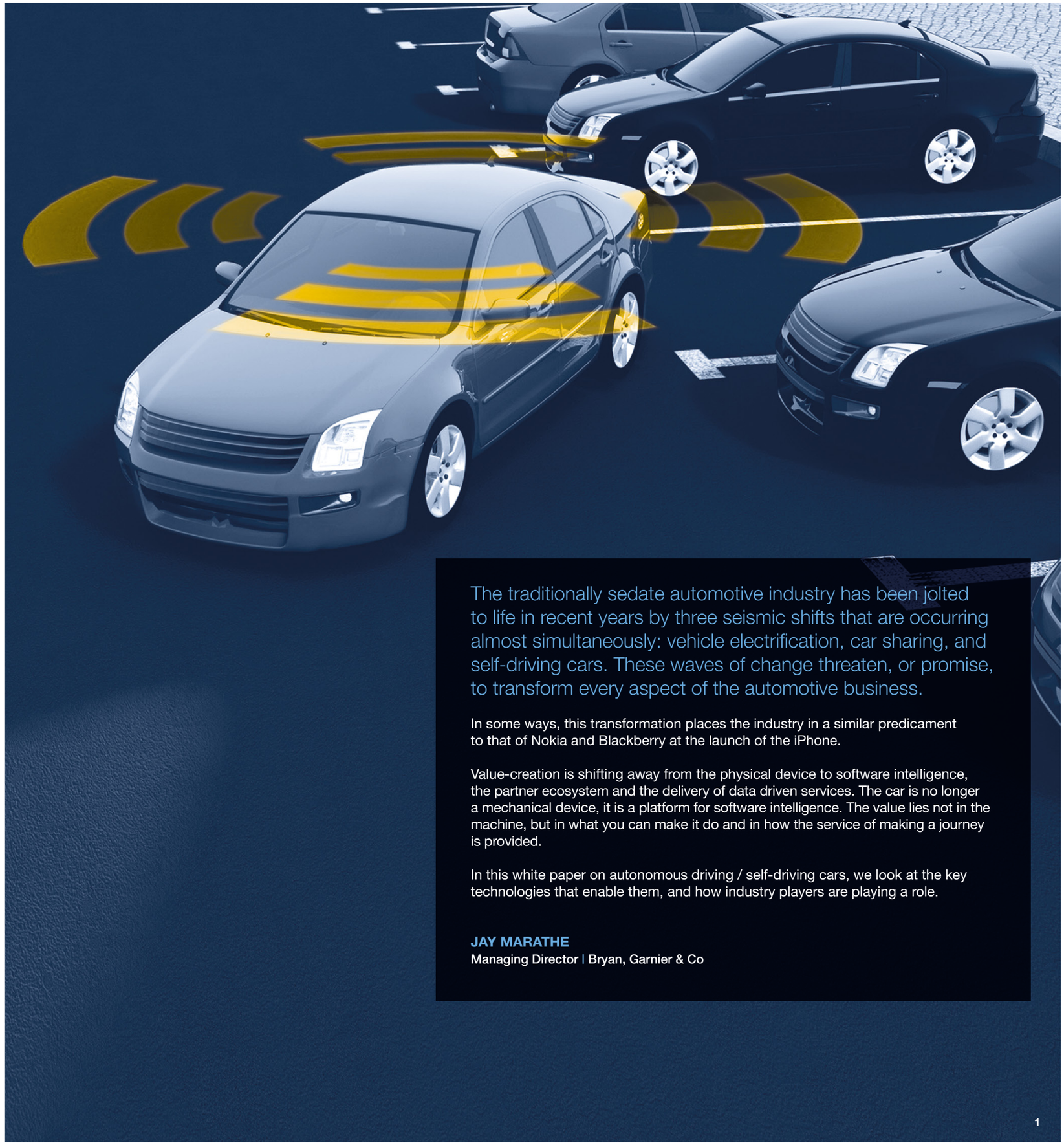
BRYAN, GARNIER & CO

Autonomous Driving

SECTOR ANALYSIS

TECHNOLOGY WHITE PAPER JUNE 2017

Contents



The traditionally sedate automotive industry has been jolted to life in recent years by three seismic shifts that are occurring almost simultaneously: vehicle electrification, car sharing, and self-driving cars. These waves of change threaten, or promise, to transform every aspect of the automotive business.

In some ways, this transformation places the industry in a similar predicament to that of Nokia and Blackberry at the launch of the iPhone.

Value-creation is shifting away from the physical device to software intelligence, the partner ecosystem and the delivery of data driven services. The car is no longer a mechanical device, it is a platform for software intelligence. The value lies not in the machine, but in what you can make it do and in how the service of making a journey is provided.

In this white paper on autonomous driving / self-driving cars, we look at the key technologies that enable them, and how industry players are playing a role.

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Challenge

THE RACE TO FULL AUTOMATION

Self-driving technologies are being developing and integrated at a pace that is bringing autonomous driving to our streets much faster than people imagined. There are self-driving vehicles on the road at this very moment in cities as diverse as Pittsburgh, London, Cologne, Gothenburg and Helsinki. Almost every major auto-maker now plans to have a self-driving car commercially ready by 2020.

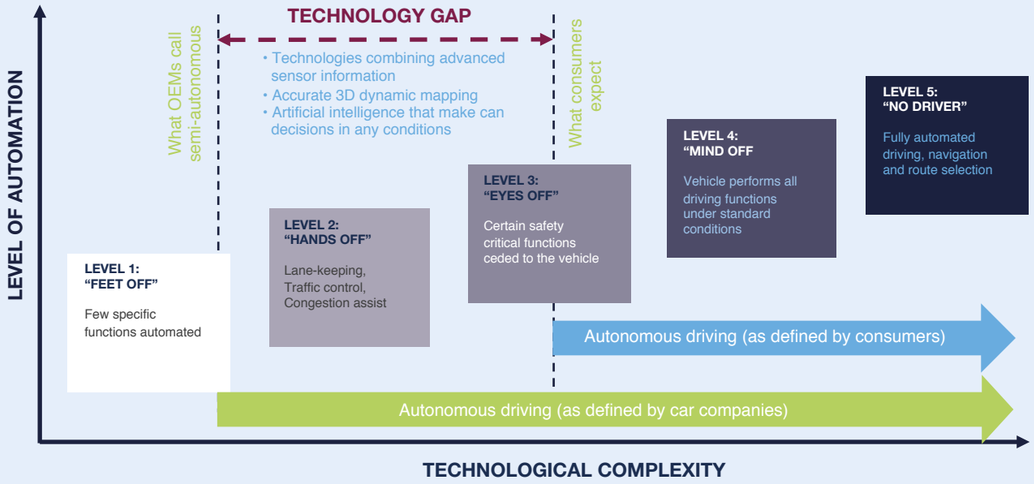
However, there is currently a disconnect between what consumers expect from self-driving, and what auto-makers claim. Many companies offer partial automation of specific functions (Levels 1 and 2 according the NHTSA autonomous driving scale) with names such as ‘driver assist’, ‘autopilot’, ‘adaptive cruise’, and ‘pilot assist’. While these features only work within limited constraints, drivers are beginning to switch off and let the car do the driving – sometimes with disastrous results.

