Telematics Wire

Technology Driven | Futuristic Vehicle

Parking Aid System

Blind Spot Detection

Blind Spot Detection

Distance : 3 m

Lane Change Assist

Blind Spot Detection

Blind Spot Detection

SAFE

Pedestrian Detection

Emergency Braking

Lidar

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Shifting to active safety system and ADAS

Last September(2020) during an industry association annual meet(virtual this time), Shri Nitin Gadkari, Minister for Road Transport and Highways had mentioned about the vehicle scrappage policy for India. It has now been mentioned formally during the budget speech by Smt. Nirmala Sitharaman, Finance Minister of India, on 1st Feb'21. Some of the highlights of the policy which is yet to be notified are- vehicles over 20 years old will need to be scrapped and those above 8 years will have to pay additional tax. According to Shri Gadkari, about 10 million vehicle could be scrapped under this new policy, giving the automotive industry a room for growth of over 30%. For automotive industry which contributes nearly 50% of gross manufacturing in India, this initiative is very encouraging in many respect.

The government push for getting old vehicle scrapped may already be having, a nearly matching pull from the owner of vehicles.

During our school days in early 1980s, it was a milestone for a small town middle class family to own a four wheeler. Those owning a vehicle were known in their locality or mohalla. And for those in middle class who could afford, it was generally pre-owned cars (2nd hand cars) which were being disposed by business community or rich and wealthy family of town. One of my schoolmate's family was proud owner of pre-owned vehicle, a Premier Padmini Fiat, which was driven for over 8 years before the owners decided to buy something new, perhaps Maruti 800, which had just appeared on the horizon. The price for the pre-owned vehicle which had run for 8 years was no less. If I have to compare the investment in terms of land or gold at todays cost, it will be worth Rs 45 lakhs in terms of land(540 square yards of land in town) or 8 Lakhs in gold(160 grams of gold). The process too was a long and tedious one, where the information of car sale took it's own time to trickle to them, meeting arranged, price negotiation done, payment date fixed and finally in the agreed time frame of a month or so, the money was paid and car brought home. Fast forward to 2020, a 10+ year old vehicle was put up for sale by my office colleague, on a newly built platform for sale of pre-owned vehicles. From the date of putting up the intent for sale and completion of transaction it was just about a week. But because of diesel engine being a rattling point, even through the car was in good running condition, it fetched a meagre amount.

Owning old vehicle is a pain than a pride today. Pre-owned value of cars have declined to the extent that given some policy incentive many would prefer to have their old vehicle scraped in exchange for a new one.

Last month, National Road Safety Month 2021 was flagged off by Ministry of Road Transport and Highways. There has been initiatives and effort at various level to sensitise people about road safety. But being a large and extremely diverse country many a times such campaign fail to reach remote corners of the country. Our sensitivity towards road safety is many a times driven by fear of law (chalan as call in many places), rather than wilfully protecting ourself. Thereby many of our passive safety systems have not been able to give desired result in bringing down the loss of life due to road accidents. Various research study talks of how miserably aware we have been about road safety laws and thereafter its compliance.

Its time to change gear to active safety system and ADAS!

Policy makers and advisors in automotive at MORTH have been looking at features like driver drowsiness, collision warning, lane departure, blind spot detection etc. MoRTH has put dates by when some of the features will be mandated in India. Use of active safety systems and ADAS could reduce road accidents and loss of life in India, as has been the case in many developed and developing economies.

Additionally in-cab coaching which has been in discussion amongst the industry experts for almost a decade now is being featured in passenger vehicle. Considering that many if not all the driver, rarely go for retraining or re-learning, apps like these could be an opportunity for many to improve their driving habit.

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THE RAPID ADOPTION OF ADAS AND THE CHALLENGES TO ITS DEVELOPMENT PROCESS

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With almost every new car nowadays having level 1 or level 2 capability, Advanced Driver Assistance Systems (ADAS) has seen a rapid integration into vehicles over the past 10 years. Initially developed for vehicle safety, ADAS is now also viewed as a key enabling technology for Autonomous Vehicles (AV). With an evolving use case to compound the rapid adoption challenge, ADAS technology is undergoing an industry-shifting update on its overall development and deployment process in the automotive space. In this article, Konrad technologies, with over 25 years of global experience in electronics and sensor test, will introduce the basics of ADAS/AV and share some perspectives of the ongoing innovation in the ADAS/AV development process to keep pace with the rapid ADAS/AV adoption.

Let's begin by going over some basics of ADAS/AV levels of autonomy, the current rate of adoption globally and in India, and sensor innovation in this market space.

Levels of Autonomy:

The ultimate objective with ADAS and AV is to reach a level of autonomy which eliminates the need for a human driver. To get to this level, there are various industry accepted stages of autonomy from Level-0 where the driver has complete control to Level-5 where the driver has no control (as shown in Figure 1).

The levels of autonomy have a tight correlation to the level of automation in the ADAS functionality as shown in Figure 2:

Level 0: There is no automation, and the human driver has complete control of the vehicle.

Level 1: ADAS features are introduced such as partial steering assist to keep vehicles within lane and speed control such as adaptive cruise control.

Level 2: Both steering and speed control can be handled by the vehicle. The human driver needs to supervise the functions constantly.

Level 3: Highly automated where the system is responsible for external environmental monitoring and handling the vehicle. The system can ask human driver to take over anytime.

Level 4: The system is capable of handling itself and decision making under most driving conditions. However, there are certain conditions the system will not drive.

Level 5: Autonomous. The system has complete control of itself.

Figure 1 : Level of autonomy

Source: https://blog.netapp.com/how-to-build-a-data-pipeline-for-autonomous-driving/

Figure 2: SAE level of driving automation

ADAS Adoption:

At the advent of ADAS, there were claims from OEMs that self-driving vehicles would be on-road by ~2025. But as research continued it became clear that the challenge at hand is more complex with several dependencies – sensor capability, ML (machine learning), ability

Figure 3: Market data on ADAS/AD adoption   Source: RBC Research

- Complexity of sensor increases
- Intelligence of sensor increases, for e.g., Mobileye camera has ADAS intelligence built-in
- Amount of data generated and processed increases

As the number of sensors and complexity increases, the need for rapid prototyping and validation plays a key role in lowering the time to market.

to validate & test ADAS electronics, infrastructure, consensus on testing standards like NCAP etc. Overcoming these technical challenges opens multiple untapped markets with new business models pulling in several global OEMs, Tiers and Silicon Valley behemoths to make significant investment for the necessary innovation.

Historically ADAS adoption was led by consumer preference for safety features but with new markets and models being apparent, the adoption will be led by competition in the industry. It will be a function of safety preference and democratization of ADAS.

As market potential became apparent (as shown in figure 4), investment into ADAS/AV technology increased several folds. One of the key areas of innovation was sensor technology which is the cornerstone of AV.

Sensor Innovation:

Sensors play a key role in making AV a reality. There are various kinds of sensors, each with its own strengths making no single type of sensor the perfect singular choice. Typically, a vehicle needs to be able identify and avoid close objects while sensing objects at ~300metres or more. It needs to function under different environmental conditions, infrastructure, and under different lighting conditions. To reliably operate an autonomous vehicle, a variety of sensors are used to accurately represent the surrounding around the vehicle.

Several technical factors are considered to choose the right combination of sensors. Resolution to determine the details, ability to distinguish between multiple static and moving objects, reliability, accuracy, field of view etc. to determine the number of
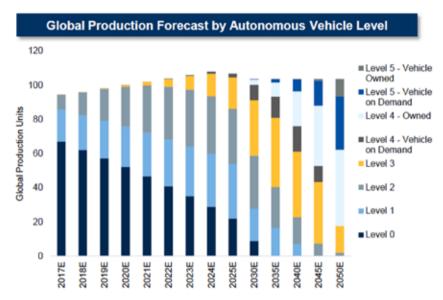
Figure 4: Global production forecast by Autonomous Vehicle level   Source: RBC Research

sensors required. Cost and size of the sensors also play a key role in deciding what kind and how many sensors will be used.

Accordingly, based on level of autonomy required, the

- No of sensors used increases

ADAS Adoption in India – KT Perspective:

Europe is expected to hold the largest ADAS market share in 2020 followed by North America and Asia Pacific. The growth in Europe is attributed to the increased safety regulation and growing

Figure 5: Sensors and capability

AD Market Outlook: Transformation in Industry Approach in Hardware and Software, Global, 2012–2025 and beyond

Level 1			Level 2			Level 3			Level 4			Level 5		
Sensor – L1	#		Sensor –L2	#		Sensor – L3	#		Sensor – L4	#		Sensor – L5	#	
Ultrasound	4		Ultrasound	8		Ultrasound	8		Ultrasound	8		Ultrasound	8-10	
RADAR (LRR)	1		RADAR (LRR)	1		RADAR (LRR)	2		RADAR (LRR)	2		RADAR (LRR)	2	
SRR	2		RADAR (SRR)	2-4		RADAR (SRR)	4		RADAR (SRR)	4		RADAR (SRR)	4	
Camera/ Short- range LiDAR	1		Camera	2-4		Camera (LR)	2		Camera (Stereo/Trifocal)	2/3		Camera (LR)	2/3	
Total	~6-8		Total	~17		Camera (Sur)	4		Camera (Sur)	4		Camera (Sur)	4	
						Camera (Stereo)	1		Camera (Stereo)	1		Camera (Stereo)	2	
						μbolo	1		μbolo	1		μbolo	1/2	
						LIDAR	1		LIDAR	2/4		LIDAR	4	
						Dead reckoning	1		Dead reckoning	1		Dead reckoning	1	
						Total	~24-26		Total	~28-28		Total	~28-32	
Lateral or Longitudinal Assistance			Observation of Environment			Awareness for Take Over			No Driver Interaction			No Driver		
2012			2016			2018			2020			>2025		

#: Average sensor count in respective levels; μbolo: Thermal camera/IR Sensor for Night Vision Approximation based on number of features supported

Source: Frost & Sullivan

Figure 6: Sensor adoption based on autonomy level

ASIA PACIFIC

India is the fastest-growing country-level market in the region

Asia Pacific accounted for approximately 25% of the global market share

BY COUNTRY, 2020 (USD MILLION)

China
Japan
South Korea
India

Source: Secondary Research, Expert Interviews, Company Presentations, and MarketsandMarkets Analysis

Figure 7 : Asia Pacific ADAS adoption

demand for ADAS features. The market growth in North America is attributed to the rising demand for semi-autonomous driving features.

Though India is the fastest growing market within Asia Pacific region it is still a small market. Indian OEMs and Tier suppliers are evaluating ADAS features and functionality, but the adoption remains slow. Some of the reasons include:

- No regulations/safety mandates pushed by government
- Low ADAS feature demand in domestic market
- Major export market are other developing countries with no clear safety regulations nor ADAS feature demand
- Most ADAS research for global OEMs/Tiers happens in their core

R&D centers, most of which are close to their headquarters away from India.
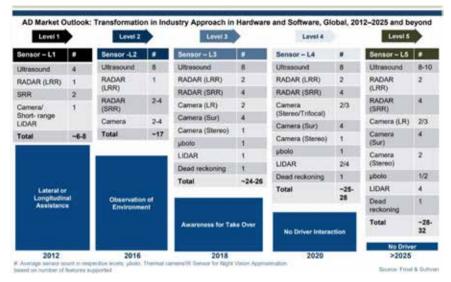
We expect ADAS demand to continue growing at a high rate in India over the next decade. To enable globally increased investment, safety regulations and infrastructure growth is needed.

As we consider rising adoption rates globally, the ADAS development process plays a critical role in meeting market expectations. There are many images depicting the ADAS development flow, and here is the Systems and Embedded Software Lifecycle image (Figure 8) that is listed in the ISO 26262 standard documents. This image depicts the typical vehicle component module development flow from system design, validation, and test with a closed loop feedback between design and test efforts. The primary challenges for ADAS and AV development efforts is added to the image as the highlighted blue area which reflects the lack of closed loop development feedback between the different phases of Design and Test efforts. A variety of different tools at different phases, a "silo" or "black box" approach to accelerate separate phases, different test focus and test techniques at each phase, and a shifting set of requirements for ADAS and AV functionality all contribute to limit the sharing of best practices and key learnings at each separate phase. And results in a longer overall ADAS development timeline before we include the topic of billions of drive test miles to validate functional safety of the ADAS systems. The fundamental challenge for ADAS is created by its core architecture that consists of multiple components that each have to be designed and tested separately before being assembled and re-tested as a single functional unit, and then
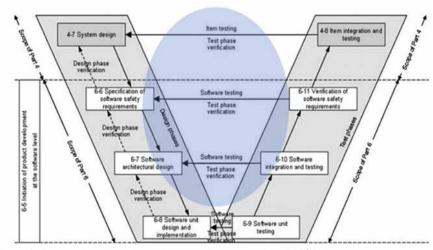
Figure 8: The blue highlighted area is the challenge area for ADAS/AV development.

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Figure 9 : From ADAS Sensor to Application Tests

which Konrad Technologies is a founding member, this test technology involves testing the actual ADAS sensors with the ECU in a lab environment before drive tests (shown in Figure 10). A single test platform can now perform simulation tests, component tests, AND system level tests for ADAS functions before the first live drive test on the road. Together with our partner VI-grade, we have showcased this ADAS test platform for drive simulations

integrated into the vehicle for yet another round of tests. In the test engineering world, this requirement is seen as a progression from component level test to application level test in a single continuous process (as shown in Figure 9) and certainly an area to be investigated and studied for innovation of appropriate test methods.

For this fundamental ADAS challenge, one test method that has been introduced

Source: Systems and Embedded software lifecycle stated in ISO 26262.

Figure 10: Sensor Fusion HIL Test

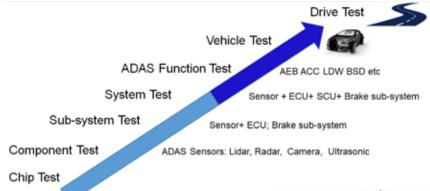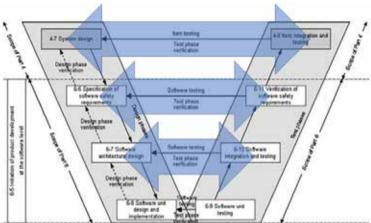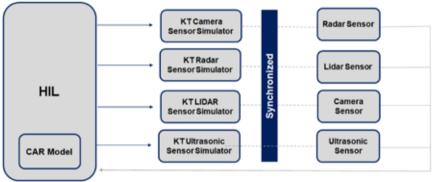to the automotive ecosystem is to have a common set of instrumentation tools for tests during the design and test efforts for ADAS components and applications. Using open instrumentation test platforms like the PXI and FPGA-based platform from NI (formerly National Instruments) enable design and test teams to customize test applications for their specific needs

and to share relevant test data for improving the designs at different phases of the development flow. Going one step further, Konrad Technologies has pioneered Sensor Fusion HIL Test as a test method to effectively accelerate the overall ADAS development process. First realized as a test concept in 2016 by the ADAS IIT Consortium (www.adas-iit.com), for

tests and currently working on several projects for vehicle in the loop (VIL) tests. With this innovative approach, complete ADAS modules and their corresponding software components in the ECU can now go through regression tests and repeatability tests in a lab environment for functional validation. And more importantly, data gathered from these lab tests can be evaluated with actual drive test data and then channeled to the design team for ADAS feature improvement or correction and quickly verified using the same test workbench.

In summary, as the challenges and expectations for ADAS continues to grow and we head towards Level 5 Autonomy, the ADAS development process will need to evolve to have a higher degree of synergy between design and test efforts as shown in Figure 11. Connected tools, common platforms, data sharing, and a closed-loop development process will lower the ADAS development time. New sensors, new test methodologies and new development processes will take ADAS features into new domains of capability with a reduced development timeline to support the rapid adoption of Autonomous Vehicles. ❏

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POWERTRAIN INFORMATIONAL ADAS

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Think tanks and future mobility reports have predicted an emergence of vehicle energy smart management. A broad area of technology, no doubt, enveloping the powertrain. One of the many contributors to this is realtime vehicle energy demand. This tech layer could become the future brain of the powertrain management system regardless of its internals being pistons or motor windings. Its more probable that the EV may receive the TLT – tender love and tech. So what is this got to do with ADAS?
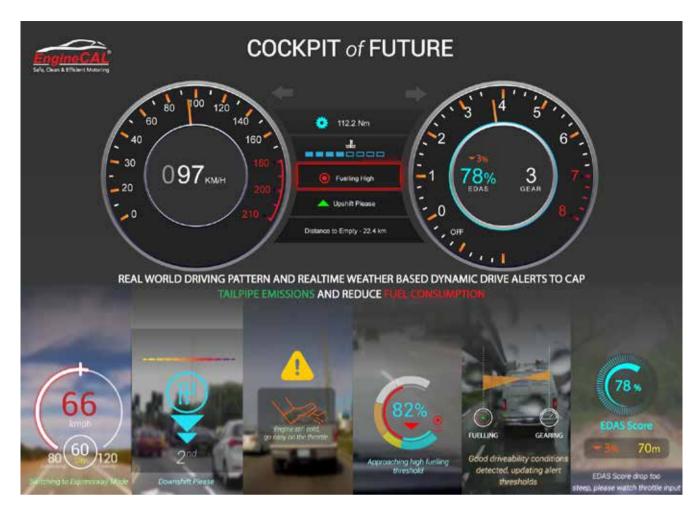
ADAS could be one medium to optimum driver demand. Driver demand is the tech layer of the engine management system responsible for taking commands from it's human for desired motive power. Realtime advice in the form of an instrument cluster indication for a select band of throttle usage has been prevalent in passenger cars and 2-wheelers. But intelligent engine performance control, one which is variable and hence optimum is a step above these now legacy systems. Ofcourse, such a system will need to be connected. It would seamlessly become a part of the vehicle's network being fed realtime weather conditions, road specific traffic information etc. over and above the all-important powertrain CAN data. Why weather conditions you may ask. In order to provide precise and accurate driver demand inputs to the human the tech must be aware of the ambient conditions. These have direct implications on driveability. It all boils down to, pardon the pun, the combustion. The right conditions aid better cylinder filling resulting in better combustion and therefore, more performance at the flywheel. All this as an intriguing form of ADAS – powertrain informational ADAS.

The slightest of factors affecting driveability need to be part of the software layer realtime ingesting his/her inputs, calculating an optimal demand and relaying to the driver. This demand layer has to be powertrain specific and designed around the target powertrain's driveability calibration. The audio and visual cue for approaching the optimum driver input and for breaching it can be projected on the HUD, the cluster or even the infotainment system. The optimum demand is not a signal to continuously follow and so will remain dormant but watching it's human. Once the driver is close to breaching the current optimal demand the system will signal the driver to adjust throttle which could be both hold or reduce. The signal will be different if there is a breach. Tests have shown that humans can adapt to such a system bringing in remarkable change in drive patterns. Drive patterns which see per drive cycle superior CO2, safety, less stress on the powertrain, the list goes on. While globally the Real Driving Emissions (RDE) is one way to ensure real-world drive patterns see closer results to the vehicle laboratory emissions, RDE still works with conformity factors. Further, RDE is for select components of emissions. These, ofcourse, are agreed standards by the global automotive emission legislations. The point being made here is that any additional tech to achieve an improvement in realworld tail-pipe emissions is going to be helpful. A special ADAS of this genre could complement the brilliant work of the men and women in this field. A more controlled, subtly ofcourse, drive pattern will impact the realworld tail-pipe emissions performance.

