DVN
Lidar

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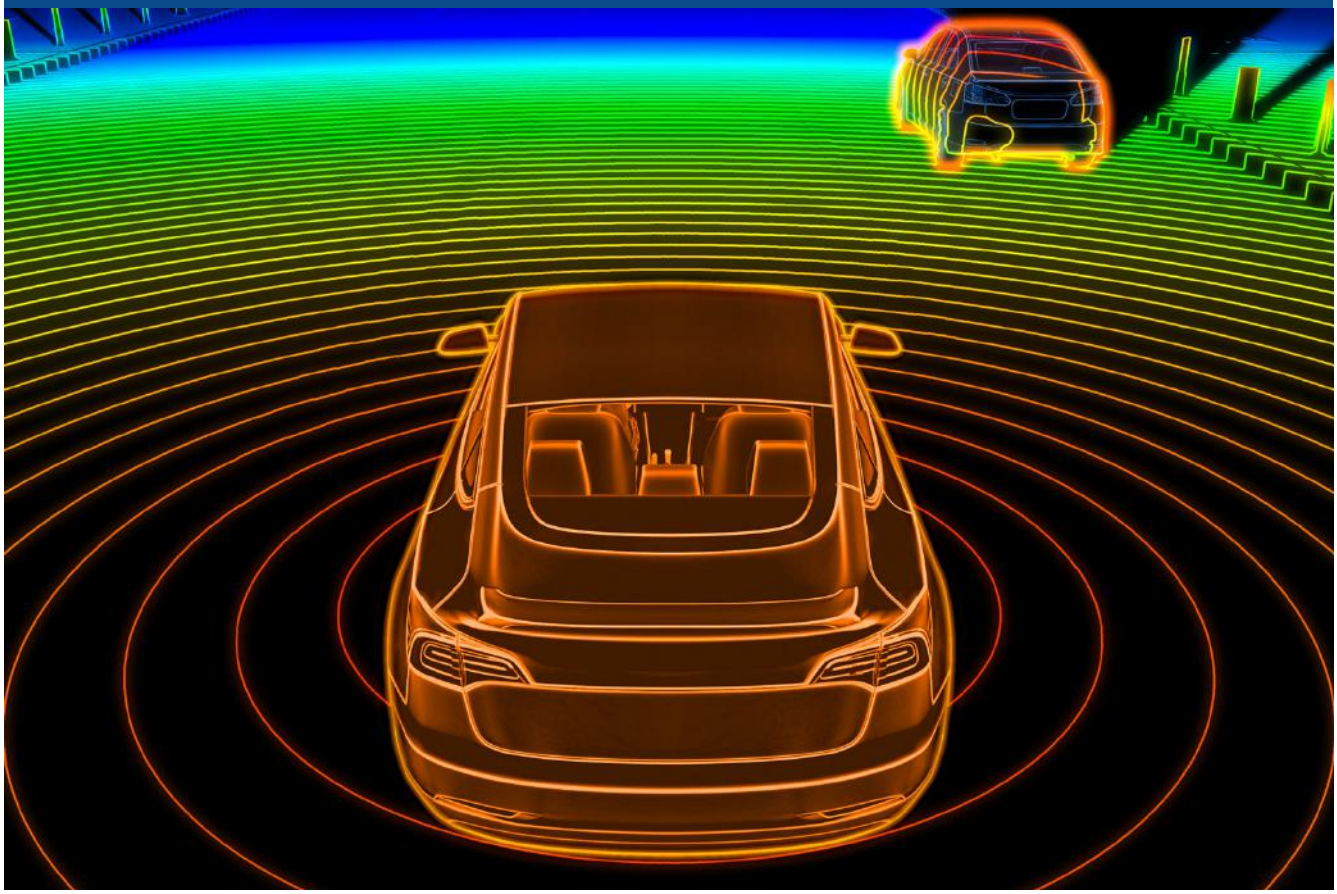


DVN-Lidar Community: Supporting You in '23 and Beyond

Editorial · January 2023

Without lidar, no $L^{3\text{-}4\text{-}5}$ autonomous driving will happen! This is the resounding consensus of virtually everyone whose opinion on the subject matters, except for notoriously cocksure Tesla CEO Elon Musk.

