THE INTERNATIONAL REVIEW OF AUTONOMOUS VEHICLE TECHNOLOGIES: FROM CONCEPTION TO MANUFACTURE TO IMPLEMENTATION

MAY 2018

Autonomous Vehicle INTERNATIONAL

LAUNCH ISSUE!

Proceed with caution

Daimler's head of automated driving calls for everyone to put safety ahead of being first to market

Artificial intelligence

The challenges on the road to developing human-like systems that learn to deal with every situation that comes their way

Autonomous Vehicle Technology World Expo 2018 preview, p56

What to see and attend in Stuttgart, Germany, June 5-7, 2018

V2X technologies

The pros and cons of the competing technologies available now, and those in the pipeline

BOSCH
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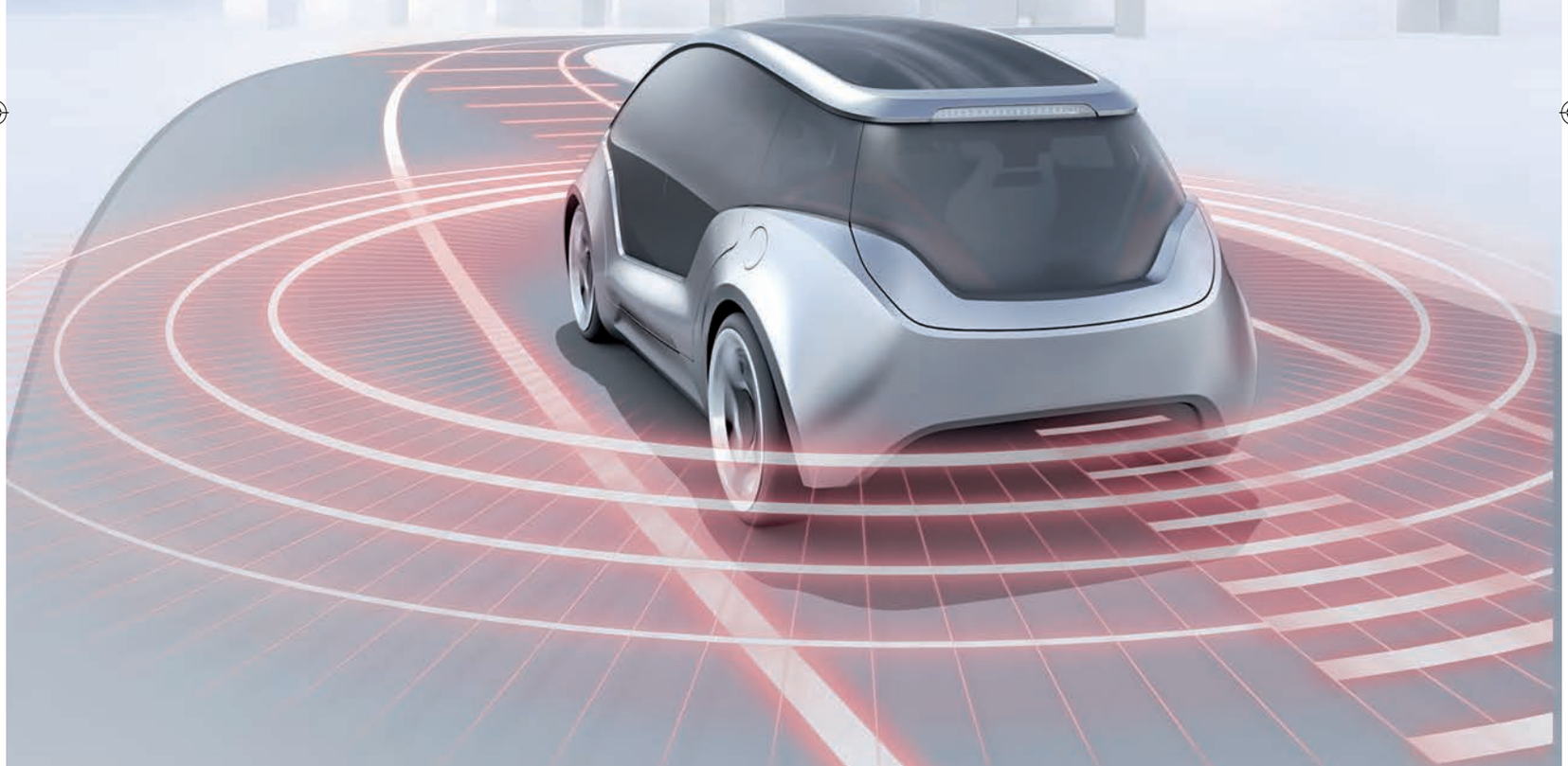
Automated mobility by Bosch



