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Martin Kahl, Editor
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There used to be a time when, after a long day at work, you could get in your car and drive home, completely disconnected from the rest of the world. Your car was an isolated island where the only people that could reach you were any passengers riding along. Then came the cell phone and everything changed. Now advanced connectivity is being increasingly built into the car. Within the next decade, consumers are unlikely to be able to buy a new vehicle without multiple connections to the world constantly transmitting data to other vehicles and to the Cloud.

It has now been two decades since General Motors introduced OnStar as the first cellular telematics system, and in the next few months, Cadillac will launch the first car to support vehicle-to-vehicle (V2V) communications into the US market. As we move towards a world where transportation becomes a service through on-demand autonomous mobility, connectivity will be as key an enabling technology as the suite of sensors packed into every vehicle.

At the most fundamental level, automated driving will rely on lidar, cameras, radar, and inertial sensors to provide situational

Thanks to connectivity, drivers and vehicle occupants will be better informed and entertained in the car; more significantly, they should be safer and will have better access to mobility, writes Navigant Research’s Sam Abuelsamid

Connectivity: a key enabler of mobility services

Delphi’s autonomous vehicle prototype combines sensors and connectivity
awareness. Unfortunately, however, every one of these sensor types is limited to a line-of-sight view within a few hundred feet. Connectivity adds a whole new layer of information to augment what the sensors can see while enabling more proactive information for a much more robust management of what the vehicle is going to do.

In the realm of vehicle connectivity, there are two primary layers: telematics to enable rich data sharing that is less time-dependent, and real-time vehicle-to-external (V2X) communications.

**Rich communications**

As cellular connectivity has increased in reliability and speed over the past two decades, so the range of what is possible through telematics has also greatly expanded. Early systems provided remote locking/unlocking of the car and automatic calls to first responders in the event of a crash. Now these systems provide a broad array of services for vehicle owners, including remotely starting their vehicles, monitoring the behaviour of young drivers, and managing EV charging.

With the launch of the Model S in 2012, Tesla significantly raised the bar for telematics system capabilities. Tesla built in an always-on 3G cellular connection in every one of its cars, making it the first vehicle manufacturer to provide over-the-air (OTA) software updates for safety-critical systems. This allows Tesla to provide new and enhanced functionality to customers without bringing the cars into a service facility, much as smartphone manufacturers do with mobile devices.

Perhaps even more importantly, however, Tesla is able to push out software updates to fix bugs and security vulnerabilities without having to conduct a vehicle safety recall. In recent years, recalls have become a major issue for vehicle manufacturers, as they have to rely on customers to actually take their vehicles to a dealer to have software updated.

OTA updates will not be able to address hardware flaws like the one affecting tens of millions of vehicles with Takata airbags. However, in mid-2016, Tesla was able to distribute software updates to its AutoPilot driver-assist system following a fatal crash. Tesla has also used its system to distribute updates for security flaws before any malicious actors exploit them.
As vehicles become both more automated and more connected in the coming decade, the need for telematics and the OTA update capability will become even greater. Navigant Research anticipates sales of nearly 27 million vehicles with high level automation (Level 3 and above) annually by 2025. Every one of these vehicles will need remote update capability to ensure that they remain as secure as possible while delivering optimal performance as this new technology continues to evolve.

Even before these automated vehicles arrive, manufacturers can leverage the projected 58 million factory-installed telematics systems that will be sold annually by 2025 for new revenue streams. Companies like Ford are already deploying apps that enable drivers to find, reserve, and pay for parking; set up service appointments; and receive location-based discounts on goods and services.

By leveraging the data available from vehicles to connect drivers to businesses, manufacturers can get a cut of the transaction for the leads they generate. Navigant Research estimates that vehicle maintenance and service lead generation could produce more than US$2.6bn in new revenue by 2025, while parking could amount to nearly US$2.9bn.

Usage-based insurance plans have become increasingly common, but they usually require the driver to install a connectivity adapter into the vehicle’s on-board-diagnostics port (OBD-II) to collect data. Telemetry data collected by vehicle manufacturers could be shared directly with insurers to provide more granular information in return for discounts on the premiums paid by customers.

Unlike telematics, which can transmit rich data that is less time-sensitive, V2X is designed to transmit short, well-defined messages with low latency. For example, V2V safety messages can include content such as the vehicle detecting a slippery surface when the ABS or traction control activates or a vehicle approaching a blind intersection. Similar messages broadcast from a pedestrian’s phone can alert drivers that they are about to step into the street.

Talking cars

The other half of the connected vehicle platform is V2X communications. While this technology has been in development for more than a decade, it is only now starting to be deployed in production. V2X is designed to provide real-time peer-to-peer communications between vehicles, cyclists, pedestrians and infrastructure.

"Consumers are unlikely to be able to buy a new vehicle without multiple connections to the world constantly transmitting data to other vehicles and to the Cloud."

FordPass App enables drivers to find, reserve, and pay for parking.
There are two main technologies vying for V2X deployment: dedicated short-range communications (DSRC) and 5G cellular. DSRC is a variant of Wi-Fi that is defined by the 802.11p protocol and has been actively developed in North America and elsewhere. In late 2015, Toyota was the first OEM to deploy DSRC for V2V communications in several Japanese market premium models.

Due to limited availability to date, Toyota has focused on using the DSRC communications to provide cooperative adaptive cruise control capability – enabling following vehicles to be alerted when the leader is about to slow down so the group can function as one, providing for smoother overall control and safer operation. This sort of ‘intent signalling’ will be a key factor in the future automated vehicle ecosystem so that a vehicle has proactive information before it does something that can be detected by sensors. V2V technology will also be an enabler of safe vehicle platooning, which enables vehicles to follow each other in closer proximity on highways. Platooning allows for more efficient use of the available road infrastructure and leads to fuel savings, especially for large trucks.

In the US market, Cadillac will be the first brand to introduce DSRC V2V communications in the spring of 2017. A proposed regulation that would have mandated V2V on new vehicles is still several years off starting in 2020 was published in late 2016; however, an executive order by the new president that requires two regulations to be repealed for every new rule means this regulation is unlikely to be enacted in the near future.

While DSRC is now well-defined and ready for mass deployment, a number of companies are pushing for the use of next-generation cellular technologies instead. 5G cellular is being developed to provide much higher speeds and lower latencies than current 3G and 4G systems, but the standards are not yet final and widespread network deployment is still several years off. One other major difference with new cellular technologies is the ability for individual network nodes – in this case, vehicles – to communicate directly without needing to go through a network backbone, which would eliminate much of the delay in sending messages.

Navigant Research expects that more than 84 million vehicles will be sold annually with V2X capability utilising one or both of these technologies.

Connecting the automated vehicle

Regardless of the specific communications technology utilised, V2X will be needed to extend the situational awareness of automated vehicles beyond immediate line of sight, provide preemptive information about road conditions that cannot be detected by the sensor suite, and signal intent. At its core, an automated vehicle must be able to navigate without connectivity – just as a human must be able to move around without using a phone. However, in order to maximise the benefits of automation, the communication layer needs to be present.

5G cellular is being developed to provide higher speeds and lower latencies than current 3G and 4G systems, but the standards are not yet final and widespread network deployment is still several years off.

Similarly, telematics services will continue to extend beyond what we have today to provide bidirectional updates for navigation and enable the summoning of automated vehicles, among many other capabilities.

Creating up-to-date, high definition maps of the world in which automated vehicles operate will require collecting and aggregating sensor data from vehicles in the field. Systems such as Mobileye’s Road Experience Management (REM) will collect data about static objects and reconfigured roads that can then be shared back to the vehicle community. When GPS is unreliable – as it frequently is in urban areas – or roads are not clearly visible, such as when covered by snow, this information about known object positions can be used to triangulate and determine precise vehicle location.

In coming decades, those commuting by car will no longer be isolated from the world outside, but they should be safer and have better access to mobility, thanks to connectivity.
India - the world’s hottest connected vehicle market

Connected Car Pune – a one-day event hosted by Automotive Megatrends – took a closer look at the trends in vehicle connectivity in India. It’s one of the hottest topics in India’s auto industry, opening up fascinating and exciting possibilities for OEMs, suppliers and new players. **Freddie Holmes** rounds up the key talking points raised at the event.

**India is THE connected vehicle market:** Although in its infancy in India, vehicle connectivity is potentially more important here than in any other market. Time spent behind the wheel in heavy traffic could be better utilised, and emergency services alerts could save lives in the event of a crash – a common occurrence on India’s hectic roads. The prospect of a cashless society also creates opportunities for connected mobility services. On-demand business models such as Ola offer mobility at around a sixth of the cost of owning a vehicle outright, and can be coordinated and paid for electronically.

**The smartphone rules:** Only 1.4% of cars sold in India today feature basic connectivity as standard, according to Accenture. This is unlikely to change in future, given India’s reliance on smartphones. The industry recognises this, and is developing technologies that can best leverage ‘brought-in’ devices. There are around 235 million smartphones in India, and the ability to use smartphone connectivity as a source of navigation, music streaming and more is significant. For consumers, the user experience (UX) is crucial, and connectivity is climbing up the ‘must have’ list headed by fuel economy.

**Cyber security – weakest link, greatest opportunity:** Connecting devices to the car comes at a risk. Widespread use of aftermarket dongles that connect to highly vulnerable OBD ports present major cyber security risks. Stakeholders admitted that an absence of autonomous vehicles means there’s little threat to human life. What Indian drivers should be concerned about, however, is the UX and the compromise of private data. The cyber integrity of a new vehicle is rarely in the consumer’s mind when it comes to making a purchase, nor is it of high priority for the industry itself today.

**Infrastructure:** A clear hurdle for achieving India’s connectivity aspirations is the limited network coverage nationwide and the currently low level of 4G penetration, which is essential for cars to maintain a link to outside data sources, such as the Cloud. A lack of standardisation adds to the already limited guidance on policy, another of the hurdles slowing the roll-out of connected vehicle technology and services. Only once these challenges have been overcome, believes Accenture, will we see an increase in connected vehicles in India.

**Self-driving cars are a LONG way off:** Reluctant acceptance was the tone of the day when it came to driverless cars in India. Such vehicles would be far too expensive for most Indian consumers, but there’s a bigger problem: autonomous cars need predictable conditions – Indian roads are anything but. Snoozing behind the steering wheel may be a long shot, but connected driver assistance systems show strong potential to improve road safety, with little change to existing road infrastructure required. And fully autonomous shuttles could potentially operate within specific zones, such as university campuses.
The connected vehicle race: you’ve got to be in it to win it

Connectivity adds value – for the customer, the fleet, and the OEM; it creates exciting business opportunities; and it transforms the driving experience. Martin Kahl talks to OEMs and suppliers about the ways in which connectivity is shaping the auto industry.

From Internet blackspot to Wi-Fi hotspot, developments in vehicle connectivity in recent years have ensured that this is arguably the most exciting and disruptive technology to hit the industry since disconnecting the horse.

Indeed, the prominence of the automotive industry at CES and Mobile World Congress – where OEMs not only attend, but use those events instead of the traditional auto shows to launch products – highlights just how far connectivity has penetrated the industry. Connectivity has ushered in new business opportunities and new industry players, and given a whole new meaning to the word ‘mobility’.

Conceived initially as a means of delivering communication, and then infotainment, the ability to remain connected is now a basic consumer expectation, and it is for the vehicle manufacturers, suppliers and other interested parties to develop business models that incorporate the technology in a way that is affordable, future-proof and commercially viable.

Beyond infotainment, however, the multitudinous benefits of connected vehicle technology are still being discovered and explored. Many of the benefits are related to convenience and the associated business opportunities that such connected services can offer to incumbent and new industry players. Others relate to safety, with vehicle to vehicle (V2V) and vehicle to everything (V2X) connectivity clearly offering the opportunity to reduce collisions and cut the consistently high number of road fatalities and serious injuries that blight every country, developed or emerging.

For connectivity to work at its best, all vehicles need to be connected – to each other and to surrounding infrastructure. Passenger vehicles are usually front of mind in connected vehicle discussions, but the benefits to operators and drivers of medium and heavy duty truck fleets cannot be overstated. Whilst infotainment may be low on the list of requirements for a freight company’s procurement division, fleet management – even in its most basic form – can significantly improve the efficiency and bottom line of a truck fleet.

The ultimate connected vehicle is, of course, the autonomous vehicle. Various launch dates exist for various promised levels of autonomy, but nothing is guaranteed, least of all the legislation required to enable public use of autonomous vehicles.

Meanwhile, connected vehicle technology advances, with an ever-wider field of topics specific to improving the lot of private car owners, companies with fleets of cars and trucks, and new mobility services providers.

Here, Megatrends presents the views of car and truck manufacturers, technology suppliers and the telecoms sector on a range of subjects including the emergence of new connected services, infotainment, cyber security, connected trucks and the tricky business of making money from the connected car.
‘Applying connected vehicle technology to antiquated services’

For technology companies, much of the growth rate lies not in device manufacturing but in the services which those devices enable. For Ford Motor Company, explains Mike Tinskey, Director of Connected Vehicle - Emerging Services at Ford Motor Company, that device (in this case a vehicle) averages at around US$34,000; once that device (the car) leaves the dealer’s forecourt, Ford estimates that vehicle owners then spend, annually, around US$6,000- US$8,000 on currently untapped services such as road tolls, fuel, parking, insurance and even drive-through restaurants. In the current state, where things are just starting to become connected, the OEMs do not participate in these annual revenues.

