TP 15469E

Vehicle of the future advisory group

Synopsis

Fall 2018 – Summer 2019

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Canada

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Table of Contents

Background

The emergence of new and transformative vehicle technologies, including connected vehicles[1] and automated vehicles[2] is the forefront of an unprecedented transformation in the transportation sector and mobility in general. As the industry changes and new vehicle technologies emerge, we expect that the way that disruptive technologies, including connected and automated vehicles, electrification, and on-demand mobility interact, will create the "vehicle of the future."

These advances in vehicle technologies have the potential to enhance many aspects of Canada's transportation system, such as:

- safety
- productivity
- accessibility
- efficiency
- environmental performance

New vehicle technologies will also drive innovation and economic growth. However, as the technologies continue to develop, the full extent of their potential benefits and risks is not yet fully understood.

Canada is well-positioned to be a leading destination for the design, development and manufacturing of the "vehicle of the future." At the centre of North America's largest automotive manufacturing cluster, Canada produces 2 million vehicles a year and is home to a world-class manufacturing workforce.

Canada also has one of the largest clusters of high-tech firms outside of Silicon Valley, with global leaders in:

- artificial intelligence
- sensors
- battery technology
- network security
- software development
- telecommunications
- other technologies shaping the future of mobility

[1] Connected vehicles interact with their own onboard operating systems, other vehicles, personal electronic devices, and road infrastructure via sensors and wireless technologies. They do not make decisions for the driver but simply provide information to the driver (e.g. GPS navigation, lane departure warnings).

[2] A motor vehicle that uses a combination of in-vehicle sensors and cameras, positioning systems, wireless communications and data processing to enable vehicles to assume partial or full driving functions, such as self-parking, advanced cruise control, automatic braking and lane-shifting controls. There are five levels of automation, as defined by SAE International - 1 (driver assistance), 2 (partial automation), 3 (conditional automation), 4 (high automation), and 5 (full automation).

By building on its key areas of strength, Canada has the potential to develop a globally competitive advantage in the connected and automated vehicle space. Canada could also maximize the reach of its innovations by taking advantage of the skills from the areas listed above and putting them to use in industries such as agriculture, mining, and construction where highly automated vehicles are already being deployed.

Regional strategic clusters offer important anchors for more investment, and opportunities to attract high potential firms with strong innovative capacity.

Examples of these clusters are:

- Southern Ontario (automotive)
- Kitchener-Waterloo and Ottawa (information technology)
- Vancouver (fuel cells)
- Toronto and Montreal (artificial intelligence, electric vehicles, smart cities)

Canada has also assigned and aligned electromagnetic spectrum across borders, enabling early cross-border tests and pilots, with recent investments in 5G test beds, opening the door to more of these early innovations. Many provinces are already organizing trials and demonstrations of connected and automated vehicle technologies on public roadways in Canada. Some provinces are providing safety guidance, and in some cases, the Government of Canada is providing research and funding support.

The trends and drivers associated with connected and automated vehicles create many public policy challenges and opportunities that will require federal leadership in cooperation with many stakeholders, including:

- the automotive and technology sectors
- various other impacted industry sectors
- provinces
- municipalities
- the academic community
- other key domestic and international partners
- representatives of impacted demographic groups
- the public at large

Preparing Canada for and maximizing the benefits of connected and automated vehicle-related innovations will require a collaborative effort by all orders of government, as well as the wide range of stakeholders in this space. Together they will have to create an enabling environment where new technologies can be safely developed, deployed, and adopted. The Government of Canada is taking proactive steps to enhance Canada's transportation system and automotive industries in the areas of manufacturing, RD&D and technological innovation.

In response to the changing transportation and mobility landscape, in February 2016, the Minister of Transport requested that the Standing Senate Committee on Transport and Communications study the

regulatory and technical issues related to the deployment of connected and automated vehicles.

The committee released the report "Driving Change: Technology and the Future of the Automated Vehicle" on January 29, 2018. It sets out 16 recommendations for advancing connected and automated vehicles in Canada. The recommendations touch on opportunities for innovation, job creation, investment attraction, and growth. They also identify challenges related to safety, personal information privacy, cybersecurity, ethics, liability, infrastructure, and labour market impacts. Notably, the first recommendation proposed that:

> Transport Canada and Innovation, Science and Economic Development Canada expeditiously create a joint policy unit to coordinate federal efforts and implement a national strategy on automated and connected vehicles.

The Government Response to the Senate report supported this recommendation and proposed that Transport Canada and Innovation, Science and Economic Development Canada co-lead an advisory group to engage representatives from all orders of government, industry, non-governmental organizations, and academics in the connected and automated vehicle space.

This advisory group would complement federal work that is already in progress to help develop a co-ordinated national approach on connected and automated vehicles and would help inform both government and advisory group members in their respective organizations.

As such, the departments launched the vehicle of the future advisory group on November 6, 2018. The advisory group is made up of senior-level members representing all orders of government, industry, academia, and non-governmental organizations. After a series of discussions, members agreed on the following overall vision for the advisory group:

> Keeping the interests of Canadians at the fore, the advisory group will seek to explore the barriers and opportunities that a society shaped by digital mobility will present. The group will focus both on the responsible and sustainable integration of this technology into the Canadian economy and society, and on leveraging this transformation to encourage innovation and investment, to Canada's advantage.

The initial work of this group focused on connected and automated vehicles within the broader mobility ecosystem. During that time, the advisory group held four formal meetings. To support their work, the advisory group established five expert working groups, which were each given the responsibility to research one of the following five key themes:

1. Safety and security
2. Innovation and competitiveness
3. Digital and physical infrastructure
4. Data privacy and security
5. Distributive social impacts and risks

The expert working groups were further tasked with providing the advisory group recommendations on proposed actions related to their respective themes.

Following below is a summary of the work of the advisory group as well as the expert working groups. Annexes B through F include the expert working groups' recommendations for proposed actions to advance the safe development and deployment of connected and automated vehicles in Canada.

Advisory group membership list

Federal	• **Charles Vincent**, Director General, Automotive, Transportation and Digital Technologies Branch, Innovation, Science and Economic Development Canada (co-chair) • **Craig Hutton**, Director General, Strategic Policy and Innovation Directorate, Transport Canada (TC) (co-chair) • **Observers:** o **Craig Oldham**, Director General, Critical Infrastructure protection, Public Safety Canada o **Tushara Williams**, Director General, Sectoral Policy, Infrastructure Canada o **Michael DeJong**, Director General, Multi-Modal and Road Safety Programs, TC o **Jim Lothrop**, Director General, Innovation Centre, TC
Provinces and Municipalities	• **Raed Kadri**, Director, Automotive Technology and Mobility Innovation, OCE, Government of Ontario • **Wendy Doyle**, Executive Director, Traffic Safety, Alberta Ministry of Transportation • **Jean Lawson**, Policy Officer, Federation of Canadian Municipalities
Automotive Industry	• **Colin Dhillon**, CTO and **Warren Ali,** Vice President, Automotive Parts Manufacturers' Association • **Mark Nantais**, President, Canadian Vehicle Manufacturers' Association • **David Adams**, President, Global Automakers of Canada • **Jean-Francois Champagne**, President, Automotive Industries Association of Canada
Non-Traditional Industry	• **Philippe Beaudoin**, Senior Vice President Research, Element AI • **Robert Asselin**, Senior Director of Public Policy, Blackberry Ltd • **Charles Boulanger**, CEO, LeddarTech • **Sherry Shannon Vanstone**, President and CEO, TrustPoint Innovation
Non-Governmental and Academia	• **Ian Jack**, Managing Director, Government Relations, Canadian Automobile Association • **Josipa Petrunic**, Canadian Urban Transit Research & Innovation Consortium

	• **Steve Laskowski**, President, Canadian Trucking Alliance and Ontario Trucking Association • **Paul LaFleche**, President and Chair, Transportation Association of Canada • **Andrew Miller**, Associate Director, Sidewalk Labs • **Barrie Kirk**, Executive Director, Canadian Automated Vehicles Centre of Excellence • **Ross McKenzie**, University of Waterloo, WatCAR • **Brent Toderian**, Founder and Principal, Toderian Urban Works • **Denis Gingras**, Professor, Laboratory on Intelligent Vehicles, University of Sherbrooke • **David Ticoll**, Distinguished Fellow, Innovation Policy Lab, University of Toronto • **Ryan Stein**, Executive Director, Insurance Bureau of Canada • **Patricia Kosseim & Adam Kardash**, AccessPrivacy (division of Osler Law) • **Wendy Reuter**, Vice President, Member Value, Canadian Urban Transit Association

Synopsis of the advisory group's work

As the automotive and transportation sectors adopt new technologies, including connectivity and automation, a new mobility ecosystem is emerging. This new ecosystem is creating diverse challenges and opportunities for industry and governments.

It is also offering consumers new travel options, such as shared mobility. As with any new technology, there are risks associated with the speed of adoption. To deal with these challenges and make the most of potential benefits for Canadians, we need collaboration across multiple organizations. To respond to this need, the vehicle of the future advisory group brings together a wide range of stakeholders working in the connected and automated vehicle space and provides an ideal platform to discuss these emerging issues.

Advisory group members had an opportunity to discuss and identify a wide variety of cross-cutting issues related to connected and automated vehicles that call for more analysis and dialogue. These include issues associated with:

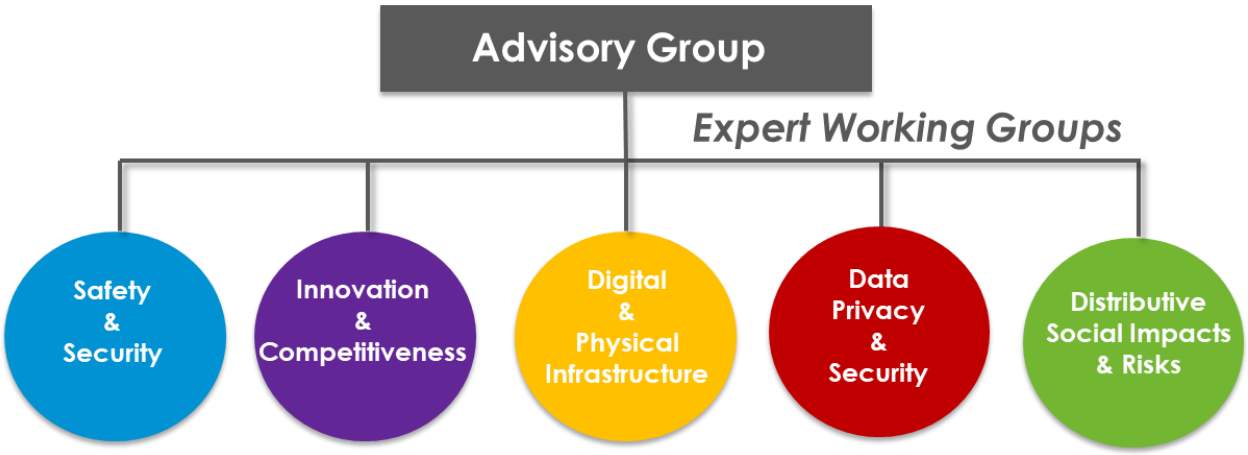
- data
- urban planning
- safety and performance testing
- cybersecurity
- interoperability
- impacts on workers

The advisory group also offers a place for its members to provide updates and insights on their respective organizations' ongoing work on connected and automated vehicles.

Expert working groups

The advisory group established expert working groups for each of the five key themes of the work of the advisory group:

- Safety and security
- Innovation and competitiveness
- Digital and physical infrastructure
- Data privacy and security
- Distributive social impacts and risks



The expert working groups were made up of subject matter experts, who analyzed the opportunities related to developing and deploying connected and automated vehicles in their respective themes.

In December 2018, the advisory group held a roundtable discussion where members identified the key areas of focus for the expert working groups. The advisory group also collectively decided that the concluding work would draw on the findings of the five expert working groups to provide input and guidance to future policy approaches, as well as to inform the work of advisory group members in their own organizations.

Each of the expert working groups met regularly from February to June 2019. They discussed key issues under each of the five themes with the overall goal of developing a series of proposals to inform public and private sector actions. The expert working groups updated the core advisory group midway through their work and received feedback in April 2019. They later presented their final findings during the June 2019 meeting of the advisory group. The final proposal papers from each of the expert working groups are attached as annexes to this document.

The role of data

During the discussions of the advisory group and the expert working groups, the role of data in developing and deploying connected and automated vehicles emerged as a critical issue that touched on

many areas. Members identified many considerations about collecting, owning, managing, and sharing data that cut across the five themes defining the work of the advisory group.

Many vehicles and intelligent infrastructure operating today have sensors. The sensors process a large volume of data about the vehicle's surroundings and the technical operation of the vehicle. Almost all new vehicles are equipped with connected features, some of which may be able to communicate with supporting infrastructure or other vehicles. This produces a connected and automated vehicle ecosystem with a lot of very complicated data flows between vehicles and infrastructure

The expert working groups raised concerns about data. They included:

- ownership
- control
- permitted uses
- access
- privacy
- security

Besides technical data for operating the vehicle itself, there are also important privacy issues[3] to consider. Connected and automated vehicles may collect, use, and share personal information. Data can also be a valuable tool for enhancing the safe operation of vehicles on the road today and it will be extremely important for safely developing and deploying connected and automated vehicle technologies.

Data from connected and automated vehicles have the potential to drive innovations and economic growth while enhancing infrastructure efficiency and safety. An example is smart traffic lights. At the same time, concerns such as proprietary technologies and fair access to markets are causing uncertainty in this newly developing field.

Taken together, the role of data in the various aspects related to developing and deploying connected and automated vehicles and supporting technologies have created many key policy challenges and opportunities. Both advisory group and expert working group members said that the topic of data required more attention moving forward. Because of this, several of the recommendations that the expert working groups made are related to issues around data.

Following below is an overview of the work completed by each of the expert working groups and their key findings. It includes highlights of their discussions and key challenges and opportunities. Recommended proposals for action are covered in detail in annexes B through F.

[3] There is also work underway to ensure vehicle connectivity does not include personally identifiable information through the implementation of a Canadian instance of a Security Credential Management System (SCMS) to support vehicle to vehicle (V2V) and vehicle to everything (V2X) communications.

EWG 1: Safety and security

The safety and security expert working group addressed issues in both existing and emerging vehicle technologies. More and more vehicles entering the Canadian market today are equipped with advanced driver assistance features. Examples include automatic emergency braking, blind spot warning, and lane keeping assistance. Some of these technologies feature low-level automation functions and have great potential to reduce road user deaths and injuries. Industry is doing important work to develop new vehicle technologies and mobility solutions using connectivity and higher automation systems. The safety and security implications of these systems will need to be further examined and tested.

Government and industry must respond proactively and appropriately to new safety and security benefits and challenges presented by rapidly evolving connected and automated vehicle technologies. Government and industry must also understand that a technological change on this level is by its nature filled with risk and circumstances that can't be predicted.

Addressing new challenges requires a forward-looking approach and flexible non-regulatory tools, including interventions beyond traditional regulations and standards, to help effectively manage risks, promote safety and security, and support technological innovation and its associated socio-economic opportunities for Canadians.

Mandate

The working group provided advice to the advisory group on the safety and security considerations for developing, testing, and deploying connected and automated vehicles on Canadian roads. They also advised on specific technical issues that Transport Canada plans to address as part of its forward work plan.

Key issues

Connected and automated vehicles are rapidly developing technologies. While there is pressure to support innovation and flexible safety frameworks for emerging technologies, the safety, security, and prosperity of Canadians remains a top priority.

Ongoing work to support these priorities includes exploring how to:

- safely and securely test and deploy innovative technologies
- use flexible tools and consensus-driven codes, standards, and guidelines
- ensure safety while supporting Canadian technological innovation
- promote alignment of domestic and international safety requirements

Discussion highlights

The expert working group was a valuable information sharing forum where members identified priority areas of concern and gave briefings on relevant initiatives to advance the state of connected and

automated vehicle safety and security. They developed a forward-looking work plan which was included in the expert working group's action proposal. The action proposal will inform government efforts on connected and automated vehicle safety and security moving forward.

Working group members discussed opportunities to help with the work that Transport Canada is leading to inform the development of regulations and standards for connected and automated vehicles. This includes encouraging connected and automated vehicle research and developing non-regulatory tools. As such, members reviewed and provided Transport Canada with strategic advice on key initiatives for connected and automated vehicle safety and security such as Transport Canada's forward looking regulatory agenda and key emerging issues including:

- cyber security
- ethical considerations related to connected and automated vehicles
- enhancing consumer awareness of the capabilities and limitations of emerging vehicle technologies
- safe testing of low speed automated shuttles and cooperative truck platooning systems

EWG 2: Innovation and competitiveness

With more integration of connected and automated vehicle technologies in the Canadian automotive space comes both important economic opportunities and risks for Canadian companies and workers. However, we also expect the increased integration to create a disruption. The disruption will require adopting new strategies to support the sector's long-term global economic competitiveness. Developing a coordinated, collaborative, and strategic approach is needed to help minimize the potential impact and maximize the benefits of this transition.

Canada is in a good place to play a leading role to develop connected and automated vehicles. Not only does Canada have an established automotive manufacturing footprint, but it is also home to the largest information technology cluster in North America outside Silicon Valley. This includes world-renowned experts in technologies, such as artificial intelligence, that are essential to developing the vehicle of the future.

Canada's significant ecosystem of companies, academics, developers, and test-beds to deploy Intelligent Transportation Systems (including smart infrastructure technologies) will be essential to enabling the highest levels of automation across the transportation system.

Also, while original equipment manufacturers, suppliers, and tool makers are mainly in Southern Ontario, work is expanding across the country, including electrification initiatives in Quebec and fuel-cell development in the West.

Canada can advance its position as a leading jurisdiction in the evolution of connected and automated vehicles. This can be achieved by focusing on attracting and developing talent, promoting the design, manufacturing, and deployment of advanced technologies, and on growing and strengthening Canadian companies.

Mandate

The working group was tasked with discussing how the broad range of stakeholders in Canada's connected and automated vehicle space can work together to promote innovation and competitiveness. They also discussed how to leverage the current ecosystem to ensure Canada is ready to address the barriers and opportunities associated with integrating emerging vehicle, intelligent transportation, and broader mobility technologies.

Key issues

As the federal government works together with the broad range of stakeholders in this space to be the leading destination for testing, designing and manufacturing vehicles of the future and smart infrastructure, it will need to explore how to best attract and develop Canadian talent. It will also need to promote the design and execution of advanced technologies, as well as expand and strengthen Canadian companies.

Besides these considerations, advisory group members also identified the following key areas of focus to be included under the theme of innovation and competitiveness:

- leveraging Canada's current strengths to contribute to future growth
- the role of data and the structure of the data market in driving innovation
- potential risks and gains for existing business models, including their impacts on Canadian workers
- supporting innovation and growth through regulations, standards and guidelines
- maximizing the role of governments and industry in supporting innovation and transition

Discussion highlights

The innovation and competitiveness expert working group's discussions focused on four main themes:

1. Connecting the ecosystem of researchers, multinational enterprises, small and medium-sized enterprises, and start-ups to ensure a coordinated approach to advance automotive innovation, and to support an enabling environment for Canadian firms to effectively grow. At the same time, anticipating a potential decrease in other areas of the economy.
2. Increasing support for pilot deployments and demonstration trials that are sustainable, coordinated and integrated into Canada's polices and programming. These pilot deployments and trials will address cross-cutting issues and take into consideration other modes of transportation beyond the scope of autos, such as cycling, bus, and rail.
3. Identifying specialized areas of Canadian expertise. Examples include:
    - cyber security
    - hydrogen fuel cell technology
    - artificial intelligence

- intelligent transportation system technologies

4. Developing the underlying policy and programs context required for innovation to take place. These policies and programs will encourage:
    - the free flow of data
    - intellectual property rights
    - data standardization
    - holistic employment approach based on strong risk management

The discussions focused largely on three topics. The first was how to increase support and resources for pilot deployments and demonstration trials as a way to connect the Canadian connected and automated vehicle ecosystem. Secondly, how to scale Canadian firms. Lastly, how to achieve an integrated approach to emerging mobility technologies.

Some challenges raised by the expert working group members included automakers and original equipment manufacturers having to shift from traditional manufacturing approaches to new areas, such as selling services and technology. Members also said that transferring knowledge from pilot projects will be important in order to build on the lessons learned rather than to solve something that has already been solved.

Members also identified specific strengths that will help promote Canada as a leader in advanced connected and automated vehicle technologies, including artificial intelligence and cyber security. Members also raised the issue of the importance of data throughout the discussions. This included how it is collected, owned, used, and shared to enable innovation in a competitive marketplace.

Members identified the need to ensure access to the market tools necessary to participate in these emerging markets as a key competitiveness challenge to be addressed. At the same time, members stated that sharing data and information with stakeholders across multiple sectors allows barriers and vulnerabilities, such as cybersecurity, to be addressed.

EWG 3: Digital and physical infrastructure

The foundation of the transformation towards automation and connectivity is the digital and physical infrastructure that makes it possible. While it is impossible to predict and prepare for all the potential impacts of connected and automated vehicles, leading international jurisdictions are making early strategic investments in their digital and physical transportation infrastructure. They are preparing to support the introduction of the vehicle of the future.

These investments are accelerating new connected and automated vehicle innovations and pilot testing. The investments are also setting the stage for large-scale deployments by promoting interoperability across jurisdictions. Interoperability can be defined as different systems and technologies that are compatible.

Communicating and implementing a clear and consistent Pan-Canadian approach to digital and physical infrastructure investments is essential. It will help the country prepare for a future of connected and automated vehicle technologies, future-proof our current infrastructure investments, and maximize the global competitiveness of our automotive sector.

All orders of government will need to make infrastructure investments to support the broad deployment of connectivity and automation. The decisions that governments make will either help develop new transportation products and services today, or discourage future innovation.

