Autonomous Vehicle Regulations: Jurisdictional Scan on the US, China, Europe, and Canada
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Introduction

Autonomous vehicles (AVs) will likely be the way of the future. The benefits of autonomous vehicles include improved safety, improved access to transportation, less congestion on roadways, and increased economic activity as there will be less traffic accidents. Autonomous vehicles operate using machine learning algorithms to identify and distinguish between cars, motorcycles, stop signs, street lights, road markers, cones, and pedestrians. Governments across the world are beginning to develop policies that will address the safety and legality of autonomous vehicles. The purpose of this jurisdictional scan is to outline the existing regulatory frameworks surrounding autonomous vehicles in 4 different regions: the United States, China, Canada, and Europe. We also highlighted the challenges that each region is facing in terms of ethical and logistic problems when considering making autonomous vehicle policy.

U.S.

There are no laws in the United States that make autonomous vehicles illegal. Currently, there are guidelines made by the National Highway Traffic Safety Administration (NHSTA 2020). NHSTA claims to support the invention of full-self driving as an answer to safety concerns, increasing mobility, decreasing economic losses, and making roadways less congested. In terms of safety, the NHSTA recognizes that full-self driving vehicles could decrease the amount of crashes as 94% of crashes in the U.S are caused by human error (NHSTA 2020). According to the NHSTA, under current guidelines there are no vehicles available on the market currently that they consider to be fully autonomous. NHSTA uses the definition of fully automonous from the Society of Automotive Engineers(SAE) Level 5 autonomy which is, “a vehicle that can do all the driving in all circumstances. The human occupants are just passengers and need never be involved in driving” (NHSTA 2020). However, all vehicles are road legal if

companies can prove that their vehicles can pass the Federal Motor Vehicle Safety Standards (NHSTA 2020). If an autonomous vehicle can pass this test, it will be available for purchase. In terms of ethics, the NHSTA admits that policymakers have yet to come up with solutions to problems that will need to be answered once Level 5 autonomous vehicles are on American roads. For instance, if a full-self driving vehicle without a steering wheel gets in an accident it is unclear whether the passenger or the company that made the vehicle will be liable (NHSTA 2020). The U.S appears to be partially prepared to have full-self driving vehicles on the road soon, especially in terms of having safety regulations in place and understanding what full-selfing driving as a definition is. However, the U.S is lacking policies that address the ethics and potential consequences that will come with full-self driving.

China

In 2014, China announced "Made in China 2025", a plan to use innovation as a driving force for China's economy and to assert itself as a global leader. In the report, autonomous Vehicles have been identified as one of China's key sectors based on the CCP's plans to become a leader in Artificial Intelligence (Taeihagh and Lim 2019).

The responsibility and jurisdiction of China's national policy framework for autonomous vehicles are held by multiple ministries including the General Administration of Quality Supervision, Ministry of Industry and Information Technology, the Ministry of Public Security, and the National Administration of Surveying, Mapping, and Geo-Information, and others (West 2016). The coordination of all these government agencies involved will be the main issue as they will need to have an integrated approach that balances innovation and security. China's advantage over other nations is that its regulatory process operates at the national level, which

simplifies regulatory rules and procedures (West 2016). As a result, there is less bureaucracy and red tape that the government must navigate to establish a national framework.

China has four challenges when it comes to autonomous vehicle developments. The first is that China has complicated signage, traffic lights, signals, and road signs (Pizzuto et. al 2019). The consequence is that optimizing AV decision algorithms for Chinese roads takes tremendous amounts of effort and training (Pizzuto et. al 2019). The second challenge is that China's regulations mandate that for pilot testing, drivers must keep their hands on the steering wheel at all times, which complicates AVs tests (West 2016). The third challenge is that much of China's infrastructure and roads need redevelopment. Driving lanes, bike lanes, and pedestrian lanes are not coordinated nor separated clearly in many areas. China will need to restructure and separate pedestrian and cyclist lanes from driving lanes and develop digital smart roads to provide network connections for AVs (Zou et. al 2018). The fourth challenge is China has weak data and privacy protection for consumers (Zou et. al 2018). AVs are highly connected to others through data and will be even more so in the future – collecting personal data from drivers and passengers. Relationship-building and trust between the consumers and technology giants will need to be strengthened, considering that Baidu, Alibaba, and others are notoriously for data abuse, misuse, and breaches (Zou et. al 2018). In response to the precarious environment, China enacted a new Cybersecurity Law which protects consumers by requiring all personal information to be anonymized, emphasizing consent requirements, and that AV network operators need to be transparent about what they are using the data for (Taeihagh and Lim 2019). Tech companies are responsible for ensuring tight security, protection of consumer information, and for the storage of the information to stay within China (Taeihagh and Lim 2019).