Driver assistance and safety systems plus vehicle connectivity make Bosch a pioneer in automated mobility. Where assistance features have already made driving safer and more relaxing, system technologies for partially and highly automated driving now go one step further, even taking over vehicle guidance for some of the way. Bosch has already created the technological basis for fully automated driving. Together with the systems Bosch has developed for automated parking, these technologies help eliminate accidents caused by human error. To make it happen, Bosch combines hardware, software, and services to create top-to-bottom automated mobility solutions.

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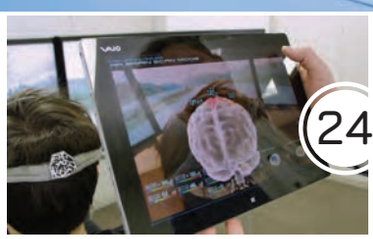

Autonomous Vehicle TECHNOLOGY WORLD EXPO 2018

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Contributors

David Smith

Tasked with evaluating how various V2X technologies might contribute to autonomous driving, Smith found several competing streams. "I thought it was especially interesting how engineers developing DSRC were working in their bubbles and didn't consider how 4G and 5G technologies would emerge as rivals," says Smith. You can read the full story on page 34.

Michael Taylor

On page 14 you will find an in-depth interview with Dr Michael Hafner, head of Daimler's automated driving unit. "For me, the most impressive part is not just how long Daimler has been involved with the development of autonomous driving, but how highly it values it," says writer Michael Taylor. "It has given tremendous weight internally to a division that didn't even exist a decade ago."

Alisdair Suttie

AI may be the key to enabling AVs to cope with every conceivable scenario they might face, but in writing the feature on page 24, Alisdair Suttie found there is still a long way to go to mature the technology. "The implications of AI for AVs are profound," he comments. "It makes a fascinating subject to research, even if this throws up more questions than it always answers."