Tesla has come under fire recently for lulling drivers into a false sense of security by using the term ‘autopilot’ to cover a range of its assisted driving features.

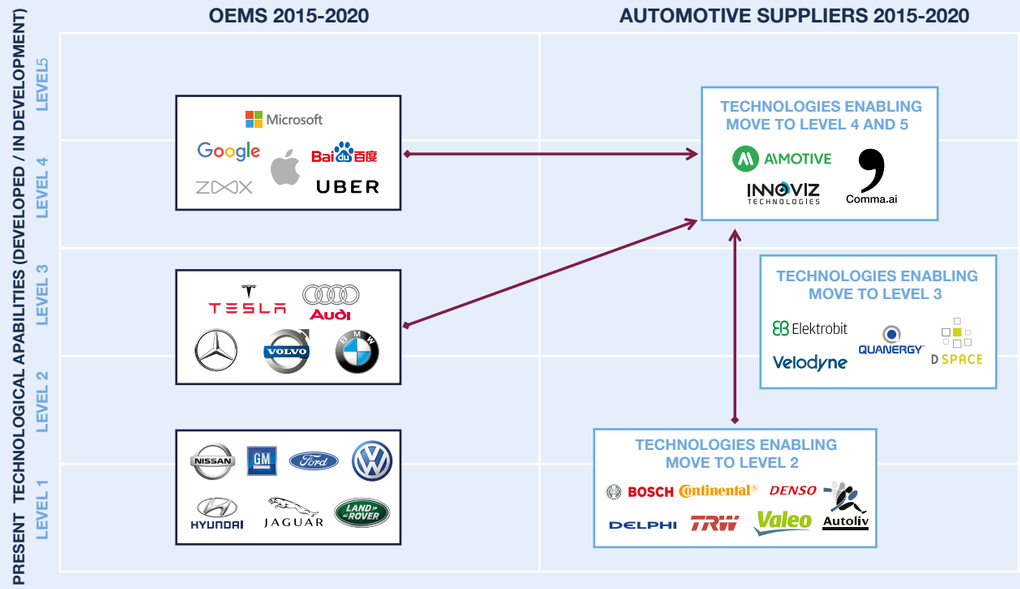
While Tesla and many established car-makers have adopted the incremental approach of continually improving assisted driving features until they reach full automation, other players, including Ford and Google’s Waymo, have adopted a disruptive approach by aiming to launch a vehicle only at Level 5 – full automation with no driver intervention. Ultimately, the disruptive approach may be the safer one.

Faced with the threat of becoming low-value box-makers while new entrants capture the high-value parts of the autonomous driving chain, almost every auto-maker and industry supplier is now scrambling to either acquire or develop the key capabilities to move them towards Level 5 – fully autonomous driving. This has created a window of intense M&A and recruiting activity.

ADDRESSING THE TECHNOLOGY GAP



LEVEL 4 AND 5 TECHNOLOGY ENABLERS WILL BE IN HIGHEST DEMAND



There is currently a disconnect between what consumers expect from self-driving, and what auto-makers claim.

Technologies

The automotive industry has been jolted to life by three seismic shifts: vehicle electrification, car sharing and self-driving cars.

Fully autonomous driving requires combining inputs from multiple sensors in a split second in order to make high quality decisions based on imperfect information. This is a challenge similar to that already addressed by the human brain.

The technologies that a car requires can broadly be categorised into five key steps:

- **SEE** the world around you using sensors to detect its components and elements
- **UNDERSTAND** holistically what is happening by combining inputs from multiple sensors
- **ASSESS** this interpretation in the context of known information (e.g. maps and weather)
- **DECIDE** what action the car should take (safely and effectively)
- **ACT** to implement that decision

Key technologies that enable each step are outlined below:

SEE (SENSORS FOR DATA ACQUISITION)

Data acquisition technologies are used for positioning, vision, and sensing. These include GPS, stereo cameras, radar, LiDAR, ultrasound, infrared and others. Many of these technologies are well established. Camera technology has evolved over generations of refinement, while LiDAR is relatively new and still very expensive.

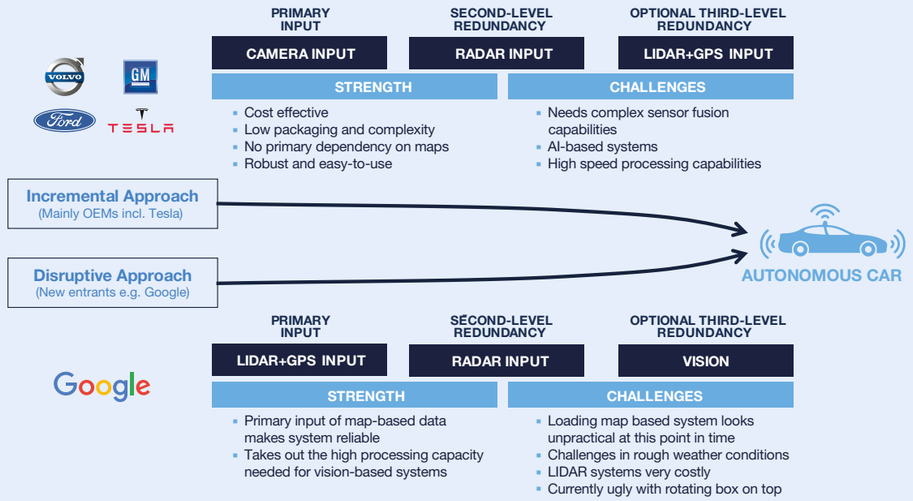
A key focus for these sensing technologies will be to ramp up volumes of production and reduce costs over time. A technology such as LiDAR may move from being a premium product produced by innovative small companies into a commodity produced by large companies with economies of scale (many such acquisitions have already occurred). Margins could fall as production shifts to lower cost locations to enable price reductions.