Due to a national strategy highlighting the importance of AVs, in recent years, China has rapidly accelerated technological and political developments to boost the sector. In 2018, the Ministry of Industry and Information Technology drafted new regulations, allowing for road testing of AVs on permitted highways (Minchin 2021). This is important because for a while China was behind on permitting AV testing compared to the US, UK, and Germany. There are stipulations in place however. Organizations that are granted the rights to test self-driving vehicles must pass a series of tests, allowing for sequential developments (Chow 2018). The first stipulation is that the organization's self-driving cars must pass a test within a "closed zone" testing site, and once it does, the government permits them to test on the roads and highways (Chow 2018). In September 2020, Changsha built China's first highway with integrated collaborative automated driving systems and vehicles sharing sensor information (Wanqing 2021). Beijing is already allowing the testing of AVs on public roads and is currently building a 10-kilometre highway that is designed for testing purposes (Wanqing 2021). In December 2020, AutoX, a startup backed by Alibaba rolled out tests for driverless robotaxis in Shenzhen on public roads and marked a huge milestone (Toh 2020). Previously, backup safety drivers were needed in place, but Shenzhen has removed that restriction after witnessing AutoX's progress in both the software and hardware of AVs (Toh 2020).

Canada

Transport Canada created the Program to Advance Connectivity and Automation in the Transportation System (ACATS) to help Canadian jurisdictions prepare for the technical, regulatory, and policy issues emerging as CAV technologies are introduced in Canada.(Transport Canada 2018) To date, ACATS has committed approximately $3 million in funding, including funding for the following reports and documents:

• CAV Readiness Plan for the GTHA and Kitchener/ Waterloo Corridor – led by a steering committee that includes the Ministry of Transportation Ontario (MTO), Metrolinx, the Region of Peel, and the City of Toronto, the plan provides public agencies with readiness guidelines related to infrastructure, institutional, operations, and public policy considerations. The committee also developed a list of CAV programs, as well as a governance structure for regional collaboration and the development of a CAV Liaison Committee.

• Codes and Standards Roadmap for CAVs – led by CSA Group, guidelines and a standardization roadmap are being developed for the safe deployment of CAV technologies in Canada.

• Impacts of CAVs for Pedestrians with Sight Loss – led by Canadian National Institute for the Blind (CNIB), the study focuses on assessing how pedestrians with sight loss may be affected by CAVs.

• CAV Testing Strategy and Capacity Building – led by City of Vancouver, the intent of the project is to prepare an urban CAV testing strategy for future trials and use, focusing on civic fleets and infrastructure.

• ITS Architecture for Canada Version 3 Update – led by Intelligent Transportation System Society of Canada (ITS Canada), the project is intended to update the Canadian ITS Architecture to include CAVs and realign it with the US ITS Architecture (ARC-IT), including enhancements and the Connected Vehicle Reference Implementation Architecture (CVRIA).

• City of Calgary Autonomous Shuttles – led by City of Calgary, the project consists of a pilot test for an electric autonomous shuttle travelling at a low speed and capable of carrying 10 to 12 passengers between the Calgary Zoo and the Spark Science Centre. The intent of the project is to understand how an automated shuttle operates in Calgary, increase public awareness of the technology, gather feedback, and help inform and train highly qualified public sector officials in the area of CAVs (City of Calgary 2019).

• National Smart Vehicle Demonstration and Integration Trial: Phase I – led by Canadian Urban Transit Research and Innovation Consortium (CUTRIC), the project is intended to explore the integration of automated connected, low-speed, electrified shuttles (e-LSA) into various Canadian communities and jurisdictions as first-mile/last-mile transit applications.

In 2019, Transport Canada also awarded a contract to advance the development of a Canadian Security Credential Management System (SCMS) for connected vehicles (Transport Canada 2019). The SCMS will ensure the security and trust of CV communications. The purpose of the initiative is to identify Canadian stakeholder requirements for the SCMS and determine a recommended operational model for its deployment in Canada. A project has also been initiated with the University of Alberta, in Edmonton, to integrate SCMS into the ACTIVE CV test bed to assist in testing and preparing for the security and privacy of connected vehicles.

Ontario, Quebec, and Manitoba have made updates to provincial regulations to enable AV testing on public roads. Other provinces have also engaged in AV pilots, but these demonstrations have been restricted to private property sites. It should also be noted that in the absence of specific regulations, CAVs are still allowed in other provinces as long as they meet

Canadian Motor Vehicle Safety Standards (CMVSS). However, they may not be able to be operated in automated modes and are limited to either manual operation or the use of driver assistive technology (e.g. adaptive cruise control, lane keep assist). Ontario has been a progressive province, updating its Highway Traffic Act and enacting Ontario Regulation 306/15: Pilot Project – Automated Vehicles in January 2016 to regulate the testing of automated vehicles on public roads. Further regulation updates in January 2019 have allowed for originally manufactured Level 3 AVs to be operated by the general public, with more advanced driverless AV testing being conducted as part of pilot projects under specific safety conditions, as well as truck platooning on defined corridors. With permissive regulation in place, and provincial support through the Autonomous Vehicle Innovation Network (AVIN), there is an array of CAV pilots and research and development (R&D) initiatives in Ontario, involving partnerships between private industry, academics, and public agencies.

