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Activities on Legislation for Autonomous Vehicles Take Off

New Reality

The COVID-19 pandemic is still holding the world in a stranglehold. Large-scale vaccination is in different stages throughout nations globally, and countries that have come far in terms of vaccinating the population are slowly beginning to open up. The commercial vehicle industry sells more vehicles than it can produce for the moment—a sort of rebound effect from when the world was put on hold last spring. At the same time, the automotive industry is experiencing semiconductor shortages, resulting from unfortunate occurrences such as fires in semiconductor factories, but also because semiconductor companies' order intakes from the automotive industry declined substantially last spring, and the companies turned to other customers. Delays in production in Europe have also been experienced due to the cargo ship *Ever Given*'s blocking of the Suez Canal for a week during the spring. The storage of automotive components is on the road to cut costs, and the manufacturing of vehicles is sensitive to hiccups in the delivery chain.

Despite the challenging times with the COVID-19 pandemic, there is more activity than ever in the field of connected and automated driving. Much funding has been invested in start-ups aiming to bring zero-emission connected and automated vehicles to market for enabling the safe and sustainable transport of people and goods. Autonomous vehicles need new types of homologation, and initiatives to create appropriate legislation for putting safe autonomous vehicles on the streets are underway. It is challenging when the driver is removed from the loop.

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Connectivity

The U.S. 5.9-GHz Spectrum

On 3 May 2021, the U.S. Federal Communications Commission (FCC) published its final report and order [1] and further notice of proposed rulemaking [2] related to the proceedings on 5.9 GHz, starting the clock on the reallocation of 45 MHz of the 75 MHz spectrum to unlicensed devices, such as Wi-Fi. Given the date of this order's publication, unlicensed devices will begin to have access to the lower 45 MHz of the 5.9-GHz spectrum on 2 July 2021. This implies that only 30 MHz will be left for safety-related applications using vehicle-to-everything (V2X) communication from this date.

The further notice of proposed rulemaking [2] covers issues related to spectrum reallocation that were not settled in the previous proceeding, including reimbursement for V2X incumbents, harmful interference concerns, and a possible alternative spectrum for V2X communications. Initial comments on this proposal were due on 2 June 2021, while reply comments were due on 2 July 2021.

Transportation stakeholders have overwhelmingly opposed this spectrum reallocation, citing the analysis by the U.S. Department of Transportation of the threat to transportation safety that such an action would represent. The chair of the House Committee on Transportation and Infrastructure, Peter DeFazio (D–OR), also spoke out against the FCC decision recently [3], but the committee of jurisdiction has not taken any action yet. The Intelligent Transportation Society of America and the American Association of State Highway and Transportation Officials have initiated a lawsuit with the intention to reverse the FCC's reallocation of 45 MHz to Wi-Fi. It was filed in the beginning of June.

The automotive market for connectivity is negligible compared to that for consumer electronics, making it even more crucial to protect the spectrum for societal benefits

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such as road-traffic safety. Hundreds of millions of vehicles are put on the market every year worldwide, and the expected lifetime of a vehicle is around 12 years (and far from all of them are equipped with connectivity), compared to the 100 million handheld devices (e.g., mobile phones and tablets) put on the market every month with an expected lifetime of two years.

The Wi-Fi market is many times larger than the vehicle market in terms of connectivity modules, making it even more important to keep the 5.9-GHz band for safety. Spectrum is a scarce resource, and this tiny part of the spectrum should have been kept for transportation stakeholders and the automotive industry. Studies are ongoing to allow Wi-Fi into the 6-GHz band with a spectrum covering 1 GHz. Road safety needs regulation: it is not until legislation on safety features is in place that a decline in accidents can be spotted in statistics. The unsecure regulatory environment for V2X communication will further stall any deployment plans. The Transportation Research Institute at the University of Michigan published a white paper in 2018 detailing the consequences of delaying V2X deployment by three years [4]. It should be noted that it takes at least three years for an automotive manufacturer to introduce a new electronic control unit (e.g., a connectivity module) to a vehicle. Because of this, swift changes in the regulatory environment hamper voluntary deployment of technologies. The automotive industry needs long-term commitments from authorities to take on the risk of investing.