Parking, for example, relies on drivers seeking parking bays without any availability information and paying with cash or credit card; the insurance model is based on claims history, credit reports and zip codes; refueling a vehicle requires a driver to stand in often poor weather at an often time-consuming credit card payment machine. “Vehicle connectivity options can make these consumer experiences much more pleasant and efficient,” notes Tinskey. The race is on for the OEMs to secure a hold in these services, facilitated by technology developments. “We're applying connected vehicle technology to antiquated services.”

However, for this to work, there has to be industry co-operation at a platform level, upon which individual brands can build. “These need to be industry plays, bigger than any one OEM,” believes Tinskey. Mobile payment for a toll road or a quick service meal, for example, can be facilitated by the OEM, but this requires a wider infrastructure. “We want our competitors to use a common framework. We want to leverage technology that will soon be in all of our vehicles, such as DSRC radios, and then it becomes a question of ensuring infrastructure compatibility. In all of our scenarios, we believe the automaker would still own the touchpoint for the vehicle and provide the best customer experience.”

As traditional businesses such as car rental and vehicle servicing mature, OEMs are ramping up their enthusiasm for downstream business – and they are doing this because they now can, not because they previously didn’t want to, says Tinskey. “You need a certain level of capability in communication to have any type of shared economy. For example, a parking space that is known to be vacant can be communicated to all vehicles in the area, and this type of communication can lead to a more efficient use of assets in a shared economy.”

Infotainment - the car as a digital companion

Hot on the heels of cell phone connectivity came navigation and in-car Internet for infotainment. The days of the six-CD changer are gone; so too are DVD-based sat-nav systems, replaced by streaming, connected navigation and in-car Wi-Fi hotspots. Where next for connected infotainment?

“People want to take their digital lifestyle wherever and whenever they go without being disconnected. And that includes when they get into their cars to drive to their next destination,” says Arwed Niestroj, Chief Executive and President of Mercedes-Benz Research & Development North America.

“Our customers expect in-car infotainment that supports such a seamless integration, be it for entertainment or for business reasons.”

Mercedes-Benz is focusing its efforts on enhancing lives by connecting the car to the Internet of Things (IoT), says Niestroj. He cites as an example a recent collaboration with Google. Announced in December 2016, the collaboration sees Mercedes-Benz integrate Google Assistant on Google Home, enabling customers to interact with their vehicle from home, via the voice-activated personal assistant. Amongst other things, this gives users the ability, before they leave their house or apartment, to send destination information to their car, set and activate the vehicle interior temperature, identify vehicle status and lock or unlock the vehicle’s doors.

“This is part of our long-term goal of creating an intelligent mobility ecosystem around cars to make everyday life more convenient for our customers. And machine learning provides an even more personalised user experience by learning from our customers’ actions and their environment.”

Ultimately, Mercedes-Benz wants to ensure seamless and intelligent interaction between its customers’ IoT and wearable devices and the Mercedes on their driveway. “Our vehicle is a digital companion more than ever,” says Niestroj.
The big issue: vehicle connectivity

The connected car at the heart of the IoT is the future — this much we know. Yet we also know that a device connected to the Internet is a device that cannot be secure. Automotive cyber security remains very much the enormous elephant in the room.

“One of the biggest efforts on cyber security from an industry perspective is the Auto-ISAC,” says Henry Bzeih, Managing Director, Connected & Mobility at Kia Motors America. The Automotive Information Sharing and Analysis Center (Auto-ISAC) was created in July 2015 as a central hub for the analysis and prevention of potential cyber vulnerabilities in vehicle electronics.

“It’s really become the forum for information exchange. We, and many others, have benefited from this pool of brainpower from automakers, the automotive supply base, researchers and academia discussing vulnerabilities and working on best practice,” says Bzeih, who sits on the Auto-ISAC board.

For an industry traditionally reluctant to share information even with its commercial partners, let alone competitors, the level of collaboration within the Auto-ISAC has been greater than expected, says Bzeih. “There are many ways that the industry comes together, but this specific area has brought people closer. Misery loves company, and nobody wants their brand subjected to negative headlines.”

Whether owned or shared, driven or autonomous, it’s clear that the car is and will remain a key part of the IoT. However, there is concern about letting the car mingle with other non-automotive devices within the IoT. If anything connected to the Internet is vulnerable, then the wider the funnel, the greater the opportunity for an attack, testing automotive security protocols to their very limits.

“The IoT is intrinsic to the convergence of the vehicle with connectivity beyond the vehicle,” says Bzeih. “We don’t want to do things for the sake of doing things. In the past it was a race to launch technology, but cyber security has changed the way we as an industry think when we bring technology to market. We test cyber security, privacy and safety before technology is signed off. If we see there’s a risk or a potential threat, we won’t proceed with it. We want to continue to innovate, but we have to do it differently from before.”

Convoy! The technology connecting trucks

Most discussions around connected vehicle technology centre on convenience and infotainment in the connected car, but it is in medium and heavy duty trucking that the greatest value will be added. “Today, the idea of a connected truck mostly means a telematics service with a limited amount of data flowing from the truck to the Cloud, and small amounts of data flowing back down to the fleet operator or the driver,” notes Josh Switkes, founder and Chief Executive of Peloton Technology. “We see considerable power in those services, and in expanding those services, but also in direct truck-to-truck and truck-to-infrastructure communication.

“Telematics can give you feedback on a daily, weekly or monthly basis about the truck, the driver and your operation. It can give you semi-real time communication with the driver, but when you add truck-to-truck or truck-to-infrastructure, you can get immediate features like platooning, alerts and driver warnings, and other actions.”

Switkes notes a significant change in the business of trucking: “To date, OEMs and Tier 1s have focused on selling physical products. We’re finding that companies are starting to see the power of services, which can serve their customers better than just components. Every OEM now has a telematics service, either in-house or with a partner. And they’re starting to see the benefit of offering automation services like platooning as a service to end customers, because it’s a very low risk, flexible financial arrangement, with no major upfront investment.”

We see considerable power in direct truck-to-truck and truck-to-infrastructure communication

Josh Switkes, Peloton Technology
Things move faster by connected truck

When Salt Lake City-headquartered Nikola Motors burst onto the scene with a promise to revolutionise trucking, the focus was on the company’s zero emissions Class 8 truck – and there the focus has remained. According to founder and Chief Executive Trevor Milton, however, the company has developed its truck from the ground up – including its connectivity.

“One of the main philosophies of the Nikola One truck was connectivity,” says Milton. “Our truck is so well connected that an operator back at base could take control of the truck and operate it remotely, and we believe this will be a prominent feature in the future. Our trucks run off Wi-Fi and 4G LTE, and we’ve done this for a reason. On any truck now you have several major components – the engine, the transmission, the emissions equipment – all transmitting on different software platforms through a telematics system. In the past, truck OEMs focused on the equipment, not on the experience. For our truck, it’s about being completely connected.”

As mentioned elsewhere in this article, connectivity offers significant benefits to fleets. “It is our belief that fleet operators need to be able to monitor their drivers’ driving habits, how safely they drive, how much attention they pay to the road rather than their phone. We can analyse all of this, which is not possible, or is limited, with basic telematics.”

Drivers, too, can benefit from being fully connected. “We have a 21-inch display in the truck which allows the driver to see every available load within a city. Consider a driver in LA who wants to go to New York, and has seven days to get there. Our system would automatically calculate for that driver the most lucrative route with the most lucrative loads, and with the appropriate hydrogen stations for our trucks. This could increase the driver’s pay by maybe 35-40% over what he’s currently making for that route.”

It’s impossible to exaggerate the importance of connectivity to trucking, concludes Milton. “The connected truck is going to be the future of trucking, replacing many of the services that trucking companies have right now, much like Uber has replaced taxi services. That’s why we have to integrate connectivity into our truck.”

- Trevor Milton, Nikola Motor
Connectivity boosts productivity - but what does that mean?

One of the great benefits of connectivity is the ability to use car time productively. The Rinspeed Etos, unveiled at CES in 2016, was a collaborative effort between Swiss concept car creator Rinspeed, Harman and other partners to conceive a vehicle with in-car solutions for the business professional, by integrating key elements of Microsoft Office 365 productivity suite capabilities, including Microsoft-owned Skype. The Rinspeed Oasis concept shown at CES in 2017 took the office-on-wheels concept further, with ZF adapting its collapsible steering wheel into one that folds flat and turns into a keyboard or work surface.

Rinspeed concepts of late have begun to explore how vehicle occupants will use their time in the cars of tomorrow when autonomous driving means no-one needs to spend time behind the steering wheel. Megatrends asked Frank Rinderknecht, Rinspeed founder and Chief Executive, how vehicle connectivity can help to maximise and productively use time spent in the vehicle.

“We need to first define what maximising and productivity mean,” says Rinderknecht. “Is it work, efficiency and output? Or time to reflect and relax? Technically, with 3G and 4G, and with 5G coming, connectivity is more than sufficient for any kind of work one might want to perform in a moving vehicle. That should also be plenty for watching Netflix and keeping in touch with friends. Maybe we should look more closely at the time gained by not concentrating on driving.”

In the autonomous car of the future, what people choose to do in their vehicles would be wide and varied, says Rinderknecht. “For me, it would depend on the time of day, my current mood, my trip distance, my workload, and so on – and it would be the same whether riding in a car, taking a train or a flight. Maximising in that sense is thus defined by quality of life, not necessarily by productivity.”

From 4G to 5G – and beyond

The automotive technology developments that have been enabled by first 3G and then 4G LTE have already resulted in new business models and a rethink of the role of the car in our lives now and in the future. But what can be expected as the industry moves from 4G to 5G and beyond?

“I see the journey to 5G as an evolution of what we already have with 4G,” says Gion Baker, Head of Automotive at Vodafone. “Rather than a sudden switch over, we will experience incremental improvements in speed, latency and overall network performance. 5G will fundamentally transform the way mobile networks are used, improving a range of applications, from responsive high-definition video streams to augmented reality and tactile Internet applications. Innovation is likely to drive applications that we have not yet even considered.”

Baker notes the automotive industry’s focus on, amongst other things, vehicle-to-everything (V2X) applications based on cellular technology. “This is considered essential to changing transportation and enabling safety applications, cooperative driving and eventually autonomous driving.”

The growth of in-car connectivity and connected services has created a need for speed, and the automotive industry is firmly behind the move to 5G. Indeed, the 5G Automotive Association, which promotes the adoption of in-car 5G, was initiated by the automotive industry, together with technology providers, network operators and Tier 1s.

As to where 5G will initially be rolled out, Baker has a perhaps surprising opinion: “I think we will see 5G first with the commercial operators, where the obvious attraction of automated trucks travelling in connected platoons will soon become a common sight on our motorways and Autobahns.”

Longer term, Baker envisages cars communicating with their owners’ smart homes, and journeys being insured in real-time based on real-time driving condition and traffic load data. “We can start to imagine cities that proactively manage traffic flows and where searching for a parking space is a thing of the past, and cities where no-one owns a car but urban populations share vehicles through on-demand providers.”

In the move to a data-driven automotive ecosystem, there will be ever more opportunities for non-automotive players to disrupt the landscape, concludes Baker. “The industry needs to recognise that innovation will come from outside the traditional market, and it needs to respond to that challenge. However, we can expect major automotive players to be well prepared.”
Monetising the connected car

Monetising the connected car, says Ford’s Mike Tinskey, is about more than making instant profit. “There are numerous models being developed for OEMs to monetise the connected car. We have to add value, and just inserting the Ford Motor Company name into a value stream is probably not the right approach. We will continue to build on trust with our customers and we will have the first touchpoint with that customer, with the dealer and purchasing experience. We want to help them have the best experience going forward. We want them to find that parking spot, or to have the lowest insurance rate.”

Customers are so accustomed to doing things in a non-connected world, says Tinskey, “that they don’t realise the inefficiency, and that there’s something we can help them with. If we can help customers find services that are quicker, faster, more efficient, then they will enjoy the product more.

“The disruption that’s coming from connectivity, and the value that the customer will see in their everyday lives will be much greater than anybody ever imagined. We’re really excited about what’s coming over the next couple of years.”

Kia’s Henry Bzeih concurs. “Monetising the connected car is not about simply making money directly from an activity. It’s about what connectivity does to the overall brand, and to make it more attractive to the customer. It’s an enabler to a brand, an enabler to potential repeat customers, and an enabler to more convenience and happiness. Indirectly, connectivity does make money for the company, planting seeds for the brand. There’s plenty of focus on whether a business model makes money. I look at it differently: what does it do for the company, what does it do for the brand?” Connectivity is an investment that goes beyond direct profit-loss from a business perspective, continues Bzeih. “That’s not to say you can’t make money, but in the grand scheme of things, the benefit for the company as a whole is much bigger than the direct revenue.”

