AUTOTECH

The Mother Of All Tech Battles

February 2019

GP. Bullhound

Dealmakers in Technology


GP. Bullhound

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Sven Raeymaekers
Partner

THE VIEW
From GP Bullhound

From the moment that Karl Benz built the first petrol-powered internal combustion engine automobile in Mannheim in 1885, car culture has relentlessly spread across the globe. Its impact has been nothing less than extraordinary: Das Auto has transformed global economies, shaped entire societies and tested the limits of engineering time and time again.

It is unquestionably one of the most important inventions in history. As it stands today, if the industry were an economy, it would be among the ten largest on earth.

More than 100 years after the petrol-powered car passed go for the first time - and despite worldwide sales at a record high in 2018 - stress fractures are starting to appear. Tesla is on track to outsell both BMW and Mercedes-Benz in the US, car sales in China are declining for the first time in decades, and several global automakers have issued profit warnings in recent months.

Indeed, the multi-trillion-dollar industry is facing unprecedented change across a number of fronts, including:

- **Social:** urbanisation and changing trends in car ownership
- **Political:** regulation and pollution levels
- **Technological:** autonomous driving, electrification and connectivity

Over the next 10-15 years, four trends are set to converge and potentially change the industry forever. They are: Electrification, autonomous driving, shared mobility, and connected experiences.

Car makers are, consequently, confronted with a myriad of challenges, particularly in relation to design and manufacturing, alongside changes to the business model and customer relationships.

In this new world, profits are expected to be redirected to areas where car makers lack prior knowledge and experience, while investment needs to be routed towards technology that in many cases remains untested.

As a result, we will undoubtedly see the emergence of new and powerful players in the mobility ecosystem.

It's common to compare the trials and tribulations of automotive with those of the mobile device industry, where value has shifted from hardware to software and ecosystems and, ultimately, has led to the demise of several global giants.

In this fast-moving world, one thing is for sure: auto industry leaders have no desire to see history repeat itself.

A TIME OF
Unprecedented Change

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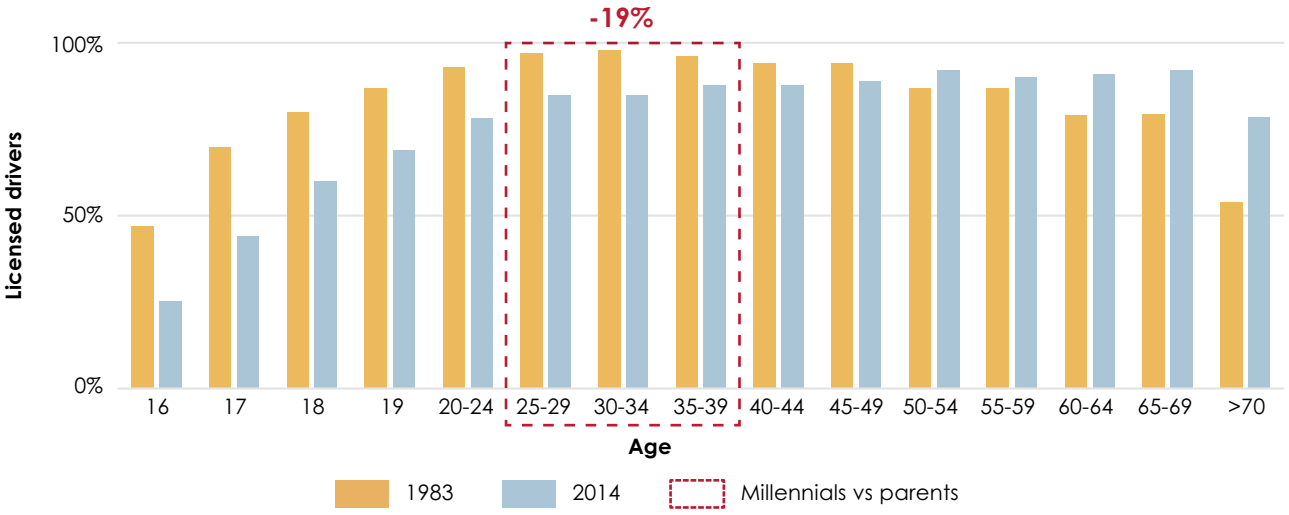
MACRO-ENVIRONMENTAL FACTORS
Are Impacting The Automotive Industry

Impacted by a number of macro-environmental factors, the multi-trillion-dollar auto industry is facing unprecedented change, with a number of social, political and technological drivers shifting and altering how businesses will perform for years to come.

Social

With people continuing to value the concept of sustainable living and embracing a pay-per-use and sharing economy, car ownership continues to fall in cities around the world, despite the world's urban population growing from 52% in 2010 to 55% today. Adding in time lost in seemingly endless traffic jams, ever-increasing parking costs, and the availability of various alternative modes of transport, including bikes, scooters and mopeds, it's perhaps not surprising to see only 36% of Parisian households owning a car in 2015, compared to 80% across France as a whole.

Proportion of age groups owning a drivers license (USA)



Political

Increasingly concerned with the wellbeing and protection of vehicle occupants and vulnerable road users, and equally applying to new standards in vehicle safety equipment as well as the operation of new mobility services, central and local authorities are calling for more stringent regulation to increase road safety. At the same time, pressure to limit the environmental impact of road transport is mounting, as illustrated by the introduction of emission targets, ICE bans, and subsidies for electrified vehicles. As vehicles progressively turn into data centres on wheels, more rigid rules are being called for around privacy data protection.

Technological

Over the past few years, we've experienced tremendous progress in terms of enabling technologies, providing a foundation for the advent of connected, autonomous, shared, and electric driving platforms. These technologies include advances in artificial intelligence, computer vision, and sheer computational power, as well as connectivity (bandwidth is set to increase hugely following the roll-out of 5G), fast evolving energy storage efficiency, and material management (such as 3D printing for instance).

Sources: GP Bullhound analysis, BCG analysis, 1. Insee, 2015

WHAT ARE THE KEY *Tech Disruptions*

ELECTRIFICATION

Despite seeing global sales of new electric vehicles quadruple between 2014 and 2017, the absolute share of plug-ins remains remarkably small. Compelled by increasingly tight emission standards and fear of being left behind, OEMs are nevertheless committing billions towards Electrification. Assuming price parity by 2024, and sufficient investment in supporting infrastructure, we can see the global electrified car count top 100 million by 2030.

Key hurdle:

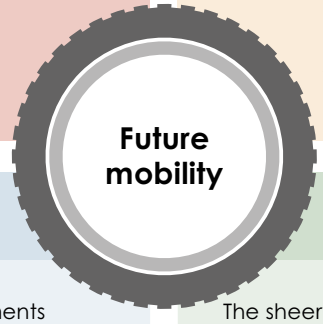
1. Supporting infrastructure
2. Price parity

AUTONOMY

With the potential to rid the transportation industry of its single largest cost, while at the same time making transport safer, cheaper, and more enjoyable, the stakes are monumental. With well over 50 companies investing heavily in driverless R&D, the market is experiencing a flurry of investments, partnerships and acquisitions. While Waymo and Cruise are arguably pulling out ahead, autonomous driving is very much a city-by-city battle leaving ample room for regional contenders to step up.

Key hurdle:

1. Legislative frameworks
2. Technology readiness



SHARED MOBILITY

Having received the lion's share of investments since 2014, shared mobility truly epitomises the coming of age of Autotech. Spearheaded by Uber and Didi – 2018 saw over half a billion people use some kind of ride hailing service – the sector continues to expand into new geographies and new modes of transportation. Once content with just minority stakes, OEMs and Tier 1 suppliers are increasing their grip on the space, launching their own services and acquiring competition in the process.

Key hurdle:

1. Legislative frameworks
2. Integration, multi-modality

CONNECTIVITY

The sheer volume of data being generated within the future automotive ecosystem will not only improve road safety, traffic management and efficiency, but will also transform how people interact with vehicles and experience mobility altogether. The explosion of data, effectively turning cars into data centres on wheels, will however require a redesign of both in-vehicle and vehicle-to-everything communication technology, as well as a fundamental discussion around data privacy and security.

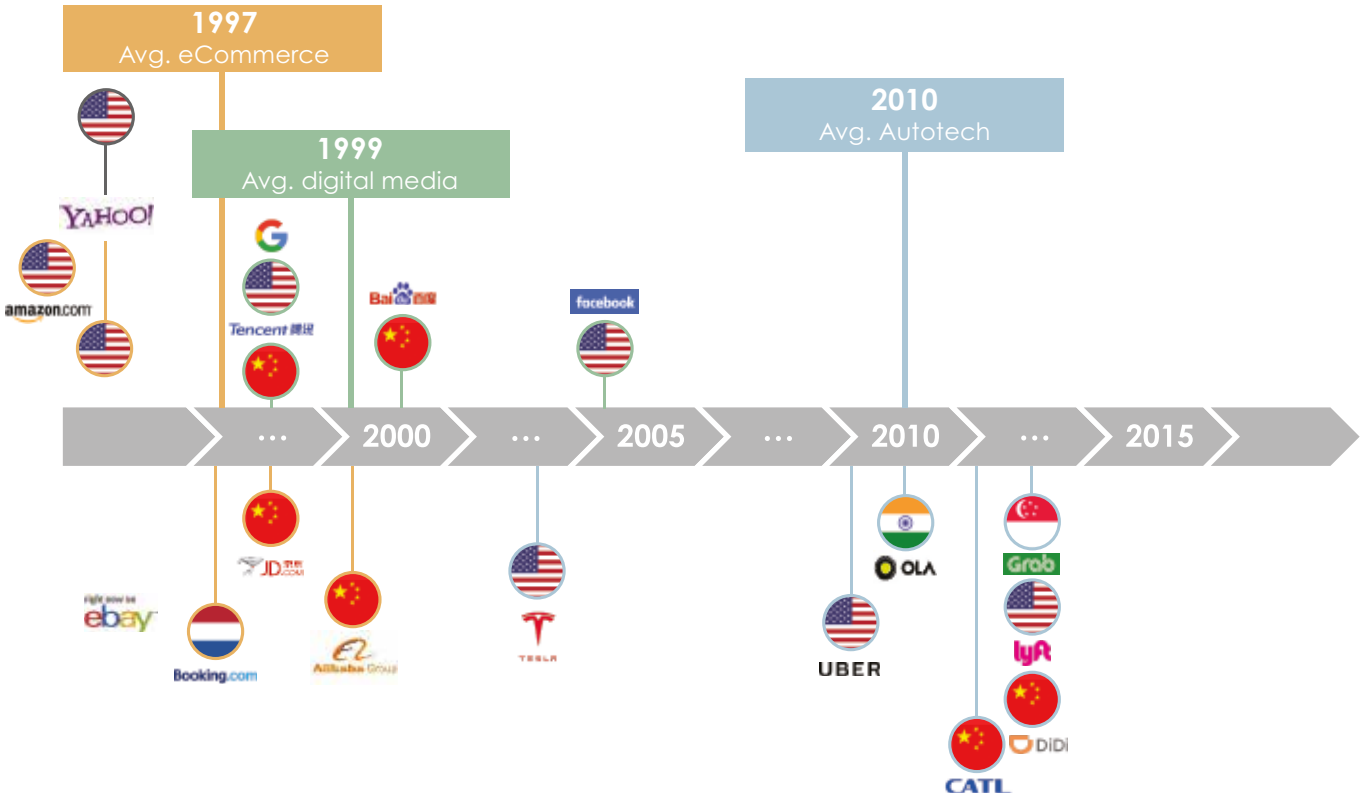
Key hurdle:

1. Standardisation
2. Privacy and security

DISRUPTION HAS COME LATE
But Will Have Lasting Effects

Held back in part by the progress in foundational technologies, and in comparison with eCommerce and digital media, disruption of the automotive industry has taken much longer to arrive. Indeed, recent progress in key enablers, such as artificial intelligence, computer vision, broadband mobile connectivity and energy management have paved the way for Autotech to really flourish. Smartphone penetration for one, has been instrumental in the widespread adoption of the industry's so called killer app: ride hailing. At the same time, capital investment for Electrification, Autonomy and Shared Mobility start-ups tend to be significant, and required a sufficiently mature venture industry to be able to finance daring bets in these spaces.

Launch date of current eCommerce, digital media and Autotech leaders



After a slow start, Electrification, Autonomy, Shared Mobility and Connectivity are set to converge over the next 10-15 years and profoundly change the automotive industry in its wake, effecting lasting changes on product design, supply chain management, manufacturing, distribution, business models, sales and marketing.

The key questions those in the industry will need to answer going forward are:

- How will value be distributed?
- Who will own the customer relationship?

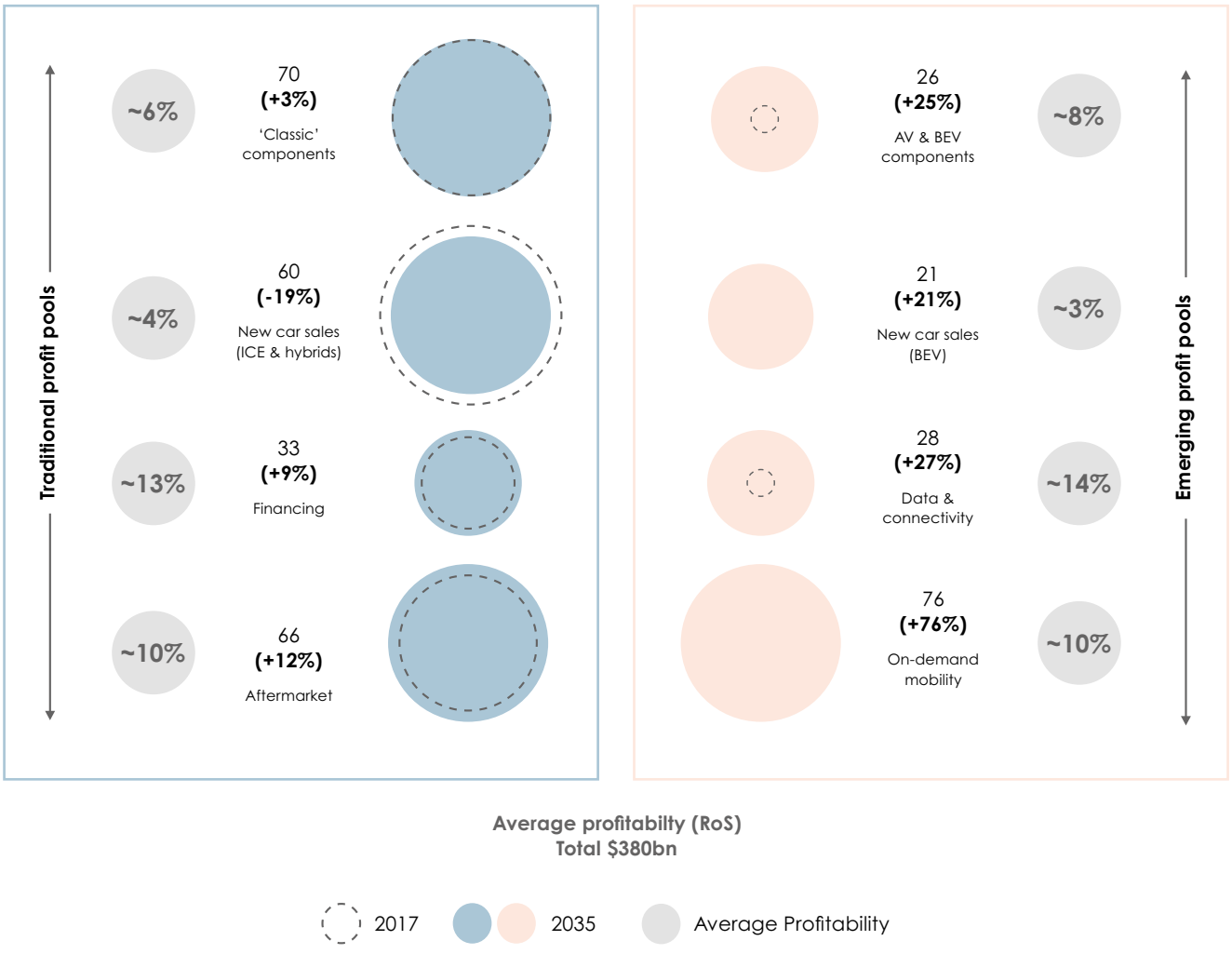
Sources: GP Bullhound analysis, BCG analysis, http://www.umich.edu/

SOFTWARE IS EATING
The Car

Since 1885, the key competencies of carmakers have arguably centered on shell design and the internal combustion engine. Software has never been core and, until recently, it was mostly outsourced to a supplier network.

In a similar vein to the reshaping of the mobile device industry in the 21st century, where value moved from hardware to software and ecosystems, profits are expected to shift to areas where original equipment manufacturers do not have a legacy - or disappear altogether.

Profit pools – future (2035, in $bn)

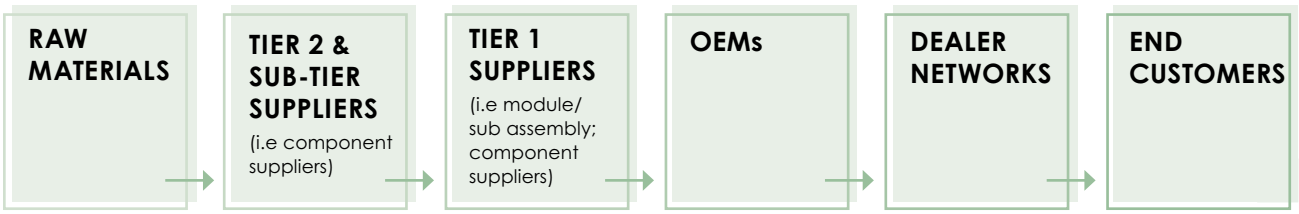


Sources: Goldman Sachs, HBS, BCG https://www.bcg.com/publications/2018/profit-tech-transforms-mobility.aspx. Note: 2Emerging profit pools includes mobility, data and connectivity, BEV car sales, AV and BEV component suppliers. BEV: Battery Electric Vehicle. ICE: Internal Combustion Engine

THE CAR IS DEAD
Long Live Mobility

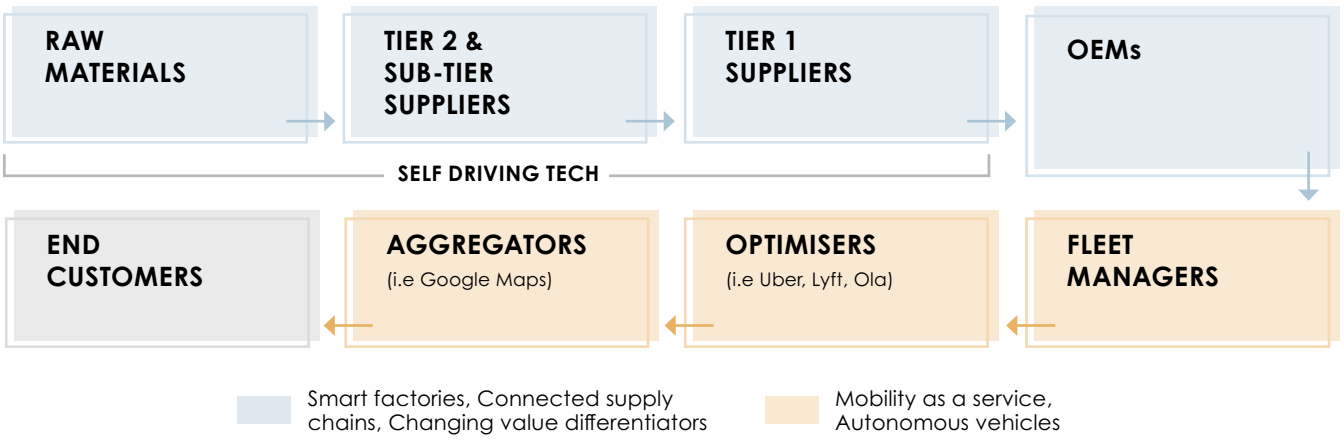
The automotive value chain – similar to its key competencies – has remained largely unchanged over the last 100 years, with a direct line between suppliers and customers tightly controlled by omnipotent auto manufacturers.

Old Value Chain



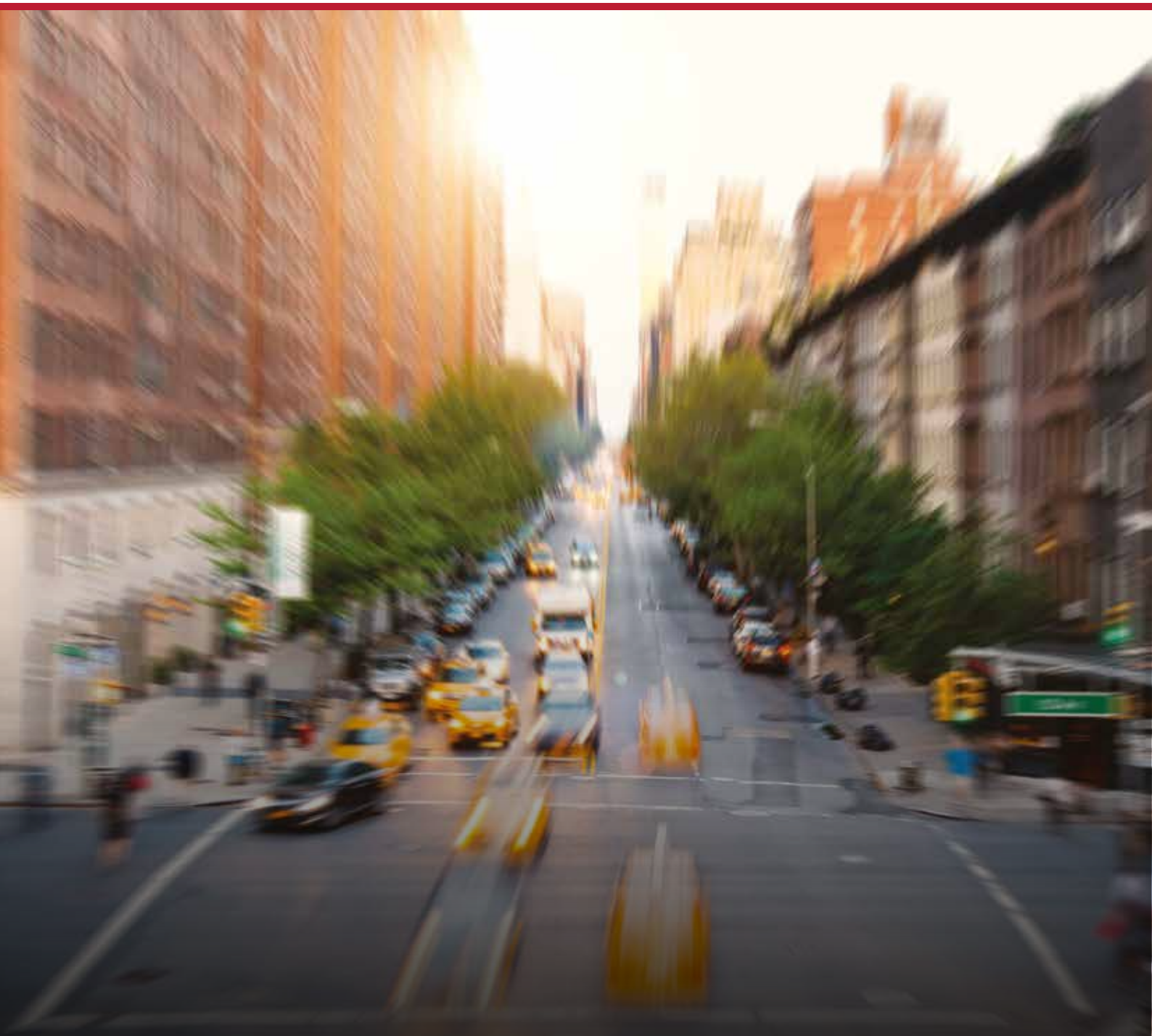
As the actual product shifts from the car to mobility-as-a-service, original equipment manufacturers find themselves in a new and increasingly more complex value chain, with several new entrants all vying to gain control of the customer relationship and reduce car makers to de facto contract manufacturers.