However, there will continue to be space for technology-driven innovation to improve sensing capability and resolution, form factor and energy consumption. For example. LiDAR still needs to become much smaller and less obtrusive.

RELEVANT TRANSACTIONS

AUG 16:	ZF Freidrichshafen acquired Hamburg based Lidar company IBEO in order to extend its car parts business into the autonomous driving space
JUL 15:	Delphi acquired LiDAR maker Quanergy for its low-cost high-performance solid-state LiDAR technology
JUL 15:	Car safety technology provider AutoLiv acquired MACOM's automotive solutions business, gaining technologies for embedded GPS modules, RF and antenna products and an advanced driver assistance system
APR 15:	Industrial conglomerate Teledyne acquired Ontario based LiDAR business Optech. Optech's technology is used vfor mobile mapping as well as airborne terrestrial mapping.

DIFFERING APPROACHES TO AUTONOMOUS DRIVING



UNDERSTAND (SENSOR FUSION, HIGH-SPEED DATA PROCESSING)

The transformation facing the industry places operators in the sector in a similar predicament to that of Nokia and Blackberry at the launch of the iPhone.

Sensor fusion is a complex task where considerable innovation is taking place. It is not trivial to combine information from different sensor types in real time to arrive at a single, accurate and dynamic view of the world around the car, particularly when the data points can be overlapping or conflicting, and can arrive with different latencies.

High-speed processing is required to enable faster reaction times. This creates opportunities for semiconductor companies that are developing car-based embedded systems for data processing. Established semiconductor companies see the internet of things (including cars) as the next growth area for processors. Consequently, they are adapting their products, acquiring technologies, and investing in start-ups in order to nurture the IOT and self-driving ecosystems that will drive semiconductor sales.

Intel's recent acquisition of Mobileye illustrates its need to remain ahead of the curve as the automobile becomes the next growth market for microprocessors – this is particularly poignant for Intel as it is seen to have missed the previous smartphone wave

A player like NVIDIA has a key advantage in real time processing – it has already developed embedded systems with advanced multi-core processing for the games environment, which it is busy repurposing into dedicated Systems on a Chip (SoCs) for autonomous cars.

A well publicised Tesla car accident in May 2016 raised interesting questions at the see / understand interface, resulting in a war of words between Tesla and its vision systems supplier MobilEye. The car encountered a truck crossing its path, but thought that it was an overhead gantry that it could safely pass underneath. Did errors occur at the SEE stage (i.e. sensors did not work properly) or at the UNDERSTAND stage (i.e. the sensors worked but the software did not understand what it was seeing)? Current assessments seem to imply that neither was individually to blame, raising complex legal questions. Nevertheless. Tesla toned down its promise of automation, and is reminding drivers that, today, they still need to hold the wheel at all times.

Tesla's well publicized car accident forced it to tone down its promise of automation and is reminding drivers today that they still need to hold the wheel.

RELEVANT TRANSACTIONS

MAR 17:	Intel acquired Israel based vision processing systems company Mobileye for its dominant market share in ICs for driver assistance systems
OCT 16:	Qualcomm acquired Netherlands based NXP Semiconductors, enabling it to add strong wireless communications functions to NXP's microprocessors for self-driving cars and drones
OCT 16:	Infineon acquired Netherlands based fabless MEMS company Innoluce to complement its strength in radar data processing with Lidar data expertise
AUG 16:	Ford acquired Israel based computer vision company SAIPS for its vision processing AI and deep learning technology
MAY 15:	Continental acquired the LiDAR business from Santa Clara based Advanced Scientific Concepts (ASC). The acquired technology uses hi-res 3D Flash LiDAR for machine vision and environmental mapping.

ASSESS (ADVANCED MAPPING, ROUTING, CONTEXTUAL DATA)

Google's expertise in the dynamic big-data processing means they are well positioned to lead in this space.

While many articles about autonomous driving focus on the complexity of tracking moving objects, identifying pedestrians and predicting the trajectories of other road users, the basic software capabilities for these tasks have already existed for some time (image recognition, object tracking etc).

However, one of the most complex elements of autonomous driving concerns determining which way the road in front of you goes (the 'drivable path'). This is because there are so many types of road markings (and often no road markings), because the edge of the road can be clearly or poorly defined (by barriers, pavement, dust, grass, painted lines, rows of parked cars or anything else) and there can be poor visibility (including rain, glare, etc). Humans determine the direction of the road by combining what they see with numerous elements of historic experience, societal context, and instinct.

Autonomous cars can also benefit from additional information on top of what their sensors see, in order to determine the drivable path. The most valuable of these are accurate maps to double check and inform the first assumption. Significant efforts are going into building three-dimensional maps that plot the visual environment on top of the road – marking out where there are road signs, pillars, bollards, traffic lights, etc. The smartest of these continue building and improving these maps with more information from each car that passes a given location.

One of the motivations for Google to enter the self-driving car space is the vast amount of information that is contained in such highly detailed pictures of the environment, and in the experience collected by millions of self-driving cars that keep adding to the field of knowledge in order to improve algorithms. Google's expertise in dynamic big-data processing means they are well positioned to lead in this space – they understand the pivotal role that information processing plays.

There are, of course, some counter-theories regarding mapping. In the UK, Cambridge based Five.ai is one among a group of players that believe that self-driving cars should be able to figure out their own way safely without d epending on maps. This makes sense from a global perspective. While Palo Alto and Mountain View have been mapped to death, there are still large parts of the world that will not have detailed 3D maps available for a very long time.

Another key aspect of mapping is its combination with historic and live traffic information to enable routing. Route optimisation becomes critical to profitability for both logistics providers (automated trucks, delivery vehicles) and for the service providers that will steadily replace car ownership with autonomous vehicles on demand (ride sharing, car sharing, taxis).