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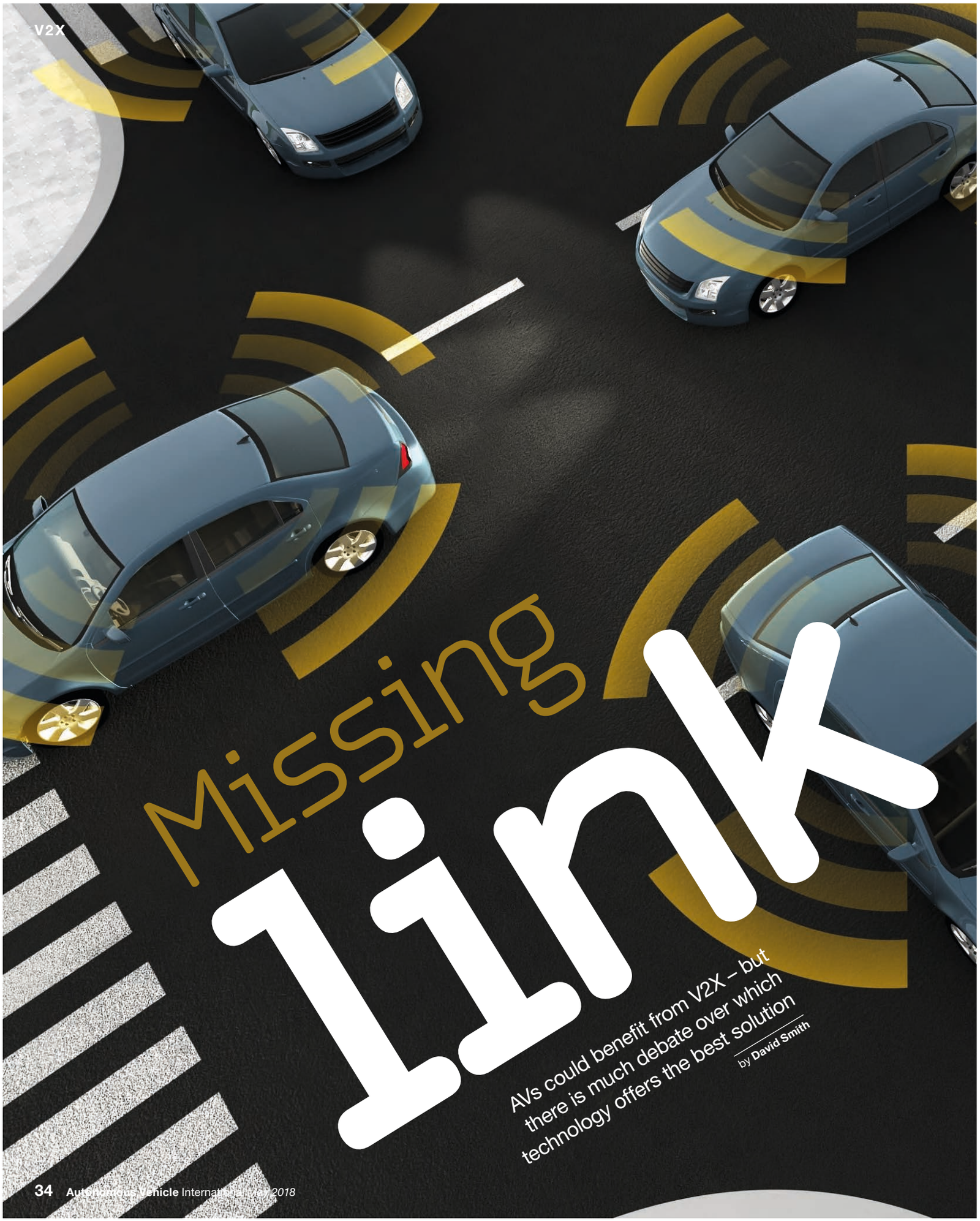
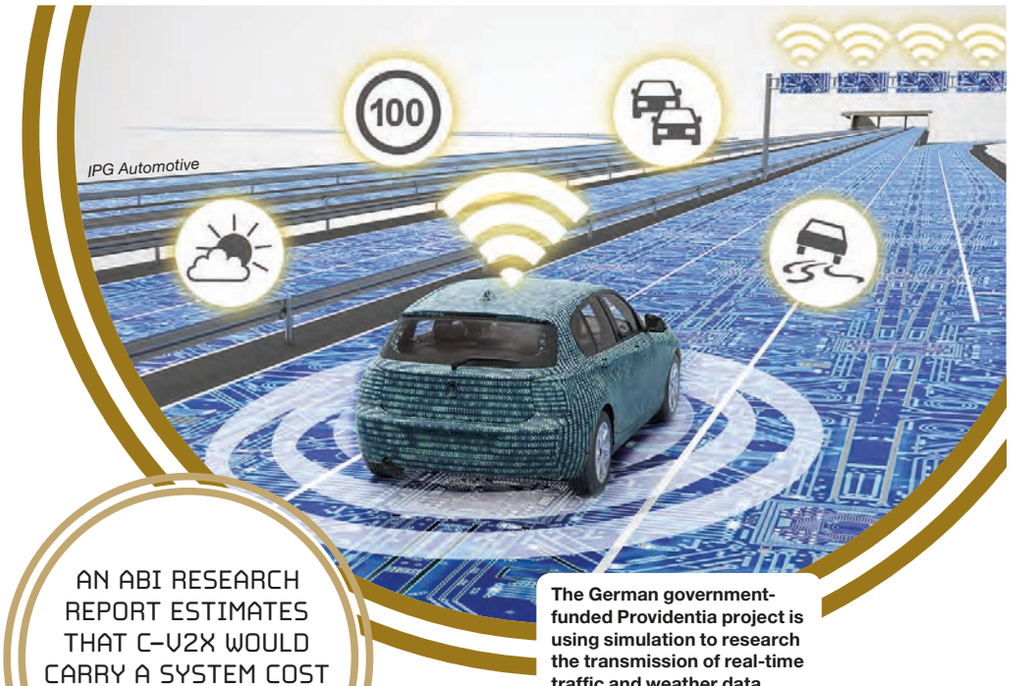


Missing link

AVs could benefit from V2X – but there is much debate over which technology offers the best solution

by **David Smith**


QUALCOMM SAYS C-V2X WILL BE READY FOR COMMERCIAL DEPLOYMENT IN CARS AS EARLY AS 2019



The German government-funded Providentia project is using simulation to research the transmission of real-time traffic and weather data from highway infrastructure to cars via cellular V2X

For years, a set of niche engineers within US car companies have been testing DSRC for V2X applications, assuming it would emerge as the standard technology. Most of these engineers never imagined that 4G – and now the longer-term option of 5G – would emerge as a competitor to DSRC. "They were flatfooted by cellular V2X [C-V2X] because the car makers have never found a convincing business model for DSRC," says Andrew Hart, director of industry research group SBD Automotive. "Who pays for the hardware in the car and who pays for roadside infrastructure?"