Testing Highly Automated Vehicles (HAV) in Canada – Guidance for Trial Organizations clarifies, for trial organizations, the role of federal and provincial/territorial levels of government involved in facilitating trials, while also establishing Canada as a destination for trials of HAVs. The trial guidelines establish a set of voluntary minimum safety practices and expectations that trial organizations are expected to follow for the temporary trials of AVs and AV systems. (Transport Canada 2018)

Canada's Safety Framework for Automated and Connected Vehicles provides stakeholders with a stable policy direction for safely deploying CAV on public roads in Canada. (ESCRPYT 2019) It provides an overview of Canada's current legislative, regulatory, and standards programs. The Safety Assessment for Automated Driving Systems in Canada was

developed by Transport Canada as a tool to support vehicle manufacturer safety reviews of SAE Levels 3 to 5 vehicles before being deployed on Canadian roads (Transport Canada 2019).

Led by the University of Alberta Centre for Smart Transportation and the University of British Columbia, the ACTIVE-AURORA project was launched in 2014 and focuses on testing a variety of applications relating to CV technologies. Since 2017, Transport Canada has also been collaborating with industry to undertake testing and evaluation of cooperative truck platooning systems (CTPS) and V2V communication systems at their testing facility in Blainville, Quebec. The goal of this research is to identify the fuel-consumption savings and improvement of road safety that could be introduced from platooning.

Europe

The European Union (EU) has taken steps to initiate conversations on autonomous vehicle (AV) technology and the implementation plan. As an employer of 12 million people and a research and innovation hub, the EU's automotive sector is a primary driver of economic growth. To embrace the digital revolution, The European Commission High Level Group GEAR 2030 report lays out recommendations and steps to make Europe more competitive (European Commission 2017). The European Parliament also passed a resolution in January 2019, calling for a more integrated AV transport system to increase mobility in the region (European Commission 2019).

The European Union faces the following challenges despite growing industry revenue in the automotive market. First, the European roads are bound by the United Nations' 1968 Vienna Convention on Road Traffic. Self-driving cars are limited to no more than 10 km/hr. The prior threshold has been updated since, but member states need to further translate these into national laws. Secondly, three separate European Commissioners (digital, transport and internal market

portfolio) are each leading isolated conversations to discuss the technology. Without centralized coordination, the EU faces challenges to take actionable steps. Thirdly, there are no firm conclusions on topics related to ethics, such as liability, data and privacy, and cybersecurity safety. Additionally, there are many technical challenges related to connected cars, as the European driving conditions are complicated in city centers (FTI Consulting 2017).

A few member states have been leading the development and deployment of AVs. In Germany, the Autonomous Vehicle Bill was enacted in June 2017, modifying existing Road Traffic Act defining the requirements for highly and fully automated vehicles, while also addressing the rights of the driver, paving ways for AV testing. The bill defines the scope of the AV and confines the technology within existing traffic regulations. It also recognizes conditional automation when the driver needs to resume control. Currently, autonomous testing legislation is charged by municipal regulatory authorities, approving pilot vehicles operating on private properties. Examples include shuttle services interacting with pedestrians and bicycles. Germany also aims to create infrastructure suitable for Level-5 AVs and expand autonomous vehicle testing on the Autobahn beyond the A9 highway in Bavaria, where it is currently experimenting with vehicle-to-vehicle communication via 5G mobile networks (Autovista Group 2019).

France is establishing a legislative framework that will allow the testing of autonomous cars on public roads, with the aim to deploy Level-4 AVs on public roads in the next few years. The French government has made EUR 40 million available to subsidize AV pilot projects, and more than 50 AV test projects have taken place since 2014 (Autovista Group 2019).

Spain is expanding its rules for AVs, as well as modifying insurance laws to offer a legal framework for the new technology. The rule will encompass Level-5 AVs. The Direccion General de Trafico (DGT) and technology company Mobileye agreed to work in collaboration to

prepare Spain's AV infrastructure ecosystem and regulatory policies. In Barcelona, a 5,000-vehicle fleet has been equipped with Mobileye technology. This partnership will also define the regulatory mandates for the future of AV (Autovista Group 2019).