For the OEMs, the importance of connectivity lies not in making money, but in preventing financial losses due to poor technology: “The key is to help the vehicle manufacturers not lose money,” believes...
Exciting and disruptive

Connectivity is improving constantly; CD became 3G, and 4G will soon become 5G. The services that rely on that connectivity – or benefit from it – are also improving, offering exciting possibilities for new entrants and a renewed interest in downstream services from the traditional OEMs.

Connectivity has also brought key players closer together, on software and payment standards, for example, and in unity against the common menace that is the cyber attack.

Consumers have seen the connected car; that the vehicle manufacturers should make it standard is now assumed. Somewhere along the line, however, someone has to pay for it. Clearly, opportunities for the OEMs to monetise the connected car exist, but it’s a two-speed affair. There is instant money to be made from life in the fast lane, with revenue from parking, road tolls and so on; the slow lane is all about making and nurturing the investment, for potentially greater returns. It’s for the OEMs to decide what happens to their cash cow.

Whatever does happen, there’s no denying the enormity of this technology’s impact. Exciting and disruptive? You bet.
Harman may have made its name as a high quality audio company, but with Samsung as a parent supplier it is set to ramp up developments in automated, connected and secured cars, homes and devices.

Over the last few years, Harman has been busy acquiring companies it believes can support its ambitions to become a leading player in the car of the future. Symphony Teleca, Red Bend and TowerSec were all brought into the fold with the aim of positioning the company in key verticals of Cloud-based analytics, cyber security and over-the-air updates. Then in November, despite the apparent effort to become a key player in its own right, Harman announced that it would be acquired by Samsung for US$8bn. Samsung stated that Harman would remain a standalone subsidiary led by existing management, but there are question marks on whether it will be able to retain the same degree of autonomy under its new parent. Will Samsung’s governance take away some of Harman’s new-found independence?

Harman’s Phil Eyler, who spearheads the connected car division, thinks not, and suggests the supplier will act as the ‘automotive funnel’ within the Samsung organisation. “If anything, this is going to create more momentum in terms of Harman expanding its reach in the connected and autonomous car space,” he affirms. “Will Harman get swept up? No, quite the opposite, and we’re pretty excited.”

There are clear synergies that can be had from the deal, such as in high quality displays, 5G connectivity and artificial intelligence, but also less obvious sectors such as autonomous driving and smart homes. Megatrends sat down with Eyler during an invitation-only event running alongside the 2017 CES in Las Vegas to see where the company is heading under new ownership.

From connected car to connected life

Behind closed doors at the Sin City event, Harman presented its view for the car of the future. What’s interesting is that the car of the future is apparently about more than just the vehicle itself. Amongst a variety of connected wearables and audio gear, a ‘smart home’ and shared mobility concept car gave a clear indication of the company’s direction.

As the connected car continues to mature, the automotive industry is looking at how its technology can be used to benefit life outside of the cockpit. Recent partnerships between companies such as Amazon and Ford, for example, have added further evidence that cars will not only interact with other road users, but with the home, workplace and other connected infrastructure. “We are absolutely thinking about this as an Internet of Things (IoT) ecosystem, connecting the home, the car and the office,” explains Eyler.

To this end, Harman has been working closely with long-term partner and concept car developer Rinspeed. “We’ve created an autonomous shared mobility vehicle demonstrator that shows our re-imagining of what the future connected car will look like. This shared autonomous mobility ecosystem is tightly integrated into a person’s life, not just into the car,” says Eyler.

In practice, a consumer could order such a vehicle to come to the house through voice recognition technology in a Harman smart speaker. Because the consumer has a personal profile, the car arrives automatically configured to that person’s preferences. The same process could occur in a workplace environment, something of particular interest to Eyler. “We think the office is a huge piece of this conversation. As cars become more autonomous, the opportunity to become more productive in the car becomes increasingly important,” he explains. “This car has embedded features that combine with your work life as well.”

In January 2016, Harman partnered with Microsoft to introduce Office productivity software to the car. At the 2017 CES, this
The car in the IoT was demonstrated with the ability to join conference calls and update work calendars directly from the car, for example.

Cyber security

With the car connected to the home, the Cloud and various other devices, the ability to protect against nefarious cyber hackers becomes ever more important. As any cyber security company will point out, whenever an additional component is connected to the Internet, a new attack surface is created.

A connected life “definitely creates a huge risk,” agrees Eyler. “This is why our first step in the connected car journey was to build a foundation and a cyber security platform to go with it.” Despite heightened risk, he observes that the industry is not moving quickly enough to ensure that consumers are not in danger of losing personal data or control of the steering wheel at the hands of remote criminals.

“It’s been interesting because last year there was real concern about cyber security in vehicles, but that has waned slightly,” he says. “I still think the industry needs to move faster, and we’ve been pretty clear about that. This is why we’ve been investing so heavily in this area.”

Interest in cyber security varies from company to company, and there are many players that are actively pushing for secure solutions. The formation of the Auto-ISAC – the automotive industry’s

“New human-machine interface (HMI) technologies will be relevant not just for fully autonomous cars, but also for semi-autonomous cars with the transition away from the classic style of driving...”
answer to a dedicated cyber security body – was a positive step, Eyler says. The launch of a comprehensive best practices document in July 2016 was another. However, “there are certainly some players that are maybe not reacting fast enough,” he admits. “Like anything, it’s a big change. Organisations, priorities and architectures have to change. In our space, that sometimes doesn’t happen as fast as we would like it to.”

In May 2016, a Model S driver died whilst using Tesla’s semi-autonomous Autopilot system, sparking outcry among various stakeholders and third-party watchdogs. Some even called for Autopilot to be banned until proven ‘safe’, and put autonomous driving under the regulatory spotlight. Would a cyber hack resulting in similar outcry act as a catalyst for improvements to security? “I hope it doesn’t happen, but it certainly would,” muses Eyler.

The handover to autonomous driving

Harman is now a company with an ancestry in audio systems, owned by an electronics giant – not the most obvious player in the driverless car space. However, Eyler believes the company is well positioned, particularly when it comes to the user experience. “This is one area we’re focussing on that maybe hasn’t yet been as prevalent in the conversation around autonomy,” he says. “New human-machine interface (HMI) technologies will be relevant not just for fully autonomous cars, but also for semi-autonomous cars with the transition away from the classic style of driving.”

The handover period – from autonomous mode to manual driving – is a key topic of interest here. It is unclear how cars with the option to drive in fully autonomous mode will transition control to and from the human driver. Transfer control back to the driver too early, and he or she may not be ready. Transfer control too late, and the car may not be able to avoid a dangerous road situation. Both instances could result in a crash.

Automotive interior supplier Faurecia conducted research in 2015 to this end, and found that five to eight seconds was a ‘good target window’ to transfer control back to the driver. An expert from Yanfeng Automotive Interiors (YFAI) also suggests that around ten seconds would be the best bet. Volvo opts for a different approach, suggesting that if the car is in fully autonomous mode, the driver should not be expected to retake control at short notice. Instead, the car will revert to a safety mode and find an ‘appropriate’ (i.e. safe) spot to pull over. In December 2016, a letter published by the US National Highway Traffic Safety Administration (NHTSA) revealed that GM’s Super Cruise semi-autonomous drive technology would stop the vehicle, after issuing alerts, if the driver with hands away from the steering wheel for an extended period were deemed inattentive.

Three steps

Harman shares a similar view in this sense, recognising that drivers may not be ready to regain control and that it is likely dangerous to assume otherwise. The Rinspeed concept car shown at CES 2017 requires a three-point checklist before control can be returned to the human driver. Hands must be on the wheel, and can be detected through sensors. Eyes must be on the road, and can be confirmed via camera-based eye-gaze tracking. The third part is a unique Harman technology, which can track changes to the pupil itself. “Our technology correlates the amount of pupil dilation to cognitive load, so it makes sure that your concentration is on the road ahead;” explains Eyler. “We recognise that the handover is probably one of the biggest concerns for OEMs.”

Eyler admits that while this is not the only approach the industry could follow for vehicle autonomy, he believes it is beneficial to continue investigating possible routes via concepts and prototyping. After all, it is not only Harman that wants to understand how cars and drivers will be affected by automated and connected technologies in future, but its peers, customers and employees. As an electronics behemoth sitting in an industry that places great importance on software, it will be interesting to see how Samsung’s Harman performs.
If reports from the 2017 Mobile World Congress Summit are to be believed, commercial deployment of 5G mobile data networks could begin as early as 2020. Greatly increased data capacity and transfer speeds are just two of the drivers behind the expected uptick in the number of connected vehicles on the road. Research from Gartner, an IT research firm, predicts that in 2017, around 21 million vehicles featuring data connectivity will be sold worldwide.

Tomaso Grossi, Senior Product Marketer at TomTom Automotive, suggests that by 2022, annual sales of connected vehicles could rise to over 60 million units. One of the main consequences of this will be the extension of the driver’s connected life beyond the home, office and smartphone. Suppliers such as TomTom, says Grossi, will find they have many more opportunities as OEMs jostle to differentiate themselves and provide drivers with brand new assistance services.

“The amount of data that can be transmitted will be greatly increased, as well as the speed,” he says. “This is great news for us, as we are effectively in the Big Data business, working with almost half a billion devices providing us GPS info. These include in-built systems, portable systems, telematics units and mobile apps.”

Better connectivity means better maps, which is better all round

Thanks to developments in connectivity, TomTom could soon provide near real-time mapping services - these could prove especially important for tomorrow’s smart cities, writes Xavier Boucherat.
The key for mobility service providers will be asset utilisation. The more trips you can make from the same car, the more profitable the model... and this requires services to send users along the best, quickest routes.

Greater connectivity, he continues, will lead to both improved services and new offerings, generally targeted at safety, efficiency and comfort. What’s more, thanks to over-the-air (OTA) updates, TomTom will be able to roll these out far quicker.

“Previously, if a driver wanted to update their navigation system it required a visit to the dealership for a USB or DVD to update the system in-vehicle,” he says. “Cycle times today are much shorter however, and we’re targeting ever shorter cycle times through OTA updates.”

Instant updates
Mapping technology, says Grossi, has come a long way in recent years, noting that only a few years ago, maps were difficult to update, and were fairly static in their reporting. Heavy investment in the transactional map-making engine and platform has improved things, he suggests, but lag still remains between changes on the road and changes on a user’s device.

A combination of faster data communication and improved AI will drive down this lag. Large amounts of data crowd-sourced through sensors such as cameras could be used to detect, for example, road signs, traffic conditions, unexpected elements such as collision incidents, and poor road conditions, such as wet roads. AI can then be used to recognise and categorise these different elements.

“The important thing is to close that loop as fast as possible, and shorten the cycle,” says Grossi. The quicker a map can be updated, the more useful offerings like TomTom’s will become as part of smart-city solutions. Ongoing urbanisation worldwide means that congestion and pollution remain major concerns for city centre inhabitants. “We see that cities in emerging countries in particular are struggling,” says Grossi, “and we want to provide city authorities with the ability to curb that.”

In 2008, TomTom began work on its ‘Traffic Index’, which measures congestion levels in 390 cities across 48 countries. The company’s discoveries underline the scale of the problem - it estimates that since 2008, congestion in city centres worldwide has increased on average by 13%. In 2016, the worst offenders were Mexico City, Bangkok in Thailand, and Jakarta in Indonesia. On average, drivers in Mexico City could expect their journey time during peak hours to take up to 66% longer when compared with a free-flow situation on the road.

Parking space
Meanwhile, figures from Frost & Sullivan estimate that in 2015, the average driver spent 55 hours looking for a parking spot, costing nearly US$600m a year in wasted time and fuel. TomTom already offers off-street parking assistance by directing users to car parks, but connectivity developments mean the company can now offer an on-street service. Launched at the 2016 Paris Motor Show, the service uses GPS data to analyse where and when drivers are looking for spots. It then feeds back the probability of finding a spot in the location, and the amount of time a driver can expect to spend looking.

“This reduces the hassle of driving,” says Grossi, “and this is what TomTom set out to do in the beginning. We analysed the key blockers, the pain points in the driving experience. Traffic is clearly one of them, and we deployed products to address that. Then we looked into the future and asked what new pain points would emerge? Parking was clearly one of them. I think it would be immensely valuable if we can give people back the time they spend looking for a space.”

TomTom is also providing city authorities the tools they need to improve situations on the ground with
TomTom City, a web portal that uses data gathered by TomTom where those tasked with helping cities flow can access traffic information, live and historic, and identify hotspots. Like many in the automotive industry, TomTom is positioning itself to work in the wider sphere of mobility services, and not just with cars. “It’s not just about navigation systems,” says Grossi. “It’s about empowering users to get from A to B as seamlessly as possible, using any transportation means.”

One development that all mapping suppliers have keen eyes on is the rise of services such as ride-hailing and car-sharing in city centres. Grossi identifies 2016 as the year the automotive industry woke up to this trend. Almost all of the major OEMs have set up a mobility service or mobility subsidiary, he says, and those who haven’t have invested in one.

“The key for mobility service providers will be asset utilisation,” he suggests. “The more trips you can make from the same car, the more profitable the model. In this business, variable costs are much more important than fixed costs. Greater asset utilisation requires an operation to run like clockwork, and this requires services to send users along the best, quickest routes.”