And fortunately for the future of autonomous driving, 2022 brought a great deal of good news:

- New UN Regulation № 157 (lanekeeping with130 km/h upper limit) and EC Regulation 2022/1426 (new rules for type approval of motor vehicle automated driving systems**)**—great regulatory infrastructure for the deployment of L^3 and L^4 vehicles.

- A strong dynamic in China, which represents 50 per cent of new lidar wins. Hesai became the world's first automotive lidar company to reach 10,000 units delivered in a month. On top of L^{2+} applications for high-end EVs, Chinese megacities like Shenzhen and Shanghai moved to authorise $L^{3\text{-}4}$ driving paves the way for multiple robotaxi experiments to start.

- The range of technical solutions is still growing: FMCW lidars are coming to allow lidar technology to reach radar-comparable performance for speed clustering—see our interview with Baraja's CCO in this issue of the DVN-L newsletter.

- DVN decided to set up this DVN-Lidar community with distinct membership; a regular DVN-L Newsletter, and three deep-dive DVN-L Workshops a year, plus the yearly DVN-L Conference. Our goal here is to bring together all the decisionmakers, experts, and movers and shakers in the automotive lidar world to talk and listen with one another about innovations, challenges, and research.

Our DVN-Lidar events in 2022 were a great success. Building on that, we're planning 2023's DVN-L Deep Dives in Europe; America, and perhaps in China before our 6th DVN-Lidar Conference:

- DVN-L Deep Dive I (Europe): 27-28 February at Dorint Wiesbaden (docket in this Newsletter)

- DVN-L Deep Dive II (Europe or Asia): end of May; location TBD
- DVN-L Deep Dive III (USA): end of August; location TBD
- DVN-L Conference (Europe): 29-30 November at Dorint Wiesbaden

We're ever so glad you're here with us in the DVN lidar community. Happy new year and enjoy this newsletter!

All best,

Alain Servel

DVN LIDAR ADVISOR

DVN-L Interview: Baraja CCO Joseph Notaro

Joseph Notaro is Chief Commercial Officer at Baraja, a global lidar technology company headquartered in Australia. He is an accomplished technology industry executive with 30+ years of experience in the automotive semiconductor market, and has held a range of management and executive positions at Onsemi; Fairchild, and STMicroelectronics.

He has successfully led R&D; business and market development; strategy, and worldwide sales organisations, and has extensive international experience across the Americas; Asia-Pacific, and Europe.

DVN-L: Joseph, will you tell us about Baraja?

Joseph Notaro: In 2016, our cofounders Federico Collarte (CEO) and Cibby Pulikkaseril (CTO) saw an issue in the lidar industry that they had observed from their experience in optical engineering from the telecommunications industry. They thought of a solution no one had tried before, five years before anyone else caught on to it. Baraja was founded to reinvent lidar from the ground up. Since then, we've set out to develop a lidar system that eliminates the most expensive; bulky, and failure-prone components of legacy lidar systems: mechanical scanning in the fast axis.

Our ambition is to make our cars and roads safer. There are way too many road fatalities every year. We are on the cusp of a revolution in mobility; a future where our roads are free of fatalities and accidents, and our vehicles are also safer while providing the driver more free time. But that's only possible if we get lidar right. To get there, we need lidar to be as ubiquitous and reliable as the three-point seatbelt; airbags, or antilock braking systems. We need to deliver the same performance and scalability that carmakers demand of their own vehicles.

Successfully creating a safer and more autonomous experience is incredibly complex, and requires several different sensing modalities working in unison. Key lidar challenges in the past have been around reliability and scanning resolution, and these are the exact challenges our Spectrum-Scan™ is solving—but not the only ones.

DVN-L: Tell us more about that.

JN: Spectrum-Scan™ technology is based on a simple concept we learned in our early physics classes: light traveling through a prism is refracted at different angles depending on its wavelength. It is built on proven optical and photonics technologies originating from the telecommunications industry. Spectrum-Scan uses wavelength-tunable lasers to scan the environment, simply by changing the colour (=wavelength) of light. This unique scanning mechanism sets us apart from other lidar technologies, and solves the single design challenge of traditional lidars: the ability to scan a laser in a wide field of view.