RELEVANT TRANSACTIONS

JAN 17:	Tom Tom acquired Berlin based 3D mapping and autonomous driving company Autonomos Systems for its stereo camera detection, sensor technologies and ability to layer 3D information on top of maps
SEP 16:	Zenrin invested in US based Abalta Technologies to complement their high definition digital mapping with wireless communications to enable map updates in real time
FEB 16:	Hexagon acquired Washington based mapping company SigmaSpace for its high definition 3D map rendering capabilities
SEP 15:	Traffic data provider Inrix acquired Santa Monica based ParkMe, a provider of parking space information and booking. The technology could, in future, be used by self-driving cars
JUL 15:	BMW, Audi and Daimler formed a consortium to acquire Nokia's HERE, an open independent cloud based mapping service
APR 15:	TomTom acquired the Location Navigation division of Australia based Sensys, enhancing its real time global mapping capabilities for automated driving
MAY 15:	Uber acquired San Jose based mapping company DeCarta, enabling it to switch from using Google maps to in-house mapping and navigation. Uber has strong ambitions in self-driving cars

DECIDE (ARTIFICIAL INTELLIGENCE)

Once you have a built a comprehensive picture of the world around you, you are faced with the huge responsibility of determining what actions to take with the car. While many of these decisions are mundane (e.g. follow the middle lane as the road turns; indicate left and change lanes when safe), some of them are much more complex, requiring fine subjective elements of judgement (is this running child likely to step in the road; could this bicycle veer suddenly; should I make an emergency stop or swerve; would a U-turn be safe here?). In addition, some of the information that the car receives could be conflicting e.g. the map says the road goes straight but I see a curve; the radar sees an obstacle in my path but the camera sees a clear road. In short, the information that is available is imperfect, the situation is moving very fast, and the car must make a safe and effective decision now.

A variety of technologies being deployed in making this decision are at the cutting edge of artificial intelligence, including deep learning. Companies such as Google are continually gathering data not only about mapping, but about the experiences their cars have of the world that they see, the decisions they made and whether these decisions were good ones. In so doing, they can continually improve the performance of the car in the same way that a learner driver becomes more experienced.

The critical importance of artificial intelligence and vast amounts of training data illustrate why car industry players must move rapidly to acquire new capabilities and to build the required data sets – these are capabilities that traditional auto-makers have never focussed on before.

RELEVANT TRANSACTIONS

MAR 16: General Motors acquired San Francisco based self-driving company Cruise Automation in order to integrate its after-market self driving kit into GM's manufacturing process

JUL 15: Delphi acquired Carnegie- Mellon University spin-out Ottomatika, a provider of artificial intelligence software to make self-driving decisions

MAY 15: Continental acquired the automotive software division of Finland based Elektrobit, gaining advanced driver assistance systems (ADAS) and infotainment software.

ACT (CONTROL SYSTEMS)

Control systems comprise all the elements that convert the decision made by the car into an executed action. These combine software intelligence (how much steering will be required for this model of car to follow the curve) with mechanical systems (steering control, brakes, acceleration, indicators etc).

This is an area where established industry players are completely at home – the basic control systems have been in development for over a hundred years, while the smarter software elements have been recently developed as part of driver assistance systems (e.g. for cruise-control, lane-following, self-parking etc). The principal suppliers of these systems are the tier one automotive suppliers (Faurecia, Continental, Delphi, Valeo, Denso, Bosch etc).

While they will always be required, control systems are likely to be commoditised over time, and many tier one suppliers are seeking to move into higher value parts of the chain – including sensors, mapping and artificial intelligence.

RELEVANT TRANSACTIONS

APR 17: Panasonic acquired a majority stake in Spanish tier 1 supplier Ficosa, Illustrating the acceleration of the automotive world into next generation electronics. The two companies will work together on ADAS, connectivity and safety systems

NOV 16: Valeo acquired UK based AI and machine learning start-up Cloudmade for its ability to adapt driver assistance systems to individual drivers.

OTHER AREAS OF INNOVATION

Next generation cars typically have several different software environments – one for autonomous driving, one for engine control and management, and one for information, media and entertainment.

The autonomous driving system is often kept isolated from the other systems because it is mission critical for safety with a continuous uptime requirement, and it should be fully protected from hacking.

The engine management system is changing rapidly with vehicle electrification. It is increasingly remotely connected, software upgradable and plays an active role in predictive maintenance.

