Self-driving cars take the wheel

Advanced technologies come together to get autonomous vehicles driving safely and efficiently.

by **MIT Technology Review Insights** Feb 15, 2019

Autonomous vehicles are here, and they're here to stay. While their use and acceptance are not yet widespread, that day is coming. Most of the major automotive manufacturers are actively exploring autonomous-vehicle programs and conducting extensive on-road testing.

“The main goal is to reduce the number of accidents.”

Jill Sciarappo, senior director of strategy and marketing, autonomous driving, Intel

Many new vehicles in the United States are already equipped with such technology, called advanced driver-assistance systems (ADAS). As the technology advances, it’s leading to a more efficient infrastructure for autonomous vehicles. Ensuring continued acceptance of these vehicles, however, will depend on resolving lingering challenges, including safety, security, and managing public perception and expectations.

“Many of the basic ADAS system building blocks such as automatic cruise control, automatic emergency braking, and lane-departure warning are already in place,” says Sumit Sadana, chief business officer for semiconductor producer Micron Technology. “We expect to see incremental developments towards full autonomy, where these building blocks are increasingly under the control of a central computer which assumes responsibility for driving the vehicles.”

The race to autonomy

Most global auto manufacturers are actively exploring autonomous-vehicle technology, including General Motors, Ford, Volkswagen, Toyota, Honda, Tesla, Volvo, and BMW. Some related developments:

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Sumit Sadana, chief business officer, Micron Technology

- In 2015, Volvo became the first automaker to state that it will accept full liability for its autonomous vehicles, getting ahead of some of the legal ramifications and public concerns.
- GM spent more than $1 billion in cash and stock in 2016 to acquire startup Cruise Automation.

As the major manufacturers continue their development efforts, several significant potential benefits are guiding autonomous driving. An Infiniti Research report details the trends it sees steering the industry:

- **Real-time route optimization:** Autonomous vehicles connect with other vehicles and the traffic management infrastructure to incorporate real-time information on road conditions and traffic levels into route selection.
- **Increased lane capacity:** Autonomous vehicles can operate at higher speeds and closer vehicle proximity, leading to greater lane capacity.
- **Reduced energy consumption:** Autonomous vehicles are lighter than conventional vehicles, so they consume less fuel.

Increased safety for human passengers will be another major benefit. ADAS takes the risk factor out of the hands of human operators and will contribute not only to improved traffic management but also increased safety, saving lives by reducing accidents.

Driven by tech

There are several critical technologies behind safe and efficient autonomous-vehicle operation—AI, safety and security, cameras, network infrastructure, and the sensor technologies radar and lidar, or laser-light radar. All these technologies must integrate seamlessly to help ensure safe and successful autonomous-vehicle operations.

Artificial intelligence: AI is a major focus for autonomous-vehicle testing and development, and the vehicles are applying AI—a collection of discrete technologies—in new and innovative ways. Experts like Sadana see deep learning as the most significant technology behind autonomous-driving AI. Deep learning, which mimics neuron activity, supports functions like voice and speech recognition, voice search, image recognition and processing, motion detection, and data analysis. Working together, these functions help the vehicles recognize pedestrian traffic, other vehicles on the road, and traffic signals, and adhere to mapped-out routes. Sciarappo compares autonomous-vehicle mapping technology to a “virtual train track.”

The AI market is responding to the growing autonomous-driving market. Another research report forecasts that the automotive AI market will reach more than $10.5 billion by 2025.

Safety and security: Autonomous vehicles won’t gain widespread acceptance until the riding public feels assured of their safety and security, not only of passengers but also other vehicles and

and other types of sensors to carefully monitor the external environment the vehicle is operating in. As the infrastructure grows and becomes more developed, more sensor input will lead to safer operations.

While safe on-road operations are the primary aspect of autonomous-vehicle safety and security, the potential for hacking a self-driving vehicle is another key concern. The market is responding to the need for advanced security technologies: a recent report predicts that the automotive cybersecurity market will grow to $5.77 billion by 2025.

Network infrastructure: Rapid and consistent connectivity between autonomous vehicles and outside sources such as cloud infrastructure ensures signals get to and from the vehicles more quickly. The emergence of 5G wireless technology, which promises high-speed connections and data downloads, is expected to improve connectivity to these vehicles, enabling a wide range of services, from videoconferencing and real-time participation in gaming to health care capabilities such as health monitoring.

There are several protocols under which autonomous vehicles communicate with their surroundings. The inclusive term is V2X, or vehicle to everything, which includes:

- Vehicle-to-infrastructure communication, which allows for data exchange with the surrounding infrastructure to operate within the bounds of speed limits, traffic lights, and signage. It can also manage fuel economy and prevent collisions.
- Vehicle-to-vehicle communication, which permits safe operations within traffic situations, also working to prevent collisions or even near misses.

Autonomous-vehicle technology resides largely onboard the vehicle itself but requires sufficient network infrastructure, according to Genevieve Bell, distinguished professor of engineering and computer science at the Australian National University and a senior fellow at Intel's New Technology Group. Also necessary are a road structure and an agreed-on set of rules of the road to guide self-driving vehicles. "The challenge here is the vehicles can agree to the rules, but human beings are really terrible at this," Bell said during a presentation in San Francisco in October 2018.