Important roles that the federal government will have include:

- supporting the development of standards
- aligning requirements domestically and internationally
- funding for sustainable pilot deployments aligned with national policy frameworks

Mandate

The working group discussed and provided advice on:

- digital and physical infrastructure requirements and changes
- long-term infrastructure planning for system-wide impacts of connected and automated vehicles
- interoperability of connected and automated vehicle infrastructure between jurisdictions
- weather and environmental conditions
- connected and automated vehicle and mobility services (public transit, in particular)
- city design
- land use planning

Key issues

To achieve a clear and consistent approach to digital and physical infrastructure to prepare for future mobility technologies, it will be important to consider four key issues:

1. standards to promote interoperability of connected and automated vehicles and Intelligent Transportation Systems
2. physical and digital infrastructure investments
3. cyber security resiliency
4. connectivity requirements

Besides these considerations, advisory group members also identified key areas of focus to be included under the pillar of digital and physical infrastructure. These include:

- the extent that connected and automated vehicles depend on smart infrastructure
- the diverse infrastructure needs in rural and urban contexts
- municipal, provincial/territorial, federal, and industry roles in filling infrastructure gaps

- municipal capacity
- shared mobility and public benefits

Discussion highlights

Physical and digital infrastructure

Current physical infrastructure in communities has been designed with the needs of human drivers in mind. Expert working group members highlighted that substantial changes will be needed as vehicles move past the current state of limited connectivity and varying automated capabilities to a scenario where connected and automated vehicles communicate with infrastructure and share the road with human-operated vehicles and pedestrians, and eventually where nearly all vehicles are connected and automated.

The main physical infrastructure requirements are roadside units and their associated radio-spectrum requirements. These are specialized devices that support communications between vehicles and physical infrastructure (V2V or V2X). V2X stands for vehicle-to-everything and is a type of vehicular communication system. V2X is a core element to support the highest levels of automation. For example, it complements on-board vehicle sensors, such as LiDAR (measures distance using light), radar, and cameras.

Provinces and municipalities will need to consider how they manage existing infrastructure as connectivity increases. This includes developing a proactive Traffic Demand Management strategy, and deploying infrastructure to support safe automation, such as smart traffic intersections and other traffic control devices. Other digital and physical infrastructure considerations the expert working group members discussed include:

- implications for grid requirements across the country
- high-definition 3D roadway maps
- position-navigation-timing requirements
- digital infrastructure that can manage and analyze a multitude of data sources to enable big data and artificial intelligence
- Intelligent Transportation Systems that include a broad range of technologies, such as sensors
- communications
- traffic control
- electronic tolling

Interoperability

Successfully deploying connected and automated vehicles across Canada will require the interoperability of equipment and infrastructure design standards across interprovincial and international borders. Vehicles will need to be able to communicate across a range of models and technologies.

Expert working group members agreed that a strong communications framework, comprised of policy, technical standards, funding, and governance, would be necessary.

The Intelligent Transportation System Architecture for Canada, developed by Transport Canada, is a common framework for planning, defining, and integrating intelligent transportation systems. It will need to be updated so that vehicles can communicate with infrastructure.

Also, a Security and Credential Management System could help ensure vehicle communications are secure. The federal government will need to work with provinces, territories and municipalities, along with the Transportation Association of Canada, and other standards development organizations, to develop standards for infrastructure, and traffic control devices that consider connected and automated vehicle requirements.

Public transit

Without appropriate action, connected and automated vehicles could pull users away from public transit because of the added convenience of connected and automated vehicles compared to conventional vehicles, making public transit even less competitive. With appropriate action, connected and automated vehicles can complement public transit systems which could lead to an increase in transit passengers and a decrease in congestion. For example, connected and automated vehicles can be used as first-mile/last-mile solutions to bring people to transit hubs. Also, public or privately owned shared vehicle systems can shuttle people to and from transit hubs. Connected and automated vehicles can also reduce the need for parking around transit hubs which leaves more room for transit-oriented development.

City design

Without appropriate action, connected and automated vehicles could increase congestion or vehicle kilometres travelled because connected and automated vehicles will be more convenient than conventional vehicles, leading to longer or more frequent trips**.**

Municipalities may consider shifting away from a car-centric design. For example, connected and automated vehicles give Canadian cities the opportunity to re-imagine their streets with less of an emphasis on vehicle transport and more on spaces dedicated to activities such as walking, cycling and public use.

Also, safer vehicles mean narrower streets, and narrower streets mean more room for pedestrians and additional green space**.** Finally, reduction in parking can lead to denser, more walkable neighborhoods, which lead to business growth, more affordable housing, and greater access to public spaces. Without appropriate policies, connected and automated vehicles could contribute to continued urban sprawl, increased congestion, and emissions.

EWG 4: Data privacy and security

Integrating digital technologies, such as wireless and sensor-based infrastructure, data and analytics, and the "internet of things", within existing transportation systems is creating:

- new possibilities for transport operations and services
- improvements to safety and efficiency
- environmental sustainability
- economic opportunities for jobs and investments

But the combination of computer-based controls and connectivity in vehicles and intelligent transportation systems also exposes these systems and the vast amount of personal information generated by these systems to a growing number of threats to privacy and data security.

Privacy advocates are concerned that such data harvesting capabilities will allow connected and automated vehicle suppliers to profile, monitor and make decisions about individuals without their knowledge and can also lead to malicious use of information by hackers.

Within the Canadian marketplace, collecting, using or disclosing personal information by original equipment manufacturers and other parts suppliers is governed by Canada's *Personal Information Protection and Electronic Documents Act* as well as by similar provincial legislation. However, the legal obligations set out in the Act are purposely broad, so it may be challenging for connected and automated vehicle suppliers to understand what their specific obligations are without more industry-specific guidance.

Mandate

The working group explored the challenges and opportunities related to transforming vehicles into mobile communications devices that can process significant amounts of personal information. Innovations are creating new business models and benefits for consumers.

Key issues

The combination of new ways to transmit data over long distances through wireless connectivity has transformed vehicles into mobile communication devices with data harvesting capabilities. The application of big data analytics to connected and automated vehicle technologies is giving traffic managers and users better decision-making abilities.

But at the same time, these changes represent significant risks to the privacy of drivers and passengers. These privacy implications form a core consideration for developing and deploying connected and automated vehicle technologies. Other core considerations are the potential for data to be exposed to hackers after the development of new networks and technologies for connected and automated vehicles, and the potential for remote compromise and remote interference.

Advisory group members identified more key areas of focus that they could work on including:

- the responsible treatment of data (beyond personal)
- ensuring privacy protections are respected, while encouraging innovation and supporting a competitive emerging market
- the international alignment of data standards, regulation and policy
- data opportunities and benefits
- data access and ownership
- consumer expectations and education about what data is shared, and with whom, how, and when
- over-the-air technology risks and standards
- connected and automated vehicles as one component of the "internet of things"
- ethical considerations

Discussion highlights

The expert working group discussions focused on developing a code of practice that could address the wide array of issues surrounding data privacy and security and connected and automated vehicles. At the start of any process to develop a code of practice, there will be a need to determine whether following the code would be mandatory or voluntary. There are pros and cons to both approaches, and connected and automated vehicles could be a test case for privacy codes of practice in other industries.

Members also provided feedback on the launch of the Government of Canada's Digital Charter and an Innovation, Science and Economic Development Canada discussion paper on options to modernize the *Personal Information Protection and Electronic Documents Act*.

There was also a proposal to encourage the use of standards and codes as part of the *Personal Information Protection and Electronic Documents Act* reform. This could involve formal recognition in the Act of instruments such as codes as a way of demonstrating compliance.

EWG 5: Distributive social impacts and risks

Advancements in vehicle automation and connectivity can offer many benefits and opportunities, but these technological improvements and their long term effects will not only touch on technology and innovation.

These changes will increasingly have a social and human impact in many areas including:

- consumer behavior and adoption
- accessibility
- human productivity
- labour market changes

- insurance
- environmental benefits

In the end, the changes will also influence how Canadians adjust to, and then adopt these new technologies.

Canada can aim to be a global leader in this industry, which directly or indirectly employs millions of people. Through targeted actions to prepare for the transformation of Canadian society our country can:

- leverage economic, social, and environmental benefits
- advance innovation and skills
- recognize the potential for increased safety (including reduced collisions)
- improve accessibility and mobility opportunities for Canadians

Mandate

The working group explored challenges and opportunities related to**:**

- labour market changes:
    - the creation, elimination, and transformation of jobs, depending on the sector
    - up-skilling workers (teaching workers new skills), retraining, and communicating change
- urban versus rural and remote contexts:
    - the impacts on cities, and rural and remote locations because of the changes in car use and ownership by companies and individuals
- enhanced accessibility and mobility:
    - the potential for more flexible and accessible transportation options for individuals including aging population, underserved populations, youth and people with disabilities
- insurance:
    - changes in insurance liability (machine vs. human), and distribution of risk

Key issues

As automation and connectivity in vehicles continues to develop, there are several areas that will ultimately influence how Canadians adjust to, and later adopt these new technological changes. These changes will increasingly have a social and human impact in areas such as:

- consumer behavior and adoption
- enhanced accessibility and mobility
- urban versus rural and remote areas
- increased human productivity
- insurance
- labour market changes
- environmental impacts

Besides these considerations, advisory group members identified more key areas of focus that members of the working group could take into consideration. These included:

- urban design
- congestion
- land use planning
- GHG impacts
- ethics
- public education for users, non-users and city planners

Discussion highlights

The expert working group focused its discussions around four main themes:

1. labour market impacts
2. urban and suburban versus rural and remote
3. enhanced accessibility and mobility
4. insurance

The pace of the transition toward automated vehicles is important, and the conditions and constraints, and subsequent impacts on labour, will change as the transition happens over time.

Different scenarios could develop over different timelines, and impact and risk frameworks for different segments of Canadian society will need to be adjusted accordingly. Members said that work is required to prepare Canada's future workforce with the skills needed for a more automated future. At the same time, we must ensure that current skills shortages, such as long-haul trucking, aren't worsened. Potential impacts could be divided by macro impacts (economic and trade) and sectoral impacts (supply chain approach).

Urban and suburban areas are most likely to see connected and automated vehicle deployments and benefits first. Differences in land use, transportation infrastructure layout, and density shape a variety of possibilities and risks.

First and last mile transit may be complicated for certain segments of Canada's population. Because of this, members agreed that deployment can't be limited to downtown areas, and that policy efforts should also support marginalized regions.

There is also a need to ensure connected and automated vehicles interact respectfully with pedestrians, cyclists, and vulnerable road users. Members said that vehicle design elements that accommodate accessibility need to be considered at the beginning of the overall vehicle design process. While difficult to design a "one size fits all" vehicle, a connected and automated vehicle brand of "fully accessible" could be useful.

Finally, in a connected and automated vehicle future, the shift that will happen for collision responsibility from human to vehicle manufacturer or technology provider could mean people in

accidents will have to go through a long and complex product liability court process to be compensated, instead of being able to rely on traditional auto insurance. Members stressed the importance of timely compensation and avoiding long mitigation processes for insurance-related matters.

Expert working group members also discussed after-market collision repair issues such as the cost of repairs and impacts on insurance claims. Another issue they discussed was the availability of businesses that can repair automated vehicles, along with the risk of unfair market practices that would give advantages to businesses with access to the vehicle technology.

Conclusions

Emerging trends in the automotive sector are transformative in nature. Focusing on connected and automated vehicles, their benefits, and impacts will have long lasting effects on many parts of society and the economy.

In order to develop and deploy connected and automated vehicles on Canadian roads, all levels of government, industry, academia, and international jurisdictions will need to work together to identify clear objectives and avoid a patchwork of policy and regulatory approaches in response to the technology. Working together, these stakeholders can identify early challenges and opportunities, actionable items, and knowledge gaps to help determine the steps needed to ensure a coordinated and cohesive policy framework.

Beyond this report, more work is needed to explore policy implications as the federal government works toward developing a national approach to connected and automated vehicles, and identifying measures that address their safety, security, ethical, socioeconomic, and technical challenges, while securing Canada as a global leader in this space.

At their last meeting on June 26, 2019, the advisory group members collectively agreed to this document, which summarizes the themes and various expert working group discussions and advice received during a six-month period. Members also agreed that the work of the advisory group would explore the opportunity to meet again after the 2019 federal election to continue the dialogue on the ever-evolving file of connected and automated vehicles.

Innovation, Science and Economic Development Canada and Transport Canada would like to thank everyone who has contributed their time and knowledge toward the work of the advisory group and of the expert working groups to date.

Annex A: Expert working group members

Note: Along with the expert working group members mentioned below, the advisory group would like to acknowledge the many contributions of Government of Canada staff in developing expert working group recommendations and enabling the proceedings of the advisory group from start to finish.

Safety and security

- Michael DeJong, **Transport Canada, *Co-Chair***
- David Adams, **Global Automakers of Canada, *Co-Chair***
- Colin Dhillon, **Automotive Parts Manufacturers' Association**
- Jason Kerr, **Canadian Automobile Association**
- Mark Nantais, **Canadian Vehicle Manufacturers' Association**
- Karen Hou, **Canadian Vehicle Manufacturers' Association**
- Greg Overwater, **Global Automakers of Canada**
- Sarah Wells, **Transportation Association of Canada**
- Geoff Noxon, **Transportation Association of Canada**
- Rob Brian Robinson, **Honda**
- Ryan Stein, **Insurance Bureau of Canada**
- Charles Boulanger, **LeddarTech**
- Daniel Aitken, **LeddarTech**
- Matthew Avery, **Thatcham Research**
- Chris Tubbe, **Toyota**
- Allison Fradette, **Canadian Council of Motor Transport Administrators**
- Adam Hatfield, **Communications Security Establishment**
- Wendy Doyle, **Government of Alberta**
- Walter Espinoza, **Government of Alberta**
- Sarah Korpan, **Government of Alberta**
- David Johnson, **Ministère des transports du Québec**
- Robert Asselin, **Blackberry Ltd.**

Innovation and competitiveness

- Warren Ali, **Automotive Parts Manufacturers' Association, *Co-Chair***
- Charles Vincent, **Automotive, Transportation and Digital Technologies, ISED, *Co-Chair***
- Craig Hirota, **Associated Canadian Car Rental Operators**
- Robert Asselin, **Blackberry Ltd.**
- Mark Nantais, **Canadian Vehicle Manufacturers' Association**
- Shagithya Deivendran, **Transportation Services, City of Toronto**
- David Adams, **Global Automakers of Canada**
- Gina van Dalen, **ITAC**
- Christianne Moretti, Partnerships, **MaRS Discovery District**
- Sarah Houde and Karine Villeneuve, **Propulsion Quebec**
- Erin D'Alessandro, **WaterlooEDC**
- Jean-François Champagne, **Automotive Industries Association of Canada**

- Josipa Petrunic, **Canadian Urban Transit Research & Innovation Consortium**
- Stephanie Medeiros, **EV Charging Infrastructure Canada, ABB**
- Philippe Beaudoin**, Element AI**
- Kelly Daize, **Ottawa Autonomous Vehicle Program, Invest Ottawa**
- Jean-Francois Tremblay, **Jalon MTL**
- Raed Kadri, **Ontario Centres of Excellence**
- Anjali Gupta, **Thales Group**
- Dr. Mitra Mirhassani, **Electrical and Computer Engineering, University of Windsor**
- Ross McKenzie, **University of Waterloo, WatCAR**

Digital and physical infrastructure

- Tushara Williams, **Infrastructure Canada, Co-Chair**
- Jean Lawson, **Federation of Canadian Municipalities, Co-Chair**
- Denis Gingras, **University of Sherbrooke**
- Wendy Reuter, **Canadian Urban Transit Association**
- Dr. Lina Kattan, **University of Calgary**
- Stephanie Simard, **TTC**
- Raseeka Rahumathulla, **Volkswagen Group Canada**
- Neil Ternowetsky, **Trainfo**
- Andrew Miller, **Sidewalk Labs**
- Greg Overwater, **Global Automakers of Canada**
- Ryan Lanyon, **City of Toronto**
- Joanna Clark, **City of Vancouver**

Data privacy and security

- Robert Asselin, **BlackBerry Ltd., Co-Chair**
- Adam Kardash, **AccessPrivacy (a division of Osler), Co-Chair**
- Patricia Kosseim, **AccessPrivacy, Co-Chair**
- Craig Oldham, **Public Safety Canada, Co-Chair**
- Charles Taillefer, **Innovation, Science, Economic Development Canada, Co-Chair**
- Ryan Schwartz, **Public Safety Canada**
- David Adams, **Global Automakers of Canada**
- Sonia Carreno, **Internet Advertising Bureau**
- Erin Chreptyk, **Automotive Industries Association of Canada**
- Sukhjit Dhaliwal, **Intact**
- Mario Fiorino, **Insurance Bureau of Canada**
- Kevin Henry, **ESCRYPT**
- Craig Hirolta, **Associated Canadian Car Rental Operators**
- Ian Kerr, **University of Ottawa (as an individual)**
- Jason Kerr, **Canada Automobile Association**
- Philippa Lawson, **privacy lawyer and connected and automated vehicle expert (as an individual)**
- Eric Lawton, **City of Toronto**
- Sam Luinstra, **Canadian Vehicle Manufacturers' Association**
- Migan Megardichian, **Volkswagen Group Canada**

- Jason Millar, **University of Ottawa (as an individual)**
- Marina Pavlovic, **Assistant Professor of Law, University of Ottawa (as an individual)**
- Sherry Shannon Vanstone, **S.V. Initiatives**
- Huw Williams, **Canadian Automotive Dealers Association**
- Murray Rosenthal, **City of Toronto**

Distributive social impacts and risks

- Craig Hutton, **Transport Canada, Co-Chair**
- Armine Yalnizyan, **Economic and Social Development Canada (ESDC), Co-Chair**
- Ian Jack, Canadian **Automobile Association**
- David Ticoll, **University of Toronto**
- Barrie Kirk, **CAVCOE**
- Dr. Judy Farvolden, **University of Toronto**
- Findlay Sams, **Honda**
- Ryan Stein, **Insurance Bureau of Canada**
- Kevin Smart, **Aviva**
- Gina van Dalen, **Information Technology Association of Canada**
- Garland Chow, **University of British Columbia**
- Pedro Barata, **United Way, Greater Toronto**
- Rajeev Roy, **Regional Municipality of York**
- Jutta Treviranus, **Ontario College of Art and Design**
- Lui Greco, **Canadian National Institute for the Blind**
- Rob Davidson / Alexandra Cutean, **Information and Communications Technology Council**
- Angela Splinter, **Trucking HR Canada**
- Joie Warnock / Lana Payne / Bill Murnighan, **Unifor**
- Luciana Nechita, **Automotive Industries Association of Canada**

Annex B: Safety and security action proposal paper

Proposed action #1: Develop a regulatory agenda and technical work plan

Members shared information about their work on connected and automated vehicles in Canada. They also reviewed and gave strategic advice on key projects related to safety and security, like the forward looking regulatory agenda. The agenda aims to keep pace with advances in vehicle technology and brings us closer to Vision Zero (the international goal of zero deaths and serious injuries on roads).

Members also discussed ways to support Transport Canada as it develops regulations and standards for connected and automated vehicles, including research and developing non-regulatory tools. In addition, the working group discussed key emerging issues such as cyber security, ethical considerations related to automated vehicles, enhancing consumer awareness of the capabilities and limitations of emerging vehicle technologies, and the safe testing of low speed automated shuttles and cooperative truck platooning systems.

The working group also developed a calendar of international engagement activities related to connected and automated vehicle safety and security, which will promote information sharing among working group members on key outcomes, and allow Canada to speak with a cohesive national voice at these events on an ongoing basis. This will in turn support continued alignment within Canada, and with international safety and security requirements, programs, and standards.

Key barriers and opportunities

The working group was an opportunity for members to share information and ask for advice on key projects to support connected and automated vehicle safety and security in Canada.

The working group supported the use of non-regulatory tools which can help develop regulations, while also promoting regulatory alignment in Canada.

The use of connected and automated vehicles in Canada will be facilitated by recent changes to the *Motor Vehicle Safety Act*. These changes give the Minister of Transport new authorities to get information, use different enforcement actions, give companies an exemption from standards when safety isn't compromised, and change or suspend regulations with more flexibility.

Timing

The actions proposed in the technical work plan are expected to take place over the next 1 to 2 years, and will support Canada's vision on safety and security for connected and automated vehicle. In the short term, Transport Canada will continue to work with stakeholders to create tools to support new connected and automated vehicle regulations, including:

- Canada-wide cyber security guidance for connected and automated vehicles
    - This will support industry by making sure that cyber security practices are incorporated

into the design, testing and use of these vehicles

- A scoping paper on safety considerations for Cooperative Truck Platooning Systems
- A scoping paper on safety consideration for trials involving low speed automated shuttles

Along with developing these non-regulatory tools, engaging with international standards setting bodies, like the International Organization for Standardization (ISO), SAE International, and the United Nations Economic Commission for Europe, will help create globally consistent safety requirements for connected and automated vehicle technologies. Timelines for this work will vary depending on the technology and standard in question. International collaboration is expected to take several years as these technologies evolve and mature.

Stakeholders involved

The stakeholders involved in connected and automated vehicle safety and security are diverse and represent a broad range of needs and interests, including all levels of government, academia, and road safety groups. They also include industry representatives like original equipment manufacturers, suppliers, technology firms, and transportation providers.

Links

Cyber security

A working group member from the Communications Security Establishment's Canadian Centre for Cyber Security (the Cyber Centre) provided information to the working group on the Cyber Centre's role as the Government of Canada's technical expert on cyber security and cryptography, and presented on Canada's cyber security posture.

Building on this presentation, BlackBerry QNX presented key issues they felt should be addressed through standards, like operating system security, chip security, and data privacy and security, among others.

The Automotive Parts Manufacturers' Association spoke about their cyber security committee which was created to provide best practices to Canadian automotive parts suppliers. The committee, which Transport Canada has joined, will be creating a governance model framework and toolkit.

Consumer awareness

The Canadian Automobile Association provided relevant and timely information on their research on Canadians' perceptions of connected and automated vehicles, perceived benefits, and concerns. Notably, their polling data highlights data privacy and information sharing as key concerns among the Canadian public. Consumer education was highlighted, including a Canadian Automobile Association website that educates consumers about connected and automated vehicle safety technologies. The website was launched in May 2019.

Toyota also shared the resources they use to educate buyers on the advanced driver assistance system features in their vehicles.

Thatcham Research shared their "Defining Safe Automation: A framework for regulating automated driving" document, which includes key criteria that automated driving systems must meet in order to be classified as "automated".

Data privacy

As vehicle safety and security and data management are closely connected, there may be links with the data privacy expert working group. The federal departments involved, including Transport Canada, the Office of the Privacy Commissioner of Canada, and Innovation, Science, and Economic Development Canada, will continue to work together, and with national stakeholders, to address these complex issues.

Testing

Alberta Transportation highlighted its alignment with Transport Canada in their proposed approach to connected and automated vehicles, which includes principles like a smarter approach to innovation, and a regulatory review. They also provided information on their current testing projects.