New Value Chain



The developing notion of urban mobility is also rapidly expanding carmakers' competitive landscape, and now includes bikes, scooters, high speed underground pods, and even aircrafts. We have seem Daimler invest in Volocopter, Tencent leading a $90m round in Lilium Aviation, and GM unfolding plans to bring electric bikes to market in 2019.

Sources: AT Kearney



THE GROWING INFLUENCE
And Power Of Tech Players

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AUTOMOTIVE WALL STREET KINGS

Ousted By Tech Usurpers

With seven out of ten of the highest earning corporations being either car makers or oil and gas businesses in the 1970s, automotive dominated big business in the US. Flash forward to 2018, and these auto giants have all been replaced by tech companies

10 Largest US-based Public Companies By Net Income

	Top US companies in 1970	1970 Net income ($m)
1	General Motors	1,711
2	Exxon Mobil	1,048
3	IBM	934
4	Texaco	770
5	Gulf Oil	611
6	Ford Motor	547
7	ChevronTexaco	454
8	Mobil	435
9	Kodak	401
10	DuPont	356

	Top US companies in 2018	2018E Net income ($m)
1	Apple	59,338
2	Microsoft	33,477
3	JP Morgan Chase	31,521
4	Alphabet	31,459
5	Bank of America	25,990
6	Berkshire Hathaway	24,154
7	AT&T	23,688
8	Johnson & Johnson	22,262
9	Facebook	21,530
10	Intel	21,299

Auto Auto-related Tech Network

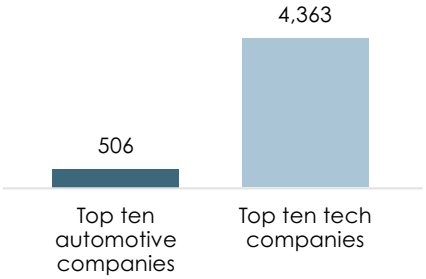
Sources: Capital IQ. Note: As of 31 Dec 2018

THE GROWING INFLUENCE AND POWER
Of Tech Players

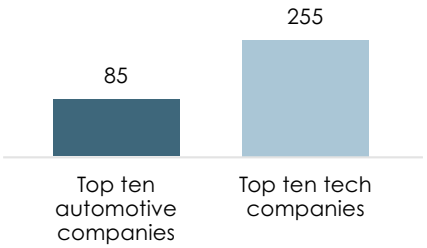
Tech leaders now hold a clear advantage in terms of scale: their profits are superior and growing faster, and their cumulative market capitalisations are almost ten-fold larger than in automotive. As a result, their ability to finance research projects, and expand into new and unproven fields is considerably larger.

Furthermore, leading tech companies invested almost twice as much in R&D as their automotive counterparts in 2017, whilst increasing their R&D spend more than five times faster annually.

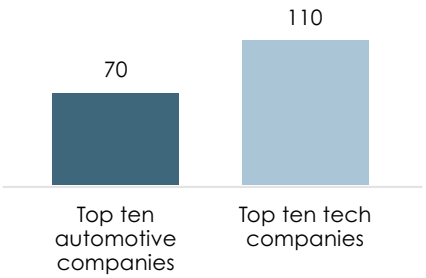
Cumulative market cap in Dec 2018 (in $bn)



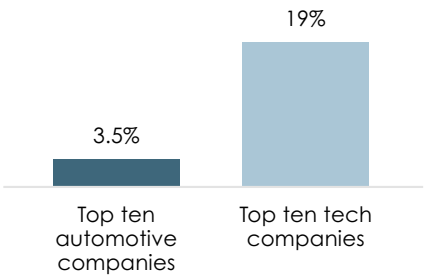
Cumulative net income in 2018 (in $bn)



Cumulative R&D in 2017 (in €bn)



R&D growth 2016-2017



Sources: Capital IQ, McKinsey.Tech companies are Apple, Samsung, Microsoft, Alphabet, Intel, IBM, Facebook, Tencent, Softbank, Amazon. Automotive companies are Volkswagen, Toyota, Renault, General Motors, Hyundai, Ford, Honda, Fiat, Peugeot, Daimler.

TECH PLAYERS

Key Movements

While most native tech players have entered the automotive space fairly recently, many of them are determined to establish themselves as global leaders in mobility. Some of them, including Waymo, have already managed to pull out in front of traditional automotive players in key areas of Autotech.

	Start date of communication	Autotech PP[1]	Autotech M&A[1]	Strategy
Alphabet	2009	c.10 LimeBike, Lyft, CARMERA, Manbang	c.5 Mobileye, Skybox Imaging	Early presence in cars via Google maps and Waze. Building Waymo as the world's leading autonomous driving solution. Partnering with automakers to equip cars with Android Auto & Google Assistant
	2014	c.5 DiDi	c.5 MAPSENSE, COHERENT, Perceptio	Offering automakers the CarPlay entertainment OS (available on car models from automakers such as Volkswagen, Peugeot, BMW, Honda etc.)
Baidu 百度	2014	c.10 NIO, WELTMEISTER, Uber, 易鑫资本	c.5 xPerception	Developing project Apollo: autonomous driving open source software platform offering free HD mapping, autonomous driving & testing platform, data sharing and deep learning capability -100+ partners to date, 10,000 developers
intel	2014	c.15 PELOTON, PROPHESEE, PERRONE ROBOTICS	c.5 Mobileye	Combining Intel processor technology with Mobileye computer vision expertise, in order to offer automotive leaders smart and connected solutions for transportation. Favouring partnerships with market participants such as Baidu, BMW and Fiat Chrysler
SAMSUNG	2015	c.20 AIMOTIVE, QUANERGY, INNOVIZ, IMAGRY	c.5 HARMAN, MAGNA STEYR (Battery pack business)	Automotive division reinforced by acquisition of Harman (infotainment) in 2016. Launched a USD 300m autonomous driving investment fund in 2017. Unveiled in January 2018 DRVline, a hardware and software platform delivering autonomous driving to auto manufacturer partners
SoftBank	2014	c.30 INNOVIZ, Uber, DiDi, OLA, Grab, nauto, ParkJockey	c.5 apical[1], stream[1]	Numerous investments across the value chain, in Chips & Components (Nvidia), AI & Navigation (Mapbox, Nauto), and Ride Hailing (Grab, Uber, Didi). Large co-investments with GM (Cruise) and Toyota (Autonomous Driving)
Tencent 腾讯	2014	c.25 DiDi, Lyft, OLA, GO-JEK	n.a	Accelerating its shift to becoming a "digital assistant to all industries". In Autotech, Tencent Smart Mobility initiative, combining in-car systems (Tencent Auto Intelligence), Tencent Passenger Ride Code (for multi-transport payment solutions), and autonomous driving including HD mapping and simulations
Yandex	AV: 2016	n.a	c.5 nowtaxi, Opteum	Operating ride-sharing platforms in Russia (Yandex.taxi). Developing autonomous driving solution, with proprietary software stack, and experimenting with driver-less passenger rides
DiDi	AV: 2016	c.20 taxify, Careem, Lyft, OLA	c.5 bluegogo, Uber China	Having pushed Uber out of China, expanding worldwide mainly via investments in local ride hailing platforms. Testing self-driving cars in China and the US, expecting to launch autonomous taxis in 2019
TESLA	AV: 2014	c.5 ALTA MOTORS	c.5 GROHMANN ENGINEERING	Favouring in-house development of disruptive technologies in Electric, autonomous driving, infotainment, production automation etc. Some partnerships like with Panasonic on batteries
Uber	AV: 2015	c.5 LimeBike, Xchange Leasing	c.5 OTTO, JUMP	Aggressively developing internationally. Expanding service to 2-wheel free float, delivery etc. Relying on partnerships (Toyota, Volvo etc.) to accelerate autonomous taxis development

Notes: Transactions from 2015 to 2018, (1) Through ARM Holdings

Tech players Pure Autotech players

AUTOMOTIVE PLAYERS
Key Movements

Incumbent automotive players are not staying idle, and though mobility services are a relatively new topic for traditional automakers and parts suppliers alike, communication around impending Electrification and Autonomy started as early as the 2000s and 2010s respectively. Today, most players are engaged in aggressive roll-out plans, which incorporate investments, mergers, and acquisitions.

	Start date of communication	Tech PP[1]	Tech M&A[1]	Strategy
BMW	EV: 2006 AV: 2016	c.30	c.5	Focus on individual premium mobility of the future, merging intelligent design, electric drive train, Autonomy and digital connectivity. Aiming for 25 electrified models in 2025 and level 5 autonomous capability by 2021
DAIMLER	EV: 2001 AV: 2013	c.25	c.5	Transforming itself from an automaker into a provider of mobility services. Aiming for at least 10 fully electric cars by 2022 and level 4/5 Autonomy in robo-taxi in 2019
VW	EV: 2007 AV: 2010	c.10	c.5	To become a world-leading provider of sustainable mobility. Looking to spend €44bn on electric and Autonomy by 2023, bringing 30 new electric vehicles to market by 2025 and level 4/5 Autonomy in robo-taxis under Moia banner by 2021
Ford	EV: 2003 AV: 2015	c.10	c.10	Making people's lives better through greater mobility, more connectivity, less congestion and reduced emissions. Aiming to launch 40 new electrified vehicles by 2022 and level 5 Autonomy in ride-sharing by 2021
GM	EV: 2004 AV: 2015	c.20	c.5	Working towards a future of zero crashes, zero emissions and zero congestion. Planning for 20 electrical vehicles by 2023 and commercialising cruise at scale in 2019
NISSAN	EV: 2007 AV: 2013	c.10	n.a	To become a major player in new mobility solutions. Targeting annual sales of 1 million electrified Nissan and Infinity vehicles, 20 models in 20 markets with autonomous driving technology, all by 2022
PSA	EV: 2001 AV: 2015	c.5	c.5	To be a provider of mobility solutions to enhance customers' freedom of movement on a day-to-day basis and around the world. Offering electric or hybrid version on its entire new line-up by 2019 and level 4/5 Autonomy starting in 2020
RENAULT	EV: 2008 AV: 2014	c.10	c.5	To become a major player in new mobility solutions. Targeting EV leadership with 8 battery electric vehicles and 12 electrified models, a push on connectivity and the launch of 15 models with autonomous drive capability, all by 2022
TOYOTA	EV: 2001 AV: 2014	c.20		Transform from a car-making company into a mobility company. Aiming to launch 10 new battery electric vehicles worldwide by the early 2020s and electric options throughout itsline-up by 2025, with L4 Autonomy by 2020 on some cars
HYUNDAI	EV: 2002 AV: 2015	c.10	n.a	To lead future innovations in the industry and invest in new technologies and businesses. Planning to introduce a "large" number of electric vehicles by 2025 and level 4 Autonomy by 2021
BOSCH	EV: 2006 AV: 2009	c.40	c.5	To be the go-to partner for electrified, automated, and connected mobility. Aiming to develop a mass-producible AI computer, acting as the brains for driverless cars
Continental	EV: 2002 AV: n.a	c.5		To make mobility clean, safe, more intelligent and affordable for all. Focus on AI, employing 700 experts by 2021, and V2X communication to eradicate vehicle accidents
DELPHI APTIV	EV: 2010 AV: 2015	c.5		To usher in the next generation of active safety, autonomous vehicles, smart cities and connectivity. Ongoing L4 Autonomy pilot with Lyft
DENSO	EV: 2005 AV: 2015	c.10		To craft the core technologies for the future of mobility, primarily focused on Electrification and Autonomy

Notes: Transactions from 2015 to 2018, (1) Through ARM Holdings

OEMs | Car parts manufacturers

MAKING THE CASE

For The Automotive Industry

Christian Herrmann

Director M&A Technology and Venture, Daimler

The automotive industry is heading in several directions. While developing autonomous vehicles definitively is a focus, this does not mean the end for human drivers once autonomous driving vehicles are on the road.

Mobility is in Daimler's DNA and so we continue to invest in its many forms to develop it even further: including the autonomous and self-drive technologies that fuel it.

At Daimler, we operate on a global scale so we naturally take a worldwide view on how we can improve mobility everywhere. However, local operations also remain in our focus because of the different needs of people in their local markets.

Based in Stuttgart, we have a strong core team where our investment and innovations strategies are aligned. This overlapping strategy is based around a future where autonomous and self-drive exist in harmony.

We call it CASE: Connected, Autonomous, Shared, Electric. The winning player in the mobility space will have to be successful within these four areas simultaneously.

Connectivity comes with two discussion points. The first of these is often forgotten: the connection of the user before even stepping into the vehicle – from dealership to the first drive. We improve the customer experience of buying a car. To do that, we are also exploring investment opportunities in car financing start-ups, which would make the purchase period an easier, overall better experience for the customer.

The second is about what goes on in the car itself, principally surrounding the driverless technology. To what extent will we use our phone or even work while being driven in our autonomous vehicle? How do you make the passenger connect to a car they do not drive? These are questions that keep our innovators and engineers inspired.

In addition to our own research and development activities we are investing heavily to get the technology we need. But regulation is also key to fully-automated driving; we will always be conservative in our approach to ensure we align with regulation. We will do what is allowed and we will test – at development stage – what is possible. But to get approval and implementation in each region we operate in, we will have to diligently monitor regulation developments to establish when it is realistic to deliver commercial, self-driving cars.

For manufacturers, the rise of car-sharing and on-demand mobility leads to questions around how to respond to driver trends that will result in cars spending less time on driveways, and more frequently taking short trips rather than cross-country journeys. It surely looks to be a good thing for manufacturers, who will need to supply the car-sharing companies with their vehicles.

Electrification is of course one of the more immediate changes facing the automotive industry. The CAS of CASE are all being worked towards and constantly improved, but the E is something every car manufacturer will need to make their dominant output.

As someone who works with tech companies and start-ups, I'm aware of what new competitors are capable of doing and we are teaming up where it makes sense for both sides.

We see this time and again at our corporate accelerator, Startup Autobahn – we pitch it as the 'Spirit of Silicon Valley in the hub of mobility engineering'. It is an innovation platform that unites young global tech companies with the best German engineers. To retain our position as industry leaders, we need to keep innovating, investing and acquiring, but we don't say 'maybe this is an area we should make investments, and this other area is only for acquisitions', it is decided on a case-by-case basis.

For the major players in the automotive industry today to be here tomorrow, they will need to find new ways to connect users to their ever-more efficient cars; protecting drivers, passengers and the environment along the way.

Deceember 2018

AUTOTECH INVESTMENTS

Growing From Strength To Strength

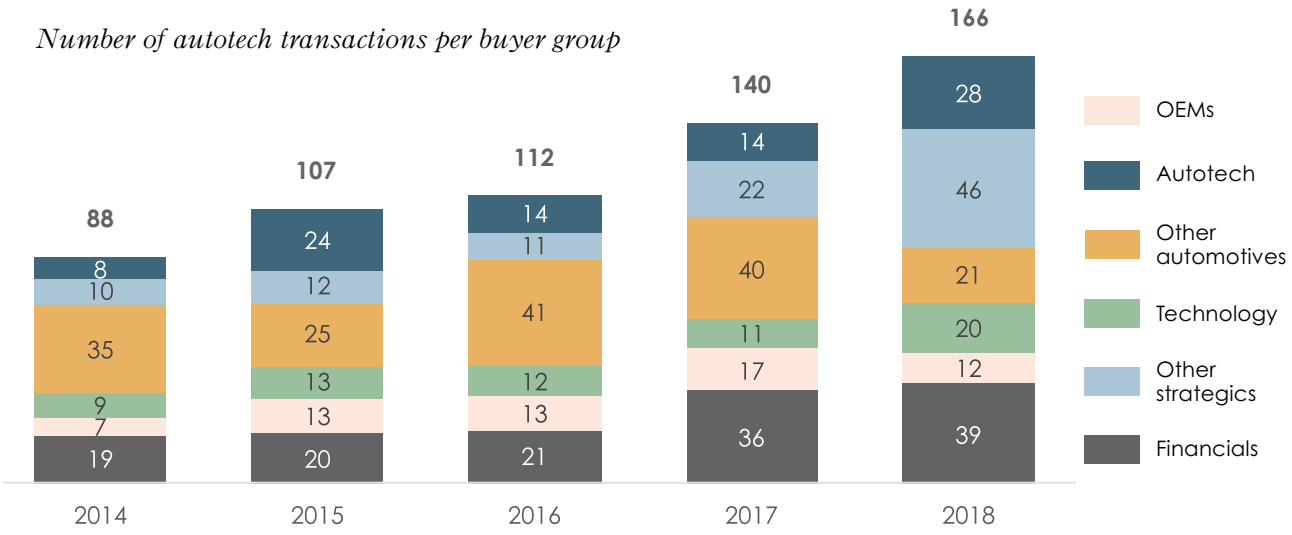
GP. Bullhound

M&A AUTOTECH

Ramping Up

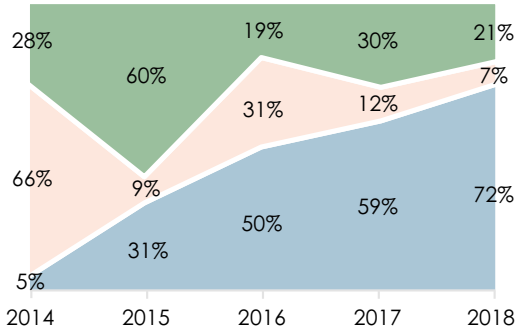
The past few years have seen a steady increase in acquisitions within the Autotech industry – culminating in a huge 166 transactions in 2018, with transactions including DiDi Chuxing's acquisition of 99 Taxis and Meituan's acquisition of Mobike. As the sector matures, it is attracting more sophisticated buyers – major financial services names are injecting significant amounts of money into the space. In addition, 2018 saw a significant increase in M&A by other strategics, showcasing the breadth of companies fighting for future market dominance.

Number of autotech transactions per buyer group

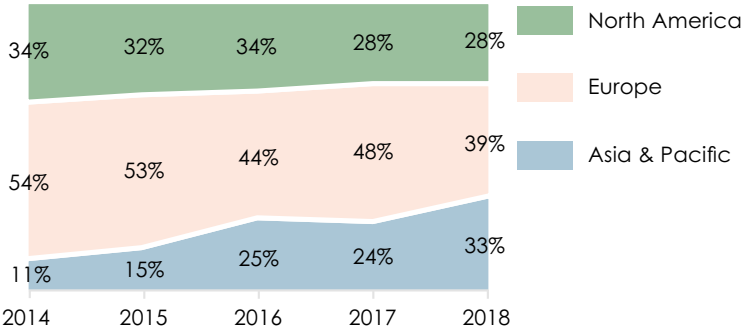


Europe in 2018 remained the most active market worldwide in terms of the number of transactions, with 39%of all global transactions. This is in marked contrast to its share of total transactions value, which has declined since 2014, to less than 10% in 2018. This highlights the difficulties for European Autotech startups to scale, as well as the fact that many European targets are local Shared Mobility players acquired by consolidators (see analysis overleaf).

Transactions by target region (% of value of transactions)



Transactions by target region (% of total number of transactions)



Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information. (1) H2 2018 extrapolated based on proportions in H1/H2 2017 and H1 2018

EUROPE DOMINATES AUTONOMOUS DRIVING

Electrification Hots Up In Asia

Europe has been the main target for acquisitions since 2014, particularly in regards to Electrification and Shared Mobility. Meanwhile, there is a clear focus on Electrification in Asia, while shared mobility has also gained momentum there. The cumulative value heat map has been shaped by two mega deals – Intel and Mobileye, Samsung and Harman.

Percentage of transactions per target region, category and selected targets 2014-2018

	ASIA & PACIFIC	EUROPE	NORTH AMERICA
ELECTRIFICATION	asimco, Yinlong	SEVCON Electrification Partner, ZKW	BRAMMO, Remy
AUTONOMY	DYNAMIC MAP PLATFORM, SB Drive	AUTONOMOS, MOBILEYE	nuTonomy, OTTO MOTORS
SHARED MOBILITY	TAXI FOR SURE, mobike	DriveNow, Xmytaxi	juno, Metavera
CONNECTIVITY	FleetLogistics, YELLOW	Fleetmatics, Zenith	HARMAN, LOJACK

Cumulative value of transactions per target region, category and selected targets 2014-2018

	ASIA & PACIFIC	EUROPE	NORTH AMERICA
ELECTRIFICATION	asimco, Yinlong	SEVCON Electrification Partner, ZKW	BRAMMO, Remy
AUTONOMY	DYNAMIC MAP PLATFORM, SB Drive	AUTONOMOS, MOBILEYE	nuTonomy, OTTO MOTORS
SHARED MOBILITY	TAXI FOR SURE, mobike	DriveNow, Xmytaxi	juno, Metavera
CONNECTIVITY	FleetLogistics, YELLOW	Fleetmatics, Zenith	HARMAN, LOJACK

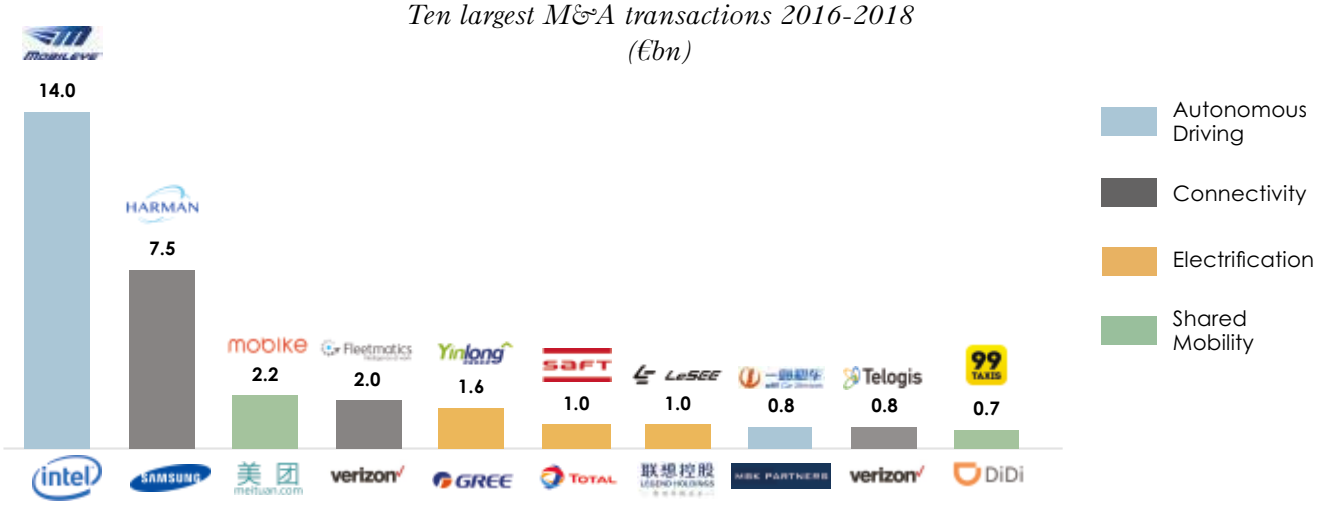
0-5% 6-10% 11-15% 16-20% 21-25% 25%>

Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information.