DSRC sidelined

The engineers, and their bosses, were banking on a governmental trigger in the shape of legislation mandating new cars to have DSRC. But that hasn't happened. General Motors introduced V2V functionality in its Cadillac CTS in 2017, in anticipation of a mandate for DSRC, but this was sidelined in November 2017 by the Trump administration. "That decision has killed off DSRC in the USA and the OEMs are no longer taking it seriously," argues Hart. "The mandate was needed to create a strong business case for DSRC so early adopters are not left paying for a technology that isn't used for years. We're now left with a chicken and egg situation. You can't just have one car on the market that can communicate. It needs something to communicate with."

Hart believes the USA and Europe are now likely to turn more toward C-V2V. The hardware is cheaper, he says, and car companies can piggyback new functionalities on the back of existing cellular applications, such as entertainment services. C-V2V requires connected boxes, but not standalone roadside units that serve no other purpose. "With cellular, car makers can guarantee millions of cars with cellular connections," he says. "There's also a well-trodden path for standardizing all the iterations of 4G we will see over the next three or four years on the way to 5G."

AN ABI RESEARCH REPORT ESTIMATES THAT C-V2X WOULD CARRY A SYSTEM COST US$13.50 TO US$15 HIGHER THAN DSRC

The experience of regulating vehicle applications in the EU has not been a happy one, Hart argues: "Legislation has been taking too long. It's taken two decades to kickstart eCall, which sends out ID data after a crash. DSRC requires so much roadside infrastructure that implementing it across different countries is complex from a business and technical standpoint."

Despite his enthusiasm for the cellular approach, Hart acknowledges technical problems: "How can you guarantee spectrum will be reserved for automotive applications and that you won't get interference from other devices? There are also tons of questions about

Every vehicle in the EU with a new type approval now must incorporate the eCall automatic emergency call system – making connectivity standard

"FOR NON-SAFETY APPLICATIONS, 4G IS FINE AS YOU DON'T NEED TO RESPOND IN SUBSECONDS"

Prof. Michael Zhang, University of California, Davis

Talking points

There will be a stream dedicated to connected vehicle and infrastructure technology at the Autonomous Vehicle Test & Development Symposium 2018, which will be held at Autonomous Vehicle Technology World Expo, June 5-7, 2018 in Stuttgart, Germany. The stream will include presentations on C-ITS projects in the Netherlands, Hungary and Finland, as well as papers on V2X technologies and validation tools. There will also be a panel discussion on a transport authority's role in implementing V2X.

Please visit www.autonomousvehiclesymposium.com for full details about the event.

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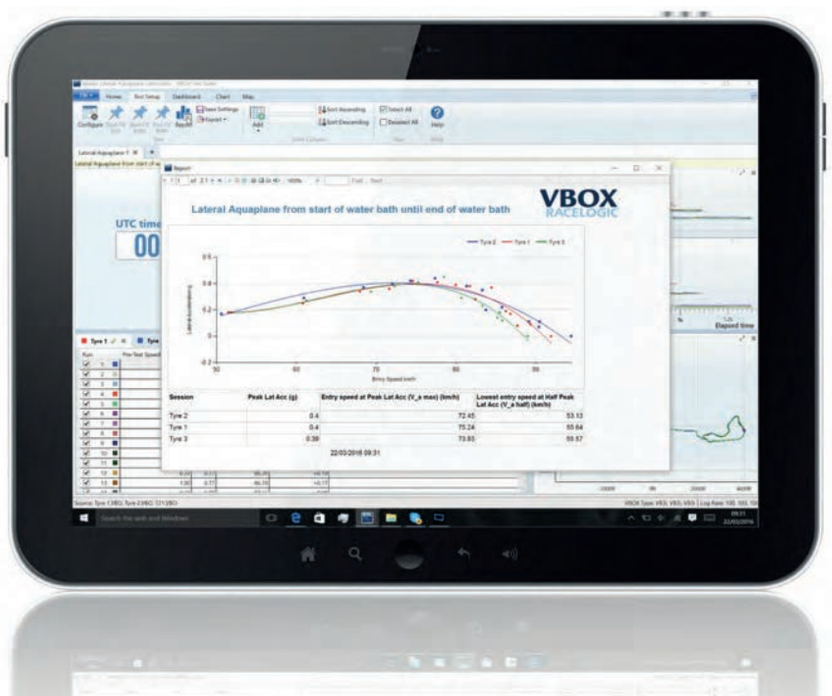