While legacy systems rely on fragile rotating lasers and/or oscillating mirrors, we simply change the colour of our laser light and let our prismlike optics do the work. Steering a laser beam, though, is only half of a lidar. Ranging is the other half, and a key lidar function. We have implemented RMCW (random modulation continuous-wave) as our ranging solution. The result is a lidar technology that has no fragile moving parts in the fast axis, and is compact and completely free of interference from other lasers. This results in unprecedented range, precision and reliability in even the most extreme environments.

DVN-L: What sets Baraja apart from other lidar suppliers?

JN: Technology, ecosystem integration, and financial backing.It's a combination of all of those, starting with our technology which can deliver the end-game lidar required for seamless and invisible automotive integration.

We understand automotive needs and the price targets required to enable mass deployment of safe autonomous driving functionalities. We are building the best sensor to meet the specifications of major automakers so we can deliver a fully-integrated lidar solving the issues of legacy lidars.

DVN-L: What made Baraja decide to go for mobile applications, especially lidar sensors for ADAS and AVs?

JN: Our Spectrum-Scan system is a unique architecture using wavelength-tunable lasers within the 1,550-nanometre C-band to scan the environment. This design innovation means we've removed the most expensive; bulky, and failure-prone components in a lidar system—mechanical scanning in the fast axis. This makes it perfect for mobile applications, whether in a heavy industry environment or out on the open road.

We have a number of static and infrastructure-related test cases under way that can leverage our unique technical capabilities, such as foveation and doppler, to solve novel sensing challenges.

Very low power dissipation and audible noise enabled by Spectrum-Scan also allows our lidars to be mounted behind the windshield, making it the lidar of choice for mass deployment on passenger vehicles.

DVN-L: One of your lidar's core strengths is suitability for harsh environments like mining. How does that inform your work on automotive applications?

JN: Certainly, the environment is a key difference between mining out in the Australian Outback and driving on city streets. However, both use cases are looking for the same product features of performance; reliability; shock resistance, and sensitivity control. The overarching robustness of the system is crucial. Testing our sensors in these harsh environments has shaped the way we think about these product characteristics. This has been a great learning experience allowing Baraja to design a lidar system that can withstand the harshest environmental conditions.

DVN-L: How have you lowered your system's power consumption, and how important will that be in the automotive applications?

JN: Power consumption is a key performance parameter along with range, resolution, etc. It continues to be one of the key areas of improvement across the industry. With Spectrum-Scan's true passive fast-axis scanning technique, Baraja have brought down power consumption to meet and exceed current automotive specifications allowing a seamless integration inside the vehicle, behind the windshield. Another important, but often overlooked, parameter is the audible noise generated by a lidar sensor. Even in this case, Spectrum-Scan allows for a significant reduction in the total system audible noise and will not disturb the driver or passengers when mounted inside the vehicle.

DVN-L: What other features do you think are needed for automotive lidar sensors?

JN: Baraja's proprietary solid-state scanning platform was designed from the ground up to completely rethink how cars see the world around them to enable true autonomy. The lidar system enables the range, resolution and performance required for safe deployment of autonomous functionalities, without the traditional tradeoffs faced by other legacy lidar technologies. In addition, Spectrum HD 25 delivers the world's first lidar system combining per-point doppler capability at the hardware level with a tuneable-wavelength laser and RMCW ranging to deliver unparalleled performance and accuracy at range and speed. Per-point doppler velocity is instantaneous; precise, and requires no additional computation power.

This allows to enhance the performance of the perception stack. Grouping points and objects by velocity helps segment and predict trajectory of objects, leading to better perception outcomes. The data can be used to not only detect movement at a distance, such as a pedestrian stepping out of a stationary crowd into the road, but also help determine prediction and intent of movement.

As more and more lidars are deployed on our roads, immunity to interference will also be as important as other parameters. In several studies, it has been proven that lidars implementing RMCW exhibit at least a 2× improvement versus traditional FMCW or ToF systems.

DVN-L: This past October, Baraja announced a development agreement with Veoneer to develop a lidar system for a major automaker. What can you tell us about that?