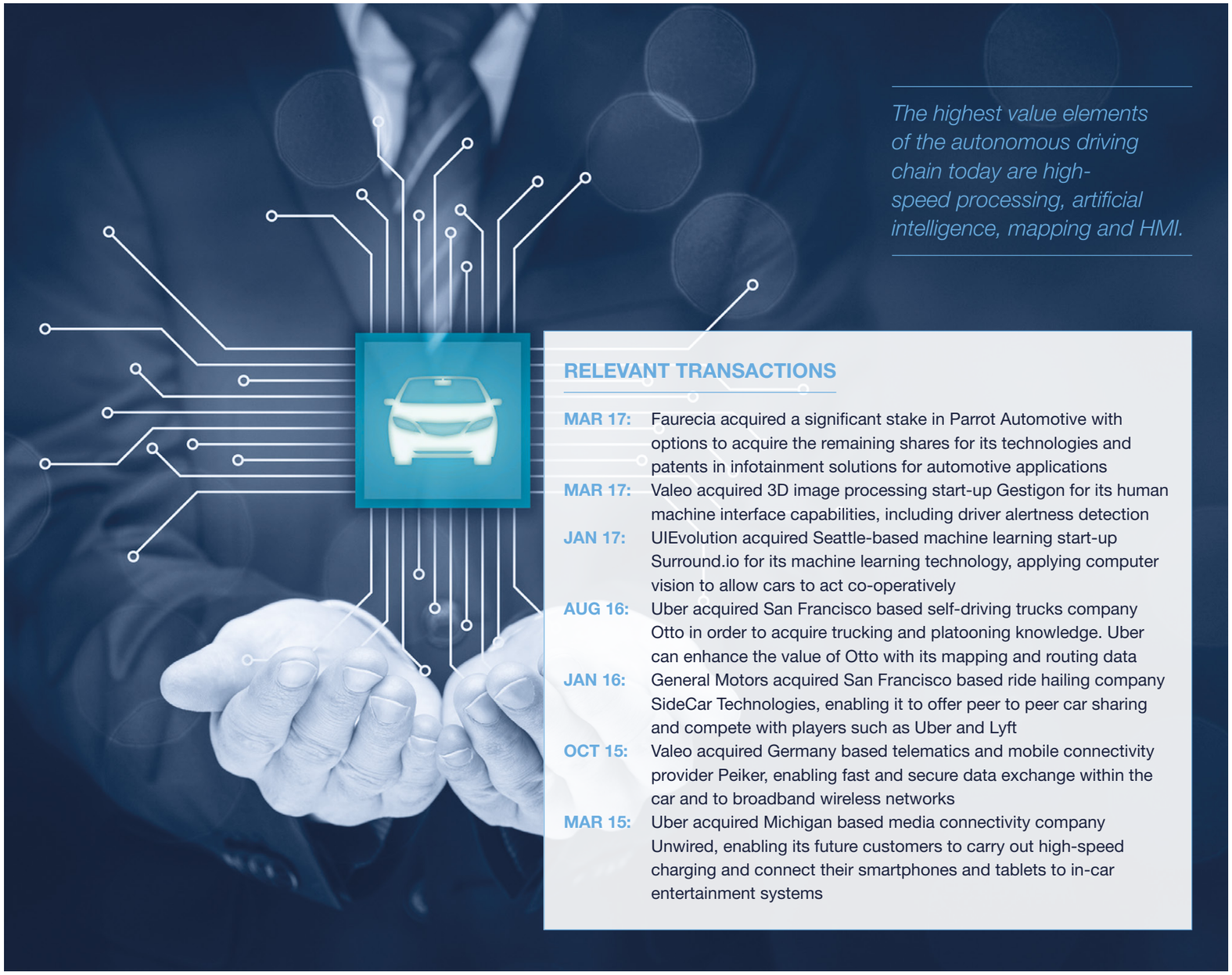
The information, communication and entertainment system is engaged in communicating key operating information to the driver, as well as managing music, movies and internet connectivity for drivers and passengers. It will play a changing and increasingly important role as cars move towards full automation and occupants start using the car as a living room and a connected workspace.

A number of companies are trying to become the 'operating system' for these different software elements. For example, Apple's iOS, Google's Chrome and Microsoft Windows are all being adapted for the car as a device – mainly in the realm of information, communication and entertainment.

V2X communications – vehicle to vehicle (V2V) and vehicle to cloud (V2C) – are required to provide users with high-speed connectivity and access to all their cloud data. High bandwidth communications is also required to transmit sensor data within the car and to gain access to real time mapping data. A key application of V2V communication is to enable 'platooning' – where multiple vehicles can work with each other to form a convoy that is efficient in its use of road space.

Human Machine Interfaces (HMI) play an important role as car users interact with multiple software systems. There is considerable innovation taking place today in areas such as touch screen technology, gesture recognition, head-up displays, voice control, haptic feedback, and occupancy and drowsiness detection.

The highest value elements of the autonomous driving chain today are high-speed processing, artificial intelligence, mapping and HMI, while other elements including sensors and control systems are increasingly becoming commoditised and will decline in value over time.



The highest value elements of the autonomous driving chain today are high-speed processing, artificial intelligence, mapping and HMI.

RELEVANT TRANSACTIONS

MAR 17: Faurecia acquired a significant stake in Parrot Automotive with options to acquire the remaining shares for its technologies and patents in infotainment solutions for automotive applications

MAR 17: Valeo acquired 3D image processing start-up Gestigon for its human machine interface capabilities, including driver alertness detection

JAN 17: UIEvolution acquired Seattle-based machine learning start-up Surround.io for its machine learning technology, applying computer vision to allow cars to act co-operatively

AUG 16: Uber acquired San Francisco based self-driving trucks company Otto in order to acquire trucking and platooning knowledge. Uber can enhance the value of Otto with its mapping and routing data

JAN 16: General Motors acquired San Francisco based ride hailing company SideCar Technologies, enabling it to offer peer to peer car sharing and compete with players such as Uber and Lyft

OCT 15: Valeo acquired Germany based telematics and mobile connectivity provider Peiker, enabling fast and secure data exchange within the car and to broadband wireless networks

MAR 15: Uber acquired Michigan based media connectivity company Unwired, enabling its future customers to carry out high-speed charging and connect their smartphones and tablets to in-car entertainment systems

Conclusion

THE NEED TO PARTICIPATE WILL DRIVE M&A

Established market players must act fast to secure key available assets. Some are more innovative, others are less innovative. Many have been caught unawares and are acting now to come up to speed. For example, one major OEM that stated barely a year ago that they would not focus on self-driving cars (because drivers want to enjoy the pleasure of driving), has now changed its mind and joined the race.

New players are entering the automotive fray from different backgrounds, including software industry players, new OEMS (e.g. Tesla or China backed players such as Faraday Future), and even media companies (e.g. Baidu spinning out its self-driving car unit).

These players will seek to complete their capabilities in core areas including artificial intelligence, high speed data processing, sensor fusion and 3D mapping. Their collective scramble to secure access to key technology resources will continue to drive M&A activity for a while.

SELECTED M&A TRANSACTIONS

APR 17	Panasonic	▶	FICOSA	Safety, efficiency & near-vision system	N.A.
APR-17	SiriusXM SATELLITE RADIO	▶	AUTOMATIC	Mobile phone based driver assist devices	N.A.
MAR-17	Valeo	▶	gestigon	3D image processing software	N.A.
MAR-17	intel	▶	MOBILEYE	Camera systems & software	$15.3bn
JAN-17	TOMTOM	▶	AUTONOMOS	Autonomous driving & 3D mapping tech	$30m (e)
DEC-16	uie UIEVOLUTION	▶	Surround	Machine learning infrastructure	N.A.
OCT-16	QUALCOMM®	▶	NXP	Audio & visual head-end unit applications	$47bn
JUL-16	Ford	▶	SAIPS	3D vision technology	N.A.
AUG-16	UBER	▶	OTTO	Self-driving trucking solutions	$680m
MAY-16	DELPHI	▶	puredepth MULTI LAYER DISPLAY	Multi Layer Display (MLD) technology	$15m
MAR-16	GM	▶	cruise	Autonomous vehicle software technology	$1bn+
MAR-16	TOYOTA	▶	JAYBRIDGE ROBOTICS	Vehicle automation	N.A.
MAR-16	Continental	▶	ast	Driver assistance sensors	N.A.
JAN-16	Valeo	▶	peiker	Onboard telematics & mobile connectivity	N.A.
JAN-16	GM	▶	Side·car	B2B on-demand delivery service	N.A.
NOV-15	DELPHI	▶	CONTROLTEC	Telematics & cloud based analytics	$125m
OCT-15	UBER	▶	Microsoft bing	Bing Map, mapping asset of Microsoft	N.A.
JUL-15	Continental	▶	Elektrobit	Embedded SW solutions for connected car	$650m
JUL-15	BMW Audi DAIMLER	▶	here	Real-time mapping & location system	$3.1bn
JUL-15	DELPHI	▶	ottomatika	Automated driving software	N.A.
JUL-15	Autoliv	▶	MACOM	Global positioning system modules	$130m
MAR-15	UBER	▶	deCarta®	Mapping platform offering search	N.A.