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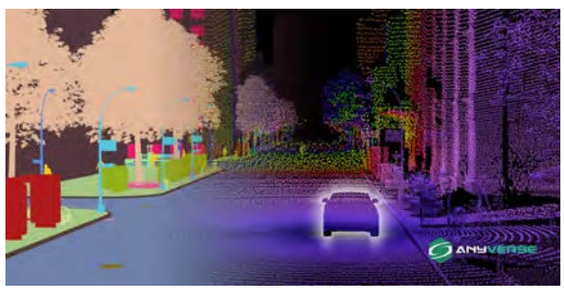
Building safe autonomous vehicles demands extremely robust learning processes. Today's training and testing of autonomous systems in real-world environments is very costly and potentially biased to predefined fixed scenarios.



Computer generated scenarios can enhance the ability to train systems for challenging cases rarely encountered in controlled real-world environments. High quality simulation accelerates the learning process and improves safety.

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GM introduced V2V in the 2017 Cadillac CTS

MARKETS&MARKETS RECENTLY PROJECTED THE AUTOMOTIVE V2X MARKET TO GROW TO US$99.55BN BY 2025, UP FROM US$27.19BN IN 2017

how cellular technology will manage latency and security."

4G safety questions

Safety remains the most critical issue for current 4G applications. With 5G an emerging technology, most tests to date have been on 4G networks. They have tended to show that most applications can be done using either technology, but that DSRC is more effective for safety. "For non-safety applications, such as traffic information or weather alerts, 4G is fine as you don't need to respond in subseconds," says Prof. Michael Zhang, an engineer who researches autonomous vehicles at the University of California, Davis. "With safety-critical applications you need much faster latency. DSRC is typically less than 0.1 seconds, much faster than 4G. It's possible 5G will be better, but that's unproven. The main problem with DSRC is the high unit cost – around US$2,000 each. That needs to drop to US$200 or lower to make it viable."

Zhang was involved in a Chinese research project in 2017, comparing DSRC and 4G-LTE (long-term evolution), which is the fastest variety of 4G available and lays down foundations for 5G. The team tested the technologies on a 2.4km (1.49 mile) high-speed circular test road at Chang'an University. They installed four DSRC roadside units and a 4G-LTE system, then tested both for three applications: collision avoidance, traffic message broadcast and V2I multimedia file download.

LTE performed worse than DSRC for collision avoidance, which the researchers put down to the Doppler effect and the cellular hand-off of the LTE network. "It means LTE cannot meet the lowest requirement of 100ms for safety applications," they concluded. "DSRC is more suitable for safety-related V2V traffic applications."

However, cellular turned out to be better for multimedia file download. The throughput was a lot higher at different vehicle running velocities and it had a much longer coverage range. Both technologies were acceptable for traffic text message broadcasts. The researchers concluded that a combination of DSRC and LTE would be best.

> "I EXPECT 5G TO CONTAIN DSRC OR C-V2V, AS WELL AS MILLIMETER-WAVE TECHNOLOGIES"
>
> *Prof. Gabor Orosz, University of Michigan*

5G solution

The issues around safety could be solved by 5G technologies, according to Harman, a subsidiary of Samsung. The company is developing a 5G solution for a European car maker, which it claims will have latency speeds of 1ms, making it suitable for safety applications. These claims have not yet been substantiated.

Continental recently acquired Argus Cyber Security to expand its cybersecurity expertise

Cybersecurity risks

In 2017, a McKinsey report said future auto designers would have to be "cybersecurity natives", installing solutions at the first stages of development, and also noted that technical solutions will only be effective if implemented consistently using high-quality software and hardware, requiring strong collaboration between product security and corporate IT security teams. OEMs will also have to create strict guidelines to minimize bugs and software security gaps. Quick patch-ups will be needed if things go wrong, while over-the-air updates will help OEMs counter attacks quickly. The authors suggest that OEMs bear ultimate responsibility for cybersecurity right down the value chain, and that it is their job to ensure that security practices have been followed consistently.