TOP 10
M&A Transactions

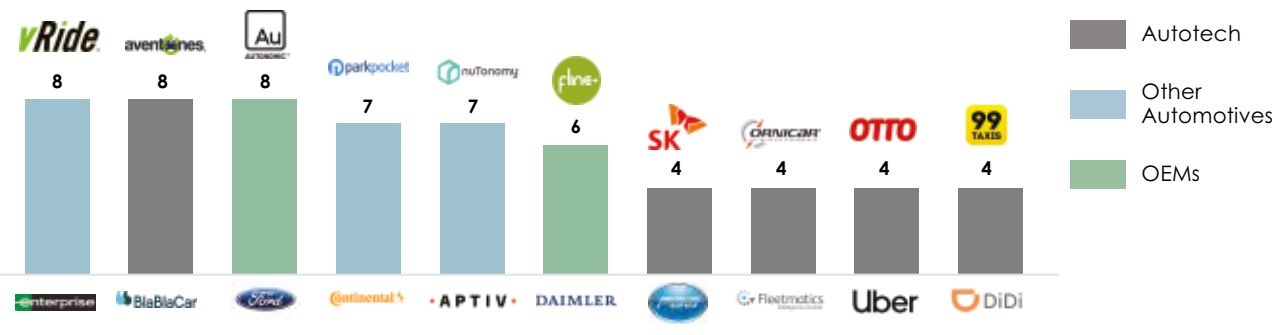
Among the top 10 largest M&A transactions between 2016 and 2018, we have transactions across all 4 subsectors. While active acquirers in the sectors, OEMs are not represented in the top 10, suggesting that they focus on smaller strategic deals.

Ten largest M&A transactions 2016-2018
(€bn)



As the automotive value chain shifts, OEMs and tier 1 suppliers are expanding the technology stack to stay ahead. As a consequence, prolific acquirers of Autotech companies include Enterprise, Continental, Aptive, Ford, and Daimler. In addition, leading Autotech companies are expanding their service offering through complementary acquisitions.

Ten most prolific M&A buyers 2014-2018
(number of deals)

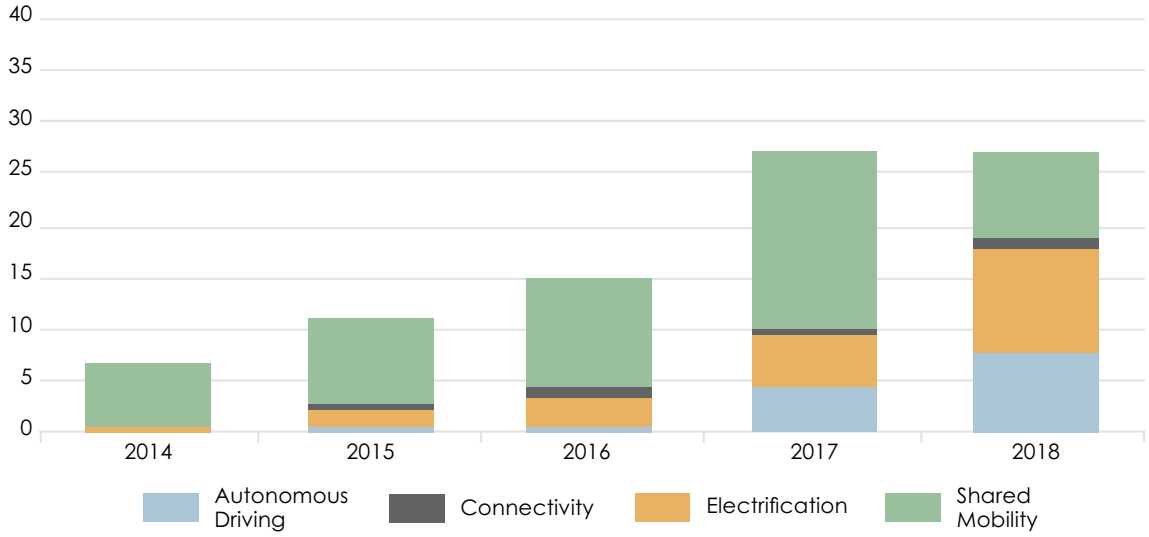


Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information

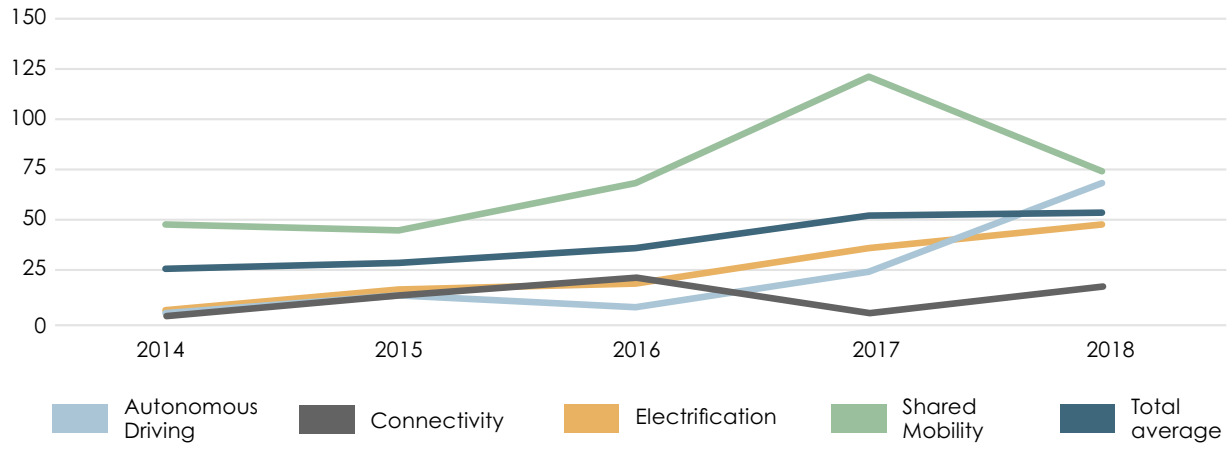
THE FUNDING ENVIRONMENT
At A Glance

While funding increased steadily between 2014 and 2017, the market experienced a stagnation in growth in 2018. Historically, Shared Mobility received the bulk of investments, but an increasing attractiveness of Electrification and Autonomous Driving are driving significant growth in funding. While the average investment size has been increasing for most sectors throughout 2014 to 2018, Shared Mobility saw a drop in 2018 as number of mega rounds decreased. Overall, increasing ticket sizes signalling heightened interest in the space as well as the growing scale of the Autotech leaders.

Total transaction value by sector (EURbn)



Average transaction size (EURm)

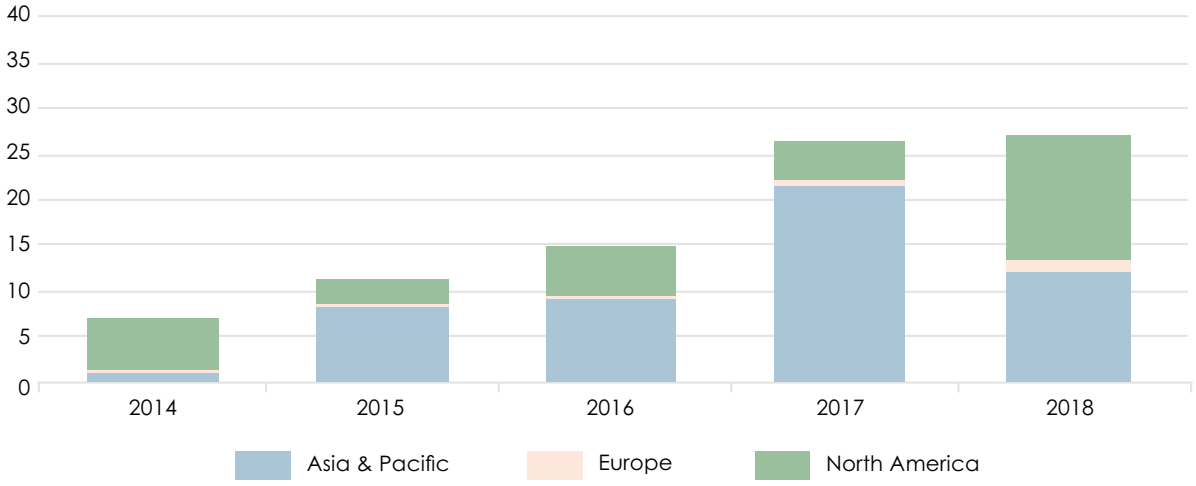


Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information.

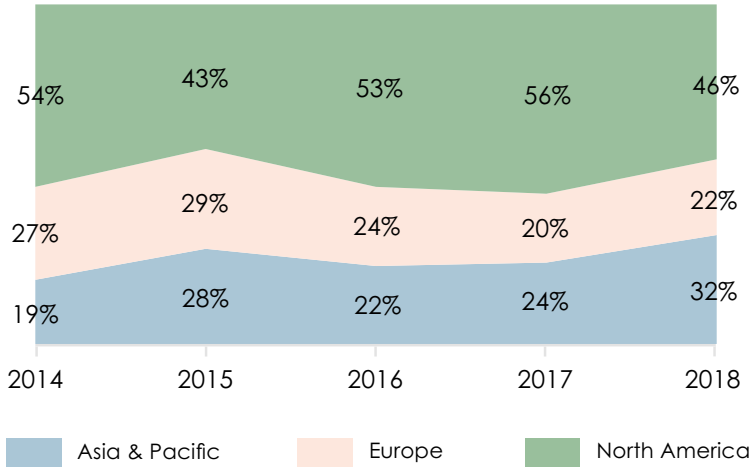
TRANSACTIONS
By Geography

Europe is lagging behind the larger funding levels seen in the US and Asia. Strong bounce back for North America in 2018.

Total transaction value by geography (EURbn)



Transactions by geography (% of total number of transactions)



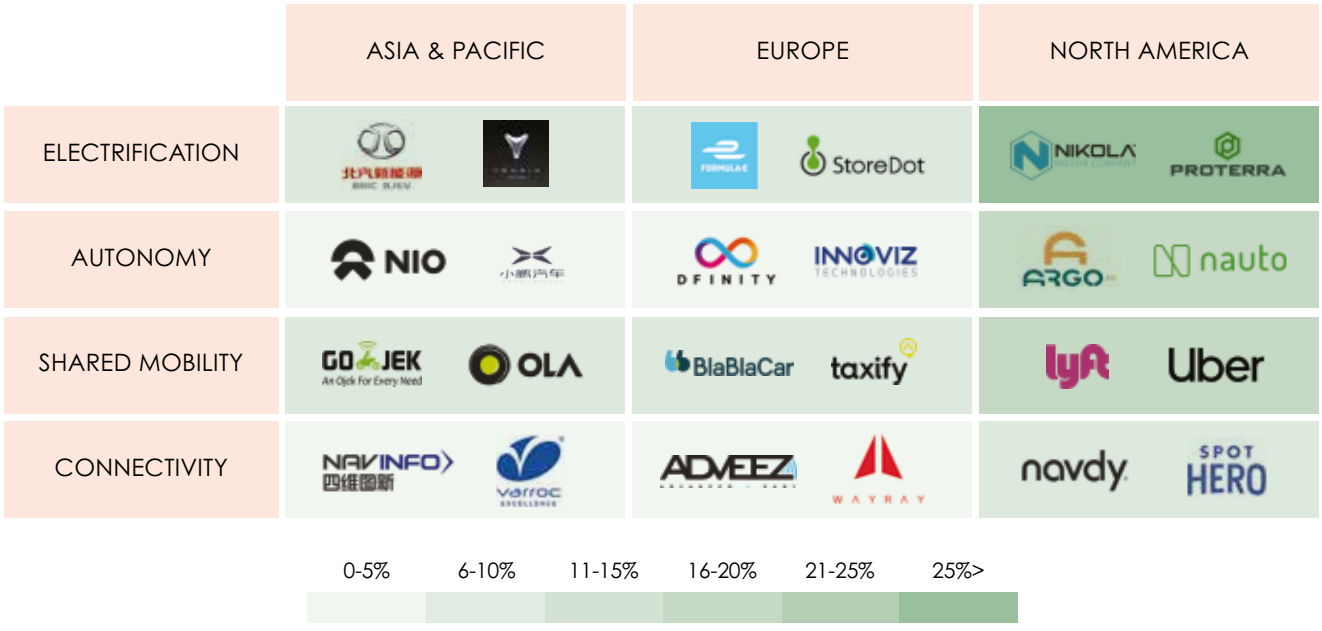
Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information.

FUNDING ENVIRONMENT

Transactions

Investments into ride hailing services are driving the bulk of investments in North America (Uber, Lyft) and Asia (Didi, GO-JEK, OLA). North America leads in terms of the number of deals – with significant investment activity in Autonomous Driving, Electrification, and Shared Mobility – while in Asia, deal activity is mainly driven by a few large transactions.

Percentage of transactions per target region, category and selected targets 2014-2018



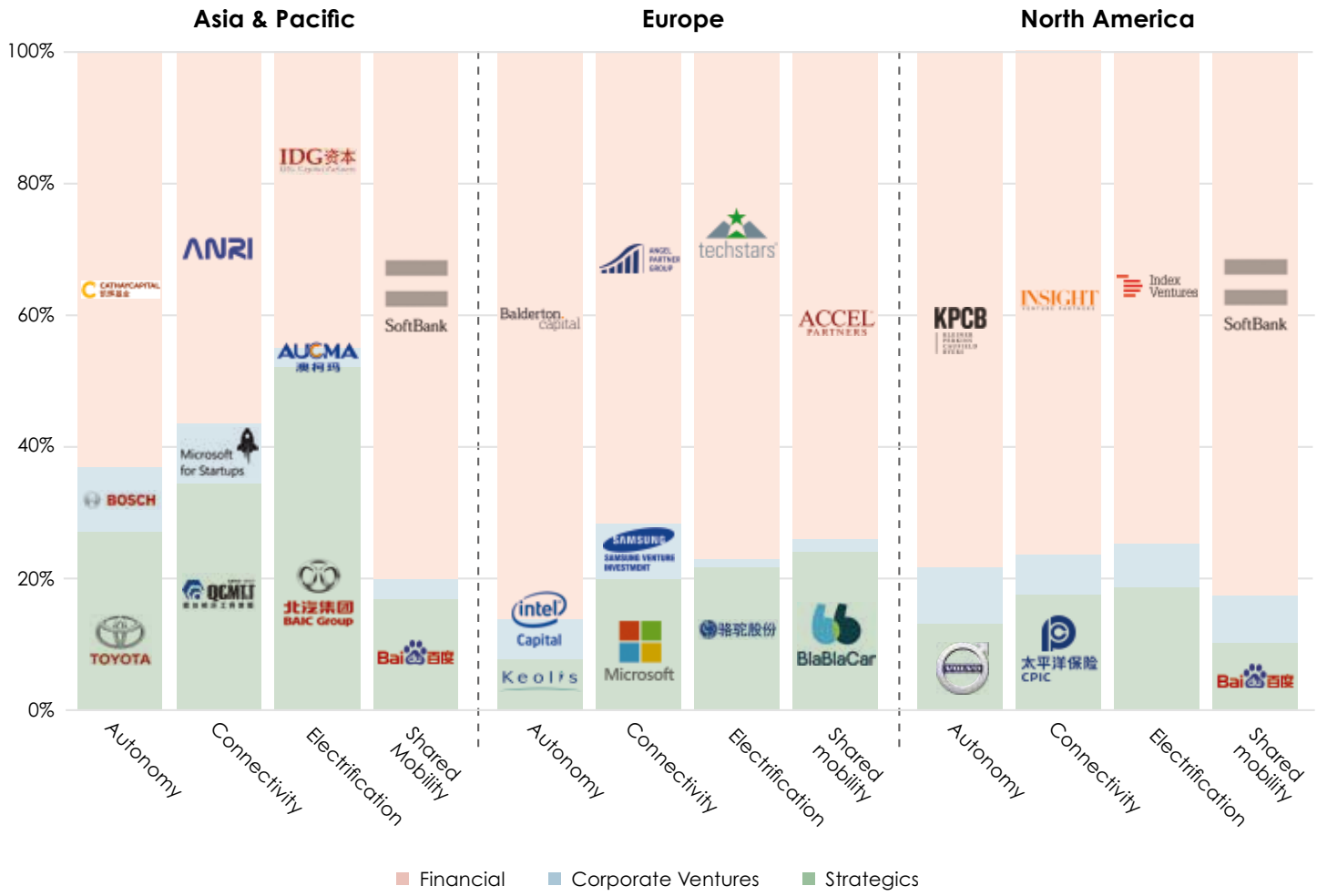
Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information.

FUNDING ENVIRONMENT

Investors

Overall, financial investors have dominated the funding rounds in Autotech, representing 73% of all investors. Notable exceptions include Electrification in Europe and Asia, and connectivity in Asia, where strategic investors have actively invested. OEMs and some tech companies have joined late stage rounds in shared mobility platforms, although financial investors have led investments in the space overall.

Share of investor type by target region and category
(Percentage of number of transactions per investor region and category)



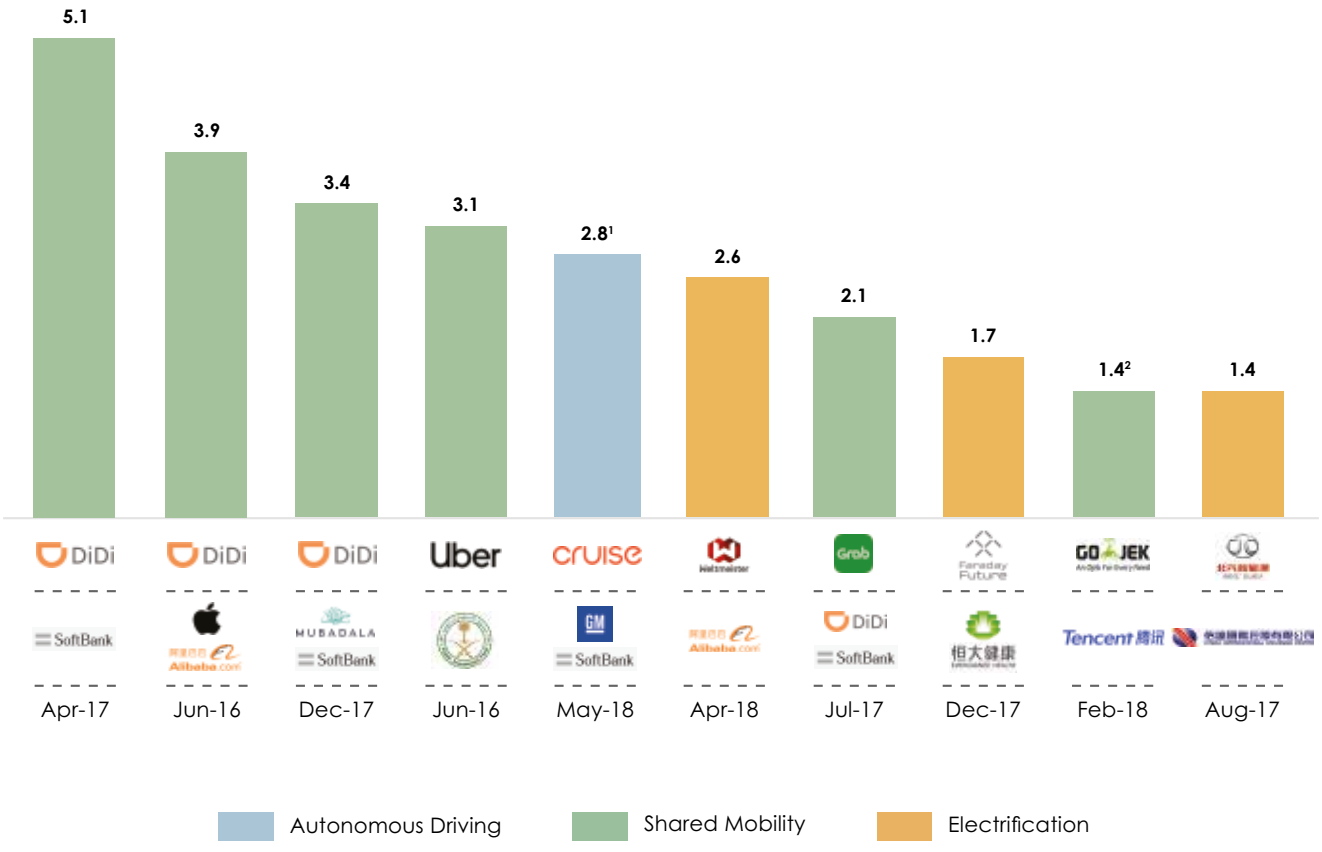
Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information.

FUNDING ENVIRONMENT

Top Ten Fundraises

DiDi Chuxing and Uber top the fundraising list, having raised €34bn in total – which helped to propel them to Titan status with valuations of over $50bn.

Ten largest fundraises 2016-2018
(€bn)



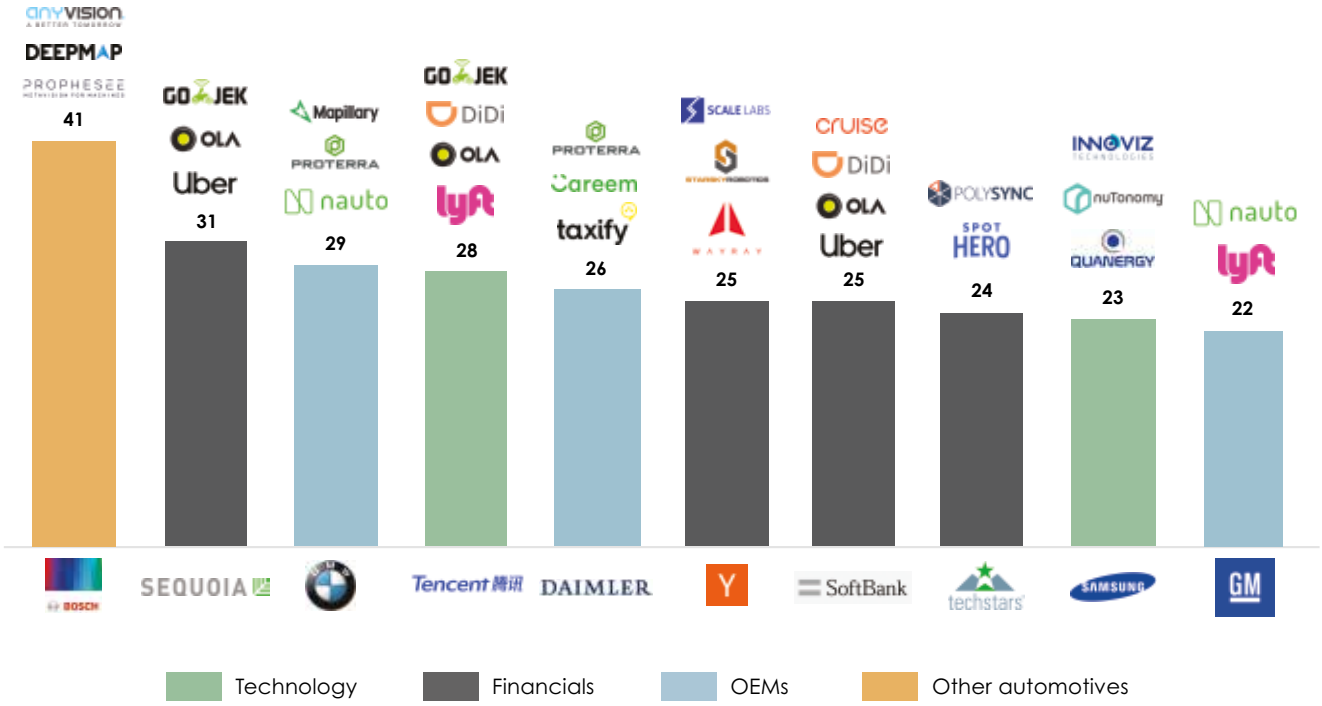
Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information. 1) Deal value includes EUR 1,140m in committed capital from Softbank to be invested when Cruise AVs are ready for commercial deployment. 2) Titan: Company founded after 2000, valued at USD 50bn or more

FUNDING ENVIRONMENT

Top Ten Investors

The diverse group of prolific investors showcases the strong need for companies to adapt to a new reality.While financial investors represent more than 70% of the investments overall, the picture differs in the group below. Of the top ten most prolific investors, 6 are strategic. This would indicate that companies like Bosch, Tencent, BMW, Daimler and the likes are pulling ahead of their competitors.