This intriguing version of ADAS will also have certain benefits similar to current ADAS applications. In other words, safety of the occupants and of the vehicle. In-cabin feel is enhanced when driver demand is optimum. While this sounds more a comfort enhancement it is in fact more wholesome than that. This automatically reduces the possibility of near-misses or even accidents with an optimum rate of acceleration. The safety enhancement applies to the powertrain too. Optimum driver demand can be, in the long run, a method to extend component level life because of capping harsh use. There is another perspective to this. Monitoring drives such that realtime alerts advice the human not to shut off the engine before operating temperatures are reached. Or, not to push the powertrain because it is still cold. Maybe even, not abruptly shut down the engine after a hot run. Such alerts will simultaneously impact emissions, protect the forced induction system, engine oil etc.. Often drivers subconsciously follow a harsh driving pattern little realizing that their 'innocuous' drive could be far more optimum, and safe.

It must be clarified that optimum driver demand for vehicles equipped with manual transmission include gear management as part of the alerts engine. This too has been seen for long in the passenger car segment. And again, this can be improved on by considering weather conditions and certain strategic realtime powertrain CAN information as part of this informational ADAS. Gear management is a deep topic in itself. Typical driver usage is low engine speed, high gear. Often, the reason for this driver strategy is the insatiable quest for a better fuel figure and sometimes lethargy. While the latter is more tongue

COCKPIT of FUTURE

REAL WORLD DRIVING PATTERN AND REALTIME WEATHER BASED DYNAMIC DRIVE ALERTS TO CAP TAILPIPE EMISSIONS AND REDUCE FUEL CONSUMPTION

in cheek there is no doubt that the former is widespread. Unfortunately this gets sometimes stretched which keeps the powertrain operating at high loads low revolutions and the typical urban traffic conditions don't help either. This leads to more soot accumulation in the diesel catalytic convertor, DPFs and GPFs. The repercussions of this is well understood. If there is anything as 'holistic deterioration', this is it. An underperforming catalyst to poor engine performance, it goes on. Though this article is not about the exhaust gas treatment (EGT) system it wont hurt to say that the aforesaid lines do pose a lot of trouble for the systems running particulate

filters. DPF equipped vehicles running in congested megacities face issues with engine oil dilution and choked DPFs. As seamless as the regeneration process was designed to be, the human not knowing about an ongoing on regeneration poses some problems. If an engine shut off is initiated by the driver while regeneration is active, the process of clearing out the DPF gets stretched. It spills into the next drive cycle and maybe another all while more soot is being continuously accumulated. This can happen in the urban jungle often resulting in a scenario where the DPF needs the service center's intervention. Powertrain informational ADAS could

learn/track and decide which drive cycle to advice it's human to allow the regeneration to be completed.

Connecting the vehicle's prognostics technology to this ADAS will be necessary. Prognostics beats the on-board diagnostics layer in detecting deterioration and can predict failures. A link with the vehicle's prognostics tech will be vital realtime information for optimum driver demand. A drop in engine performance will require an intelligent algorithm to be embedded in the optimum driver demand decision engine to calculate any leeway, if at all. This also means state of the art prognostics capability to assess various systems like injection, ignition, forced induction etc. If any exhibit deterioration it will impact engine torque, a parameter which new generation prognostics layers are able to calculate based on powertrain specific AI models.

Automotive technology has been incessantly evolving. We 'humans' are in the golden era of advanced, utilitarian and delightfully 'assistive' cockpit electronics. The future is optimum. ❏

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Anubhav Amarnath is a passionate automotive engineer. He claims he has been lucky to work in areas of powertrain engineering which have truly broadened his thinking and instill ideas. He is grateful to his former employers and colleagues for the prolific work he was made part of. He works as the CEO of EngineCAL.

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Role of LOCALIZATION in Autonomous Vehicles

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What do we mean by Localization? Should be the first question coming to us. Localization is the process of locating an object in a particular place or environment. Having said this, now the process of locating the vehicle on the road is "localization" in autonomous vehicles. For the autonomous vehicle to navigate its way through the destination, the vehicle has to localize itself on the road at every timestamp.

Therefore, the next question is "Why is it so hard to localize?" Let us start with "human driver" first. For any driver to reach the destination, the driver has to know where the source is and where the driver is currently. This is the basic concept of localization. For humans, the localization works differently based on the experience their perceptive of looking at the environment. However, in autonomous vehicles, there has to be a certain common criteria defined as the standard operating procedure across all the vehicles.

Programming the autonomous vehicle is similar to teaching a newborn to walk and navigate. The only difference is with autonomous vehicles, we are looking at two different worlds at the same time namely, static and dynamic. When a newborn is walking around, the dynamic world is at standstill giving way to the newborn, but with the autonomous vehicles, the vehicle has to find its way carefully through the dynamic world.
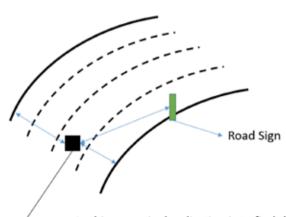
Static world are the objects in the environment that does not move or change as the vehicle is passing through. Like the roads, lane markings, signboards and other objects along the road. Dynamic world comprises of the pedestrians, cyclists, motorists and other vehicles. These keep moving along our vehicle and may or may not cross our intended path towards the destination.

How does the autonomous vehicle move? For any autonomous vehicle, the basic information is the HD map from the server. The HD map will have all the static information about the road. Similar to what a human driver sees in front of him and behind him through the rear view mirrors. Similarly based in the GPS coordinates, the vehicle will download the part of the road from the server. Now the road map is available and the vehicle can determine the geometry and other parameters of the road. On top of this, merge the dynamic map and obtain a fused map around the vehicle. Before the vehicle can move forward or backward, the Localize the vehicle with reference to the static objects. Why is the localization of the vehicles based on static map and not dynamic map? Dynamic map has objects that are moving constantly and not confined to any particular location (GPS coordinate). Hence, it is not advisable to localize the vehicle with respect to the dynamic map.

How does the vehicle get dynamic map? The dynamic map comprises of the all other dynamic objects around the vehicle like the pedestrians to other vehicles. The autonomous vehicle is equipped with camera and sensors, which will determine the moving and stationary objects around the car. The quality of sensors have gone up high in the recent past that they can give the dimension of each object around the vehicle. With the help of machine learning algorithms, the vehicle predicts the trajectory of the moving objects around it.

In this scenario, localization is to find the position of the vehicle with respect to the "Road Sign", "Right border" and "Left border" of the road. This is just an illustration.

The fused map is now available with the vehicle. Next step for the vehicle is to plan the route to the destination. Similar to the navigational route provided by some of the map providers, google maps used commonly by everyone. The autonomous vehicle will have a route calculated to the destination similarly and in addition, the vehicle has to plan the route for every timestamp. Meaning, the vehicle has to consider the dynamic objects around it, the static objects for reference and navigate through them carefully without any mishaps. In case of a road construction or diversion that a traffic regulator signals standing on the road, the vehicle has to sense the same and plan to change lanes or take an exit. The autonomous vehicle must also read the dynamic road signs on the road to detect lane closure, accident and other dynamic events along the route. The autonomous vehicle should abide by the local traffic rules at all times, in terms of maintaining speed limit, driving on the proper lane, giving way to emergency vehicles, reading the traffic lights and everything that a human driver does. At every juncture or timestamp, the autonomous vehicle has to plan the path for the next position on the road. For the autonomous vehicle to plan the path efficiently, it should know the exact location of the vehicle on road at a given time.

Localization provides the exact position of the vehicle on the road with reference to some of the static objects. Only after knowing the exact position of the vehicle, the machine can decide its movement along the road. Say for example, if the vehicle is on the right corner of the road, the vehicle has to come onto the driving lane to move forward. With just the free space alone, the vehicle cannot decide and move forward. Localization helps to determine all the factors like the lane closure, non-drivable, or restricted to drive at regular speeds. The calculation of the lane information is mathematical and several filters like particle filter, kalman filter, etc are considered. Noise reduction and detection also plays an important role here. The filters reduce the noise and give an exact estimate for the calculations. What is Kalman Filter? Kalman filtering

provides estimates of unknown variables given the measurements observed over time. Using linear models with Gaussian noises, Kalman filter provides optimal estimates. In case of autonomous vehicles, we will be dealing with landmark based maps i.e., the static map consists of objects like a traffic pole, road sign, mile marker or overhead signs on the road which are considered as landmarks. So Kalman filter is widely used over the particle filter, which is useful for feature-based maps.

The other difficulty for the localization is the coordinate system. The GPS signals of the static map are global coordinates and the vehicle can see the objects with respect to the vehicle or in other words, the vehicle coordinate system. Before we can associate any object on the map, we have to transform the position of the objects to a common or global coordinate system. The most common mathematical model used for the transformation is the "Transformation Vector" which is a 3-D representation of the Euclidean space in Cartesian coordinates.

The GPS coordinates determine the vehicle's initial position on the map. This is not the localized position of the vehicle. On top of this, the localization algorithm helps to determine the exact position of the vehicle with reference to an object on the map. As the vehicle progresses on the road, the wheel odometry sensors determine the distance travelled by the vehicle with respect to the origin. The further positions are calculated in the Cartesian or global coordinate system surpassing the need to do the transformation for every time stamp.

Summarizing the points, "Localization" is to find the position of the vehicle at time (n) which is the best estimation based on the previous measurements, the sensor observations and the past trajectory of the vehicle. The sensor variations (noise) can be approximated using Gaussian distributions. The Kalman filtering is for the linear models and approximation of non-linear motions. For any autonomous vehicle, Localization is the foundation stone without which the navigation and path planning will not work. In short, without localization there is no autonomous vehicles. ❏

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ADAS: NEXT GENERATION OF DRIVER AND VEHICLE MOVES IN TANDEM

VINAY SOLANKI
GM & HEAD – DIGITAL SOLUTIONS, NAPINO

Automotive purpose has evolved from being just a medium of transportation and commute to being an environment of digital experience and advanced technologies. From being just a mechanical and electronic machine to being a complete digital experience and interface for its owner or driver. From the early days of building automotive one of the key focus areas has been safety for the driver, passengers, and commuters on the road. Automotive technology has evolved from human controlled and manual driven options to computer controlled autonomous vehicles or autonomous driving. OEMs and vehicle brands continue to focus to make driving safer using intelligent technologies in the vehicle such as sensors, actuators, machine learning, internet of things, real time connectivity, 5G, ADAS and so on.

Let us understand the role of ADAS (Advanced Driver Assistance Systems) by first looking at the need for safe driving. Ever year more people are killed in road accidents compared to other crimes such as war, terrorism, civil unrest, etc. As per transport research wings of the ministry of road transport and highways in the year of 2019 approximately 151,000+ people were killed in 480,000+ road accidents across India. This is an alarming rate of one accident every five minute in India.

"Traditionally, for any accident or crash, the major causes could be 'driver/human', 'road infrastructure' or 'vehicle-related factors'. Sometimes, there might be combinations of these factors which might lead to accidents. Among these major factors, 'driver/human' related factors or errors dominate," said Nagendra R Velaga, associate professor, department of civil engineering, Indian Institute of Technology (IIT), Bombay in an interview to Hindustan Times.

So most road accidents occur due to human error then how can ADAS help? ADAS is defined as a system composed of electronics and mechanical technologies that assist the driver in functions such as parking, lane control, speed management, etc. A safe and seamless machine-to-human interface can support and enhance both vehicle and road safety. In order to avoid collision or accidents
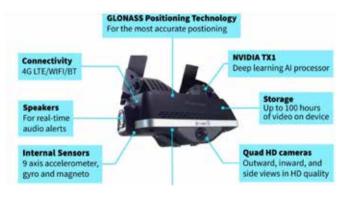

Image Credit: https://www.netradyne.com/

ADAS system can implement alerts for various conditions such as over speeding, lane departure, route diversions, tale-gate, obstacles on the road, cruise controls, traffic warnings, poor lighting, sleepy drivers, distractions, etc. Vehicle manufacturers and supply chain ecosystem for the parts and components of the vehicle adopt camera, computer vision, radar, LIDAR, ultrasound, sensor fusion and other connected technology to support such alerts.

One such ADAS solution is using a dashcam device with artificial intelligence and image analytics to monitor driver behaviour and safe driving practices. Such a solution is typically used by B2B fleet operators to monitor their drivers and safety of the vehicle, which are expensive and critical assets, for smooth and efficient business operations. Typically, requirements from logistics companies, fleet management businesses and transportation industry are to monitor real time efficiency and behaviour of commercial truck drivers; assist in maintaining safe driving distance and avoid tailgate; monitor and capture imagery before and after the accident; OR improve compliance to road safety and traffic guidelines.

For example, Napino (https://www.napino.com/), one of the largest electronics designs and manufacturing player in India, partnered with VVDN Technologies to manufacture an ADAS dashcam for Netradyne. Products consist of four cameras to monitor the driver (rear), the vehicle in the front (front), and two cameras each on the left and the right for side view capture. To generate real-time alert, the device consists of high-performance processor and GPU on the PCB to support deep learning models in conjunction with long range connectivity to upload the information to the cloud. Device also supports Wi-Fi and Bluetooth connectivity for short range communications with mobile phone application. Using multiple sensors which are embedded on the device PCB such as accelerometer, gyroscope, magneto, GPS with GLONASS, audio buzzers and option to integrate with the vehicle telemetry data.

While dashcam comes in multiple options with one or max two cameras and limited processing power to make it affordable for usage in different vehicle types they all come with basic internet connectivity via cellular network to upload the captured data to a remote server or cloud for processing and analytics. Business benefits observed by the customers using ADAS solutions are many with few listed here. Engaging drivers with timely and relevant information reduces the need for management intervention, monitor driver performance and behaviour in near real time giving the fleet manager tools to optimize the fleet performance, capture distracted driving incidents, and analyse the same to reduce violations, speeding and safe distance alerts reduce probability of accident, and so on.

With adoption of ADAS and other technology solutions inside the vehicle to increase vehicle to driver communication and driver to vehicle feedback we can observe that gradually the driver and vehicle understand each other better and move in tandem like how first-time sky diving diver fly in tandem with an expert without much help. ❏

BUILDING A SCALABLE ADAS SOLUTION FOR AN EMERGING MARKET

SANTHOSH BRAHMAPPA

APTIV TECHNICAL CENTER INDIA

Radar can be located behind the outer body of a vehicle.

As vehicle manufacturers look to implement advanced driver-assistance systems (ADAS) to save lives and meet government regulations, they want to use cost-effective yet reliable technologies that create a foundation for today's ADAS capabilities and scale to support more sophisticated capabilities in the future.

ADAS has been proven to reduce the number of vehicle crashes. One of the fastest growing ADAS features is automatic emergency braking (AEB), where the vehicle detects whether it is closing on an object too quickly and engages the brakes if the driver does not. The U.S. Insurance Institute for Highway Safety says that AEB can reduce front-to-rear crashes by 50 percent.

Emerging markets such as India are also moving towards ADAS technology deployment in vehicles. Automakers in India have requested the Central government to open up a spectrum band that will enable them to offer solutions to enhance passenger and pedestrian safety via satellite. This has definitely paid off, and now the government has approved the use of very low power radio frequency devices – such as short-range radar systems – and freed up the 77 GHz frequency spectrum to be used by the auto industry. The entire industry, and more so the consumers in India, will definitely benefit from this move.

With AEB's effectiveness demonstrated around the globe, the government of India is also helping to ensure that new vehicles ship with the technology by 2023. Major OEMs in India are already getting ready to move beyond AEB, with plans to include Level 2 and Level 2+ ADAS functionality in their vehicles in 2021.

Sensor Fusion

Multiple sensing modalities required; sensor fusion brings them together

RADAR
- Long-range sensing
- Object movement
- All-weather performance

LIDAR
- Precise 3D object detection
- Range accuracy
- Free-space detection

CAMERA
- Object classification
- Object angular position
- Scene context

	RADAR	LIDAR	CAMERA	FUSION
Object detection	+	+	O	+
Pedestrian detection	−	O	+	+
Weather conditions	+	O	−	+
Lighting conditions	+	+	−	+
Dirt	+	O	−	+
Velocity	+	O	O	+
Distance - accuracy	+	+	O	+
Distance - range	+	O	O	+
Data density	−	O	+	+
Classification	−	O	+	+
Packaging	+	−	O	+

+ = Strength   O = Capability   − = Weakness

To enable AEB and other ADAS technologies, radars provide reliable, foundational sensing capabilities. They not only can tell how far away an object is – up to as much as 500 meters with long-range automotive radar – but in the same measurement they also determine how quickly that object is moving toward or away from the vehicle.

Radars use radio waves to "detect" those objects, which means they work well in a variety of weather conditions, including rain, snow, fog or smoke. Unlike cameras, radars do not require a clear line of sight, so they are not affected by dirt or grime. In fact, a radar can be hidden out of sight behind a panel or the grille and reliably deliver accurate information about the environment around the vehicle.

Cameras are also cost-effective, but they have to try to estimate an object's distance by looking at the size of the object in the camera's image, their range can be limited by the camera resolution, and they have to estimate speed by looking at multiple image frames.

However, cameras are excellent at classifying objects – that is, being able to discern between, say, a pedestrian and a bicyclist – and they can even read street signs. Each object or road user will behave differently, so an intelligent system could better anticipate those objects' movements if it knows what it is looking at.

Lidar can measure distances accurately, and its high resolution allows it to determine the edges of objects precisely. However, lidar is very expensive, and, like cameras, it requires a clean and clear surface in front of it to be effective.

Sensor fusion

The main sensors in use today on vehicle are radar and cameras, with ultrasonics playing a role in short distances at low speeds and lidar used in autonomous driving.

The key, then, is to take the best attributes of different sensing and perception technologies and combine them. As vehicle manufacturers look beyond the simplest ADAS functions to Level 2 and 3 functionality, this sensor fusion will be critical to building a durable environmental model.

In the past, manufacturers packaged processors with the sensors themselves. The processors would analyze the data coming from the sensors and track any objects they had identified. Now, many OEMs are looking at removing the processing power from all of those sensors and consolidating it into a centralized domain controller.

This approach makes the sensors smaller and lighter. In this satellite

> **INDIA AS AN EMERGING ECONOMY IS ON THE RIGHT PATH TO SPEED UP THE WIDESCALE ADOPTION OF ADAS.**

Radar can perceive its environment in a variety of weather and lighting conditions.

architecture, radars, for example, are up to 70 percent smaller than smart sensors. Power supplies, housings and brackets are reduced or eliminated, resulting in an overall mass reduction for the ADAS of 30 percent. OEMs have more flexibility in where they place the sensors, and heat management becomes less of an issue.

The centralization also helps enable low-level sensor fusion. Instead of each sensor individually processing data and forwarding it on, the data from multiple sensors and sensor modalities is combined in a single step. This reduces latency and allows the ADAS system to make decisions faster.

With the right data, that centralized domain controller can also apply machine learning to get more out of it. For example, with machine learning, a system can better identify and classify objects from radar data. Machine learning allows the system to see pedestrians in a cluttered environment. It allows the system to identify vulnerable road users such as bicyclists and motorcyclists, reducing misses by 70 percent compared to classical radar signal processing. Further improvements are possible by combining the data with that from other types of sensors through sensor fusion.

The result is a robust environmental model that becomes the basis for higher levels of automation, giving the system the information it needs to make intelligent decisions. Such reliability is necessary for advanced features such as highway assistance or traffic jam assistance.

Each innovation builds on the next. OEMs can start with a smart radar to meet regulatory requirements for AEB today, while planning for a satellite architecture that leads to centralized intelligence for more advanced functions. The approach allows them to add new sensors easily, and add new, differentiating ADAS functions to their vehicles at their own pace. In this way, OEMs can democratize safety while moving to advanced capabilities for safety, comfort,

convenience and automated driving as consumers demand them.

While the Indian ADAS market may seem to be in its early stages, with only a small percentage of vehicles fitted with Level 1 or Level 2 autonomous driving features, in fact the ADAS market in India is responding rapidly to the need for safer driving conditions.