Setting standards

Accurate maps capable of updating quickly will also prove essential as further autonomous technology arrives on the roads – a key example, Grossi points out, of connectivity as an enabler of autonomous driving. “These vehicles will require the shortest lead-time possible between changes in reality and changes on a device,” says Grossi, as it will enable vehicles to react pre-emptively and avoid traffic build-ups.

For Grossi, issues around autonomous driving present one of the main difficulties moving forward. “Not everybody in the automotive industry is ready to embrace the newest technologies,” he says. “There is still hesitancy among OEMs and Tier 1s with limited interest, or a different view. Cycle times remain long compared with those in the tech world, and TomTom believes what is required is standardisation.”

To that end, TomTom launched the Advanced Driver Assistance Systems Interface Specifications (ADASIS) Toolkit, which aims to define standards for ADAS applications with access to map databases.

“We believe the more standardisation within the industry, the easier it will be to establish a clear path towards safe autonomous driving,” he says, concluding that the services enabled by improved connectivity will also speed the industry along the route. “We want to smooth out the driving experience. We started with traffic. Now we’re working with parking, and weather. And ultimately these are stepping-stones towards autonomous driving – the connected car is the key building block for the autonomous car.”

Not everybody in the automotive industry is ready to embrace the newest technologies. Cycle times remain long compared with those in the tech world, and what is required is standardisation.
The rise of the connected car is turning Big Data into a big business opportunity – provided companies can harness, store and access that data. On this front, Quantum is pioneering innovative approaches that promise pivotal development cost savings for players across the automotive spectrum. The company has earned a reputation in the field of data protection and has recently begun to use data more predictively.

Asking questions of the data

“We’ve been in the automotive sector for over a decade, dealing with IT and corporate data. In the last six or seven years, we’ve continued to grow more in the research and design portion of the sector,” explained Molly Rector, Vice President of Marketing at Quantum. Extrapolation is the key. As she elaborated: “You can ask questions of the data. You can predictively use that data to cut the number of simulations and the number of physical prototypes, reducing time and cost.”

Pointing to crash test simulation as an example, Rector noted that where a company would previously have run perhaps ten simulations, now it can run hundreds of thousands with simulated data. “We really are opening up a new world of capabilities, not just in terms of time to market, but also by generating really good results to make better decisions.”

Quantum has worked with a range of traditional vehicle manufacturers around the world, from Asia, across Europe and the US. It has also collaborated with racing teams from Formula 1 and NASCAR. More recently, the rise of the connected car has opened up new challenges and partnerships. “With the evolving market of autonomous driving, new players are jumping up in very unexpected countries,” Rector told Megatrends. “They could never go out and compete in the traditional automotive market, but they are doing autonomous work in smaller markets.”

Opportunities abound. With the rise of connectivity and greater autonomy, Quantum has been considering how to collect sensor data and transfer it safely to where it needs to be. As Rector explained: “There’s the question of how to collect the sensor data coming off an autonomous vehicle. We have been working with the military, for instance, where there is a need to be able to collect data in a war zone. We have rugged equipment that can go into the trunk of a vehicle to collect that sensor-generated data. It’s then crucial to be able to recover that data from such vehicles.”

One priority will be to continue efforts to make the systems easy enough to use so that a scientist, and not just an IT specialist, can use them relatively easily.

- Molly Rector, Quantum

The right fit

Once the data has been acquired, the challenge turns to transferring it to the researchers and designers and storing it. At this point, the right data storage programme could make or break a project. “The systems that can cost-effectively store this kind of data for a business unit are very different from those you would use for Microsoft Exchange or Oracle, for example. One of the biggest obstacles for these researchers and developers is to figure out the right kind of systems they need,” she commented.

With a rapid increase in connectivity, Quantum saw a leap in the capacity requirements among its automotive customers in a short period of time. “We looked into the R&D processes of the vehicle manufacturers and component suppliers to see how they were generating this data. What we saw was that they are attaching more and more technology – sensors, new cameras with better
Vehicle manufacturers and component suppliers are attaching more and more technology - sensors, new cameras with better resolution, LiDAR, sonar - to collect more and more data as they drive their R&D efforts

- Andrew Mortemore, Quantum

In this sense, Quantum’s experience with the media and entertainment industry serves as a valuable precedent. “95% of the data generated by these automotive customers and companies involved in advanced driver assistance systems (ADAS) consists of media files or like-video files. We see them adopting the same types of workflows as media and entertainment companies because the traditional IT strategies of storage just aren’t feasible,” Mortemore explained.

**Competitive environment**

Much of the rise in demand for Quantum’s expertise stems from the competitive nature of the industry, where the race to be first to market with a new technology has assumed greater importance. “The automotive companies have always been concerned about safety and what happens as they design a more efficient engine. What they need to accomplish has not changed. What has changed is the competitive landscape and how quickly innovation is occurring. Just think about Tesla and other similar companies coming into the market. The pace at which the market is evolving has changed considerably,” said Rector. “The ability to use high performance computing systems and data analytics to remain competitive or to get ahead of the competition has become extremely strategic.”

Not long ago, companies would have been looking at a time to market window of five years. Now, suggested Rector, they are looking at a two-year time-span. “What we can do is share our experience in similar use cases from other industries. We partner with these users to significantly change their business models. Simulating a crash test instead of physically doing it, and knowing you can trust the data, represents a huge business model change.”

Quantum itself faces competition as new players enter, but believes it has something unique to offer. “The market is not very crowded today. There are many IT companies out there that sometimes get the nod from a business unit to do the work. Then they discover their systems either are too expensive or they are not designed for this use case and they end up not working,” she explained. “There is only a handful of organisations that have systems purpose-built for this type of heavy data analytics and global data sharing.”

**Still work to do**

Quantum faces a number of headwinds, but will be putting considerable effort into ease of use in particular. “One priority will be to continue efforts to make the systems easy enough to use so that a scientist, and not just an IT specialist, can use them relatively easily,” said Rector. “We are working towards the idea of an analytics system in every researcher’s work group area that is easy enough to manage and configure so that you don’t have to be a specialist to use it.”

Achieving this will add scale – and scale is crucial. As previously noted, thanks to growing demand for, and supply of, connected car technology, a burgeoning volume of data will need to be handled. Covering nearly all Tier 1 suppliers in North America and 85 Fortune 100 organisations, Quantum’s automotive customer base is wide. Big Data really is big business.
Securing the connected car will require hefty investment and collaboration, but it doesn't have to be a reinvention of the wheel. Companies that can draw on experience from other industries will not only find themselves ahead of the competition but also pull forward development efforts for all players.

Spread the burden

To start with, companies along the supply chain are going to need to work together. “There is no one vehicle manufacturer on the planet that will be able to take on the challenges of automated driving, safety and security, by itself. The investment is too great and the market is moving too fast,” warned Marques McCammon, General Manager of Connected Vehicles Solutions at Wind River. “You are going to see more collaboration between the OEMs to make sure that they can find solutions that all of them can use to spread the expense and the business risk of moving into these new technologies.”

He points to the recent collaboration between BMW, Audi and Daimler, which came together to invest in HERE for high definition mapping. McCammon suggests this move “was a direct strategy to hedge their brand positions against the Google brand position.” It’s not just the OEMs, though, that are pulling out all the stops as they scramble to adjust to new software requirements.

Standards: the next big focus

Wind River has been applying learnings and expertise from other industries. The company, an Intel subsidiary specialising in embedded software, has built up knowledge in mission critical industries that require fail-safe technologies. The Boeing 787 Dreamliner, for instance, uses its VxWorks 653 real-time operating software platform. VxWorks also provides the core operating system of the spacecraft control system in NASA’s Mars Rover, Curiosity.

It is this sort of experience that sparks its calls for an industry-wide standard on software. “In the aerospace, industrial and defence industries, public and private sector agencies and corporations came together to create software standards that everyone could design to,” McCammon pointed out. “They maintained the openness of the standards in a way to preserve competition between the constituents. After all, competition drives innovation.”

In aerospace, for instance, ARINC 653 (Avionics Application Standard Software Interface) sets out the software specification for space and time partitioning in safety-critical real-time operating systems. For the defence industry, the FACE approach represents a government-industry software standard and business strategy for the acquisition of affordable software systems, designed to facilitate fast integration of portable capabilities across different defence programmes around the world. “All of these standards created some normalcy around the way that the whole industry approached software, which de-risks it and spreads the investment across all the constituencies,” McCammon told Megatrends. “There was still enough openness in the community to allow those who service these industries to compete and to drive innovation. This will be the next big wave of discussion in the automotive space, and I firmly intend for Wind River to be in the middle of it.”

The many faces of security

For Wind River, to be ‘in the middle of it’ is to play at the heart of cyber security for connected vehicles – and that security comes in many forms. One of the most straightforward is personalised information management, namely the ability to bring consumer information to the vehicle and control it in such a way that it is not easily accessible to outsiders.

“Going forward, the vehicle will have more and more access to the driver’s personal information. It has moved far from the basic notion of a driver profile that emerged in the late 1990s or early 2000s, when you enter the car and pushed a
button and the seats and the steering wheel would move to your desired position. Nowadays you come into the car and the vehicle recognises you as the driver and brings up your music list, your contact information, your key points of interest on your map, the location of your home and your place of business," he elaborated.

The more this sort of connectivity – the same sort that is present on mobile devices – comes into the car, the more the industry opens itself up to the potential of someone gaining access to that information. Well-publicised white hat hacks have spread that message clearly.

Additional challenges come as the car takes on more software-based functions. "The notion of more vehicle functions defined in software, and the fact that there is connectivity to the vehicle at various if not all points in time, means that there is potential for someone to gain access to the vehicle in whole or in part," warned McCammon. "If I want my vehicle to have connectivity it entails a threat vector for someone to enter into that vehicle and to take action."

**Transformational risks and opportunities**

Software in general brings with it safety risks. "There is no such thing as bug-free software," McCammon emphasised. With smartphones or laptops, updates are relatively quick and painless but it’s not so straightforward for vehicles. "It becomes a very real point of concern if you put that into the context of a 3,500 pound hunk of metal and plastic hurtling at speeds of up to 150mph," he observed. This is where over-the-air updates come into play, offering an essential means of managing that update process. "It becomes a way for us to mitigate risks and to make real-time corrections to vehicle functions and software as we go forward."

While software brings new risks into the vehicle, it also brings new potential and capability to the vehicle and McCammon regards it as something as transformational to the industry as the introduction of the mass production assembly line. "We are at an inflection point and software is at a critical part of that inflection," he explained. "With any transformation, the change that it brings can mean risk and opportunity. If it is not managed properly then the notion of risk overshadows the notion of opportunity. As an automotive community, we need to be open about what the transformation means and be cognisant of where the risks and opportunities are."

**Autonomy ups the game**

McCammon regards the move towards autonomous driving as an extension to the security concerns today. "What becomes a factor as we look at security is the level of computing that we talk about with automated driving. It is going to be vast. We’re talking about data centres and terabytes of data in minutes. You need to be able to make sure that this is maintained, controlled and made secure so that information provided to the vehicle is the best possible information at every point in time. You need to ensure it cannot be corrupted," he said. "If there is any new introduction of threat, that will be it because many of the algorithms will not necessarily live on the car."

A handful of commitments have been made for launching self-driving vehicles, and ensuring their safety by this time is essential. At just a few years away, some of these deadlines may seem impossible. "2020 and 2021 are key dates for automated driving," said McCammon, but these don’t necessarily mean wholesale, high volume production of automated vehicles. "I would expect to see controlled fleets of vehicles in highly manageable environments, which would allow the industry to learn what it doesn’t know. Historically, when the industry has brought in new technologies, it typically is pretty measured."

Electric vehicles (EVs) offer one example. "In the 2004-2005 timeframe, we saw each of the vehicle manufacturers doing very limited, very controlled pilots of EV technology in select markets with a select customer base," he noted. "This afforded tremendous amounts of data capturing and collection so that they could prepare themselves for the next wave of product rollouts, which came three to five years later."

He expects a similarly prudent approach on the autonomous roadmap: "They will be spending considerable time in testing to ensure that they can qualify and quantify the risks both from a safety and security standpoint." And, he adds, "Wind River, with its experience and advice gleaned from other industries, will be there to help."
Incidents of car-hacking have grabbed plenty of headlines in recent years, rightfully prompting concerns for tomorrow's connected vehicles. Whilst it's true that all known car hacks to date have been research-based, and performed in controlled environments, it's not hard to imagine a future where drivers will face threats in the wild. That's according to Joe Fabbre, Director of Platform Solutions at Green Hills Software. The way he sees it, these threats will largely fall into two categories. One is the type that nobody hopes to see – a malicious attack, launched to hijack and even purposely crash a vehicle on the road. Terrorist organisations and organised crime syndicates are just two examples of groups who may seek to wreak havoc.

