Independent market research and
competitive analysis of next-generation
business and technology solutions for
service providers and vendors

HEAVY READING
WHITE PAPER

The Connected Car Taxonomy Decoded:
An Overview of Connected Autonomous Vehicles & Intelligent Transportation Systems

A Heavy Reading White Paper

AUTHOR: STEVE BELL, SENIOR ANALYST, IOT, HEAVY READING

INTRODUCTION

This paper gives a broad overview of the autonomous vehicle and Intelligent Transportation Systems (ITS) landscape, and how it is evolving. It addresses the confluence of connected vehicles with Advanced Driver Assistance Systems (ADAS) and how the evolution of multiple convergent technologies is accelerating autonomous vehicle timelines, causing disruption for the automotive ecosystem and value chain.

CONNECTED VEHICLES

The connected vehicle has its origins with the original analog cell phones that were sold as line-fitted equipment in the late 80s. Throughout the 90s and into the early 2000s, various telematics applications started to appear on multiple manufacturers' vehicles, including GM's OnStar suite of services and Volvo's On Call, in partnership with service provider WirelessCar. With the advent of 3G and later 4G LTE, manufacturers were prompted to include modules for telematics and high-end infotainment systems.

Together with the rapid growth of smartphones, these infotainment hubs provide unprecedented levels of connectivity. The use of applications, including streaming of digital music and remote downloading of traffic information, combined with this connectivity, deliver experiences that were inconceivable at mass-market price points five years ago.

Despite these advances, the challenges that the auto industry now faces are numerous. Probably the most pressing is the issue of security, particularly after the high-profile hacks of Jeep and BMW. Another challenge relates to vehicle-to-vehicle (V2V) communication: whether to deploy and evolve the proposed dedicated short-range communications (DSRC) solution that the auto industry has jointly developed – and for which the FCC has allocated spectrum – or whether to wait for the potential benefits of a 5G low-latency V2V system.

Going forward, as more cars become connected, information from a fusion of in-car sensors will be passed to the cloud. In this way, swarm intelligence can be gathered and passed back to vehicles so that they self-organize and work together as a collective swarm. By sharing information and alerts about such things as micro-level weather, road temperature, surface conditions and violent breaking ahead, more efficient and consistent traffic flows will be achieved that reduce congestion and emissions. The aggregated and interpreted data will provide more informed driving information, as well as alert and, when necessary, activate onboard safety systems to prevent accidents.

ADAS AS A MILESTONE

Integration of technologies will play a major role in the future development of ADAS. For instance, adaptive cruise control will not just be based on radar and cameras; it will be closely integrated with increasingly accurate, high-definition 3D maps and navigation systems that receive traffic alerts and traffic congestion information.

However, it's not just a matter of vehicle technology. The powerful combination of connectivity and driver assistance is further enhanced by the addition of cloud technologies, and artificial intelligence (AI)-enhanced analytics, as well as the relentless innovation in smartphones and wearables. This rich cocktail is creating the opportunity for the ecosystem of companies serving this market to provide human machine interfaces that facilitate diverse, unique and new applications, and use cases. These, in turn, are delivering monetization opportunities and business models, previously unimagined.

There is a cross-pollination of ideas and technology occurring that is disrupting not only the auto industry, but also the service and support industries, and this has caught many by surprise. For example, usage-based insurance that accesses onboard data to monitor driving, and adjust insurance rates accordingly, has reduced rates for some drivers. However, the cost of repairing ADAS-enabled cars has increased due to increased use of sensors. Additionally, the ecosystem of vendors is expanding with the growth of startups supplying aftermarket backup cameras, dash cams and heads-up displays to improve driver safety. Some of these companies are enhancing their products with computer vision and voice assistants.

Therefore, the planned and anticipated milestones for autonomous vehicles, ITS and smart cities could prove to be increasingly conservative and pedestrian, from a technology and commercial perspective.

AUTONOMOUS VEHICLES

The autonomous vehicle – sometimes known as the driverless or piloted vehicle – has five different states. These states, or levels, are defined in a taxonomy and definitions document from the Society of Automotive Engineers (SAE): **Level 0** is no automation, and covers warnings such as lane departure and forward collision warnings. Lane keeping and adaptive cruise control are considered **Level 1**. Assisted parking is **Level 2**, since it is partially automated. **Level 3** is conditional automation, an example being the car chauffeuring you while in a traffic jam. **Level 4** is high automation, where the vehicle pilots itself independently within a parking garage to find a slot to park. **Level 5** is full automation, and is characterized by the robot taxi.