India as an emerging economy is on the right path to speed up the widescale adoption of ADAS. Next, it must build up the IT infrastructure on highways and implement stricter regulations for road safety. Technology development and innovation continue at a rapid pace within the auto industry, allowing companies to gain a first-mover advantage in this emerging market. ❏

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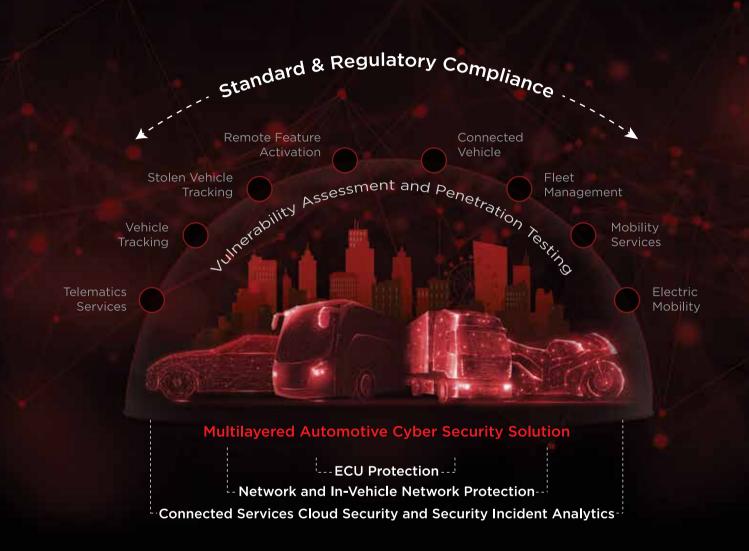
Santhosh Brahmappa is site director at Aptiv Technical Center India, which develops multiple products and technologies enabling the future of mobility. He is a seasoned business leader with global engineering responsibility, driving transformation through software enablement, building talent for automotive software and driving technology practices across the globe. He has diverse industry experience across verticals, including automotive, software products, industrial automation and medical devices.

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ACHIEVE DESTINATION ZERO ACCIDENT USING ADAS TECHNOLOGIES

MANU GOWDA

KPIT TECHNOLOGIES
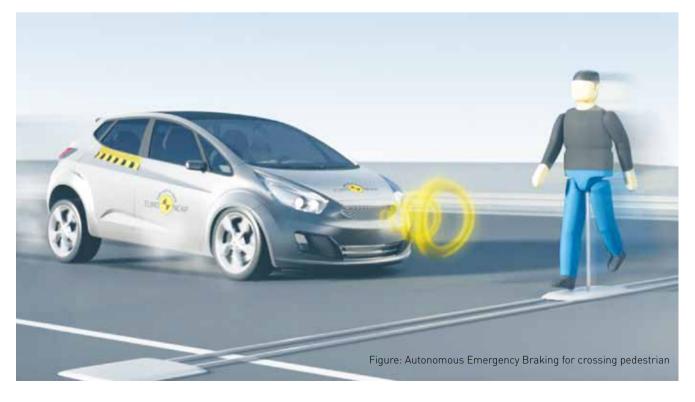
According to World Health Organization (WHO) 2018 'Death on the roads report', approximately 1.35 million people die each year due to road traffic accidents in India alone estimated deaths is 299,091. As per the Indian road ministry website 467,000 accidents were reported in 2018. Destination Zero is an aspiration to achieve zero accidents, zero pollution and zero congestion by automotive manufacturers, governments, environmentalists and other industries around the world. There is a growing demand for more vehicles on the roads to aid the movement of people, goods and services. Consequently, it is becoming complicated and vital to achieve safety of people and countryside animals on roads. Accidents do not only impact the individual involved and their families, it can also effect the GDP of the country.

It's been more than a century since the first traffic lights in the world seen on London's roads to save people's lives. As the decade's pass, we have developed traffic laws and complex infrastructure to avoid accidents worldwide. In the modern world we still have increased number of accidents and deaths on roads. Developed countries in the Europe have good infrastructure and stricter laws but we still see 50.5 accident fatalities per million people. This highlights existing traffic laws and infrastructure is not enough, we need to make vehicles and roads safer than before with the help of niche technologies to achieve Destination Zero accidents.

Human senses are not always accurate and that human error is often the cause for many accidents on the roads, there are many studies around this. To make vehicles safer, advanced driver assistance equipment can be used to alert, warn and aid the driver to avoid accidents. We have started using old known camera and radar technologies to make modern and advanced vehicles. The automotive manufacturers may have started late but never the less in 21st century we have engineered them for luxury brands but this is not enough to achieve destination zero accidents. Safe technology shall be part of every all vehicles in all countries. Safety must become affordable and it

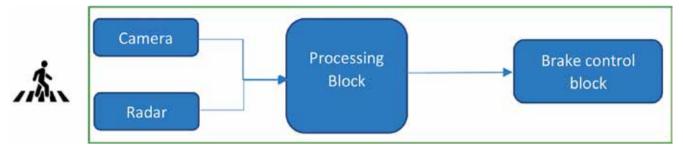Figure: Autonomous Emergency Braking for crossing pedestrian

Figure: Simple block diagram for autonomous emergency braking system

shall be primary right for every individual born in any civilised nation.

Human error is possible in every activity includes driving no matter how advance the infrastructure and laws are, this is exactly the primary focus and that's why we need higher aspirations like destination zero. Errors can be reduced by automating driving activities using Advance Driver Assistance systems (ADAS) and Autonomous vehicles, ADAS is the first step in that direction. There are various levels of autonomy within the industry, starting with level 0 and ending with level 5. Level zero being the lowest, with just alerts to the driver when threat is detected and level 5 being the highest for full driving automation without driver intervention.

There have been a handful of advance driver aid systems available in market over the past 2 decades such as Autonomous Emergency Braking (AEB) to brake when threat is detected in the vehicles driving path, Emergency Lane Keeping to maintain the vehicle within the lane to avoid unintentional drift due to driver fatigue, Blind Spot Detection to detect unseen objects around the vehicle etc. Alert systems help the driver to be attentive when a threat is detected in the vehicles path. If the driver does not take corrective action for alerts actuators such as braking and steering systems receives automatic request to apply brake or steer away from threat.

To develop ADAS systems, at-least a sensor or combination of sensors are required to detect a threat. A simple block diagram below describes a pedestrian walking into the vehicle path. The camera and radar sensors detect the object and the processing block identifies if the object

is going to be a threat. If the driver does not detect and does not take corrective action, then the processing unit will pass on the request to the brake control block to apply the brake immediately to avoid the collision.

These systems are getting more popular and are becoming a unique selling point for other equipment manufacturers (OEMs). Having no extra assistance is no longer an option in many countries as statutory laws getting stricter to have safety systems in vehicles to reduce fatalities on roads. Automotive standards like New Car Assistance Program (NCAP) provides certification to make vehicles more sellable by proving they are safer in different scenarios and environment. ADAS systems have already proven to have started saving lives on roads; researchers say around 40% of potential accidents can be reduced by integrating them on passenger vehicles.

Challenges and possibilities:

Unfortunately, as safety increases so does the price. It's a challenging problem for OEMs and end customers. Development, integration and validation is getting expensive due to complex distributed ADAS systems. Government policies helping OEMs and supplier to come together to build a sustainable ecosystem to reduce safety cost and increase affordability. Unless safety becomes mandatory people tend to treat it as a second priority since it is an invisible factor while buying a vehicle. This is human nature.

Robustness of systems are at the mercy of the advancement of sensor technology. Sensors have limitations in their hardware and software which causes false or missed

detection of objects, meaning false braking or steering for non-existent threats, or missed braking or steering for real threats in the vehicles path. Lidars have brought hope to resolve these limitations we have in the camera and radar; it can scan the environment more precisely and classify objects with high confidence. Challenges are not just limited to sensors but it extends to the systems engineering activities to develop reliable systems which includes developing well thought through functional and non-functional requirements (e.g. performance, maintenance, reliability etc.). Systems engineering is a wide discipline and enables engineers to understand systems systematically to develop complex and distributed systems. Having reliable systems is vital to increase the confidence on these systems. As technology advances systems are becoming more reliable and sustainable to achieve destination zero.

To achieve zero accidents, forces need to be combined such as OEMs, suppliers, government and researchers need to come together seamlessly to overcome challenges. There are ADAS platforms already in the market that are capable of achieving level 3 automation after great research and big capital investments. OEMs working with tier 1, 2 and 3 suppliers as partners, is the key to success. No single OEM or supplier will be able to achieve Destination Zero aspirations on their own. Many OEMs and suppliers have already realised this and joint ventures are in place to work-out challenging areas by complimenting each-others weakness. Governments are also funding to build facilities for research and validation of ADAS and autonomous features development.

Having excellent systems is not enough, educating users is also key to making the most out of ADAS systems and to avoid abuse of the system. There are plenty of sources available online and offline, it's the responsibility of users to go through them. There have been incidents where the user has abused systems by not following safety cautions which have led to hazardous events. One such example is the driver falling asleep after setting the vehicle into auto pilot mode in a Tesla vehicle. It's also the responsibility of the OEMs to consider user behaviours into system design to reduce the abuse and increase the safety. There are regulations such as United Nations Economic Commission for Europe (UNECE) and Federal Motor Vehicle Safety Standard (FMVSS) in the U.S. in place to ensure systems do provide enough warning to users when not attentive or not placing their hands on the steering wheels continuously.

Human machine interfaces (HMI) play an important role to make the systems more co-operative with the driver. It's essential that systems don't fight the driver, if so driver becomes irritated and loses confidence on systems. HMI includes audio and visual warning, having an appropriate and natural level of warning & alert to make sure the driver understands the information provided to take control of the system and situation to avoid hazardous events. HMI can be used as a tool to teach the driver how to use systems. Partial learning could lead to inefficient use of the system. This may result in not meeting the required purpose of it in the vehicle.

After all development on the left side of product development V cycle the next

> ## DESTINATION ZERO ACCIDENT USING ADAS TECHNOLOGY COULD SAVE LIVES WHEN WE HAVE SUSTAINABLE ECO SYSTEM BETWEEN OEMS, TIER 1,2,3 SUPPLIERS, GOVERNMENT AND RESEARCHERS.

big challenge is validation. Every ADAS feature could have hundreds of scenarios on roads, parking spaces etc. To build sensible scenarios you need to consider the environment, road type, objects around the vehicle, weather conditions and other factors. A combination of all these factors and its variants could result in thousands of scenarios. Increase in affecting factors, increases complexity of validation. Imitating these environments with limited resources and time is a great challenge. After all the testing is complete, analysis of huge data and generation of a meaningful report is exponentially time consuming and a huge challenge at the moment for the whole industry to deliver reliable systems. Performing validation is not limited to specific location, it varies

from country to country to account for weather, driving pattern and driver behaviour. There are plenty of simulation and emulation tools in market to validate software, hardware and vehicle itself. It's much quicker but it always comes with the risk that in a virtual environment it's not possible to take into account all real noise factors.

Insurance companies started taking advantage of ADAS systems fitted in vehicles to get to know how safe the vehicle is to protect occupants which in-turn saves the insurance companies money on what they pay post accidents. This is a win-win situation for both vehicle and insurance owner, it's not just that insurer's pay less bills but the insurance for such vehicles are also relatively less compared to vehicles having no ADAS systems.

Conclusion:

Safety should not be limited to luxury vehicles; it is important for each individual to have the option to be safer by using ADAS systems. Destination Zero accident using ADAS technology could save lives when we have sustainable eco system between OEMs, Tier 1,2,3 suppliers, Government and researchers. Reduction of accidents by 40% is an excellent achievement of ADAS technology which is leading us towards Destination Zero accident aspiration. Non-traditional automakers are proving this is possible even quicker meaning we will not be required to wait for decades to save lives. Technology is evolving to achieve L4 and L5 automation, it is possible that it will be in our vehicles within in the next 2 decades, not too far into the future.

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AUTHOR

MANU GOWDA
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Manu Gowda has enriched experience in systems engineering discipline with management skills underpins to emerge as a successful leader. Provided technical leadership in building & guiding successful teams to develop complex distributed systems. Objective is to work towards achieving Destination Zero with strongly believed principles i.e. SMART objectives, leads by example, team work and gets it done.

AUTONOMOUS VEHICLES TO BOOST MEMORY REQUIREMENT

🖋 AMAN MADHOK
COUNTERPOINT RESEARCH

Automotive innovation has majorly been in hardware during the last two decades. For instance, the efficiency of internal combustion engine has considerably increased during this time. However, during the last few years, the focus of automotive industry has shifted towards digitalisation, automation and electrification. The cars of the future will be electric, connected and autonomous. They will continuously accumulate, process and share data received from sensors and infotainment systems. By 2025, we expect, around 30% of cars sold globally will support Level 2 or above automation.
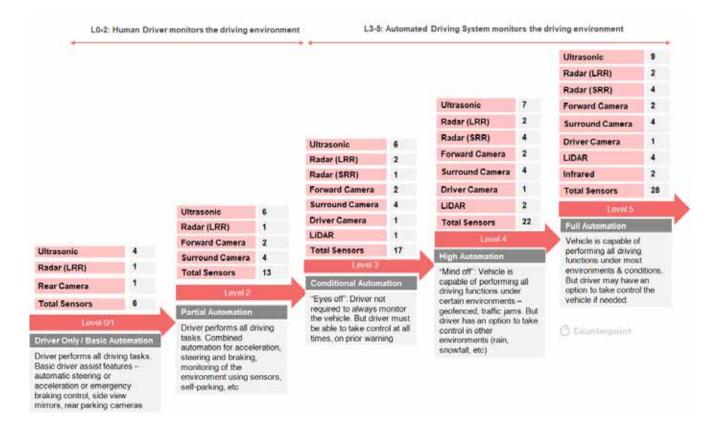
Advanced Driver Assistance Systems (ADAS) having multiple sensors will form the foundation of autonomous vehicles (AVs). The exhibit below highlights the increasing number of advanced sensors required for the goal of achieving highly or fully-automated driving.

Vehicles will be increasingly designed to gather, process and store data locally as well as selectively upload data at an appropriate time. This will create a need for data storage and computing infrastructure within the car, as well as in the cloud.

How Much Data Will AVs Generate?

AVs will generate huge amounts of data, not all of which will be stored in the vehicle. Some of it will be discarded or transferred to cloud. It is difficult to accurately gauge the amount of data generated by an AV. Data generated by a sensor depends on its application and specifications. For instance, data generated by a front camera could range between 70 GB/hr and 300 GB/hr depending on its resolution, color depth, frame rate and compression levels.

The amount of data generated by an AV will also depend on the type

L0-2: Human Driver monitors the driving environment

L3-5: Automated Driving System monitors the driving environment

Level 5	
Ultrasonic	9
Radar (LRR)	2
Radar (SRR)	4
Forward Camera	2
Surround Camera	4
Driver Camera	1
LiDAR	4
Infrared	2
Total Sensors	28

Level 5

Full Automation

Vehicle is capable of performing all driving functions under most environments & conditions. But driver may have an option to take control the vehicle if needed.

Level 4	
Ultrasonic	7
Radar (LRR)	2
Radar (SRR)	4
Forward Camera	2
Surround Camera	4
Driver Camera	1
LiDAR	2
Total Sensors	22

Level 4

High Automation

"Mind off": Vehicle is capable of performing all driving functions under certain environments – geofenced, traffic jams. But driver has an option to take control in other environments (rain, snowfall, etc).

Level 3	
Ultrasonic	6
Radar (LRR)	2
Radar (SRR)	1
Forward Camera	2
Surround Camera	4
Driver Camera	1
LiDAR	1
Total Sensors	17

Level 3

Conditional Automation

"Eyes off": Driver not required to always monitor the vehicle. But driver must be able to take control at all times, on prior warning.

Level 2	
Ultrasonic	6
Radar (LRR)	1
Forward Camera	2
Surround Camera	4
Total Sensors	13

Level 2

Partial Automation

Driver performs all driving tasks. Combined automation for acceleration, steering and braking, monitoring of the environment using sensors, self-parking, etc

Level 0/1	
Ultrasonic	4
Radar (LRR)	1
Rear Camera	1
Total Sensors	6

Level 0/1

Driver Only / Basic Automation

Driver performs all driving tasks. Basic driver assist features – automatic steering or acceleration or emergency braking control, side view mirrors, rear parking cameras

Counterpoint

of vehicle. For instance, robo-taxis and OEM test vehicles, which are less sensitive to hardware costs when compared to passenger vehicles, will generate more data. A typical OEM test vehicle will generate around 80% more data when compared to a passenger car of same autonomy level. With more than 20 different types of sensors that can be integrated into a Level 4 AV's ADAS, the vehicle can generate data in the range of 1-2TB/hr, depending on whether it is a passenger vehicle, commercial vehicle, or a robo-taxi.

Key Applications Using Data

While sensors will be the primary data source in AVs, there are many other applications which will consume data. Moreover, different entities within the vehicle ecosystem as well as smart city will likely use the data generated by all such vehicles.

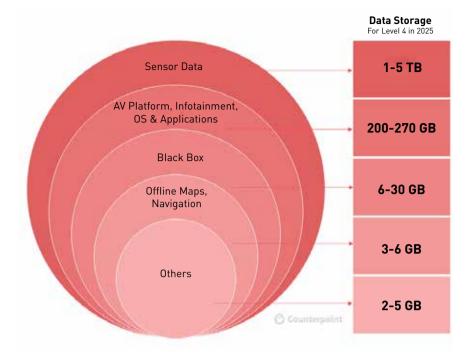Some of the key applications using data are explained in detail below:

Sensors

- Sensors will account for the largest share of a vehicle's on-board storage data. Sensor data will mostly come from ADAS systems and V2X capabilities.

AV Platform, Infotainment, OS and Applications

- The AV platform is required to run various autonomous/ADAS features that drive additional storage needs for an advanced operating system (OS), voice AI applications, productivity, and other offline content.
- With improving safety regulations, a black box for recording the most recent information is expected to become a mandatory requirement. Data generated from connected and safety services, OTA updates, and similar services will also require some additional local storage space.

HD Maps

- Unlike the 2D maps used in current cars, the high-precision (HD) maps of AVs vary a lot in terms of frequency of refresh rates and sampling methods.

Data Storage
For Level 4 in 2025

Layer	Storage
Sensor Data	1-5 TB
AV Platform, Infotainment, OS & Applications	200-270 GB
Black Box	6-30 GB
Offline Maps, Navigation	3-6 GB
Others	2-5 GB

Counterpoint

HD maps will wirelessly have real-time updates to accurately drive the AV with precision and safety.
- HD maps are so accurate that they can complement some of the sensor deficiencies to increase positional accuracy. Current 2D maps have only a static layer which can be updated once a month. However, HD maps have a static layer, semi-static layer,

semi-dynamic layer and a dynamic layer. HD maps are updated every hour, minute and second.
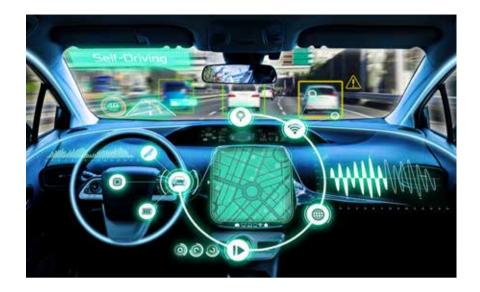
Data Storage Strategies for Automakers

Today, automakers prefer to store the data locally as the amount of data generated by the car is relatively modest. But as they move to autonomy Levels 4-5, a combination of cloud and edge computing strategies will prevail. Automakers will not rely entirely on cellular networks due to the following challenges:

- Large size of data sets
- Requirement of high-speed and real-time processing
- High bandwidth costs
- Security and privacy issues

The cost of transmitting the data to the network will become a deciding factor on how and what data is transmitted. For instance, the cost to transfer all the data from a Level 4-5 AV to the cloud for a single day could run into thousands of dollars for automakers. This is unlikely to be a viable solution across an entire fleet of cars, creating a huge opportunity for on-board storage.