The 2017 Cadillac CTS's V2V is based on DSRC

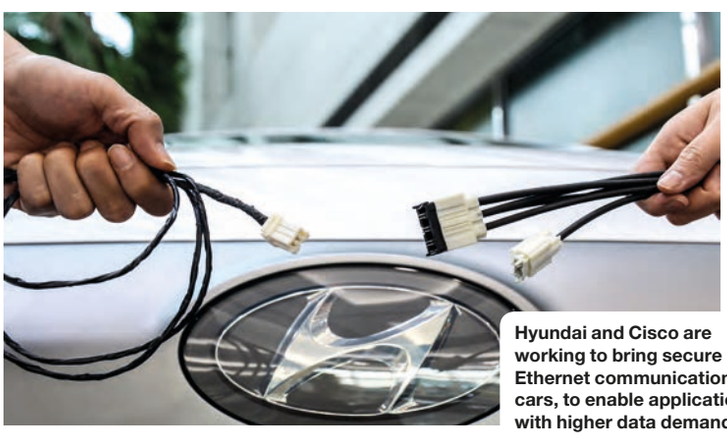
A research project at the University of Michigan is using GPS sensors and DSRC-based V2V to detect vehicles beyond the car's line-of-sight

TELEFONICA AND HUAWEI PLAN TO CARRY OUT LARGE-SCALE FIELD TRIALS AFTER A SUCCESSFUL PROOF-OF-CONCEPT TEST FOR 5G V2X

At the University of Michigan, Prof. Gabor Orosz heads a research group investigating a new technology that uses GPS sensors and V2V to detect vehicles beyond line-of-sight. Although Orosz is testing this with DSRC, he remains unsure which technology will win out. One likely scenario, he believes, is that both DSRC and 4G will coexist with 5G for a few years, before one or both is incorporated into 5G.

"What we call 5G is a collection of technologies, some still in development," he says. "For example, 5G contains millimeter-wave-based technologies (30-300GHz) that show the potential of very high bandwidth to allow sharing of camera images between vehicles, but it is missing important capabilities offered by DSRC and C-V2X. With DSRC and C-V2X, no line-of-sight is required for V2V, which can help vehicles to avoid safety-critical scenarios and mitigate traffic jams. That's why I expect 5G to contain DSRC or C-V2V, as well as millimeter-wave technologies."

Speaking at Silicon Valley's Innovation and Impact Symposium 2017, Brian Daugherty, CTO of the Motor & Equipment Manufacturers Association, also suggested the two technologies could be knitted together: "Low-latency things – collision avoidance – will be handled by V2V and the active sensors. Slightly longer-range things, like traffic congestion, will be handled by cellular LTE and 5G systems of the future."



Hyundai and Cisco are working to bring secure Ethernet communications to cars, to enable applications with higher data demands, including V2X

"THERE ARE MANY WHO ARGUE THAT V2V MIGHT NOT BE NECESSARY"

Andrew Hart, SBD Automotive

With so much doubt about which technology will be taken up, Qualcomm has been working with both. However, in 2017 a Qualcomm spokesperson said there was now "momentum behind C-V2X". He pointed out that the 5G Automotive Association now has more than 60 members including Audi, BWM and Daimler, plus Tier 1 suppliers and mobile operators. Qualcomm also announced the first US trials of C-V2X, in San Diego, in collaboration with AT&T, Ford and Nokia.

Communications breakdown?

Hart sees US developments as evidence of a shift to cellular, but offers another perspective on the debate. "There are many who argue that V2V might not be necessary," he says. "Solutions need to be compared with standalone autonomous cars that use sensors to map what's around them without needing connectivity. Whatever V2X technology is used, it could take years to implement. In the UK, the average car is scrapped after 11 years, so it would take at least a decade to become standard and it could take 25 to 30 years without legislation."

Orosz, however, is convinced that autonomous vehicles will be safer if they are connected: "We recently saw a tragic accident when a pedestrian in Arizona was killed by an Uber autonomous car. I believe that had the car been connected to the roadside infrastructure, it could have averted the tragedy. My research supports the conclusion that the push for connectivity will come from automated vehicle manufacturers, to make their products safer and more affordable." ‹