Sensor technology: Sensor systems are rapidly evolving to meet the demands of expanded autonomous-vehicle operations, including radar, lidar, and cameras. These technologies enable the vehicles to operate at five increasingly sophisticated and autonomous levels (as defined by SAE International):

environmental conditions.

- **Level 4:** Vehicle can operate without requiring human input.
- **Level 5:** Vehicle operates with full automation in any environment (weather or traffic).

The gradual introduction of autonomous driving will come about through the tempered deployment of self-driving capabilities. “Increasing levels of capabilities starting from driver assistance to eventually fully autonomous will be deployed in progressive stages, as the markets warm up to autonomous capabilities, the price points drop, and the technologies mature,” says Sadana.

Fred Bower, distinguished engineer at the Lenovo Data Center Group, is also optimistic. “Advances in image recognition from deep-learning techniques have made it possible to create a high-fidelity model of the world around the vehicle,” he says. “I expect to see continued development of driver-assist technologies as the on-ramp to fully autonomous vehicles.”

Keep driving

Auto manufacturers are racing to deliver increasingly autonomous vehicles. Former Ford CEO Mark Fields has stated that Ford plans to have a level 4 vehicle by the year 2021 with “no gas pedal, no steering wheel, and the passenger will never need to take control of the vehicle in a predefined area.” Volvo plans to roll out a fully autonomous car the same year.

Elmar Frickenstein, BMW’s soon-to-retire senior vice president for automated driving, expects the company to produce level 3 cars by 2021 but could even deliver cars with level 4 or 5 capacity by then. And in 2017, BMW announced it would collaborate with Intel and its subsidiary Mobileye to work on autonomous-vehicle development.

Continued advancements in the technology and widespread acceptance of their use will require significant collaboration throughout the automotive and technology industry. Sciarappo sees three landmarks required to ensure widespread acceptance of autonomous vehicles. “Number one: ADAS features need to become standard. Number two: there needs to be an industrywide effort to figure out how to measure and test the technology and its ability to avoid accidents and put us on that path to that autonomous future,” she says. “Number three: policymakers need to get on board and help figure out how to push this technology forward.”

[1] https://www.iihs.org/iihs/sr/statusreport/article/53/7/2

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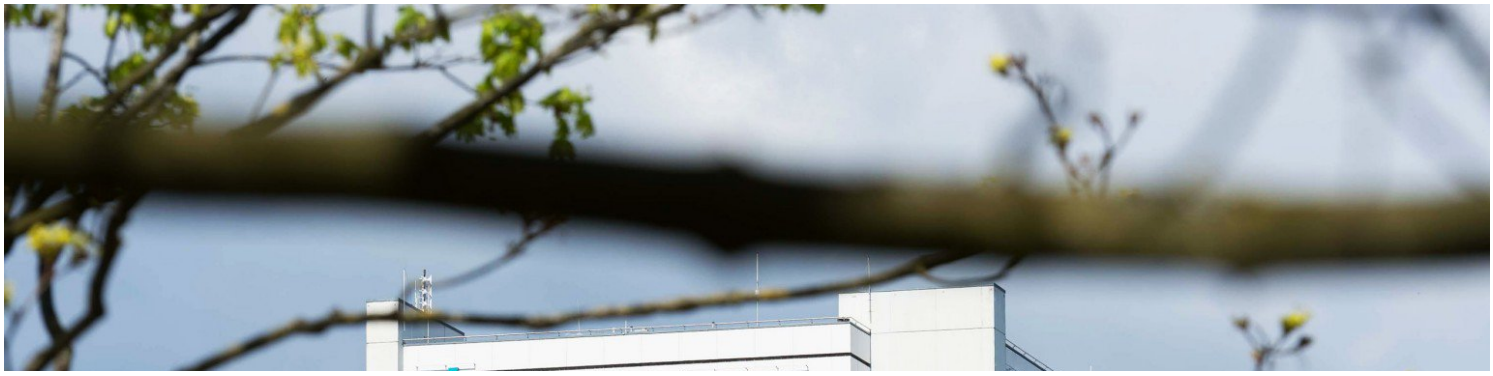