TYING UP THE LOOSE ENDS

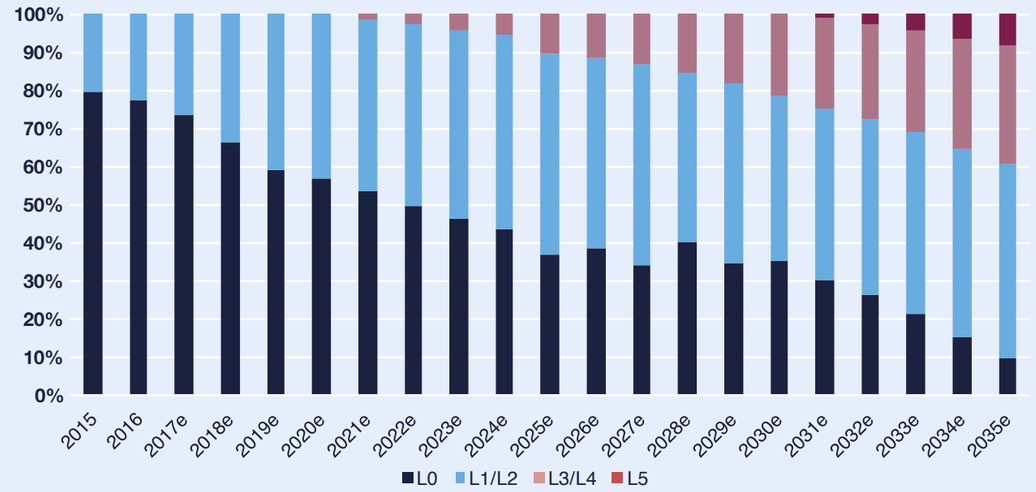
Once you have the basic building blocks of a self-driving solution in place, you need to tie up the loose ends in order to deliver world class complete systems. This means ensuring security, reliability, user management, connectivity, billing and payment, improved performance etc.

We expect to see increased fundraising activity as well as M&A in supporting areas such as security, management of local versus cloud data (important to enable the large amounts of data required for mapping), operating systems, payment and billing and user management.

THE ROAD TO MASS ADOPTION

While the technologies that enable self-driving cars are being developed faster than expected, there are parts of the ecosystem that move more slowly. Notably, these include national and city regulations, driver behaviour and user acceptance of self-driving cars on the roads. As more innovative players and cities put self-driving cars on the roads, there may be a spurt of accidents during the teething phase. In many cases these may occur at a lower rate than if human drivers had been involved but, no matter how low the incidence, there will be little public tolerance of deadly errors by robotic machines.

BRYAN, GARNIER & CO ESTIMATES FOR THE AUTONOMOUS VEHICLE MIX



Consequently, while there is already an initial presence of self driving cars that will spread very soon, the road to mass adoption is a lot slower.

In 2016, vehicles equipped with level 1 and level 2 options (semi-autonomous vehicles) represented just over 20% of new worldwide registrations. We expect this to grow to over 60% by 2026. Meanwhile, we expect autonomous vehicles (levels 4 and 5) to reach over 20% of new car registrations only by 2030.

In summary, the key technologies required to develop autonomous cars are being acquired or developed now, there will be a global early presence of semi-autonomous vehicles on the streets very soon, but mass adoption of fully autonomous cars will take over a decade to occur.

We expect to see increased fundraising activity as well as M&A in supporting areas such as security, management of local versus cloud data, operating systems, payment and billing and user management.

M&A ACTIVITY

With the level of change that the automotive industry is experiencing, the need for non-organic evolution is enormous. This explains the flurry of M&A activity across automotive technologies. A great deal of this activity has been driven by the race towards fully autonomous vehicles.