The other type is less extreme, and is often seen in consumer and IT markets. "The same types of things we've seen in the enterprise world are possible," he explains. "Attackers in this case would be seeking financial gain. Depending on which analyst you believe, there could be over a hundred million more connected cars on the road by 2020, making them a very attractive target for things like botnets, which can steal personal information. And it's very easy to imagine a future where people will have credit card numbers and other personal information stored on computers in their vehicles for convenience."

In this context, botnet refers to a network of internet-connected devices which, unbeknown to their users, have been infected with malware which can receive and carry out instructions from a 'botmaster'. Botnets are one of the most popular methods in modern cyber crime, and when designed well, they can go undetected for a long time.

But it's important to distinguish one threat type from another, says Fabbre. Whilst losing a credit card can be a major inconvenience, insurance mechanisms are in place to prevent loss, and people ultimately move on with their lives. Conversely, were a hacker to suddenly gain control over a car, or a number of cars, the consequences for the drivers, pedestrians and other road users may well prove irreversible.

The question for Green Hills and others is, how do you make such hijack scenarios impossible? The company's expertise in embedded software means it is positioned well, but what's really needed, suggests Fabbre, are much stronger policies and standards. "When I think about the safety and security standards in the automotive space today," he says, "I don't think they are strict enough to deal with well-funded attacks which are intentionally trying to break systems, and do harm to people."

As OEMs respond to demands for connected features, the cyber security challenges grow. Green Hills believes software separation could hold the key to meeting these. By Xavier Boucherat
Look to the skies

Luckily, there are already safety and security standards out there which, in Fabbre's opinion, have the level of rigour which the automotive industry will need. In the avionics industry there is a safety standard called DO-178C, which is the document used to approve software used in commercial aeroplanes. Using the document, software-based systems on planes can be placed in one of five categories, from A to E. Anything controlling or monitoring safety-critical functions is classed as level A.

“That's the level of rigour that I feel we ought to be applying to safety-critical internet-connected devices, and certainly things like autonomous cars,” he says. Green Hills’ ‘INTEGRITY’ real-time operating system (RTOS) is, according to Fabbre, the result of a laser-sharp focus on safety since the mid-1990s – an OS built from the ground up with safety in mind. Vulnerabilities in the lowest layers of software architecture can put an entire system at risk. For an effective security architecture within a critical system, he says, an operating system needs to be designed with two things in mind.

Firstly, there can be no vulnerabilities in the operating system - the code must be fully understood. It has to be rigorously evaluated and tested by external trusted certification organisations. This type of rigour applies not only to the code for the operating system, but also any safety or security critical applications hosted on that operating system.

Secondly, an operating system must be able to guarantee separation and isolation of critical and non-critical software components. “If you look at a car's in-vehicle infotainment system, composed of graphics drivers, multimedia codecs, and all of the other software that allows you to run things like Pandora and take phone calls in your car,” he says, “that's a lot of extremely complex code, made of millions of lines. That software is simply too big and too complex to be evaluated to the degree I’m talking about. That kind of software needs to be isolated away from the critical software that does go through the rigorous safety checks.”

Green Hills' research over the last four years shows a repeated failure to achieve this separation, with hackers penetrating vehicles through the infotainment system as one common attack point. One example came in September 2016 when a team of researchers in China took remote control of a Tesla Model S from 12 miles (19km) away, successfully interfering with a number of features including brakes and locks. These are clear indications that attackers were able to issue commands on the Controller Area Network (CAN) bus of the car, indicating a failure of separation within the

It’s very easy to imagine a future where people will have credit card numbers and other personal information stored on computers in their vehicles for convenience.
architecture. Moving forward, how can manufacturers ensure the same doesn’t happen to them?

**Strict division**

There are a number of ways to achieve separation, says Fabbre, but the volume of new technology and features coming together inside the car in conjunction with more capable and powerful processors means that OEMs favour software-based separation over hardware-based separation: “Software separation grants much more freedom and flexibility of design, compared to hardware-based separation that requires more space and power for additional ECUs inside the car.”

Function consolidation therefore needs to be done safely and securely, particularly as advanced driver assistance systems (ADAS) are deployed in increasingly high-volume models. Along with separation capability, OEMs need to identify the critical components within the car, and with which other pieces they need to communicate.

As Fabbre points out, there is a risk that ECUs running safety or security critical code may be combined with ECUs running insecure code that has not been evaluated with the same rigour. The company’s INTEGRITY Real-Time Operating system was developed to fix this exact problem, enabling safety-critical components to run alongside other non-critical internet-connected components running huge code bases on operating systems such as Linux, or Android.

“This allows for all the functionality we’d like on our centre console,” he says, “but it’s guaranteed to be kept safe and secure, isolated within its own partition, such that it cannot interfere elsewhere.” Once again, Fabbre stresses, the key to designing this architecture is holding it to a higher benchmark.

Separation is a matter of security, and just like safety standards such as DO-178C exist, so do higher security standards. In the case of security, there is an international standard called the Common Criteria, which rates software components against ‘Protection Profiles’ — in this specific case, the Separation Kernel Protection Profile. Results range from Evaluation Assurance Level 1 to Level 7, where 7 is the highest.

“Once you become involved in seeking higher levels of assurance, the government becomes involved,” says Fabbre. “The National Security Agency (NSA) spent 18 months performing penetration testing on INTEGRITY.” INTEGRITY was eventually awarded an EAL 6+ certification, or ‘High Robustness’, deemed suitable for use in a hostile environment featuring well-funded hackers out to attack a system’s security policies. By contrast, he says, other operating systems that have gone through the same process have never achieved ratings higher than EAL 4+, or medium robustness, and not intended for use within a hostile environment.

“They’re only intended to protect against casual or inadvertent attempts to breach the system’s security,” he concludes. “This minimal level of assurance is not enough against hacks that could crash tens of thousands of cars at the same time.” One can surely guarantee that much of the public will feel the same way, as connected cars and autonomous vehicles appear on our roads in greater numbers.

In today’s high-end luxury cars, over one hundred ECUs run hundreds of millions of lines of code. Continuing down that path is simply untenable. Carmakers will have to reduce the number of ECUs while simultaneously growing the software content.
India’s truck sector: the long haul overhaul

Despite the allure of advanced connectivity features and associated services, fuel economy was the overriding trend of the day at HD Truck Pune, a one-day conference hosted recently by Automotive Megatrends. Freddie Holmes summarises the key takeaways highlighted at the event by OEMs, suppliers and industry analysts

**GST – at last!** Is the long-awaited Goods and Services Tax (GST) the biggest change to trucking in India? Yes, according to various Indian executives and experts. GST is expected to boost trucking and freight efficiency, and was well received by all stakeholders at the conference. Today, Indian trucking is all about cost control. GST is pegged as the catalyst to shift the industry towards productivity instead. However, questions remain: will it really be implemented in 2017? And will it will live up to the industry’s expectations? In theory, it will effectively free up long-haul trucking routes, making the market more attractive to big fleets.

**Trucking powers up:** With GST opening up long-distance routes, big fleets will take keen interest – and big fleets will want to buy big, powerful, fuel-efficient trucks. That's the idea anyway, with most executives confident that overall demand for clean, high horsepower trucks will increase thanks to GST. At the same time, India is leapfrogging emissions standards to Bharat VI, which will affect all vehicles manufactured on or after 1 April 2020.

**Telematics – there’s a gap in the market!** A growing number of trucks across India feature a telematics system, but mostly only in its most basic form. Advanced telematics is deemed an industry ‘game changer’, and will solve the current ‘primitive’ handling of freight. In partnership with other connected services, productivity could be drastically increased. An accurate estimated arrival time, with information on the goods being carried – all transmitted over-the-air – could radically change the interaction between truck and depot. Fleets need to be convinced that the upfront investment can improve safety, efficiency, maintenance and, of course, customer satisfaction.

**‘Truck as a service’ comes to India:** Concurrent with movements in developed markets, stakeholders are looking to leverage heavy trucking in new ways through connectivity. Companies such as Truckola plan to utilise data and predictive analytics to link businesses that require shipping with heavy trucks that need road time. The message to India’s freight hauling sector: get ready for business models vying to be called the Uber of heavy trucking.

**Stand by for change, but let’s be realistic:** India’s CV sector is due a significant overhaul, but that doesn’t mean the imminent arrival of electrified autonomous trucks. Partial driver assistance is feasible, and for India would mark a leap in safety standards. Advanced powertrain and fleet management technologies – although a must-have in established markets – are also set to make ground breaking improvements to freight efficiency in India.
The future of Trucking India: bigger, better, faster, stronger – and connected

India’s trucks, a decade from now? Faster, more powerful and more efficient than today. But the self-driving electric truck? That’s many decades away from India’s roads, writes Martin Kahl

Few single markets face greater change over the next decade than India. Despite the course alterations that will result from the popular votes for Brexit and Trump in the UK and the US respectively, and the political uncertainty in key European markets, it is India – one of the world’s fastest-growing economies – that awaits a number of policy implementations sure to change the very structure of this rapidly evolving market.

Already at 1.31 billion, by 2027 India’s population will be the largest in the world, at over 1.4 billion. Growth means urbanisation, and urbanisation requires ‘stuff’. As small villages develop into large, and as people move from rural to urban locations, so demand for ‘stuff’ will increase. Great news for truck fleets, and the OEMs who supply those stuff-hauling fleets; but the changes to trucking in India over the next decade will be seismic in proportion. Just about the only certainty is that ‘Trucking India’ in 2027 will look very different from its 2017 ancestor.

To picture how different the two will be, consider how much Trucking India has changed over the last decade. In that period, the market has made serious contenders of BharatBenz, Scania, Volvo and Asia Motor Works (AMW), each posing a considerable threat to the established, dominant domestic players.

Change is already under way: India’s truck industry is now working towards a nationwide rollout of Bharat IV (BS IV), an emissions standard equivalent to Euro IV. The Indian government recently brought forward by several years the rollout of BS VI, leapfrogging BS V. That’s huge – it took Europe a decade to switch from Euro IV to VI, yet in India, OEMs are expected to make the grade in just four years. A major challenge for vehicle manufacturers – and a major opportunity for suppliers.
Assuming it is (finally!) implemented in April 2017, the long-awaited Goods and Services Tax will, in 2027, have been in place for a decade. GST is expected to free up long-distance road routes currently broken up by lengthy state border crossings; with trucks able to travel the length of the country comes the need for trucks that can make such journeys, built for greater power and greater speed. India is known for its unusually low-powered trucks and high number of two-axled CVs – there’s a gap in the market right there.

And the market itself will look very different; currently still dominated by the domestics, it’s easy to envisage a much greater role for the aforementioned global truck manufacturers that already have a secure foothold in the market – plus other interested OEMs such as Hyundai, which has its eyes on HD trucking in India. Those overseas OEMs are used to running big rigs to increasingly stringent fuel economy and emissions regulations. All that’s needed to support increased speed and power is appropriate infrastructure, and in India, that means massive investment.

That’s not to suggest that India’s government is trying to make life difficult for vehicle manufacturers; indeed, accelerating growth in vehicle manufacturing is at the heart of Make in India, the heavily-promoted local investment strategy that encompasses all sectors. For the automotive industry, that includes the second iteration of the government’s Automotive Mission Plan, AMP II, which by 2026 aims to make India’s automotive industry one of the Top 3 worldwide, increase automotive exports to 35-40% of production, increase the industry’s GDP contribution to over 12%, and create 65 million automotive industry-related jobs.

What, then, can India’s truckers expect in 2027?

AMP II will have drawn to a close, with key metrics highlighting its success or failure; and regardless of how successful the rollout will have been, BS VI will be in place. Big international fleets will be running long-distance lines, and the OEMs will have seen the benefits of equipping their trucks with state-of-the-art connectivity and adapting their networks for full service package offerings.

Clearly, to navigate the choppy waters of the next decade, stakeholders need a detailed schedule and strategy. India is a nation increasingly accustomed to a government that throws up surprises – a surgical strike demonetisation policy here, a registration plate-based capital city diesel car ban there, a truck age ban, the promotion of local diesel engine production, the cancellation of diesel subsidies, an acceleration of emissions norms. That the business community is prepared to accept – or is resigned to – not knowing what the government might deliver next, highlights the challenge.

As for what the government of 2027 might look like, it’s difficult to call; for Narendra Modi – a leader who likes to get things done – to still be in post, aged 77, he would have had to survive the current and highly divisive demonetisation strategy; he would need to have made it into a third term; and, of course, he would need to have the inclination and motivation to carry on.

India’s truck of 2027? Bigger, better, faster, stronger, connected and more efficient than today – that’s for sure. Just don’t go expecting too much technological development; reality prevails in India, and the harsh reality is that Trucking India already faces enormous change. Look elsewhere for electrification and autonomous driving – such technology remains many decades away from the on- and off-ramps of National Highway 27, 44, 48...
A world with little or no waste – it’s not just a nice idea for the distant future, it’s a means of improving the environment, public health and even profit margins today.

Companies across many industries are moving towards the idea of a circular economy as an alternative to the traditional linear model of make, use, dispose. In many regions around the world, governments are stepping up with support in the form of guidance and legislation.

The European Commission (EC), for example, is pushing legislation that would encourage the recycling or reuse of “most if not all products and materials” through repairing, refurbishing and recycling. The savings could be substantial. For instance, the EC estimates that if 95% of mobile phones were collected for re-use, savings on material costs of more than €1bn per year could be generated. Imagine what the savings could be for cars.