10 most prolific investors 2014-2018
(Number of deals)

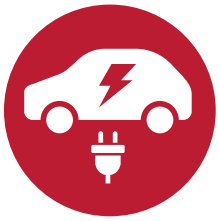


Sources: CapitalIQ, Mergermarket, Pitchbook, Press, Company information. 1) Deal value includes EUR 1,140m in committed capital from Softbank to be invested when Cruise AVs are ready for commercial deployment. 2) Titan: Company founded after 2000, valued at USD 50bn or more

FOUR KEY TRENDS
In Autotech

GP. Bullhound

FOUR KEY TRENDS
In Autotech

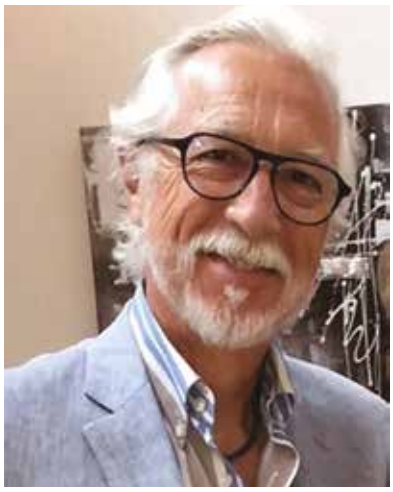


ELECTRIFICATION

AUTONOMY

SHARED MOBILITY

CONNECTIVITY



AUTOMATION HAS TO BE
A Long-Term Vision

Alain Tiquet
Group Director, Nvidia

The biggest threat we face as a company is not our competitors, but ourselves if we do not listen to or understand the expectations of our customers. We therefore spend a lot of time doing our own development on autonomous vehicles, to be able to understand the problems that could come up in the future.

Artificial intelligence, autonomous driving, automation in general: these are the technologies that will dominate the landscape in generations to come. We therefore have to ensure that our software responds not just to the problems of today, but those of tomorrow as well. To do that, at Nvidia we think about the future and what the market is going to be like in two, four, six years and beyond.

Thinking long-term though is not just about preparing for the technology to come, but the infrastructure that allows this to work and flourish. The key example being electric cars, which are being pushed onto the market due to the urgent nature of climate change and their role in reducing pollution and traffic.

Yet by concentrating more on the technology than the practicalities of its use, extreme regulation and a lack of infrastructure means the environmental problems that electric vehicles are meant to solve, cannot be adequately addressed.

In France for example, it is extremely difficult to find a charging point for electric vehicles. An automotive magazine in the country a few months ago tried to get from Paris to the South of the country in an electric car, and the cost of re-charging exceeded the cost of petrol.

As of May 2018, there were just 1,500 rapid electric charging points in the UK, each one, on average, with the space to charge up to two vehicles. By comparison, there are 9,000 petrol stations across the country, each with multiple pumps that fill up a car faster than charging.

With a higher price to re-charge and a lack of options for doing so, it soon becomes somewhat impractical and inefficient to choose to buy an electric car over its petrol counterpart. This is not to say charging stations should be free, but the infrastructure and political will to standardize access to electricity must be there, otherwise electric vehicles will remain a tokenistic, rather than practical, solution to pollution and traffic.

So, the infrastructure is needed and we are pushing for this to improve. In the meantime, we must continue innovating and Nvidia does not stand still.

As a platform provider for automotive companies, our products have to be indispensable to our customers. If they

do not match their needs, then there is no use for us as a company. This means we have to operate with a mindset of constant innovation.

Thankfully, there is no shortage of innovation for us to research, develop and deliver for our customer base.

As a platform supplier for the automotive industry, we provide software and hardware at multiple levels in multiple markets; from mobile solutions to cloud infrastructure solutions, to high-performance computing and more recently, artificial intelligence. We also provide software libraries that allow engine performance optimisation.

These platforms give our clients a range of software to use for their various activities. Doing all of this puts us in a good market position – with most big cloud providers such as Google, Microsoft, AWS, Alibaba, IBM and others using our technology. Just this summer, Google chose to use our Tesla P4 graphic cards for its artificial intelligence cloud services.

Artificial intelligence is no longer an intimidating future, but a part of our everyday lives. We now live in harmony with self-learning AI devices in our homes, whether the Amazon Alexa or Google Home, while Netflix and YouTube recommend what we watch to us based on our previous viewings. The likes of Tesla meanwhile are bridging the gap between human-driven and autonomous vehicles.

The continued development of GPUs (graphic processing units), alongside the use of our high-performance computing software, Cuda, has made a big contribution to the rise in artificial intelligence into the mainstream. Uber for example, is using our Cuda platforms to develop its autonomous driving technology. Cuda, which was developed in 2006, did not just answer the questions of 12 years ago but answers the needs of now. This constant improvement and adaptability to different times is what we aspire to with all of our software and hardware.

Companies with an eye on an automated world that want to revolutionize how we travel need to be aware of this obstacle.

If I could leave you with two key considerations: firstly, will the software and hardware solve problems for customers – today and tomorrow?

Secondly, does the correct infrastructure exist to implement the technology successfully and efficiently, and if not, what are you going to do about it?

November 2018

ELECTRIFICATION

COMPANIES TO WATCH

BYTON · CATL · chargepoint · northvolt · RIVIAN · Weltmeister

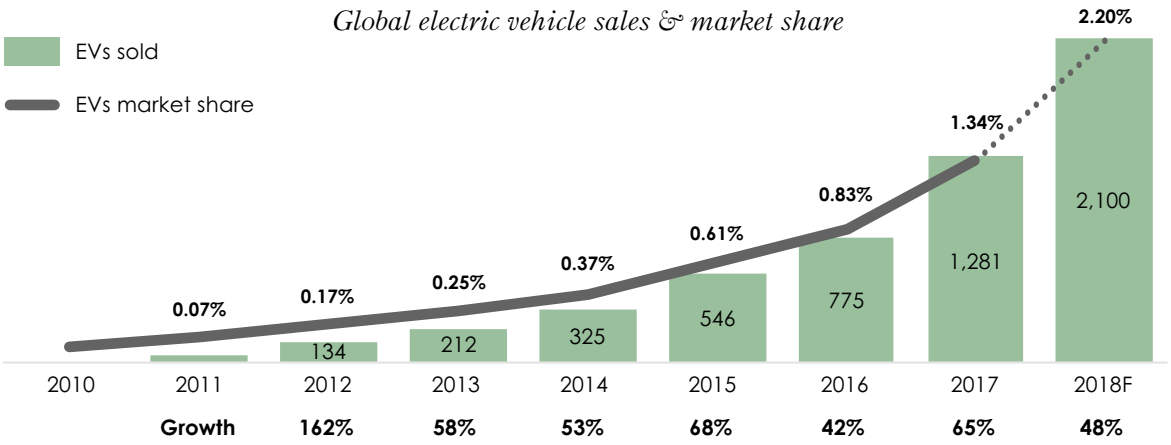
GP. Bullhound

ELECTRIC VEHICLE INNOVATION RAMPS UP

Yet Market Share Of Plug-Ins Remains Small

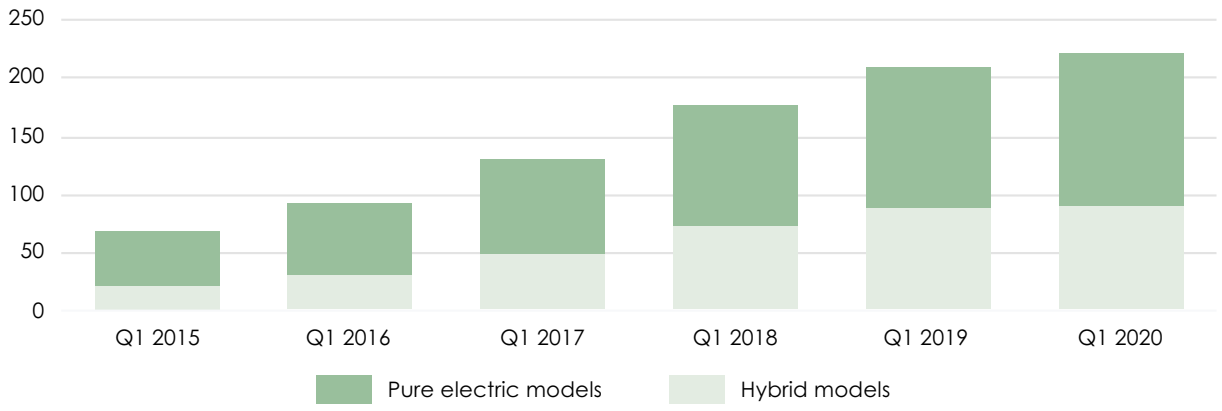
Despite seeing global sales of new electric vehicles nearly quadruple between 2014 and 2017, the absolute share of plug-ins, estimated to come in at around 2% or slightly below 2 million units for the full year 2018, is still remarkably small.

Global electric vehicle sales & market share



This has not stopped car makers from announcing a host of new models and initiatives. Mercedes-Benz has already invested more than €10bn into the development of its fully electric EQ line of cars, Volkswagen announced a multi-billion euro electric offensive, as did Ford Motor Company. Renault, whose Zoe is currently Europe's best-selling electric vehicle – announced the launch of the K-ZE all electric crossover, Audi is working on the E-Tron, BMW has the I and iNEXT line, and Volvo committed to their Polestar. Evidently nobody wants to be left behind when it comes to Electrification.

Automakers' growing electric offering (number of models)

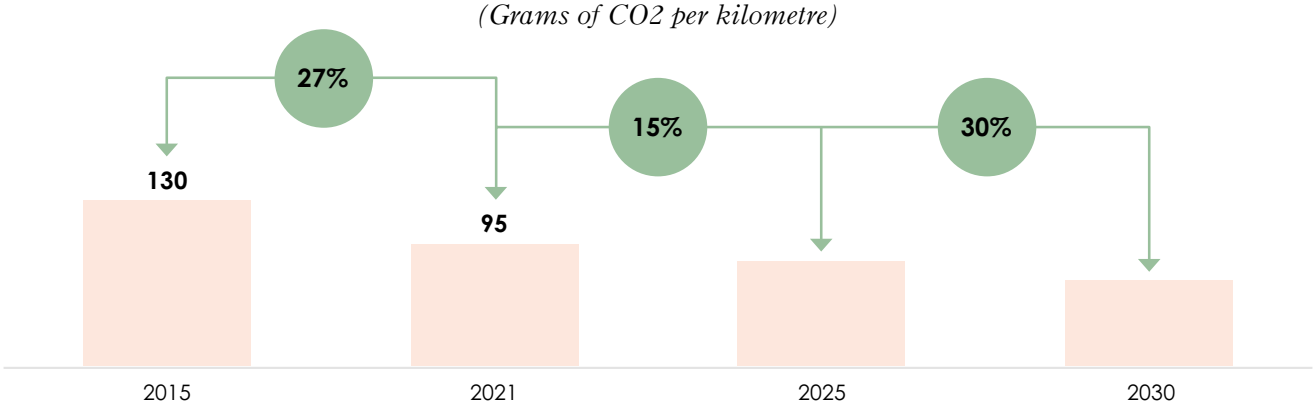


Sources: https://www.bloomberg.com/news/articles/2018-09-04/mercedes-readies-first-tesla-rival-in-12-billion-attack-plan, http://business-review.eu/business/auto/volkswagen-to-invest-eur-44-bn-in-electric-car-production-191083, https://www.reuters.com/article/us-autoshow-detroit-ford-motor/ford-plans-11-billion-investment-40-electrified-vehicles-by-2022-idUSKBN1F30YZ, https://www.press.bmwgroup.com/global/article/detail/T0285924EN/bmw-group-northvolt-and-umicore-join-forces-to-develop-sustainable-life-cycle-loop-for-batteries?language=en, https://www.reuters.com/article/us-europe-batteries-germany/germany-to-unveil-battery-cell-consortium-on-november-13-tagesspiegel-idUSKCN1MK1Y0, https://electrek.co/2018/10/08/vw-task-force-battery-supplier-lg-supply-ev-ramp-up/, https://asia.nikkei.com/Business/Murata-to-pour-450m-into-Sony-battery-ops-after-purchase, https://asia.nikkei.com/Business/Murata-to-pour-450m-into-Sony-battery-ops-after-purchase, https://www.engie.com/en/journalists/press-releases/engie-majority-stake-in-green-charge-networks/

TIGHTENING EMISSION STANDARDS
Are Accelerating Electric Vehicle Development

Increasingly tight emission standards play a key role in the industry's move towards electrified and electric vehicles. Emission reduction targets set by the European Commission require car makers to achieve a fleet average of 95 grams of CO2 per kilometer by 2021, or face a debilitating fine of up to 95€ per gram and per kilometer. Many manufacturers were counting on diesel to help them through this transition, but recent scandals have forced them to radically rethink their strategies. BMW recently joined Toyota and Honda in abandoning diesel sales in the US and go all-in on hybrid/electric vehicles. As Fiat's CFO put it: "non-compliance is not an option".

CO2 emissions from passenger cars, EU targets
(Grams of CO2 per kilometre)

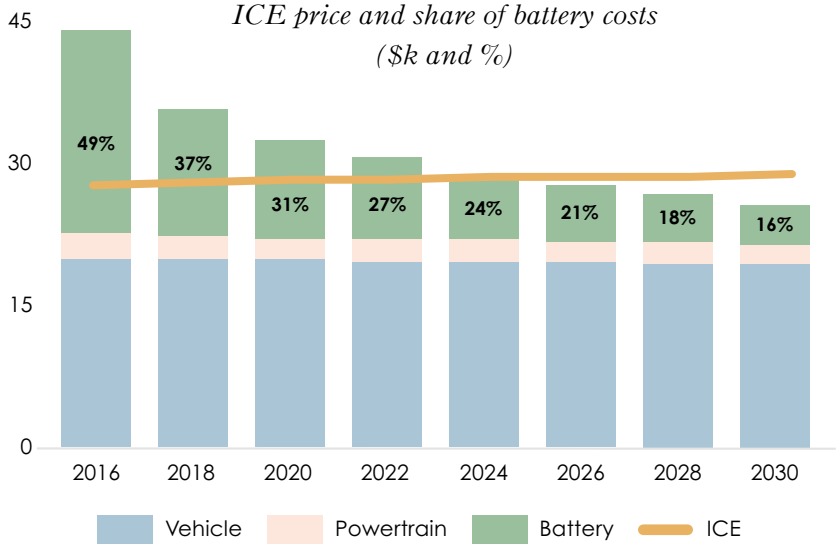


Aside from policy, a major factor in reaching the tipping point is price parity: the point at which electrified cars will cost the same as their internal combustion engine counterparts, the point at which one can expect a massive uptick in the sales of plug-ins.

Bloomberg New Energy Finance estimates price parity could come as soon as 2024, leaving the industry with very little time to get organized around battery manufacturing, infrastructure development, and changing business models.

Aurora Energy Research estimates the growth of electric vehicles in Germany and the UK alone will require an astounding $17bn investment in charging infrastructure.

US medium BEV price breakdown, ICE price and share of battery costs
($k and %)



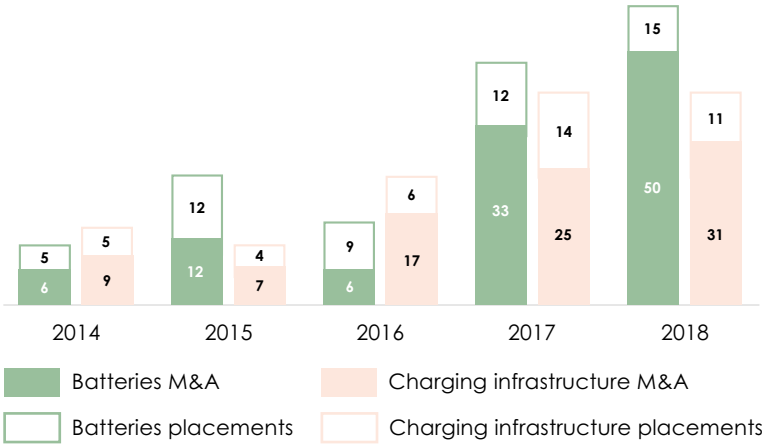
Sources: https://ec.europa.eu/clima/policies/transport/vehicles/cars_en#tab-0-0. http://www.automotivebusiness.com.br/abinteligencia/pdf/EV-Price-Parity-Report.pdf. https://www.bloomberg.com/news/articles/2018-03-22/electric-cars-may-be-cheaper-than-gas-guzzlers-in-seven-yearsBEV: Battery electric vehicles; ICE: Internal combustion engine; Plug in: Vehicles that are recharged from an external source of energy (e.g. wall sockets), https://www.motor1.com/news/265689/bmw-end-diesel-sales-us/

THE DAWN OF THE ELECTRICAL ERA

Has Spurred Investment Activity

Over the years we have seen an increasing activity in the M&A and private placement landscapes as both financial and strategic sponsors are preparing for Electrification through investments in batteries and charging infrastructure.

Battery and charging infrastructure transactions (number of deals)



Oil Giant Total acquired the battery maker Saft for **$1.1bn**

Murata acquired Sony's battery operations and invested **$450m** for battery development

ENGIE acquired Green Charge Networks, a provider of energy storage solutions

ChargePoint raises more than **$500m**

While much has been written about the Gigafactory collaboration between Panasonic and Tesla, OEMs across the board, including BMW and Daimler, are earmarking billions of euros in battery and energy management research and development, and partner up with a variety of old and new players. The rapid influx of capital has also spurred the growth of new and ambitious pure-play manufacturers. Northvolt in Europe and CALB in China are just two examples of the upcoming giga-factory revolution.

Examples of deals:

Panasonic / Tesla: Planned Gigafactory as part of a **$5bn** investment

CATL: Announced **$2bn** investment to build two giga factories

Daimler: Investing **$1.1bn** in the battery market

Northvolt: Created a partnership for future supply of batteries

Ford / Varta: Consortium for a battery factory supported by **$1bn** of government financing

VW / LG: Created a task force for the supply of EV batteries

Awareness is equally building at an institutional level. Both the European Union as well as individual member states such as Germany have announced setting aside billions of euros for the production of and research into battery cell technology.

Sources: qz.com, electrek.co, electrek.co, press.bmwgroup.com, reuters.com, electrek.co, asia.nikkei.com, asia.nikkei.com, engie.com, https://www.forbes.com/sites/neilwinton/2018/11/28/chargepoint-raises-more-than-500-million-profit-pressure-will-start/

WIDESPREAD ELECTRIFICATION

The Price Has To Be Right

Martin Anderlind

Chief Business Development Officer, Northvolt

It can seem like everybody in the automotive industry is obsessing over electric and autonomous technology at the moment. And while there may be some truth in that, a stubborn question remains: when will a majority of drivers abandon petrol and switch to electric?

The biggest obstacles to that happening tomorrow are the price and supply of batteries. There is, nevertheless, great work underway. Norway has shown that price parity between premium electric and petrol cars has resulted in over 50% of the country's people buying them. Further research from Norway found that 70-80% of consumers would consider buying electric vehicles if they could afford them.

In Europe, manufacturers are already struggling to keep up with electric vehicle demand – an issue I expect to get even worse in the years ahead, as customers are increasingly tempted to go electric by better performing, more affordable vehicles.

Electric vehicles could be in the majority in Europe sometime between 2030 and 2040 – provided there are enough batteries. This cannot not be achieved through Norwegian style government policies alone, but more crucially by manufacturers offering electric cars customers both can afford and want to buy.

Right now, there are two very different trajectories that will determine when this shift takes place.

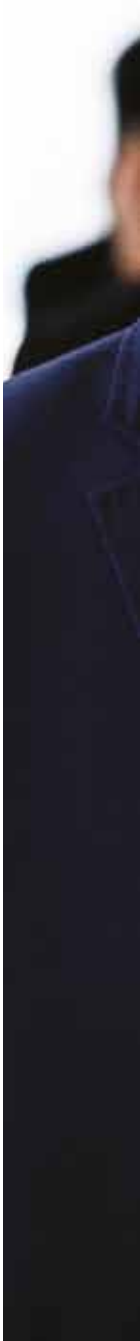
On the one hand, automotive manufacturers are racing each other to bring to market attractive and affordable electric cars. There are three main areas manufactures are looking to excel in: travel distance, charging speed, and long-term battery durability. In all of these, batteries are the largest hurdle to conquer, in both cost and supply.

On the other hand, the same manufacturers are trying to sell as many cars as possible, making the most of their investments in existing technology and manufacturing platforms.

At Northvolt, we are battery manufacturers, with the mission of manufacturing the world's greenest battery, in very high volumes, at consistently high quality and competitive cost.

Due to the complexity of building batteries that are both green and cutting edge, at a competitive cost, we will see few automotive companies manufacturing batteries themselves. Instead, most will outsource these operations to businesses like ours.

Building green, affordable batteries is an exciting industry to be in. Not only are electric vehicle batteries rapidly developing, but these developments are also a catalyst for lots of other Electrification happening too. Electric scooters are becoming commonplace, and even if the trend doesn't last, it will have a lasting impact by encouraging more people out of cars and onto other modes of greener transport. If you look at bikes for example, some stores now carry more electric bikes than non-electric. In fact, around 8,000 new e-bike companies have launched around the world in the last five years, a quickly growing market which is partly driven by people who are not traditional cyclists giving the saddle a go.



For Electrification to happen in these – along with countless other – industries, the price of batteries and the vehicles they power needs to be right – and regulation needs help.

I see no reason why this won't happen. The private and public sectors are under more pressure than ever to deal with pollution. The political will for a greener world through environmentally-friendly Electrification is strong. Politicians no longer simply wish us 'good luck', they say 'this cannot fail, how can we help?'

If we cooperate to get it right – and Northvolt is on the frontline of this cooperation – then we can look forward to a much cleaner world, much sooner.

