Technology Trends

Autonomous Vehicles

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Business Brief

Autonomous vehicles are vehicles capable of self-navigating and sensing their surrounding environment without a human input required. The goal is to ensure safety, and reduce accidents and deaths on the road by eliminating human error when driving. Autonomous vehicles make use of several different technologies to obtain sensory information to process the world around them. These technologies include radar, laser light (known as LIDAR), GPS, odometry, inertial measurement units and computer vision.

Currently, there are at least 36 automotive companies that already make use of sensory technology in their non-autonomous vehicles. These systems notify and assist the driver in real-time about various aspects of the surrounding environment. Some of the systems include Forward-Collision Warning, Blind-Spot Warning, Emergency Auto-Breaking, Lane-Assist, and more. With these technologies already functioning and in use, the transition to autonomous vehicles, although complex, is becoming easier and an attractive proposition for automotive companies.

According to Transport Canada, an automated vehicle uses a combination of sensors, controllers, on-board computers, and software. On the other hand, a connected vehicle uses more wireless features and does not have any automated features such as communicating through: mobile devices, other vehicles and road users, roadways, traffic lights, and applications.[1]

The global market for autonomous vehicles will reach a projected $65.3 billion from 2016 to 2027. This is due to the fact that 90% of road accidents are caused by human errors. The NHTSA (National Traffic Highway Traffic Safety Association) reports that the adoption of autonomous vehicles may save more than 69 lives in the United States annually. Reports state that automobile companies are expected to launch fully automated vehicles in 2020. [2]

Top performing companies in the autonomous vehicles market are: Google, General Motors, Volkswagen, BMW, Ford Motor Company, Baidu, Toyota, Tesla, Audi, and Jaguar. As fully automated vehicles are still under development, one can find advanced driver assistance (ADAS) in the market today. The top 3 companies that are leading in this industry are: Tesla, Google Alphabet's Waymo, and NVIDIA.

Tesla

Tesla Inc. was founded by Martin Eberhard and Marc Tarpenning in 2003 at San Carlos, California. Originally, it was named Tesla Motors which the company changed in 2017.

In 2012, Tesla's Model S Sedan went into full production. It was highly acclaimed by critics for its excellent performance and intuitive design. It was an improvement from the past Tesla model called the Roadster. With the Model S Sedan, the car batteries were located underneath the car which resulted in a more balanced center of gravity for the vehicle. Compared to the last model, it had batteries at the front of the vehicle.

In 2014, The Tesla Autopilot was made available as an over-the-air update in the Model S Sedan. It included limited controls on the freeway, and traffic jams. However, it did not offer full autonomy to the vehicle.

Tesla boasts that 47 million miles of logged driving data was analyzed to conclude that a tesla with autopilot is 50% safer than an unassisted car system. Elon Musk claimed that the system is three times safer than just a human driver behind the steering wheel. Tesla has yet to offer a full level 5 autonomous vehicle despite numerous promises made over the years. At the moment, a tesla vehicle is equipped with eight cameras, one radar system, 12 ultrasonic sensors, and a supercomputer. It's rear cameras give a 360-degree view and a birds eye view of its surroundings.

Google Alphabet's Waymo

Google Alphabet's subsidiary, Waymo, started the journey of self-driving technology in 2009. [3] After completing successful challenges, one of which was driving autonomously for more than 100 miles straight in Toyota Prius vehicles, they then developed the project even further. In 2012, they added the Lexus RX450H to their fleet and tested their technology in highways. Then, they built their own sensors. Three years later, they took their autonomous vehicle, Firefly, on public roads with a legally blind individual in the driver's seat. The company is also well known for using and manufacturing their own LIDAR technology. LIDAR stands for light detection and ranging. These are the sensors most autonomous vehicles use. It is placed on the top and sides of the vehicles, and uses it to detect its environment. In 2017, the company stated they were producing their own LIDAR technology to eliminate costs from $75,000 to just $7,500. However, they will only partner with companies who are not in the self driving taxi service as they are trying to build their own reputation as that. They subject that they want to offer their LIDAR technology in robotics, security, and agriculture. Their newest update, called Laser Bear Honeycomb, features a wide 95 degree field of view, up to four different objects in the laser beams system, and has virtually no minimum range which means it can view anything at no minimum distance with its sensor. [4]

NVIDIA

NVIDIA was founded by Jensen Huang, Chris Malachowsky, and Curtis Priem in 1993. The company spent a majority of their time as a graphics chip company that was being used in the gaming, entertainment, and electronic industry. 27 years later, they are the only independent graphics chip company still standing.[5]

They have branched out to self-driving cars that offer products such as NVIDIA Drive, Drive AP2X, Hardware, Software, and Simulation. Drive AP2X is a level 2 automated driving platform that promises safe and AI-assisted driving. Meanwhile, the hardware they offer, named NVIDIA Drive AGX, is synonymous to a human brain for autonomous vehicles. They boast that the scalable and open platform is the only one of its kind. On the other hand, the NVIDIA Drive software provides multiple and customizable layers. It includes a safety force field that detects collisions from other vehicles which is also offered by many level 2 autonomous vehicles. However, it offers a Drive IX intelligent software development kit that uses AI assistants for the people on board the vehicle.