**Playing out**

“The automotive industry depends on different raw materials to produce vehicles. Much of the supply of materials goes to car manufacturing. An increase in demand will lead to increases in prices, which can potentially increase the costs to car manufacturers,” explained Khaled Soufani of Cambridge Judge.
The circular economy covers a complex and wide range of initiatives ensuring we work to make the best use of the valuable resources that go into our vehicles.

- Adrian Tautscher, Jaguar Land Rover

A handful of OEMs, including Jaguar Land Rover, have been investigating the potential for reuse and remanufacturing. "The circular economy covers a complex and wide range of initiatives ensuring we work to make the best use of the valuable resources that go into our vehicles. This includes technological innovation - such as recycling, remanufacturing, autonomous vehicles and ownership models that consider the future mobility needs of our customers," suggested Adrian Tautscher, Sustainable Aluminium Strategies, Jaguar Land Rover.

From OEMs to suppliers

JLR’s REALCAR (REcycled ALuminium CAR) and the REALCAR2 projects have identified huge opportunities around the circular economy and resource efficiency. The OEM worked with Novelis and Innovate UK on this closed loop value chain project, creating new materials and production systems to introduce closed-loop aluminium into Jaguar Land Rover cars. The work resulted in the development of a recycled aluminium-based alloy for use in vehicles and the implementation of an innovative closed-loop aluminium recycling process. JLR claims that the closed-loop enabled it to reclaim more than 50,000 tonnes of aluminium scrap back into the production process during 2015 and 2016. This prevented emissions of more than 500,000 tonnes of CO2 equivalent.

"REALCAR has delivered a technical and supply chain solution that allows aluminium scrap generated in manufacturing processes to be recycled in a much more efficient way," explained Tautscher. "REALCAR applies ‘circular economy’ principles by ensuring that high quality automotive grade material is reclaimed and put back into the same high quality product. This transparent and traceable process adds value and keeps a tight logistical loop for the material where it is needed, in the UK and Europe."

Material suppliers are also making headway on this front. ArcelorMittal’s head of R&D, Greg Ludkovsky, has spoken about sustainability as a catalyst for change. Amongst other things, the supplier is using waste created during the steelmaking process to make agricultural fertiliser, and the waste gases created during steelmaking have been used to create bioethanol for aeroplanes. "Sustainability, and specifically the role that steel is playing in the circular economy, are resulting in the creation of new business models and pan-industry collaborations that are potential game-changers," Ludkovsky commented.

Speaking to Megatrends, a spokesman for the steel supplier added: "Our innovation is helping our automotive customers to reduce their carbon footprint. Add to this the fact that steel is inherently recyclable without any loss of quality, so it is a perfect material for the circular economy."

The shared economy

Another good fit with the circular economy is alternative ownership models. The shift towards a shared economy, with concepts such as car-sharing and ride-sharing, attack the problem from a very different angle. "The shared economy is about the shared use of an asset that is not fully used by its owner. The sharing economy model contributes to extending the time usage of an asset or a product, so the economic objective is the maximisation of the usage of the asset," explained Soufani. "When this is applied to the automotive sector it is understood that cars are parked over 90% of the time, and thus a sharing model might increase utilisation and hence contribute to the circular economy. But there could be some challenges and again more research is required in this area."
Headwinds and potential

A number of headwinds currently prevent automotive material recycling from reaching its full potential. As Soufani pointed out, the whole concept of the circular economy “is relatively new in the minds of consumers and producers. There is a need for greater awareness and more information and education about the need to explore this model in the different industries. When consumers and producers are more informed about the benefits of this system probably more would decide to learn about it and possibly consider the application.”

JLR’s Tautscher called for greater financial support. As he told Megatrends: "The solutions are complex but attainable; industry expertise needs to be supported with funding to innovate materials and recycling technologies. The steps to achieving this are equally complex." These steps could include optimising current and future materials to allow increased recycling rates. He also flagged potential in advanced waste separation technology that is applied to end-of-life, post consumer and industrial waste streams to liberate a purer material source for recycling. There could also be potential in full supply chain engagement - from raw material producers to end users to the recycling industry, as Tautscher cautions that “automotive companies will not be able to deliver in isolation.”

Financial payback

All of these developments promise financial payback at some point for the companies involved. A report by Cambridge Judge Business School concluded that “full adoption of the circular strategy not only conserves resources, but can also raise businesses’ net profit margins and earnings dramatically over the long run.” As Soufani elaborated: “Reusing some of the used materials in the process of producing new products might reduce direct material costs, which is included in the cost of sales, and consequently would impact profit margins.” He cautioned that further research could uncover that different industries see different results.

JLR anticipates a return on its investment. “Fortune favours the brave, and ambitious thinking to break beyond existing established ways of working, as part of a long-term strategy, will yield financial benefits,” asserted Tautscher. “Specifically for recycling, maintaining material quality and purity helps ensure material properties are retained; this maximises the market value of the material. The challenge is delivering the technology alongside the associated business model to make it economically viable. A long-term strategic approach helps, because the financial benefit can take time to build as ideas go from small scale to fully industrialised, with scale and volume.”

Our innovation is helping our automotive customers to reduce their carbon footprint. Add to this the fact that steel is inherently recyclable without any loss of quality, so it is a perfect material for the circular economy.

- ArcelorMittal
The automotive industry has finally embraced the digital experience, and most brands have either launched, or are about to announce, the ability to buy new cars online. But in the race to attract online buyers, it’s crucial to not leave customers out in the cold. The problem for consumers is that although OEMs may have ‘gone digital’, few have re-engineered the shopping journey to address the many pain points customers encounter when trying to make purchase decisions about their next car.

The issues for consumers do not relate to showroom stock, or fulfilment of online orders; they lie in the lack of support during the buying decision itself, when the majority of customers still do not feel sufficiently in control of the choices and options that manufacturers present in the car buying process.

A recent survey by Auto Trader, a UK-based digital automotive marketplace, found that the majority of consumers, 99% in fact, said they were unhappy with the current car buying process. Clearly, consumers are more than ready for a change in approach.

Last year’s JD Power survey revealed that millennials accounted for over a quarter of new car buyers in 2015, and this number...
is set to rise dramatically over the coming years. Millennial buyers have grown up with digital, and bring with them the highest level of expectations for the digital experience, and a preference for subscription-based ownership models.

Manufacturers that aim to get channels right for this user group will have the best chance of future-proofing their platforms for customers going forward.

Insight generated by Foolproof observing car buyers has highlighted that browsing online and visiting a dealer are not binary choices – consumers expect to do both during their decision-making process. Many even look forward to a trip to the dealer, and make an occasion of it, because they enjoy getting an up close, physical experience of the cars, before making a final choice.

Crucially, what most manufacturers continue to miss is the joining up of the online and offline experiences. Today, too much responsibility for that falls on the customer, asking them to bridge the gap between a website and the dealer.

Customers want to feel in control of the car buying process, and it is here that manufacturers should help them with their research online, empowering them to feel more confident when interacting with a dealer.

A case in point here is Suzuki, a vehicle manufacturer which has taken this knowledge to the heart of its digital strategy. The brand has recently re-launched its UK website to improve the experience customers have with the brand online, and in the transition from digital to the dealership. The OEM understood that customers needed an online experience that would help them make better decisions about the type and grade of car that they wanted to buy, before reaching out to a dealer.

The new Suzuki website works for multiple users, supporting the varying needs of three different potential customer profiles. The first is the buyer who relies primarily on the dealership experience, and appreciates seeing and touching the car, and talking to someone about it; the second, the online shopper, believes the Internet, not the dealer, should provide all of the information to keep them in control of the decision-making process; the third is the multi-focused shopper who likes to mix dealers’ views with independent sources.

Make better decisions faster

Better decision-making for each of these groups lies at the heart of the relaunched Suzuki website. The newly designed site helps customers narrow down their choices to find the car that is right for their needs more quickly, and with more confidence, than before.

During research, customers told Foolproof researchers that they found it difficult to understand the value of buying a more expensive version of their chosen car, when online. Most car websites provide this information over multiple pages, or long feature lists, complicating what should be a clear and easy comparison process. Suzuki has cleverly implemented a side-by-side comparison feature that visually differentiates which key features become available, as the price increases.
It has become clear that overly-complicated car configurators are a major turn off for many customers. For this reason, the decision to simplify this function was the first part of the design challenge. Suzuki’s new ‘Send to Dealer’ button enables customers to easily send their choices to a local dealer, prior to booking a meeting or a test drive.

Not only does this feature bridge the gap between customer and dealer, but it has also improved one of the more arduous tasks in buying a car, namely the test drive booking.

Many commentators have questioned whether the new showrooming approach, trialled by some manufactures in retail outlets, will be the death of the test drive. Auto Trader’s study, however, suggests that test-drives will continue to play an important role in the car buying process: “88% of consumers said they would not purchase a car without test-driving it first.”

However, 80% of consumers also said they would welcome a different test-drive experience from the traditional accompanied test-drive model that predominantly exists today.

In the future, we can expect the booking of a test drive to be as easy as making a restaurant reservation. Customers will be able to book a test drive through their chosen dealer, selecting date, time and model from an online diary.

Manufacturers that aim to get channels right for millennials will have the best chance of future-proofing their platforms for customers going forward.

The future of ownership

Automated scheduling and booking of test drives is one development that will hugely benefit dealers by reducing the amount of time it takes to make booking arrangements with customers. Piloting this new functionality, in addition to continually learning from this initial implementation, will allow manufacturers to pave the way for other future innovation that could use digital channels to streamline the online vehicle buying experience.

For example, car manufacturers are expected to develop more subscription models to help consumers ‘rent’ rather than ‘own’ their car. This will go beyond the traditional personal contract purchase and hire purchase arrangements, and could include monthly subscription fees giving access to a range of cars that customers can book in advance. Date night on Friday? Book the two-door sports model. Carpool to football training every other Wednesday? Book the spacious minivan. Planning a drive on country roads? Book the SUV.

And the winner is...

The automotive industry must take note of established digital practices that are now mature and commonplace in the financial services and retail sectors. These industries have long since discovered the value and importance of experience design, product design, and service design methodologies to help create frictionless, elegant, and truly engaging digital experiences for their customers. The top brands in these sectors understand that customer experience is the best way to differentiate and create a lasting competitive advantage.

Those automotive players that adopt the same principles, as they move in to this improved digital phase, are the ones that will take the lead over their competitors.
In India, fuel economy is king

Hindi phrase ‘kya chal raha hai’ loosely translates to ‘what’s going on?’. During Fuel Economy Pune, a one-day conference hosted by Automotive Megatrends, various stakeholders asked that very question about fuel economy and emissions in India. Freddie Holmes identified five topics that will define the fuel economy debate.

**In India, fuel economy is king:** The top question for most, if not all new car buyers in India is “what’s the fuel economy?” Connectivity can be brought in via the smartphone and aftermarket devices, but customers expect a frugal engine to be built in. Less obvious to consumers are efforts in lightweighting, and the trend is yet to find its feet with domestic OEMs. Suppliers are confident that demand for advanced solutions will pick up in coming years, with weight reduction driven primarily by innovations in steel and structural plastics.

**India leapfrogs to Bharat Stage VI:** With India’s worsening air pollution, the government plans to skip a generation of emissions standards, heading straight from Bharat Stage (BS) IV to BS VI. The start date has also been brought forward, with BS VI standards to apply to light- and heavy-duty vehicles – as well as two- and three-wheeled vehicles – manufactured on or after 1 April 2020. Vehicles using compressed natural gas (CNG) are believed to ‘easily’ meet BS VI standards, but the fuel currently lacks sufficient infrastructure nationwide for it to be a viable option for most.

**Diesel’s days are numbered:** Particulate matter (PM) emitted by diesel engines is the most common air pollutant in India, and can cause serious health issues. Stakeholders agreed on a likely shift away from diesel to gasoline, particularly in passenger cars. Diesel bans were implemented at the start of 2016 in certain cities such as Delhi, but protests from automotive stakeholders saw them lifted after eight months. A pollution charge on vehicles with larger engines followed. Tighter emissions regulations in 2020 will likely act as a catalyst to this shift.

**The future looks bright for hybrids:** There was a general agreement at the event that hybridisation appears a far more realistic aspiration than pure EVs, which would struggle to sell and fail to meet most consumers’ range requirements. In many cities, overcrowding also means there simply isn’t room for roadside charging stations. Existing alternative fuel infrastructure such as for CNG and liquefied natural gas (LNG) requires further investment, and is currently under-utilised across the country.

**The rise of the AMT:** In India, the manual transmission rules the roost. However, various stakeholders believe there is a significant opportunity to leverage low-cost and low-maintenance automatic-manual transmissions (AMT). A blend of conventional stick shift and automatic transmission, the AMT is thought to be an effective compromise in India’s highly cost sensitive market. Today, the manual transmission remains an attractive proposition, but impending emissions regulations are expected to shake things up and push India closer to developed markets.
Future lighting tech

When lights and lighting regulations were first rolled out in the world’s mature automotive markets, the priority lay in making a vehicle visible to pedestrians at night. Interior lighting was barely a consideration. The picture now however is very different, and moving forward, lights in the cabin are set to take on more safety, convenience and design functionality.