November 2018

AUTONOMY

COMPANIES TO WATCH

AIMOTIVE · Aurora · FIVE AI · pony.ai · PROPHESEE · sensible4

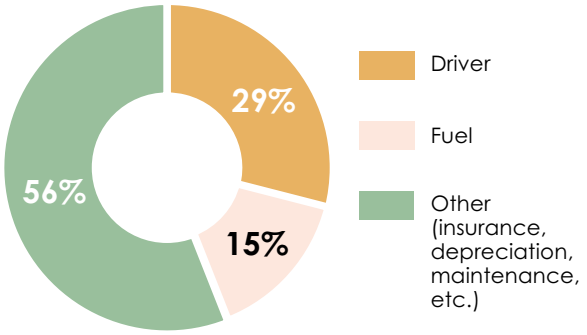
GP. Bullhound

AUTONOMOUS VEHICLES

A Paradigm Shift For Transportation

With the potential to rid the transportation industry of its single largest cost - human drivers, while at the same time making transport safer, cheaper, and arguably more enjoyable, it should come as no surprise that the stakes surrounding autonomous driving are monumental.

The current cost structure of road transport

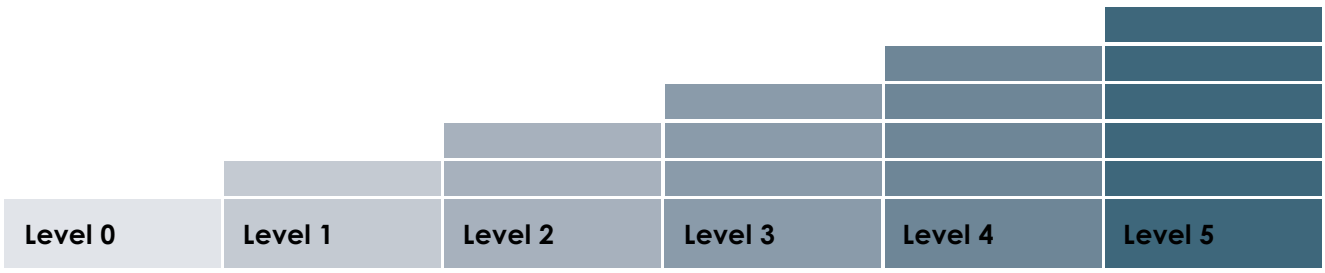


Safety, society, mobility & quality of life

SAFETY	SOCIETY	MOBILITY & QUALITY OF LIFE
94% of US crashes involve human errors	**$242bn** in annual economic costs for vehicle crashes in the US	**42h** wasted in traffic congestions each year per commuter in the US

Under international standard J3016, the Society for Automotive Engineers identified six levels (level 0 - 5) of driving automation ranging from no automation at all - the vehicles we all grew up with - to vehicles no longer requiring people to navigate traffic.

The six levels of Autonomous Driving



Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No driving automation No driving automation anywhere	**Driver assistance** Assistance in steering or acceleration, human driver performs all remaining aspects	**Partial automation** Execution of both steering and acceleration, human driver performs all remaining aspects	**Conditional automation** Automated driving, expectation that the human will intervene	**High automation** Automated driving, even if human driver does not respond appropriately	**Full automation** Automated driving everywhere and in all conditions

Sources: https://www.theverge.com/2018/2/7/16988628/elon-musk-lidar-self-driving-car-tesla, https://authentise.com/news/tag/donald-w-feddersen/, https://arstechnica.com/cars/2017/01/googles-waymo-invests-in-lidar-technology-cuts-costs-by-90-percent/, Coyle, John J., Bardi, Edward J. & Novack Robert A. (2000) "Transportation", 5th Edition, West Publishing Company, St. Paul; http://www.tlog.lth.se/fileadmin/tlog/Utbildning/Examensarbete/2008/Exjobb/5665_Annika_Knutsson_ver2.pdf

WHICH TECHNOLOGIES
Underpin Autonomy

Achieving any level of advanced Autonomy is not an easy task and requires a variety of hardware and software components to work in perfect harmony, enabling the system to **sense**, **perceive**, **plan**, and **act**, all within a split second.

Key technologies enabling autonomous driving

LIDAR SENSORS
Continuously firing laser light and calculating how long it takes for the light to return, LIDAR – though expensive – excels at providing a full and incredibly accurate 360 degree view of the surrounding environment.

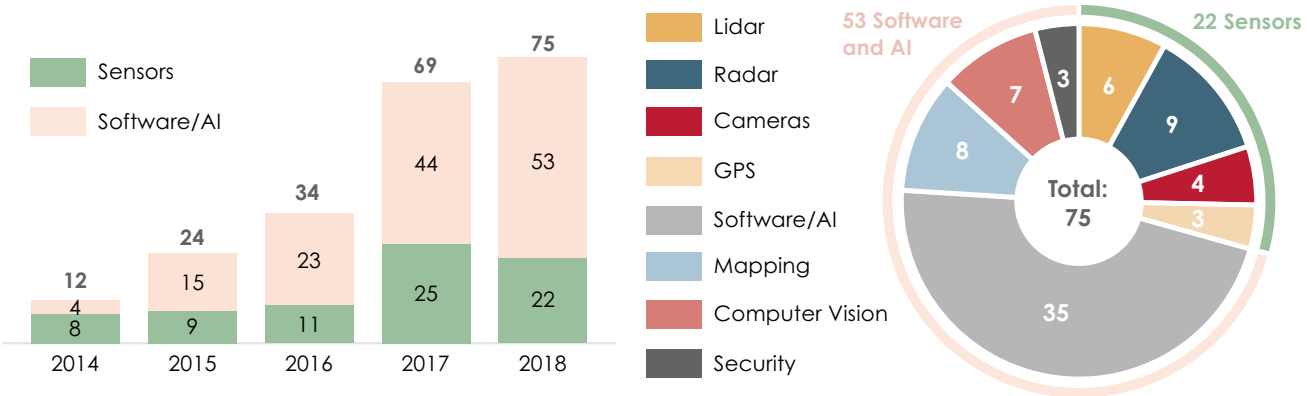
CAMERAS
Continuously snapping 2D pictures, cameras – cheap, readily available, and able to distinguish colour - excel in classification and interpretation. Work is ongoing to provide accurate 3D pictures from 2D data.

GPS & MAPPING
Most companies are using high precision Global Navigation Satellite System (GNSS) technology plus additional sensors to locate the car at all times.

MACHINE LEARNING & AI
Central brain of the system fusing all data together to be used for assessing, planning, and executing desired scenarios as the vehicle moves in traffic.

While Elon Musk's Tesla and MobilEye are notable exceptions, most actors in the space assume full Autonomy to require a mix of radar, camera, and LIDAR sensor systems, supplemented by GPS, thermal, ultrasound and possibly other devices. Of these, LIDAR arguably represents the biggest hurdle in terms of price and all-weather compatibility. As a result, several companies, including Google-Waymo and GM-Cruise, have brought development in-house.

Investments into Autonomy enablers
(Number of investments)



While the overall number of investments into autonomous driving has grown more than six-fold between 2014 and 2018, the number of investments in software & AI represented over 70% in 2018, indicating a rising need for technologies able to process, understand and predict the exponentially increasing volumes of data collected.

WHO IS WINNING THE RACE
For Driverless Cars?

Despite Google and Tesla commanding much of the headlines, there are at least 60+ other companies investing heavily in driverless research and development.

There are obviously the **car makers** themselves who are beefing up internal development through either acquisitions, investments, partnerships, or a combination of these. For example, GM acquired Cruise Automation in 2016 for a rumoured $1bn, an amount similar to what Ford invested in Argo AI in 2017. Luxury car makers BMW and Daimler have opted for strategic partnerships with Intel (MobilEye) and Bosch respectively.

Concerned about their future position in the value chain, a large number of **tier 1 suppliers** have also joined the fray. As an example, Aptiv, formerly known as Delphi Automotive Systems, acquired a series of companies, including Ottomatika, NuTonomy, and Quanergy in an effort to re-invent itself from the ground up.

Of the 56 companies who obtained a permit to conduct autonomous vehicle tests in the state of California, an astonishing 71%[1] are tech native companies, all ready to seize control of the end user in this new era of mobility. These include **Tech Titans** such Google, Apple, Intel and Samsung as well innovative **start-ups** such as Drive.ai, Zoox, and Pony.ai.

So who is winning the race to driverless? While it's definitely too early to call, two companies are clearly pulling out ahead. Behind them, in addition to OEMs and Tier 1 providers, there's a number of companies making significant progress.

WAYMO – ALPHABET (US)

Born out of the Google self-driving car project in 2009, Waymo has already crossed 10 million autonomous miles driven on public roads in 25 cities, in addition to 7 billion miles in simulation. Relying on its in-house built hardware and software, the company was the first to put a fleet of fully self-driving vehicles on the road as part of an Early Rider program in Phoenix Arizona. As it gears up to launch its robo-taxi service, Waymo ordered an additional 82,000 cars to its fleet, with deliveries started late 2018.

CRUISE AUTOMATION - GENERAL MOTORS (US)

Acquired by General Motors in 2016, Cruise Automation has since received over 5 billion in funding commitment from GM, but also from Softbank and most recently Honda, manifesting itself as a leading player in the field. Having absorbed Strobe, a LiDAR sensor maker working on reducing an entire LiDAR array to just one chip, the company is currently testing its fleet of Chevrolet Bolt Evs on the busy streets of San Francisco, readying for a 2019 launch.

APTIV (IRELAND), AURORA (US), FIVEAI (UK), ZOOX (US)

Hot on the heels of Waymo and Cruise,a number of contestants are all making significant progress towards a driverless future, including Dublin-headquartered Aptiv, formerly known as Delphi Automotive and primarily building on the acquisition of Ottomatika and NuTonomy; Aurora, fielding a who's who of self-driving experts; London-based FiveAI; and Silicon Valley-based Zoox with their permit to transport passengers in driverless cars.

While it's tempting to speak in terms of winners and losers, it's important to note that the race to autonomous is won city by city and data model by data model, leaving ample of time for e.g. European players to claim their stake.

Sources: (1) As of August 23, 2018. https://www.smmt.co.uk/wp-content/uploads/sites/2/automated_driving.pdf; https://medium.com/waymo/where-the-next-10-million-miles-will-take-us-de51bebb67d3; https://www.reuters.com/article/us-fiat-chrysler-waymo/waymo-to-get-more-than-60000-cars-from-fiat-chrysler-for-robotaxis-idUSKCN1IW2BC https://medium.com/waymo/where-the-next-10-million-miles-will-take-us-de51bebb67d3. https://www.reuters.com/article/us-fiat-chrysler-waymo/waymo-to-get-more-than-60000-cars-from-fiat-chrysler-for-robotaxis-idUSKCN1IW2BC. https://techcrunch.com/2017/10/09/cruise-acquires-strobe-to-help-dramatically-reduce-lidar-costs; https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/permit

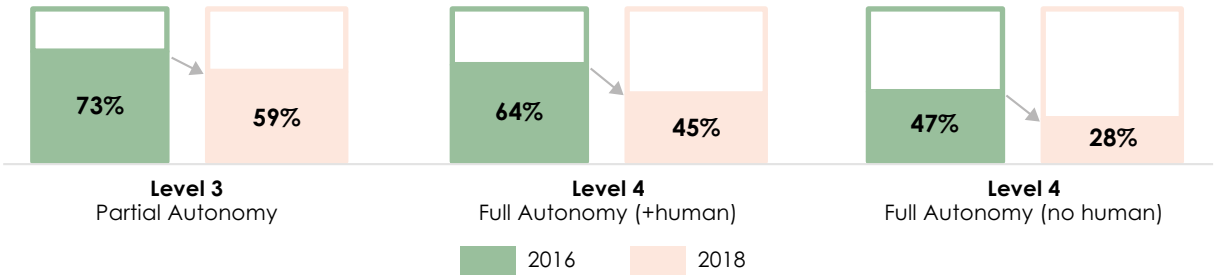
SEVERAL ISSUES NEED ADDRESSING

On The Road To Driverless

Irrespective of when fully autonomous vehicles will begin to hit the mass market (the consensus seems to be somewhere between 2020 and 2025) it will probably not be until 2050 before driverless cars are ubiquitous on our roads. And until that day comes, there are several issues that need addressing.

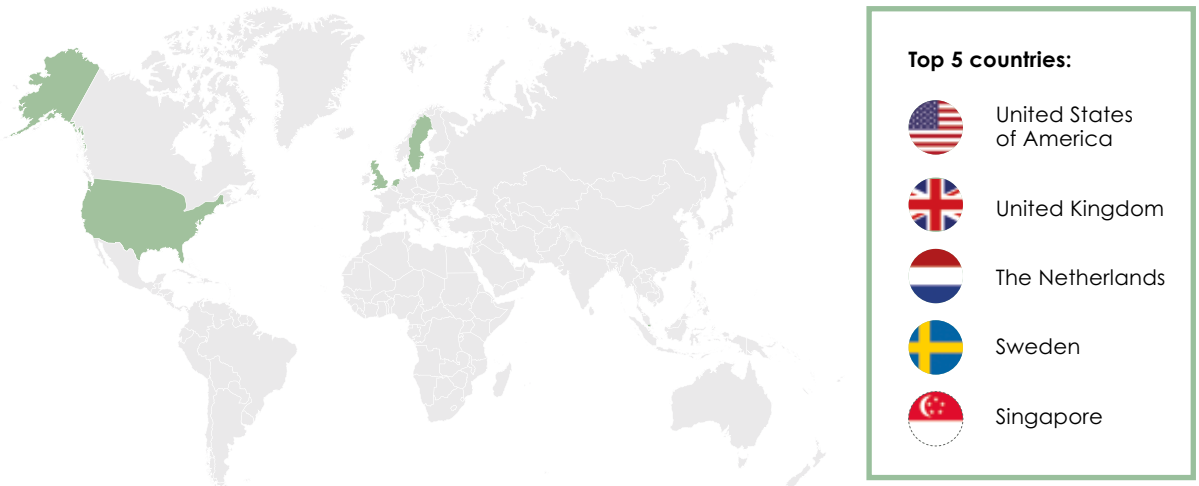
One of them is consumer acceptance, which, according to research by Cox Automotive has actually decreased from 47% in 2016 to a mere 28% in 2018, despite (or perhaps as a result of) awareness increasing from 40% to 64% over the same period.

Safety perceptions of autonomous vehicles have dropped



Governing road traffic in over 75 developed countries, the 1977 Vienna Convention on Road Traffic requires a driver to always be in full control and responsible for the behavior of his or her vehicle. Obviously problematic in a self-driving context, stakeholders have called for regulatory clarifications regarding safety, insurance, and cyber security. Despite great progress during the last few years, continuous hard effort will be needed to remove barriers, set standards, and proactively engage in autonomous driving development.

Countries with the highest regulatory policies for autonomy



Sources: https://d8imphy647zzg.cloudfront.net/wp-content/uploads/2018/08/2018-Cox-Automotive-Evolution-of-Mobility-Study_Autonomous-Vehicles-Research-FINAL.pdf. https://assets.kpmg.com/content/dam/kpmg/nl/pdf/2018/sector/automotive/autonomous-vehicles-readiness-index.pdf.

SAFETY FIRST:
The Right Approach To Autonomous Vehicles

Stan Boland
CEO, FiveAI

At FiveAI, we're using the power of Autonomy to transform Europe's cities – for everyone. We're bringing together the best minds in AI, engineering and mobility to develop self-driving technology and deliver a fully autonomous shared transport service.

Safety is crucial to our mission. Any self-driving system and service must be at least as safe as a human-driven equivalent, and that turns out to be a really high standard indeed. Humans are fortunate in having amazing sight, a well-developed visual cortex, trained reflex reactions, and high-functioning general intelligence that can make sense of complex situations in poor lighting and weather conditions.

Currently, most driverless cars are still dependent on an array of narrow intelligences – a small flock of well-trained pigeons. Most computer scientists would be thrilled with anything approaching 99 percent accuracy – that's pretty much state-of-the-art. But for a self-driving car, it's woefully short of what we need for safe operation. At FiveAI, we're building much richer processes and intelligences and are making them robust to all weather conditions, at every time of day, in every lighting condition.

The target for us all working on urban environments is to build driverless technology that is very geo-specific and which can be trained to work in that environment, often referred to as Level 4. Services will therefore be launched route-by-route, block-by-block and city-by-city. It won't be Level 5 – able to drive anywhere – for decades. Even to get to a broad Level 4 deployment on our streets, there will need to be a significant increase in the complexity, performance and verification of today's systems.

We not only need to develop these technologies, we need to verify they work and ensure they meet standards set by regulators. To achieve this, we need to design and build highly sophisticated systems and to support that, FiveAI invests in two additional important processes.

The first is domain analysis, which means discovering the requirements for a city – roads, buildings, signage, trees, lighting, shadows, satellite coverage, foliage, reflectivity – and then building the database of all the things we might find there. Types of cars, cyclists, pedestrians, buses, vans and trucks, of course, but also their appearances, gestures, behaviors and interactions. This is complicated since every country, city and region is different and these requirements change over time, but we are developing a full understanding of the local scene.

The second of these processes is simulation. Here we create a high realism 3D replica of a city, which features roads, objects and the many ways in which they move and interact. We then use this simulation to train our system, develop our models, find cases where we fail, and fix them. It's only through high speed simulation that we could ever possibly test our cars in huge numbers of theoretically possible and difficult situations, without having to run the risk of doing it in reality. That work is of course supported by post-simulation testing on carefully selected public roads, using expert human safety drivers who keep their eyes on the road and hands in contact with the wheel at all times.

So far, the development of autonomous driving technology has really been a US phenomenon, with investment of around $11 billion. China has seen big investment too. Until now, Europe hasn't competed, but we're here to change that. We're building a serious player – in Europe, for Europe.

Because our cities and roads are so different from those in the US, a dedicated solution is a must. Europe's streets are narrower and busier, with less lighting, and more vulnerable road users. All these factors make it much more difficult to develop and test autonomous driving technology.

Talent is the answer. All the work we do depends on attracting and keeping the very best. Already, FiveAI is home to a growing team of Europe's strongest high-performance research scientists and software engineers who are working on intricate problems, to make our system's intelligence radically precise.

Whilst in the US we can already see autonomous driving and will see the first commercial services as early as the end of this year, Europe might not see fully autonomous vehicles until 2022. But we believe the UK will be the first country in Europe to launch the commercial use of autonomous driving and we are helping the UK government with regulation to achieve that. Route-by-route, we'll build a network effect, at which point consumers will notice better traffic flow, breathe cleaner air, spend less on cars, and enjoy their cities more.

FiveAI has what it takes to succeed. Europe is super-saturated with the remarkable talent that's needed to solve these complex problems. We're also attracting the right capital, and have the sheer will to make our vision a reality.

December 2018

SHARED MOBILITY

COMPANIES TO WATCH

bestmile · BlaBlaCar · cabify · careem · taxify · Trafi

GP. Bullhound

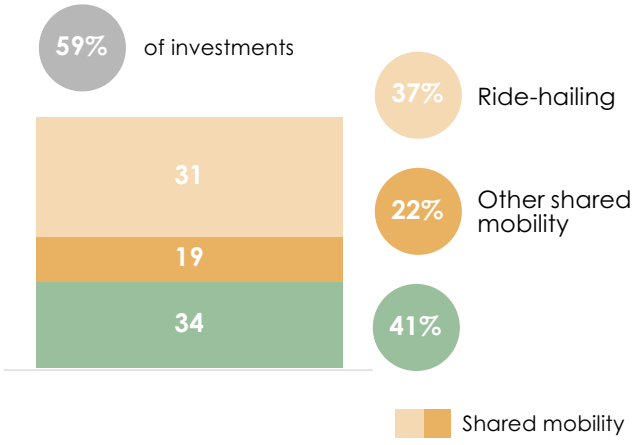
SHARED MOBILITY

The Largest Autotech Vertical

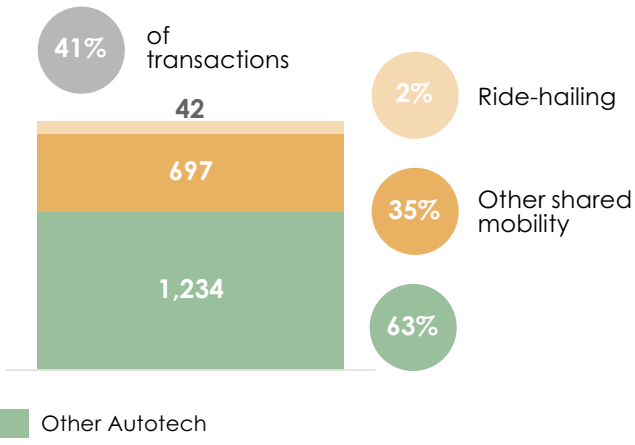
Shared mobility, and in particular ride-hailing platforms, epitomses the coming of age of Autotech. It fits well with people's growing aspiration for more flexibility and freedom in the way they move. Ride-hailing platforms have been used by more than half a billion passengers in 2018, and provide the Autotech sector with its most visible successes to date: Didi and Uber, both valued over $50bn each.

Shared mobility players have received the lion's share of Autotech investments, some 60% of the Autotech market since 2014, equating to a staggering $50bn versus $34bn for raises in other Autotech sectors and averaging at around $67m.

2014-2018 H1 cumulated funds raised (€,bn)



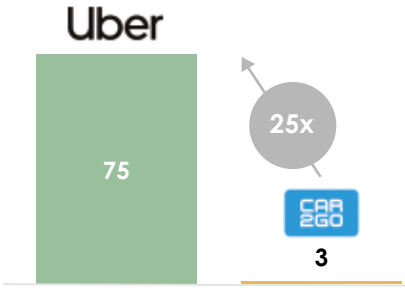
2014-2018 cumulated number of transactions (#)



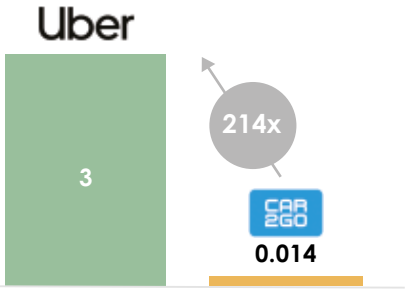
Shared mobility
Other Autotech

Shared mobility encompasses several forms of car and ride sharing, including free floating car fleets, car sharing, carpooling, car clubs, ride-hailing and more. In terms of traction and usage, ride-hailing apps have eclipsed all other forms of Shared Mobility.