Coexistence of V2X Technologies

The European Telecommunications Standards Institute (ETSI) standardization in Europe has developed two technical reports on coexistence between Dedicated Short-Range Communications (called Intelligent Transportation Systems-G5 in Europe) and Long-Term Evolution-V2X. One report describes a framework for sharing available spectrum at 5.9 GHz by prioritizing different technologies on frequency channels. The other technical report has elaborated on cochannel coexistence among technologies on the same channel in the same geographical area. The latter contains suggestions for techniques that have been scrutinized through simulations. There are promising methods allowing both technologies to share resources. The technical reports will be publicly available at ETSI's homepage for download when this column is published. The official names of the reports are ETSI TR 103 667 and ETSI TR 103 766.

5G Deployment

Network coverage outside densely populated areas is typically poor. Of course, the reason is that operators have no incentives to install equipment where hardly any people are using the resources. There is an overbelief that 5G is essential for automated vehicles and that road automation will not happen until 5G is in place. I claim that the automotive industry has far greater challenges than proper network coverage for road automation. Network coverage is, of course, important but not essential. An automated vehicle needs to be able to return to base or come to a safe stop without network coverage.

The European Commission (EC) has decided to provide funding for accelerating 5G deployment along the major transport network in Europe called the Trans-European Transport Network, consisting of 26,000 km of roads. The budget for deploying 5G along this transport network is estimated at €18 billion (~US$22 billion) or k€700/km (~USk$855/km) [5]. The cost for enjoying the 5G network along this road network would be €1–5/10 km for every vehicle. Long-haulage trucks have an expected mileage of around 1,000,000 km; if these trucks use 5G connectivity, the total cost of ownership would increase substantially. The EC initiative to fund 5G deployment for roads is great, but it should not come at the expense of other technology investments for decreasing emissions and air pollutants, such as facilitating electrification of vehicles by building charging infrastructure.

Autonomous Vehicles

Waabi: New Start-Up

Waabi is a new start-up in the self-driving technology world that uses an "artificial intelligence (AI) first approach." Raquel Urtasun is the CEO and sole founder. She is a full professor at the University of Toronto and was the chief scientist at Uber Advanced Technologies Group. Her background is routed in AI and deep neural networks. *Waabi* has two connotations: in Ojibwe it stands for "she has vision," and in Japanese it means "simple." Waabi just raised US$83.5 million, and there will be offices in Toronto as well as in California [6]. The first focus for Waabi will be to automate long-haulage transportation of goods. Deep neural networks applied in vehicle automation have their own set of problems stemming from the black-box effect, where traceability back to why, for example, a vehicle responded in a certain way to a situation cannot be understood. Urtasun states that, by adding statistical interference and complex optimization to deep neural networks, the decision process of AI can be traced back, hence opening up the black box. Waabi will work with a closed-loop simulator to speed

up the process for testing automated driving technologies.

ISEE: New Collaborations

ISEE is a start-up working on self-driving technology for confined areas, solving the routing of goods at logistic hubs. The small vehicles can move around containers in yards and work alongside with people (see Figure 1). ISEE has its roots at the Massachusetts Institute of Technology, and the company was established in 2017. Recently, it received attention for its new collaborations with Maersk and Lazer Spot. Maersk is considered the largest logistics company in the world, and Lazer Spot dominates yard operation at distribution centers in North America. ISEE asserts that its AI approach is robust and capable of handling unexpected events.

Einride Raises US$110 Million

The Swedish start-up Einride (see Figure 2) mentioned in earlier columns raised US$110 million in funding in its series B round in May. Its investors include several venture capital firms, but also Maersk and Ericsson. Einride produces electrified, automated, and connected pods for transporting goods. The money will be used for closing new customer agreements, growing in terms of headcount to meet customer demands, and opening new offices in the United States. Einride reports a reduction of 94% in emissions for its customers compared to driving with diesel. It sells transportation as a service by providing a digital platform addressing all of the needs for transporting goods from point A to point B.

Legislation

Initiatives fostering legislation for autonomous vehicles are ongoing in different parts of the world. Pivotal for putting vehicles on the market is homologation, demonstrating the conformity to regulatory, technical, and safety standards issued by different markets worldwide. In Europe, this goes by the name *whole vehicle type approval (WVTA) framework,* and the European Union (EU) collects WVTA in its Regulation (EU) 2018/858 as amended by General Safety Regulation 2019/2144. Automated vehicles require new types of homologation, depending on, for example, the automation level. Safety features included in traditional homologation such as an automatic emergency braking system might not be relevant for an automated vehicle because the vehicle should not even end up in dangerous situations but avoid them in the first place. Physical attributes now required by homologation, such as wipers or rear mirrors (or even windscreens), which are in place for drivers today, are unnecessary for automated vehicles. Legislation on automated vehicles is essential for deployment, and more work needs to be performed on this topic before automated vehicles are a commodity.