That’s the opinion of Ana Bizal, Head of Pre-Development at Hella Interior Lighting. Along with basic functionalities such as reading lights and trunk lamps, Hella’s work now reaches into ambient lighting and integrated electronics. The diverse work load requires the company to pay attention to a number of megatrends, and a broad range of customers, including upmarket manufacturers, enables it to stay on the cutting edge of technology.

A car of one’s own

One of the company’s latest developments to reach the road is dynamic lighting, which was rolled out in the 2016 Chevrolet Camaro. On the road, drivers can set lighting features in the cabin to one of 24 colours, and assigned a colour to each driving mode, such as a bold colour for sport mode, and a more relaxing shade for cruise mode. But there’s another feature – when in park mode, the driver can select ‘show mode’ lighting, in which colour changes appear to flow outwards from the instrument panel and through the vehicle, as opposed to all the lights changing at once.

In the future, says Bizal, innovation will come thick and fast. Light could run through interior LEDs like a ‘spark,’ for example. Such features will enable OEMs to offer customers increased customisation options. “If someone spends a lot of money on a car, they’re going to want to feel that luxury,” says Bizal. “This is what personalisation allows. Perhaps you’ll be driving full speed down the highway, and you want a colour to reflect that, or coming back from work, and you want something subdued, such as amber.”

Along with personalisation, the other design trend occupying Hella is integration of lights into parts within the interior, as opposed to simply fitting on top. As Bizal explains, the interior of a modern car has two distinct designs – one for day, and one for night. “Initially, cabin lighting was simply about illumination, but now it is far more of a sculpturing feature, to compliment design features,” she says, “so the experience at night is completely different. At night, the light appears as if from nowhere.” Lighting strips help to orientate the driver within the cockpit, making the way they move inside more intuitive, whether looking for a space to put a drink, or somewhere to place a smartphone.

This trend is important moving forward as it requires Hella to consider the effect of the material the light is built into, which may be chrome, matted, or glossy. With OEMs using an increasingly mixed set of materials to build cars, this will become more complex with time. Over the long-term, however, Hella will have even bigger changes to consider – namely, how the rise of autonomous driving may change requirements completely.
A new lived environment

Self-driving cars have the potential to completely change the nature of vehicle interiors. With the driver's attention no longer required on the road, the car has the potential to become a living environment outside of the home, or the office.

Concepts from suppliers such as Yanfeng show that this isn't merely wishful thinking on the part of futurists. The seats inside the Chinese interiors supplier's XiM17 concept, unveiled at the 2017 North American International Auto Show (NAIAS), can be rearranged at the touch of a button. In 'office mode', for example, the steering wheel folds away, the back seats retract, the driver's seat moves to the rear of the car, and the passenger seat revolves 180 degrees, giving both occupants an unobstructed view of each other.

This has obvious implications for a lighting supplier such as Hella. "If the driver is no longer driving, they have time to touch, to see and to enjoy other things," says Bizal, "and we will see lighting take steps forward to facilitate this. We need to be able to deliver different experiences – an office, a playroom, a lounge. This is looking many years ahead, but when imagining scenarios like this, light is completely essential."

Swivelling seats, for example, will present practical challenges. Fixed seating fixtures are relatively simple to illuminate when necessary, as the light can be fixed into place, but when the seat arrangement changes, so does the area requiring illumination. "A swivelling seat might be used to deliver an office environment," says Bizal, "and this really needs an intense, feeding light, able to cover a very large field. Unpredictable movement of the occupants means lights will need to move much more, and provide more functions."

Herbert Wambsganss, Director of Engineering at Hella Interior Lighting, agrees. "It will have to adapt to the passengers' situation," he says. Part of the challenge lies in the fact that the proliferation of autonomous technology will represent an evolution for the industry, and not a revolution. "Autonomous driving will not be 100% autonomous. Rather, there will be autonomous portions, perhaps after a period of manual driving at the start of a journey. Periods of manual driving will require the non-distractive lighting used today, which limits options, but there will be new autonomous scenarios with different requirements. The task for lighting suppliers will be to find ways of adapting to these scenarios."

"Initially, interior lighting was simply about illuminating the cabin. But now it is far more of a sculpturing feature, to compliment design features. The experience at night is completely different."

One of the major design trends in interior lighting is the integration of lights into interior parts, rather than simply fitting them on top.
Safety first

The opportunities for improved comfort and convenience may be many, but above all else, lighting remains a safety function. Hella has clear ideas on what lies ahead here, particularly with the introduction of additional sensors to the car. The company has developed considerable expertise in electronics integration, and through linking ambient lighting with sensor data, interior lighting could be made intelligent.

For example, says Bizal, if a pedestrian were to step in front of a vehicle, the instrument panel might turn red to alert the driver. It could even ‘move’ across an instrument panel to track that pedestrian. Similarly, door-lighting could be connected to sensors monitoring blind spots, and be programmed to turn red when a driver, cyclist or pedestrian was detected, warning the driver not to attempt a lane change or to open the door. There is even potential to connect Cloud data to interior lighting, to provide information on the way ahead, or navigation tips.

However, says Bizal, Hella will need to move carefully. Whilst the hope is that new developments will improve safety, it will have to ensure that new features don’t distract or confuse a driver. Features such as the Camaro’s Show Mode are only available in park mode for a reason, and whilst a flashing-red dashboard might make sense to some, it’s entirely possible it could confuse and exacerbate an emergency situation for others. Regulation could provide guidance in this area, as more autonomous technology appears on the roads.

“I have a huge number of issues moving forward,” explains Bizal. “Blinking lights in the cabin will surely be subject to rules, because these lights are close to the driver, and there’s a fine line between assisting and distracting.”

However, she concludes, whilst these are problems that will doubtless need to be solved in the long term, autonomous driving is “something of a question mark for all sides involved right now, and these are issues we aren’t facing yet.” For now, she notes, “these wild scenarios with hard blinking lights while driving just aren’t there.” A feature like dynamic lighting is mostly related to welcome and goodbye scenarios, and it’s down to automotive suppliers such as Hella to work out how to implement them safely into the car of the future.

“Blinking lights in the cabin will surely be subject to rules, because these lights are close to the driver, and there’s a fine line between assisting and distracting.”
Autonomous drive tech advances – can regulations keep up?

Freddie Holmes speaks to Elektrobit’s Walter Sullivan about how autonomous driving technology has ramped up since the supplier set up shop in Silicon Valley

In January 2015, Elektrobit (EB) established a Silicon Valley-based Innovation Lab as a means to ramp up developments in connected and autonomous vehicles. At the time, Walter Sullivan, Head of Innovation at the San Jose facility, said the plan was to “collaborate and engage” with the ecosystem of companies in this space.

Two years down the line, the small EB team has made serious progress. “This summer we built a self-driving car at our Innovation Lab,” Sullivan tells Megatrends. “We started from an existing platform, but we replaced some of the sensors and we now have an automated driving development platform.”

In addition, EB has been carrying out research on sensor technologies, and has been working on a joint project with a US-based OEM to collect operational data for that company’s automated driving systems.

Nurturing concepts

Today, the Innovation Lab is where initial concepts and ideas are formulated, but most of what Sullivan calls the “heavy lifting” is then coordinated out of EB’s headquarters in Erlangen, Germany. “Not every idea starts life in the Silicon Valley office, but the point of having an innovation centre in Silicon Valley is twofold. One is that pretty much every vehicle manufacturer has a research office there, so part of my responsibility is to maintain communication with those guys, understand what they’re doing, and see if there are ways Elektrobit can work with them,” explains Sullivan.

The second key benefit is that EB can essentially scout out new technologies coming from the innovative and fast-paced Bay Area, or to see which start-ups are attracting venture capitalist money. “We’ve been in contact with a number of new LiDAR manufacturers,
An autonomous vehicle has to know very precisely where it is, to within centimetres. GPS in a traditional car today is only accurate to roughly five metres, and that can be a problem for driverless cars.

The time it takes for a concept to enter a full production programme varies, and there is no defined process to dictate whether it is two weeks, two months or two years. For example, EB's project with the OEM was prototyped in EB's Silicon Valley office for just under a month before it was handed off to a separate team in other offices. "The amount of work for this project was more than my little team can do, so we ramped up a team in a couple of other offices and handed it over," explains Sullivan. "We're just a very small team in Silicon Valley, and I'm looking to expand the team by adding people with experience in autonomous driving or robotics, and in basic vehicle networking."

Generally speaking, says Sullivan, setting up with bricks and mortar in Silicon Valley has proven a welcome addition to the company's wider operations in autonomous and connected driving software.

Faster, better, stronger

Having been met with a high degree of scepticism, the idea of autonomous driving is now deemed an inevitability by most. Since the Innovation Lab's establishment at the start of 2015, there has been a significant rise in activity from all stakeholders, from established suppliers and OEMs to up-and-coming start-ups. Regulatory bodies have begun to allow for pilot tests on public roads in several cities and states, in the US and around the world, in an effort to provide driverless systems with real-world experience.

Various OEMs have announced plans to launch vehicles with varying degrees of automation. On the SAE scale, level four automation describes a vehicle that can drive itself in practically all situations, whereas level five vehicles do not even require a human behind the wheel.

In October 2016, Tesla announced that all its vehicles would have the required hardware (sensors) for ‘full self-driving capability’ that would be ‘substantially’ safer than a human driver. At CES in January 2017, Audi announced that it plans to launch a level four autonomous vehicle in 2020. Mercedes-Benz also announced at the event that it would launch a car featuring self-driving artificial intelligence ‘within 12 months’ BMW plans to launch a ‘fully autonomous’ road car in 2021, with Ford also set to roll out a fleet of autonomous ride share vehicles that year.

“We may or may not see some limited availability of Level 5 autonomous driving in the first half of the 2020s, but we’ll definitely be at Level 4,” muses Sullivan. Such optimism, he believes, has been triggered by some key recent technology shifts, notably increased computing power and efficiency.

Creating a vehicle that can drive safer than a human requires considerable computing power. Most autonomous research vehicles on the road today still feature a rack of laptops in the luggage area, but computing power has improved dramatically in recent years, and has facilitated the integration of greater driverless capabilities.

Sullivan highlights the work of companies such as Nvidia and Intel. "They’ve been reducing the size of compute modules, and Nvidia in particular has been cranking up the compute cycles to levels where we can have a reasonable set of functionalities," he explains. "That's been a big change." Nvidia's latest system on chip (SoC) computer, dubbed ‘Xavier’, can perform 30,000 TOPS (trillion operations per second) and will be used as the self-driving computer for several OEMs. It can track eye gaze, and even lip-read driver speech with around 95% accuracy.

In addition to computers becoming more capable, Sullivan adds that they are also becoming more efficient in terms of electrical consumption. This reduces the amount of heat produced by the computer, which ultimately needs to be expelled from the car. “Heat generation is a problem, particularly when it comes to getting the heat out of the car so that passengers can be comfortable,” he explains. “The car could handle the heat, but those in the vehicle wouldn’t like it.”

The other change that has fast-tracked the development of vehicle automation is the falling cost of camera, radar and LiDAR sensors, the latter of which is deemed vital for level four/five autonomous driving. The LiDAR sensor used in Google’s first prototype test vehicle reportedly cost around US$75,000 per unit, but Waymo – the recently spun-off self-driving division of Google – announced in January 2017 that it had achieved a 90% decrease in the cost of LiDAR sensors in the space of 12 months.

Other start-ups, such as Magna-backed Innoviz, plan to launch LiDAR sensors for US$100 per unit.

“We’re really starting to see cost reductions in LiDAR coming,” says Sullivan. “We need a device that’s in the US$200 range because there could be four of them on the car – you can’t have an US$8,000 sensor if that’s the case.”
Today, we don’t know what rules we’re going to be operating under. It’s somewhat counterintuitive, but the faster regulation can move, the greater the degree of certainty

Regulation - a ‘wild card’

Contrary to popular belief among many consumers, development of the driverless car is not being held back by technology. Today, the primary challenge is the speed of development of road safety regulations, and securing the necessary support from national and regional governments.

In the US, brands need to prove that their autonomous driving vehicles are safe to test on public roads by submitting supporting data to the government. Numerous licenses have been granted across various states so far.

In September 2016, the National Highway Traffic Safety Administration (NHTSA) published a 112-page policy on automated vehicles, a document that was issued as ‘agency guidance’ as opposed to a firm rulemaking. The idea was to speed up the creation of an initial regulatory framework by issuing guidance on how to deploy autonomous vehicles and model state-by-state policies. Shortly after, in December, Michigan’s Governor signed the SAVE Act, which allows for free operation of autonomous vehicles on any road in the state. In January 2017, NHTSA then published an advisory best practices document with the aim of further improving how autonomous vehicles are tested, and ensuring they are deployed safely.

Sullivan is troubled by the speed of regulation to support the roll-out of autonomous vehicles, which he feels is moving too slowly. The problem, he points out, is that until firm regulation is in place, the industry is unaware of the requirements to which it will be working.