Commercialisation of 5G networks can reduce the data latency to less than 10 milliseconds. However, 5G will take several years to roll out and have a broad

> " THE COST OF TRANSMITTING THE DATA TO THE NETWORK WILL BECOME A DECIDING FACTOR ON HOW AND WHAT DATA IS TRANSMITTED. MANY NEW BUSINESS MODELS MAY EMERGE IN FUTURE FOR OFFLOADING THE DATA TO CLOUD. "

coverage across the world. Till then, the systems will be based on 4G LTR networks. Therefore, on-board storage will be the best option for automakers to store data.

There are challenges at each stage of the data journey which warrant prudent data collection, storage and usage strategies. An AV will face design and cost limitations, whereas network and cloud will have limitations related to bandwidth, latency, security and connectivity. Therefore, an AV will need to have an intelligent storage and offload system.

Many new business models may emerge in future for offloading the data to cloud. The data can be offloaded at charging stations over an ethernet cable, or at service stations during routine car service. The data itself may be pared down to simpler metadata rather than raw unprocessed data streams depending on the need to for the type of data to train the models or enrich the database.

The business model for data management will vary depending on the usage of vehicle – passenger vehicles, commercial vehicles, robo-taxis and OEM test vehicles. For example, OEM test vehicles will have a larger share of data stored locally when compared to passenger vehicles. OEM test vehicles and commercial vehicles could regularly visit a base station for swapping of physical storage systems.

Opportunities for Storage Players

Embedded Multimedia Card (eMMC) storage is the most common way to store data from in-vehicle infotainment systems. However, eMMC cannot support future AVs, which will have sophisticated graphical user interfaces and will require high-speed access from memory. Moreover, there has to be more storage space in the infotainment system to store multimedia and high-resolution maps.

In the evolution of fully autonomous driving, signals from sensors are processed at a high speed by the drive computer, which requires high bandwidth. Besides, drive computers will likely include redundant systems running in parallel and comparing decision outcomes in real time, potentially multiplying memory requirements.

To cater to this exponential increase in storage with increasing autonomy levels, the storage technology needs to evolve from Single-Level Cell NAND (SLC NAND) to e.MMC/Universal Flash Storage (UFS) to embedded Solid-State Drive (SSD)

SLC NAND

- Applications: Event log in Event Data Recorder (EDR), code storage in embedded system, data storage in dashboard
- The capacity is small and needs to be managed by the system
- Widely used from Level 1 to Level 5 with a maximum capacity of 4GB

e.MMC/UFS

- Applications: Infotainment system, navigation system and code storage in ADAS
- MLC eMMC/UFS has been so far widely used in ADAS since it provides a good compromise between performance and cost, data security, durability, price and capacity
- Further, a move to 3D NAND (TLC) eMMC/UFS has helped from a cost perspective
- It will be used in Level 2 to Level 4

UFS/embedded SSD

- Applications: Storage of high-resolution maps, AV computer, AI database, black box data recorder
- Price of SSD is higher than other storage systems, but it can provide better speed, larger capacities and higher bandwidth
- It will be used in Level 3 to Level 5

Safety, reliability and quality are critical for automotive memory storage units. Automotive memory must, at a minimum, conform to these three standards – ISO26262, AEC-Q100 and IATF16949. ❑

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OPPORTUNITIES FOR AD/ ADAS STARTUPS

ANIL RACHAKONDA
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For the past 5 years, venture capital investment in AD/ADAS ecosystem was heavily skewed towards Automated Driving (SAE levels L4/5). This was driven by the belief that large-scale deployment of AD deployment was imminent.

Several startups emerged and raised capital in the order of billions of dollars, i.e., Cruise, Zoox, Auro, Aurora, Nuro, TuSimple, to name a few. These companies focused on the full stack for various vehicle segments.

Along with these full stack companies, other startups have focused on specific elements in the AD Tech Stack such as 3D Navigation, Lidar and 3D Radar.

The AD technology development ecosystem

AD Full Stack Developers (startups, or startups that got acquired by OEMs/Tier1s)	
Tier1s & Tier2s for subsystems	Startups

Shifting timelines and capital-intensive nature of AD industry made this approach an unsustainable game. As positive cash flow forecasts continue to push out few Full Stack players, only those who raised ton of capital, are able to survive.

As the hype for AD tempered a little, startups and VCs instead have shifted the focus towards ADAS (SAE L1 to L3), in search of next big growth opportunity. In part this is because of the greater degree of specific value that a start-up can develop with an acceptable level of investment and within a more reasonable timeframe. The rapid near-term growth of ADAS makes it an attractive opportunity for startups.

ADAS is estimated to grow at double digit CAGR reaching to a market size of > $90 Billion by 2030 (source: UBS). The strong growth is driven by market pull for ADAS functions such as Automated Parking, Lane Assist, Adaptive Cruise Control, Collision Warning and Mitigation, Driver-Alert, Front and Rear Object Detection, Pedestrian Detection, Blind Spot Warning, Reverse Parking etc. up to Highway Chauffeuring.

Opportunity in ADAS stack

To identify high value opportunities, startups must understand both the Tech Stack and the business value chain of ADAS system.

ADAS stack comprises of several layers from Application layer down to Hardware layer. OEMs are more active in the higher layers of the stack and the lower layers are served by Tier1s and Tier2s.

Startups have opportunities across the stack, and in particular AI/Sensor Fusion/Perception layer, Compute Layer and associated Tool Chains.

ADAS Tech Stack	Role
Application Layer	OEM defines / leads
AI / Sensor Fusion / Perception layer	Both Tier1s and Tier2s, and including several startups (Room for Innovation)
Still there, room for Innovation	
Middleware & OS	Tier1s
Compute layer	Tier1 System Integration Tier2 Core Tech (Room for Innovation)
Sensor HW (+ Edge AI, Edge Perception)	

Opportunity in Tool Chains

In addition to the tech stack, there are new tool chains required to handle the massive data generated by the ADAS sensors and enable the AI training for developing the Perception layer, either on-prem or public-cloud.

While Simulation has been a focus area, Cloud companies are aggressively pushing into the AD/ADAS Tool Chain. While cloud providers have expertise in data management and tool for AI/ML development, they lack the subject matter/domain expertise that is essential to identify and solve niche high value problems within the AD/ADAS data stack. This is another area where AD/ADAS startups can potentially excel.

Tool Chains

@ On-Prem / Edge
Data Management
ML Ops
Simulation

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IMPACT OF AUTONOMOUS DRIVING TECHNOLOGY ON COMPONENT DESIGN

SAURABH KUMAR

ELEKTROBIT INDIA PVT LTD

In the past decade there has been a significant evolution of technologies in personal computing, wireless communication, and automotive. The emerging convergence of these technologies is leading to new possibilities like advanced features for automation, safety, and convenience in modern vehicles. The attractive opportunities in the areas of sustainability and reducing road accidents are driving future investments towards the mission of realizing autonomous vehicles. While the journey towards this mission has already begun, there are still several legal and technological barriers to be addressed before the benefits are widely dispersed across the globe. Additionally, the pandemic in 2020 has impacted the timelines towards fully autonomous vehicles slightly further. As per a recent Global Data vehicle market forecast, only around 2% of all light vehicles will be fully autonomous by 2034. However, it is not too far to imagine that by 2050 a significant percentage of vehicles will be fully autonomous.

While the design of the autonomous features is important, the impact on existing components must be investigated because of the potential for a wide-spread adoption of autonomous vehicles. For example, the impact on the two categories below are interesting to consider:

1. **Human-to-vehicle interface:** With autonomous vehicles there will be an increase in sensors and the ability for the vehicle to take real-time decisions. To build trust, the vehicle would need to interact with the occupant in multi-modal manner. To reduce the cognitive load on the occupant, who must respond rationally, the user interface has to be redesigned to make it more intuitive and intelligent (situation aware) leveraging technologies in speech processing, touch and gesture recognition, augmented reality, artificial intelligence, and graphics.

2. **Vehicle-to-road interface:** Road transportation networks are significantly well developed across the globe and are here to stay even with the advent of autonomous vehicles. However, the autonomous vehicle manufacturers have to reconsider the design of tires. There are emergent requirement changes on range, vehicle weight, torque demand and sustainability. Additionally, there are new possibilities which can be considered to increase the safety and reliability of vehicles.

Let us look at the current megatrends which are accelerating the technology towards achievement of fully autonomous vehicles, and their impact on the two components above as an example.

1. Increase of software in vehicles

With the advancement of sensor technology, additional software is implemented to process more information about the state of the vehicle and the environment. As a result, software is becoming increasingly pervasive in automotive system design. The latest trend reports indicate that the software and E/E content in the car is expected to grow at a much larger rate (~7%) compared to the automotive market (~3%) until 2030. (Reference: McKinsey Report – Automotive software and electronics 2030).

Traditional vehicle architectures are predominantly distributed, with information exchanged between sensors and various ECUs and gateways via multiple network technologies like CAN, LIN, Ethernet, etc. With new sophisticated ADAS features like lane departure warning, automatic emergency braking, etc., interaction at system level becomes complex, increasing the possibility of introducing errors in design, performance, or user experience. To increase reliability, such risks must be addressed by multiple approaches.

Firstly, with the increasing availability of higher computing power in a single electronic chip, it is possible to rationalize the ECU network architecture itself. Multiple ECU software can be consolidated into a single hardware called domain controllers. Besides system design and performance, this leads to advantages like the reduction in cost, weight, and power consumption. Further consolidation is possible with zonal and

> **WHILE THE DESIGN OF AUTONOMOUS FEATURES IS IMPORTANT, THE IMPACT ON EXISTING COMPONENTS MUST BE INVESTIGATED BECAUSE OF THE POTENTIAL FOR A WIDE-SPREAD ADOPTION OF AUTONOMOUS VEHICLES.**

vehicle level architectures. As a result of all these shifts, the complexity is now moved from hardware to software domain. For example, until recently an HMI was distributed with separate ECUs for the head unit, instrument cluster, and heads-up display. In latest platform architectures all these ECUs are replaced by a single "cockpit" domain controller. On such high-performance computing platforms, advanced design tools are required to allow OEMs to focus on differentiating software IPs. One example of such a tool is EB xelor which includes standard & generalized basic software platforms like AUTOSAR (Classic & Adaptive), a configuration tool like EB tresos along with a hypervisor, and a container-based Linux distribution.

Secondly, with the arrival of 5G networks it is possible to move some of the computing to the cloud instead of onboard. This gives rise to new possibilities. One example are the tires equipped with modern sensors like pressure, temperature, and depth monitoring. Such information transmitted to the cloud can be utilized to increase fuel efficiency and predictive maintenance for large-fleet operations. ContiConnect is one example of this application.

Thirdly, with the increased complexity of advanced driver assistance features, it is critical to re-design user interfaces to reduce the cognitive load of the drivers. HMIs are now utilizing advanced speech processing, with a lot of computation on the cloud. By collating data from the environment, internet, and user's preferences together on the cloud

Source: Elektrobit, EB Assist (https://www.elektrobit.com/products/automated-driving/eb-assist/)

platform, a context-aware and situation-aware multi-modal interaction is possible. Further, to enhance the experience of the vehicle occupant, the critical information can be directly visualized on the driver's line of sight with augmented reality systems such as head-up displays. To realize the design of such complex interactions of HMIs with voice, touch, and gesture, a suitable HMI software design tool is required. EB GUIDE and EB GUIDE arware are examples of such a tool.

Finally, for complex ADAS/AD software features to be integrated successfully along with other vehicle components, it is critical to undertake a comprehensive validation and verification. This includes capturing in-vehicle sensor data, processing this test data in the cloud, and conducting tests to ultimately make them reliable for series

production. The EB Assist product line covers both the measurement technology and the software tooling for globally distributed development teams to efficiently conduct these tasks.

2. Changes in vehicle platform – electric vehicles

The battery technology has reached an inflection point where the dropping price of lithium-ion batteries makes it an attractive opportunity to be utilized in vehicles. Current global trends indicate that by 2025 more than 30% of global vehicle sales will be electric (reference: Frost &Sullivan Global Electric Vehicle Market). With Tesla leading the race, OEMs like Volkswagen and General Motors, among others, are changing their strategy to include more electric vehicles in their product portfolio. Besides the direct advantage of reducing

Source: Elektrobit, EB GUIDE arware (https://www.elektrobit.com/ebguide/blog/eb-guide-arware-release-for-augmented-reality-huds/)

the carbon footprint, the BEVs (Battery Electric Vehicles) reduce the number of components in the vehicle significantly. Hence, it is possible to reduce the overall cost of vehicles while achieving the same features as traditional gasoline vehicles.

There are several new features that an electric vehicle offers. For example, the braking torque can be utilized to recharge the battery by regenerative braking. This reduces the wear on the brake pads which will now last longer. Higher roll stability is obtained by the weight of the batteries which supports in tight maneuvers. The adoption of BEVs simplifies the management and control of vehicle dynamics by directly driving the torque on individual wheels, essentially through electric motors. This allows for interesting applications like 1-pedal driving especially on off-road terrain. Additionally, designers can focus on higher-level functions like path planning and localization, to design autonomous vehicles for urban transportation.

However, the design of existing components is impacted. The tires must be re-designed to reduce the rolling resistance. Additionally, BEVs generate relatively higher instantaneous torque, which needs to be handled by tires. The NVH generated by the tires has to be managed, since the overall noise of the BEV is significantly reduced. EcoContact 6 is an example of a tire for electric vehicles from Continental.

From a user interface perspective, reporting the battery state of charge, alerting, and navigating to the next charging station are some of the aspects to be considered.

While electric vehicle technology is maturing and becoming mainstream fast, the current challenges in terms of charging infrastructure and battery life

Continental BEE (Balanced Economy and Ecology mobility concept) for individual mobility in urban environment

cycle management must however be addressed to increase adoption.

3. Emergence of new business models: Mobility as a Service (MaaS)

The shift towards BEVs disrupts the existing relationships between OEMs and suppliers. Additionally, the emergence of ride sharing services like Uber and Lyft has re-segmented the automotive marketplace, where end users are interested in the mobility service instead of ownership. MaaS increases the overall utilization of the vehicle. OEMs must find new business models to continue their growth with focus on B2B instead of B2C segments. For example, OEMs could directly offer vehicle as a service. This allows OEMs to manage the entire life cycle of the vehicle to meet the sustainability goals, optimizing revenues and product portfolios.

With level 4 and 5, autonomous vehicles becoming a reality, MaaS would increasingly become a dominant trend. Already autonomous delivery services

like Nuro are coming up.

Other models are also being adopted. For example, GM recently launched BrightDrop offering fleet management solutions to large logistic businesses like FedEx.

As MaaS gets widely adopted, it will impact the vehicle tire design. Manufacturers will now have to provide tires which have a higher range performance. Additionally, life cycle management of tires and offering them as a service is becoming a viable business. It is possible to retread the worn-out tires and re-supply them to the market with original performance.

MaaS will also impact user interfaces, with in-vehicle entertainment, connectivity, and augmented reality becoming prominent. Multi-modal user interfaces, with the ability to customize the experience inside the vehicle based on occupants' preferences and mood, are going to be a differentiator between services.

Conclusion

While there are significant opportunities in the journey towards autonomous driving, there are going to be changes in the design of traditional components and business models. Advanced design tools and new mechanisms of collaboration between designers of various components to analyze the system behavior will be critical to harmonize the changes and provide reliable and sustainable products to end customers. ❏

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VIRTUAL SCENARIO GENERATION FOR ADAS TESTING – TOOLS, METHODOLOGIES AND BENEFITS

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1. Introduction

Advanced driver assistance systems (ADAS) can defined as a vehicle based intelligent safety system which could improve road safety in terms of incident avoidance, incident intensity mitigation and protection and can also include post- incident phases. It is an integrated in-vehicle or infrastructure based system. For example, intelligent speed adaptation and advanced braking systems have the potential to prevent an incident or mitigate the severity of the incident.

In recent years, automotive active safety systems have become more prevalent. Furthermore, these systems will be used as the stepping stones for the imminent fully Autonomous Driving (AD). With the rising level of automation onboard vehicles, intelligent systems have to deal with an increasing amount of complex traffic scenarios. In turn, the intelligent systems themselves are also becoming more complicated.

They consist of a plethora of different sensor technologies as well as increasingly advanced algorithms for sensor fusion, object tracking, classification, risk estimation, driver status recognition and vehicle control. As a result, it is rapidly becoming infeasible to check the performance of each new sensor or system in the traditional way by manually driving around, storing data, manually labeling the data for reference, and evaluating the results. This is where an integrated Virtual Scenario Generator can be leveraged for ease of testing and validation.

2. Prevalent ADAS Features and Themes

2.1. Features

There are a variety of features that encompass active safety including: Adaptive Cruise Control (ACC), Forward Collision Warning (FCW), Lane Departure Warning (LDW), Automatic Emergency Braking (AEB), Electronic Stability Control (ESC), Lane Keeping Assistance (LKA), Pedestrian Avoidance (PA), Adaptive Headlights (AH), Automatic Park Assist (APA), Seat belt reminders (SBR), Blind Spot Monitoring (BSM).

2.2. Themes

Driver safety is a key theme used in addressing road casualty reduction targets through ADAS. Vehicle safety addresses the safety of all road users and currently comprises measures for incident avoidance and injury prevention (primary safety); reduction of injury in the event of an incident (secondary safety) and systems which assist with post impact care (to reduce consequences of the injury).

2.2.1. Incident avoidance systems

There is a large scope for casualty reduction from driver assistance systems, as long as development is prioritized to provide maximum casualty reduction. Since driver behavior can modify the performance of safety systems which aims for incident avoidance, assessment of the regional driving patterns, human-machine interface (HMI), while complex, is essential.

2.2.2. Incident mitigation systems

These refer to active onboard systems which aim to mitigate the severity of the incident. Examples include intelligent speed adaptation and advanced braking systems.

2.2.3. Incident protection systems

Substantial improvements have been made in the recent past for the scope of enhanced vehicle safety from improved crash protection which aims to reduce injury severity during the impact phase. Examples include improvements in occupant restraint systems which better reflect the different human tolerance thresholds of male and female occupants and a range of age groups.

2.2.4. Post- Incident response systems

A new development is the deployment of

systems which aim to alert and advance emergency medical system support in the event of an incident.

2.2.5. Integrated systems

The prospect for in-vehicle systems to integrate incident avoidance, incident protection and post- incident objectives is being increasingly researched on, as are vehicle to vehicle and vehicle to grid communications (V-2-X).

3. Testing Methodologies

There are various testing methodologies in the automotive sector that are being used to test and evaluate various features that may or may not be specific to ADAS. The most used approaches include:

3.1. Model-in-the-Loop (MIL) Testing, where algorithmic developments are used without involving dedicated hardware. This development generally involves high-level abstraction software (Simulink) frameworks running on general-purpose systems.

3.2. Software-in-the-Loop (SIL) Testing, where the actual implementation of the developed model will be evaluated on general-purpose hardware. This step requires a complete software implementation used to test production ready source code derived from the model.

3.3. Hardware-In-the-Loop (HIL) Testing, which involves the hardware, running the final software with input and output connected to a simulator. This process is very widely used in the automotive industry and has enabled the development of very high quality components which are then integrated into bigger systems or vehicles.