Users/members (#,m)



Drivers/cars (#,m)



Largest ride-hailling
Largest car sharing

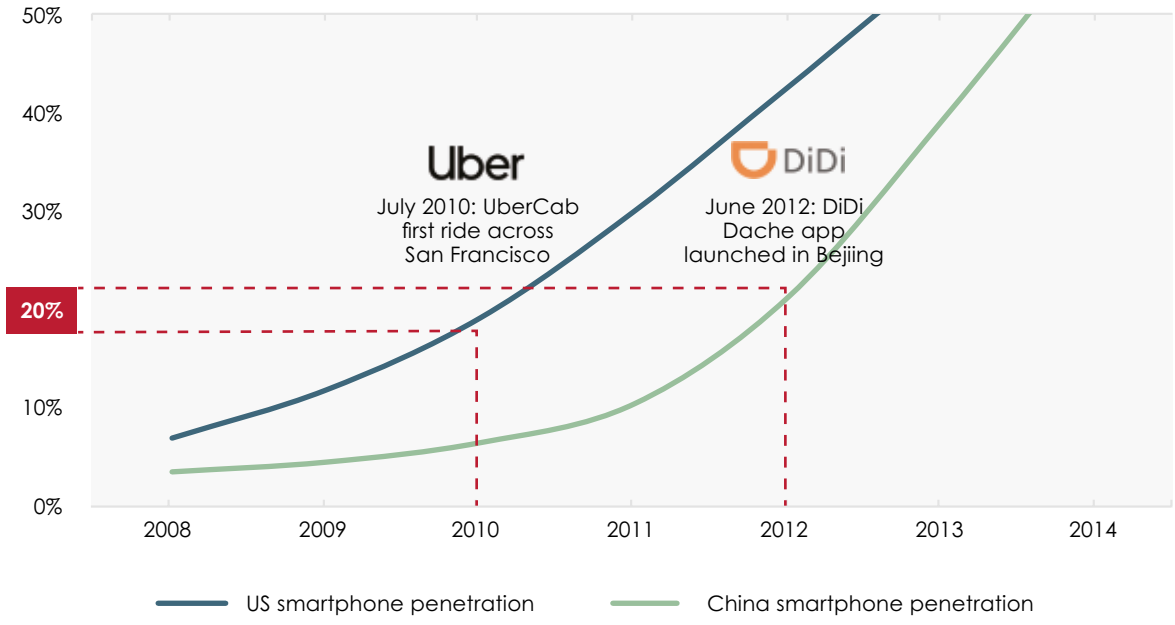
Sources: Pitchbook & Capital IQ, Companies website, Forbes, The Drive

UBER HAS BROUGHT
Shared Mobility To The Masses…

The sector's expansion was triggered by the rise of smartphones from 2007 onwards. This enabled instant connection between passengers and transporters. Uber and Didi, the two breakout successes in the space to date, both launched their offerings just as smartphone penetration reached 20% overall in their domestic markets

The combination of a service that fulfils a universal needand the low level of investment needed – aside from marketing – explains why a few well-financed start-ups managed to expand their service at a speed rarely seen since Facebook. The Uber app has been downloaded more than 100 million times since it launched.

Uber/Didi launches vs. smartphone domestic penetration
(% of total population)



Extraordinary success has generated an extraordinary controversy. Around the world, licensed cab drivers have taken to the streets to defend their quasi-monopoly, while city councils have suspended Uber's licenses. In several countries, courts are currently ruling whether drivers should be treated as workers, thereby making them entitled to a minimum wage and benefits such as holiday pay. Uber has faced numerous #DeleteUber viral campaigns on social networks, and Didi faced a similar challenge in August 2018.

Sources: Asymco (US population older than 13), GSMA Intelligence, estimate for china before 2010

LOCAL MARKETS

Demand Local Players

Uber might have seemed bound at one point to arch-dominate the sector and relegate all other parties to role of subcritical also-rans. This has not materialised. In most cities, several local alternatives exist, and it seems that city councils, clients and drivers all ensure that no monopoly emerges. Uber's tough stance towards the drivers, exacerbated by former CEO Kalanick's antics, has made it easier for other players to paint a friendlier image. Markets are also essentially local, with widely differing transport habits, regulations etc. Local knowledge plays a critical role, as Careem's success illustrates. However, the underlying Tech is complex and increasingly expensive, constantly evolving. We believe a few local players will emerge – most of them probably already have.

Valuation:$76bn
Total Amount raised: $24bn
Countries: 73
Uber

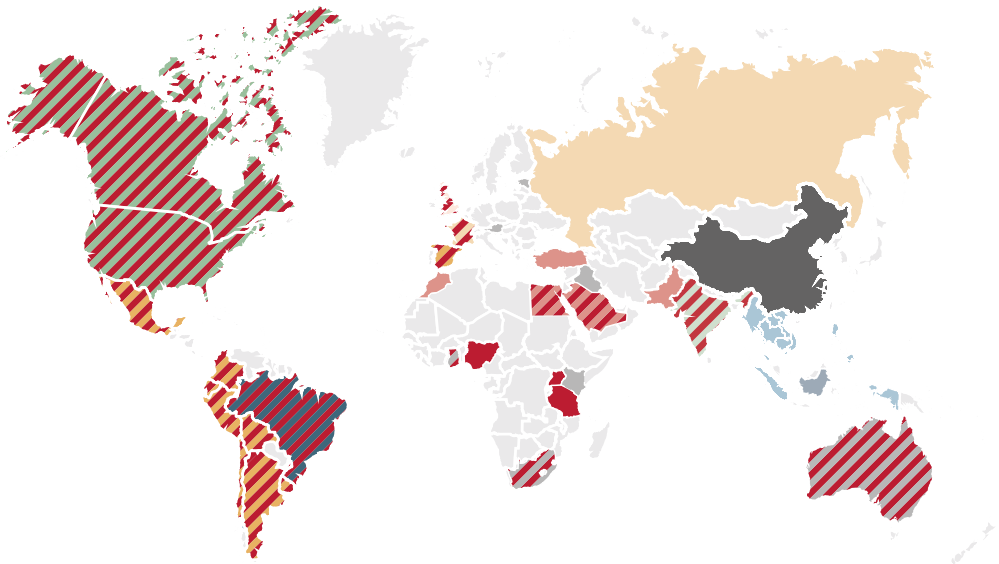
Valuation: $15bn
Total Amount raised: $5bn
Countries: 2
lyft

Valuation: $1bn
Total Amount raised: $177m
Countries: 32
taxify

Valuation: $1.4bn
Total Amount raised: $407m
Countries: 11
cabify

Valuation: $1.4bn
Total Amount raised: $693m
Countries: 4
Gett

Valuation: $56bn
Total Amount raised: $21bn
Countries: 4
DiDi



Valuation: $11bn
Total Amount raised: $7.1bn
Countries: 8
Grab

Valuation: $6n
Total Amount raised: $3.4bn
Countries: 4
OLA

Valuation: c.$9bn
Total Amount raised: $3bn
Countries: 4
GOJEK

Valuation: $3.7bn
Total Amount raised: $225m for the newco with Uber
Countries: 6
Yandex Taxi

Valuation: $2bn
Total Amount raised: $772m
Countries: 14
Careem

Sources: Pitchbook, Companies website, Data as of January 2019

ALL HAIL THE CHAMPIONS
Of Mobility

Magnus Olsson
Founder & Managing Director, Careem

Ride hailing apps and car sharing may have boomed in popularity in infrastructure-heavy countries in the West, but it is in countries with poor public infrastructure that they are fuelling a mobility revolution.

There are an estimated 910 cars per 1000 people in the US, that number drops to 313 in the United Arab Emirates and 20 in Pakistan.

Without access to a car, people across the world are unable to conveniently do what they want and when. This could range from dropping children at school, getting to work on time or even using a car as a primary or secondary source of income.

At Careem, our mission is to simplify and improve the lives of people in MENA, Pakistan and Turkey by being the best ride-hailing app to work for and to use. Six years after launch, we operate in 15 countries, have 800 000 captains – what we call our drivers – and roughly 25 million customers are registered to the platform.

Our reach and continued growth mean we solve two critical problems found in the regions we operate. For our customers, we are filling the gap left behind by poor provision of public transport. While for our drivers, we provide employment opportunities, which are particularly welcomed by younger people who often face worse career prospects in these countries.

We have no intention of slowing down. Our growth plans include expansion in the areas where we already operate as well as moving into new sectors and activity.

So far, we have reached around 1% penetration of what is possible – based on a prediction there are 100 million rides that either happened today across our markets or could have happened. It's important to remember that the ceiling for growth in markets like ours is much higher than western European because of the lack of public transport.

The second dimension of our growth strategy is to launch in new cities. There are around 200-250 cities that are sizable enough for our model to work. Each city requires an individual approach. In certain markets we have introduced two wheelers and tuk-tuks because of the demand for more and more affordable options. We have also experimented with buses and other high-density vehicles in an attempt to bring the price down for customers further.

Thirdly, we will be going down the same path as our counterparts elsewhere in the world and exploring delivery options of food and similar items.

A key challenge we face is density. Customers need to have access to a car quickly and easily from the very first day of business. That means an organisation like ours has to be able to scale quickly in new markets. This is an expensive, investment-heavy pursuit. We have managed to compete successfully with players that have far greater funding because of our dedication to local knowledge and expertise.

What has become increasingly clear in recent months is that this is a local game. Customers, captains, regulations and mapping are all local at the point of delivery. Questions you therefore have to consider include: How does a mobility provider pivot their strategy in a market where Google Maps does not work well? Or how does your compliance team work in markets where people have varying levels of concern over their privacy?

Keep your customers happy by keeping your priorities localized. This approach has allowed us to win over the customer and make their lives easier over the long term, not just on a one-off trip from A to B.

You can draw comparisons to the telecoms industry, where the businesses may be internationally based but what they do, and how they do it, depends on local circumstances.

Looking ahead, the hotspot for mobility innovation – in my opinion – will be the UAE and Dubai in particular. They are set to see autonomous, in particular, take off for a number of reasons. Firstly, they have the political backing, secondly, they have the capital to make it happen and thirdly they have the regulatory flexibility and willingness to try new things. Finally, their modern road networks make them a natural launchpad and home for autonomous technology on a large scale.

A mobility revolution has begun and by thinking local you can expand your footprint and keep your growth forecasts sky high.

November 2018

CONNECTIVITY

COMPANIES TO WATCH

ARGUS CYBER SECURITY · INRIX · Mapillary · ONTRUCK · otonomo · Peloton

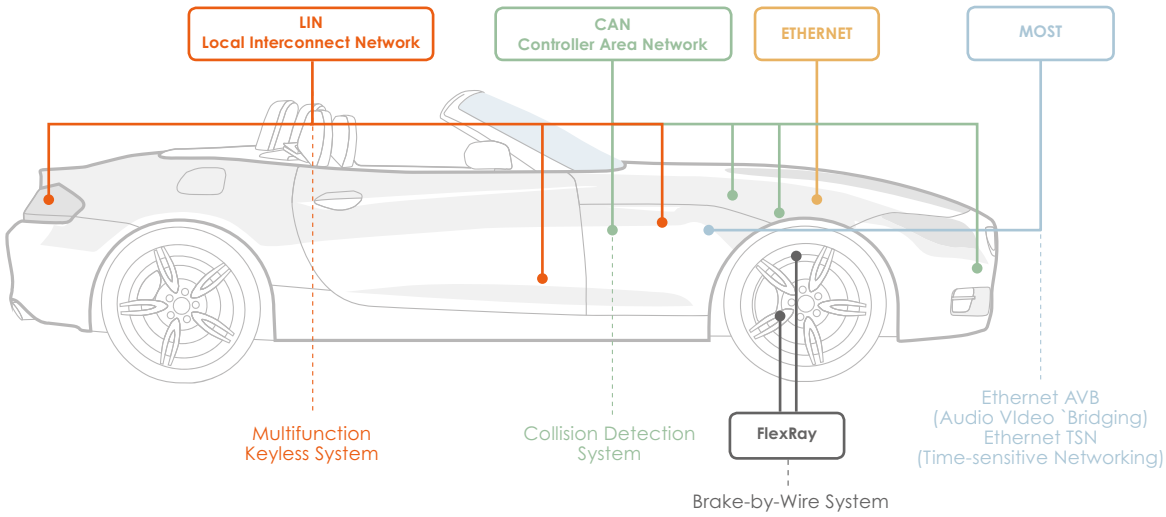
GP. Bullhound

THE CAR OF THE FUTURE

May Soon Need New Plumbing

While ECM data has been used by manufacturers since the late 1990s, the few hundreds of kilobytes of service data can impossibly be compared to the volumes generated by tomorrow's array of vehicle sensors, generally estimated to be coming in at around 4 terabytes per hour. Similarly, where the first car computer - literally - had the processing power of a 1994 SEGA gaming console, Nvidia's latest driverless-car platform can crunch up to 320 trillion operations per second.

While automakers have certainly evolved their in-vehicle networks over the years by adding a number of new technologies to supplement the in 1983 Robert Bosch developed CAN (Controller Area Network) bus, the current architecture may simply not be enough for when the autonomous data-tsunami comes to shore.



Several consortiums and interest groups are actively vying to take control of the next generation in-car networks, each touting a combination of speed, flexibility, and cost-efficiency:

» Established by LG Electronics, Samsung Electronics, Sony Pictures Entertainment and Valens, the HDBaseT Alliance already boasts over 200 member companies since its inception in 2010, including Denso, Daimler, Aptiv, and Aurora.

» Launched in June 2018 by Aquantia, Bosch, Continental, NVIDIA and Volkswagen Group of America, the NAV Alliance strives towards developing the ecosystem required for Multi-Gig Ethernet networking in the automotive industry.

» Most recent, MIPI – an international organisation that develops interface specifications for mobile and mobile influenced industries – announced that it has initiated development of a physical layer for autonomous driving. Companies participating in the automotive working group include Mobileye, Qualcomm, ST, and NXP Semiconductors.

» While use cases and requirements are abundantly clear, it remains to be seen how fast they'll become mainstream, thus necessitating change. Until then, we'll likely see chip makers involved in several initiatives.

Sources: Dataconomy.com, CNET.com, Indusoft.com, Technologyreview.com, NYtimes.com, HDbaset.com, Support Ixia.com, Eetasia.com, Nav-Alliance.com, EEtimes.com

V2V, V2I, V2P, V2N
Let's Talk Connectivity

A key enabler in a host of next-generation intelligent experiences is V2X – Vehicle to Everything Communication. While V2X has the potential to supercharge a large number of applications and services, initial use cases are focused on road safety, traffic management, and efficiency. The US National Highway Traffic Safety Administration estimates that V2X could eliminate or mitigate the severity of up to 80% of non-impaired crashes. Audi for example, introduced a "time- to-green" feature in select cars in select US cities as part of its Traffic Light Information service. Other carmakers to have introduced V2X functionality include Daimler, GM and Toyota.

There are four main components to V2X:

V2V or Vehicle-to-Vehicle communication is the transmission of data between vehicles. Primed to become a key component of ADAS and Autonomous driving, V2V effectively allows cars to see beyond their line of sight. Augmenting human eye perception and sensors, cars and drivers are informed of unexpected road hazards, lane changes, or local weather phenomena. V2V will also enable vehicles riding in convoys as currently being tested by MAN, Volvo Trucks, Scania and others.

With **V2I** or Vehicle-to-Infrastructure communication, cars are able to exchange information with surrounding infrastructure. Instead of vehicles needing to analyse their surroundings, their surroundings will communicate their state with vehicles in real-time. Scenarios where cameras are unable to read the colour of a traffic light due to snow, rain or fog will thus be a thing of the past.

V2P or Vehicle-to-Person communication involves the exchange of data among cars, motorcycles, bicycles and pedestrians. By assisting drivers or autonomous systems in locating vulnerable road users, V2P is destined o enhance road safety.

V2N or Vehicle-to-Network communication will provide both driver and vehicle access to operator networks for non-critical applications, including entertainment and other cloud services that enhance driving experience.

Given the potential repercussions in terms of road safety, having a robust enabling network in place is crucial for V2X. Whereas early design favoured WIFI-based 802.11p technology (DSRC/ITS), Cellular V2X has lately gathered momentum. Volkswagen, Renault, and NXP are pushing for the former, whereas C-V2X is backed by the likes of Daimler, Ford, PSA Group, Intel, Qualcomm, and Samsung.

Sources: One.nhtsa.gov, zdnet.com, Qualcomm.com, Audiusa.com, Siliconupdates.com, DB schenker.com, Reuters.com, Sata.com

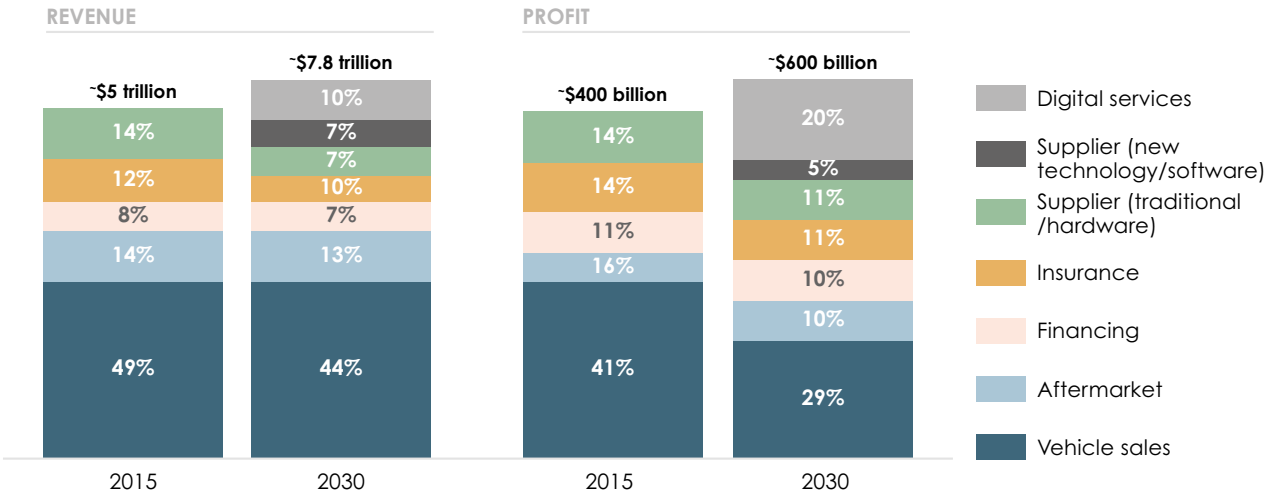
DATA AND CONNECTIVITY

Driving New Revenue Streams

As the number of connected vehicles on our roads grows to reach 305 million by 2021, the opportunity surrounding it is massive. With projections ranging from 40 to 100 billion dollars in annual revenues by 2020, increasing to 750 billion by 2030, it's no surprise to see players from across the ecosystem trying to secure their piece of the pie.

Whereas the value proposition for commercial fleet managers has been clear in terms of operational efficiency, there's still lingering uncertainty in how to best monetise data, software and services as it relates to consumers.

Auto industry value chain mix (2015-2030)



Already today, a wide variety of in-car services is being offered ranging from infotainment to telematics (e.g. usage-based insurance), Safety and Security (e.g. automated road assistance), Navigation (e.g. routing) and Remote Vehicle Services (e.g. lock/unlock). In the future, one could easily imagine hardware-as-a-service scenarios, such as purchasing backseat entertainment, just for that long road trip ahead.

While Infotainment is often touted as the cornerstone of consumer services offerings, uptake of paid services has so far been slow, in no small measure due to user experience being far below what most people are accustomed to on recent smart phones. OEMs have taken note and significantly ramped up collaboration efforts. Renault, Nissan and Mitsubishi announced to bring Google apps and services into future models, Ford and BMW are integrating Amazon's Alexa voice UI, and Daimler teamed up with What3Words, a UK start-up simplifying navigation.

Monetisation of the above services will undoubtedly come in many forms, including the delivery of contextual ads inside vehicles, subscriptions, pay- per-use, revenue sharing, as well as the packaging and reselling of data to third parties such as insurance companies or repair shops.

Sources: 2025AD.com, Gartner.com, TUAuto.com, Audiusa.com, BCG.com, Ariasystems.com, TechCrunch.com, Counterpointresearch.com

A CONNECTED CAR
Technologies And Services

For OEMs to retain control of the in-car connectivity ecosystem, and thus the lion share of revenues, will largely depend on their ability to establish a direct relationship with their customers and bundle highly relevant and integrated packages of services - mostly from third-party developers - and sell them to the right audiences. Should they fail to do that, tech platform and content owners such as Google, Apple, Tencent and Amazon, who already regulate our connected lives outside the vehicle, might invade the cars as well and impose their connectivity to the OEMs.

Sources: https://www.strategyand.pwc.com/media/file/Connected-car-report-2016.pdf

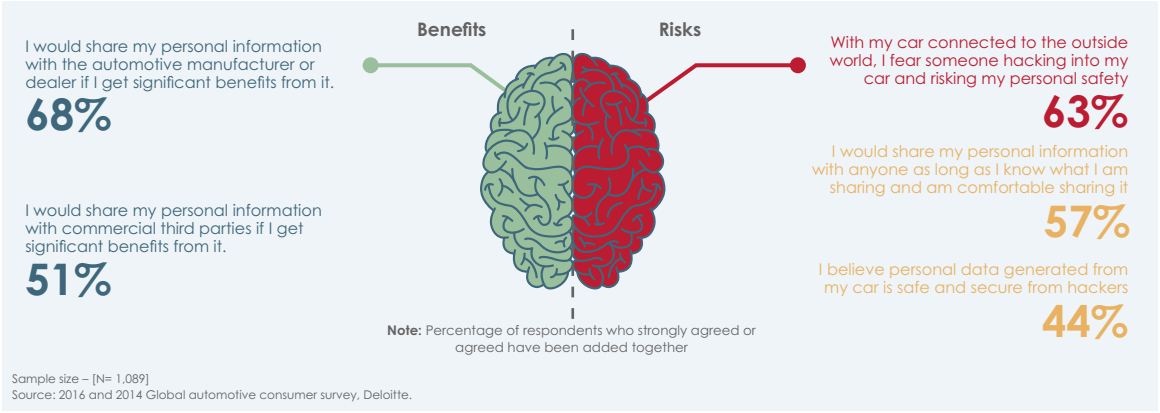
BATTLING IT OUT

For The New Black Gold

While a survey by the International Automobile Federation revealed that 90% of all respondents felt that the data generated by cars should be owned by the owner of the vehicle, the reality is quite different. In fact, car makers not only have the legal right to use and monetise the data, they often also have the right to transfer such data to third parties. How and when they choose to do that is not necessarily at the consumers' discretion, as illustrated by tweets by Elon Musk in response to Autopilot incidents. Recently, Associated Press' Erika Kinetz revealed that in China, over 200 manufacturers transmit position information and dozens of other data points to government-back monitoring systems.

While car makers may need to tread carefully if they are to avoid Facebook-Cambridge Analytica type of data scandals, customers do indeed appear to be willing to share personal data with manufacturers, dealers and even commercial third parties, provided they get significant benefits from it.

Consumer opinion on personal data sharing and privacy



In the absence of an updated regulatory framework, different actors continue to push their own agendas. For example, several OEMs are said to be working with Israeli company Otonomo, which collects, cleanses, enriches and sells vehicle data to third parties. BMW in 2017 launched BMW CarData, a proprietary data platform enabling customised services for BMW drivers. Subject to explicit customer consent, and subject to payment, third parties may also offer services on the platform. Opponents of OEM-centric data models include Automobile Clubs, Insurance and other Service Providers all wanting direct access to vehicle data without interference from manufacturers.

So where does the law stand on all of this? For European consumers, OEMs are currently (only) bound by GDPR, which came into force on May 25 2018. In March and November of 2018, the European Parliament requested the European Commission for legislation to ensure fair, unrestricted and real-time access to in-vehicle data, but updates are still pending. In the US, the sector continues to be self-regulated with neither Congress nor the Department of Transportation having instituted any new requirements recently.

Sources: Fiaregion1.com, Apnews.com, 2.deloitte.com, nordic.businessinsider.com, press.bmwgroup.com, 2025AD.com, I-scoop.eu, Fiaregion1.com, Consumerreports.org

PUTTING IN THE HARDWORK

With Software

Dieter May

Senior Vice President, Digital Products and Services, BMW Group

Technology's constant evolution is altering how we interact with everything in our lives: from the way we listen to music to how we shop and how we drive.

Whether it's your voice assistant at home or the apps that track your fitness, technology's evolution has centred around the customisation of devices and applications. At BMW, we have seen this trend play out into automobile software that is capable of controlling the speed and direction of the car while playing films in the back seat.

As we move into a new era we have identified four key priorities for the business - Electrification, connectivity, mobility and autonomous driving – that will help us continue to provide a safe, seamless and enjoyable experience for our drivers.

In the first instance – Electrification – there are now more than a million electric cars across Europe and we are committed to helping this green wave only get larger. Over the next couple of years we will be releasing 25 new electric and hybrid models into the market.