International forums

Transport Canada gave an update on its work in various international forums to develop guidance, standards and recommendations, and share best practices on the safe testing and deployment of connected and automated vehicles.

At the United Nations Global Forum for Road Traffic Safety, Transport Canada works with other countries to develop resolutions that include recommendations for automated driving systems and users of connected and automated vehicles in relation to the 1949 and 1968 road traffic conventions. Transport Canada participates in various connected and automated vehicle working groups under the World Forum for Harmonization of Vehicle Regulations to develop international standards for connected and automated vehicles. Transport Canada also participates in similar working groups under various international standards organizations, like SAE International and the International Organization for Standardization.

Research questions

Working group members discussed ways to contribute to the global body of evidence on emerging vehicle technologies by using federal resources.

Notably, Transport Canada's Motor Vehicle Test Centre is a government-owned testing ground located in Blainville, Quebec which does an array of connected and automated vehicle tests. This includes evaluating the performance of advanced driver assistance systems like:

- automatic emergency braking
- lane keeping assistance
- pedestrian detection and avoidance systems
- cooperative truck platooning systems
- vehicle-to-vehicle communication

The centre's research is also looking at the limits of these systems to identify potential risks to road safety, and to provide scientific evidence to help develop regulations for connected and automated vehicles.

Transport Canada is also running driving simulations to develop ways to evaluate the safety of driver interactions with automation, and explore test methods, interface design, and the importance of appropriate trust in automation. This research will help develop standards and guidelines for safety practices.

In addition, non-federal stakeholders will be able to pursue new research and implementation solutions to support connected and automated vehicle safety through the Enhanced Road Safety Transfer Program. The resources committed in Budget 2019 will support provinces and territories in working toward aligned road safety requirements, including for the use of connected and automated vehicles.

Funding will also be available to other stakeholders, like academia and industry associations, to identify innovative road safety options, including emerging technologies. This program complements Transport Canada's existing Program to Advance Connectivity and Automation in the Transportation System, which helps Canadian jurisdictions address technical, regulatory and policy issues related to connected and automated vehicles.

Communication and educational opportunities

The Government of Canada's web presence for connected and automated vehicles was launched in February 2019. This web presence provides information on what emerging vehicle technologies are, their benefits, and safety considerations; highlights the non-regulatory tools available for testing and deploying connected and automated vehicles; presents information about the testing of new vehicle technologies taking place throughout Canada; and provides an overview of the Government of Canada's funding opportunities in this space.

The website's goal is to educate the Canadian public on these technologies, including their functionalities and limitations, in order to promote safe driving practices on public roads.

Consumer awareness and acceptance of connected and automated vehicles is an area where Transport Canada is exploring a range of methods to reach the Canadian public. The department is currently conducting research to better understand the Canadian public's awareness of and confidence in new automated vehicle technologies, and how they learn about them. Ultimately, this research will help

inform future collaboration with a diverse range of stakeholders on ways to improve consumer awareness of new vehicle technologies in order to promote their safe and secure use on Canadian roads.

Considerations

While there is pressure to adapt quickly to emerging technologies, the safety and security of Canadians remains a top priority. Ongoing work in support of this commitment will be guided by:

- a new and innovative approach to regulation and non-regulatory tools
- timely, thorough and transparent engagement with stakeholders
- clear and consistent oversight
- a commitment to regularly review and improve safety requirements, frameworks and non-regulatory tools

Annex C: Innovation and competitiveness action proposal paper

Proposed action #1: A collaborative framework for big data collection

Data is key to transforming existing industries and developing new opportunities. Developing an open and accessible data trust (an approach to looking after and making decisions about data) and sharing protocols could help manage the vast amounts of data being collected by vehicles and can help standardize, maintain, and manage how data is used and shared.

Governments, municipalities, cities, academics, innovators, and companies could access data directly, remotely, in real-time or based on specific procedures to improve technology, overcome obstacles, address policy constraints, and share best practices.

Creating an open and accessible data trust could happen through:

Pilot projects

There are a number of connected and automated vehicle pilot projects currently in Canada. A single, shared framework could allow cities, academics, non-profits, and industry to learn about the results of the pilot projects, share best practices, make sure each pilot builds on previous ones, and offer guidance to public policy makers on how they should shape regulations. Pilot projects could also be used to develop a standard set of performance metrics.

Consultations

Understanding the type, format, and timeframe for collecting data would help different parties participate in new opportunities as a way of attracting new investment. Consulting a wide range of stakeholders in this space could help us better understand vehicle data uses, types, and formats, and how to integrate this information into policy decisions.

Reviewing legislative and regulatory frameworks

As vehicle technologies evolve, it is important to make sure that laws and regulations stay up to date while also maintaining regulations that encourage innovation. Reviewing the existing laws and regulations that relate to connected and automated vehicles could help us adapt to these changes and make sure that Canada's automotive industry is open, fair, and competitive.

Key barriers and opportunities

Vehicle data will drive opportunities, innovation, and productivity for the automotive and transportation sector. New areas of competition, new business models, and new entrants could be developed. There could also be many ways to use the lessons learned from pilot projects to make sure that Canada becomes a global leader in connected and automated vehicles.

The first automated and connected vehicles will likely be placed into fleets (instead of owned by private citizens). As such, many of the lessons learned will carry over across public and private fleets. A data trust would support industries and businesses with operational and competitive needs related to vehicle data, and provide access to and use of vehicle data.

A possible barrier is that industry may be unwilling to openly-share data. We could address this issue by making sure that original equipment manufacturers:

- provide feedback on some metrics, and
- understand the benefits of sharing certain datasets

Another option would be to include a requirement to share information as part of federal contribution agreements.

Another barrier could be determining details like:

- What platform would be best to host the datasets?
- Who should be responsible for overseeing the collection of data?
- How do we make sure that reporting is done accurately and that enough data is collected?

If a third-party provides the platform to collect, store and share the data, then there would need to be an agreement that includes open access to data for all participating stakeholders.

Timing

In the short-term, organizations working in this field could expand their work to create a data trust or repository (storage system) for vehicle data. They could work with new partners to explore the possibility of data sharing protocols that also respect commercial interests.

Following that, a consultation could be launched to begin building a legal, technical, and social framework for a big data trust.

Multi-year federal funding combined with provincial funding for smart mobility projects could also be tethered to the big data trust to build on the framework produced.

Stakeholders involved

Designing an interoperable, standardized, open, and accessible data trust would involve many stakeholders, including:

- original equipment manufacturers
- auto parts manufacturers
- automotive aftermarkets
- farm vehicle manufacturers and service providers

- retail auto parts suppliers
- auto insurance providers
- Canadian companies that offer data related products and services
- auto dealers
- independent garages
- academia
- not-for-profits in the mobility sector
- federal, provincial and municipal governments
- fleet operators, vehicles owners and users

Links

- The data trust could be linked to government funding programs for technology and innovation
- Standard-setting bodies need to be involved in creating the data trust so they can help create public disclosure and data collection consent systems and standards
- The data trust must protect the privacy of individual vehicle owners and users, and follow all relevant privacy laws
- The data trust should be informed by the work of the International Organization for Standardization, the Society of Automotive Engineers, and the IEEE Standards Association
- Canada's policies should be open, secure, interoperable and use the standardized interface designs developed by experts in cybersecurity, automotive engineering, and data communication working through these bodies

Other considerations

- **Consumer awareness**
    - How can we improve consumer awareness about privacy, control, and who owns a vehicle's data?
- **Cybersecurity**
    - What is the most secure method to access, send, and store vehicle data?
- **Fair market competition**
    - How could fair market competition be affected by innovations that use motor vehicle data?
    - How could fair market competition be affected by businesses who depend on accessing and using vehicle data?

Proposed action #2: Matching open data with 4D/HD mapping

In order to target the long-term needs of industry, stakeholders could encourage Canada's automotive industry to focus on the benefits and advantages of taking a leading role in developing the vehicles of the future.

The proposed action would match open data with 4D/HD mapping to create a national approach to deploy pilot projects and run trials that are sustainable, coordinated, and integrated. This could also be a way to connect, scale, and strengthen Canadian companies in the connected and automated vehicle sector.

Key barriers and opportunities

A collection of detailed and up-to-date maps could help with rolling out a 5G network, deploying connected and automated vehicles, and monitoring infrastructure. Matching open data with 4D/HD mapping could:

- increase support for pilot projects in a sustainable and integrated way
- encourage innovation by equipping Canadian industry and academia with digital infrastructure
- connect and strengthen the network of researchers, multinational enterprises, small and medium-sized enterprises, and start-ups that focus on connected and automated vehicles

Key barriers could include:

- the project's complexity
- issues around data ownership, availability and privacy, and costs of the project

Stakeholders involved

Academia, industry, government and non-governmental organizations could work together to fund a project to create real-time HD maps of Canada's streets to help with 5G rollout and automated driving and make this data available for future projects.

Cameras could be installed on municipal or utility company vehicles to record road images as they travel. These images would be processed to identify details like road signs, traffic lights, lamp posts, bollards, drains, and man-hole covers, which would then be sent to the relevant stakeholders. This in turn could be matched with open-data.

Proposed action #3: Automotive Parts Manufacturers' Association of Canada Car 2.0

In 2014/2015, the Automotive Parts Manufacturers' Association of Canada (APMA), 13 member companies, and the University of Waterloo equipped a Lexus RX350 with various technologies developed by Canadian companies. The car includes broadband connections, on-board Wi-Fi, a camera, vehicle proximity sensors, and an early-warning system that alerts drivers when emergency vehicles are nearby. The Automotive Parts Manufacturers' Association of Canada could develop another next-generation concept car (APMA Car 2.0) aiming to include more Canadian-made technologies, including zero-emission powertrains and new connected and automated vehicle technology.

Key barriers and opportunities

An APMA 2.0 concept car project could help to identify and strengthen the way Canada supports innovation, while connecting researchers, multinational enterprises, small and medium-sized enterprises, and start-ups. This will help make sure there's a coordinated approach to automotive innovation and creating an environment for Canadian firms to scale up.

Timing

There will be many timelines and goals for a project such as this, similar to the first connected and automated demonstration vehicle that led to the Autonomous Vehicle Innovation Network (AVIN) in Ontario. Key milestones of an Automotive Parts Manufacturers' Association project along these lines would be:

- Building up awareness and highlighting the core competencies of project partners
- Using existing platform-level players to support the growth of next-generation or complementary companies that complement the automated, connected, electric, and shared vehicle model
- Developing a fully-Canadian based solution, where the goal would be to design the program / narrative to tie everything together across the country – which the Automotive Parts Manufacturers' Association can easily do

Stakeholders involved

An APMA 2.0 project could create partnerships between a wide range of stakeholders, including traditional automotive industries, emerging technology start-ups, and all orders of government, as well as hydro utilities and academic institutions. This proposal could also leverage Canada's digital, advanced manufacturing, and artificial intelligence superclusters (a cross-industry collaboration of diverse organizations), and could help provinces with single utility oversight (everywhere but Ontario) to think of energy partnerships in a whole new light.

Links

- Autonomous Vehicle Innovation Network Demo Zone
- Ontario Automotive Modernization Program
- Ongoing relationship development with Propulsion Quebec and the Canadian Hydrogen and Fuel Cell Association

Considerations

- Canada's innovative automotive and auto-technology value propositions should be promoted more. These propositions should be based on more than framing Canada as an ideal jurisdiction to set up manufacturing, but also to create, develop, and improve systems and talent development networks, via the building of new platforms.

- Metrics should be developed to measure the impact of an APMA 2.0 concept car project would have on Canada’s automotive industry.

Annex D: Digital and physical infrastructure action proposal paper

Issue #1: Interoperability

Successfully deploying connected and automated vehicles across Canada will require equipment that can be used across provincial and international borders. Using different approaches will delay large-scale deployments and could keep consumers from using these vehicles.

When connected and automated vehicles are fully deployed, millions of vehicles will be broadcasting and "listening" for data, all at the same time. Vehicles, drivers, and traffic systems will all act on the information they receive.

In order for connected and automated vehicles to function, road-users must be able to trust the messages they receive. This means that each unit (vehicle) will need to confirm thousands of messages per second. In order for vehicles to travel across provincial/territorial borders or between Canada and the US, systems will need to communicate seamlessly with each other.

Key barriers and opportunities

Technology

Connected and automated vehicles will need to be highly connected to their environment, regardless of the technology used. While we don't know what technologies will be used in the future, both dedicated short-range communication and cellular-vehicle to everything (C-V2X)/5G technology are being developed and tested. As such, jurisdictions and infrastructure owners need to prepare for the possibility of different types of wireless technology being used to connect with infrastructure.

Substantial research, development, and testing has been done to develop dedicated short-range communication, including its use in connected vehicles. Dedicated short-range communication is an open-source protocol for wireless communication similar to Wi-Fi, but meant for secure, fast, low latency wireless communication between vehicles and infrastructure with limited interference from other signals and weather conditions.

Over the last few years, the information and communication technologies sector has been developing an alternative solution called cellular vehicle-to-everything (C-V2X). This technology could have better range and reliability for intelligent transportation systems that are independent of a cellular network, as well as network communications (V2N) in traditional mobile broadband licensed spectrum.

Most C-V2X testing and development currently relies on 4G LTE technology, and as 5G technology advances, this could allow better performance through greater speeds, lower latency, and the ability to connect to more devices. 5G technology is still years away from being rolled-out across Canada, and in order to support the first generation of connected vehicles it will be necessary to standardize dedicated short-range communication and/or C-V2X technology.

Both technologies operate on the 5.9 GHZ spectrum and there are concerns about preserving this bandwidth for connected vehicles, especially in the United States. For example, in the US, Toyota

announced they would postpone the deployment of its vehicle-to-everything (V2X) communication technology on vehicles in the US based on a need for greater automotive industry commitment as well as federal government support to preserve the 5.9 GHz spectrum band for dedicated short-range communication.

Backwards compatibility between some technologies may be possible (for example, 5G may be able to be bridged with C-V2X), but interoperability between dedicated short-range communication and C-V2X/5g is unlikely due to key differences in the technologies. We also don't know whether these technologies can coexist, and there are concerns about congestion and interference.

Regardless of the technology used, it will be important to establish a robust communications framework (including policy, technology standards, funding, and governance mechanisms) in order to govern the safety, security, anonymity and privacy of communications as well as ensuring the interoperability between on-board-units and roadside infrastructure.

ITS Architecture

The existing National Intelligent Transportation Systems (ITS) Architecture for Canada provides the planning tools, guidance, and support necessary to make sure ITS systems are interoperable. ITS Architecture is a critical piece for connected and automated vehicle interoperability, helping to ensure that vehicles are able to communicate with traffic signals and roadside equipment across national and international borders.

However, Canada's Intelligent Transportation Systems architecture was last updated in 2008, and does not include provisions for connected and automated vehicles. Work is being done to update and align the Canadian Intelligent Transportation Systems Architecture with the US Intelligent Transportation Systems Architecture, and this is scheduled to be completed before the end of 2019.

There also needs to be more incentives for the Intelligent Transportation Systems architecture to be consistently followed. Many companies don't follow the architecture in part because it's out of date, but more could be done to encourage compliance, possibly even through a certification process.

In addition to updating the Intelligent Transportation Systems Architecture, regional and local transportation authorities need to understand its benefits, and use the architecture as part of their planning processes, in order for interoperability benefits to be realized.

For all this to exist, significant training and awareness will likely need to be provided to make sure the architecture is followed and relevant.

Security and credential management systems

A solution called "Security and Credential Management System" is being proposed to help make sure that connected vehicle communications are secure and can be trusted. The system incorporates privacy-by-design principles, and enables communication without revealing personal information about the vehicle or the driver.

In March 2019, Transport Canada's Advance Connectivity and Automation in the Transportation System awarded a $1.3 million contract to ESCRYPT to develop a Canadian security and credential management system for connected vehicles.

As part of the contract, ESCRYPT is responsible for developing Canadian requirements for the system, and recommending an operational model for how the technology could be deployed in Canada. Similar systems are being prototyped in the European Union, Australia, and the US.

Key considerations

Regulation

One of the main reasons for the slow deployment of connected and automated vehicles is the patchwork of regulations for provincial and/or municipally controlled roadways. Manufacturers face the prospect of having to geofence (create a virtual geographic boundary) vehicle abilities according to each jurisdiction's laws, and need to build a vehicle that behaves differently when invisible boundaries are crossed.

Differences between jurisdictions

A key challenge will also be designing connected and automated vehicles that can function under different regulations, norms, environmental conditions, and infrastructure standards. Differences between jurisdictions increase the computing and variances in the decisions of automated driving systems. Different road markings and signage across Canada add to the complexity of the environment. Integrating pavement marking and signage standards for connected and automated vehicles into the Manual of Uniform Traffic Control Devices for Canada could help standardize these indicators across Canada.

Privacy

With data being constantly broadcasted, governments will need to make sure that any standards or privacy legislation accounts for the privacy needs and rights of vehicle users while being mindful of interoperability requirements.

Stakeholders involved and links

Interoperability standards can be dealt with at the industry level. Government's role is to influence the performance component of these standards (in other words, what should the performance targets be), make sure the legal and privacy rights of citizens are being respected, understand how to enforce standards, and harmonize standards across borders.

Canada will need to bring together technology, security, legal, and institutional policy experts from government and industry to work together, and with the US. The goal would be to design, implement, and deploy an interoperable, continental security and credential management system, while

maintaining Canadian sovereignty and national security, and compliance with federal, provincial, and territorial privacy laws.

Beyond the Intelligent Transportation Systems Architecture for Canada, most connected and automated vehicle standards will be developed through existing standards organizations outside of government agencies, including SAE International and the Institute of Electrical and Electronics Engineers.

The Standards Council of Canada could also be engaged to accredit Standards Development Organizations and represent Canada in international Standards Development processes. Other Canadian organization like the National Research Council, Intelligent Transportation Systems Canada, and the Transport Association of Canada will also be important players in advancing the interoperability of connected and automated vehicles and smart infrastructure.

Proposed actions

The federal government should:

- play a leadership role by bringing together provinces, territories, and municipalities to make sure systems are compatible and coherent
- work with established bodies in the US and Mexico to make sure that systems work between countries
- work to implement a certification process for connected vehicle applications and hardware interoperability across Canada
- strongly encourage the use of the Intelligent Transportation Systems Architecture for Canada
    - Doing this would require investments to maintain and upgrade Canada's Intelligent Transportation Systems architecture. Of note, the US ties access to funding from the Highway Trust Fund for Intelligent Transportation Systems deployments, to the use of the national or a regional Intelligent Transportation Systems Architecture

Issue #2: Impacts of connected and automated vehicles on public transit and mobility

With all levels of government investing billions of dollars in public transit over the next decade, it is critical that these investments factor-in a future that includes automated and connected vehicles.

Connected and automated vehicles present an opportunity to improve and complement public transit services, especially in places where mass transit is not currently possible or profitable – in other words, in low-density or low demand areas. Providing public transit to underserved areas has major advantages, including equal access to mobility for the elderly, persons with disabilities, and youth.

Due to lower labour costs, connected and automated vehicles could provide a low-cost option to increase the frequency and reliability of transit. Frequency of service has been shown to be a major obstacle to growing ridership, but is often costly for transit systems to implement due to operational

funding constraints. Automated shuttles could be used to complement existing transit services to improve frequency and convenience.

Instead of operating fixed routes, connected and automated vehicles could provide first mile/last-mile services to users, shuttling them between transit hubs and their origin or destination. The attraction of point-to-point travel for only slightly higher prices helps explain the popularity of ride-hailing in Canadian cities. Automatic vehicle shuttles could be used to drop commuters off at transit hubs, and could convey patrons from hubs to other destinations within a few kilometres radius of such hubs. Transit agencies can't offer this service now due to the cost. In the future, as buses begin using connected and automated technology, their human operators could focus on other duties on the vehicle or provide an additional level of safety for operating the vehicle.

Bus rapid transit systems are separated from normal traffic, and offer safer environments to pilot and use connected and automated vehicles. Fixed bus routes that operate in mixed traffic are another place to test automated technology, since they would have simpler technological demands.

From a policy perspective, encouraging these types of pilot projects is a good idea. Among other things, the knowledge and experience related to using connected and automated vehicles should improve a public transit authority's ability to deliver efficient service, and ensure their continued viability in the face of private connected and automated vehicle based competition. In addition, the potential for public transit agencies to expand ridership by increasing service levels in the provision of first-mile/last-mile service is obvious.

The introduction of connected and automated vehicles may align with increased Mobility as a Service options for Canadians—transportation platforms that group varied transportation options together through mobile technology and payments. This digitization of travel demand will create large amounts of data on the mobility of Canadians. This will create opportunities to improve transportation planning, but it will also raise privacy concerns for Canadians.

What needs to change?

Even if every Canadian driver used a connected and automated vehicle, this wouldn't address a major issue that cities are facing – a lack of urban roadway space. The challenges posed by limited road capacity won't change if the use of connected and automated vehicles doesn't support more use of shared use vehicles.

As such, it's important for governments to promote shared mobility, including through mass transit, in any national effort that seeks to ready Canada for a connected and automated vehicle future. The objective of such an approach might be to maintain or decrease the total number of vehicle kilometres driven, while increasing the number of passenger kilometres travelled.

In the absence of specific interventions to encourage shared use of connected and automated vehicles and integration with public transit networks, connected and automated vehicles will likely contribute to an overall increase in vehicle-kilometres travelled, congestion and greenhouse gas emissions, as well as

a decrease in demand for public transit, walking, and cycling. While the arrival of connected and automated vehicles together with other transportation innovations (electric vehicles, ride-hailing, journey planning apps, etc.) offer possibilities to encourage a greater reliance on shared forms of transportation, deliberate policy action at all levels of government will be needed to achieve desirable outcomes in efficiency and sustainability when connected and automated vehicles are deployed on a larger scale.

Using connected and automated vehicles for public transit design is needed to preserve and strengthen the benefits that encourage public transit ridership, and to compete with low-occupancy vehicles on a cost and reliability basis. Municipalities must identify and utilize policy tools that optimize the benefits of high occupancy connected and automated vehicle transit to lower congestion on their roads and lower greenhouse gas emissions.

Connected and automated technology can increase the safety of transit systems while decreasing operating costs. Installation of connected infrastructure along major transit routes will allow for transit vehicles to communicate with infrastructure that gives priority access to transit, like traffic signals, as well as inform advanced driver-assistance systems about potential hazards. Connected infrastructure can increase operational efficiency, increase safety and in turn, decrease associated insurance costs.