Modern vehicles however integrate so many components that the integration phase has become more complex and also requires a multi-step validation process, followed by the final integration tests performed on tracks or roads. While mandatory, these real-condition tests are limited because of multiple factors and have a very high cost. Testing a complex system like a modern vehicle on a test track or on a real road involves complex and costly engineering.

First of all, to be testable the vehicle must be fully or nearly-fully functional. This limits the testing opportunity to a very late stage in

the development process and implies high engineering costs. Moreover, because the real-condition test is constrained in time and space, the test cases are not complete and only a very small pool of real-world conditions can be tested.

To address these limitations and lower the cost, modern ADAS tests uses virtual scenario generations where realistic generation tool is used to enable faster and less expensive tests with better coverage on complete vehicles.

A detailed note on the virtual testing follows.

3.4. Virtual Scenario Testing

While test driving is still the main method for ADAS evaluation, the resulting data rarely contain events that would truly contribute to the active safety system analysis; even with thousands of miles driven. Crashes are rare and difficult to capture. Even close range encounters are rare. Hence, the test might end up with much of the collected data being simple false positives (i.e. driving with no difficult decision to make).

Many of the drawbacks of hardware testing of ADAS are not present for a virtual test environment. Virtual testing with simulation software provides an efficient and safe environment to design and evaluate ADAS. Moreover, simulated scenarios are completely quantifiable, controllable and reproducible. As a result, the creation of virtual driving scenarios can be less time-consuming and laborious compared to on-road tests; in particular, when real testing data and conditions must be manually converted into analysis data for further testing.

4. Typical Scenario Generation Tools

Some tools are available as an Open Source (OS) platform and can be leveraged at no cost and can be used for preliminary level tests and for developers

testing their algorithms. Users can build their own API's that can be integrated with the OS tools. These tools can also be used to test the Deep Learning models created for ADAS/AD requirements.

The Licensed tools provide a range of options for the user to generate a scenario and comes with various interface models that can dovetail with the user's current hardware or model configurations. These tools can be used for high level simulation requirements and does not require much manual model creations as there are various inbuilt resources within the pool.

The following are few of the widely used tools for virtual scenario generation. The current text classifies the tools in two groups depending on the delivery model.

*Note: The list is not exhaustive and features only selected tools.

5. Methodology for Virtual Scenarios

5.1. Creating Scenarios

The interactive road editors allow to design road networks in full detail with unlimited numbers of lanes, complex intersections, comprehensive signs and signaling. It links and exports logic and graphic data consistently from a single source, for example from Google Maps data.

Virtual scenes can be designed from scratch or compiled from existing database in the given tool. Various import and export formats (example: Open DRIVE) as well as large libraries of 3D models and country specific signs/ signals can be made use of to accelerate the creation process. The export of the graphics data also can be customized.

5.2. Configuring Scenarios

Dynamic content can be defined with the scenario editor. Most tools have a database pool that allows the user to specify traffic as individual controllable objects or as autonomous swarms around the host

Licensed Tools	Open Source Tools
Mechanical Simulation **CarSim,** IPG **Car-Maker**, dSPACE **ASM**, Siemens **Prescan**, Ansys **SCANeR**, Cruden **Panthera**, **rFpro**, Vector **DYNA4**, Vires **VTD**, AVL **VSM**, Math-Works **RoadRunner**, Nvidia **DRIVE Sim**	**CARLA**, **LGSVL**, **Autoware**, Baidu **Apollo**, Microsoft **AirSim**, **TORCS**, **OpenDS**, Voyage **Deepdrive**, Udacity Simulator, **Unity** and **Unreal** Engines

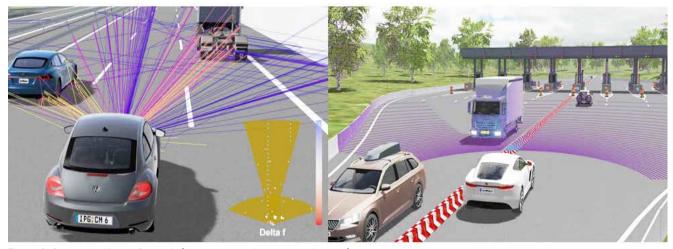Table 1: Virtual Scenario Generation Tools

Figure 2: Sensors in Virtual Scenario (Image source: ipg-automotive.com)

entity. Various driving environments can be configured (example: RHD/LHD).

The basic library of vehicles, pedestrians and driver properties may easily be customized. The user can define paths for individual entities, configure signal control programs, place objects and add events from a large set of actions. Real-time monitoring and command injection for the used entities can also be performed during the simulation phase.

5.3. Simulating Scenarios

The generation tools integrate with a range of environments such as; X-in-the-Loop (XIL), real-time or non-real-time and co-simulation with various modelling tools (example: MATLAB, LabVIEW). At any time, the user may take full control over the execution of the simulation, specify varying time steps and consume object, image and sensor data via a whole range of interfaces. Various externally computed simulation models can be injected and multiple iterations can be run either in parallel or inter-connected.

5.4. Customizing Scenarios

The user can customize the scenario generation tools on various levels. Either through SDKs along with ready-to-go

Road Creation

Define the required route as per scenario requirement on the road editor phase, generally given in the DVP&R file.

Lane Line Patterns

Lane patterns as per requirement can be applied Solid, Dash, Black-White, Race Track lines etc.

Traffic Objects

Place traffic objects such as flags, cones, milestones, speed limit boards as per scenario.

Host and Traffic Vehicle Properties

*The properties include the starting points of each vehicle with respect to each other and within the defined route.

*Traffic vehicles sequence in a case of a multi-vehicle scenario.

*Special maneuvers such as lane change, reacting to traffic signs, reacting to traffic among others can be defined.

*General traffic behavior changes that is to happen when other vehicles are performing special maneuvers.

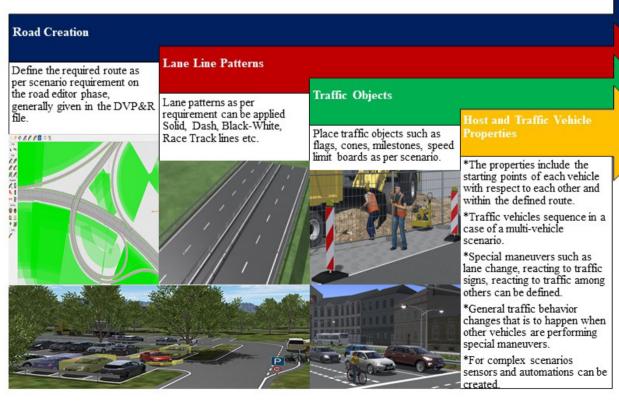*For complex scenarios sensors and automations can be created.

Figure 1: Simple Steps

templates for sensor simulation (object-list based and physics based), dynamics simulation and image generation, co- simulation with modelling tools. The open interfaces for run-time data and simulation control make it easy to integrate the tools in any environment (Virtual, Hardware or In-vehicle).

6. Steps for Creating Scenarios

6.1. General Maneuvers

The testing process follows a dedicated Design Verification Plan and Report (DVP&R) which defines the required test parameters such as the roads, lanes, traffic objects placed on the rod/roadside, host and traffic vehicle properties among others.

The process may vary with each tool based on their dedicated structure, the following illustration shows the general steps that might be followed. The steps need not be followed in the shown order of sequence and is up to the priority of the user and the test case requirements.

The generic steps include:

6.2. Sensor based Maneuvers

Figure 1 represents a simple workflow of the process. In addition to the basic scenario requirements such as road, vehicles and objects; the scenario generation tools have various sensors that can be added to the host vehicle for performing various tests.

6.2.1. Commonly Used Sensors

The sensors commonly used in ADAS and Autonomous Driving and can be found in a scenario generation tool may include:

- Light Detection and Ranging (LIDAR, ToF - Solid State/Mechanical)
- Radio Detection and Ranging (RADAR, Short/Long Range)
- Positioning/Navigation Sensors (GPS/GNSS)
- Inertial Sensors (IMU/INS)
- Ultrasonic Sensors
- Camera

The individual sensors mentioned above or the combination of more than one sensor could be made use to test various ADAS scenarios as mentioned in Section 2.1.

6.2.2. Example Cases

- A combination of Camera and LIDAR can be used for long range route mapping and obstacle detection at highway speeds.
- A combination of Camera and Ultrasonic sensors can be used for Park Assist.
- A short range RADAR for detection of potholes and small obstacles (small animals, trash etc.) in close proximity.
- Inertial sensors can be used for Stability Control scenarios, and so on.

6.2.3. Sensor Models

Each tool delivers sensor data in different models, the models represent the perceiving methods of the sensory output. It can be explained under two models namely; Physics based and Math based.

• Physics Based Model

Physics based model capability is the real-time computation of the sensor data directly from the visual scene, with no offline pre/post computation or storage requirements. This real-time model combines automatic scene classification of visual depth and RGB imagery, and a physics-based data and sensor model.

The actual physics based model takes full account of the local scene environment, factoring information such as time of day, current traffic conditions, rad/terrain and other sensor data as per requirements. The result is a physically accurate sensor scene derived from a visual spectrum database.

• Mathematical Model

Unlike physics based model, a math based sensor model does not take real-time scene data for vehicle simulation. Rather these models make use of precomputed scenario conditions and formulae for maneuvers. The formula based actions are triggered by maneuvers specific maneuvers or commands and in certain cases a dedicated Human Machine Interface (HMI) can also be made use of.

7. Conclusion and Benefits

In conclusion, considering the simplicity in creating the scenarios, virtual generation methods have found a widespread acclaim. Especially in the upcoming startup environment, purchasing actual tools for ADAS/AD requirements may not be practically possible considering the high costs, particularly most of the sensors mentioned in section 5.2. In these cases, the usage of the sensors provided by the virtual tools can provide enough testing accessories in both developing an ADAS feature and in testing and validating a specific feature. The major benefits are listed below:

- Complex scenarios can be created precisely without expenditures for generating generic and realistic test cases.
- Cost and usage feasibility in case of type of sensors and architecture being used.
- Extensive scenario and situation coverage in simulation.
- Feasible testing times for larger test pools.
- Minimum to no safety hazards.
- Shorter development time.
- Reusable scenarios. ❑

AUTHOR

DARSHAN RAJAGOPAL
ADAS SYSTEM ENGINEER
XITADEL CAE

Darshan has a vast experience in scenario generation, testing and validating ADAS and Autonomous Systems (Automobile & Marine) in conjunction with a range of Startups, Tier 1s and OEMs. He was an integral part of a startup who were one of the first teams to deploy Autonomous Vehicles on Singapore public roads. Designed an ADAS module actively used by a Tier 1. Co-developed a custom Autonomous System Framework (ATON) and has authored 6 papers and 2 books based on the build.

SMURv Testing for ADAS

HITESH WAFGAONKAR
MANAGER (CONNECTED VEHICLE, INDUSTRY 4.0), UMLAUT PVT LTD

We are witnessing the most fundamental shake up of the automotive and mobility sector ever. While manufacturers and the supply chain are investing heavily in connectivity, electric mobility and autonomous driving, more and more functions are being connected both inside vehicles and beyond their physical borders, allowing them to communicate with other vehicles and the infrastructure. At the same time mobility has evolved from car ownership to other models such as vehicle sharing, ride sharing, usage by the hour and other means of transport.

With more than 20 years of industry expertise and a deep understanding of automotive R&D, sales and after sales, we don't just help our OEM customers and their supply chain to maintain a profitable core business and optimize processes. We make their organisations future-proof.

We are knocking on the door of future mobility! Advanced driver-assistance systems (ADAS) made to support monitoring, warning, braking and steering to reduce the risk of human error and increase car and road safety, are paving the way for autonomous driving.

Public and regulatory interests in safety applications that protect drivers and reduce accidents will further increase the demand for ADAS over the next decade. By 2020, all vehicles in the European Union and the United States are required to be equipped with autonomous emergency-braking systems and forward-collision warning systems.

To ensure a safe and comfortable driving experience in the future, these assistant systems need to be put through their paces. Naturally, it would be irresponsible to test these systems and their functionalities in real-life scenarios on the road during their pre-development phases.

So, umlaut has developed a craft car called SMURV - short for SMart URban Vehicle – to test ADAS functions in a safe environment in the field. With a solid understanding of its functional safety requirements' impact, umlaut engineers began instrumenting the SMURV platform to evaluate autonomous and connected vehicle concepts.

Its various sensors, GPS and cameras are mounted onto the vehicle, using appropriate brackets and racks. Sensor connectors and wiring are prepared according to the desired layout and interface elements. PC's have also been installed to log sensor data. Consequently, the SMURV enables OEMs and Tier 1 suppliers to test different configurations of hardware and software in real-time under authentic dynamic driving conditions.

Moreover, the SMURV's remote access allows for global collaboration. Via rapid prototyping and cloud connection, a colleague from the other end of the world can install a new function – like object detection, for example – and get measurement data in the blink of an eye.

In a nutshell, the key benefits of our umlaut craft car are playful testing of new ADAS ideas and functions in predevelopment phases, as well as fostering internal cooperation across different locations and even continents.

That's why leading automotive OEMs and Tier 1s entrust umlaut with the definition of their technology strategy, the development of use cases and requirements, and the delivery of new connected services and autonomous technologies to the market.

umlaut is an expert in the area of der ADAS/AV sensor software development and integration. For more than ten years, the company has been active the field of autonomous driving and has developed and executed sensor integrations and upfitting of different types of vehicles. Always a challenge: to procure all of the necessary hardware, software and other items for the vehicles. Multiple purchase requests and approvals can limit or slow down progress. In order to optimize this process, umlaut has closed a partnership with the LiDAR manufacturer Velodyne.

With our cross-industry insights and looking from a position so close to the process and the product itself, we are able to foresee technological developments and prepare well in advance before new regulations and industrial standards make modifications and upgrades of products necessary and factor these in to its further development before they become an issue.

We are renowned for our prototyping and product capabilities and the development and realization of prototypes, testing tools, wire harnesses, and test vehicles used in the research and development of new innovations around the automotive, aerospace, and telecommunications industries. In doing so, we ensure that our customers' new technologies reach the market. ❑

UTILIZING VIRTUAL TESTING SOLUTIONS FOR EFFICIENT ADAS DEVELOPMENT

JESUS BUJAUE

ADAS ENGINEERING PROJECT LEAD, ZF

Electric Vehicle (EV) development has grown significantly and ADAS is one of the major key elements in this competition. In the past, ADAS only include anti-lock brakes, blind spot system information, adaptive cruise control, and lane departure warning. However, these features had become standard and evolved dramatically. New features being developed includes FCW (Forward Collision Warnings), TFL (Traffic Light Recognition), TSR (Traffic Sign Recognition), AHL (Advanced Hi-Low Beam Assist) and more advanced features.

Hence, the most important and critical part of ADAS development is how to make it right at the first attempt. In order to do this, the organization should have systematic and strategic approach in terms of validating or verifying these technology features in an efficient manner with robust quality results adhering to a universal accepted quality standard.

For an instance, one of the most critical features which requires safety validation is FCW-AEB (Forward Collision Warning/ Advanced Emergency Braking) which cannot be easily tested in a real-world scenario due to the complexity of defined test cases. Therefore, most organizations are using advanced virtual testing simulation tools to validate safety critical test scenario.

Choosing the best virtual simulation testing tool that fits with the organization's expected results and configurations needs to be carefully considered. In my experience, one of the advanced solutions in the market is the IPG CarMaker simulation tool developed by IPG Automotive (https://ipg-automotive.com/products-services/simulation-software/carmaker/). It is developed specifically for testing passenger cars and light-duty vehicles. Using this software, you can accurately make real-world test scenarios, including the entire surrounding development in the virtual environment. It is capable of modeling for vehicles, roads, drivers and traffic scenarios. It is an open integration and test platform and can be applied throughout the entire development process from model-to-software-to hardware-to vehicle-in-the-loop. The event and maneuver-based testing method ensures that the necessary flexibility and realistic execution of rea-world test driving are also included in the virtual test driving scenario.

Virtual testing simulation tool with complete model environment has the biggest advantage for more efficient, fast and accurate verification results. It should have the visualization of virtual test runs, interfaces with third-party tools and allowing to easily incorporate or integrate with your existing development process. Furthermore, allowing you to switch between open-loop and closed-loop testing without any problems using the interactive maneuver control, and can create most difficult test scenarios.

In the fast emerging EV competition, organization who can manage to advance their ADAS development skills, process and tools are the ones who can dominate and keep up with the crowd of EV developing companies.❏

Route Optimization to Address Last-mile Logistics and Delivery Challenges

⛰ **TUSHAR BHAGAT**
DIRECTOR, UFFIZIO INDIA

Last-mile delivery is the key customer satisfaction driver in a logistics and supply chain business. It directly impacts profitability as it is the most time consuming, expensive, and unpredictable part of the entire process. Tight delivery schedules, varying fuel costs, and limited control over delivery teams make managing last-mile delivery complex.

Challenges faced by last-mile logistics and delivery businesses

1. Managing delayed deliveries: Late deliveries ruin your customer experience and lead to loss of revenue. A minute delay in timelines can lead to dissatisfaction at the customer end and involve rescheduling for your business as well. Managing offended customers and re-planning deliveries would exhaust a significant amount of time, resources, and capital of your business.

2. Cutting down last-mile delivery costs: Rapidly increasing competition and evolving customer expectations have made last-mile delivery cost-intensive for logistics operators. A research report by Capgemini suggests last-mile services account for 41% of supply chain costs. Offering competitive delivery charges or completely waiving them off is becoming the new norm to keep up against the competition. Customers are expecting faster deliveries, which pushes costs higher making maintaining profitability tougher.

3. Optimizing delivery density: Managing delivery workloads becomes complicated due to fluctuating order numbers. While logistics companies are tackling the influx of deliveries during festive or discount seasons, they also have to work upon generating revenues during times of sporadic ordering. Irrespective of these supply chain complications, customers expect orders to be delivered within timelines and as per their convenience. Research reports suggest 90% of buyers track the status of their packages and expect delivery as per their schedule, making dynamic scheduling a necessity for delivery companies.

4. Handling customer disputes: False claims of non-delivery and late delivery can harm your reputation and involve unaccounted expenses on customer support. Dissatisfied customers may raise fake concerns over social media, which would taint your brand image and business. Online reviews matter to your prospects, as only 48% of them would consider investing in a business with a rating below 4 stars. It requires you to spend time and money on clarifications and grievance redressal.

Offer frictionless experience through route optimization software

Seamlessly fulfilling last-mile deliveries is not simple, but technology can help you overcome the associated challenges and meet customer expectations on delivery timelines. Route optimization software works effectively to enhance the productivity of your supply chain and offer a great customer experience. It helps you in the following ways:

1. Reduce costs: Using AI-backed advanced route optimizing software solutions helps you to plan, schedule, and re-route efficiently. Pre-planning your delivery schedule helps you to minimize travel time and fuel costs from one customer address to the next. Dynamic re-routing allows you to utilize time windows effectively, prioritize deliveries, and communicate route modifications to drivers in real-time.

2. Boost efficiency: Reduce operating costs by cutting down fuel costs and monitoring driver performance through a route optimization solution custom-made for your business. Using multi-stop route planning helps you save time from manually charting routes and calculating fuel expenses. The software picks the shortest and fastest routes so you deliver more in less time and optimize fuel consumption, reducing your carbon footprint.

3. Offer transparency: Route optimization software built for last-mile delivery comes with real-time tracking and in-built digital delivery receipts. It allows customers to select their preferred time slots for delivery and alternate delivery locations. They can be apprised of package status and accurate delivery timings. With real-time driver monitoring, you can keep track of each item and avoid fraudulent activities.

4. Reroute and reschedule quickly: Route planning and scheduling are important for all logistics businesses. You may have to reroute delivery orders due to unprecedented conditions such as traffic, road conditions, sudden weather change, address discrepancy, and fulfilling emergency deliveries. Route optimization software will help in faster rescheduling and swift communication with drivers to maintain delivery rate within time windows.