Having just celebrated 20 years of ConnectedDrive, we certainly have a legacy and genuine commitment when it comes to connectivity. With the driver's permission, BMW User ID's mean we can understand exactly what the customer wants and we are able to provide a service that allows them to continue their digital life without interruption when they are in the vehicle. The car will increasingly be a key touchpoint for digital, and we are gearing up to provide experiences inside and outside of it.

To provide a world-class connected experience we are investing in our 'agile technology teams' in Chicago, Shanghai and Munich to develop the most adaptive cars possible. We have also been able to get the best out of third-party technologies because we were early adopters. We began years ago look to at how we could use Amazon and Alexa in our vehicles, so are now we able to provide to our customers the most up-to-date versions of personal voice assistance.

As for mobility, we're finding ways for our customers to easily and enjoyably get from A to B. To do that we've chosen to collaborate with other automotive businesses, namely Daimler. In March 2018 we announced our partnership with Daimler, joining forces to offer single sources for car sharing, ride hailing, parking, charging and more. By offering a single source for urban mobility services, we hope to give drivers and passengers alike a higher quality of life in the world's biggest cities.

The fourth priority is autonomous driving. To deliver momentous work in this area we've teamed up with Mobileye and Intel and we plan – by 2021 – to have a fully autonomous car on the streets under the sub-brand.

People often miss the link between connectivity and Electrification. As the car industry continues to move in the direction of them both, the distinction between electric cars and connected cars will effectively disappear.

What's more, for our autonomous vehicles, we will have a much bigger offer for media entertainment and productivity services, which is why we've joined up with Amazon and Microsoft, which gives BMW drivers access to Prime services and Microsoft 365 applications.

At BMW, we are always looking for ways to give our customers the maximum brand experience. By sustaining and developing a sophisticated platform that drives the car and helps the driver lead a better life, we hope to do exactly that.

Security is similarly a major investment area for us – on the customer and car sides. Our software needs to be secure and we're investing heavily into maintaining that security, otherwise our brand would seriously suffer.

There is, naturally, work to do and software companies are a particular target for us right now. The issue we're coming up against is finding the partners to invest in so that our platform, machinery and capabilities of the future can be turned into reality.

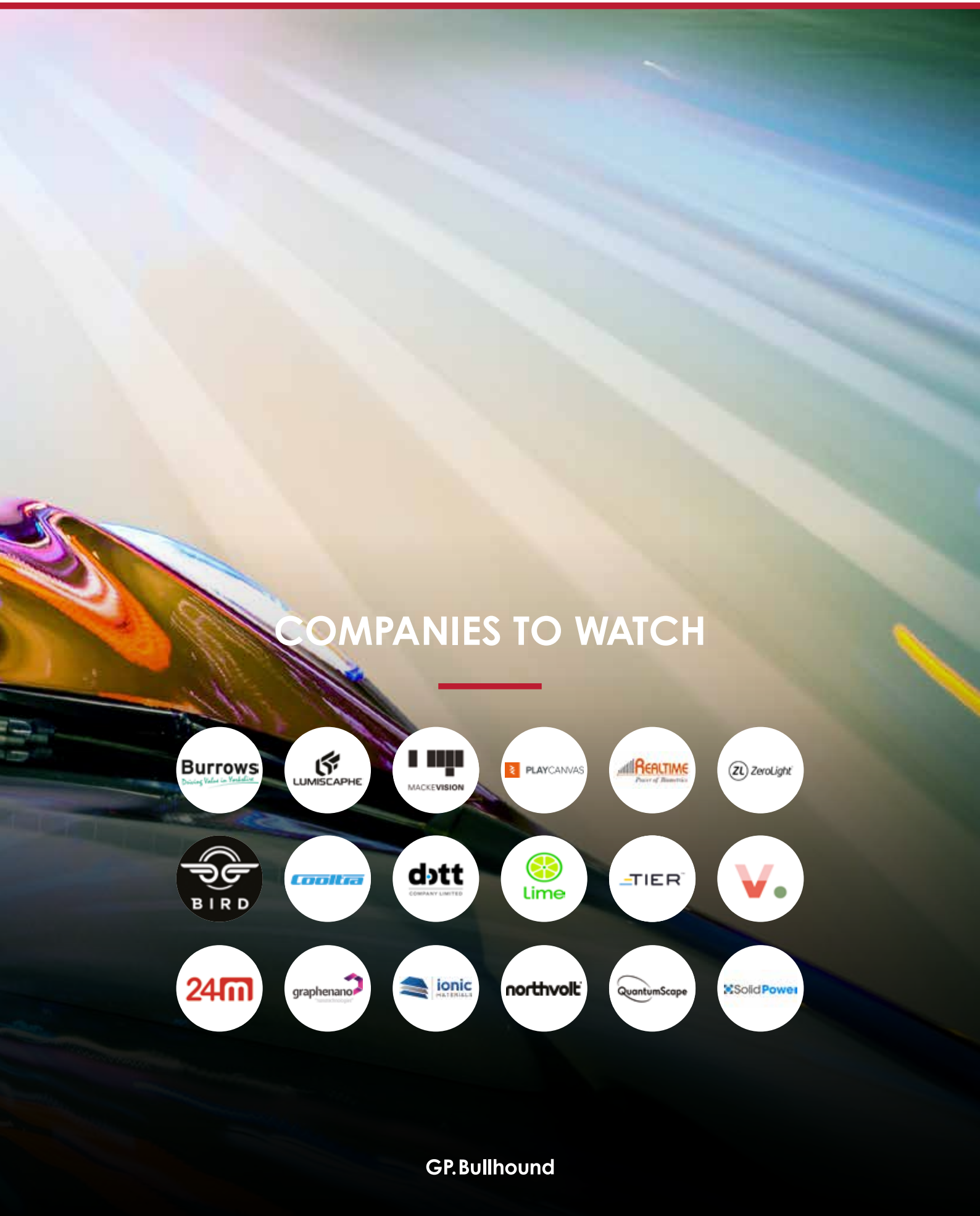
Without wanting to diminish the leaps forward we've seen when it comes to automobile hardware, the prominence of software in the advancement of the industry has grown exponentially.

The needs of the customer are changing rapidly, and software has emerged as the way for businesses to respond at a similar speed. Software is connecting us to the customer and enabling BMW to provide the personalised service that customers have come to expect from their daily, routine interactions. Advanced technology is adding value to our vehicles and it is, quite literally, driving our inventions into the future.

November 2018

FUTURE
Battlefronts

GP. Bullhound


COMPANIES TO WATCH
Burrows
LUMISCAPHE
MACKEVISION
PLAYCANVAS
REALTIME
ZeroLight
BIRD
Cooltra
dott
Lime
TIER
24m
graphenano
ionic
northvolt
QuantumScape
SolidPower

DEALERSHIP DISRUPTION

From Black Box to Omnichannel Engagement

Much like the cars themselves, the experience of purchasing passenger vehicles hasn't materially changed over the last few decades, despite society becoming increasingly digital in all other aspects. Whereas the dealership was undoubtedly the place for discovery for a generation of baby boomers, digital natives increasingly view it as a place for validation. It should therefore come as no surprise that dealership visit numbers are down.

Decline in UK and US Dealership Visits

UK dealership visits down by 15 million over five years

US average dealership visits down from 5x to 1.6x over 10 years[1]

With more than 60% of customers deciding on brand, model and price before ever setting foot in a showroom, the challenge for car makers is to connect with customers at the point of consideration, not the point of purchase. In contrast with the past where automakers only became aware of customers once a deal was closed - if at all, digitalising the entire path-to-purchase, using data to personalise offerings and drive showroom engagement, is the only way forward.

Moving from 2D to 3D

Real-time 3D configurators overcome the limitations of static 2D configurators, delivering fully interactive and engaging experiences that allow customers to configure their car in a completely immersive way.

Virtual reality

VR experiences are increasingly being deployed as part of the automotive sales and marketing suite. VR configuration experiences improve customer experience, purchase intent, longevity, and enhance brand perception.

Human-centric approach

Customer participation is promoted via product personalization at the point of sale, increasing conversion potential. The influence of personalization is changing the retail landscape from a focus on product traits to one of customer choice.

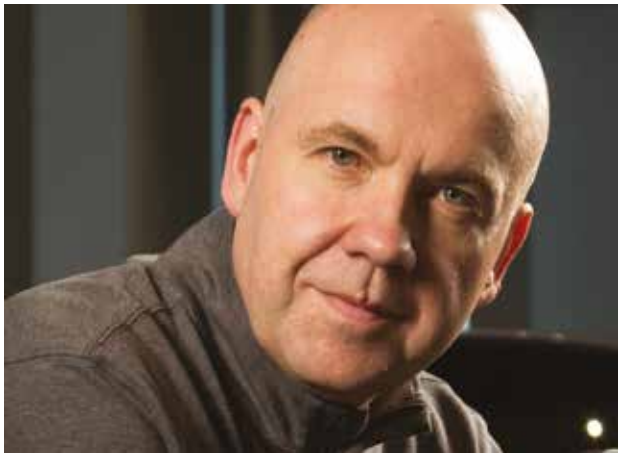
Omnichannel

Omnichannel sales will create a more interactive and personalized brand experience for customers. Brick-and-mortar stores will just be one step in the customer journey, as contact and coordination online will reach a new high through intelligent data management.

Sources: Note: (1) Average number of times a buyer visits a dealership when purchasing a car. http://think.analogfolk.com/articles/a-new-journey-shifting-from-dealer-centric-to-customer-centric-selling/ Analogue Folk - http://think.analogfolk.com/articles/a-new-journey-shifting-from-dealer-centric-to-customer-centric-selling/ Deloitte 2015 - http://www2.deloitte.com/content/dam/Deloitte/ec/Documents/consumer-business/deloitte-uk-consumer-business-mass-personalisation.pdf Automotive Management - http://www.am-online.com/dealer-management/the-future-of-showroom-technology Audi and VR - https://www.campaignlive.co.uk/article/audi-rolls-global-vr-experience-people-back-showroom/1441935 **5** VW and Tesla - https://uk.motor1.com/news/272362/vw-launching-new-sales-model/ https://www.bain.com/insights/the-future-of-car-sales-is-omnichannel/ http://www.autonews.com/article/20140511/RETAIL07/305129998/audi-makes-london-showroom-a-tech-rich-showpiece-for-the-brand

PUTTING CUSTOMERS

In The Driving Seat



Darren Jobling
CEO, ZeroLight

Imagine exploring the virtual twin of the car you've always wanted. Imagine no more fruitless trips to the dealership. Imagine understanding your new car's features before you buy it.

With ZeroLight technology, we make all that a reality: putting customers in the driving seat so they can design, test and get to grips with their dream car in a more immersive way than ever before.

By creating a digital twin of the vehicle they are about to buy, we can walk customers through every step, while also showing the customizable features they can add and giving them a feel for the driving experience before they commit.

ZeroLight span out of a successful driving game developer called Eutechnyx. So, even though we are a relatively young company, we have more than twenty years of producing driving-related technology in our DNA.

By working with information the customer is happy to give us, we are able to offer what the automotive industry has so far severely lacked: personalization. Our client list includes Audi, Pagani, BMW, Toyota, Volkswagen, Nissan and more.

Why is personalization so important? Because the transactional relationship relating to cars is undergoing a radical transformation the likes of which has not been seen since the 1950s. Customers are, at least mentally, "buying" cars online: the average person spends 14 hours visiting at least 18 different websites before making a purchasing decision.

When they arrive at the dealership they know all the details of the car, all of the options and the purchase price of the model they want to obtain. They really just decide whether they're going to buy that car at that dealership. Dealership visits have therefore dropped off significantly: a decade ago, the average person would visit a dealership seven times - now it's just over 1.5 times before they buy.

Decisions that used to be made in-person at the dealership are now made online. Responding to this, ZeroLight offers a service that automatically creates the digital twin of the car the customer is interested in buying. This means a customer can view the car in every possible configuration, whilst its interactive nature allows the customer to do everything from opening the doors, looking in the boot, or seeing what it looks like in Iceland or on the streets of New York.

It's a revelation for customers and it's a boon for the automotive business. Being able to visualize what they want means the customer is more likely to buy it – leading to impressive upselling that suits the needs of the customer.

Car manufacturers are waking up to the importance of personalisation. However, some are still sleeping on the opportunities. Take, for instance, those who show a carbon copy website to all their prospective customers, even when they have the data to personalize the experience. In today's world, it's not acceptable and it doesn't make business sense.

If the car manufacturer knows that you have children, then they should show car seats installed in the car; if you're a fan of cycling then display a cycle rack attached to the roof. A big risk for car manufacturers is that a third party creates a platform capable of offering a better car buying experience than they can. Consumers currently spend roughly half of their purchasing time on the car manufacturer's site, but the other half is lost to third party websites. Manufacturers need to be careful someone doesn't come along and make a car-buying experience that persuades the customer to buy direct from them rather than through the manufacturer.

ZeroLight's technology has enabled a level of personalization that massively benefits the customer and the manufacturer alike. We are shedding light on what's possible but we're also just at the start of the revolution in the digital customer journey. Twins have never been more in.

November 2018

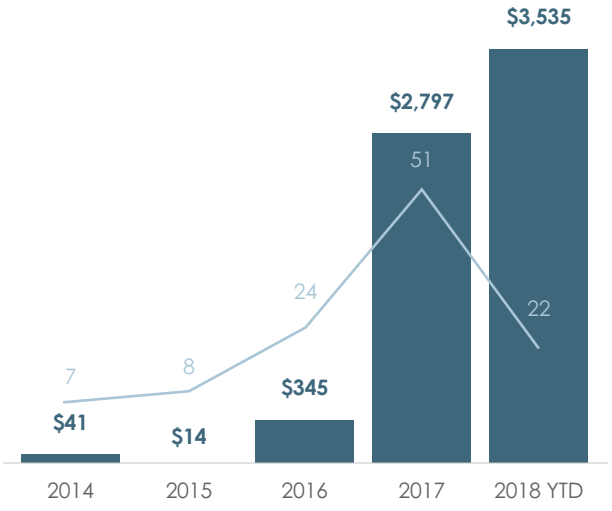
MICRO-MOBILITY IS SURGING

But Regulatory Uncertainty Is Looming

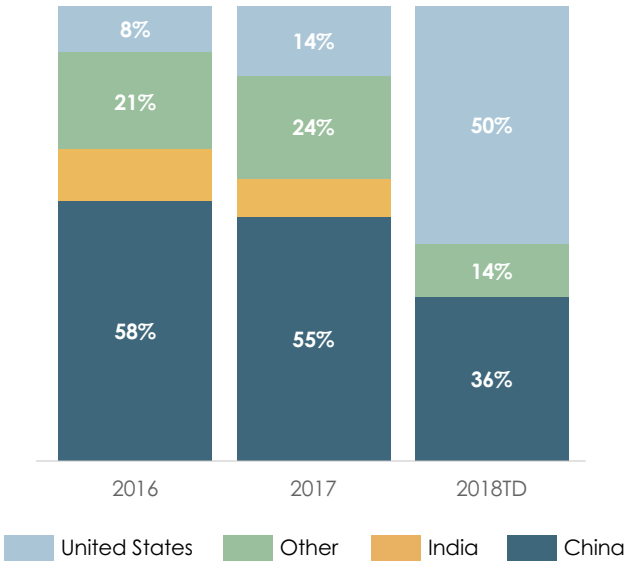
Given that well over half of all vehicle trips in the US and Europe come in at under six miles, while at the same time addressing a number of first and last mile transport inefficiencies, it should come as no surprise that micro-mobility is booming.

What arguably started out in China in 2016 with traditional, dockless bike sharing - key players include Hellobike, Mobike and Ofo - quickly spread to the US and Europe in the form of (e)bike, (e)scooter and (e)moped sharing platforms.

Funding to bike/scooter-sharing reaching new peak, deal activity from 2014-2018TD



The US is gaining deal share from China Deals by geography; 2016-2018YTD



Growing from a valuation of zero to billions of dollars in record-breaking pace, Lime and Bird are just two examples of Western micro-mobility companies experiencing extreme growth. Others include Spin (acquired by Ford), Jump (acquired by Uber) and Motivate (acquired by Lyft) in the US, and Cooltra, VOI and Coup (acquired by Bosch) in Europe.

As demonstrated by San Francisco's well-documented crack-down on e-scooters in April 2018, regulation is still playing catch up when it comes to these new modes of transport. While electric kick-scooters have been banned outright in cities including London and Barcelona, they are happily zooming across town in Stockholm, Paris and Vienna – and it's expected appetite for these vehicles will continue to grow.

Sources: https://s3.amazonaws.com/cbi-research-portal-uploads/2018/07/10160350/bike-and-scooter-sharing-growing-funding-s-5-1024x654.png (7/10/2018) https://www.energy.gov/eere/vehicles/articles/fotw-1042-august-13-2018-2017-nearly-60-all-vehicle-trips-were-less-six-miles https://s3.amazonaws.com/cbi-research-portal-uploads/2018/07/10161414/US-gaining-deal-share-3.png (7/10/2018) https://safety.fhwa.dot.gov/ped_bike/docs/walcyng.pdf https://www.cbinsights.com/research/mega-rounds-bike-scooter-trends/ https://www.cbinsights.com/research/disrupting-cars-car-sharing-scooters-ebis/ https://sanfrancisco.cbslocal.com/2018/04/23/san-francisco-seize-hundreds-electric-scooters-finalizing-regulations/ https://www.wired.co.uk/article/electric-scooters-london-san-francisco-lime-bird-spin

SHARING IS THE NEW OWNING

Cooltra and the Scooter Revolution

Timo Buetefisch
CEO & Co-Founder, Cooltra

Over recent years, the concept of sharing has steadily caught on in the transport world. Car sharing schemes and pick up-and-drop off bicycle systems have led the way – rocketing in popularity and transforming how millions around the world treat the transport in their lives.

Customers have voted with their feet for the schemes and capital has flocked to the initiatives. Private equity and venture capital, in particular, like the business case presented: they are able to amortize the price of a bike over just a few days, while the apps are sticky and create plenty of opportunities to upsell.

At Cooltra, we've worked for over ten years to provide people with a scooter service they love, and we're focusing more and more on electric vehicles and our app-on-demand offering.

Out of our 500,000 users, nearly 75% are aged 25-35, the range in which people are most likely to share their vehicles. In a generational shift, many do not want to acquire an asset, but rather just make use of it.

Unlike previous generations, millennials are happy to dodge the responsibilities and costs that come with ownership. In another millennial-friendly move, shared ownership is better for the environment, given its propensity to reduce traffic congestion and emissions.

The shared ownership sector, however, still runs up against challenges in persuading older customers to use its services. They typically have an emotional connection to their privately-owned vehicles, which can be difficult to overturn.

Global governance now needs to do its part to help shared-ownership flourish. Why? Because we are helping solve two key issues that city councils and regulators face: traffic-halting congestion and dangerous emission levels. The World Health Organization this year warned that 90 per cent of the world's children live in areas where the air breaches pollution guidelines.

At Cooltra alone, our service has reduced CO2 emissions by 370 tons over the last 24 months. So, while we want to work with councils on measures like parking and security, we believe we are partners in making cities better, so we reject the idea of paying operational fees.

We find ourselves in a transition phase when it comes to transport: regulators just as much as our own software developers are building new systems from scratch. We know that simplicity is the key. We're dealing with customers who do not want to walk more than three minutes to the vehicle, so accessibility and volume are very important. Hire a Cooltra scooter and you get two helmets, insurance and maintenance.

Similarly, the app you offer and how a customer signs up and uploads their details needs to be fool-proof. What may surprise you is that pricing is not a key criteria for our customer. Due to the 'small ticket' nature of shared scooter use, price is not something we've had to obsess over.

Whatever the context, sharing is definitely the new owning, and over the next 12 months I predict that shared-ownership schemes will both grow in popularity and capability. Customers, innovative businesses and entire cities stand to benefit. This is just the beginning of our shared journey.

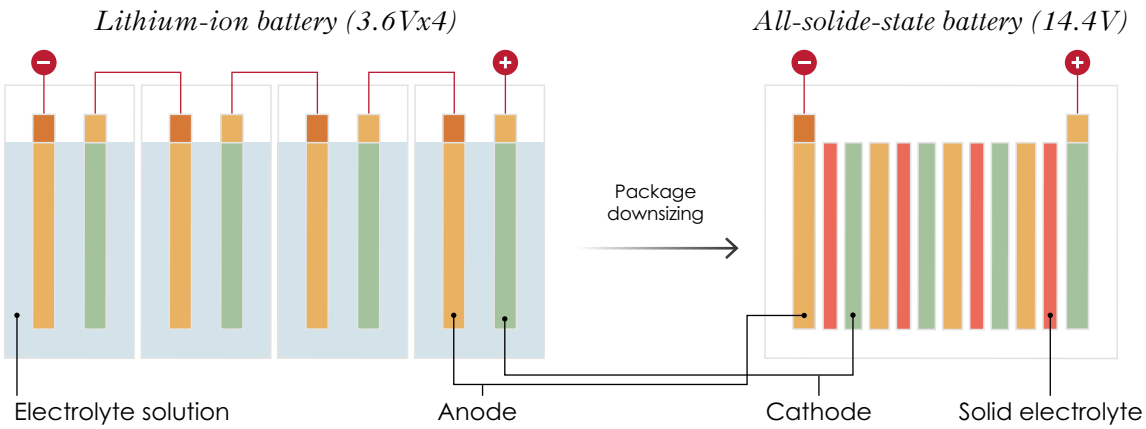
December 2018

FUTURE BATTERY TECHNOLOGY

Solid-State Looking Solid

Though lithium-ion may be the battery of choice for the overwhelming majority of today's electric vehicles, battery manufacturers, automakers and tier one suppliers alike are already working towards a world without the liquid electrolyte - resulting in higher energy density, faster charging times, and less need for cooling.

Solid-state batteries use a solid – rather than a liquid – electrolyte, which greatly diminishes the risk of fire and thus enhances safety. Whereas a typical lithium-ion sees performance degrade after a few thousand cycles, solid-state would allow for more than 23,000 charge-discharge sequences. In addition to faster charging times, solid-state batteries also have the potential to hold a higher charge in a more compact shape, potentially doubling the driving range of today's electric cars.



Despite work starting during the late 1950s, it was arguably not until 2013 when development truly accelerated in this field. Researchers at the University of Boulder Colorado announced the development of a solid-state lithium battery promising higher energy capacity. The automotive sector took notice and we saw a noticeable uptick in partnerships and investments. As an example, BMW's development partner Solid Power raised $20m in December 2017, Ionic Materials raised $65m from Total, Renault-Nissan, Mitsubishi and Hyundai a few months later, and in June of 2018, Volkswagen invested $100m in QuantumScape. It should however be noted that true commercialization of the technology is still years away, mass production – according to Toyota – will be expected by 2030.

Sources: ADL page 16. https://www.machinedesign.com/motion-control/solid-state-batteries-evs-key-long-distance-driving. https://www.bloomberg.com/news/articles/2018-10-11/here-s-where-telsa-s-supplier-says-the-lithium-market-is-heading, https://cen.acs.org/articles/95/i46/Solid-state-batteries-inch-way.html, https://insideevs.com/toyota-says-solid-state-batteries-still-more-than-decade-away/

BETTER BATTERY TECHNOLOGY

Is The Key To Mass Auto Electrification

Lewis Horne
Uniti

Customers care about green technology and would be willing to dig deeper into their pockets in order to support it. That's according to research and data firm Nielsen, which found three out of four consumers would be willing to pay more for sustainable offerings over the generic alternatives.

