connected and Automated Vehicle Plan.

Further public consultation will be engaged in during the draft review stage of this Connected and Automated Vehicle Plan.

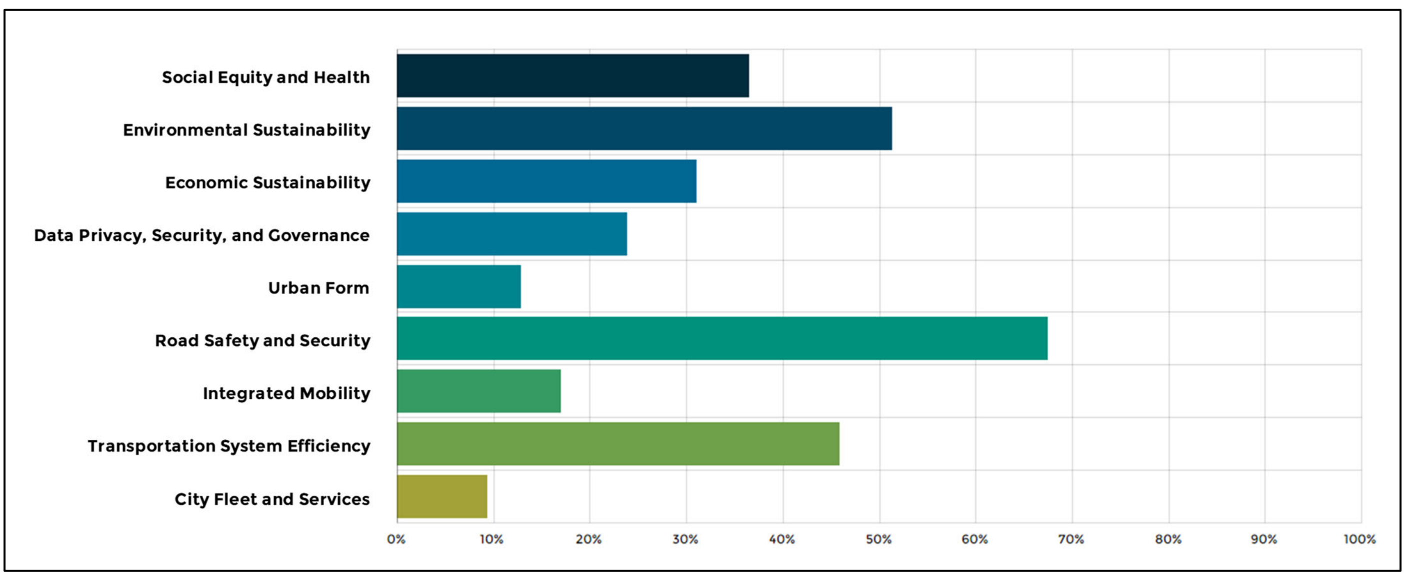
4.3.1 KEY STRATEGIC AREAS OF FOCUS

Identify the Top 3 Strategic Areas of Focus that are most important to you.

- While all Strategic Areas of Focus are important to the Strategic Plan in the preparation for the arrival of CAVs, the three key areas that were identified by more than 40% of survey respondents were **Roadway Safety and Security**, **Environmental Sustainability**, and **Transportation System Efficiency**.

More information on the Strategic Areas of Focus is detailed in **Part II: Detailed Actions** of this Connected and Automated Vehicle Plan as shown in **Figure 6**.

Figure 6: Key Interest in London Strategic Areas of Focus



It should be noted that in the further development of this plan since the initial 2020 public survey, the **Integrated Mobility** and **Transportation System Efficiency** sections have been combined into the new **Mobility Integration and Efficiency** section and the **Urban Form** section has been expanded to include **Land Use and Urban From**.

4.3.2 PREPARING FOR CAVS

What should the City of London do to prepare for the arrival of Connected and Automated Vehicles?

- Top preparation answers for CAVs included providing educational programs for the public (19%), performing more studies and testing on CAVs (19%), improving existing infrastructure (e.g. cycling, transit, street design, traffic signals, etc.) to prepare for CAVs (14%), and ensuring EV charging stations are more readily available for CAVs (13%).

4.3.3 CONCERNS ABOUT CAVS

What are your biggest concerns with the arrival of Connected and Automated Vehicles in London?

- Safety concerns regarding CAVs and their interactions with vulnerable road users including pedestrians, cyclists, and those with mobility aids and people abusing the use of CAVs (29%).
- Privacy and security concerns including computer glitches and cybersecurity (12%).
- Congestion concerns that CAVs will be largely single occupancy or zero occupancy and contribute to increased traffic, higher emissions, and less people cycling or walking (8%).
- Operational concerns that CAVs will respond poorly to bad weather, missing road signs, faded lane markings, construction, and emergency vehicles passing (8%).
- Liability concerns over who should be held responsible for collisions involving CAVs (6%).
- Other noteworthy concerns (less than 5% of respondents) included ensuring that public transportation still has a human operator present to allay safety concerns, that CAVs will have a negative impact and should be completely banned, and job loss impacts as CAVs impact the economy.

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London
CANADA