Technology and other forms of transit including electric scooters or shared bikes can also be incorporated into transit networks and transit hubs, increasing last-mile connectivity where vehicles are unable to operate effectively. Municipalities and transit agencies need to start building up the capacity to incorporate these technologies into their operations to make sure their services are able to compete with personal vehicle ownership.

Consensus among experts is that maximizing the potential societal benefits of connected and automated vehicles requires a proactive response on behalf of all levels government to encourage shared versus individual connected and automated vehicle use. The most promising categories of policy response include effective road pricing, integrated multimodal mobility hubs, incentives that encourage shared use, and the incorporation of connected and automated vehicle technology into public transit fleets. Going forward, transit system design that incorporates these factors, with a specific focus on improving and building strong mass transit lines and improving first-mile/last-mile service, will support continued viability and success of transit systems.

Early opportunities

Recently, there has been a lot of progress in developing small, low-speed, electric, automated shuttles as a way to improve transit services. These shuttles are being extensively tested, including through the Canadian Urban Transit Research & Innovation Consortium who are working with twelve Canadian municipal jurisdictions on possible first-mile/last-mile transit solutions. These trials include:

- the standardization of vehicle-to-vehicle and vehicle-to-infrastructure communication protocols
- interoperability standards for manufacturer equipment
- standardized cybersecurity protocols

The City of Candiac, supported by the Quebec Government, in collaboration with Propulsion Québec and private sector partners, have set up a pilot project that will run a 100% electric automated shuttle on public roads, a first in Canada. The shuttle, with a capacity of 15 people, will ferry passengers along a two kilometre route making five stops along the way. The shuttle is able to autonomously cross an intersection thanks to a connected smart traffic light and operates in mixed traffic while connecting riders with other transit routes. Similar trials are also now underway in the cities of Edmonton and Calgary.

Key considerations

Socioeconomic benefits

For the most part, policy discussions has been technical in nature, focused on distinct areas like safety, liability, privacy, and cybersecurity. Governments at all levels, as well as private sector stakeholders and the general public, must identify the socio-economic objectives of connected and automated vehicle deployment—like reduced congestion, improved access to rapid or frequent transit, and lower on-road greenhouse gas emissions. Policy and regulations regarding connected and automated vehicles should then be developed with these objectives in mind.

Connected and automated vehicle transit bus operations

The industry is already preparing for automated buses, but a series of operational challenges remain that governments could help to address. In addition to being increasingly connected, the fixed infrastructure of a transit system that integrates with connected and automated vehicles will need to be compatible to new mobility patterns.

For example, curbside management policies may need to be revised to create more pick-up and drop-off areas around transit stations while park and ride facilities may need to be re-examined to ensure efficiency. From a technological perspective, safeguards must be put in place to make sure transit users without smart phones can still hail connected and automated vehicle buses. Additionally, due to opportunities for cost savings on fuel, many future connected and automated vehicle transit vehicles may be fully electric. This would require updating both the operational needs of transit systems as well as integrating much of their fixed infrastructure into the electrical grid—including major assets like transit garages.

Labour issues

It may be inevitable that automation will lead to some form of job loss in the transit industry if driving is replaced for the most part by connected and automated vehicle technology. However, there are opportunities for the role of transit operators to be reimagined in a way that improves service for riders. Some responsibilities of these new roles may include: securing the safety of vulnerable people, like minors, on buses without a human driver and ensuring that people with accessibility needs can still

board and request a stop without a human driver. New high skilled jobs will be created to manage and operate more advanced transit systems and vehicles.

Mobility pricing and community design

To keep the amount of vehicle kilometres driven in a community at an acceptable level, mobility or congestion pricing may need to be implemented in certain circumstances. Mobility pricing could include road tolls, parking fees, and other tools that discourage over-use of automated private vehicles, especially zero-occupant trips. As municipalities plan how their community will look in the future, mass and community transit, combined with appropriate mobility pricing, has the potential of maximizing the benefits from connected and automated vehicle technology while reducing potential risks.

Safety and trust

Safety and trust in connected and automated vehicle technology is a significant consideration in its development and deployment. Early advances in connected and automated vehicle technology can improve the safety of transit operations through the adoption of Advanced Driver-Assistance Systems. However, the public may be much more forgiving of human error than error from an automated driving system. In a more fully automated world, transit accidents caused by non-human error could greatly discourage transit riders. Transit agencies and municipalities must make sure that safety remains a central consideration when deploying, regulating, and operating connected and automated vehicles.

Stakeholders involved and links

Preparing transit for the proliferation of connected and automated vehicles will require a proactive response from all levels of government, transit agencies and industry.

Federal government

The federal government should work with all orders of government to develop a policy and regulatory framework for connected and automated vehicles that contributes to environmental sustainability, public safety, and transportation planning objectives (like reducing congestion), including through the encouragement of shared-use connected and automated vehicle services. The federal government will need to support municipal investments in mass transit, and incorporate connected and automated vehicles into larger transportation networks. The federal government is also involved in building and maintaining key pieces of transportation infrastructure which may need to be compatible with connected and automated vehicle deployment in the future. From a technical perspective, the federal government has a role to play in the creation of standards and public regulations regarding the development of connected and automated vehicle vehicles.

Provincial governments

The provincial government will also need to support municipal investments in mass transit and work with municipalities in their regions to develop cohesive regional transportation networks. Provincial

governments have jurisdiction over considerable amounts of transportation infrastructure which could be adapted to connected and automated vehicle use as well as authority over provincial transportation regulations.

Municipal government and transit agencies

These local authorities must begin planning today for the proliferation of automated and connected vehicles, and make sure shared mobility options are competitive and affordable compared to personal use vehicles. This includes working with original equipment manufacturers to continue to innovate and understand how transit vehicles and systems of the future will be integrated into urban infrastructure. These authorities will have regulatory responsibilities regarding access to municipal roadways and other fixed infrastructure like curbsides.

Transit vehicle manufacturers

In order to compete with large personal vehicle manufacturers making advancements toward automated and connected vehicles, enterprises that manufacture public transit vehicles need to make sure that their products remain competitive with the convenience and safety of connected and automated vehicle personal-use vehicles. New Flyer, North America's largest bus manufacturer, announced in May 2019 that they have begun working on advanced driver assistance and automated bus technology.

Proposed actions

Investment

Make long-term investments in high quality transit and continue to establish funding sources for transit expansion and operation. This includes support for transit agencies' efforts to innovate and remain resilient ahead of disruption through capacity building, readiness strategies, funding, partnerships, and knowledge exchanges.

Data and mobility pricing

- Given the limited amount of road and parking space, encouraging the use of mobility pricing is necessary to discourage an increase in vehicle kilometres driven by zero-occupancy vehicles. This may also serve as a revenue-generating substitute for fuel taxes as electric vehicles gain popularity and fuel tax revenues decline.
- Enable aggregate data collection from connected and automated vehicles for transportation planning purposes while ensuring individual privacy is protected and personal movement is not tracked.

Integrate multimodal mobility

Connected and automated vehicles and other forms of transportation will require efficient infrastructure integration, conducive urban planning and street design, and partnerships with private mobility companies. This will include the creation of mobility hubs that link mass transit, local transit, and other forms of active or electric transportation (like shared rental bikes, electric scooters) that allow transit riders to have efficient and affordable trips using varying modes of transportation.

Public transit

- Prioritize connecting transit fleets into municipal infrastructure through the use of lane and signal prioritization. Improve the travel experience of transit users through smart technology, as well as improve station and facility design
- Make sure transit fares are competitive with private commercial passenger services (in other words, ride-hailing, automated taxi fleets) and affordable for low-income citizens
- Public transit agencies in numerous jurisdictions are already experimenting with automated vehicle technology in the form of shuttles. Focus on developing this technology could improve bus rapid transit and feeder bus service by enabling more frequent service
- Municipalities should, through strategic planning and informed procurement, make sure their fleets and fixed infrastructure are designed to be compatible with connected and automated transit technology
- Future transit vehicles, according to many municipal transit procurement plans, are likely to be increasingly electric, which calls for a need to re-examine the operational and fixed infrastructure needs of transit systems (like charging stations)

Timing

With large scale investment being made in connected and automated vehicle technology today, there is an immediate need to make sure current and future public investments respond to the long term impacts associated with connected and automated vehicles. With long-term useful asset lives of over a decade, buses being procured today may have need to incorporate connected and automated vehicle technology in the future.

Over the next decade, as usage of connected and automated vehicles grows, public transit systems and governments that fund transit should be proactive in incorporating connected and automated vehicle technology and adaptability into their infrastructure, especially in situations where safety and efficiency gains could be made.

Over the longer term, as connected and automated vehicles proliferate, municipalities will need to consider how the design of their roadways and existing transit lines in their community support the best use of available land while still ensuring affordable and accessible mobility options to Canadians.

Issue #3: City design

How can cities, suburbs and rural areas incorporate connected and automated vehicles into design processes and improve land use planning? What can governments do to support this change?

How could these vehicles improve city design and land use?

Connected and automated vehicles offer municipalities (especially urban municipalities) the opportunity to shift away from the car-centric design choices that have dominated municipal planning over the past decades. This includes too-wide rights-of-way that were created to allow for fast travel, which has not been fully realized as the induced demand sparked by increased road size and construction has led to continued gridlock in peak periods. This approach also has resulted in urban spaces where street design discourages comfortable and safe passage for pedestrians and cyclists; and where the bulk of space is reserved for automobiles. Cyclists in particular have suffered as there is limited dedicated space for them and they are often forced to share space with higher-speed, more dangerous vehicles.

The arrival of connected and automated vehicles may permit these tendencies in community design to be undone. Fully automated vehicles could be designed to operate more safely and predictably than human operated vehicles. This would contribute to vehicle design changes (like smaller vehicles), allowing for optimized infrastructure design like narrower lanes and speed controls. Connected and automated vehicles permit Canadian cities the opportunity to re-imagine their streets with less of an emphasis on vehicle transportation and more of an emphasis on space dedicated to active transportation and communal spaces.

While seismic changes are far away, one possibility that land-use planners have highlighted is that on residential and side streets, connected and automated vehicles could be the only cars permitted to operate, and human-driven vehicles could be kept to major roads. In this scenario, cyclists and pedestrians would be able to mingle with connected and automated vehicles safely. These connected and automated vehicles could be operated by local transit agencies or though shared ownership models that offer first-mile/last-mile trips. This approach to planning would prioritizes safe, community-based transportation planning that encourages business growth, affordable housing, and recreational areas.

One relatively optimistic scenario is that connected and automated vehicles could allow people to live in exurban and rural areas free from car ownership while simultaneously reducing the need for car-centric infrastructure. Connected and automated vehicles could be viewed as an opportunity to bring the types of walkable neighbourhoods and communities that are increasingly sought after in urban centers to relatively small towns that currently rely on car-oriented design. The end result might be a series of dense, walkable, village-type nodes, surrounded by a variety of types of housing. These could be efficiently connected to each other and major urban centres via the combination of shared connected and automated vehicles and public transit.

A more pessimistic scenario exists in which connected and automated vehicles are focused on private ownership. Reduced travel costs and increased convenience could lead to a stronger overall desire to

live further from urban centres. It then follows that in the absence of specific efforts to structure the growth of connected and automated vehicles, increased auto-oriented urban sprawl would result. Given that the relative profitability of publicly or privately-operated shared use connected and automated vehicles is likely to be reduced in these areas compared to more dense urban areas, shared use could struggle to take hold.

The high-degree of uncertainty in a connected and automated vehicle future makes large-scale decision making today difficult. However, long-term infrastructure plans could start by identifying which major urban arteries will remain as streets for legacy vehicles, and other streets where - at the appropriate time - only connected and automated vehicles will be permitted (excluding emergency vehicles). This includes prioritizing space for mass transit lines and transit centric development. Making meaningful policy direction changes now in preparation for the day when connected and automated vehicles arrive gives governments the flexibility to more quickly adapt to technological change.

Considerations

Parking

Vehicle parking often makes up a large chunk of public space in cities as well as rural villages as a consequence of accommodating car-driving residents and visitors. Given that shared use connected and automated vehicles could result in a reduced need for parking, considerable space could be made free for amenities like wider sidewalks, bike lanes, gardens, parks, public squares, and housing.

Mobility pricing

To make sure existing space is used efficiently, congestion pricing can price out very low occupancy vehicles operating on road infrastructure. Individual ownership could also result in higher numbers of vehicles in circulation and the requirement of parking spaces – potentially exacerbating existing problems of inefficient land use and congestion in rural, suburban and urban areas. Ideally, as city planning is improved and shared transportation is increased, much of the negative economic, environmental and social consequences associated with congestion could be alleviated.

Green space

Freeing up land use from transportation infrastructure can allow for green urban renewal, often cited as integral to combatting poor air quality, urban heat islands, and other associated urban health concerns. More efficient transportation design will also allow for more active transportation and increased access to public green space, which will have positive impacts on mental and physical health of citizens.

Rural vs urban

Design challenges differ between rural and urban communities. Urban areas will greatly benefit from more efficient use of land and the designation of green and communal spaces. Rural areas can better design their communities to alleviate safety issues associated with higher speed travel and utilize

connected and automated vehicles to help address social isolation issues that can be more prevalent for those living far from population centres.

Stakeholders involved and links

The federal government has a limited role in how municipalities are designed. However, it could use its role as convener and regulator to encourage best practices in land use, and provide funding for infrastructure and mass transit while supporting smaller municipalities with less fiscal and planning capacity.

Provincial governments can also work with cities to begin planning changes to their road networks to determine where some streets could be narrowed and public space reclaimed at such time as connected and automated vehicles become common place. Provinces could also provide training to planners to help them understand the public goals and the tools needed to achieve them. Provinces have a variety of ways to encourage municipalities to make sure official plans are made and kept current.

Municipal governments will be the most important decision makers in determining how cities incorporate and change based on the deployment of connected and automated vehicles. They will require a combination of expertise and funding, as well as the foresight of long term municipal plans, to make sure that advances in connected and automated vehicles meet long-term transportation, economic and social goals.

Proposed actions

Incorporating vehicles into existing infrastructure

- In the short term, communities will need to think about how to incorporate connected and automated vehicles into existing infrastructure. This could include creating designated transit lanes, dedicated connected and automated vehicle lanes, and signal prioritization for automated transit

- Infrastructure owners and operators could set aside curb space for connected and automated vehicle passenger loading and unloading zones, particularly in dense urban corridors and other areas where passengers are commonly picked up and dropped off like airports, public transportation stations, and sporting and event venues

Policy and planning

- Develop policies and standards that prioritize safety, security, and accessibility of all road users while prioritizing sustainable transportation options like walking, cycling, and transit

- Support policies that encourage density around transit hubs and plan for focused growth around walkable communities near social services. This includes fostering a culture of shared mobility and active transportation

Congestion and land use

- Consider whether road and/or highway expansions or extensions make sense with the increase of connected and automated vehicles
- Find ways to convert space currently used for vehicle transportation and/or parking to green spaces or affordable housing in the future
- Put in place mobility pricing to make sure the transportation system is equitable, manage traffic congestion, and support infrastructure investments

Issue #4: Digital and physical infrastructure requirements

What changes to physical infrastructure (roads, highways, grid capacity, parking) and digital infrastructure (broadband connectivity, digital twins, data analytics) are needed for connected and automated vehicles to operate in Canada – including in rural, remote, and Northern communities?

As governments develop long-term infrastructure plans, what actions should be taken to future-proof existing assets and prepare for the impacts of connected and automated vehicles? What actions can be taken to build the infrastructure that we'll need?

The physical and digital infrastructure requirements for connected and automated vehicles aren't yet well understood as the first generation of vehicles being tested don't need any special infrastructure and are being designed to operate on today's roads.

That being said, highly automated and connected vehicles will affect infrastructure going forward, as technology allows for the better use of existing infrastructure (like increasing lane capacity) and through changes to infrastructure due to changing transportation patterns. The use of connected and automated vehicles will require updates to both physical and digital infrastructure, and eventually, how entire communities are designed.

The physical infrastructure where connected and automated vehicles will operate, as well as the digital systems that support them, will need to be part of an integrated connected and automated vehicle sector. Leading global jurisdictions understand the interdependence of connected and automated vehicles and the infrastructure on which they operate. These jurisdictions are bringing together government stakeholders, industry and academia to develop a plan to guide investments in connected and automated vehicle infrastructure.

Physical infrastructure

Existing physical infrastructure has been designed with the needs of human drivers in mind. Major changes will be needed as vehicles move towards a scenario where connected and automated vehicles communicate with infrastructure and share the road with traditional vehicles and pedestrians, and eventually where nearly all vehicles are connected and automated. This will require rebalancing communities and infrastructure for high-capacity people movement through efficient and connected

transit, the prioritization of safe pedestrian and cycling transportation, and enhancing the usage of public and green spaces.

Smart roadside infrastructure

At the core of physical infrastructure requirements are smart roadside infrastructure units, which are essentially specialized devices that support communications between vehicles and physical infrastructure. Different technologies will be used and road authorities should prepare for an environment that includes different kinds of wireless connectivity, including DSRC, C-V2X, and 5G. Smart roadside infrastructure units can communicate with connected vehicles and can alert drivers to impending collisions, upcoming roadway obstructions, traffic light timing, or slippery road conditions in real-time. Mounted at traffic intersections, gantries, and other places along the road-side, smart roadside infrastructure units can support both connected and automated vehicles.

An example of this type of smart roadside infrastructure would be intelligent lamp posts. Intelligent lamp posts are multifunctional platforms with a lighting unit, as well as GPS transceivers and wireless abilities. They can be equipped with perception sensors like radar, LIDAR (light detection and ranging), or video cameras. This would allow for scene monitoring and traffic analysis to guide vehicles, detection of anomalies or abnormal traffic behavior, and would provide data for further traffic analysis for transportation agencies.

To successfully deploy smart roadside infrastructure units, we'll need to upgrade legacy traffic control systems and deploy the digital infrastructure backbone upon which it relies. This will require significant financial investments by municipalities and provinces.

Roads and highways markings

The current generation of automated vehicles rely on sensors for automated driving, and therefore, lane markings must be clear and visible to enable their safe operation. Canada has an ever-expanding road network with over 13,000 kilometres added in 2016, with road conditions varying across the country and 18% of road conditions being described as "very poor" or "poor". Some municipalities, provinces and territories struggle to maintain a standard of road quality that would be necessary for widespread use of automated vehicles due to numerous freeze and thaw cycles and the related maintenance costs. Therefore, encouraging better asset management, increased investment, and the introduction of road marking standards will be required to make sure basic road infrastructure allows for the successful operation of automated vehicles.

Each jurisdiction may have their own pavement marking standards, but consistency and harmonization may be required, as well as paint that can withstand winter conditions and be detected more easily under snow. Signage and lane marking standards will need to include features that will improve the detection of sensors, including highly reflective surfaces, high-contrast signage designs, and more purposeful and effective placement of signage (line of sight, unobscured, etc.) to make sure that connected and automated vehicle technology is not reliant on human intuition and to limit the variability in connected and automated vehicle decision making when vehicles travel from jurisdiction to

jurisdiction. In addition, as connected vehicles and HD mapping efforts advance, it may be possible for connected and automated vehicle to both inform municipalities of lane marking degradation or insufficient signage, as well as use information gathered from HD mapping and V2X communication to impute where information from sensors or cameras is unavailable.

Lane and curbside management

In addition to smart roadside infrastructure and better defined road markings, provinces and municipalities will need to think about how they manage existing infrastructure as connectivity increases, including the development of a proactive traffic demand management strategy. This may include creating designated transit lanes, dedicated connected and automated vehicle lanes and signal priority, as well as dynamic curbside management that involves freeing up space historically used for vehicle parking. These strategies should incorporate provisions for effective and efficient connected and automated vehicle travel and drop-off, while prioritizing pedestrian and cycling travel and safety.

Electric vehicle infrastructure

As electric vehicle uptake continues to increase, it is likely that many connected and automated vehicles will also be electric vehicles. Their adoption will require an adequate number of well-placed charging stations. In addition, there are implications for the grid requirements across the country as most vehicles will rely on the electric grid for power, which will affect the costs and capacities of electricity grids. Investments in charging stations and the support of renewable energy sources will be needed and should not be overlooked when designing infrastructure for a future with connected and automated vehicles.

Digital infrastructure

Connected and automated vehicles rely on the power of real-time communications to provide driver advisories and warnings and to generate data about performance of the transportation system. Higher degrees of automation will require infrastructure owner/operators and vehicle manufacturers to work together to develop high-definition 3D roadway maps and seamless information sharing of data (like connected intersections, by-passes, highways). These maps and shared data will be necessary to make sure that fully automated vehicles can navigate their environment safely.

HD mapping and digital twins

Global navigation satellite systems and GPS currently available in vehicles lack the necessary accuracy and reliability required for connected and automated vehicles. Furthermore, connected and automated vehicles will need maps that are continually updated to make sure they can operate at the highest level of automation and can cope with the full array of situations that occur. While some original equipment manufacturers may develop the baseline maps, road authorities will have an important role to play in reporting on accidents, breakdowns, and when and where road maintenance and construction is occurring.

Position navigation and timing technologies are already critical to the modern global transportation system and technological advances—as well as wide-scale availability over the past several decades—have enabled significant innovations that have improved the safety, efficiency, and reliability of all modes of transportation. Moving forward, advances in position navigation and timing technology will help the shift toward greater automation. Ground-based infrastructure systems will be essential in augmenting these systems to improve performance accuracy in advanced driver-assistance systems and automated driving systems not possible solely with satellite-based global navigation satellite systems.

A mappable digital mirror of the physical world, or a "digital twin", is also important for both the testing and eventual deployment of connected and automated vehicles. Digital twins are especially important in testing, allowing connected and automated vehicles to "drive" millions more miles in a virtual world to allow for artificial intelligence to improve in terms of reliability, operability and safety.

Big data and artificial intelligence

The benefits of data obtained from connected and automated vehicles and smart infrastructure roadside units are numerous, and the proper analysis will assist in building more flexible transportation models that improve efficiency, safety, and asset management. Sufficient digital infrastructure that can manage and analyze a multitude of data sources will need to be in place to make sure data received from sources can be transformed into usable information.

This will also require continued advances in artificial intelligence that are able to better process information and make predictive decisions. With these advances, there is a need for the corresponding training of the human operators managing these systems. There are also important questions that will need to be addressed about data storage, data management, and privacy. Ideally, data will allow for the optimization of infrastructure management, safety and efficiency.