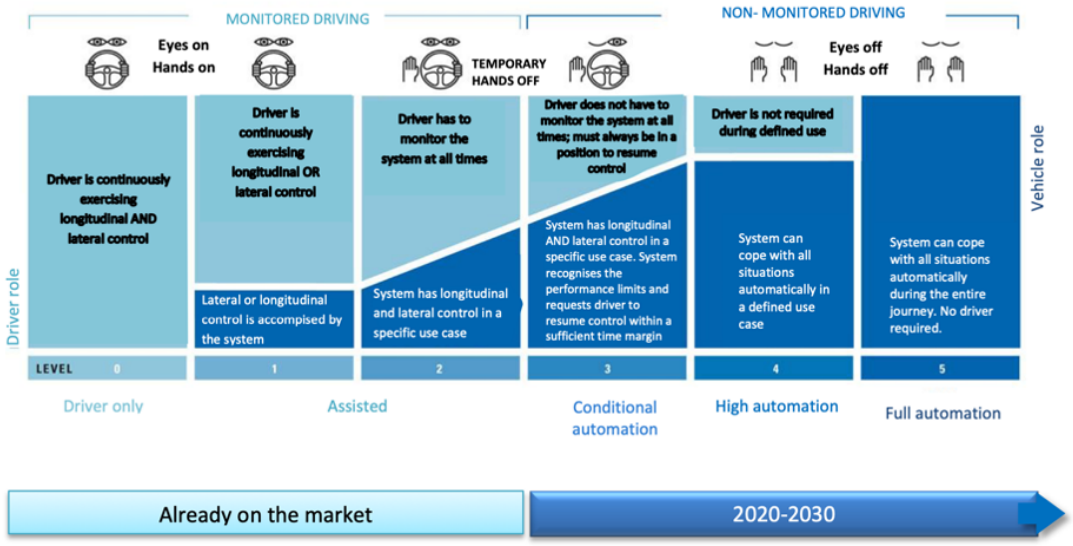
Italy passed its first law regarding AV testing in 2018, permitting specific roads authorized by road operators. All tests will have to be authorized by Italy's Ministry of Infrastructure and Transport (Autovista Group 2019).

Outside of the European Union, the United Kingdom's Centre for Connected and Autonomous Vehicles (CAV) is working on legislation to allow testing on major roadways and providing funding for R&D projects. According to Transport Systems Catapult (TSC), since 2014, the UK Government has helped fund over 200 organizations and over 70 projects. TSC is a government-backed center of excellence that has helped create and deliver Connected and Autonomous Vehicle (CAV) projects in the UK. In 2020, the Future of Transport Urban Strategy Regulatory Review was launched. The Law Commission of England and Wales and the Scottish Law Commission are also undertaking a review of the legal framework to update legal requirements suitable for AV technology (Autovista Group 2019).

Overall, both the UK Government and the European Union recognize the urgency to update legal requirements and legislative frameworks that are suitable for an autonomous future. The regions' main challenges include the fragmentation of governments and decision makers, high infrastructure demand and cost for research and development, and the decrease in competitiveness of the European economy. The AV technology also presents the European region with many opportunities. The pressure to achieve a carbon-free society gives the AV market the momentum and the attention it needs. Europe's established automotive industry presents export opportunities to market with great purchasing power. Urbanization and

technology disruption encourage the development of new market segments, such as the AV market, to make Europe more competitive.

Figure: Different levels of automation (source: Society of Automotive Engineers-SAE[11])



Source: European Commission (2018)

Conclusion

Our study and analysis provide an overview of the national regulatory landscape of autonomous vehicles in the US, China, Europe, and Canada. Autonomous vehicle developments are in their infancy and are predicted to have seismic economic and social benefits, but also unintended consequences. With autonomous vehicles primed to be a large sector in the future for advanced economies, government regulations will become increasingly important in AV developments and deployments, as well as addressing relevant issues around ethical algorithm development, safety, data privacy and protection, cybersecurity and safety of operating systems, infrastructure development, and accident liabilities.

While each jurisdiction has their own set of challenges regarding governance structures, the common theme is that to improve AV development, national governments will need better coordination between different levels of government, as well as reducing the regulatory red tape. National governments should collaborate with other countries, devising strategies and establishing best practices for governing AVs. National governments will also need to work closely and consult with private sector partners, industry experts, and researchers on forming and implementing legislative frameworks that entrench the values of safety, responsibility, and ethical development. Laws regarding accident liabilities will need to be clearly defined and easily accessible to the general population. Algorithm design will need to be accountable and transparent in order to mitigate potential biases. Policies that revolve around responsible privacy data usage and data-sharing by AV makers and software operators will need to be scrutinized and examined in close detail to protect consumers. Operational systems developed should be robust and have the utmost security levels to prevent hacking and breaches that would either cause harm to consumers and/or steal vital private information. Future infrastructure projects should be AV-friendly and should have the necessary structures to provide network connections between AVs. As AVs become the future of transportation, the cohesion and sharing of information between regulators, policymakers, tech giants, and startups should be prioritized to promote responsible, ethical, and agile development.

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