SELECTED RECENT TRANSACTIONS IN AUTOMOTIVE TECHNOLOGIES

COMPLETION	TARGET	CTY	TARGET DESCRIPTION	ACQUIROR	VALUE ($M)
Mar-17	gestigon	DE	3D image processing software for the vehicle cabin	Valeo	
Mar-17	Mobileye	IS	Computer vision, machine learning, data analysis, localization and mapping	Intel	14700
Feb-17	PVI	FR	Electric and natural gas conversion	Renault	
Jan-17	Autonomos	DE	Research & Development consultancy services for automated vehicle assistance systems	TomTom	
Dec-16	Surround.io	US	Machine Learning infrastructure	UIEvolution	
Nov-16	CloudMade	UA	Developer of smart and innovative big data-driven automotive solutions	Valeo	
Oct-16	NXP Semiconductors	US	Automotive computer chip developer	Qualcomm	$47,000
Oct-16	Innoluce	NL	Fabless semiconductor in micro electro-mechanical systems (MEMS)	Infineon Technologie	
Sep-16	Abalta Technologies	US	Automotive software including infotainment, mobile, and mapping softwares	Zenrin	$13
Aug-16	Otto	US	Self-driving freight trucks technology developer	Uber Technologies	$601
Aug-16	SAIPS	IL	Computer vision and machine learning technologies	Ford	
Aug-16	Ibeo Automotive Systems	DE	Manufacturer of LIDAR Technology environmental recognition software	ZF Friedrichshafen	
AUG-16	Fleetmatics	US	GPS fleet tracking solutions	Verizon	$2,400
MAY-16	PureDepth	US	3D Display technology	Delphi Automotive	$15
MAR-16	Cruise Automation	US	Autonomous vehicles technology	General Motors	$1,000
FEB-16	SigmaSpace	US	High-quality 3D Maps	Hexagon	
JAN-16	Sidecar Technologies	US	Ride, carpooling and delivery apps	General Motors	
DEC-15	Peiker acustic	DE	On-board telematics and mobile connectivity solutions for the car industry	Valeo	
OCT-15	Control-Tec	US	Telematics and cloud based analytics solutions for the transportation industry	Delphi Automotive	$104
SEP-15	ParkMe	US	Real-time parking data and services	Inrix	
JUL-15	Ottomatika	US	Automated vehicle software	Delphi Automotive	$27
JUL-15	HERE	NL	Digital mapping and location-based services	BMW; AUDI; Daimler	$3,043
JUL-15	M/A-COM Automotive	US	Navigation technologies, RF and antenna products for the auto industry	Autoliv ASP	$100
MAY-15	Elektrobit Automotive	DE	Embedded software solutions and services for the automotive industry	Continental	$685
MAY-15	Hi-Res 3D Flash LIDAR	US	Sensor technology business of Advanced Scientific Concepts Inc. (ASC)	Continental	
APR-15	Optech	CA	Laser-based surveying, mapping, and imaging instruments	Teledyne DALSA	$45
APR-15	Location Navigation Pty	AU	Navigation and digital mapping solutions	TomTom	
MAR-15	DeCarta	US	Location and map service software	Uber	
SEP-14	Unwired Technology	US	Media connectivity modules	Delphi Automotive	$210
SEP-14	Antaya Technologies	US	Glass automotive connection solutions	Delphi Automotive	$157
JAN-14	skobbler	DE	Location-aware applications and map technology for mobile devices	TeleNav	$24
NOV-13	MAC S.A.	CO	Production, distribution and recycling of batteries	Johnson Controls	

PRIVATE PLACEMENTS

(US$ in Millions)

DATE	TARGET	CTY	COMPANY DESCRIPTION	INVESTORS	"AMOUNT RAISED"
02/17	Argo AI	US	Artificial Intelligence for autonomous vehicle	Ford	1000 *
01/17	EasyMile	FR	Electric driverless shuttles	Alstom	$15
01/17	CloudCar	US	World-leading developer of connected driver experiences	Jaguar Land Rover	$15
01/17	99	BR	On-demand taxi and ride sharing company	Didi	$100
12/16	Mojio	CA	Cloud-based Platform for connected cars	Amazon; Deutsche Telekom; BDC Capital; Relay Ventures; BC Tech	$15
12/16	Parrot Automotive	FR	Supplier of infotainment and connectivity solutions	Faurecia	-
10/16	Navya	FR	Driverless vehicle tech company	Group8; Keolis; Valeo	$34
09/16	Karamba Security	IL	Security systems for connected cars	Fontinalis Partners; GlenRock; YL Ventures	$3
08/16	Quanergy Systems	US	Solid state LIDAR sensors and smart sensing solutions	Sensata Technologies; Samsung; Delphi; Motus Ventures; GP Capital	$90
08/16	Velodyne Lidar	US	Developer, manufacturer and supplier of LiDAR	Ford; Baidu	$150
08/16	Innoviz Tech.	IL	High Definition solid state LIDAR sensors	Vertex; Magma Venture; Delek Investments; Amiti Ventures	$9
07/16	Civil Maps	US	Geospatial AI-based mapping	Motus Ventures; Ford; StartX; Wicklow Capital; Yahoo Co-founder	$7
07/16	FiveAI	GB	AI-based autonomous vehicle software	Amadeus Capital; Notion Capital; Spring Partners	$3
06/16	TravelerCar	FR	Online car-sharing platform	PSA group	-
05/16	Zubie	US	Connected-car enabling device and mobile app	NGP; Magna; Innoventure; Comporium	$8
05/16	Zoox	US	Self-driving taxi and control system	AID Partners	$200
05/16	nuTonomy	US	Software for autonomous/self-driving passenger vehicles	Highland; Fontinalis; Signal Ventures	$16
04/16	Automatic Labs	US	Mobile phone based driver assist devices and apps	Comcast Ventures; USAA; CDK Global	$24
04/16	Auro Robotics	US	Autonomous campus shuttle service	Motus Ventures; Rothenberg Ventures	$2
03/16	NAUTO	US	Connected camera network and AI-driven smart cloud	BMW; Draper Nexus; Playground; Allianz; Toyota; Index Ventures	$12
03/16	TravelerCar	FR	Online car-sharing platform	MAIF	$6
03/16	Comma.ai	US	Open Source self-driving car kit developer	Andreessen Horowitz	$3
03/16	Almotive	HU	AI-based software for self-driving cars	Inventure; Robert Bosch; Draper Associates; Innoventure	$6
03/16	Drive.ai	US	Software enabling control of cars by small computers	Oriza Ventures; Northern Light	$12
02/16	Zendrive	US	Traffic data tracking application for mobile phones	Sherpa Ventures; Nyca; Thomvest Ventures	$14
02/16	5D Robotics	US	Secure positioning and navigation technology	Undisclosed investors	$6
01/16	Lyft	US	Ridesharing service	GM; Alibaba; Didi; Rakuten; Janus Capital; Prince Al Waleed	$1,000
12/15	Xevo (UIEvolution)	US	Cloud-based software solutions	Mirai Creation	$10
10/15	2GIS	RU	Cloud based application that provides mapping services	Baring Vostok; Ru-Net	$40
09/15	VuLog	FR	Software for electric vehicles fleet management	BPI; ETF; Opus	$9
07/15	Almotive	HU	AI-based software for self-driving cars	Robert Bosch; Day One Capital; Nvidia; Draper Associates	$2
07/15	RideCell	US	Fleet automation software solutions	BMW; Khosla Ventures	$12
04/15	Telogis	US	Cloud-based fleet management SW	Undisclosed investors	$40
03/15	GreenRoad Tech.	US	Driver behavior and fleet performance SW	Israel GP; Virgin Green; Amadeus; DAG Ventures; Benchmark	$26
03/15	Mojio	CA	Platform for secure connected car services	Deutsche Telekom Capital; BDC Capital; Relay Ventures	$8
03/15	Vizzuality	US	Mapping and geospacial vizualisation app	Accel Partners; Earlybird; Salesforce Ventures; Kibo ventures	$23
01/15	Cohda Wireless	AU	Safe vehicle and connected vehicle design solutions	NXP Semiconductors	-
12/14	Quanergy Systems	US	Solid state LIDAR sensors & smart sensing solutions	Rising Tide; Wicklow; Motus Ventures; Wardenclyffe (Tesla founders)	$30
10/14	Telogis	US	Cloud-based fleet management	General Motors	-
03/14	INRIX	US	Real-time and predictive traffic information	Porsche Family	$55
01/13	Cohda Wireless	AU	Safe vehicle and connected vehicle design solutions	NXP Semiconductors	-