Clearly, experimentation with autonomous vehicles is increasing, and 2020 as a date for some form of commercial implementation is certainly becoming feasible from a technology perspective. Probably the best-known self-driving car project belongs to Google, now called Waymo, which was started in 2009 and, to date, has clocked well over 1 million miles. Google is not alone: Tesla, BMW, Audi, Mercedes and, most recently, Ford and GM have all showcased self-driving concept cars and demonstration projects. These come as no great surprise, but Uber and Chinese search giant Baidu are also working on autonomous technology and self-driving cars.

The success of Tesla's electric car has shown that a clean-slate approach to fundamental problems can create compelling and innovative solutions. It has resulted in the traditional automotive manufacturers accelerating their development of electric cars. Additionally, it has attracted other startups around electric vehicles (Chinese backed Lucid Motors and NIO), which are also emphasizing autonomous functionality.

Another area that startups are focused on is AI-based autonomous driving systems, with considerable focus on the training data to help vehicles recognize objects and context – this is critical during changing weather and light conditions, as well as for tackling road construction.

Consequently, as companies outside of the traditional auto industry continue to collaborate and experiment, it can be expected that major automotive supply-chain companies will be partnering, investing and making acquisitions.

As already alluded to, the motivations for creating an autonomous vehicle go beyond just technology. It's about reducing emissions through better fuel consumption, as well as addressing the demographic changes of an aging population that increase, rather than decrease, the potential for human error-induced accidents. It's also about leveraging the convergence of the shared economy and urban living, where young and old people no longer feel the need to own a car if there's a cost-effective and convenient alternative, such as Zip Car rentals, or on-demand ride-sharing services, such as Uber.

THE HUMAN FACTOR

Driver distraction is the counterpoint to the increasing use of connectivity and technology to assist drivers. Baby boomers, who had been the major car-buying demographic throughout the 70s and 80s, are beginning to recognize that their reaction times are slower, and that the potential for information overload from connected technologies could impair their driving abilities. Consequently, there is an increasing openness to automated systems that make driving safer and simpler, with less distraction. Ultimately, this could result in a reduction in accidents, and a shift of focus in the insurance industry away from coverage that's based on individuals and accidents, and toward technical vehicle failure.

Autonomous vehicle pilots provide not only lessons for OEMs, but also insights for national and local government vehicle and driver licensing departments. Nevada, which has been one of the guinea-pig autonomous vehicle states, has identified the requirement to certify drivers and have them prove that they understand the technology on their vehicles. Additionally, if an autonomous vehicle is lent to somebody else, the autonomous features should be disabled or inaccessible to the borrower, unless that borrower is also certified. Over time, this will become critical because there will be an increasingly mixed fleet of vehicles with different levels of autonomous driving capabilities.

During a Daimler-Benz testing of autonomous trucks in Nevada that were moving in convoy, or platooning, a tricky question was raised: What happens when the truck moves from an autonomous zone and the driver fails to resume command of the vehicle, due to something like a heart attack, stroke or falling asleep? Because of this, a feature was added that automatically slows the truck down, and navigates it to a safe stop if the driver doesn't respond within 10 seconds.

This all highlights the necessity for governments to partner with the auto industry in defining training, certification and legislation, to ensure safe operation and practices for autonomous vehicles.

INTELLIGENT TRANSPORTATION SYSTEMS

ITS involve applying a broad range of communications, computing and sensor technology to all modes of transportation, and the supporting infrastructure. The intent is to improve the efficiency and effectiveness of passenger and freight transportation by road, rail, air and water. The European Commission claims that the application of such technology to road transportation will result in a 5 to 15 percent reduction in congestion, fatalities and traffic-related injuries, as well as a 10 to 20 percent reduction in CO_2 emissions.

The development and creation of technologies and innovative services to support ITS is considered a huge business opportunity, in developed as well as developing countries. Consequently, there is significant effort to harmonize international ITS standards to reduce research costs, development times and manufacturing costs through scale, and to ensure interoperability across borders. However, there is also a pragmatic perspective that recognizes the multiple global orchestrators and standards bodies at play in this arena. In this world, harmonization doesn't mean that everything is identical. The intent is that the core elements are sufficiently similar to allow common hardware and software, as well as similar architecture and policies, while also considering regional/local technical and legal policy differences. This harmonized similarity should allow a base level of interoperability, and significant benefits to accrue to all involved.