Intelligent transportation systems

Intelligent Transportation Systems is the application of different technologies (like sensors, communications, traffic control, electronic tolling) to make road transportation safer and more efficient. It includes a broad range of technologies that affect the design, construction, management, and operation of road transportation systems. An Intelligent Transportation Systems architecture provides a common framework for planning, defining, and integrating the deployment of Intelligent Transportation Systems technologies. As connected and automated vehicles advance, including them in Canada's Intelligent Transportation Systems Architecture will be extremely important to make sure municipalities can operate efficient and safe transportation systems in their jurisdictions, and improve the performance of advanced driver-assistance systems, and eventually, autonomous vehicles.

Connectivity

There will be a need for connected and automated vehicles to be highly connected to the environment in which they are operating and for that connection to have a low latency. Vehicle to infrastructure communication will eventually need communication that goes beyond line-of-sight-limited sensors, like

cameras, radar and LIDAR (light detection and ranging). However, the exact connectivity technologies that will be used in the future is not certain, and jurisdictions and infrastructure owners need to prepare for the possibility of different or multiple forms of wireless connectivity being used, including DSRC, C-V2X, and 5G. There are also concerns related to basic connectivity along many rural and remote roadways, with numerous points without broadband connectivity that may severely limit the operability of automated and connected vehicles. Spectrum allocation is also a concern with demands for access from both the automotive and telecomm sectors in conflict.

Early opportunities

Development and improvements in advanced driver-assistance systems that operate on current roads will be able to alleviate many safety concerns associated with vehicle operation if the associated national roadway infrastructure is updated and maintained in a manner that meets the needs of the technology. This includes well-defined and well-maintained lane markings and roadway signs and advances in traffic signaling.

As stated earlier, low-level automated vehicles are designed to function within current physical infrastructure constraints. Higher levels of automation will require connectivity if vehicles are going to function in bad weather with higher levels of safety than current human-operated vehicles. So far, vehicle to infrastructure communication has mostly been considered for gathering and sharing information about traffic, weather, and road conditions.

Since road infrastructure can be equipped with systems that have more sensing, computing, and communication abilities than on-board units, they will likely be better at capturing the dynamics of the surrounding vehicles at intersections and predicting potential collisions. Connected infrastructure placed strategically at high collision intersections will have the ability to feed information related to other vehicles, pedestrians, and other hazards to improve the performance of advanced driver-assistance systems, and eventually, autonomous vehicles, greatly improving safety.

Smart roadside infrastructure is already being tested by original equipment manufacturers. Incorporating information gathered from units will be essential in improving near-term performance of first generation automated and connected vehicles and improving how cities manage intelligent transportation systems, including safety concerns. This can have a major impact on the pace at which driverless vehicles will be deployed on the roads. An example of this strategy has been used in Japan where instruments are being installed on urban highways to support short-term driving automation in some locations.

Key considerations

Operating in silos

Until recently, there has been limited integration or alignment between the development and design of physical road infrastructure with the development and design of new vehicles. For example, civil engineers responsible for planning, managing, and maintaining infrastructure have had limited

interaction with mechanical engineers who design and manufacture the vehicles that run on Canada's roads and highways. Any progress in transportation connectivity and automation technology will require breaking down these silos for the successful design, testing, and use of connected and automated vehicles, including the infrastructure that supports them.

Canadian weather

The numerous freeze-thaw cycles during winter in most areas of Canada, and the high use of road salt, contribute to the degradation of road quality and increase in potholes. Poor weather, road degradation, potholes, and obstructed lane markings can be a significant impediment to the operation of current generation automated vehicles that generally operate in controlled weather environments. Rain, hail, and snow in the air refract and obscure sensors that are intended to detect objects several hundred meters away, and accumulation on the ground compounds problems with lane markings and road conditions. Given that cities across Canada experience a multitude of different weather conditions, not all technological solutions will work in all areas, and differing jurisdictions should focus on what infrastructure solutions meet their needs as they are developed and deployed.

HD mapping and connected infrastructure is expected to solve some of the navigation challenges posed by poor road markings, inclement weather and other non-ideal conditions in operational design domains. However, the process of producing these maps and installing connected infrastructure across a country as vast as Canada will be a slow process. Until these technological solutions can be achieved, it will be important to properly maintain existing infrastructure to improve the safety of automated vehicles, as their systems will continue to rely on a variety of vision, laser, radar, and ultrasonic-based sensors of varying capability.

Financing and capacity across jurisdictions

Canada is a large country with an extensive transportation network and the federal government, provinces, territories, municipalities, and indigenous communities all have different responsibilities for the physical and digital infrastructure necessary to support connected and automated vehicles. Harmonizing standards and approaches across different levels of government will be challenging. The fiscal and operational capacity as well as the conditions (weather, density) of these different jurisdictions also vary greatly, which will impact their ability to be ready for connected and automated vehicles proliferation.

Rural areas provide a particular challenge for connected and automated vehicle infrastructure growth as these areas often have limited existing road maintenance budgets and capacity. There is likely an important role for the private sector to play in the funding and operation of connected and automated vehicle infrastructure, though proper regulation will be required to make sure citizen's privacy concerns are addressed. Jurisdictions also need highly qualified personnel that have experience integrating smart roadside unit technologies into their traffic management systems and operations.

Non-passenger vehicles

While much of the focus will be on passenger-carrying connected and automated vehicles, understanding and incorporating non-passenger vehicles into the ecosystem, like flying autonomous drones or automated snow-clearing vehicles, will be essential in exploring the full benefits of technological advances in this sector.

Connectivity gap

Regardless of how the advancements related to connected and automated vehicles develop, there will likely be a continued connectivity and investment gap between urban and rural areas. Many rural areas already struggle to maintain basic levels of connectivity due to costs and sparse populations, and if not properly accounted for, this gap is likely to carry over into connected and automated vehicle digital infrastructure. While rural communities may not have the same connectivity needs as urban centres, it is important to make sure that rural communities aren't left behind.

Future proofing

In the short term, it will be desirable to make sure that new infrastructure being constructed incorporates some aspect of future proofing in its design. The Information Technology Association of Canada proposed the introduction of a "Smart Infrastructure Lens" for all federal infrastructure investments as part of their 2019 Pre-Budget submission. Such a lens could include the requirement that infrastructure be smart/connected and designed to incorporate the realities of a future that includes connected and automated vehicles, especially as the effective lifespan of infrastructures assets is multiple decades. Investing in infrastructure that is not future proof, or does not account for all possibilities in future urban infrastructure design and planning, may limit the possibilities that advances in connected and automated vehicles have to offer.

Stakeholders involved and links

All levels of government and private industry will need to work together to make sure physical and digital infrastructure are prepared for the proliferation of connected and automated vehicles.

The federal government is primarily a provider of funding for infrastructure and will need to use its role as convener and regulator to ensure a cohesive national approach to physical and digital infrastructure that supports the proliferation of connected and automated vehicles, interoperability between jurisdictions, and safe operation.

Provinces, territories and municipalities own a majority of the infrastructure that will be impacted by the advances in connected and automated vehicles and will need to build, improve, and maintain current and future infrastructure that supports proliferation, including the need for robust asset management plans that can meet the immediate needs of connected and automated vehicles. All levels of government will need to work together to map assets, implement real-time mapping technologies, and develop data strategies and data sharing standards.

The private sector, including original equipment manufacturers and software providers, will need to work together and with governments to make sure that connected and automated vehicles are able to operate across jurisdictions with existing and future infrastructure. Major telecom companies will also be important in supporting wireless infrastructure connectivity that is necessary for connected vehicle communication.

There also is a need to coordinate efforts that are already underway. For example, there is an Ontario initiative that is being coordinated by the Ontario Good Roads Association – Municipal Alliance for Connected and Autonomous Vehicles to create an automated vehicle-approved map for municipalities based on the prior work with Municipal 511. This map would include a lot of data and will be extremely valuable for many automated vehicle applications.

Canadian connected and automated vehicle testing centres will be very important in designing vehicles that work well across the nation, including the testing of connected and automated vehicles in winter weather and advances in communication technology. The Autonomous Vehicles Innovation Network links together six testing sites across Ontario with differing specializations, while the ACTIVE-AURORA Connected Vehicle Testbed Network links together facilities in Western Canada.

Proposed actions

Standards and regulations

- Governments at all levels establish a pan-Canadian technical working group to map-out and create guidelines to make sure vehicle and infrastructure equipment/data formats are compatible and to set standards for connected and automated vehicle infrastructure investments
- Set priorities for intelligent infrastructure installation that take into account usage and risk, and initiate pilot projects at selected locations according to this criteria to maximize safety gains
- Set minimum performance and maintenance standards for digital and physical infrastructure, like road signage, pavement markings, and high definition maps. These standards could incorporate features that will improve their detection by connected and automated vehicles, like highly reflective surfaces or road lines, high contrast signage designs, and more purposeful placement of signage (line of sight, unobscured, etc.). Integrating these elements into the Manual of Uniform Traffic Control Devices for Canada would facilitate their application across jurisdictions in Canada. The manual is currently undergoing a major update which is expected to be completed by 2021

Investment and programs

- Current and future funding programs are needed to support the testing and deployment of infrastructure which is able to advance connected and automated vehicle pilots, and nationwide deployment. Infrastructure plans for connected and automated vehicles will need to take into account the constraints of a vast Canadian geography, harsh winter weather, and limited fiscal capacity municipalities, while taking into account differing needs of urban and rural areas
- Make the necessary investments to bring all provincial and municipal roadways up to a

minimum maintenance requirement (signage, lane markings, etc.). This would benefit the safety operations of both automated and non-automated vehicles

- Investing in trial deployments of smart roadside units will be critical to enhancing road authorities' understanding of the technology and its benefits, and informing how they can securely and effectively integrate their use into transportation systems. These trial deployments can also help inform standards development and interoperability
- While it is still uncertain what infrastructure requirements connected and automated vehicles will need to operate, it is clear that HD maps will play a huge part in their operation. Roles, responsibilities and standards for developing, updating, and maintaining these maps need to be identified
- Review the connectivity and spectrum requirements that will be needed to meet the deployment needs of automated and connected vehicles in urban and rural areas

Workforce development

Identify core personnel requirements necessary to manage and maintain new digital and physical infrastructure requirements, and develop training tools, workshops, and webinars in collaboration with provinces and territories, industry, academia, and non-governmental organizations.

Timing

In the short term, government action must focus on providing the physical infrastructure necessary for the first generation of connected and automated vehicles to be successful, with limited initial changes needed due to their low penetration. There is also a need to promote the planning of smart infrastructure today and recognize the value it can provide to improve transportation system operations and maintenance.

As connected infrastructure becomes more common, work needs to be done to make sure secure and reliable connectivity across the country, especially in underserved rural areas and high-collision zones. There is high uncertainty in the 10-year forecast especially in regard to vehicle automation technology and its impacts. It's likely that vehicle connectivity of one type or another should be very common by then, providing comprehensive information to vehicles and transportation system operators to assist them in making better decisions.

Finally, over the longer term, there may be significant changes to transportation infrastructure and community design, depending on how the proliferation of connected and automated vehicles occurs, as well as the needs of communities. There is significant uncertainty as the overall changes to the economy and society could occur in ways that aren't imaginable today. It is expected that the widespread use of connected and automated vehicles will influence travel patterns, with potential for both positive and negative societal impacts.

Annex E: Data privacy and security action proposal paper

Proposed action #1: A privacy code of practice

A privacy code of practice, developed through a structured multi-stakeholder process, would help address privacy considerations associated with connected and automated vehicles. A code that is designed to provide practical guidance on how the requirements of the Personal Information Protection and Electronic Documents Act (PIPEDA), and substantially similar provincial privacy laws, are applied to connected and automated vehicles will help organizations meet their regulatory obligations for personal information. It may also help regulators like the Office of the Privacy Commissioner of Canada assess if organizations follow the law.

The Data Privacy and Security working group also identified many separate initiatives that would support developing a code, or that would be a beneficial complement to such work. We've included these initiatives as "sub-recommendations."

A code of practice is a set of commitments designed to influence, control, or set benchmarks for organizations' behaviour. The intent for a privacy code of practice for connected and automated vehicles is to provide sector-specific guidance and best practices on compliance with Canada's legal frameworks for privacy.

Some of the benefits that we see for the code include:

- helping stakeholders follow *PIPEDA*, and other privacy laws that apply to connected and automated vehicles
- making the marketplace more predictable and certain for everyone and levelling out the playing field
- ensuring that consumers' privacy is protected
- enhancing consumer trust in connected and automated vehicle technologies and services
- supporting data-driven innovation in the connected and automated vehicle sector and the emergence of new business models and services

Key barriers and opportunities

Modern vehicles contain many sensors and systems that collect and process significant amounts of data. They also rely on a complex web of data transmissions through various communications systems like:

- cellular
- satellite
- Wi-Fi
- Bluetooth
- short-range radio
- short-range radar

The vehicles use the systems above to communicate with many parties like:

- communications service providers
- individuals' electronic devices
- infrastructure operators
- other vehicles
- third-party service providers
- advertisers
- insurers

Not all of the data moving from automated and connected vehicles is made up of personal information, but operating a connected vehicle still involves extensive collection, use, and disclosure of data about individuals that can be identified.

Nearly all automotive manufacturers currently in the Canadian market offer connected vehicles, or plan to.[4] This reflects global trends, where data and connectivity have become increasingly valuable sources of innovation and growth for the automotive sector. Globally, 85% of automotive executives believe that the "digital ecosystem" will create higher revenues than vehicle hardware.[5]

Organizations are using data and digital technologies to create new money-making opportunities, reduce their costs, and increase the overall safety of their vehicles.[6] While these innovations have created a lot of benefits for consumers, there are many privacy and security considerations caused by how modern vehicles handle data.

Important considerations include:

Accountability

The complexity of personal data flows makes it unclear which organization is responsible to ensure data processing is done in a way that follows privacy laws, which can be different for each jurisdiction.

Transparency and consent

Issues with privacy notices in the sector are creating the risk of data processing taking place without consumers giving meaningful consent. Several stakeholders noted this. There are also concerns over

[4] United States Government Accountability Office, *Vehicle Data Privacy: Industry and Federal Efforts Under Way, but NHTSA Needs to Define its Role* (July 2017). ; Desrosier Automotive Consultants, Inc., "December 2018 Canadian Sales," email to ISED (January 2019).
[5] KPMG, *Global Automotive Executive Survey 2017* (2017).
[6] McKinsey & Company, *Monetizing Car Data: New service business opportunities to create new customer benefits* (September 2016).

whether and to what extent consumers and organizations know which third parties process data in the digital ecosystem.[7]

Limiting collection, use, disclosure, and retention of data

Several reports noted various examples suggesting the over-collection of personal data and limited ability for consumers to control uses and disclosures of their information that aren't essential.[8]

One aspect of these concerns that has been the subject of reports in recent years is the collection of data from electronic devices that users sync to vehicle "infotainment" systems. Most consumers may not know how much information is collected, which can include data that is not needed for specific connected services they're actually using. A related issue is that synced data is saved onboard vehicles and it's often difficult to delete. Saving data, which may occur without individuals knowing or consenting, is a particular challenge for used, leased, or rented vehicles. A 2018 poll by the Canadian Automobile Association found that 38% have previous users' data stored onboard vehicles.[9] Other studies are consistent with these findings.[10]

Safeguarding

There is growing evidence that personal data is under threat from cyber attacks and breaches.[11] While vehicle safety has understandably been a cybersecurity priority for governments and the automotive sector, we need to pay attention to the issue of how to secure personal data.

We need to take action to address these and other risks. The goal is both to protect consumers and to ensure that organizations have the capacity and understanding to fully follow Canadian privacy laws. A practical and clear code of practice would be a useful policy tool that would help us meet that goal.

PIPEDA and similar provincial privacy laws apply to the entire marketplace and tend to be broad in terms of the legal protections and obligations they create. They are meant to be flexible and technologically neutral, since they apply to all sectors of the economy and businesses of all sizes. This has the benefits of ensuring the law's relevance over time and supporting flexibility. But in the data-driven economy it is becoming more and more complex to apply the law's requirements to certain new technologies and business models and to make it easy for stakeholders to follow the laws and assure protection.

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[7] Andrea Amico, Ivan Tsarynny, and Noemi Chanda, *Oh no, my car leaks data…now what?*, presentation at the 2019 Canadian Symposium of the International Association of Privacy Professionals (May 24, 2019).
[8] British Columbia Freedom of Information and Privacy Association, *The Connected Car: Who is in the Driver's Seat?* (2015).
[9] CAA, *Vehicle Data Privacy: Building Trust*, presentation to the Office of the Minister of Innovation, Science, and Economic Development (2018).
[10] Andrea Amico, Ivan Tsarynny, and Noemi Chanda, *Oh no, my car leaks data…now what?*, presentation at the 2019 Canadian Symposium of the International Association of Privacy Professionals (May 24, 2019).
[11] Upstream Security, *Global Automotive Cyber Security Report 2019: Research into Smart Mobility Cyber Attack Trends* (2019).

A code of practice could make the situation more certain and clear for organizations by making the laws more accessible and practical in the context of connected and automated vehicles. A code could also be more responsive to emerging issues, technologies, and business models, compared to regulatory or legislative reform. From a governance perspective, a code could take advantage of the strengths in the existing laws, while also mitigating risks and concerns that non-prescriptive laws might not specifically address.

Privacy regulators are increasingly studying using codes of practice and other mechanisms to add to existing regulations. The Office of the Privacy Commissioner of Canada has stated that they support using codes to apply *PIPEDA* for specific technologies and sectors, and has specifically called for a code that applies to connected and automated vehicles. The office also has a mandate to encourage the development of codes of practice. European privacy laws contain specific provisions recognizing the utility of codes of practice and encouraging their use by regulated organizations.

For example, the United Kingdom privacy law, the Data Protection Act, 2018, requires the Information Commissioner's Office to issue codes of practice for some specific contexts like direct marketing. During proceedings related to an organization's compliance with the law, how well the organization follows the code must be considered.[12]

At the same time, the European Union General Data Protection Regulation encourages organizations to put into effect voluntary sectoral "codes of conduct" that they can submit for approval by regulators like the Information Commissioner's Office.[13] By following an approved code, organizations can demonstrate that they comply with the regulations.

Canada has also committed to exploring how it can use codes, standards and certification more strategically as we examine policy options related to *PIPEDA* reform. We will discuss this issue in more detail later in the document.

Also, a privacy code of practice for connected and automated vehicles would provide a mechanism to acknowledge certain privacy considerations in the automotive sector that stakeholders have identified. This way, it would further show the sector's due diligence when dealing with these considerations.

Considerations

There are several key considerations when developing and implementing a code of practice.

Success factors related to the process of developing a code include:

- Participation by all relevant stakeholders in the code's development
- A robust governance structure to develop and apply the code, including:
    - clear rules for engagement and disengagement of stakeholders from the process

[12] *UK Data Protection Act, 2018, s.127.*
[13] GDPR, Arts.40-41.

    - clear roles of participating stakeholders and understanding of whose views they are representing
    - a process for ensuring broad and balanced representation by various stakeholders
    - a clear and fair process for developing and approving the code that encourages broad participation from stakeholders and supports the credibility of the completed code
    - a mechanism for updating the code and ensuring that it stays relevant over time
- Involvement with the Privacy Commissioner and other relevant regulators and policy makers early in the development of the code:
    - in particular, engagement as early as possible in the process and at appropriate intervals
    - also, it should be clear from the beginning what the role of the regulator in the process is, for example if they are an:
        - observer
        - advisor
        - active participant
        - endorser
- The cost for stakeholders to follow the code must be a consideration when it's developed
- There must be clear incentives for organizations to follow the code
    - this will ensure that sound privacy and security practices are adequately rewarded in the marketplace
- It must be clear to stakeholders at the start of developing the code how it will be enforced. Key questions include:
    - what status will the code have in the eyes of the regulator?
    - will there be a standard for certification against the code?
    - is the code purely voluntary?

Success factors related to the content of a code include:

1. Developing an overall introduction to the code that properly explains the purpose, audience, and context
    - Potential elements the introduction could note include:
        - the overall goals of the vehicle of the future Advisory Group and the code's connection to those goals
        - the goals would reflect the need to support innovation and economic growth, while also upholding Canadians' privacy
        - that consumer connected and automated vehicles are highly personal and private spaces, with commensurate expectations of privacy
        - that moving vehicles have public safety implications
        - that connected and automated vehicles are an innovation driver

- that there are risks to consumers that result from the accumulation of personal information generated by connected and automated vehicles without individuals' knowledge and consent
- that the Office of the Privacy Commissioner, under the auspices of the *Resolution on Data Protection in Automated and Connected Vehicles* passed at the 39th International Conference of Privacy and Data Protection Commissioners in September 2017, has called for the development of privacy standards for connected and automated vehicles[14]
- that the Government of Canada has released proposals for PIPEDA reforms that envision a greater role for codes of practice

2. The code must have a clearly defined scope for the types of markets and sectors that would and wouldn't have to follow the code
    - this would include identifying any data flows that are "mission critical" to make connected and automated vehicles and the connected and automated vehicle ecosystem function safely, which a code would need to treat differently from other categories of personal data

3. The code must be based on existing legal requirements (including PIPEDA's core principles and requirements) and must take into consideration the legal or policy frameworks of other jurisdictions, especially the US, given its proximity

4. The code must be "technology agnostic" while also being granular and practical

5. The code must be scalable, and able to meet the needs of both small enterprises and large companies

Stakeholders have identified the governance structure that would apply to the code as an especially important consideration. For example, the government, in consultation with stakeholders, will need to decide from the start of the process whether organizations should follow the code on a mandatory or voluntary basis. Both approaches have merits.

For example, a mandatory code would ensure a level playing field for all organizations and make the regulations more certain. On the other hand, a voluntary code would inherently be more flexible. Organizations would be able to adopt the elements of the code that are most appropriate for their business. Also, there would be incentives for organizations to participate in a voluntary code, like building trust among consumers by showing that they follow best practices.

There may not be a need for an "either/or" choice between a mandatory or voluntary code. Using small steps, the government could develop a code and stakeholders could adopt it on a voluntary basis. Then

[14] https://edps.europa.eu/sites/edp/files/publication/resolution-on-data-protection-in-automated-and-connected-vehicles_en_1.pdf.

it could be assessed over time to determine whether there are areas that have been widely adopted and are so generally accepted, and/or expected, that they should become mandatory.