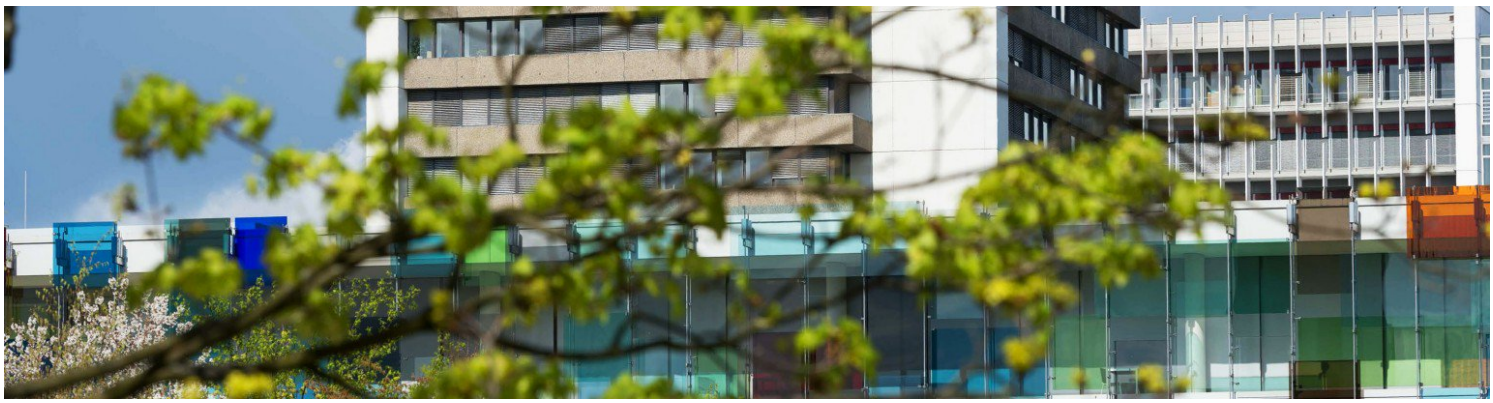

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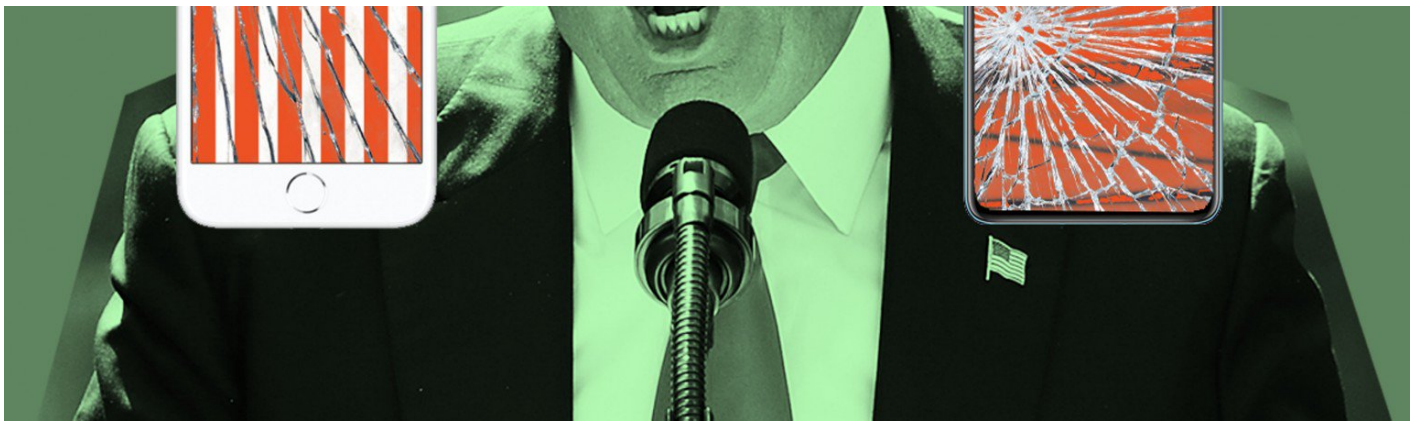

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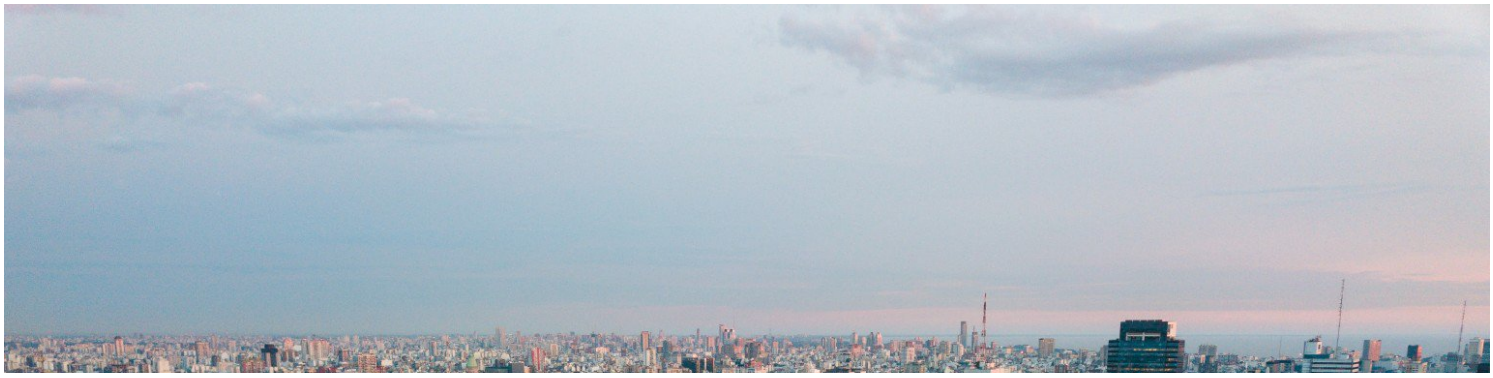

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