KEY SECTOR NEWS

Apr-17	Ford, GM, Renault-Nissan, Daimler lead self-driving car race
Mar-17	Hyundai-Kia targets to launch a dedicated platform for battery electric vehicle
Mar-17	Daimler accelerates its electric car program
Mar-17	Didi Chuxing is reportedly considering a $6 billion investment backed by SoftBank Group
Mar-17	Uber suspends self-driving car program after Arizona crash
Mar-17	Porsche bets on digital services to counterbalance car-sharing
Mar-17	Tesla Looking to Raise More Cash to Help with Model 3 Production
Mar-17	BMW detailed its 2021 autonomous vehicle
Jan-17	Nissan to begin autonomous driving tests in London
Jan-17	Honda unveiled its first EV autonomous concept car
Jan-17	Valeo unveiled a range of 5 major innovations destined for autonomous and connected vehicles
Jan-17	Faraday Future unveils its first EV
Dec-16	General Motors to start autonomous vehicle manufacturing and testing in Michigan
Dec-16	BMW is creating an autonomous vehicle test center in Munich
Dec-16	China plans to adopt a national standard in vehicle-to-vehicle communication, fostering autonomous vehicle development
Dec-16	BlackBerry opens an autonomous vehicle research facility
Dec-16	PSA launches a car-sharing service in Madrid with a fleet of 500 Electric vehicles
Dec-16	Japanese robotics startup ZMP to delay Tokyo listing
Dec-16	Uber removes its autonomous cars from San Francisco due to regulatory issues
Dec-16	Ford will raise $2.8bn debt to fund new technologies including self-driving cars, EV and mobility efforts
Dec-16	Harman shareholder Atlantic Investment says no to the proposed $8bn acquisition by Samsung
Dec-16	Google creates Wayne, its new unit dedicated to self-driving cars
Dec-16	Michigan State enact first law for full autonomous testing and sales
Dec-16	Apple formalizes its self-driving car project in a letter to National Highway Traffic Safety Administration
Dec-16	BMW to launch its own autonomous ride-hailing scheme
Nov-16	Hyundai unveiled its EV autonomous concept car Ioniq
Nov-16	Nissan plans to offer a connection device solution to existing customers in Japan and India starting next year
Nov-16	Porsche targets to sell about 20,000 models per year of its all-electric car 'Mission E'
Nov-16	Audi hires new R&D chief coming from Volvo
Nov-16	NuTonomy to test autonomous vehicles in Boston
Nov-16	Jaguar unveils its first new electric SUV model

KEY INDUSTRY PARTNERSHIPS & R&D INVESTMENTS

Apr-17	Daimler And Bosch Plan to Bring Self-Driving Taxis to Cities
Mar-17	Microsoft and Toyota expand their partnership in connectivity
Mar-17	Nvidia and Bosch team up on self-driving car AI supercomputer
Feb-17	Renault-Nissan Alliance & Transdev to jointly develop driverless vehicle fleet system
Feb-17	BMW and Mobileye signed an agreement to generate new kind of sensor data
Jan-17	Panasonic to extend its partnership with Tesla into ADAS
Jan-17	Mercedes-Benz and Nvidia make a partnership to produce cars empowered by Artificial Intelligence
Jan-17	Nissan partners with Japanese internet firm DeNA to develop self-driving car
Jan-17	Partnership between Audi and Nvidia to develop self-driving cars by 2020
Jan-17	Ford and Toyota established SmartDeviceLink consortium to accelerate the implementation of standards for in-vehicle apps
Jan-17	Autoliv and Volvo Cars to set up JV to develop software for autonomous driving and driver assistance systems
Dec-16	Magna partners with Innoviz on Lidar for autonomous driving systems
Dec-16	BMW teams with IBM's Watson on driver-assist technology
Dec-16	Honda and Waymo discuss collaborating on self-driving technology
Dec-16	Volkswagen created its division for digital mobility services with a budget in the hundreds of millions of euros
Nov-16	BMW, Daimler, Ford and Volkswagen to build an European EV charging network
Nov-16	Intel teams up with Mobileye & Delphi for autonomous driving
Nov-16	Daimler is planning to invest €10bn in developing electric vehicles
Nov-16	BMW and Baidu to end self-driving car partnership
Nov-16	Jaguar Land Rover focuses on EV while setting aside self-driving vehicle
Nov-16	Toyota to create new team for EV development
Nov-16	Intel will invest more than $250m over the next 2 years to develop technology for autonomous vehicles
Oct-16	Renault, Nissan and Mitsubishi to share EV platform
Aug-16	Volvo and Uber join forces and commit $300m to develop autonomous driving cars
Jul-16	BMW, Intel and Mobileye team up to work on autonomous driving
Jul-16	Mobileye ends partnership with Tesla
May-16	Fiat and Google partner on self-driving minivans and ride-sharing
Mar-16	Toyota and Microsoft tie partnership to develop new vehicle connectivity and telematics services
Mar-16	Hyundai ramps up investments in AI and sets up a new business unit to develop 'hyperconnected' and self-driving cars
Mar-16	Valeo and Mobileye form an alliance for the design of front-facing camera & sensor systems
Sep-15	Volvo and Autoliv start the Drive Me project: the world's first largescale autonomous driving initiative

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CANATU — Series C financing — faurecia, European Investment Bank — € 22 000 000

VISEDO electricity in motion — Series D financing — emerald Technology Ventures — € 20 000 000

SKELE+ON TECHNOLOGIES — Secondary MBO — HARJU ELEKTER — € 10 000 000 — *Sole Advisor*

McPhy energy — Initial Public Offering — EURONEXT Paris — € 32 000 000 — *Bookrunner*

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