Also, a code could be voluntary but still evolve into an "industry standard" that courts and regulators start to use to assess "reasonableness". In such a situation, guidelines in the code could still have legal value for organizations, especially if the Office of the Privacy Commissioner and other regulators formally recognized it.

Mandatory codes used in some jurisdictions (like in the United Kingdom and Europe as we mentioned above) are based in a relevant legal framework, and so they are enforced by mechanisms found in that framework. This includes provisions in laws on how regulators should treat voluntary codes. The *PIPEDA* is different because right now, it doesn't have a clear regime for either mandatory or voluntary codes. Related to this issue, we want to note that the Government has recently announced that it is exploring codes of practice as part of its proposals to reform the *PIPEDA* Act.[15]

Stakeholders involved

The main target audience for a code of practice would be any supplier of products or services that is likely to have an effect on how personal information is collected, used, disclosed or protected in the connected and automated vehicle ecosystem. It's very important to have stakeholders from many areas like industry, the public sector, and civil society participate in developing a code. This is to encourage stakeholder buy-in and ensure that the code is credible and will be successfully adopted by industry.

Another important audience for a code would be regulators, especially the Office of the Privacy Commissioner and other similar authorities in the provinces and territories. Regulators may think of a code that has been developed through a robust multi-stakeholder process, as a tool to help assess how an organization follows privacy law. So, working group members agreed that it would be important to engage such regulators early on the in the process of developing a code. Although formal endorsement by regulators may not be a necessary pre-condition for the success of a code, some form of recognition by the regulator will be important as an incentive for organizations to follow the code.

Links

Developing a privacy code of practice has links to other initiatives focused on protecting the integrity of the connected and automated vehicle ecosystem, as well as to other work by the Government to protect privacy and marketplace frameworks.

On May 21, 2019, the Minister of Innovation, Science and Economic Development released a new Digital Charter which lays out a set of principles to set the foundation for modernizing rules which govern the digital sphere in Canada. The Digital Charter sets out 10 principles intended to ensure that Canada continues to be a leader in the digital and data-driven economy and to protect Canadians' privacy:

[15] *Strengthening Privacy for the Digital Age: Proposals to modernize the* Personal Information Protection and Electronic Documents Act, Innovation, Science and Economic Development Canada

1. **Universal access**: All Canadians will have equal opportunity to participate in the digital world, and the necessary tools to do so – including access, connectivity, literacy, and skills.

2. **Safety and security**: Canadians will be able to rely on the integrity, authenticity, and security of the services they use and should feel safe online.

3. **Control and consent**: Canadians will have control over what data they are sharing, who is using their personal data and for what purposes, and know that their privacy is protected.

4. **Transparency, portability and interoperability**: Canadians will have clear and manageable access to their personal data and should be free to share or transfer it without undue burden.

5. **Open and modern digital government**: Canadians will be able to access modern digital services from the Government of Canada, which are secure and simple to use.

6. **A level playing field**: The Government of Canada will ensure fair competition in the online marketplace to facilitate the growth of Canadian businesses and affirm Canada's leadership on digital and data innovation, while protecting Canadian consumers from market abuses.

7. **Data and digital for good**: The Government of Canada will ensure the ethical use of data to create value, promote openness, and improve the lives of people – at home and around the world.

8. **Strong democracy**: The Government of Canada will defend freedom of expression and protect against online threats and disinformation designed to undermine the integrity of elections and democratic institutions.

9. **Free from hate and violent extremism**: Canadians can expect that digital platforms will not foster or disseminate hate, violent extremism or criminal content

10. **Strong enforcement and real accountability**: There will be clear, meaningful penalties for violations of the laws and regulations that support these principles.

There's a chance to align the guidelines and principles of a privacy code of practice with relevant principles of the Digital Charter, especially the principles of:

- Safety and security
- Control and consent
- Transparency, portability, and interoperability
- A level playing field
- Data and digital for good

As part of the launch of the Digital Charter, Minister Bains also announced an initial set of actions to implement the Charter's principles, highlighted by proposals to modernize PIPEDA.

The Government's discussion paper on this topic proposes reforms along the general themes of:

1. Enhancing individuals' control
2. Enabling responsible innovation
3. Enhancing enforcement and oversight

The discussion paper discusses and examines the potential role of codes, standards, and certification schemes for making regulations more responsive, which is especially relevant for developing a code of practice.

Within the context of the vehicle of the future advisory group, there are direct links between these recommendations and the work of the Safety and Security working group, which has also examined cyber security issues.

The focus of this working group is on the overall integrity and safe operation of connected and automated vehicles, following the cyber security framework that Transport Canada is advancing as part of its forward regulatory agenda. In contrast, the cyber security concern for the Data Privacy and Security working group is on protecting personal information from unauthorized access, use, or disclosure. This follows obligations for protecting data that exist in privacy laws. The secretariats for both working groups have worked together to ensure these that these efforts complement each other. From a privacy policy perspective, Innovation, Science and Economic Development Canada has also contributed to Transport Canada's broader work on the cyber security framework for connected and automated vehicles.

Separately, Transport Canada is also leading a multi-stakeholder process for implementing the secure credential management system. This system is an advanced public key infrastructure solution to ensure that the systems for connected and automated vehicles operate safely in North America. Ensuring that privacy is protected is a key design objective for this project. It will be important for any privacy code of practice to consider developments from the secure credential management system working group, and the principles of a code could help guide the protection of privacy within secure credential management system deployments.

Finally, the Data Privacy and Security working group also discussed several data governance challenges that go beyond privacy-related issues. An important challenge is access to, and use of connected and automated vehicle data, which is important for providing aftermarket services and developing new mobility-related products and services. This applies to both personal data and technical data related to operating the vehicle.

Broader data governance-related issues like the right to repair relate to emerging privacy concepts, for example, data portability rights. But, they also have significant implications for policies around competition, intellectual property, safety, and innovation. While we can't consider these issues only through the lens of privacy and data protection, it will be important for the work on a privacy code of practice to be connected to other relevant data governance initiatives.

Timing

Work on a code of practice, and related initiatives, which are dealt with in our other recommendations, should begin as soon as it's practical and possible. This will depend on timing of the release of our recommendations to the Government. Moving forward on the heels of the Government's acceptance of our recommendations would provide leverage to attract the attention and support of relevant stakeholders for developing a code.

Sub-recommendation: Use case analysis

An examination of the privacy implications through practical, real-world use cases involving personal data in specific connected and automated vehicle services and technologies should provide the foundation for developing a code of practice.

Description

To determine how privacy laws apply in a connected and automated vehicle context, first it's necessary to establish a common understanding of common data use cases. As a result, examining the privacy implications of real world use cases involving personal data in specific connected and automated vehicle services and technologies is a critical component of the process for developing a privacy code of practice.

By mapping out data flows and related privacy and security risks in practical terms, data use cases can help distinguish between different uses of personal information. For example they can identify legitimate and "mission-critical" uses of personal information that are necessary to safely operate a vehicle versus other uses. Use cases can help determine what is "personal information" and what may not be personal information in a particular scenario.

This could involve taking stock of:

- the types of personal data involved
- the identity of the organizations collecting or receiving such data
- how organizations are using the data
- the individual agency of consumers in these processes

The purpose of running a data case study like this would be to create an empirical basis for developing a code.

The working group examined several areas of concern that have been reported by the media, as well as discussed in the research of academics, private sector, and civil society institutions. While important, this literature mainly covers issues and challenges at a broad, sectoral level. For a code to be useful to organizations, it would need to address the flow of data at a more detailed level.

However, this more detailed research would build not only on the existing state of knowledge from academics and private institutions, but also on regulatory mechanisms that are in place in other institutions. In particular, in 2018, the French data protection authority, la Commission Nationale de l'Informatique et des Libertés, released Connected Vehicles: a compliance package for a responsible use of data, a set of sectoral guidelines (similar to a code) on connected and automated vehicles. Also, in 2017, the International Conference of Data Protection and Privacy Commissioners passed a Resolution on Data Protection in Automated and Connected Vehicles with instructive recommendations for privacy protection for the sector.

The use case analysis could also support further research. Examining data flows in the connected and automated vehicle ecosystem could identify areas where more research and pilot projects on particular technical challenges or opportunities for privacy protection are needed.

Annex F: Distributive social impacts and risks action proposal paper

Issue #1: Urban and suburban vs rural and remote impacts

We expect that connected and automated vehicles will affect Canada's urban centres, suburbs, and rural and remote areas in different ways due to a change in the nature of car use and ownership by companies and individuals. What actions are needed to help Canada and Canadians prepare for this transition and to meet public and private sector objectives?

Context

The perfect view of connected and automated vehicle deployment includes a more efficient, environmentally sustainable transportation system that costs less and can be accessed by all members of Canadian society.

But along with the adoption of connected and automated vehicle services there are risks like:

- more congestion if connected and automated vehicles replace existing mass transit systems[16]
- negative environmental impacts if more cars are on our roads
- increased inequity if the price of new services is out of reach for many potential users or if our infrastructure can't support their operation

This mobility revolution will provide new options and opportunities for municipal planners and developers, with consequences that aren't well understood. For example, some have suggested that connected and automated vehicle use will result in more urban sprawl. For certain, the associated benefits and risks of connected and automated vehicle deployment will be felt differently within Canada's urban centres and across our suburbs and rural and remote regions.

The timing of impactful connected and automated vehicle deployment, which is still not known, will determine where and when we see change. It's likely that our urban centres and suburbs will be the first to see new mobility options from private providers (or possibly public providers or private providers with public support), like "first and last mile" shuttles. If these services are implemented properly, they have the potential to improve access and complement existing transportation networks.

But there's a risk that without proper planning, which includes appropriate policies, guidance and regulation, these services will only benefit certain segments of the population and that others will be left behind.

For example, in many large urban centers, including Toronto, lower income households have been pushed farther out of the downtown core, so better transportation connections between outlying areas and city centers are needed, and they have to be affordable for these lower income households and individuals. Connected and automated vehicles could be a solution to this challenge by providing "first and last mile" mobility options in and out of city centres.

[16] The City of Toronto is developing a CAV policy that is "transit supportive".

People could make an argument that these types of solutions should be found without waiting for connected and automated vehicles. We also have to keep in mind that the price of connected and automated vehicle services will be directly linked to who can afford to use the services and who will benefit from them.

It is worth noting though that the concept of "first and last mile" in a country that spans nearly 10 million square kilometres can mean different things to different people. For some, the distance between a transit station and a private residence may well be much longer than "one mile". For example, intra-city and intra-provincial travel, involves longer travel distances and is a reality for many. One day, connected and automated vehicles could be a realistic mobility solution for this type of travel, but, without extensive public investment in core infrastructure, like dedicated lanes and broadband, the vehicles can't operate.

Some of Canada's rural and remote areas don't have access to efficient broadband, or any broadband at all. Broadband access will be a significant factor for who does or doesn't have access to new, connected and automated vehicle transportation services[17]. Broadband access may also affect vehicle owner access to vehicle maintenance and repair that is increasingly going wireless, including over-the-air updates and remote diagnostics.

The infrastructure that's needed to successfully operate connected and automated vehicle and who pays for it is an important consideration. It's especially important because new infrastructure costs are expected to be higher during the early days of the roll-out of these types of vehicles. It's not likely that private sector operators will pay the costs. New public infrastructure, including dedicated lanes on highways, seamless access to broadband across remote expanses, and even simple improvements, like clear lane markings, and municipal services, like snow clearing, are expensive. Private companies won't invest in rural or remote regions where there is less opportunity to make money, where other companies can benefit from their investments at no cost (the free-rider problem), or regions lacking in infrastructure like paved roads and lane markings. There is also an expectation by taxpayers that public funding of infrastructure should create public, instead of private, benefit.

Many of the advertised benefits of connected and automated vehicles, like improved mobility and increased productivity may not come about as quickly in rural and remote areas because of low density and low demand. For example, only 18.7% of Canada's population lived in rural areas in 2016. Other mobility options that work better in rural areas could include a bus owned and operated by a community or small ride hailing companies.

Despite the challenges, there is great potential for connected and automated vehicles to mitigate the feelings of isolation often felt in more rural and remote communities by providing new mobility options for people who may not be able to (or chose not to) drive a traditional vehicle. This can, in turn, reduce

[17] Through ongoing government action in this area, it is possible that broadband access will be less of a challenge in rural areas at the time of mass CAV deployment (timing still unknown).

pressure to move to cities, increase the resilience of smaller towns, and improve mental well-being. Feelings of social-connectedness are enabled by mobility.

There will also be differences with how urban and rural and remote areas are impacted by the movement of goods. Urban centres may see an increase in automated deliveries of consumer goods, and highways that intersect rural areas may see impacts because of connected and automated long-haul trucking of larger cargo, animals, and dangerous goods. The nature of the cargo will likely have links to regulatory requirements related to autonomy and the need for a driver. For example, a driver may always be needed to transport dangerous goods as well as in the hand-over of any good, urban or rural.

An essential consideration related to connected and automated vehicle deployment is the issue of data. It is sometimes noted that the value of vehicles in the future will be in the data they generate, rather than their value as a physical asset. Whether a connected and automated vehicle is privately owned, or part of a fleet, there will be a growing number of data points for private sector profiling, including data related to driving habits, the nature and type of usage, and rider destinations, among other information.

All of this data has potential to shape effective urban planning. But, where data collection methods are owned by companies, the ownership may raise issues about who is collecting the data, who can access the data, and how they will use it. We will also need to be mindful that data-driven decision-making for planning, often implies majority rule. It might not adequately take into the needs of the minority.

The data generated by connected and automated vehicles is a commodity, and an input for deepening and broadening markets. But it's also a public utility that could be used to help improve transportation planning and decision-making as well as enhance access and lower costs. These two goals could conflict. Stakeholders should acknowledge the dual purpose of big data, and keep this in mind as they govern data. Without rules and regulations to govern the access to and use of data that is collectively generated, the public interest will be less important than companies' plans to make money.

Proper planning and continuous dialogue, along with the right policy tools, can help prevent the potentially negative impacts of connected and automated vehicles on our cities, suburbs, and rural and remote areas. They can also help ensure that we can gain the greatest benefit. All levels of government, as well as industry players, and other stakeholders, will have a role to play.

Opportunities

- Holding meetings with federal, provincial, and municipal officials to share lessons-learned from a Canadian and international perspective and to help identify and advance ways to develop regulations for accessing and using data generated by connected and automated vehicles.
- Implementing connected and automated vehicle services to extend the reach of fixed services (hospitals) for those who live outside of fixed service locations.
- Using existing policy levers (for example, congestion pricing) to mitigate the risk of increased congestion.

- Improving efficiencies in the transportation system by creating transportation nodes in suburban areas for more frequent service. For example, using connected and automated vehicle vans instead of busses that are at one-third capacity.
- Conducting more pilots and testing to identify what is needed for improved mobility and equity. For example, shuttles from suburban transit stations or "park n' rides" to private residences.
- Encouraging and exploring innovative partnerships between public transit authorities and other mobility service providers.
- Examining more broadly the "Urban and Suburban versus Rural and Remote" impacts to include municipal and rural planning, development, and economic impacts. For example:
    - active transportation
    - street design
    - building design
    - optimal urban designs
    - new economic opportunities and threats for urban and rural areas

Proposed action #1: Roundtable on data

Federal-provincial-municipal officials, key stakeholders, partners, industry, and civil society would meet to share lessons-learned from a Canadian and international perspective. They would also discuss how to help identify and advance ways to develop regulations for accessing and using data generated by connected and automated vehicles.

Key barriers and opportunities

The data generated by connected and automated vehicles has potential to shape effective urban planning. This is because the data the vehicles collect includes information about driving habits, the nature and type of usage, and rider destinations. Developing regulations that would govern data access and use can support improved transportation planning and decision-making as well as enhance access and lower costs.

Barriers include the potentially high cost of accessing proprietary data or data that is generated for public or not-for-profit analysis (for example, by academics and think tanks). Even in cases where data-sharing arrangements are made, there are risks that vehicle and infrastructure companies may intentionally keep some data to themselves.

Timing

Because connected vehicles and telematics are a present-day reality, a round table on data should be held in the near- to short-term. ABI Research estimates that "some 78 million existing vehicles are already connected to the web" and "By 2021, 98% of all new vehicles sold in the United States and

Europe will have web connections."[18] IHS Automotive conservatively estimates that the average car will produce up to 30 terabytes of data each day.[19]

Stakeholders involved

The issue of access to and use of data generated by connected and automated vehicles has the potential to impact multiple partners and stakeholders, including, but not limited to:

- municipalities
- industries
- businesses
- Canadian consumers
- citizen privacy

Links

This action is linked to two actions proposed in the action paper on "Enhanced Accessibility and Mobility":

- Action #2: Municipal roundtable on data
- Action #3: Identify and advance an optimal communication platform

Considerations

Activity related to regulation of access to and use of data by public and private sector actors could go along with consumer education and awareness initiatives. These initiatives would inform the Canadian consumer about the current models of access to and use of their vehicle data and the potential consequences of different vehicle data access and use models. For example, the Auto Care Association (representative of the automotive aftermarket industry in the United States) runs a consumer campaign with the slogan, "Your car. Your data. Your choice". The objective of the campaign is to inform vehicle owners in the United States of current models of their vehicle data and the consequences of this control.

Proposed action #2: A Canadian Strategy on the vehicle of the future

To develop a national strategy for the "vehicle of the future", similar to the United Kingdom's "*Future of mobility: urban strategy*", which was released in March 2019.

[18] PYMNTS. (June 4, 2018). Who Will Control Data Sharing in Web-Connected Vehicles? *PYMNTS.com*. https://www.pymnts.com/innovation/2018/data-sharing-smart-cars-privacy/

[19] SAS. The connected vehicle: Big data, big opportunities. https://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/connected-vehicle-107832.pdf

Proposed action#3: Improve Canada's connected and automated vehicle preparedness

Develop and implement strategies to improve Canada's connected and automated vehicle preparedness, and then improve our ranking on KPMG's Autonomous Vehicle Readiness Index.

Issue #2: Better accessibility and mobility

Connected and automated vehicle technology has the potential to improve mobility and independence for many segments of society, including, but not limited to, people with visual and other physical impairments, cognitive disabilities, and the elderly. What can governments, industry and other stakeholders do to help ensure that all members of Canadian society can benefit from connected and automated vehicle deployment?

Context

Within the context of demographic shifts (like population aging), connected and automated vehicles have the potential to improve mobility for underserved populations, including:

- senior citizens
- low-income households
- patients undergoing health treatments
- people with disabilities

Improving mobility for these populations has many benefits for society like providing these individuals with more independence and respect, encouraging more inclusiveness, and decreasing reliance on social and healthcare resources.

That said, there may be limits to this approach. For example, there could be legal and liability considerations, or logistical considerations for people with low mobility who need help to access the vehicle. Some potential connected and automated vehicle users may feel fear or intimidation if they have to get into and out of the vehicles without any help.

The design of the vehicle interface itself will also determine who will be able to use it. Stakeholders recognize that it would be very difficult to design a "one size fits all" vehicle. But designers should consider the different needs and limitations of many types of users when they design elements like infotainment systems, basic vehicle controls like temperature control, seat adjustment, and window and door operation.

Designers should consider these elements at the start of the vehicle design process or there's a risk of the vehicle needing expensive after-market customization, which is less likely to occur. Thoughtful and inclusive vehicle design would not only help decrease worry about how the vehicle works and how users can get in and out of the vehicle. It would also support connected and automated vehicle deployment. A vehicle that can't be used by individuals with disabilities or other health issues, would be an incredible

discouragement to connected and automated vehicle uptake for people who could benefit the most from them.

Designers also have to consider the way connected and automated vehicles interact with non-users, and specifically:

- vulnerable road users with a disability
- people who need a little extra time to get where they are going (like the elderly)
- people that may cross intersections in unusual or unexpected ways

For example, visual warnings that show how the vehicle will move by using a light bar (for example, changing colours or flashing lights) wouldn't work for people with sight loss. Likewise, using a sound like a horn or a beeping sound wouldn't work for people with hearing loss. An approach to vehicle design that uses a variety of tools and techniques would be most effective to increase how useful these vehicles are for the widest possible user base.

The pricing of connected and automated vehicle services may also keep certain groups from benefiting from the new mobility options these services can provide. Research into transportation network companies, like Uber and Lyft, has found that these services are most frequently used by people with over US$50,000 (approximately CAD$67,000) in household income.

Many connected and automated vehicle services may be too expensive for large parts of the Canadian population. Consideration will also need to be given to the links between service pricing and connected and automated vehicle data. Service pricing will probably be determined by the private corporations providing the service – the same corporations that will have access to connected and automated vehicle-generated data. Non-extractive platform co-operatives[20] are increasingly appearing as alternatives to traditional data governance and ownership models and could be pursued.

Municipal access to connected and automated vehicle-generated data will be key for supporting fair access to connected and automated vehicle-based mobility services. Without this data, municipalities won't know who is using these services and how, where, and when. But, while there should be a goal to have as much open data as possible, we need to be sensitive to market realities and the fact that data can be proprietary for legitimate realties. These could include businesses seeing data as a key source of competitive advantage to their operations, services or revenue growth. It will be important to balance the realities of proprietary data with the data needs of, for example, municipalities, end-users, and Canadian industries that depend on vehicle data, like the auto repair sector.

The potential that privacy protections can fail, like in the case of de-identification of outliers is also a concern. Many privacy protection strategies don't work for people who are outliers or minorities when they're not camouflaged by data driven by the majority.

[20] A platform cooperative is a cooperatively owned business that establishes a computing platform, and uses a website, mobile app or a protocol to facilitate the sale of goods and services. They are intended to bring about a more equitable and fair digitally mediated economy compared to traditional, venture-capital-funded platforms.

Existing public transit networks are also an important piece of the accessibility picture. Connected and automated vehicles should augment, rather than erode, the benefits of mass transit. Incorporating vehicle services within these existing networks, like filling a first and last mile gap, can go a long way in encouraging independence and more inclusiveness for many parts of society.