JN: Our partnership with Veoneer is critical to this agreement. Veoneer will help us scale the development of our Spectrum HD25 platform and enable future opportunities for high-volume automotive integration. The support for Spectrum HD25 from Veoneer; the automaker, and partners is a significant validation for Baraja and its path towards enabling more autonomous vehicles.

We are excited about the progress we are making and the market response for our Spectrum HD25. Stay tuned for further updates in 2023!

DVN-L: How do you forecast the automotive lidar market's development? Do you expect L^3 to be the biggest market segment, or will $L^{1\&2}$ ADAS applications to take the bigger share of lidar sensor applications?

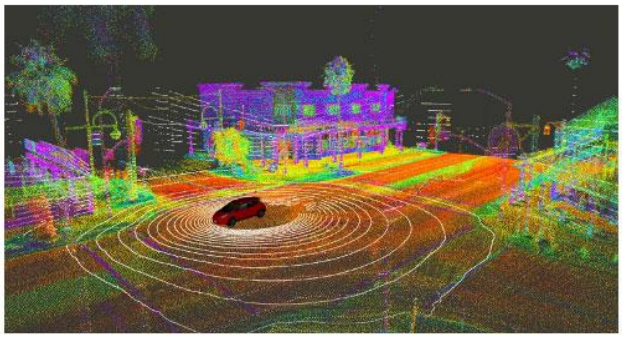
JN: We see growth across each of these markets in the next five years, with advanced ADAS solutions presenting the largest opportunity for automakers to bring the latest safety technology to a wide range of their product line. While we do not have a crystal ball to reliably predict the distribution between L^3 and $L^{1\&2}$, we are certain that lidar will be deployed on more and more vehicles.

We need to dramatically reduce the number of fatalities on our roads, and the existing sensor suite, while contributing to safer roads for everyone, is not sufficient to reach our goal of zero road fatalities. lidar is complementary to other sensors. Either making existing vehicles safer—moving from L^1 or L^2 to L^{2+} or L^3, or enabling more autonomous driving functionalities—we are certain that lidar is a must in both cases. Speed of deployment regionally will vary based on the automakers' appetite for innovation and legislation. We can expect mass deployment in China to lead, followed by Europe and USA, and then Japan.

DVN: Joseph, thanks so much for talking with us! We hope to see you and your Baraja colleagues at our upcoming DVN-Lidar events.

JN: Thank you very much for the opportunity. I am looking forward to working together again in 2023!

GM Expanding Hands-Free Driving Access



Communication from GM to DVN-L

GM are committed to expanding access to advanced driver assistance systems (ADAS), bringing these technologies to more vehicles on more roads, while prioritising safe deployment. We want to help our customers expand their driving experience with these systems, which is why we're laser-focused on testing, validating, and improving our ADAS technologies to provide our customers with advanced features and systems—like the industry's first true hands-free advanced driver assistance system, Super Cruise.

A key piece of Super Cruise's accessibility is its road network, the compatible mapped highways where customers can engage the hands-free system. In August 2022, the company announced plans to double the Super Cruise Road network to more than 644,000 km of roads in the U.S. and Canada on select vehicles.

The first vehicles to receive this expansion will be full-size SUVs built starting on 3 October 2022, arriving in customers' hands starting in mid-November. Hundreds of thousands of additional miles of roads will be unlocked for customers with these Super Cruise-equipped vehicles:

- 2023 Chevrolet Tahoe, High Country and Premier trims
- 2023 Chevrolet Suburban, High Country and Premier trims
- 2023 Cadillac Escalade, Escalade ESV and Escalade-V
- 2023 GMC Yukon Denali Ultimate