In the automotive world, the principal sustainability debate revolves around Electrification. And although it can be tempting to come up with a prediction for when more drivers will be using electric vehicles than not, there are challenges we must overcome.

The primary issue is unlocking the capital to make Electrification practical and affordable for the average consumer. Ask a driver who's considering the switch to electric and you're likely to hear two well-founded concerns: the lack of charging infrastructure and the length of time it takes to charge a vehicle, both of which make electric car ownership a frustrating pursuit.

An answer to both concerns is solid state-batteries; technology that takes much less time to charge than lithium-ion batteries. However, there is a major sticking point – the price. As they stand today, the cost of solid-state batteries makes them unlikely to file out into the mainstream anytime soon.

So, will there be a point when a solid-state battery will be delivered at a price that makes a meaningful impact on the market's growth? Absolutely. We are getting there. Solid-state batteries have to be treated as the long-term vision to mass Electrification. While the industry must continue to develop lithium-ion batteries so that electric technology continues to evolve and become a common sight in the market.

Lithium is performing well for now, however there is no single standard cell format. This creates issues for cars operating in different environments. Some lithium batteries perform well in hot climates, for example, while others perform well in colder surroundings.

Naturally, this poses all sorts of challenges for global manufacturers. We need to get to a stage where lithium-ion batteries are a flexible, yet standardised cell that is able to excel regardless of its external environment.

Blockchain and augmented reality, for example, are both set to improve the customer experience and are deserving of attention and investment. The advantage of the former is that the lack of a centralised authority will make industry transactions more secure and seamless for customers.

At Uniti, we design and create lightweight, energy efficient electric vehicles that feel like electronics and offer a digital first experience. Our electric city car brings a new approach to safety, sustainability and driving:

Since June 2018, a lot has happened and we've successfully streamlined the business into an efficient, lean team. We are now looking ahead to 2019 as the year when we will have our first two pre-production models, the 2-seater and the 4-seater.

In addition to the long-term technological advances, there has to be a cultural shift away from the 'one size fits all' ownership model, where consumers are paying more money for a larger vehicle that can fit all possible use cases. The strategic model going forward should be to develop cars for specific use cases that can be selected by customers on demand to suit their needs (e.g. for their daily commute, or a larger SUV for a family trip). This will address inefficiencies in charging and infrastructure, with smaller batteries that need less time to charge

As an industry, we are at a tipping point with Electrification – in the next three years there will be a lot of entrants to the market, with much lower costing, and well-built, electric cars. I envisage it will be a trillion-dollar market within a decade, which promises a direction of travel pointing towards a more sustainable world.

We have all the pieces to build a world where the majority of vehicles are electric, and while the balance of price and practicality remains a challenge, I'm confident manufacturers will overcome it.

November 2018

JOCKEYING
For Position

GP. Bullhound

JOCKEYING FOR POSITION:
Acquisitions, Investments, and Partnerships

Faced with unprecedented change and increasing technological uncertainty, carmakers have over the last few years mostly responded by striking a barrage of deals with electric challengers, tech companies, and each other. In exchange for dollars, and sometimes lending an air of credibility, several tech players teamed up with one or more OEMs or Tier 1 Suppliers looking for access to talent, technology, and insight into new and emerging business models.

For example - and almost a decade ago now - in an effort to develop an electric Smart car, Daimler in 2009 teamed up with Tesla, and subsequently saved them from certain bankruptcy by investing $50m in the then troubled startup. Toyota similarly invested $50m in Tesla's 2010 IPO in return for Elon Musk's team agreeing to work on the electric RAV4, a project Toyota later abandoned. Ever since then, there's been a flurry of acquisitions, investments and partnerships around all key development areas: Electrification, Autonomy, Shared Mobility, and Connectivity. Key examples include BMW's partnership with Northvolt, Honda's $2.75bn investment in Cruise Automation, Daimler taking a stake in ride-on-demand platform Taxify, and Porsche leading a $80m round in head-up display company WayRay.

However prolific incumbents are today in terms of corporate development, and however focused on software and services, this has not always been the case. Illustrative of this era are undoubtedly vehicle infotainment systems. Deemed a key element of customer experience and satisfaction, OEMs have traditionally insisted on leading the design and integration of them, all too often resulting in counterintuitive menus, unresponsive touch screens and a user experience – still to be found in many modern cars – lacking behind a low-end 2010 smartphone.

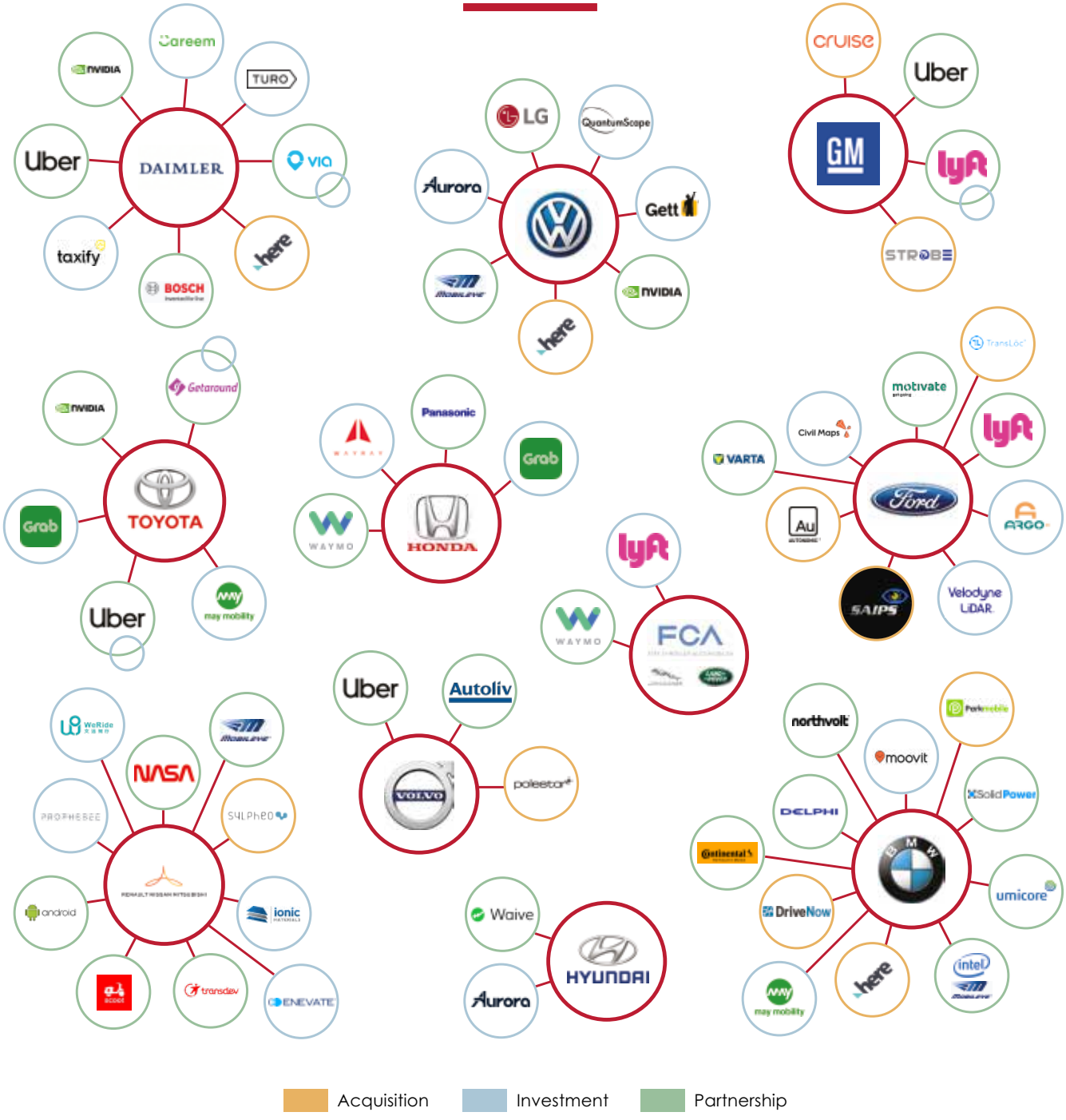
The HERE consortium – Strategic Stakeholders

A landmark deal for the industry was undoubtedly the 2015 $3.1bn acquisition of digital map maker HERE from Nokia by Audi, BMW and Daimler. In a joint statement, the 3 German automakers declared the deal was intended "to secure the long term availability of HERE's products and services as an open, independent and value creating platform for cloud-based maps and other mobility services accessible to all customers from the automotive industry and other sectors". The consortium was later joined by Intel, Continental, Pioneer and Bosh.

Sources: https://www.press.bmwgroup.com/global/article/detail/T0228722EN/audi-ag-bmw-group-and-daimler-ag-agree-with-nokia-corporation-on-joint-acquisition-of-here-digital-mapping-business?language=en

CORPORATE DEVELOPMENT ACTIVTY

Among Selected Carmakers



Sources: CapitalQ, Mergemarket, Pitchbook, Press, Company Information

CORPORATE RESTRUCTURING
For Future Survival?

Following the initial flood of mobility services launches and corporate as well as business development organisations working significant overtime, an increasing number of incumbents are currently restructuring and breaking up operations, and spinning off their mobility units in the process.

For example, General Motors is spinning off its Cruise Automation unit, in which SoftBank made a significant investment; BMW and Daimler are merging their car-sharing activities; and Ford is creating a separate entity for its autonomous-driving initiatives, and seeking outside investors to it.

Splitting up current and future business initiatives is not just about re-aligning investment and risk profiles, but about safeguarding their own long term survival. Indeed, in a world dominated by software, OEMs and Tier 1s are not only competing against tech companies on product, but also on talent. To be able to attract the best and brightest, and have a chance at competing with the likes of Microsoft, Facebook, Amazon and Google, they'll likely need a massive overhaul in terms of brand, culture, salary, and equity incentive plan.

CONCLUSION

The world is watching in awe as global tech giants take on the car industry. There is an assumption that car manufacturers will lose the fight or end up being contract manufacturers to tech powerhouses, much in the same way the mobile phone hardware industry unfolded over the last decade.

However, don't write the automakers off just yet. Especially in the luxury car segment, their hold on the end customer remains powerful, and so is the cost advantage they derive from a century of mass production experience. In addition, they have reacted with energy: investing billions in research and development, restructuring and breaking up operations, and spinning off their mobility units in the process, taking minority or majority stakes in upcoming players, as well as engaging in full-scale acquisitions. They have also proven increasingly adept at partnerships and alliances, willing to relinquish a portion of the value chain, as a quid pro quo for keeping what they deem essential: control of the consumer and the brand.

More than anything, success will depend upon incumbents' ability to effectively change corporate culture, creating a brand and working environment to which they can attract top software talent otherwise destined to join the Googles, Facebooks, Amazons, Didis and Microsofts of this world.

So while the mother of all tech battles may not unfold after all, one thing is certain: we are about to see the most fundamental change in terrestrial transportation since combustion engine vehicles replaced horse carts – fasten your seat belts!

METHODOLOGY

For this report we did an in-depth assessment of the state of Automotive technology to date. We have taken a global approach with focus on four areas within the sector: Electrification, Autonomy, Shared Mobility, and Connectivity. As part of this, we have analysed how the major incumbents and entrants communicate on their strategies on the light of their tangible actions in the field: R&D, investments, acquisitions and partnerships. We have as well analysed how the funding and M&A market activity has developed. We have taken a comprehensive approach to understanding the current status and future potential of each of these areas as well identified key hurdles and enablers – supported by sector expert interviews. Our goal is to provide the reader with an understanding of what we believe to be one of the biggest technology disruptions to date – The Mother of All Tech Battles.

The report is based on aggregated data from a number of transactional databases including CapitalIQ, Pitchbook, Mergermarket, Crunchbase and supported by public news and company press releases. The majority of the transaction data throughout the report covers Autotech related transactions. Spanning from January 2014 to December 2018. However, specific mentions could occur outside of this time span. Transactions have thereafter been assessed and categorised per sector, sub-sector, bidder type etc. No limitations on size of the company or the transactions were regarded.

Please note that as our sources include public data (e.g. press articles, blogs, and industry rumours), and the accuracy of our dataset is limited to such extent.

AUTHORS

GUILLAUME BONNETON
Partner

SVEN RAEYMAEKERS
Partner

JOY SIOUFI
Director

KARL BLOMSTERWALL
Associate

MANON RODIER
Analyst

ABOUT US

GP Bullhound

GP Bullhound is a leading technology advisory and investment firm, providing transaction advice and capital to some of the best entrepreneurs and founders. Founded in 1999, the firm today has offices in London, San Francisco, Stockholm, Berlin, Manchester, Paris, Hong Kong, Madrid and New York.

MERGERS & ACQUISITIONS

We act as a trusted adviser to many of Europe's leading technology companies in competitive international sale and acquisition processes. The firm has completed 400 successful M&A transactions to date, worldwide, with a total value of over USD 17.5bn.

INVESTMENTS

Through our investment team, we provide investors with access to the most ambitious privately-held technology and media companies. We currently manage four closed-end funds for a total value of more than USD 100m and our Limited Partners include institutions, family offices and entrepreneurs.

CAPITAL TRANSACTIONS

We advise companies and their owners on capital related transactions including venture capital, growth capital, acquisition funding, secondary block trades and Initial Public Offerings. The firm has completed 116 rounds of financing for technology companies to date, with a total value of USD 1.5bn.

EVENTS & RESEARCH

Our events and speaking activities bring together thousands of Europe's leading digital entrepreneurs and technology investors throughout the year. Our thought-leading research is read by thousands of decision-makers globally and is regularly cited in leading newspapers and publications.

OUR MARQUEE CREDENTIALS

RIGHTWARE
sold to
THUNDERSOFT

GRUPO DETECTOR
sold to
VIASAT NETWORKS

GP BULLHOUND FUND IV
invested in
ONTRUCK

ICOMERA
sold to
ENGIE INEO

AUTOTRADER SA
sold to
OMX, part of Nasper

TYRESONTHEDRIVE
investment from
HALFORDS GROUP PLC

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Managing Partner

PER ROMAN
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Associate

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Associate

CHRISTOPH GRUNEWALD
Associate

OKAN INALTAY
Associate

MATHILDE JAKOBSSON
Associate, Events & Marketing

PIERCE LEWIS-OAKES
Associate

ADAM PAGE
Associate

DIPAM PATEL
Associate

ED PRIOR
Associate

JAIME SENDAGORTA
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CARL ELFVING
Analyst

HAMPUS HELLERMARK
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Analyst

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Analyst

THEA MOELL
Analyst

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Analyst

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Analyst

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Co-founder & Senior Advisor

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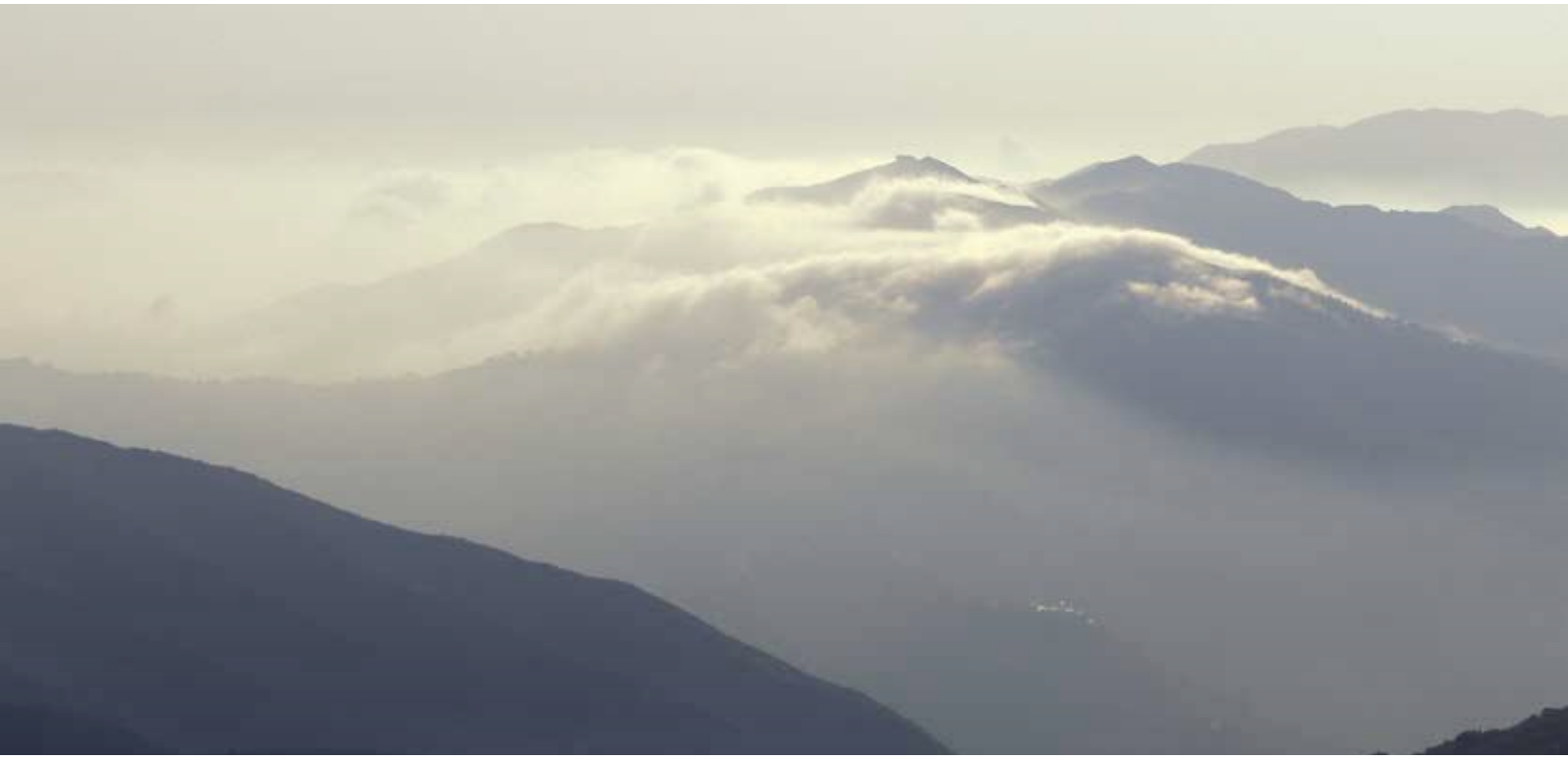

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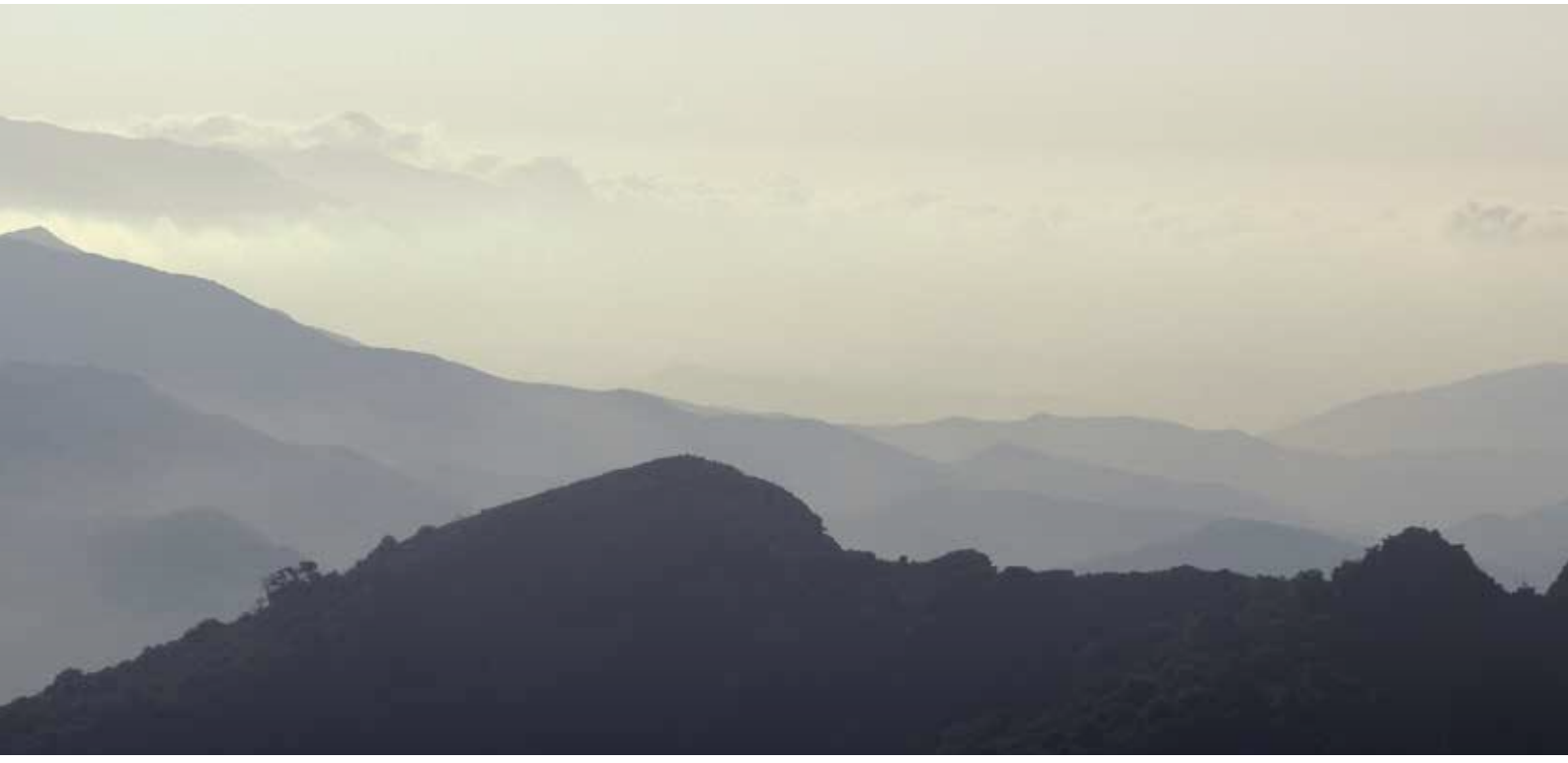


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To advise the most passionate technology entrepreneurs
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GP. Bullhound

Dealmakers in Technology

LONDON
tel. +44 207 101 7560
52 Jermyn Street
London SW1Y 6LX
United Kingdom

SAN FRANCISCO
tel. +1 415 986 0191
One Maritime Plaza Suite 1620
San Francisco CA 94111
USA

STOCKHOLM
tel. +46 8 545 074 14
Grev Turegatan 30
114 38 Stockholm
Sweden

BERLIN
tel. +49 30 610 80 600
Kleine Jaegerstr. 8
10117 Berlin
Germany

MANCHESTER
tel. +44 161 413 5030
1 New York Street
Manchester M1 4HD
United Kingdom

PARIS
tel. +33 1 82 88 43 40
45 rue de Lisbonne
75 008 Paris
France

HONG KONG
tel. +852 5806 1310
Level 6, Champion Tower
3 Garden Road, Central
Hong Kong

MADRID
tel. +34 609 279 661
Paseo de Recoletos 6
28001 Madrid
Spain

NEW YORK
tel. +1 212-759-1870
489 Fifth Avenue, 34th PH
New York, NY 10017
USA

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