Lastly, it offers a virtual reality autonomous vehicle simulator called NVIDIA Drive Constellation. This simulator is capable of detecting road, traffic, and weather conditions before hitting the road. It creates and tests different weather scenarios which are then sent to its Pegasus AV computer to ensure the correct algorithms are in play.[6]

The use of autonomous vehicles will revolutionize the world of transportation and shipping. Accidents, deaths and careless driving due to human error will decrease, which will result in saving emergency services' resources. Packages for delivery will be able to be tracked in real-time. Disabled people and seniors will find it much easier and comfortable to get around by car. Autonomous vehicles will require *edge computing* to process the sensory information they obtain, and with *internet of things* devices, this information can be used in many different instances. *SmartCities* will be explicitly enabled to deal with this information and assist in traffic flow, minimization of pollution, etc.

Technical Brief

Autonomous vehicles need to make use of several technologies in order to function properly through correct decision making on the road. Autonomous vehicles use various sensory technologies including radar, sonar, laser sensors (also known as LIDAR), odometry, inertial measurement units and computer vision. Odometry is a technology used in robotics by some legged or wheeled robots, and it processes the data of motion sensor in order to plot changes in position over time. Computer vision is an image processing technology. It is designed to process the image and analyze it in order to recognize certain features, essentially giving a computer a human eye. These tools function in combination with intelligent software that can distinguish aspects of the surrounding environment and plan accordingly. The software plots the path of the vehicle relaying data to the "actuators" which control steering, acceleration and braking. The controlling software of autonomous vehicles also makes use of several algorithms, including obstacle avoidance algorithms, predictive modelling, and object discrimination (this allows the car to differentiate between a motorcycle and a bicycles). These systems make use of *edge computing* in order to process the data within the car, providing little to no reliance on server connections or cloud computing. However, with autonomous vehicles, there still are several concerns about the cyber security risks associated with them. The security systems as well as failure detection of these vehicles must be extensive in order to guarantee the safety of passengers and pedestrians.

V2V Technology[7]

Vehicle-to-vehicle communication composes of wireless technology that enables an exchange of information about other surrounding vehicles speed and position to avoid crashes, alleviate traffic congestion, and decrease the number of lives taken annually.

This is all achieved by dedicated short range communications (DSRC) which is combined with GPS technology. It includes a 360 degree awareness of other vehicles. It can send visual, tactile, and audible alerts to warn drivers. It has a range of more than 300 meters. With the help of DSRC and GPS technology, it helps drivers survive and avoid road-related accidents. It can be used in any automotive vehicle. According to NHTSA, there have been 615,000 motor vehicle accidents that could have been prevented with the use of V2V Technology.

Vehicle to Infrastructure[8]

It is a two way communicative exchange of wireless information between automotive vehicles and traffic signals, lane marking, and other smart road infrastructure. V2I has similar goals as V2V, which is to reduce crashes, improve road safety, and alleviate traffic congestion. However, V2I supports road work zones.

There are 2 V2I technologies:

Smart Traffic Lights

Standard traffic lights control traffic flow based on an interval that coordinates with its surrounding traffic lights. Additionally, it is pre-programmed based on rush hour times. On the other hand, smart traffic lights consists of cameras and sensors. It can detect the number of cars that are waiting and can calculate the amount of time reduced to clear each lane. Also, smart signals communicate with other traffic signals to decrease traffic flow during rush hour.

Benefits:

- Alerts drivers of a nearby pedestrian crossing
- Helps give way to emergency vehicles
- Gives cyclists a head start
- Countdown of a signal change to drivers
- Warns other drivers if a red light is ahead

2. Smart Parking

Smart parking allows easy access to available parking lots. It is already being used in the UK, New Zealand, and Australia. The benefits are: an easier access to available parking spots, and automatic payment.

The most used locations for smart parking are: city streets, railway stations, airports, malls, and universities.

Benefits:

- Live and real time information on available parking spots

- Automated vehicle identification and payment
- Allow parking enforcers to have a global view of payments and edit policies on fare rates
- Reduce idling time searching for an available parking spot

Industry Use

Autonomous vehicles when functioning correctly provide an array of possibilities in shipping and transportation. Having an autonomous vehicle delivering packages allows items to be tracked in real time, as well as to be delivered safely. This could be very applicable in situations where the items being transported provide dangerous consequences should the driver be involved in an accident. It also means that packages can be shipped faster because autonomous vehicles can remain on the roads for longer periods of time.