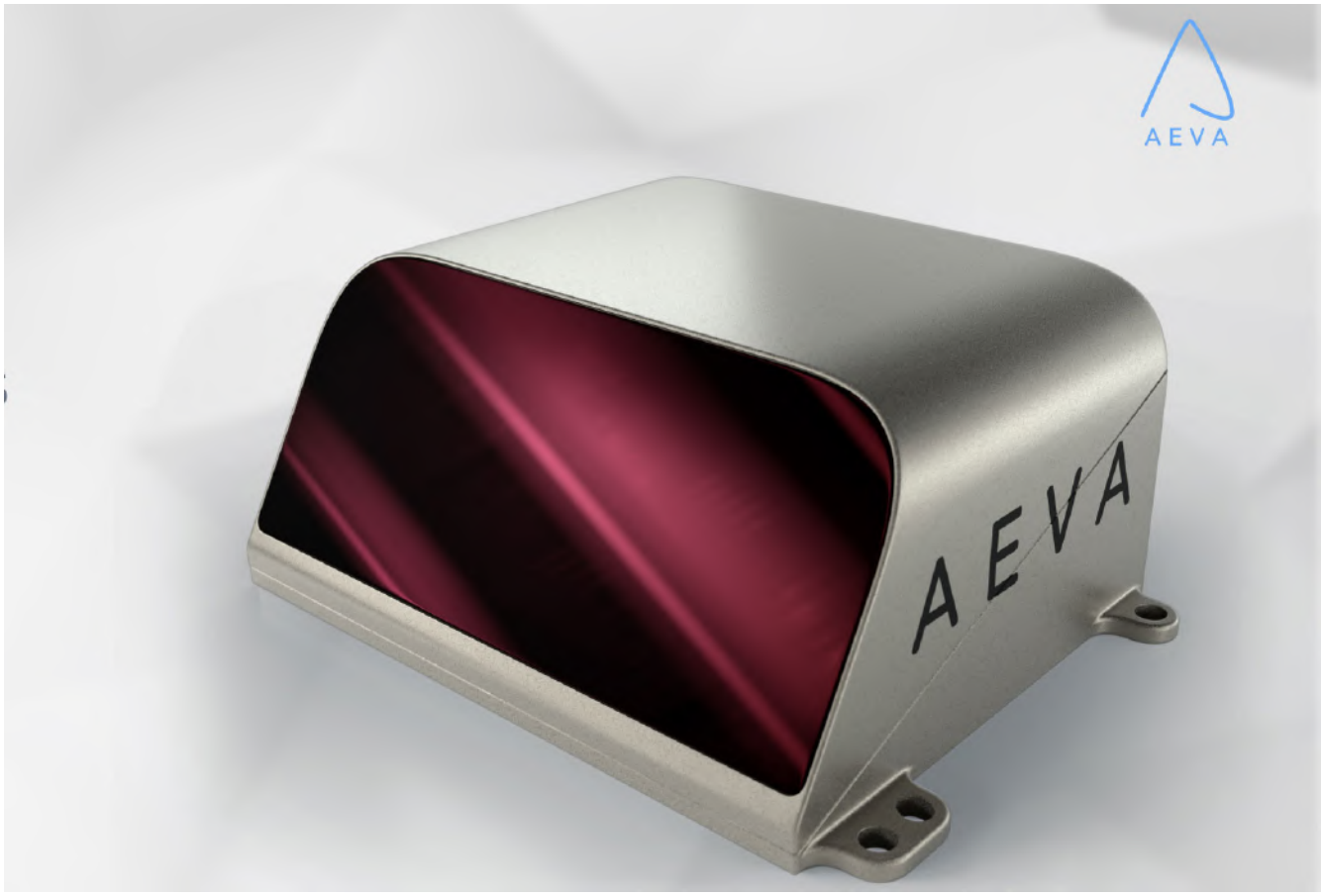
For existing Super Cruise vehicles built on GM's VIP electrical architecture, GM will expand the road network starting in the coming months via over-the-air (OTA) updates at no additional charge. OTA software updates can provide more enhancements over time for eligible vehicles. Through the connectivity of our vehicles, OTA updates are automatically downloaded and installed with the simple push of a button.

Super Cruise is coming to 22 vehicles globally by the end of 2023. Ultra-Cruise will later be available on certain premium entries. Together, these technologies will bring ADAS to more customers on more vehicles, in more regions at more price points.

DVN comment

Step by step, we see automakers gradually expanding the operational design domain for L2+ and L3 applications. This is required to make these applications more attractive for end users in the future, and this is also a prudently cautious path to validate safety performance.

Aeva Win CES Innovation Award



Aeva's Aeries II sensor has won a CES Innovation Award—this after the Aeries II and Aeva's 4D lidar technology were recently chosen as one of Time Magazine's Best Inventions of 2022.