Takeaway

Route optimization technology is a delivery innovation to empower supply chain businesses offering last-mile deliveries. It offers end-to-end visibility throughout the delivery process and even managing returns. Leveraging technology helps you optimize your last-mile operations and scale your business by automating route planning and delivery management processes while offering a top-notch customer experience. ❑

ADAS with DAAS* – A Behavioral Shift towards future

⛊ **NISARG PANDYA**
DRIVEBUDDYAI

32nd years of National Road Safety Week campaign, and question arises have we really improved as a society? How many more safety week/month campaigns would we need to achieve GOI's target of zero death or achieving zero fatality in road accidents. India accounts for 11% of fatalities worldwide and data from 2019 shows that pedestrians, cyclists and two-wheelers are at the higher risk. Over 400 people are killed and over 1200 people get injuries on everyday basis in India and no wonder we would like to top in every domain. As per the Road Accident Report for 2019, 449K accidents took place leading to 151,113 deaths and 451,361 injuries across India. The numbers are definitely improved compared to 2018 reports in terms of 3.86% for the numbers of accidents while accident-related deaths have improved by 0.20% and injuries by 3.86%. The major reason reported is amendment in Motor Vehicle Act 1988 in 2019 as well as stiff hike in penalties for traffic violations as well as enforcement of law. Further analysis of data is shows 35.7% of deaths happened on national highways, 24.8% of deaths happened on state highways & 39% of deaths on other roads.

This gives indication that severity of accidents leading to death has nothing to do much with highway or city driving, it's almost contributing to the same level. This also raises a question that with law enforcement on city roads by installing surveillance cameras can solve problems at some extent, will it lead to long-term solution of road safety concerns of the nation or world. Globally the stats are very similar and severe as in India. How do we make the societies safer, by increasing penalties, by amending laws,

by technologies or by psychological shift in mindset of people while driving? One way is to remove human drivers and put robots to do the job but then we have employment concerns and robots have not yet learnt enough to survive. In terms of driving, we are living with two extremes, one way we have huge numbers of road accidents, deaths and using generation old vehicles and nearly zero adoption of technology to help and on the other hand the same technology has reached a stage in other part of globe where they are preparing, learning for driving and it's doing the job at some level. There seems to be a large gap between these two extremes and we need a bridge to fill-in and help the transition. That bridge is nothing but the larger adoption of ADAS & implementation of ADAS with Telematics.

ADAS – Little Technical

ADAS aka Advanced Driver Assistance Systems. The first car with ADAS features was launched in 2000s in USA. The major component forming an ADAS are camera & radars. The ADAS according to SAE J3016 levels of automation is at Level 1 i.e., second level and Level 2 which defines partial automation. The Level 0/1/2 defines that even if the vehicle has all these features of braking the vehicle, accelerating the vehicle or adaptive cruise control, human drivers are must and from Level 3 to 5, human drivers are supposed to drive only when technology asks you to do so.

In a very brief way, ADAS is something which helps you to drive using technology like camera, radar and sometimes it relieves you from the driving and takes a charge. What ADAS does is sense, process, connect, map & drive. The sense part is done with proximity sensors,

cameras in quantity of 1 to 8 depending on the level of complexity and use case, radars in quantity from 1 to 4. The process part is taken care for small sensors by ECUs & for cameras and take real-time decision-making GPUs are utilized. The connectivity is expected to be from 2G to 4G & will turn to 5G in near future which is expected to change the autonomy infrastructure. The mapping is handled by APIs & it is also depending on the complexity level and feature requirements for specific use cases. The actuators are for driving the vehicles and applying brakes when necessary. To have successful implementation of ADAS we also need to have cloud infrastructure for data processing and analysis.

ADAS adoption is the key

The world is heading towards complete autonomy and as described earlier, ADAS is a one of the key elements of the incremental autonomy. What do you think will be the trigger point towards transition to autonomy? This is very interesting part of the market adoption is very uncertain and in the times of data and communication the success of anything depends on how well it is being received by the audience. If we compare the stats, COVID-19 killed 150K people in the country in a year's time since March 2020. Road accidents reports share the same numbers. COVID has accelerated technological adoption in different categories of industry by 10 years but the same is not happening for the case of ADAS.

Ideally, all things are related. OEMs are going the ADAS way to improve the road safety, government is trying to enforce laws to improve road safety, one has a barrier of cost of adoption and other has barrier of mindset for following the

rules for the sack of society. Both of these barriers can be lowered down by trying for larger adoption of ADAS in all the vehicles. Currently, in India around 6% of the vehicles come with ADAS as built-in feature which is very less to trigger a change.

The technological advancements in the domains of telematics are heading towards the ADAS. In my previous month article named "Changing face of telematics …", I had mentioned that how ADAS can gradually progressed to autonomy and how the software stack for autonomy can be used for building ADAS & telematics. In the case of ADAS the technology is ready, but deployment and adoption at larger level is missing. The root causes are cost and ROI against it. The most common person in world will always think of the ROI at first, when you ask someone that you install the device of x amount and it'll help you save from accidents may be once or twice in a year. This is not going to help businesses to sell the product because selling safety is very difficult in cost conscious markets like India where the first question asked is how I'll benefit from this and what do I get from this.

Psychological Shift

Adoption of ADAS depends on the behavioral aspect of it to the person who's benefiting from it. It doesn't make sense for burning billions of dollars if the adoption is very slow or the product is not showing any signs of ROI.

Introducing a new concept called as DAAS. DAAS also means "Data as a Service". But here DAAS means "Driver Assistance & Analytics Service".

The typical incremental phases of ADAS adoption to DAAS are as shown below.

The phases are assistance, response, analytics & incentivize. If with the ADAS products this cycle is completed successfully the adoption is surely to increase.

Assistance

One of the ADAS feature is assistance. The assistance means telling a driver what to do and what not and encouraging them to drive cautiously, safely and contributing to the safer ecosystem where everyone who's driving safer is benefitting with their behavior. This can happen
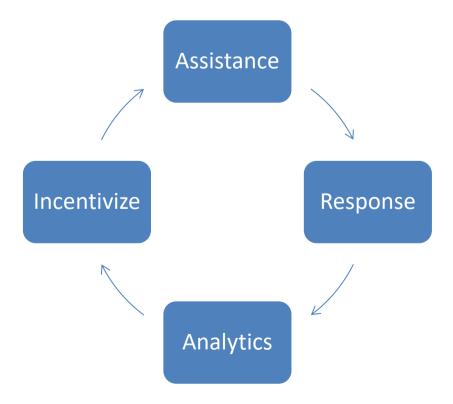
with installation of retrofit ADAS in any vehicle. This will break the first barrier of cost of having ADAS equipped

vehicle and now you can have ADAS which can fit into any vehicle which will be able to deliver L1 & L2 levels of autonomy. These kinds of ADAS systems comes with camera sensors and location sensors. The camera sensors are not only record the video but uses AI algorithms to identify safety critical scenarios of driving. For example, if the driver is driving in fatigue state, is he feeling drowsy, is he talking on the phone while driving, is he watching videos on navigation phone while driving. These are most common reasons for accidents these days and distraction has evolved as the biggest reason globally for collisions. To avoid that, an ideal ADAS system is supposed to be able to identify such scenarios and alert the driver for not get into any of the activities mentioned above. The idea here to tell drivers every time for such cases and coach them to improve by assisting. Next part comes here to respond to the assistance.

Response

Response to the provided assistance is one of the critical aspects towards adoption. The systems will only succeed if they will be able to gel with drivers while driving. Driving safe need not to be a law, it need not to be a compliance but it should be behavior. Forcing anyone to drive safe and penalizing them for not following it will just help them to pay for fines but it's not going to be a long-term solution. In our ecosystem, either the law enforcer will withdraw or people in following traffic rules. There's also an uncertainty that how many of the drivers really know what's there in the traffic rules. The driving style of a person largely depends on their own experience of driving. The adoption of such coaching technology should be there from the first day a person starts to learn driving so that his/her driving style will be carved according to what the technology is suggesting and eventually will help the drivers to drive safer.

The ADAS systems with assistance have another issue is that majority of luxury car drivers turn it off and very less people allow the cruise control to drive vehicle. This happens when the psychologically the person has very less

confidence on the technology as it is quite obvious that you'd definitely think twice before sitting beside someone you don't know in driving. The same thing applies to the ADAS as well, if you have the level of interaction with the AI then it'll definitely go further to the level when humans start listening to the AI installed and also follow from the next time and improve. These psychological changes take good amount of time because of behavioral aspect associated with it. The human-AI interaction is dependent on the response towards it. The ADAS systems will look for road side on the driver's face and if everything seems under control it'll continue monitoring, but in any case, if it seems where driver is not focusing or the next vehicle in front or someone is suddenly coming from the side, pedestrian crossing, etc. will trigger an alert for the driver to respond and save him from the accident. The active attention to the alerts generated from AI will have to be well received by drivers and they should also get enough response time to avoid such collisions. The next stage for this is analytics which is the key for increasing adoption.

Analytics

Since the GPS tracking is made mandatory, OBD-II is adopted well in by OEMs & consumers, analytics and driver profile is becoming standard. The driver profiling defines the behavior of a driver and this has to be done with context added. Many companies in the world have done variety of analytics on drivers from speed-based data and derived conclusions from that but there're challenges associated with it as GPS based speed data is ambiguous and will not be precise in deriving analytics, still there are reports of companies who has done that successfully and are continuously doing it.

Every driver has a different way of handing situations and there's no standard defining any one as right. For example, every driver will have different styles of braking the vehicle for the speed breaker. Some will come fast, apply short brake & jump the hurdle but will increase gradually. Now another way of doing it as, once you see the speed breaker, you slow down, jump it and then accelerate

> **A NEW CONCEPT CALLED AS DAAS. DAAS ALSO MEANS "DATA AS A SERVICE". BUT HERE DAAS MEANS "DRIVER ASSISTANCE & ANALYTICS SERVICE.**

fast. Both the approaches are right and only speed-based data will not able to distinguish between the two and for that reason you'd need visual information. Visual information adds context to the data and helps analyze and deriving behavior. The analysis should normally involve the behavior of driver in all urban, highway & rural driving, day and night time, various geography, seasons etc. and most importantly their response to the assistance provided in the vehicle and how well they are interacting with it and improving. The improvements to make it on upwards trajectory it must be linked with incentivization.

Incentivize

Incentivization is the trigger point for adoption. The better drivers are analyzed, the better they'll be incentivized and eventually this can lead to wider adoption of the technology as now it is rewarding for safety, following traffic rules and contributing to the safer driving ecosystem. Recently, the honorable

high court gave a judgement that the insurance companies will have traffic violation premium which will be added while upgrading the insurance for both OD & TP. This is one way of improving behavior because now it is going to be costly in a long-term basis and it'll not be just a one-time penalty. Now this should continue in different aspects as well where insurance companies analyze, generate driving reports, pass it on to the drivers and fleet companies managing them, fleet companies then associate with the ADAS companies for data driven coaching for personify it to a specific driver and encourage them to drive safer and better.

Leading the way - ADAS with DAAS

Hence the adoption of ADAS is the key challenge to solve instead of technological challenge. Making technology is always easier than adoption and that's where lots of companies are trying hard to come up with the models which benefits the user and help the adoption.

ADAS being Advanced Driver Assistance Systems must be linked to DAAS i.e., Driver Assistance & Analytics Services which are offered by many ADAS & Telematics companies in India and globally to the logistics and fleet companies.

Think of the world, where your driving score counts for every license renewal, insurance renewal and you're incentivized for tolls, car services and many other values adds just because you're driving safe.

Safety is always rewarding one way or the other way, it will not only incentivize for insurance but every life saved is also a reward to earn. ❏

AUTHOR

NISARG PANDYA
FOUNDER & CEO drivebuddyAI

An emerging startup in Automotive Tech domain working on AI implementation for providing active assistance to the drivers through their camera-based device, majorly working with logistics & insurance players.

Nisarg is an entrepreneur and with a background of Electronics Engine & experience on working with IoT & AI based products. He started DrivebuddyAI 2018 and leading the way forward to mark the global presence in the domain of intelligent fleet & driver management systems.

He's aiming to solve the autonomous tech. but he's charting his own way towards it.

PRIMER ON ACTIVE SAFETY SYSTEMS & ADAS

RICHA TYAGI

TELEMATICS WIRE

ADAS origin dates as far back as 1948, when the first modern cruise control was invented. In present time, Advanced Driver Assistance Systems (ADAS) has become one of the fastest-growing automotive electronics segments. It has reduced the complexity of driving, with features such as lane monitoring, emergency braking, stability controls, and others. According to MarketsandMarkets, the global ADAS market size is projected to grow from USD 27.0 billion in 2020 to USD 83.0 billion by 2030, at a CAGR of 11.9%. Increasing demand and compliance with upcoming safety mandates for semi-autonomous driving systems will drive the market for ADAS. The governments of Asia-Pacific region have recognized the growth potential of the automotive industry and have taken different initiatives for active safety system. The Ministry of Land, Infrastructure, Transport and Tourism (MLITT, Japan), announced plans to mandate AEB for all new passenger cars by November 2021. The Ministry for Road Transport and Highways (MoRTH, India) planned to adopt ADAS features by 2022. Tier 1 manufacturers are collaborating with OEMs in India to support the implementation by 2022-2023.

Mentioned below are some of the active safety systems and ADAS-

Anti-Lock Braking System (ABS)

As an Active Safety System, Anti-lock Braking Systems have been around since the late 1920s. In 1929, the first anti-lock brakes were invented by Gabriel Voisin, 1929 to solve the problem airplanes had with braking. But it wasn't until several years later that they were successfully developed for cars.

It took a decade after the first ABS brakes for cars were developed in the 1960s until the first reliable such brakes were invented. Jensen FF and Ford Zodiac were the first commercial vehicles with ABS brakes. Chrysler, co-developing with Bendix Corporation, introduced the 1971 Imperial with their 'Sure Brake' system, rest is the history.

According to Mordor Intelligence report, the automotive anti-lock braking system market is expected to register a CAGR of over 7.5% during the forecast period (2020 - 2025). Asia-Pacific is one of the fastest-growing markets globally. In 2017, the Ministry of Road Transport and Highways (MoRTH) in India mandated the ABS for all new passenger cars from April 2019.

In the automotive anti-lock braking system market some of the major players are Robert Bosch GmbH, Autoliv Inc., Continental Reifen Deutschland GmbH, DENSO Corporation, and ZF Friedrichshafen AG.

Bosch ABS Generation 9, Source: Bosch
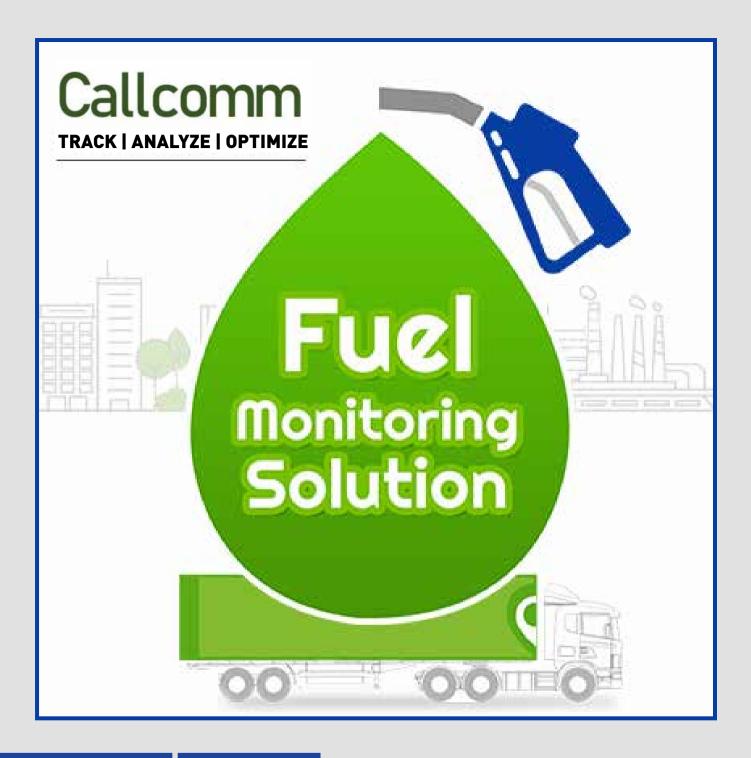
Electronic Stability Control (ESC)

Electronic stability control (ESC), also referred to as electronic stability program (ESP) or dynamic stability control (DSC), provides traction and anti-skid support in cases of oversteering and understeering. ESC systems work by using ABS brakes as a foundation and with the addition of sensors measure

steering wheel angle, yaw rate and turning force.

ESC's first version was traction control that developed in the late 1980s by BMW and used the engine control system to reduce torque in "stability critical" situations. By 1992 Mercedes was in development and testing of ESC with supplier Bosch. Auto giants like Ford, Mercedes, Toyota and others were not behind. Ford referred their ECS system as Interactive Vehicle dynamics (IVD).

It was not until 2020 that the Indian government mandated the new cars in India had to be equipped ESC by amending the Motor Vehicle Act and other measures. In addition to ESC the government is expected to add autonomous emergency braking in the list in 2022-2023. The other Group-20 countries that are not complying with the ESC norms set by the UN are Argentina, Brazil, China, Indonesia, Mexico, and South Africa.

According to Global Market Insights, ZF Friedrichshafen, Robert Bosch GmbH, Autoliv Inc., Continental AG, Hitachi Automotive Systems Ltd., Johnson Electric, and WABCO are some of the leading players in the electronic stability control system market. WABCO launched its electronic stability control systems for commercial vehicles in India, in October 2017. In September 2018, ZF Friedrichshafen announced that it is expanding its safety system product offerings as well as manufacturing capacity in India to cater to

ZF ESC, Source: ZF

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the growing demand for safety systems in the country.

Electronic Brakeforce Distribution (EBD)

EBD maximizes the effectiveness of brakes and allows the rear brakes to apply a greater proportion of the braking force. It alters the distribution of the vehicle's braking force in accordance with the rear wheel's load condition and speed.

EBD is a sub system of the vehicle's anti-lock braking system and electronic stability control (ESC). The EBD system uses the vehicle's ESC and ABS to determine the ideal brake force distribution to all four wheels in a braking event. EBD also uses the vehicle's yaw sensor to detect the pitch and roll of the vehicle through a turn.

Most modern day cars with ABS and ESC have some sort of EBD system that will distribute the brake force evenly based on the driving situation. In India Maruti Suzuki S Presso, Datsun Go D, Honda Jazz V and many more comes equipped with ABS, ESC and EBD.

Bosch iBooster, Bosch

Brake Assist (BA)

Brake assist is an active vehicle safety feature designed to help drivers come to a stop more quickly during an emergency braking. Brake assist is called by other names including Emergency Brake Assist (EBA) and Predictive Brake Assist (PBA). It usually works in combination with anti-lock braking systems (ABS) to help make braking as effective as possible while avoiding wheel lockage.

In 1996, Brake assist was first introduced in high-end European vehicles. BAS premiered to the world on the Mercedes-Benz S-Class and SL-Class, in December 1996. In 1998 Mercedes-Benz made Brake Assist standard equipment on all its models; other brands including Volvo and BMW soon followed suit.

According to Mordor Intelligence, the

automotive autonomous emergency braking system market is expected to register a CAGR of over 7% during the forecast period (2020 - 2025). Many OEMs are equipping their products with emergency braking systems in most medium and luxury cars segment. In 2017, Toyota equipped 50% of its vehicle fleet with an emergency braking system.