Opportunities

- Hosting a workshop to get input on what Canada can do in the short- to medium-term about improving accessibility. There's a possibility of reaching out to Intelligent Transportation Systems Canada on the subject.
- Introducing standards (Canadian Standards Association standards) that would require vehicle suppliers to develop connected and automated vehicles that can be used by people with disabilities.
- Exploring implementing accessible onboard interfaces to ensure that connected and automated vehicles can be used by people with disabilities.
- Establishing and defining vehicle-to-everything (V2X) protocols including digital connectivity between connected and automated vehicles and pedestrians. Relying only on visual interactions (like light bars above vehicle windshield) will cause problems for people living with vision loss.
- Leveraging new data-sets created by connected and automated vehicles by using mobile digital apps to enhance way-finding or navigating the built environment. This could include real-time access to municipal data like street closures, potential obstacles or social events like festivals. The result could be that more people with sight loss and other disabilities are engaged in their communities.

Objectives

- **Maximum usability:** As many people as is reasonably possible must be able to interact with connected and automated vehicles. The inside user interface should be designed with accessibility in mind from the beginning. This includes not only accessible design for actions like selecting a destination, but also the ability to perform basic functions like using climate control and entertainment systems. For the outside of the vehicle, vehicle-to-everything (V2X) protocols should be developed which include digital connectivity between connected and automated vehicles and vulnerable road users.
- **Open data:** Municipalities should be able to leverage data generated by connected and automated vehicles to benefit all pedestrians, including people with disabilities. With access to data, municipalities can create datasets that include considerations about pedestrians. They would be designed to enhance mobility for vulnerable road users, identify road and sidewalk hazards and obstacles (like construction) and provide opportunities to better engage with the community, like travelling to a local festival.

Proposed action #1: Connected and automated vehicle accessibility workshop

A connected and automated vehicle accessibility workshop would bring together key partners, stakeholders, and civil society to discuss and find solutions for connected and automated vehicle accessibility. The focus of the workshop would be user needs with the ultimate longer-term goal of developing connected and automated vehicle accessibility standards for Canada.

Key barriers and opportunities

This action would help participants, especially automakers, better understand what people with disabilities would need to find a connected and automated vehicle service, get into and out of a connected and automated vehicle, and operate the user interface.

Timing

The workshop could be held within the near to short-term (next 1 to 2 years). We expect that further engagement on the topic of connected and automated vehicle accessibility would need to take place as the technology develops. Developing connected and automated vehicle accessibility standards is a longer-term goal. Without existing examples of connected and automated vehicle user interfaces, it's difficult to determine when the workshop should take place.

Stakeholders involved

The workshop would include participation from:

- all levels of government
- key stakeholders
- the private sector
- academia
- the Canadian public

A successful workshop would require participation from multiple accessibility experts. These would include:

- experts in physical, perceptual, and cognitive disabilities
- inclusive designers
- individuals with lived experience of the challenges
- automakers
- technology developers
- third party component suppliers
- municipalities
- transit authorities
- end-users
    - individuals with lived experience on disabilities

    - senior citizens
- experts in standards development

Proposed action #2: Municipal roundtable on data

Municipal engagement to discuss the importance of leveraging available connected and automated vehicle data to support vulnerable road users. As connected and automated vehicles will be both inputting and extracting data to and from municipal networks to navigate city streets, municipalities can be encouraged to develop datasets that embed considerations about pedestrians. While data already exists through platforms like Google maps etc., these robust platforms do not always provide real-time information. Connected and automated vehicle data would be useful to fill this gap.

Key barriers and opportunities

Encouraging municipalities to develop datasets that consider vulnerable road-user needs can support enhanced mobility, hazard and obstacle identification, and provide opportunities to better engage with the community. In an ideal scenario, app developers would be able to extract data feeds based on geography or a user's specific needs and then provide extracts based on that user's unique needs or preferences.

Timing

The workshop or roundtable could be held in the near-term (within the next year or two).

Stakeholders involved

- municipalities
- network and data architects
- mobile app developers
- members of the public
    - including vulnerable pedestrians
- producers of minority data

Links

This action is linked to "Action #1 – Roundtable on data" proposed under the theme of Urban and Suburban vs. Rural and Remote Impacts. It proposes that officials from federal, provincial and municipal governments should convene to help identify and advance ways to develop regulations for the access to and use of data generated by connected and automated vehicles. We propose that the subject of "data and accessibility" could be one topic included in the agenda for this roundtable.

Proposed action #3: Identify and advance an optimal communication platform

Through research and bringing together relevant stakeholders, identify and advance the best vehicle communication interface platform to leverage data generated by connected vehicles to support a competitive marketplace. Stakeholders would include:

- members of Industry
- government officials
- technology experts
- academics

Key barriers and opportunities

Together, the connected vehicle and vehicle telematics create big data. Big data represents opportunities to create new products and services that can benefit Canadian consumers and communities. The more stakeholders that can access vehicle data, the more competitive the marketplace will be for services and products. A more competitive marketplace is likely to lower the cost of products and services, making them accessible to a larger number of Canadians, and to drive product and service innovation.

The following excerpt from the Commission Communication on "Free Flow of Data": Input from the Independent Automotive Aftermarket details how big data and algorithms support a competitive marketplace:

> "Many studies have shown that large data sets ("big data") and algorithms (i.e. data calculation/processing applying own know-how which becomes the basis for analysis and decision-making of companies) are valuable assets for economic growth and social progress. They are the new "super power fuel" of the economy of the future and are the drivers for innovation.
>
> This fully applies to the automotive aftermarket. The ability to innovate and compete in the digital era greatly depends on continuous access to in-vehicle generated data and the ability to apply a company's know-how and applications. Competition in the digital age starts already in the vehicle where the data quality directly determines the service quality.
>
> FFoD [free flow of data] and the concept of the "Connected Car" are associated in the public debate primarily with new telematics applications like the intelligent control of traffic flows or new communications and entertainment functions. This blocks however the view onto the serious economic impact of the "Connected Car" on the market for motor vehicle parts and services and on adjacent markets like the leasing business, fleet management, insurance or new mobility services.

Especially timely data or data in real time around the clock brings about a wide variety of new products and services relating to the operation of vehicles. The independent aftermarket for motor vehicle spare parts, service and repair needs direct access to such data in order to foster innovation and continue to compete with the vehicle manufacturer. Foreseeable use cases are for example the proactive monitoring of safety-critical vehicle systems, the predictive and thus especially efficient maintenance in the workshop, remote monitoring of operations to prevent defects, remote maintenance through software updates or reconfiguration and automated services in case of a breakdown on the road.

Example: The key condition to all independent repair and maintenance services is the innovation and improvement of independent diagnostic testing equipment. Independent diagnostics is the basis for all competitive servicing and repair processes. To this end the independent operator requires direct access to real time in-vehicle data in order to apply algorithms which are running on the control units of the car. Unfiltered and direct access to this data is mandatory to allow a live monitoring and the creation of interoperable algorithms for multi-brand testing devices or apps which would allow independent diagnostics or prognostics as key for all subsequent digital services in the independent aftermarket.

The emergence of new business models and changes in existing ones will not only unlock new customer segments, but will also attract industry newcomers. The benefits of connectivity and automation may expand the traditional driver/passenger segment while also allowing players to tap into segments (e.g. governments and municipalities) that so far have not been attended to by the traditional automotive industry.

While this opens multiple new business models to the car manufacturers, the decisive disadvantage to third parties is that they have no direct access to the in-vehicle data and information via the telematics system of the vehicle. Direct communication with the vehicle owner via the central information display is also not possible for third parties or limited to few functions (like entertainment or navigation) which are however yet unrelated to the repair and maintenance needs of the car.

While all future use cases are hardly predictable in detail, it is already obvious that the “extended vehicle” concept as currently envisaged by the vehicle manufacturers (to be looked at in more detail later under section 9) will create a data monopoly of the vehicle manufacturer which significantly differs from the today’s analogue situation.

Conclusion: Data access and the opportunity to use data with embedded algorithms represent already today decisive factors for companies when it comes to their competitiveness and to establishing innovative, digital business models for the benefit of the consumer. It is needless to say that the quantity of data will grow rapidly in the future and thus increase the dependence of entrepreneurs on such data. Any access barriers or restrictions concerning the data access

complicating a direct and independent communication with a vehicle will therefore significantly impede free competition and the competitiveness of the single market players."[21]

Timing

Near- to short-term: Connected vehicles and telematics are a present-day reality. ABI Research estimates that "some 78 million existing vehicles are already connected to the web" and "By 2021, 98% of all new vehicles sold in the United States and Europe will have web connections."[22] IHS Automotive conservatively estimates that the average car will produce up to 30 terabytes of data each day.[23]

Stakeholders involved

Government: They are involved in developing the framework around standardizing and implementing a vehicle communication interface platform. They're also active in, among other things:

- motor vehicle technical standards
- compliance of standards for manufactured and imported vehicles
- motor vehicle innovation

Canadian consumers: Consumers can potentially benefit from a competitive marketplace, more affordable connected vehicle products and services, and innovative connected vehicle products and services.

Canadian businesses: Businesses could befit from direct access to telematics vehicle data (and resources) needed for operational purposes.

Links

This action is linked to "Action #1 – Roundtable on data" proposed under the theme of Urban and Suburban vs. Rural and Remote Impacts.

It proposes that officials from federal, provincial and municipal governments should meet to help identify and advance ways to develop regulations for the access to and use of data generated by connected and automated vehicles. We propose that the subject of vehicle communication interface platforms could be one topic included in the agenda for this roundtable. You can find more information on proposed vehicle communications interface platforms in Annex A.

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[21] FIGIEGA. (Dec. 23, 2016). Commission Communication on the Free Flow of Data: Input from the Independent Automotive Aftermarket. https://www.figiefa.eu/wp-content/uploads/Free-Flow-of-Data-FIGIEFA-Input-2016_12_23.pdf

[22] PYMNTS. (June 4, 2018). Who Will Control Data Sharing in Web-Connected Vehicles? *PYMNTS.com*. https://www.pymnts.com/innovation/2018/data-sharing-smart-cars-privacy/

[23] SAS. The connected vehicle: Big data, big opportunities. https://www.sas.com/content/dam/SAS/en_us/doc/whitepaper1/connected-vehicle-107832.pdf

This action item would link to the Canadian Automotive Service Information Standard agreement signed in 2009 by stakeholders in the Canadian automotive industry. Please see Annex B for more information.

The proposed action also links to work being done by international stakeholders to regulate access to and use of telematics vehicle data. Examples include:

- In the United States, the Massachusetts Right to Repair Coalition (a group of auto repair firms), recently filed legislation that would require automakers to equip their vehicles with "an inter-operable, standardized and open access platform across all makes and models that is capable of securely communicating all telematics vehicle data in a standardized format via direct data connection to the platform."[24] The bill would protect consumer rights to own and control data generated by their vehicle; data would be "accessible by the owner or lessee of the vehicle through a mobile-based application…"[25]

- The European Commission has aggressively studied vehicle connectivity and telematics to develop policy that protects fair and undistorted market competition and creates a climate that supports the growth potential of the digital economy. A seminal study by the European Commission, Access to In-Vehicle Data and Resources,[26] accessed different technological solutions to access in-vehicle data and resources in the era of vehicle connectivity and telematics. The study concluded that the "on-board application platform" is the relatively best solution… that would lead to more compatibility with the principle of fair and undistorted competition."[27]

- In a 2017 study by the Australian Competition and Consumer Commission, the "Right to Repair" agreement implemented in 2014 was found to be ineffective. It was found to create competition barriers and affect consumers' choice of repairer. To address this issue, the commission recommended that a mandatory scheme "be introduced for car manufacturers to share technical information with independent repairers, on commercially fair and reasonable terms. The commission highlighted that a mandatory scheme should provide independent repairers with access to the same technical information that car manufacturers make available to their own authorised dealers and preferred repairer networks (including environment, safety, and

[24] Lowe, A. (March 12, 2019). Right to Repair coalition takes on vehicle data in Massachusetts. *Auto Care Association*. https://www.autocare.org/government-affairs/capital-report/capital-report--march-12,-2019/
[25] Tire Review Staff. (March 13, 2019). Massachusetts Right to Repair coalition takes on vehicle data in new bill. *Tire Review.* https://www.tirereview.com/massachusetts-right-to-repair-coalition-takes-on-vehicle-data-in-new-bill/

[26] McCarthy, M., Seidl, M., Mohan, S., Hopkin, J., Stevens, A., Ognissanto, F. (May 18, 2017). Access to in-vehicle data and resources: Final report. *European Commission.* https://ec.europa.eu/transport/sites/transport/files/2017-05-access-to-in-vehicle-data-and-resources.pdf
[27] Kerber, W. (2018). Data governance in connected cars: The problem of access to in-vehicle data. https://www.jipitec.eu/issues/jipitec-9-3-2018/4807/JIPITEC_9_3_2018_310_Kerber

security-related information)."[28] The Government of Australia "committed to supporting appropriate commercial dealing and competition in the new car retail supply chain for the benefit of both small businesses and consumers."[29]

Moving forward on recommendations, the Australian government recently released a consultation paper on a Mandatory Scheme for the Sharing of Motor Vehicle Service and Repair Information (February 2019). The scope of information to be accessed by repairers with fair and equal real-time access includes "on-board information and telemetry, and codes for computerised systems".[30]

Considerations

Big data represents opportunities to create new products and services that can benefit Canadian consumers and communities. Access to telematics vehicle data (and for some parties, resources) is also a requirement for some Canadian businesses' operations. They may be at risk of having to close if they can't access the data that they need.

Because of the highly integrated North American automotive supply chain, a standardized vehicle communication interface platform may develop from the North American vehicle market.

Stakeholders would have to standardize and implement a framework to develop a vehicle communication interface platform.

Proposed action #4: Set accessibility standards for connected and automated vehicles

Conduct an exhaustive side-by-side analysis of human interface guidelines keeping in mind how the interfaces would be used by people with disabilities. This would leverage existing guidelines and standards like those published by SAE on vehicle accessibility and usability.

Key barriers and opportunities

Currently, connected and automated vehicle standards don't often deal with human interface considerations for people with disabilities. While SAE has begun working to narrow this gap, the work so far has mainly looked at physical access; maneuvering a mobility device into and out of a connected and automated vehicle. What is missing is a robust understanding for designers, engineers, and manufacturers about perceptual and cognitive disabilities. There is very little evidence about research being done by the design community to build the dynamic requirements of people with disabilities,

[28] Charity, S. (Sept. 6, 2018). Consumer Data Right. *Australian Automotive Aftermarket Association Ltd.* https://static.treasury.gov.au/uploads/sites/1/2018/09/t329531-Australian-Automotive-Aftermarket-Association.pdf
[29] Consumer Data Right.
[30] Consumer Data Right.

other than physical limitations. Even these are sparse and will require appropriate consideration as connected and automated vehicle technologies become better defined.

Timing

There is an urgent need to develop connected and automated vehicle accessibility standards to define how to improve mobility, increase access, and build accessible features into the current generation of connected and automated vehicles. A concentrated effort throughout the connected and automated vehicle development life cycles with a focus on diverse needs of all users will be required.

Stakeholders involved

As above, developing suitable standards on accessibility and usability will require input from all stakeholders. People with disabilities that have extensive knowledge of "the lived experience" must be present at all stages of standard development.

Links

This action is linked to "Action #1: Connected and automated vehicle accessibility workshop" proposed above. Findings from the workshop could help develop connected and automated vehicle standards.

Considerations

Connected and automated vehicle accessibility standards may fall short because of the rapid rate of change and dynamic nature of connected and automated vehicle technology. Because of this, Canada may need to assume a global leadership role to communicate how connected and automated vehicles can be accessed by people with diverse physical, perceptual or cognitive barriers.

Proposed action #5: Analyze vehicle simulations

Carry out a series of simulation analyses on potential future connected and automated vehicle use scenarios involving different groups of people that would examine the various characteristics of the ride (speed, price, comfort, reliability, etc.). People that should be involved include:

- the elderly
- people with a physical or cognitive disability
- people in lower income brackets

This exercise could also include a comparison of competing modes (for example, private vehicle, public transit) with the ultimate goal of creating and tailoring future connected and automated vehicle services to meet the needs of a variety of people.

Annex A: Vehicle communication interface platforms

Two vehicle communication interface platforms that have been proposed to serve as the access point to connected vehicle data are the extended vehicle concept and the secure vehicle interface.

Extended vehicle

"An extended vehicle is a vehicle with external software and hardware extensions for some of its features. These extensions are developed, implemented and managed by the vehicle manufacturer. The concept entails a connected vehicle that communicates to backbone servers via mobile networks. Vehicle data from the server is then made available to stakeholders via standardized interface.

The extended vehicle is a concept developed by original equipment manufacturers where data generated by a vehicle is sent over a secure and encrypted communication channel to a dedicated original equipment manufacturer server. Data made available at the original equipment manufacturer back end server using a standardised interface will standardise sets of data that can be used by vehicle manufacturers or third-party participants for post processing and development of applications for vehicle users."[31]

"The Extended Vehicle (ExVe) Methodology requires gateway security measures for initial access to be located outside of the vehicle within the automaker's cloud server."[32]

Secure vehicle interface

"Secure vehicle interface provides a standardized, secure design for vehicle data to be shared with third parties at the owner's discretion. It enables a smart global infrastructure where vehicles can "talk" to their surroundings (e.g., traffic lights, emergency vehicles, other vehicles, etc.) in order to adapt to an evolving driving environment, which results in safe and more efficient roads.

Solutions based on secure vehicle interface use hardware and software connected to a vehicle's internal network that translates its data into common language. It creates two secured interfaces for the data to be transmitted—the first, at the vehicle network, either through a wired or wireless method, and the second, at the external receiving point collecting data."[33]

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[31] McCarthy, M., Seidl, M., Mohan, S., Hopkin, J., Stevens, A., Ognissanto, F. (May 18, 2017). Access to in-vehicle data and resources: Final report. *European Commission.* https://ec.europa.eu/transport/sites/transport/files/2017-05-access-to-in-vehicle-data-and-resources.pdf

[31] Kerber, W. (2018). Data governance in connected cars: The problem of access to in-vehicle data. https://www.jipitec.eu/issues/jipitec-9-3-2018/4807/JIPITEC_9_3_2018_310_Kerber

[32] Telematics Talk. (Nov. 14, 2016). Are vehicle scan tools endangered? *Equipment and Tool Institute*. http://www.telematicstalk.com/vehicle-scan-tools-endangered/

[33] Auto Care Association. (n.d.).SVI Fact Sheet. https://www.autocare.org/uploadedfiles/autocareorg/government_affairs/issues/resources/auto_care_secure_vehicle_interface_fact_sheet.pdf

In the United States, the Massachusetts Right to Repair Coalition (a group of auto repair firms in the United States), recently filed legislation that would require automakers to equip their vehicles with "an inter-operable, standardized and open access platform across all makes and models that is capable of securely communicating all telematics vehicle data in a standardized format via direct data connection to the platform."[34]

The bill would protect consumer rights to own and control data generated by one's vehicle; data would be "accessible by the owner or lessee of the vehicle through a mobile-based application…"[35]

A study by the European Commission, Access to In-Vehicle Data and Resources,[36] assessed different technological solutions to access in-vehicle data and resources in the era of vehicle connectivity and telematics. The study concluded that the "on-board application platform" is the relatively best solution… that would lead to more compatibility with the principle of fair and undistorted competition."[37]

The on-board application platform expands on secure vehicle interface as it would allow third party "access to vehicle data and the execution of applications inside the vehicle environment,"[38] including equal access to the in-vehicle dashboard.

[34] Lowe, A. (March 12, 2019). Right to Repair coalition takes on vehicle data in Massachusetts. *Auto Care Association*. https://www.autocare.org/government-affairs/capital-report/capital-report--march-12,-2019/
[35] Tire Review Staff. (March 13, 2019). Massachusetts Right to Repair coalition takes on vehicle data in new bill. *Tire Review.* https://www.tirereview.com/massachusetts-right-to-repair-coalition-takes-on-vehicle-data-in-new-bill/
[36] McCarthy, M., Seidl, M., Mohan, S., Hopkin, J., Stevens, A., Ognissanto, F.
[37] Kerber, W. (2018). Data governance in connected cars: The problem of access to in-vehicle data. https://www.jipitec.eu/issues/jipitec-9-3-2018/4807/JIPITEC_9_3_2018_310_Kerber
[38] McCarthy, M., Seidl, M., Mohan, S., Hopkin, J., Stevens, A., Ognissanto, F.

Annex B: The Canadian Automotive Service Information Standard (CASIS) Agreement

The CASIS agreement was signed in response to disruptions caused by the introduction of the onboard-diagnostic-port II (OBD-II-II). The OBD-II disrupted how vehicle information needed for service purposes was accessed. This left independent repair shops, those in the aftermarket industry, in a vulnerable position. They didn't have all of the information they needed from all of the automakers to offer their services to the Canadian consumer that was on a playing field that was level to automaker dealership networks.

The objective and intent of the agreement was to maintain an open, fair, and competitive automotive manufacturing, import, distribution, service and repair industry in Canada. To do so, automakers agreed to share their "emission and non-emission related Service Information, Diagnostic Tools and Training Information"[39] with the aftermarket for repair and diagnostic purposes.

Since the CASIS agreement was signed, vehicle technology has advanced rapidly. The connected vehicle and telematics are revolutionizing the automotive industry. They are bringing in a digital revolution. A competitive, fair, and open Canadian automotive industry depends on the automotive aftermarket having access to telematics vehicle data and resources. They need to offer their services to the Canadian consumer on a level that is equal to automakers, their dealership network and those that automaker's have contact with. So the Automotive Industries Association of Canada is investing resources to examine the CASIS agreement to determine if it guarantees the aftermarket direct access to telematics vehicle data and resources.

To ensure the future sustainability of the aftermarket industry, champions of the automotive aftermarket in Canada, the United States, Australia, and the European Union are advocating for a secure vehicle interface vehicle communication interface platform.

[39]Association of International Automobile Manufacturers of Canada, Canadian Vehicle Manufacturers' Association, National Automotive Trades Association. (Sept. 29, 2009). An Agreement Respecting the Canadian Automotive Service Information Standard. http://www.natacanada.ca/pdf/CASIS_EN.pdf

Issue #3: Labour market changes

Technological advancements in connected and automated vehicles will likely have mixed implications for Canadians working across many sectors like:

- automotive
- trucking and hauling
- transportation

It will also affect both the production and after-market service of vehicles. Labour markets are expected to change across sectors and regions at variable rates because of pacing and timing of adoption. Both labour shortages and labour surpluses are possible. What actions or collaborative opportunities are needed to communicate and address current and potential future impacts to the Canadian labour market with the deployment of connected and automated vehicles?