Aeva's Aeries II 4D lidar sensor delivers breakthrough sensing and perception performance using FMCW to directly detect the instant velocity of each point, in addition to precise 3D position at long range. Its capabilities go beyond legacy time-of-flight 3D lidar sensors to enable the next generation of driver assistance and autonomous vehicle capabilities, including:

- Instant velocity detection directly measures velocity for each point of detection, in addition to 3D position, to perceive where things are, and precisely how fast they are moving.
- Long-range performance to detect; classify, and track objects such as vehicles; cyclists, and pedestrians at long distances.
- Ultra Resolution: A real-time, camera-level image providing up to 20 times the resolution of legacy time-of-flight lidar sensors.
- Road hazard detection to detect small objects on the roadway with greater confidence, at up to twice the distance of legacy time-of-flight lidar sensors.
- 4D Localization: per-point velocity data enables real-time vehicle motion estimation with six degrees of freedom to enable accurate vehicle positioning and navigation without the need for additional sensors, like IMU or GPS.

Aeva say the Aeries II is the first sensor on the market to integrate the company's unique lidar-on-chip technology, which integrates all key sensor components including transmitters; receivers, and optics onto silicon photonics in a compact module. This design uses no fibre optics, resulting in a highly automated manufacturing process which allows Aeva to scale deployment of their products and lower costs to meet the needs of automakers and other volume customers.

DVN comment

We see an increasing number of suppliers developing FMCW lidars. This technology, providing real time doppler and also used on automotive radars, should become more popular in future.

Cepton to Launch New Lidar, Show Auto Integration at CES

Cepton's 3,000-ft^2 CES booth will feature live demonstrations of their full suite of automotive lidar solutions, as well as their collaborations with leading automotive partners.

Their booth will feature a Chevrolet Silverado and a Ford F-150 equipped with Cepton's latest vehicle integration solutions; short- and long-range automotive lidars will be seamlessly embedded into multiple locations around the vehicles, including the headlamps, fog lamps, side mirrors, front grille, and tailgate.

Visitors can expect to see one of the industry's first full, integrations of lidar technology into a vehicle's lighting system. This involves a combination of Cepton's automotive lidars embedded within headlamps and fog lamps to simultaneously enable near-range blind spot detection and long-range obstacle detection. Combined with a fully-integrated cleaning system from Koito, the state-of-the-art automotive lidar integration enables a dual-light self-cleaning mechanism to address real-life driving needs.

During CES, Cepton will also unveil their next-generation automotive lidar, the Vista-X120 Plus. With an unprecedented combination of ultraslim compact design; top-end performance; and real-time adaptive 3D perception, it is designed for today's vehicles as well as the next generation of intelligent, electrified, and software-defined vehicles. Cepton has been recognised with a CES Innovation Award in the Vehicle Tech & Advanced Mobility category for this product. Cepton representatives will be available to share additional details about the Cepton Vista-X120 Plus, with product demonstrations available upon request.

DVN comment

Car integration is still a big topic for the lidar technology, and we see more and more proposals to integrate lidars around the car, including cleaning systems. This is a key issue to speed up lidar applications.

Innovusion's Falcon Lidar for Faraday FF 91 Futurist

California-based EV maker Faraday Future have chosen Innovusion's Falcon lidar to power the FF 91's autonomous driving system. The system is intended to seamlessly integrate into the FF 91 Futurist to deliver real-time 3D vision, even in adverse weather conditions and at night, providing a safer and more reliable driving experience.

Innovusion's Falcon lidar is designed to give the FF 91 Futurist unprecedented insight into the environment far in front of the car. Enabled by Falcon's long-distance capability and high angular resolution, other vehicles in the FF 91's path can be detected up to about 500 metres away, and even pedestrians and small road debris can be detected over 200 metres away.

The Falcon's advanced vision capabilities assimilate uninterrupted full field-of-view and high-resolution data collection, enabling superior visibility and improved safety in complex road conditions. Leveraging 1,550-nanometre laser technology, the Falcon can cope with challenging weather and environmental conditions. Rain, snow, in the dark of night, or on the sunniest of days, the forecast provides consistent, real-time precision.