There are over a dozen automotive and technological companies working on producing fully autonomous vehicles. Companies such as Tesla have classified their cars' autonomous driving capability on a level scale from zero to five, where zero is non-autonomous and five is fully autonomous, which means not requiring a driver present. This is an important distinction as a survey conducted in the U.S. and Germany in April 2017 revealed that 55% of individuals will not consider passenging (being a passenger) in an autonomous vehicle while 71% of individuals will consider passenging in a partially autonomous vehicle.

Another important company who has invested in research is Uber. They have paired with Volvo to develop an autonomous vehicle. This provides insight into how these cars can impact the transportation industry. With fully autonomous vehicles, there would be less of a need for individuals to own cars in favour of using services like Uber as a means of transportation.

Canadian Government Use

The Government of Canada (GC) is responsible for establishing national transportation policy and regulations to ensure safety standards on Canada's roads which includes the use of autonomous vehicles.

Provincial and Territorial governments are responsible for driving licenses, vehicle registration, insurance, rules of the road, and changes to infrastructure in accordance with the GC's safety requirements.

In October of 2017, the first autonomous vehicle test on public roads in Canada was driven in Ottawa, Ontario, as part of a project by QNX, the Research In Motion (RIM/Blackberry) subsidiary.

Ontario is the only province that allows autonomous vehicles to be tested on public roads. In 2017, the Ontario Government launched the Autonomous Vehicle Innovation Network (AVIN) in Stratford, Ontario. A network and demonstration zone is included in the AVIN program which provides an area to test the autonomous vehicles with realistic traffic conditions. Additionally, the Ontario Government has committed to invest approximately $80 million over five years in AVIN.

In June 2018, Transport Canada announced the release of a report entitled "Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations".[9] This report established a consistent baseline for safety practices for automated vehicle testing.

In August 2018, Transport Canada announced $2.9 million in funding to conduct research into what Canada will look like when autonomous vehicles become the norm.[10]Funding was provided under the program "Advance Connectivity and Automation in the Transportation System" in order to help Canada prepare for connected and automated vehicles.

In January 2019, the Council of Minister Responsible for Transportation and Highway Safety, which is made up of transport ministers from each of the federal, provincial, and territorial governments, released and endorsed the "Automated and Connected Vehicles Policy Framework for Canada".[11] This framework affirms that the safety of Canadians is a top priority for testing and deploying autonomous vehicles. This framework aims to help Canada advance shared objectives and strengthen partnerships between governments, industry and academia as it relates to autonomous vehicles.

In February 2019, Transport Canada released two new documents to help industry accelerate the safe introduction of automated and connected vehicles on Canadian roads. Transport Canada published "Canada's Safety Framework for Automated and Connected Vehicles" which provides an overview of Canada's current legislative and regulatory regimes and standards.[12] Transport Canada also published "Safety Assessment for Automated Driving Systems in Canada" which is a voluntary tool to assist developers of autonomous vehicles to review safety measures of vehicles they intend to manufacture, import, operate and/or sell in Canada.[13] This tool is part of Canada's effort to align with similar polices in the United States.

Implications for Shared Services Canada (SSC)

Value Proposition

Broadly speaking there are a number of value propositions in terms of autonomous vehicles that organizations should be aware of:

- Improved Safety – autonomous vehicles could reduce the number and severity of crashes by providing drivers with early hazard warnings, initiating emergency breaking when hazards are detected, and helping human drivers make better decisions on the road.

- Increased Accessibility – autonomous vehicles have the potential to enhance the mobility of Canadians, especially those that may be under-served by existing transportation options, including seniors, people with disabilities, rural populations, and low-income families.

- Environmental Benefits – autonomous vehicles could help by reducing traffic congestion and in turn decreasing fuel consumption and vehicle idling and emissions.

- Economic Opportunities – autonomous vehicles have the potential to open up new and innovative economic avenues in transportation services, automotive manufacturing, and digital technology.

- Reduced Costs – there is a potential for lower costs associated with public transportation. Since there would no longer need to be human drivers, there would be a savings in driver salary expenditures. Additionally as more and more people opt for ride-sharing services, this could reduce the need for parking infrastructure. With less need for parking, current parking spaces could be converted for other uses. Fewer human drivers would also decrease the investment in driver licensing, administration, policing traffic and parking enforcement.

Challenges

A number of challenges in terms of autonomous vehicles organizations should be aware of include:

- Technology – the autonomous technology has not yet advanced to the point of mass produced fully autonomous vehicles. Although there are semi-autonomous features that exist in some vehicles today, there is still a way to go before vehicles become fully driverless. Developers still need to resolve many technical challenges, such as: improve the ability of autonomous vehicles to interpret their environments and make safe driving decisions, empower autonomous vehicles to anticipate the actions of other road users, and to enable autonomous vehicles to overcome challenges like construction zones and unmarked or snow-covered roads.