United Nations Economic Commission for Europe

The United Nations Economic Commission for Europe (UNECE) plays a key role in many parts of the world in establishing harmonization of homologation to ease the burden on automotive manufacturers in terms of selling products in different countries. The whole purpose of homologation is to deliver safe products to end customers. UNECE established the Working Party on Automated/Autonomous and Connected Vehicles in 2018 by converting the former Working

FIGURE 1 ISEE yard vehicles.

FIGURE 2 An Einride next-generation Pod.

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Party on Brakes and Running Gear. Two major UNECE regulations have been published since then that are also relevant for automated vehicles: UN Regulation No. 155 (R155) addressing cybersecurity and UN Regulation No. 156 (R156) addressing software updates.

R155 covers cybersecurity for the whole vehicle with its internal electrical architecture as well as interfaces (e.g., onboard diagnostics, Wi-Fi, and telematics unit) including the vehicle back-end system, i.e., both onboard and offboard systems. R155 provides a practical approach with concrete examples of threats and specified mitigations as well as a holistic approach with process and governance perspectives. It explains what but not how, and the regulation is intentionally technology neutral; it does not mandate specific technical solutions because of the dynamic nature of automotive cybersecurity. Rigid technical requirements might counteract a swift response to an intrusion. R155 applies to all phases of the vehicle's lifecycle—development, production, and postproduction—when the product is owned by the customer. Suitable standards, such as ISO/SAE 21434, *Road Vehicles: Cybersecurity Engineering*, support fulfillment of R155. Vehicle manufacturers must demonstrate how the regulation is fulfilled.

R156 particularizes secure over-the-air software updates and mandates a software update management system to keep track of software inside the vehicle. This regulation also addresses the whole lifecycle of vehicles as R155 does; hence, it is under the responsibility of the vehicle manufacturer. Software updates of functionality included in homologation are given extra attention, and the manufacturer must prove that the software update does not change the intended functionality. Traceability is a core concept in R156.

Germany Adopts Law on Autonomous Vehicles

Germany seems to be the first country in the world adopting a law on autonomous vehicles. The law is aimed at vehicles with automation level 4. Focus in the legislation is on certain applications such as logistics, company shuttles, and public transport. There is a requirement on technical supervision of driverless vehicles that can turn off the vehicle. Liability insurance is also required by operators of autonomous vehicles. This first law should not be regarded as final; it instead establishes a framework for testing, moving away from permitting testing on a case-by-case basis. There is still work to be done before large-scale deployment of driverless cars is a reality on German roads.

Homologation for Connected and Autonomous Vehicles in Europe

European policy makers plan to have a type approval framework in place for automation level 4 and level 5 vehicles in a year. The first attempt at legislation has been shared in the Motor Vehicles Working Group chaired by the EC. In this group, experts from industry on the topic are invited. The first draft presented is based on elements from German law. It defines an automated driving system (ADS) comprising a set of hardware and software components. The operational design domain in which the dynamic driving task (DDT) is carried out makes up the ADS. The DDT should be able to manage all normal driving situations by appropriately selecting a trajectory and speed. There is still much missing from a definition point of view, leaving the implementer with many options. Examples of requirements under normal driving are "driving in a predictable manner," "cautious with right of way at intersections," and "leave sufficient time and space for others in lateral maneuvers." The terms *sufficient*, *predictable*, and *cautious* create subjective loopholes, and they can be interpreted in numerous ways. Such language needs to be clarified. Further, there is, for example, a requirement on a time to collision (TTC) of 4 s when performing a left turn in an intersection. A TTC of 4 s in low-speed scenarios in an urban environment might cause the vehicle to be standing still for a very long time before being able to turn left. The current proposal leaves too much open for interpretation, which can cause very different behaviors in real-traffic scenarios such as very conservative driving, which annoys other traffic participants. It is indeed challenging to draft legislation for autonomous vehicles for large-scale deployment in the public domain, and the time plan from policy makers in Europe is ambitious.

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