ITS is not just about technologies, although it benefits from the trends in big data, analytics, location technology, faster and better communications, advance sensors and cameras. The reality is that significant investment decisions related to long-term infrastructure are made more difficult by the rapid technology changes occurring. Therefore, it requires political foresight and determination, as well as vision and insight, to determine future market scenarios, business models and requirements. Further, as indicated above, this must be done within the context of interoperability on a global scale, to ensure that the existing transportation infrastructure is evolved into a global digital tapestry.

AUTONOMOUS VEHICLES & ITS COMMUNICATION

V2V and vehicle-to-infrastructure (V2I) communication are essential ingredients of ADAS, autonomous vehicles and ITS. Over the last couple of years, the debate has been about which technology to adopt. DSRC (802.11p) technology has been developed over the last 17 years by the automotive industry, and has been targeted at 70 MHz of spectrum reserved for ITS at 5.9 GHz. In 2017, the U.S. National Highway Transportation Safety Administration sought to mandate DSRC for V2V communications in this spectrum. There has been mixed feedback from the automotive, technology and mobile industries. There's a growing belief that the spectrum should be technology-neutral to allow interoperability, and take advantage of the rapidly evolving 4G and 5G capabilities of cellular vehicle to everything (C-V2X) specifications being developed as part of 3rd Generation Partnership Project's (3GPP) Release 14.

The C-V2X standard was agreed in September 2016, and the first commercial chipsets are expected to be available in the first quarter of 2018. This approach uses enhancements to 4G LTE direct at the PHY/MAC layer for lower latency and better range. It also reuses established SAE automotive services and application layers, as well as standards (ETSI/ISO/IEEE) defined security and transport layer protocols, similar to DSRC. It raises the question of whether a common chipset is possible, given that Qualcomm supports DSRC, and is an active proponent of C-V2X and its evolutionary advantages toward very low-latency 5G.

While the jury is out on the choice of technology in the U.S., it seems likely that China and Japan will adopt C-V2X. The question then is: Which way will Europe go? There is significant European activity around the 5G Automotive Association, as well as the E.U.-funded 5GCAR project, part of the 5G Infrastructure Public Private Partnership (5G PPP). The 5GCAR Consortium, led by Ericsson, with 13 other partners including Bosch, Huawei, Nokia, Orange, PSA group and Volvo, aims to develop an overall 5G system architecture for end-to-end V2X network connectivity for low-latency V2X services. The 5GCAR project will run for two years and employ approximately 30 full-time researchers, with a budget of €8 million, or about $8.9 million.

THE UNKNOWN UNKNOWN

No one yet knows the full impact that the autonomous vehicle and ITS will have on society and the economy. For example, the Toyota Research Institute of North America predicts that, while Level 3 automated driving will increase highway speeds and reduce congestion and accidents, it may also encourage suburban dwellers to move further away from city centers, because the driving experience is less onerous. Could this be a contraindicator to the current trend of increased urban dwelling? If it is, then smart city planning, which is anticipating fewer parking requirements, may need to be reconsidered. The good thing is that, in an integrated scenario of IoT with ITS and autonomous vehicles, the use of analytics and big data in real time should enable more rapid identification of these unknown unknowns.

CONCLUSION

The developments in the connected car and ADAS markets have significantly advanced in recent years. The continued global rollout of LTE networks, and the decision by major manufacturers to include LTE modules in most of their fleets, has increased the number of vehicles connected to the network. This has occurred in parallel to the increasing use of tethered smartphones in vehicles for hands-free calling, audio streaming and traffic and navigation services from Apple and Google. Combined, these have encouraged consumers to take advantage of the benefits of connectivity and ADAS. This has started the process of shaping consumer behavior and awareness, and opens the path to further adoption.

The combination of rapid semiconductor development, together with enhanced machine learning and software capabilities, have made the achievement of the autonomous vehicle much more probable, from a technology perspective, than had been previously considered. This, in turn, has attracted new companies to explore the possibilities of what an autonomous vehicle could mean – not only from a technology perspective, but also in terms of a fundamental restructuring of the auto industry and support industries, such as parking and vehicle maintenance, as well as city infrastructures.

This review of the autonomous vehicle and ITS landscape highlights how automotive business model assumptions – which have slowly evolved over the last 130 years – have all effectively been turned upside down over the last 10 years. The autonomous vehicle and ITS still have many hurdles to overcome from a technical, security, standards and regulatory perspective. However, consumers' continued willingness to adopt technologies that make their lives easier bodes well if autonomous cars actually do arrive earlier than most are predicting.