DVN comment

Here we see yet another interesting example of how to integrate lidars into cars.

Ficosa, LeddarTech in Smart Parking Development Pact

Ficosa and LeddarTech have signed a development and commercialization agreement for the development of a smart automatic parking assistant.

Ficosa will integrate LeddarVision™ software into their parking ADAS. LeddarVision is high-performance sensor fusion and perception software which provides extremely accurate 3D models of the vehicle's surroundings, developed using raw data inputs from sensor systems. This raw data fusion and perception software enables the detection of even the smallest obstacles on the road, with fewer false alarms and greater accuracy than with traditional object-based perception solutions. This agreement will enable the full potential of this software to be combined with Ficosa's leadership in cameras and vision systems in the automotive sector.

Ficosa already offer a range of products to cover all vehicle segments, including an independent rear-view camera; independent intelligent rear-view camera; surround view system, and autoparking system—and they produce more than eight million rear-view cameras a year.

With this announcement, Ficosa continue to strengthen their intelligent in-vehicle parking assistance system with a solution that allows a more detailed, more precise perception of the surroundings. Based on this information, the vehicle will be able to better 'understand' the context in which it is moving, and better detect and respond to unexpected objects such as a pedestrian crossing its path.

The agreement between Ficosa and LeddarTech is an important milestone that will enable car manufacturers to offer an improved experience using advanced driving assistance systems. This alliance also represents further progress towards the consolidation of the autonomous vehicle. In the autonomous mobility ecosystem, the collection and analysis of reliable and detailed environmental data is an essential step towards ensuring the highest standards of safety and comfort for users.

DVN comment

The use of lidars in automated parking functions can greatly improve the perception of immediate vehicle's environment. Such perception is traditionally done by low-cost ultrasonic sensors, which suffer of a lack of spatial resolution—which limits the performance of automation in complex situations such as curb detection.

PreAct Release New Flash Lidar now available from PreAct

PreAct Technologies' new T30P flash lidar has been released, and PreAct are saying it's the only flash lidar on the market capable of supporting over-the-air updates for software-defined architectures for a vehicle's entire service life.

The T30P sensor, designed to be software-definable and easily integrated into a complete ADAS or autonomous vehicle software stack, is said to deliver future-proof, high-performance sensing at a lower cost than other lidars.

PreAct CEO Paul Drysch says in addition to the excitment of launching the T30P, his company "have multiple production projects in the works and this is just the beginning of a period of rapid growth (...) we've spent the last three years creating a solution that fulfills the need of software-defined vehicles, providing the most value over the long term and our work has been validated" by tier-1s and automakers.

PreAct are working with automakers to future-proof vehicles by providing increasingly sophisticated ADAS and safety applications throughout a vehicle's lifetime. The supplier's new software-definable lidar enables new and better ADAS applications, in addition to improving the performance of hardware over the life of the vehicle through software upgrades.

Due to its flexible design, PreAct's flash lidar also enables tier-1 suppliers and automakers to package one sensor for multiple use cases, such as curb detection and parking assistance or automatic door actuation and self-parking.

DVN comment

Affordable flash lidars for short-range applications should contribute to better, more widely-available parking applications.

DVN-L Deep Dive I: 27-28 February, 2023

The first DVN-Lidar Deep Dive of 2023 will take place this coming 27 and 28 February at the hotel Dorint in Wiesbaden. Here's the docket in its current form:

27 February

18:30 Welcome of live participants
19:00 Cocktail
20:00 Dinner

28 February

8:30 Opening and introduction of participants
9:00 Automaker presentation including key questions for break-up groups
9:30 Supplier presentation including key questions for break-up groups
(The theme for both presentations is **contamination and cleaning**)

10:00 Coffee break

10:30 Four breakout groups, each discussing two questions
11.30 Breakout group reporting and discussion

12:15 Lunch break

13:30 Tier-2 presentation including key questions for break-up groups
14:00 Research outfit presentation including key questions for break-up groups
(The theme for both presentation is **optics**)
14:30 Four breakout groups, each discussing two questions

15:30 Coffee break

16:00 Breakout group reporting and discussion
16:30 What did we learn together?
17:00 Closure