Significant players operating in the global automotive brake assist system market include Continental AG, Robert Bosch GmbH, WABCO Holdings Inc., Dana Limited, Mobileye, ZF Friedrichshafen AG, Hitachi Automotive Systems, Ltd, and AISIN SEIKI Co., Ltd.

Continental BA MKC1, Source: Continental

Hill Hold Control

Hill Hold Control or Hill-Start Assist helps prevent a vehicle from rolling backward down a hill when starting again from a stopped position. This feature holds the brake for you while you transition between the brake pedal and the gas pedal. In hill this feature is extremely helpful in avoiding accidents due to vehicle rolling backwards specially on a steep slope.

In 1936, it was first introduced as an option for the Studebaker President. The device, called "NoRoL" by Bendix, was available on Hudson, Nash and many other cars, by 1937. The device is offered by Studebaker and many other carmakers as either optional or standard equipment for many years. Beginning of 2005, the technology became more widely available, when Volkswagen adopted it into its mass produced cars like the Passat, Jetta, and Touareg.

Currently, it is used in vehicles having manual transmission as well as automatic and semi-automatic vehicles also. Electronic Stability Program (ESP) installed in many cars, often comes bundled with HSA.

As per the Research And Markets' report, amid the COVID-19 crisis, the global market for Motorcycle Hill Hold Control System estimated at 606.5 Thousand Units in the year 2020, is projected to reach a revised size of 2.1 Million Units by 2027, growing at a CAGR of 19.6% over the period 2020-2027. Some of the key players in automotive hill start assist market are Robert Bosch GmbH, Continental AG, Knorr-Bremse Australia Pty Ltd, WABCO, ZF Friedrichshafen AG, Murata Manufacturing Co., Ltd.

Murata HHC SCA800 Accelerometers
Source: Murata Manufacturing Co.

Traction Control System (TC/TCS)

Traction control system is used to help drivers accelerate on slippery or low-friction conditions. Modern ABS and traction control systems are setup with the ECU and the hydraulic modulator attached together so that while they have different functions, they are physically one unit.

In 1987, traction control systems were first debuted on high-end vehicles, even though some powerful rear-wheel drive vehicles in the early 70s were equipped with early version of traction control. In modern time, traction control is generally available on any vehicle that has ABS since traction control was designed and built off existing ABS technology.

According to Allied Market Research, the traction control system market is expected to reach $44.14 billion by 2025 from $27.59 billion in 2017 with a CAGR of 6.7% from 2018 to 2025. The growth in the market can be observed with the rise in demand for safety applications. Traction control system industry includes players such as, Robert Bosch GmbH, Continental AG, Autoliv, Inc., Nissin Kogyo Co. Ltd., WABCO, ZF TRW, Hyundai Mobis, Denso Corporation, Hitachi Automotive Systems, Ltd., and ADVICS Co., Ltd.

Hill Descent Control

Hill Descent Control is a controlled downhill descending technology that permits the vehicle to descend a slope at a controlled speed. It works with ABS and traction control to manage the speed of each wheel independently to maximize the grip of each wheel to the terrain.

Bosch developed the first hill descent control system for Land Rover in 1993, which introduced it as a feature of its Freelander model. The Freelander lacked the low range gearbox and differential locking features of the Land Rover and other 4WD off-road vehicles, and HDC was billed as a fix for that situation.

Four Wheel Drive

Four-wheel drive, also called 4x4 or 4WD, refers to a two-axled vehicle drivetrain capable of providing torque to all of its wheels at the same time. It may be full-time or on-demand, and is linked via a transfer case providing an additional output drive shaft and, in many instances, additional gear ranges.

The first 4WD system was developed in 1893 by British engineer Joseph Diplock, who patented a four-wheel drive and four-wheel steering system for traction engines. After six years, Ferdinand Porsche built a four-wheel drive electric vehicle. The world's first 4x4 internal combustion engine car was the 1903 Spyker 60 HP. Early 1950s, Harry Ferguson, developed a 4WD system known as the Ferguson Formula for passenger cars in a factory near Coventry, England.

Aisin 4WD, Source: Aisin Seiki Co., Ltd

According to Research And Markets' report, global Four-Wheel Drive/All-Wheel Drive (AWD) Vehicle market accounted for $405.04 billion in 2019 and is expected to reach $695.93 billion by 2027 increasing at a CAGR of 7.0% during the forecast period. Based on the technology, the four-wheel drive (4WD) segment is likely to have a

huge demand due to it is generally used on large SUV Four-Wheel Drive (4x4) vehicles designed to use the extra traction of four-wheel drive in off road conditions.

Differential Lock

Differential locks allow both wheels to travel at the same speed, so when traction is lost for one wheel, both wheels will still keep spinning regardless of the amount of resistance. These can be added to either the front or rear axle, or even both axles if you're planning on performing some hardcore off-roading. The differential lock is found in all modern passenger vehicles, commercial vehicles, and electric vehicles.

AAM DL, Source: American Axle & Manufacturing Holdings, Inc.

According to Allied Market Research, the worldwide automotive differential market was valued at $22,390.84 million in 2019, and is projected to reach $31,637.92 million by 2027, registering a CAGR of 4.4%. Asia-Pacific was the highest revenue contributor, accounting for $9,361.61 million in 2019, and is estimated to reach $13,983.96 million by 2027, with a CAGR of 5.4%. Market players, like American Axle & Manufacturing, Inc. (AAM), BorgWarner Inc., Dana Incorporated, Eaton, Hyundai Wia Corporation, JTEKT Corporation, Linamar Corporation, Melrose Industries PLC, Schaeffler Group, ZF Friedrichshafen AG, and others hold major automotive differential market share.

Limited-slip differentials are considered as an alternative of differential lock because they operate more smoothly, and they do direct some extra torque to the wheel with the most traction, but they are not capable of 100% lockup.

Ride Height Adjustment

Height adjustable suspension systems allow the motorist to vary the ride height or ground clearance. Height adjustment is mostly achieved by air or oil compression replacing the "metal springs" of the

vehicle, when the pressure is varied, the vehicle body rises or lowers.

The first vehicle with adjustable suspension was on the 1954 Citroën 15CVH. The Range Rover offered this feature from 1993. In 2012, the Tesla Model S and Tesla Model X offered their own patented height adjustable suspension as an option. Many modern SUVs use height adjustability as a part of active suspension systems to enhance the vehicle's versatility on and off-road.

As per Allied Market Research, the global air suspension market size was valued at $5.94 billion in 2019, and is projected to reach $9.22 billion by 2026, registering a CAGR of 6.50%. Asia-Pacific was the highest revenue contributor, accounting for $19.56 billion in 2018, and is estimated to reach $33.52 billion by 2026, with a CAGR 6.9%. Market players including Continental, ThyssenKrupp AG, Hitachi, Wabco, Firestone Industrial Products, Hendrickson, Mando Corporation, BWI Group, SAF-Holland, Accuair Suspension and others holds major air suspension market share.

Government throughout the world have made it mandatory to replace metal-based spring systems in vehicles with air suspension system keeping safety and security in mind. This has enabled vehicle manufacturers to install air suspension systems in vehicles subsequently leading to the growth of the air suspension market.

Ultrasound Height Pressure Sensor
Source: Continental

Limited Slip Differential (LSD)

A limited-slip differential (LSD) allows its two output shafts to rotate at different speeds but limits the maximum difference between the two shafts. Limited-slip differentials are used in place of a standard differential, where they convey certain dynamic advantages, at the expense of greater complexity.

InfiniTrac electronic LSD, Source: Eaton

In the 1930s, Ferdinand Porsche commissioned German engineering firm ZF to create a differential that would help to reduce wheel spin in Auto Union's Grand Prix cars, as their vast power outputs easily overcame the grip provided by the narrow tires of the time.

Afterwards, the benefits of this type of differentials were exploited in cross country vehicles, but the limited-slip differential gained prominence again in the 1960s and the US Muscle Car era. These machines were built during a performance car arms race between the US manufacturers American Motors, Chrysler, Ford and General Motors.

According to 360 Research Reports, in the last several years, global market of limited slip differential (LSD) developed year by year, with an average growth rate of 4%. Global "Limited Slip Differential (LSD) Market" size is projected to reach USD 849.3 million by 2026, from USD 595.3 million in 2020, at a CAGR of 6.1% During 2020-2026.

Companies Included in Limited Slip Differential (LSD) market are GKN, KAAZ, BorgWarner, JTEKT, AAM, Eaton, Quaife, DANA, Magna, CUSCO, TANHAS.

Automotive head-up display

An automotive head-up display is any transparent display that presents data in the automobile without requiring users to look away from their usual viewpoints. In 1988, General Motors introduced the first heads-up display in a car and the systems were originally used for showing speed, tachometer and other basic readings from the dashboard. In 1989–1994, Nissan offered a head-up display in the Nissan 240SX.

The first color display appeared on the Chevrolet Corvette (C5) in 1998. Pioneer Corporation introduced a navigation system in 2012 that projects a HUD in place of the driver's visor that presents animations of conditions ahead, a form of augmented reality (AR).

Nowadays, almost every luxury car brand offers at least an optional head-up display, that reflect some information from a small TFT panel onto the windshield, speed, GPS-guided turn-by-turn directions, what song is streaming.

According to MarketsandMarkets, the automotive HUD market is estimated to be worth USD 866 million in 2020 and is projected to reach USD 3,372 million by 2025, at a CAGR of 31.3% during the forecast period. By 2025, Asia Pacific is estimated to be the largest market for windshield HUD due to the growing demand for advanced in-vehicle technology in advanced markets such as China and India, growing demand for premium vehicles with advanced in-vehicle safety systems and a significant installation rate of windshield HUDs in mid-segment vehicles. Major automotive HUD manufacturers and suppliers of automotive HUD market are Bosch, Continental, Denso, Visteon, Nippon Seiki, Panasonic, Pioneer, Yazaki, and others.

Automotive Night Vision

Automotive night vision systems assist to alert the drivers regarding the presence of potential hazards before they become visible, through the usage of either a thermal camera or infrared light sources. These systems help in preventing accidents.

The technology was first debuted in the year 2000 on the Cadillac Deville. This technology is predicated on the night vision devices (NVD), which generally denotes any electronically enhanced optical devices operate in three modes: image enhancement,

Providers/Features	ABS	EBD	BA	ESP	HHC	TC/TCS	HDC	4WD	DL	RHA	LSD
Aisin Seiki Co., Ltd	✕	✔	✔	✔	✕	✕	✕	✔	✔	✕	✕
American Axle & Manufacturing Holdings, Inc.	✕	✕	✕	✕	✕	✕	✕	✕	✔	✕	✔
Autoliv Inc	✔	✔	✔	✔	✕	✔	✕	✕	✕	✕	✕
Bosch	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✕
Brakes India	✔	✔	✕	✕	✕	✔	✕	✕	✕	✕	✕
Continental AG	✔	✔	✔	✔	✔	✔	✔	✔	✕	✔	✕
Delphi Technologies	✔	✕	✔	✔	✕	✕	✔	✕	✕	✔	✕
Denso Corporation	✔	✔	✕	✕	✕	✔	✕	✕	✕	✕	✕
Eaton	✕	✕	✕	✕	✕	✔	✕	✕	✔	✕	✔
GKN Automotive	✕	✕	✕	✕	✕	✕	✕	✔	✕	✕	✔
Hyundai Mobis	✔	✔	✕	✔	✔	✔	✔	✔	✕	✔	✕
KMP Drivetrain Solutions	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✔
Mando Corporation	✔	✔	✕	✔	✕	✔	✕	✕	✕	✔	✕
MathWorks	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✔
Mobileye	✕	✕	✔	✕	✕	✕	✕	✕	✕	✕	✕
Murata Manufacturing Co.	✔	✕	✕	✔	✔	✔	✔	✕	✕	✕	✕
WABCO	✔	✔	✔	✔	✔	✔	✔	✕	✕	✔	✕
ZF Group	✔	✕	✔	✔	✔	✔	✔	✔	✔	✔	✕

ABS- Anti-Lock Breaking System, EBD- Electronic Brakeforce Distribution, BA- Brake Assist, HHC- Hill Hold Control, TC/TCS- Traction Control System, HDC- Hill Descent Control, 4WD- Four Wheel Drive, DL- Differential Lock, RHA- Ride Height Adjustment, LSD- Limited Slip Differential.

Table1: Compilation of Tier 1 suppliers of active safety system

End-to-End ADAS/AD Solutions across Development & Validation

EC.MOBILITY

Validation Solutions	Data Solutions	Software Solutions	Vehicle System Solutions	Measurement Solutions
Validation Concepts	Annotation Services	Embedded Software	Requirements Engineering	Measurement Engineering
Validation Services	Annotation Tools	Validation System	Sensor & Functions	Measurement Hardware
Vehicle Prototyping	Intelligent Data Analytics	Applications	Concepts	Measurement Software
Data Collection	Data Management	KPI Scripting	Reference Systems	
	Smart Data Algorithms		Driver Monitoring	

Annotation Experience

Data Types
- Camera Data - 2D Froint,
- 2D Side, Fish eye,
- Driver Cam
- Lidar
- RADAR

Annotation Types
- Bounding Box
- Semantic Segmentation
- 3D & 2D Point Cloud
- Bounding Box
- 3D & 2D Point Cloud Semantic
- Eye Labeling

Use Cases
- Pedestrian Detection
- Junction Scenario
- Lane Annotation
- Scene Annotation
- Free space Annotation
- Traffic Signs & Light
- Construction Sites
- Drowsiness Detection etc.

300+ team members delivering consistent accuracy of 98%*

Images Labeled
- 2 Million+ images
- 1000+ Hours of Key LIDAR Sequences
- ~8 Million+ Dynamic RADAR objects
- 12 million eye frames

Industry Verticals
- Passenger
- Commercial
- Agriculture
- Construction
- Mining

Experience
- 700+ Man-years

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Cars with ADAS Features

Volkswagen Polo GT

Comp: Volkswagen, Source: Auto Car India

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Hyundai Verna SX (O) 1.5 CRDi AT

Hyundai Verna SX (O) 1.5 CRDi AT

Comp: Hyundai Motor Company, Source: Carwale

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Hyundai Verna SX (O) 1.5 CRDi AT

Audi A8 L 55 TFSI Quattro

Comp: Audi, Source: The Car Guide

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Four-Wheel-Drive – Torque on Demand
- Differential Lock - Electronic
- Ride Height Adjustment

BMW 3 Series Gran Limousine 330Li Luxury Line

Comp: BMW, Source: Carscoops

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Limited Slip Differential (LSD)

Kia Sonet GTX Plus 1.5 AT Dual Tone

Comp: Kia Motors, Source: Cars24

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)

Mahindra XUV300 1.2 W8 (O) AMT

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)

Maruti Suzuki Ertiga ZXi AT

Comp: Maruti Suzuki, Source: Car and Bike

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control

Tata Harrier XZA Plus Camo

Comp: Tata Motors, Source: maxabout.com

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Hill Descent Control

MG Hector Plus Sharp 2.0 Diesel Turbo MT 6-STR Dual Tone

Comp: MG Motor, Source: Car wale

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)

Jeep Compass S 2.0 Diesel 4X4 AT

Comp: FCA, Source: Overdrive

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Hill Descent Control
- Four-Wheel-Drive – Torque on Demand

Volvo S60 T4 Inscription

Comp: Volvo, Source: Internet

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)

Toyota Vellfire Hybrid

Comp: Toyota, Source: The Economic Times

Features
- Anti-Lock Braking System (ABS)
- Electronic Brake-force Distribution (EBD)
- Brake Assist (BA)
- Electronic Stability Program (ESP)
- Hill Hold Control
- Traction Control System (TC/TCS)
- Four-Wheel-Drive – Torque on Demand

thermal imaging, and active illumination.

As per Vision Impact Institute, 60 percent of the accidents that happen globally happen due to impaired vision. India specific figures are that out of the 80 percent road fatalities in the country, at least one incident is due to vision impairment.

According to Mordor Intelligence, the automotive night vision system market is anticipated to register a CAGR of over 16.5% during the forecast period (2020 - 2025). However currently, night vision systems (NVSs) are available only for luxury cars, they are expected to be available in the mass mid-car segments by the end of 2023. Though, the high prices of night vision systems pose a significant hurdle, as the technologies used in systems, like sensors and the display units, are expensive.

Some of the major players dominating the market are Denso Corp., Autoliv, and Magna International.

Collision Avoidance System

Since the late 1950's, engineers have been looking at ways to prevent collisions using sensors. Harley Earl designed a car, named Cadillac Cyclone, equipped with a radar detection system for collision avoidance.

In 1995, Hughes Research Laboratories and Delco Electronics demonstrated a radar-based forward collision avoidance system. Radar has progressed and evolved, featured heavily in many automatic collision avoidance systems. An additional technology was introduced to automotive design in 1997 by Toyota, which introduced a vehicle in Japan that included adaptive cruise control employing a laser detection system.

With the use of radar, lasers and cameras, collision avoidance alert systems provide:
- Forward-collision Warning (FCW)
- Blind-spot Warning (BSW
- Cross Traffic Warning
- Lane Departure Warning (LDW)

According to Mordor Intelligence, the automotive collision avoidance system market is anticipated to register a CAGR of about 12.11% during the forecast period (2020 – 2025). The automotive collision avoidance systems market is influenced by few players such as Continental, Delphi, Denso, Autoliv, Mobileye, Panasonic, and Hella. Toyota is the front runner in terms of the entire number of vehicles produced with a crash avoidance system. The automaker enabled 90% of its 2.5 million vehicles with it, followed by Nissan and Honda. Group of manufacturers made

the voluntary commitment to equip every new passenger vehicle with the crash avoidance technology by September 1, 2022.

Bosch Collision Avoidance System
Source: Bosch

Intelligence Park Assist System

The automotive intelligence park assist system helps to park the vehicle safely by tracking the parking area. It automatically operates the steering, leaving the driver free to concentrate on operating the accelerator and brakes and checking the surroundings.

Intelligent Parking Assist System (IPAS), for Toyota models in the US, was the first production of automatic parking system developed by Toyota Motor Corporation in 1999. The first version of the system was installed on the Prius Hybrid sold in Japan in 2003. In 2006, an upgraded version introduced for the first time outside Japan on the Lexus LS luxury sedan, which featured the automatic parking technology among other brand new inventions from Toyota. In 2009, the system appeared on the third generation Prius sold in the U.S.

As per 360 Research Reports, automotive Intelligence Park Assist System Market size is projected to reach US 29040 million by 2026, from US 23170 million in 2021, at a CAGR of 3.8%. The key players in the global automotive intelligence park assist system include Siemens AG, Valeo, Robert Bosch GmbH, ZF Friedrichshafen AG, Magna International, Continental AG, NXP Semiconductors, Toshiba Corporation, HELLA GmbH & Co. KGaA, and Delphi Automotive.

Ref:

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TELEMATICS WIRE

Quectel 5G modules to drive 5G commercialization

Quectel Wireless Solutions launched three 5G New Radio (NR) Sub-6GHz modules in 2021, including the RM500Q-AE, the RM502Q-AE and the RM505Q-AE.

The modules have Qualcomm® Snapdragon™ X55 5G modem. The three modules support coverage of 5G NR Sub-6GHz, LTE-A and WCDMA frequency bands and provide 5G solutions to IoT customers globally. The key features of the modules include: (1) Data rates, up to 5.0Gbps, (2) DL 4 × 4 MIMO for 5G NR and

LTE-A bands, (3) Multi-constellation GNSS capabilities, (4) Interfaces: USB 3.0/3.1, PCIe 3.0 and eSIM and

(5) M.2 form factor, compatible with Quectel LTE-A Cat 6/Cat 12/Cat 16 modules.

