From a Blip to a **Boom**

by Sebastian Blanco

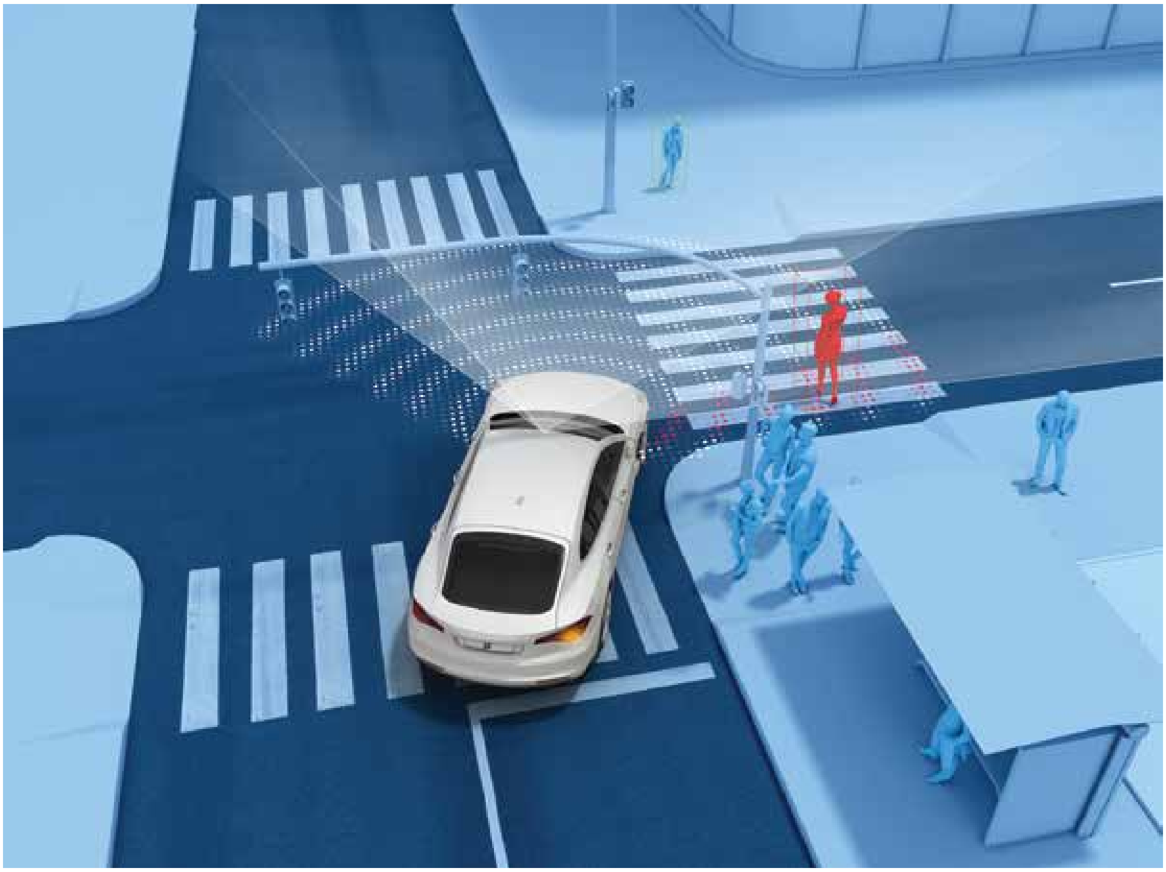
Automotive radar rides the 77-GHz technology wave toward greater capability and vehicle safety.

Since it first appeared in automobiles in the 1980s, radar has become a reliable and increasingly cost-efficient tool for detecting objects on the road and along the roadside. The technology is forecast to be in 50% of all new cars and light trucks by 2020, where it will be "fused" with other on-board sensors—cameras, LiDARs, ultrasound—to offer multiple layers of detection and reliability in various environments and scenarios.

"Making traffic accidents a thing of the past is going to require a full stack in the car, the brain, and using sensor fusion," stated Michael Peredo, senior solutions engineer for Velodyne LiDAR. Speaking with SAE's Autonomous Vehicle Engineering at the

Bosch

A telltale radome in a Tesla front grill.



ZF

Radar delivers significant object-detection benefits in slow-speed urban driving. In this scenario from ZF, the vehicle combines two lateral front radar units, a front camera and the braking system. With the combined camera and radar signals, the car can detect a pedestrian crossing the street even when turning. ZF's braking system can then safely stop the car. This function meets the criteria for Euro NCAP 2020.

2019 CES, he noted that while his company obviously focuses on LiDAR, radar remains a vital component of tomorrow's vehicle-sensor suite.

In July 2017, the FCC adopted new rules to expand the spectrum for automotive radar use. The agency is phasing out 24 gigahertz (GHz) and is opening frequencies for automotive use in the 77-GHz band—into the contiguous five GHz of millimeter waves within the 76-81 GHz band. In addition to providing higher resolution in depth perception and range, experts note the change to 77-GHz also enables a reduction in antenna area and less interference with other on-board systems.