- High Cost – fully autonomous vehicles could add at least $100,000 to the overall cost of such a vehicle.[14]Auto manufacturers will need to figure out how to design and build affordable autonomous systems that will be accessible to all types of individuals.

- Privacy and Data Security – Fully autonomous vehicles will work by sharing information with servers and other vehicles. This entails the collection and use of large quantities of data. The appropriate safeguarding on this data has not yet been fully considered. Autonomous vehicles, as with any IT system, are vulnerable to hacking and will need to be properly secured against such cyber threats.

- Legislation/Regulation – Current Canadian legislation and regulation has not been developed to govern autonomous vehicles. The GC must work co-operatively with other stakeholders to ensure the safety of Canadians is protected while balancing economic interests of the marketplace.

- Trust – Often, a person will trust another human to drive before they trust a robot or algorithm. It will take some time to win everybody over, and some people may never be comfortable getting into autonomous vehicles.

SSC continues to face challenges related to the modernization of the GC's IT infrastructure. The ongoing replacement of aging IT systems could have an impact on SSC's ability to deliver newer services such as autonomous vehicles. SSC's capacity and tools for service management may not be sufficient to support excellence in the delivery of services to partner organizations. Additionally SSC's capacity and tools for project management may also be insufficient to complete projects on time, on scope, and on budget considering the operational burden already borne by SSC's workforce. Taken as a whole these weaknesses could have a negative impact on SSC's ability to deliver on future customer requests for autonomous vehicle support.

Currently all traffic management systems (i.e. traffic lights, road signs, etc.) are built for humans and therefore manufactures are building self-driving cars that will function in these human-based systems. As more and more self-driving vehicles are introduced onto roadways, the introduction of traffic management and safety systems designed specifically to function with autonomous vehicles will become apparent. Additionally, the transition of traffic management systems from human to fully autonomous is an unknown area for all cities and countries.

Efficiency and safety could be enhanced when self-driving cars will be able to communicate with other vehicles and the infrastructure around them. Vehicle-to-vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technologies will be a vital future component of autonomous transportation systems.[15] Challenges with future transportation systems will arise with interoperability between different manufactures and infrastructure systems. Universal standards and protocols will need to be developed, accepted, and implemented as part of these future systems. Governments, who are responsible for public roads, will have a central role to play in terms of this infrastructure and the standards which will govern them.

Considerations

Looking forward, SSC has a number of things to consider in terms of autonomous vehicles.

First, SSC should consider how the increased use of autonomous vehicles will impact its role as an IT service provider for the GC. As the IT infrastructure provider for the GC, SSC should consider how requests for autonomous vehicle support for the GC's vehicle fleet might impact on its ability to deliver services. At this point in time it may be difficult to determine the best approach but it is reasonable for SSC to ask itself what role (if any) it will play in the future of autonomous vehicles.

The demand for autonomous vehicle support from SSC's customers has not yet been realized. It is reasonable to assume that at some future point SSC may be required to support the IT infrastructure upon which autonomous GC vehicles operate. The Policy on Management of Material and the Directive on Fleet Management: Light Duty Vehicles will be foundational documents to which SSC can understand it's IT support role in the future.[16] Consequently there is still time for SSC to develop plans on how to best to support autonomous vehicles of its partner departments. While there could be other net efficiencies for the GC, it remains unclear as to the impact to SSC in terms of IT service support.

Secondly, SSC may wish to be involved with decisions around what type of traffic management platforms will be used to manage the GC vehicle fleet. The GC will likely need to access a secure fleet of autonomous vehicles for multiple purposes. There is the question whether the GC subscribe to third party autonomous vehicles services or operate and maintain its own fleet? If the GC were to choose to operate and maintain a comparatively large fleet of autonomous vehicles, there will be a need to use a management platform to make their operations safer and more efficient. In any case, SSC may be required to support such a potential traffic management platform and house the data in the GC's enterprise data centres or Cloud. Technologies used to manage traffic should be securely interoperable with GC infrastructure.

Thirdly, SSC should consider if additional or new security measures are required for autonomous vehicles that are connected to or interact with GC networks. SSC takes cyber and IT security very seriously and should consider if protocols needed to secure GC supported autonomous vehicles are sufficient and properly followed. SSC should expect to work with GC security departments and agencies to determine how best to support their IT infrastructure security needs. With the deployment of autonomous vehicles, SSC will need to concern itself with the security issues they bring forth. Placing the driving of the vehicle entirely in the hands of the computer would mean that the cybersecurity would need to be extensive. The implications of hacking an autonomous vehicle could be very dangerous.

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