Currently, the **RM502Q-AE** has completed IC/FCC/ PTCRB/ GCF/ RED/RCM certifications, while the RM500Q-AE and the **RM505Q-AE** have completed CE/RCM certifications. These compulsory approvals with global launch firmware (FW) baseline help customers enter each local market quickly and reduce their cost of device development and certification.

Thundercomm- Edge AI Box and E-cockpit solution

Thundercomm launched Edge AI Box–EB5 and E-cockpit Solution 4.5 in 2021. EB5 empowers data processing capabilities at the device side so as to ease the burden posed on the cloud side, which will enable the data transmission between clouds and devices more efficient and cost-effective. EB5, the edge computing box that can support both Linux and Android operating systems as well as 5G connection, is based on powerful Qualcomm IoT System-on-Chip (SoC) and can deliver 15 TOPS AI performance as well as up to 24 channels FHD video processing capability. It also integrates multiple IoT communication protocols such as Modbus, BACnet, CAN, MQTT, zigbee and supports mainstream cloud platforms including AWS, Microsoft Azure.

E-cockpit Solution 4.5 is built on the 3rd Generation Qualcomm® Snapdragon™ Automotive Digital Cockpit Platform, and features a Software Platform of QNX Hypervisor 2.1, running QNX 7.0 and Android P Operating System. It is a fusion cockpit platform based on SOA, which enables developers to complete the development, changes, or upgrade of services more efficiently. It also contains an intelligent engine solution and AI assistant solution that can cater to the individual demands from different customers. E-cockpit solution 4.5 supports autonomous driving functions, such as autonomous parking, through reusing the computing power of the chip built in the cockpit.

Raythink's AR HUD system

Raythink launched its wide-angle spatial imaging AR HUD system.AR HUD solution combined with intelligent driving, uses Raythink's patented technology – OpticalCore® to a wide-angle field of vision (FOV 23 degrees * 5 degrees @ 900mm eye relief, VID 15m ~ infinity).

I Raythink's AR HUD display product combines ADAS multi-sensor environment perception, map and navigation, and visual-assisted technology for precise lane positioning, to display a number of intelligent driving functions on the windshield to revolutionize the interaction with drivers, including lane-level navigation, front collision warning (FCW), pedestrian collision warning (PCW), lane departure warning (LDW), etc.

Aptiv ADAS platform

Aptiv PLC launched its Level 1-3 capable ADAS platform for driverless and electrified vehicles. It will help to decrease complexity and system costs. The ADAS platform features modularized software, high-end radars, vision and light detection and ranging, advanced artificial intelligence and machine learning algorithms for 360-degree sensor inputs. Its covers all vehicle segments and is capable of handling software complexity and supporting features from entry-level safety compliance to advanced highway pilot and parking assistance. Development Tool Chain: Gives OEMs the flexibility to drive further innovation on top of Aptiv's proven solutions to accelerate the development of safe, green and connected features consumers want with the proven automotive-grade systems they can trust.

IDA Ireland

Why Ireland for Connected and Autonomous Vehicles

Ireland has become a global technology hub of choice when it comes to next generation of business and technology for connected mobility.

Transport is changing and Ireland is in the driving seat. Global companies that innovate are most likely to succeed, particularly in the fast-changing automotive and mobility space.

IDA Ireland, your partner
on your investment journey

Ireland's inward investment promotion agency, IDA Ireland, is a non-commercial, semi-state body promoting Foreign Direct Investment into Ireland through a wide range of services and supports. We partner with potential and existing investors to help them establish or expand their operations in Ireland.

Awareness (Consideration)	Engagement (Short-listing)	Investor Evaluation (Comparing)	Decision (Validating)	Implementation	After-Care

- Hosted Site Visits
- Introductions to:
  - Peer Companies
  - Industry Associations
  - Professional Services

- Employment Permits & Visas
- Property Solutions
- Collaborative Research Opportunities

- Funding Programmes & Incentives
- Public Relations & Media Support
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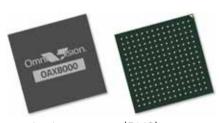# Ireland. We make it happen.

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MORAI's autonomous vehicle simulator

MORAI's autonomous vehicle (AV) simulation solution, by recreating roads, sensors, and even vehicles within a virtual 3D simulation environment, allows users to freely test how their algorithms and software will react to difficult or dangerous scenarios without risk to drivers or other vehicles. Simulation also grants full control of the scene to the test operator, enabling tests for drastic, diverse weather and edge cases not commonly seen while driving.

Real-world data is also key to building MORAI's simulation environments, which are digital twins of specific regions of interest, based on a combination of detailed geospatial map data and satellite imagery. Simulation environments can range from single city blocks or small highway segments to entire city districts.

OmniVision's driver monitoring system ASIC with integrated AI neural processing unit, image signal processor and DDR3 memory
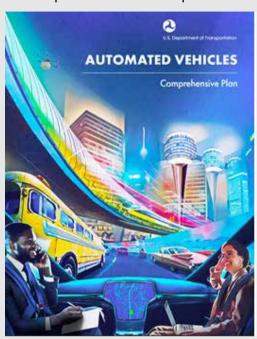
OmniVision Technologies, Inc has launched the OAX8000 AI-enabled, automotive application-specific integrated circuit (ASIC), which is optimized for entry-level, stand-alone driver monitoring systems (DMS).

The OAX8000 uses a stacked-die architecture to provide the industry's DMS processor with on-chip DDR3 SDRAM memory (1GB). This is also the dedicated DMS processor to integrate a neural processing unit (NPU) and image signal processor (ISP), which provides dedicated processing speeds up to 1.1 trillion operations per second for eye gaze and eye tracking algorithms.

These fast processing speeds with 1K MAC of convolutional neural network (CNN) acceleration, along with integrated SDRAM, enable the lowest power consumption available for DMS systems—the OAX8000 and OmniVision automotive image sensor consume just 1 watt in typical conditions, combined. Further optimizing DMS systems, this integration also reduces the board area for the engine control unit (ECU).Boot-up time for the OAX8000 is significantly faster than its nearest competitor. This rapid startup eliminates any delay between ignition and activation of the DMS camera. Additionally, it supports secure boot features to provide cybersecurity.

US DoT releases automated vehicles comprehensive plan

The US Department of Transportation (USDOT) has released its Automated Vehicles Comprehensive Plan (AVCP), a document that lays out a multimodal strategy to promote collaboration and transparency, modernize the regulatory environment, and prepare the transportation system for the safe integration of automated driving systems (ADS).

The AVCP illustrates how the USDOT's work, including myriad efforts with our stakeholders beyond government, is concentrated on meeting the challenges of transportation that has got to adapt to technological advancements. The AVCP provides real-world examples of how the USDOT's operating administrations collaborate to deal with the requirements of emerging technology applications.

The AVCP builds on the US Government's core principles associated with automated vehicles, outlined in Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0 (AV 4.0). It also complements the Department's earlier statements A Vision for Safety: Automated Driving Systems 2.0 (ADS 2.0) and Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0).

TI automotive battery monitor and balancer

Texas Instruments (TI) has introduced a new automotive battery monitor and balancer that reports high-accuracy voltage measurements in systems up to 800V. The BQ79616-Q1 streamlines Automotive Safety Integrity Level (ASIL) D compliance in hybrid electric vehicles (HEVs) and electric vehicles (EVs).

The BQ79616-Q1 meets battery safety goals and maximize distance per charge in wired and wireless battery management systems. When paired with the BQ79600-Q1 SPI/UART communication interface, it enables total system shutdown when the vehicle is parked or turned off.

The BQ79616-Q1 enables automotive manufacturers to more precisely measure battery state-of-charge and state-of-health, thereby reducing cost. The BQ79616-Q1's integrated digital low-pass filter and high-precision digitizer converter optimize signal measurement accuracy, delivering cell-voltage measurements with less than 2mV of error

Panasonic augmented reality HUD

Panasonic Automotive launched its new Augmented Reality Head-up Display (AR HUD). The display utilizes advances in optics, volume optimization and imaging technology, combined with AI technology from its SPYDR cockpit domain controller to render near-field and far-field content for vehicle information (like speed), object and pedestrian detection, and mapping/route guidance. Panasonic's AR HUD system projects 3D, AI-driven key information into the driver's line of sight to help reduce driver distraction and potentially increase safety on the road. Panasonic's AR HUD development utilizes a PRIZM process to address all aspects of users' needs.

Panasonic has partnered for laser holography with Envisics; and for navigation and situation awareness with Phiar.

Panasonic introduces wireless charging for vehicle

Panasonic Automotive has announced two variants of in-vehicle wireless charging technology (moving coil and static coil.) Both of these variants will provide efficient in-vehicle charging that meet or exceed most current in-vehicle charging systems. Panasonic Automotive's wireless charging system aims to be a more accurate and more efficient way to charge. Panasonic's wireless charging includes Exclusive Detection Technology (Moving coil charge variant). In this patent pending tracking technology targets the wireless charging coil moves into the optimum position to align with the mobile device's charging coil and quickly begins to charge wirelessly. In addition, this moving coil technology has better coupling capability vs. other wireless charging systems It supports 15W of charging power. The wireless charger is Qi 1.3 certified for both static/moving coil variants.

XPeng unveils beta version Navigation Guided Pilot function

XPeng Inc. unveiled the beta version of its NGP (Navigation Guided Pilot) highway autonomous driving solution in a series of media road tests in Guangzhou. It plans to launch the widely anticipated NGP function, a key part of its XPILOT 3.0 autonomous driving package, to customers in China.

XPeng's NGP highway navigation function conducts automatic navigation assisted driving from point A to B based on the navigation route set by the driver.

The NGP highway solution will be launched via an OTA (over-the-air) upgrade to XPeng in February. Once launched, NGP, which covers a wider range of driving scenarios and situations, will be implemented on the Premium version of the XPeng P7 with the XPILOT 3.0 system.

Kaspersky launches threat intelligence reporting for the automotive

Kaspersky has launched a threat intelligence (TI) reporting tool for connected cars. Kaspersky's TI reports provide car manufacturers with analysis of automotive-related security threats and identify information that could be utilized by attackers to target vehicles, connected vehicle infrastructure and other vehicle-related systems.

Kaspersky says its automotive TI service helps organizations – from vehicle manufacturers to suppliers – stay updated on relevant security issues that may influence the automotive industry, and allows them to take appropriate and timely remediation steps. The service seeks to identify existing and emerging automotive-related threats against in-vehicle components as well as connected vehicle infrastructure.

If the TI report finds a threat that needs to be resolved urgently, customers are notified immediately.

AEV introduces Traumahawk Telematics

American Emergency Vehicles (AEV), part of REV Group® has launched Traumahawk Telematics, integrated vehicle intelligence solutions as a standard feature on select AEV models.

Traumahawk Telematics generates advanced vehicle informatics to help ambulance fleet owners manage their fleets more efficiently and keep their crews and patients more safe. Additionally, Traumahawk Telematics enables remote fleet management and maintenance, monitors driver behavior, tracks fleet utilization, and provides an intelligent platform for additional capabilities such as RFID asset tracking.

Traumahawk Telematics, which is powered by ACETECH™, includes the following benefits: Accelerometer & turning data, Vehicle Accessory Information (i.e. lights on), Battery Monitoring, Fuel Use Monitoring, Ambulance Status, Geo-Fencing, OBD2 Codes, Collision Alerts, Data collected, preserved, and stored even in cellular dead zones.

Spireon FL360, vehicle tracking device with optional dashcam

Spireon unveiled FL360™, a modular vehicle tracking hardware device, with an optional FL Dashcam. The FL Dashcam is enabled by Surfsight™, a solution of Lytx®. FL360 is an upgraded version of Spireon's FL1™ and FL4™ devices. It is a fleet telematics device capable of supporting all vehicle types – from light to heavy duty. It offers a robust solution for reporting new advanced vehicle data and diagnostics. FL360 consolidates multiple hardware offerings into one modular solution. Further, additional fleet management and compliance use cases such as driver ID, Electronic Logging Devices (ELD), Power Take-offs (PTO), starter disable, and more, are made available with expandable Input/output communication capabilities.

FL Dashcam integrates seamlessly with the new FL360 device, and is compatible with all existing FleetLocate devices.

AB Dynamics showcases simulated swarm testing

AB Dynamics showcased its capability to replicate simulated swarm tests quickly and accurately within the real world and vice-versa. By using a common toolchain, complex scenario testing is often transferred from one environment to the other with centimeter accuracy.

Scenario testing using a swarm of vehicles is a vital aspect of development for ADAS and autonomous vehicle technologies. It assesses the power of autonomous functions to interpret the behavior and intentions of drivers and vehicles within the close vicinity. Scenarios like merge-in, caused by lane closures on divided highways, cut-in and cut-out are common events that force a vehicle using ADAS or autonomous systems to make a decision.

AB Dynamics recently conducted a track test with VW Group where eight objects were coordinated during a swarm test using the company's vehicle control robots and wireless telemetry system.

Signal Quality Analyzer-R MP1900A Anritsu publish 116-Gbit/s PAM4 Error Detector FEC Analysis function

Anritsu Corporation has published details of MP1900A in its web site about its new FEC Analysis function of the 116-Gbit/s PAM4 Error Detector (ED) MU196040B option for the Signal Quality Analyzer-R MP1900A series.

The MP1900A series is a high-quality bit error rate tester (BERT) for evaluating next-generation 400 and 800GbE *1 high-speed devices and transceivers. The newly announced FEC Analysis function is BERT to support real-time measurement of Forward Error Correction (FEC) Symbol Errors *2; in addition to conventional bit error measurement, it also supports jitter tolerance *3 measurements for assessing error correction capability using FEC as required by transmissions using high-speed PAM4 *4 signals. Sales of this new MU196040B option start in March 2021.

Anritsu has added the FEC Analysis function for detecting FEC Symbol Errors based on the 400GbE FEC standard to its PAM4 ED with world-beating input-sensitivity performance.

this new FEC Analysis function is compatible with conventional jitter tolerance automatic measurement software; one-button jitter tolerance measurement is supported based on whether or not error correction using FEC is possible.

The Signal Quality Analyzer-R MP1900A series is the BERT for testing various high-speed interfaces, including 400GbE and future 800GbE, etc. Adding the high-sensitivity PAM4 ED MU196040B with expanded FEC Analysis functions supporting reliable bit error and FEC Symbol Error measurements will help cut development times for high-speed devices and transceivers.

Mercedes me Eco Coach app: a personal trainer for eco-friendly driving

Mercedes has launched Eco Coach app, as a part of its "me ecosystem". The Eco Coach app has been developed to help customers take advantage of their electric cars.

By following the suggestions of the app, customers can improve their driving style. Through a points program, they can earn exclusive rewards and services. The app makes available to people for "challenges". By completing each challenge, you get points. The app also allows users to enter into competition with the Eco Coach community. The points earned can then be redeemed for rewards as part of an integrated bonus program. Following the suggestions of the app people will be able to drive more efficiently, to the benefit of the environment. The app was initially launched in Germany for Apple and Android platforms. Mercedes says it will soon be available in many other European countries as well.

Continental, HERE and Leia Inc jointly create natural 3D automotive navigation

Continental, HERE and Leia Inc. announced at CES 2021 that they are partnering to bring three-dimensional navigation into display solutions for vehicle cockpits. HERE's 3D depiction of buildings and topography are displayed with Leia's Lightfield technology. The Lightfield technology makes the 3D effect visible from various angles, allowing both driver and passengers to view

The content enabling this solution comes from HERE Premier 3D Cities, consisting of HERE premium map content and highly detailed 3D representations of 75 global city centers that are fully interactive and customizable. Each building is indexed and accurate in terms of physical location, volume, elevation and façade color. 3D terrain models also provide elevations for

representative depictions of a city's layout. Detailed 3D landmarks are included within the coverage of each city and are integrated into the 3D terrain, as well as the various styles of the surrounding buildings.

Based on Continental's Natural 3D Display, Leia's Lightfield technology and HERE's 3D map content, the companies have created a joint demonstrator and plan to work with vehicle manufacturers to bring this solution into the next generation of vehicles.

BYTON and Foxconn announce partnership for M-Byte production

BYTON, Foxconn Technology Group and Nanjing Development Zone officially signed a cooperation agreement for production of BYTON's 1st model M-Byte by the first quarter of 2022.

According to the agreement, Foxconn will provide its expertise in advanced manufacturing technology, solid operational management experience and will share industrial resources to support the production of BYTON's M-Byte. The electric SUV BYTON M-Byte premiered at IAA Frankfurt in 2019, featuring seamless connectivity and unique user experience.

The construction of BYTON's industrial 4.0 manufacturing base in Nanjing has been completed. The first batch of pre-production vehicles rolled off the production line and completed safety tests in the first half of 2020.

Xpeng to use Livox Lidar for its autonomous vehicle

Xpeng Inc. has collaborated with Livox to deploy its automotive-grade lidar technology in Xpeng's new production model in 2021. Livox has customized its Horiz sensor for Xpeng. The implementation of lidar in Xpeng's ADAS system, called XPILOT will further enhance XPILOT's safety as well as the ability to cover a comprehensive range of driving scenarios. Livox is enhancing the detection range of its Horiz sensor to 150m, enabling Xpeng's XPILOT system to easily detect any remote obstacle while on highways and urban roads. Livox's customized solution for Xpeng also includes a new "ultra FPS" (Frames Per Second) lidar technology concept. Through a cleverly designed rotating-mirror technology, the objects within the lidar's ROI (Region of Interest) will acquire a 20Hz point cloud data when the whole system is working at a frame rate of 10Hz.

TCS launches Autoscape solution suite

Tata Consultancy Services (TCS) has launched the Autoscape™ solution suite to enable connected and autonomous vehicle ecosystem players, such as automotive OEMs, suppliers, fleet owners, and start-ups, to pursue new business models, launch new services quickly and deliver differentiated experiences and value to end-customers.

The Autoscape Autonomous Vehicle (AV) solution suite covers the whole end-to-end AV development value chain and consists of AV Data Services, a Data Annotation Studio and AV validation services. Through AV Data Services, TCS offers comprehensive compute infrastructure architecture, a data management solution, AI workbench, and toolkits to accelerate AV development. The Autoscape Connected Vehicle solution suite consists of Vehicle in the Cloud, Connected Vehicle Experience, Connected Insights, and a Data Monetization Toolkit. Vehicle in the Cloud provides the foundational capabilities required to manage a connected vehicle, and its digital twin in the cloud. The Connected Vehicle Experience solution, built on top of the Azure-based Microsoft Connected Vehicle Platform, enables personalized customer experiences inside and outside the vehicle during a scalable and secure manner.

2021 Mercedes me connect

Mercedes-Benz launched the 2021 Mercedes me connect, in its S-Class 'Maestro Edition'.

S-Class Maestro Edition integrates additional features and the latest connected car technology in addition to other features such as Magic Sky Control with a panoramic sunroof, front seats with memory package. Another highlight with the S-class Maestro Edition is the latest version of the Mercedes Me Connect (MMC) in-car connectivity system. In addition to offering the usual connected car features such as real-time vehicle tracking, speed alerts, remote operation of the windows and sunroof, the latest version of MMC brings Alexa and Google Home integration for the S-class Maestro. Using a Google Home/Alexa Echo device or the mobile app, customers can receive real-time updates or issue commands to the car.

Okaya Power gets contract to set up 4,244 EV charging points

Okaya Power has bagged a contract from state-owned Rajasthan Electronics and Instruments Limited (REIL) for setting up 4,244 multi-standard EV charging stations. The contract is funded by the Department of Heavy Industries (DHI), Ministry of Heavy Industries and Public Enterprises. The company further said last year REIL had given a contract to Okaya for supply, installation and commissioning of over 200 multi-standard EV chargers in all metro cities and major highways, starting with Delhi-Jaipur-Agra and Mumbai-Pune.