The FCC's rule change has triggered greater focus on radar technologies among the supply leaders—Robert Bosch, Aptiv, Continental, Denso, Hella, Valeo, Veoneer, and newcomer Magna, whose Icon radar was developed in collaboration with Uhnder. Semiconductor suppliers in this space, such as Infineon, NXP, STMicroelectronics and Texas Instruments have followed suit with new signal-processing developments.

"The sensors, ultimately, will be millimeter-wave radar," Peredo observed, which is "less susceptible to snow, rain, and dust. It's really good at spotting a car." Its capability also dovetails with that of LiDAR. For example, 77-GHz automotive radar translates to 2.3 mm wave radar. Velodyne's LiDAR operates near-infrared at 905 nanometers. Modern radar thus shines, so to speak, in low-visibility situations where LiDAR suffers.

"You don't want [the sensors] to disagree, and you want [the artificial intelligence algorithm] to weigh radar more heavily in its dynamic assessment of the data" in snowstorms and heavy rain, for example, Peredo said. "Because of these operational differences, they really complement each other in a self-driving vehicle or in a driven vehicle with these additional safety features."

Aintein's two-chip solution

The explosion of new players in the mobility-radar space includes Ainstein, which at the 2019 Detroit auto show debuted a new imaging radar sensor for AVs. Dubbed K-79, the sensor is designed for self-driving industrial vehicles in hazardous conditions. Ainstein—the name is a portmanteau of (Albert) Einstein and AI—got its start with radar-based altimeters and collision avoidance sensors for drone aircraft. Two years ago, the company expanded into the automotive space.

The K-79 is Ainstein's third automotive sensor product. It's being tested on a specialty vehicle by an unnamed customer that is using just the imaging radar to navigate in dusty conditions, where cameras and LiDAR have trouble collecting data.

A K-79 unit on display at CES'19.

Sebastian Blanco

The K-79 is able to build a 2D point cloud for mapping, produce 3D shapes of this objects that it detects, and distinguish between vehicles and pedestrians. Ainstein's imaging radar is an improvement over other radar systems because it cascades two radar sensors to increase the resulting image resolution, claimed company sales engineer Andrew Megaris. He said LiDAR has about a one-degree angle of resolution and most radars have about 15-20 degrees. "We're at about 2.5 degrees, and there's still room to improve," he said.

Each of the two radar chips in the K-79 can handle eight channels. Joe Liu, Ainstein's chief radar technologist and global director of automotive products, said adjusting the chip placement can even open up more channels. The company also is considering using four chips in the eventual production version of the K-79, which would give the resulting image even more resolution.

"Stacking the chips together certainly is one of the key technology enablers," Liu said. So is more processing power. "As you generate more and more data, you need more processing power to process it," he said. "This is basically a digital camera that has a lot of processing power that can allow us to create these real-time point clouds that basically look like LiDAR, in some cases even better."

Even with four chips, Ainstein's radar sensors will cost less than a LiDAR system, Liu claimed, because adding chips does not linearly increase. "LiDARs are currently about three orders-of-magnitude more expensive than radar, so even if I increase this by a factor of 10, we're still way under the cost of LiDAR," he said. "This is what the OEMs have been begging us for."

–SB

Higher-res solutions

Sensor fusion is also the name of the game at ZF. At CES, the German tech giant showed three new radar sensors: the Gen21 full-range radar (for SAE Level 4 and 5 autonomous driving), the Gen21 mid-range radar (for Level 2 and up), and the Gen5 short-range corner radar (to detect stationary and moving objects, up to 160 meters away). All operate at 77 GHz.

"Each and every sensor has its pros and cons," explained Damit Bartulovic, ZF's global sales lead for ADAS. "With radar, you can just get rid of the negative aspects of any light device, like camera and LiDAR. When it comes to automated driving, you will want to have not only two sensors being redundant but also a third one due to the fact that if one is telling you, 'I see an object' and the other one is telling you 'I don't,' you need a third one to arbitrate.

"To balance out this portfolio, it makes sense to have not only one, but two or three different sensors," he asserted.

Martin Randler, ZF's director of sensor technologies and perception systems, said his company's challenge was to build a radar that has LiDAR-like resolution. He said the company's new offerings are "very close" in resolution performance.

"For Level 4, you always need a mixture of technologies," Randler said. "If you're going to build a redundancy to LiDAR, you need to have similar capabilities. If the redundancy is only one-tenth the resolution, that's not enough."

ZF's full-range device can bring high-resolution radar to Level 4 and 5 autonomous vehicles. The antenna pattern is larger and the resulting point cloud looks more like something like you would see with LiDAR.

"This is why we believe radar is going to be important in the future, as performance increases in a way that's suitable for Level 4 and 5 automated driving," Bartulovic said.

Not all radar-related tech at CES was looking forward, literally or figuratively. Steelmate, a Chinese company, showcased an aftermarket 12-24-volt blind spot detector, based on 79-GHz microwave radar, that it aims to retail for around $2,000. Steelmate's international account manager, Kitty Yang, said that blind spot detection has been incredibly popular in China in recent years. The company wants to offer the technology for mid- and low-price cars already on the road. Steelmate's next version will offer parking assist and collision alert, Yang said. ■