Context

We expect that the arrival of connected and automated vehicles will create and eliminate jobs, as well as transform existing jobs. Direct impacts will be seen in many different sectors, including:

- auto and vehicle manufacturing
- vehicle sales maintenance and service
- parts and aftermarket
- financing
- mobility services like:
    - taxis
    - ride-sharing
    - transit
- long haul of goods and short haul transportation of people
- mining
- construction
- health care services
- services like:
    - sales
    - software development
    - insurance
- energy sectors

The future of labour market impacts in the Canadian transportation sector will likely be a result of:

- timing of deployment
- the role of Canadian design, engineering, R&D and assembly in production, itself a result of public policies regarding trade
- increasingly standardized technological advances

- technology shift toward increased connectivity, automation, and electrification
- pace of investment in manufacturing connected and automated vehicles, and the pace of divestment in traditional vehicles
- shifts in vehicle ownership trends and on-demand services

As with previous transportation revolutions (rail and internal combustion), we could also see large scale second and third order effects in sectors across the economy. Many of these changes are unpredictable, but we are already seeing the signs of change in the sectors listed above.

While the net impact on employment can't be predicted, some have suggested that approximately one million Canadian workers, currently in these fields, could be affected by changes from the introduction of connected and automated vehicles. An Export Development Canada report published in 2017 said that "the Canadian automotive manufacturing sector is currently the fourth largest exporter of cars in the world and the ninth largest auto producer in the world"[40]. The rise in importance of this sector is a direct result of the Canada U.S. Auto Pact of 1965.[41]

Because there is still uncertainty on the timing of the transition to fully automated vehicles, it would be beneficial to prepare for these real and immediate pressures, including the advancements of public policies. For instance, the trucking industry is currently facing significant labour shortages for long-haul driving, and all the attention on automation and driverless vehicles is making the problem worse.

Electrification of vehicles and continued automation of production processes will change traditional manufacturing procedures. Fewer parts, more lightweight materials, more software-driven components, shifting supply chains, and sourcing of auto parts can all impact Canadian labour requirements.

But, vehicles with conventional internal combustion engines have more parts than electric powertrain vehicles and it is anticipated that internal combustion engines will still be produced in significant numbers over the medium-term, even though the amount of powertrains in use, including electric, will continue to grow. Also, trade policies and Canada's robust market for connected and automated vehicle software development, artificial intelligence, and testing are options that could somewhat offset job losses caused by these technological changes.

Another possible offset will be a result of job transition where workers will need to develop and/or scale up certain knowledge and/or skill sets because of increased automation. For example, auto technicians with skills related to fuel-based powertrains and hydraulics will likely need to expand their knowledge and skill sets to work on vehicles with electric powertrains and software systems. As the vehicle design changes, so do the production technologies, which will also demand an upgrade in skill sets. Up skilling

[40] Graham, Jeff (2017). Canada's automotive industry: A history in exporting. *EDC. https://www.edc.ca/en/blog/canadas-automotive-industry-exporting-history.html*
[41] https://www.thecanadianencyclopedia.ca/en/article/canada-us-automotive-products-agreement or https://en.wikipedia.org/wiki/Canada%E2%80%93United_States_Automotive_Products_Agreement

may also be needed in areas not related directly to vehicle or vehicle parts production. For example, vehicle repair and maintenance, IT systems, and vehicle operations.

On-demand vehicles will be used more frequently and intensely and they will need frequent replacement. This will impact manufacturing and aftermarket maintenance requirements. As connected and automated vehicles become more and more dependent on proprietary software, open data will be essential for "mom and pop" shops and even large scale operations (like Canadian Tire) to continue to provide maintenance and repair services. This challenge requires careful consideration of appropriate regulations governing the access to data and other technical details that can enable some jobs and growth.

Also, on-demand vehicles will, in the near-term, still require drivers. The surge in supply drivers on an occasional basis is creating more volatility and unstable earnings opportunities for all drivers in this sector. Add to this context the likelihood that dense urban centres will be the first to introduce driverless vehicles to the public.

In rural and remote areas, we already see automated vehicles in use on private, closed lands (like for agriculture, mining, and forestry sectors) where there are fewer regulatory issues than those related to operating on public roads. Continued growth of automation in these sectors could create economic gain. But, at the same time, it may have economic consequences for the small, rural and remote towns that rely on these industries for employment.

Consideration surrounding the concept of "human in command" is needed for many reasons like safety, trust, security, and labour-displacement. People in the mining and forestry sector have already noticed that some jobs have been lost where heavy machinery and equipment, in remote or dangerous locations, are being remotely driven by workers. This technology could easily work from other countries where individuals located overseas control connected and automated vehicles on Canadian territory. This could create job losses.

While there will surely be positive and negative economic consequences because of mass connected and automated vehicle adoption and a predicted labour shift, there will also be social and distributional impacts, as losses and benefits won't materialize equally.

Job losses and changes to jobs are expected to largely impact males and challenge employee profit sharing models, for example business models shifting away from employees having some portions of profit equity in the company or union jobs. While women have made great progress in transportation as they have taken on roles and responsibilities often filled by men, women still don't receive the same opportunities as men in this field and only take up approximately 23% of those employed in the sector[42].

[42] Minister Garneau highlights the roles women play in Canada's transportation systems. Retrieved from https://www.tc.gc.ca/eng/mediaroom/minister-garneau-highlights-roles-women-play-canadas-transportation-system.html

Also, females entering science, technology, engineering, and math (STEM) fields often switch their focus to research in this sector. Women aged 25 to 34 represent 39% of university graduates with a STEM degree.[43] Consequently Canada's increasingly important roles in R&D, engineering, and software development could see the sector become more, rather than less, gender balanced.

More work may need to be done to prepare Canada's future workforce with the skills needed for a more automated future. This would include examining not just post-secondary education or training for adults, but also adapting the types of skills taught in primary and secondary schools, for example a focus on "life-long" learning.

While connected and automated vehicles may create disruption in the long-haul trucking sector, widespread adoption of such technology isn't expected to happen for some time because of current limitations of the technology, technology costs, and the lack of supporting infrastructure like dedicated lanes. Communication on what trends are unfolding will be important and could encourage or decrease anxiety related to potential job losses and future transitions. This will depend on how messages are relayed, and what information is communicated. How public policies deal with actual job losses and growing precarity, and adapt to emergent trends, will be equally important.

Opportunities

- Multi-sectoral scenario-based foresight planning could help to determine the location and extent of potential labour market impacts
- The entry of electric vehicles into the market is a learning opportunity to help predict connected and automated vehicle labour impacts in specific sectors, skills, and manufacturing, because the electric vehicle is the platform on which autonomy is added
- A transition toward more technical jobs (as opposed to mechanical) provides employment opportunities for those historically under-employed like:
    - women
    - immigrants
    - young professionals
    - people with disabilities
- Develop a national connected and automated vehicle communications and education plan to prepare the public for future potential impacts of these vehicles
- Encourage connected and automated vehicle acceptance, while improving and regulating connected and automated vehicle design and future deployment
    - how impacts are communicated will be important to manage fear of job losses

[43] Statistics Canada (2016). Women and Education: Qualifications, Skills and Technology. Retrieved from https://www150.statcan.gc.ca/n1/pub/89-503-x/2015001/article/14640-eng.htm

- Unique jurisdiction of federal regulations over long-haul trucking could support new regulations guiding and advancing human/machine interface in autonomous fleets and public safety on roads
- Canada has a solid logistics network to build on
    - ICT clusters geographically overlap with auto manufacturing in the Windsor-Toronto corridor and in Quebec City for artificial intelligence
- Discuss mechanisms, including regulatory measures, for access to proprietary data and other technical information associated with the aftermarket maintenance and repair services offered by independent private sector businesses, especially small and medium enterprises

Goals

- Develop scenarios on alternative timing, policy, and mitigations to explore location and extent of labour impacts
- Maintain health and social benefits during transition periods for workers
- Reduce labour market frictions by:
    - planning for shortages and surpluses
    - improving access to training and information
- Stabilize and increase the relationship of production to consumption in the auto sector
- Optimize existing efficiencies and capacities in Canadian supply chains
- Expand up-skilling potential on the job and for unemployed people
    - this includes the access to proprietary data issues
- increase opportunities for new technical capacities like:
    - software development
    - R&D
    - testing
- Improve regulations for workers' access to data to minimize displacements and maximize competition for after-market maintenance and upgrades

Proposed action #1: Sector-based analysis of potential labour impacts

The importance of Canada's auto sector to its GDP (gross-domestic product) can't be understated. Currently, the Canadian automotive manufacturing sector is the fourth largest exporter of cars in the world and the ninth largest auto producer in the world. The sector shipped $137 billion in 2016, and was the second biggest exporter in 2018, after oil and gas.

The working group proposes that a scenario-based, multi-sector analysis should be conducted to help understand the full scope of potential Canadian labour impacts because of the gradual deployment of connected and automated vehicles. It should include potential policy options and their likely outcomes. The full scope of the study would need to be determined, but could include the following sectors:

- long-haul trucking
- short-haul trucking
- urban delivery
- public transit
- taxi
- automotive design
- automotive manufacturing
- automotive assembly
- vehicle sales
- vehicle maintenance and repair
- car dealerships

Key barriers and opportunities

The study would assist governments and other players in this space such as industry and academia understand, more fully, present and future potential labour impacts. This would help determine the steps that could be taken to manage risk and encourage economic growth.

Timing

The study could take place in the near-term, such as in the next one to three years.

Proposed action #2: Engagement on skills

Convene stakeholders to identify and advance practices to ensure the automotive aftermarket's workforce is equipped with the skills necessary to manage connected and automated vehicle technology. The stakeholders would include:

- government
- the Automotive Industries Association of Canada (AIA Canada)
- training institutions
- automotive industry stakeholders
- academic and research practitioners

Key barriers and opportunities

Stakeholders are preparing for the arrival of connected and automated vehicles in Canada. It is well acknowledged that vehicles have and will continue to change. The automotive industry has transformed,

undergoing a digital revolution. While much attention is given to the manufacturing process, very little attention is given to what comes after.

Changes in vehicle manufacturing will require changes in how vehicles are serviced and repaired; what gets made must be maintained. If the current and future workforce that services vehicles in independent shops (aftermarket industry) doesn't have the skills and tools needed to properly maintain vehicles of today and in the future, the consequences could be, but aren't limited to:

- independent vehicle service repair shops closing and the workers losing their jobs
- essential vehicle service repairs becoming less accessible for people in rural and remote communities where dealerships are less likely to set up shop
    - independent vehicle service shops have four times the reach of dealerships[44]
- limited consumer choice in vehicle service and repair
- increased costs for vehicle service and repair because of a less competitive marketplace and shortage of trained technicians
- the sustainability of the entire aftermarket industry supply chain becoming compromised because independent vehicle service shops are one of the largest consumers of the supply chain's products
- a less competitive aftermarket industry causing:
    - more expensive vehicle replacement parts and supplies
    - less innovative vehicle replacement parts and supplies
    - limited supply of aftermarket replacement parts and supplies
- economic impact to the national as well as local economies
    - the aftermarket industry contributes $21.6 billion to the Canadian economy annually and employs 389,900 Canadians in big and small communities[45]

Timing

More and more vehicles are being equipped in the manufacturing process with advanced vehicle technology. So it's critical that the workforce that will service these vehicles gets trained as soon as possible for the skills and tools needed to properly maintain vehicles of today and the future.

Stakeholders involved

Canadian consumers:

- limited choice in vehicle service and repair

[44] DesRosiers Automotive Consultants Inc. (June, 2105). 2015 study of automotive service bays in Canada. *Automotive Industries Association of Canada.*
[45] DesRosiers Automotive Consultants Inc.

Canadian automotive industry:

- less open, fair and competitive
- engage to ensure CASIS agreement guarantees independent shops labour force needs (skills and tools)

Software developers:

- collect, generate and analyze data related to the vehicles of the future

Employers (independent shops)

- partnership, collaboration and support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Canadian government:

- partnership, collaboration, support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Academic and Research Practitioners:

- partnership, collaboration, support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Training institutions:

- partnership, collaboration and support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Apprenticeship jurisdictions:

- partnership, collaboration and support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Public and Secondary School Educators:

- partnership, collaboration and support to ensure independent shops are equipped with skills and tools necessary to properly maintain vehicles of today and the future

Links

This action is linked to “Action #1 – Roundtable on data” proposed under the theme of Urban and Suburban vs. Rural and Remote Impacts.

It proposes that officials from federal, provincial, and municipal governments should meet to help identify and advance ways to develop regulations for access and use of data generated by connected and automated vehicles. The working group proposes that the subject of the automotive aftermarket workforce could be one topic included in the agenda for this roundtable. Access to telematics vehicle data is necessary to properly equip the current and future workforce with the skills and tools necessary to properly maintain vehicles of today and the future.

Considerations

Ensuring the current and future workforce that services vehicles in independent shops (aftermarket industry) is equipped with the skills and tools needed to properly maintain the vehicle technology of today and the future:

- training institutions have access to advanced vehicle technology needed to train students
- independent shops have access to advanced vehicle technology needed to train their current workforce
- training institutions have access to telematics vehicle data to train students
- independent shops have access to telematics vehicle data needed to train their current workforce
- vehicle servicing and repair is transitioning from a mostly mechanical to technical trade. This transition is an opportunity to attract new individuals to the industry, including women, people with disabilities, and immigrants. These groups represent people who are vulnerable to being left out of the "modern" economy and whose participation in the workforce is vital to sustain the Canadian labour force.
- if the current data access and use model remain (original equipment manufacturers as gatekeepers) the entire automotive aftermarket industry labour force is vulnerable to job losses and reductions

Issue #4: Insurance

We expect that connected and automated vehicles will impact insurance as accident liability shifts away from the human party and toward the automated technology. What actions are needed to help prepare Canadians and insurance companies for this transition?

Context

We expect that connected and automated vehicles will provide safety benefits and reduce the number of collisions. This is because fewer accidents will be caused by human behaviour, which is the cause of over 90% of accidents today.

While connected and automated vehicles will reduce the number of vehicle collisions, the risk of being in a collision will remain. These risks will be linked to technology malfunction and human behaviour. Related to this, a shift away from private vehicle ownership toward on-demand, shared vehicle access could transform how insurance and risk are defined. This shift in collision responsibility from human to vehicle manufacturer and/or technology provider could mean that the people injured in an accident will be faced with complex and lengthy litigation processes to be compensated, instead of being able to rely on traditional auto insurance.

One approach that could help to prevent long litigation processes is adopting a single insurance policy to cover both driver negligence and the automated technology malfunctioning. With a single policy, the connected and automated vehicle's insurer would compensate injured people if the vehicle caused a collision, regardless of whether the human operator or automated technology was in control.

After paying a liability claim but subject to a deductible, the insurer could try to recover the payment from the party responsible for the collision, like the vehicle manufacturer or technology provider. During the recovery proceedings, the insurer and vehicle manufacturer or technology provider would have access to a mandatory binding arbitration process to settle any disputes. The United Kingdom has started to use a single policy approach since it passed the Automated and Electric Vehicles Act in 2018[46].

Besides a single insurance policy, a data-sharing arrangement with vehicle owners and/or insurers could help determine several important factors. These include, the cause of the collision, whether the vehicle was in manual or automated mode at the time of the collision, and the vehicle operator's interaction with the automated technology.

Sharing the vehicle's data could also help facilitate the liability claim and any recovery proceedings between the connected and automated vehicle's insurer and the party responsible for the collision, like the vehicle manufacturer or technology provider. The data architecture and rules of a data sharing arrangement could be structured so that all interested parties like manufactures, software providers, insurers, police, and vehicle owners and users, can access it in order to protect their interest and the public interest. This would include regulatory reviews of "decisions" made by vehicle software.

One challenge faced by insurance companies is that vehicles with Level 4 or 5 automated technology don't exist yet, and it will be some time before these vehicles are the most common vehicle on our roads. The features of a single insurance policy approach would probably need to be reviewed and amended as automated technology advances and more vehicles with automated capabilities are on the roads.

For example, insurance companies may need to consider what happens in situations where a vehicle is being controlled or data is stored in foreign jurisdictions. Notably, the insurance industry recommends that the single insurance policy also compensates people injured in a collision caused by a cyber breach of the vehicle's automated technology.

Also, the gradual shift towards increased automation creates challenges in predicting future insurance rates and the procedures for resolving complex litigation processes. Insurance companies have noted that injury claims have started to decrease with the introduction of advanced braking systems and may continue to decrease once human drivers are removed.

[46] United Kingdom Government (2018). Automated and Electric Vehicles Act 2018. https://www.legislation.gov.uk/ukpga/2018/18/enacted

How this will impact rates will need to be considered. While there may be a reduction in the number of accidents because of human behaviour, which could cause cheaper insurance rates, rates could in fact be higher as the technology in the vehicle becomes more complex and expensive to repair.

Related to vehicle repair, consideration should be given to after-market collision repair, specifically, the relationship between the cost of repairs and impacts on insurance claims. The availability of businesses that can repair means a more competitive market, which can potentially help achieve lower repair costs.

Opportunities

- Examine how appropriate it is to use existing frameworks and policies, like the *Automated and Connected Vehicle Policy Framework for Canada* and International policies (from the United Kingdom), to create a single policy approach that would allow claims to be resolved quickly, for example when a collision is caused by faulty technology.
- Explore a policy approach that would allow insurance companies to retain part of the loss associated with technology malfunctions and also establish a binding arbitration process that would be designed to settle disputes between insurers and other potential responsible parties, like vehicle manufacturers and/or technology providers, relieving pressure on the court system.
- Pursue approaches that would leverage available data collected from vehicles involved in collisions to assist with insurance claims, and may add value for police/RCMP investigations.

Goals

- **Prevent lengthy litigation processes**: Accidents involving connected and automated vehicles should not result in costly and time consuming litigation processes. Injured people should be able to be compensated fairly and quickly.
- **Update insurance laws:** The insurance laws should reflect the unique risks associated with connected and automated vehicles.

Proposed action #1: Consider a single insurance policy approach

The Provincial-Territorial Council of Ministers could encourage a single insurance policy approach by facilitating discussions with, and urging action by provincial and territorial governments who hold the authority for insurance policy development in their jurisdictions. A single insurance policy approach could help address the Council of Ministers' call for "amendments to provincial legal frameworks for vehicle liability and insurance…to reflect the unique risks associated with automated and connected vehicles"[47].

[47] Policy and Planning Support Committee (2018). *The Future of Automated Vehicles in Canada.*

Key barriers or opportunities

A single insurance policy could support fair and quick compensation in the case of an accident involving a connected and automated vehicle and prevent long litigation processes. Insurance companies would absorb part of the risk associated with accidents involving connected and automated vehicles and would be responsible for resolving claims with companies or individuals at fault, like vehicle manufacturers and technology providers.

Timing

A provincial or territorial government could implement a single insurance policy in the short-to-medium term. Legislative and supporting regulatory changes would also be needed.

Stakeholders involved

The main stakeholders that provincial and territorial governments should consult are:

- insurers
- insurance customers
- insurance regulators
- vehicle manufacturers
- technology providers

Links

A single insurance policy would benefit from a data-sharing arrangement between vehicle manufacturers, vehicle owners, and insurers. Making data available after an accident would help the liability claim and any associated recovery proceedings between connected and automated vehicle insurers and the parties responsible for the collision, like vehicle manufacturers or technology providers.

Currently, the Canadian Council of Insurance Regulators is examining the current limitations of the law regarding connected and automated vehicles to help identify future regulatory needs. The council will release its conclusions in the spring of 2020. The outcome of this effort could help the provincial and territorial governments update the insurance laws to reflect the unique risks associated with connected and automated vehicles.

Considerations

Insurance is a mandatory purchase for vehicle owners. People using connected and automated vehicles will be considered as passengers or operators and will expect appropriate insurance to be in place. That insurance policy should provide access to fair and quick compensation.

Proposed action #2: Facilitate a data-sharing arrangement

A data-sharing arrangement between the vehicle manufacturer, vehicle owner and/or insurer would help facilitate the liability claim and any recovering proceedings between the connected and automated vehicle's insurer and the party responsible for the collision, like the vehicle manufacturer and/or technology provider, as described in the single insurance policy.

A data-sharing arrangement would identify the specific data elements meant for sharing, for example:

- GPS-event time stamp
- GPS-event location
- automated status – on or off
- automated mode – parking or driving
- automated transition time stamp
- record of driver intervention like:
    - steering
    - braking
    - throttle
    - indicator
- time since last driver interaction
- driver seat occupancy
- driver belt latch
- speed
- vehicle warning or notifications to the vehicle's operator

A review of potential data elements would need to be conducted to determine if there are any privacy implications.

Key barriers and opportunities

A data-sharing arrangement could support fair and quick compensation in the case of an accident involving a connected and automated vehicle and prevent long litigation processes. A potential barrier could be developing a consistent process for sharing data between one vehicle manufacturer and another vehicle manufacturer. As much as possible, the process should be streamlined to help with the data transfer and avoid any administrative burden on vehicle manufacturers, vehicle owners, or insurers.

Timing

A data-sharing arrangement could be implemented in the short-term. This could be done by building on existing guidance resources, like the Safety Assessment for Automated Driving Systems in Canada, for manufacturers of connected and automated vehicles.

Stakeholders involved

The main stakeholders that should be consulted are:

- insurers
- insurance customers
- vehicle manufacturers
- technology providers
- law enforcement organizations

Links

A data-sharing arrangement would complement a single insurance policy by helping determine the cause of the accident. This would allow the insurer to settle the claim quickly with the injured person. Then they could engage the other parties, like the vehicle manufacturer and/or technology provider, in recovery proceedings, if the connected and automated vehicle technology was responsible for part or all of the accident.

Data recording extraction by law enforcement officers will become more important when the human operator isn't personally responsible for an accident. The data elements described above should be easily available to law enforcement so they can investigate collisions without needing a court search warrant.

Transport Canada's Safety Assessment for Automated Driving Systems in Canada includes an expectation on connected and automated vehicle manufacturers to have processes in place to share data with law enforcement and with vehicle owners and operators to facilitate insurance claims. Listing the data elements meant for sharing in the Safety Assessment could streamline the process.

Considerations

By working together after an accident, vehicle manufacturers and insurers can help customers and anyone who was injured by compensating them fairly and quickly.

Consideration should be given to structuring the data architecture and rules of a data sharing arrangement in a way that would allow all interested parties (for example, manufactures, software providers, insurers, police, and vehicle owners and users) access to protect their interest and the public interest. This would include regulatory reviews of "decisions" made by vehicle software.