“Today, we don’t know what rules we’re going to be operating under. It’s somewhat counterintuitive, but the faster regulation can move, the greater the degree of certainty,” he concludes. “There’s the corollary that if you can get there first, the regulation will effectively bend around what exists. That might also be true, but right now I would say regulation is still a wild card.”
Active safety systems are evolving at a rapid rate, with vehicle manufacturers constantly seeking to remain at least one step ahead of the regulators. In March 2016, the US Department of Transportation’s (DOT’s) National Highway Traffic Safety Administration (NHTSA) and the Insurance Institute for Highway Safety (IIHS) announced that 20 OEMs had committed to making automatic emergency braking systems (AEBS) standard on their models by September 2022.

Estimates from the IIHS suggest that this commitment alone will prevent as many as 28,000 crashes and 12,000 injuries over the course of about three years. Many OEMs, however, have already been offering AEBS for some time, as well as a variety of other active safety solutions fitted ahead of any mandate.

The OEMs are not alone in seeking to stay ahead of the curve when it comes to developing and deploying advanced active safety systems. Several suppliers are also looking to lead the way, with many sensing significant market opportunities around futuristic concepts and ideas. With such rapid advances in driver assistance technology, the prospect of semi- and fully-autonomous cars becomes increasingly realistic. As the OEMs’ products evolve, so the parts and systems that go into those cars also need to evolve and adapt.

Swedish safety supplier Autoliv has a host of new and innovative technologies pencilled in for launch over the next decade and beyond. That’s according to Ola Boström, the supplier’s Vice President, Research, who talked through the challenges and opportunities of preparing safety technology and equipment for autonomous driving.

“We are making some great progress in terms of pushing forward with safety tech, but I can’t give you a specific timeline for our solutions,” he teased during an interview at CES 2017. “We would like to become more transparent in our expectations, but at the same time I don’t believe in launching everything as fast as possible in one car model. We don’t want to treat humans as guinea pigs, so we believe in taking things step by step.”

Platforms are in place

In terms of safety, even a baby step like reducing risk of serious injury by 5% is highly significant for the automotive industry, Boström continued. This could have an impact on many thousands of people every year. According to the US National Safety Council: ‘...the number of motor-vehicle deaths in 2016 totaled
Future safety tech

If the OEM is saying that people can relax or recline all the way back in their seat, they must comply with crash tests using those positions. The good news is that there are tools for this.

40,200, up 6% from 2015 and the first time the annual fatality total has exceeded 40,000 since 2007. The 2016 estimate is provisional and may be revised when more data are available. The total for 2016 was up 14% from the 2014 figure. The annual total for 2015 was 37,757, a 7% increase from 2014. The 2014 figure was less than 0.5% higher than 2013.

NHTSA data also shows a rise in recent US road traffic fatalities, and in Europe, recent data shows a plateau in previously declining road traffic deaths; around 25-26,000 people die on the roads of the European Union each year.

“It will take time to deploy technologies that reduce these statistics, because it’s so important that we get them absolutely right,” Boström acknowledged. “However, at the same time I think we are advancing quite quickly, and there will be more innovative solutions from Autoliv coming out in the near future.”

The reason behind Boström’s optimism is that there are already fundamental technologies in place that are vital for the deployment of others. “Emergency braking, for example, is becoming a standard in the Western world,” he noted. “This tech alone is an important prerequisite for a whole range of features, like adaptive cruise control.”

Cameras and radars, he continued, are now considered standard automotive technology. This is providing many new opportunities for safety systems suppliers. “About 15 years ago, this type of hardware just didn’t exist in vehicles, so developing new advanced passive safety features didn’t really count for anything. Now they have fully penetrated the industry, and cars are even designed around the hardware. It’s opening up so many new doors and expanding possibilities.”

Autonomous vehicle progress

Looking further ahead, Boström considered the potential of bridging the gap between advanced active safety features and highly automated vehicles (HAVs). Just as features like emergency braking are crucial for the development of next-generation active safety technologies, so cameras and radars are vital for the realisation of autonomous vehicles. This goes for those that are semi-autonomous, in which driver attention is still extremely important, all the way up to HAVs.

“We’re involved in several projects that have autonomous vehicle development at the core,” Boström noted. “We recently announced that we are taking part in a programme with 30 different partners to understand how drivers interact with highly automated driving solutions, called ADAS&ME. This understanding is one of the critical parts in moving from passive safety features to fully automated driving.”

If autonomous vehicle development is to continue progressing, Boström thinks that a strong regulatory framework needs to be in place to support on-going tests. The US, he added, is currently ahead of the game and leading the way, as many OEMs have licenses to test their autonomous vehicle technologies on public roads.

“When it comes to the public deployment of different levels of autonomous cars, a regulatory framework is absolutely essential. But when it comes to developing autonomous driving tech, I would say that it’s a race in the automotive space at the moment,” he noted.

Boström also highlighted Sweden as a potential hub for autonomous vehicle deployment in the future. He referred to Volvo’s Drive Me project that is currently being hosted in Gothenburg and is soon to be rolled out in London and later in other major cities. “As well as ADAS&ME, we’re also a partner in Drive Me, and we have sat down with Volvo, Swedish authorities, universities, city planners and other suppliers to discuss the challenges and prospects for autonomous cars,” he revealed. “I’m confident that, because we are having these discussions in Sweden already, the realisation of autonomous vehicle deployment will come much quicker than in those countries not having such discussions.”

Into the virtual world

While the establishment of regulations and the progress with on-going projects is important, Boström was eager to
Future safety tech

stress that both passive and active safety must remain at the heart of all vehicle development.

“When it comes to looking at the future of autonomous vehicles, Autoliv takes a broad stance on safety,” he observed. “Take the recent guidelines published by NHTSA on the testing and deployment of autonomous vehicles, for example. It is very clear that these vehicles cannot be treated differently when it comes to active safety – they must still comply with the same crash tests. We agree wholeheartedly with this.”

He described the current crash tests that are carried out by IIHS, which evaluate vehicles on two primary aspects of safety, namely crashworthiness and crash avoidance. The cars are rated good, acceptable, marginal or poor based on their performance in five tests: moderate overlap front, small overlap front, side, roof strength and head restraints.

Independent crash testing methods evolve constantly to accommodate new technologies and trends. One aspect of crash testing that will surely need to change is the positioning of the dummies. Just as in all crash testing, the IIHS uses crash test dummies which are placed in upright, forward-facing positions, as human vehicle occupants would sit in a car today. “This means, of course, that the occupants of an autonomous vehicle won’t be able to lie down. If the OEM is saying that people can relax or recline all the way back in their seat, they must comply with crash tests using those positions,” Boström mused. “The good news is that there are tools for this.”

Virtual simulation of crash tests could become increasingly important as the automotive industry moves forward with autonomous vehicle development, and Boström thinks simulation could be used to include detail in crash tests that would not be achievable through physical crash tests.

“As well as doing thousands of tests in a matter of hours, simulation tools give the added benefit of including human body models with active muscles,” he described. “We can even adjust the size of the occupant’s liver, for example, to see how the impact of a crash moves it. The level of detail we can get into is incredible.”

Euro NCAP, which marks its twentieth anniversary in 2017, could be an early adopter of some virtual simulation alongside physical tests, suggests Boström, with the IIHS soon to follow suit. However, he cautions, physical tests are likely to still be around for at least another decade, primarily because they give the consumer hard evidence as to what can happen.

“I’ve been at Autoliv for over 20 years, and I can tell you without a doubt that this is the most exciting time ever for passive safety, for active safety, and for the integration of all these solutions into the passenger car space,” Boström concluded.
In a move to centralise the global interdisciplinary development of connected and autonomous vehicle technologies, FEV has announced the establishment of its ‘Smart Vehicle’ Center of Excellence (CoE). The company’s aim is to make progress in the areas of vehicle-to-everything (V2X) and vehicle-to-cloud (V2C) communication, as well as cyber security and advanced driver assistance systems (ADAS).

Headquartered in the US, the CoE’s global activities will be managed by the FEV’s Vice President of Electronics Stephan Tarnutzer. Speaking to Megatrends, Tarnutzer described his expectations for the CoE and a long-term vision for the smart, connected vehicle.

Going above and beyond

“The ultimate smart vehicle is connected through a variety of different means to the outside world,” he explained. “That could be through Wi-Fi, Bluetooth-connected smartphones, through dedicated network access devices or cellular connectivity, all of which are embedded in the vehicle.”

As well as being highly connected, Tarnutzer believes that the ultimate smart vehicle will come equipped with a battalion of cameras and sensors, which are vital for the realisation of highly automated driving.

Some vehicles on the market today already come with many cameras and sensors. For example, in October 2016 Tesla announced that all its vehicles would now come off the production line with eight cameras and 12 sensors, as well as forward-facing radar, installed and ready for use. This, said Tesla Chief Executive Elon Musk, would...
The ultimate smart vehicle is connected through a variety of different means to the outside world, all of which are embedded in the vehicle allow the company to push forward with autonomous driving in the future.

“All these sensors are currently focused on enabling ADAS features,” Tarnutzer noted. “But very soon, those building blocks will be used to achieve Level 3 autonomous driving and beyond.”

Another important characteristic of the ultimate connected vehicle, Tarnutzer continued, is to act as a secure source of data. He suggested that infotainment systems will be able to provide drivers with more data and information, helping them to get to their destination in the safest, quickest and most fuel-efficient manner.

“It can even go beyond that,” he noted. “These infotainment-come-telematics systems can already provide information on movie times, or the nearest fuel station. They could soon interact with grocery stores, or make appointments for hospitals to stop the occupant from waiting in line, for example. There are so many opportunities out there.”

Integral but not central

All of these capabilities, Tarnutzer continued, will be reliant on a solid and robust connection to the Cloud, where information can be passed back and forth between the vehicle and the necessary parties safely and securely. “The Cloud can also be used to store data from other vehicle owners regarding the weather or traffic conditions ahead,” he said.

With a robust connection to the Cloud, Tarnutzer thinks that a number of new connected car services will be available. It will also ensure that the vehicle becomes an integral part of the Internet of Things (IoT).

“On a basic level, the vehicle isn’t necessarily the centre of the universe, but we see it as an important part of the IoT,” he stated. “For so many decades the automotive industry has always considered the vehicle as the heart of everything, but now it’s all about different ecosystems that come together.”

A handful of OEMs have already started to explore the way that vehicles can connect with a greater number of objects. Aside from smartphones and tablets, there is scope for connecting the vehicle to a place of residence. For example, at CES 2017 in Las Vegas, Hyundai showcased its Mobility Vision concept, whereby the vehicle can connect to the occupant’s residence both over a network and physically in a pod.

The OEM believes that this is an example of how the car could become an increasingly important part of the IoT, as it “blurs the line between mobility, living and working space, integrating the car into the daily lives of the users.”

As vehicles become increasingly connected and integrated into other aspects of people’s lives, companies from various different industries are forming partnerships with vehicle manufacturers and suppliers. A primary example is the 5G Automotive Association (5GAA), whereby the likes of Audi, BMW, Daimler and Ford are working alongside Nokia, Samsung, T-Mobile and Vodafone.

“The telecommunications industry, the consumer electronics industry, the information industry and even the entertainment industry are now coming together with the transportation industry to drive development in automotive,” he observed. “The connected car resides in
the IoT, and is part of a much larger, smart ecosystem. That includes smart cities. Anything and everything in this world will be able to communicate.”

**Complex connected cars**

There are several projects around the world that are currently exploring the potential behind smart and connected cities. In Europe, cities like Amsterdam in the Netherlands and Oslo in Finland are looking at ways to allow residents to live in a more sustainable, inclusive and smart environment.

Numerous cities across the US have also started smart city projects. In Portland, for example, the Smart City Challenge has provided funds for a variety of different ideas, such as the development of a single app for transportation. Users can gain access to private mobility, ride-sharing vehicles and public transport, as the app offers each option with comparative information regarding cost, schedule and even CO2 emissions for the journey.

Although there will be hundreds, thousands, perhaps even millions of different connected devices and components in these smart cities, Tarnutzer thinks that the car will hold the highest degree of complexity. “It is definitely the most complex connected device,” he emphasised. “We also think the vehicle is the most powerful sensor in the world. It has cameras, sensors and super computers to detect driving patterns, weather patterns, street conditions, and more. In fact, it can detect so many different things and provide, very soon probably on a daily basis, a terabyte of data to the Cloud. That’s huge.”

It’s clear we have to develop services that make sense to be in the vehicle and add value to the consumer, as adding value to the consumer is often synonymous with saving them money.

Adding value, saving money

A report from consulting firm Strategy& suggests that the connected vehicle market will grow threefold, from around US$50bn in 2017 to US$150bn by 2022. By the end of the forecast period, two in every three new cars sold worldwide will be equipped with extensive connected car packages as a result.

China is highlighted as the top market for connected cars. The report found that 85% of Chinese customers would accept a 10% higher price for a car if that meant it came with the additional connected car features they desired.

“What we’ve seen over the last five years is a willingness from customers to pay extra for value-add services,” Tarnutzer observed. “There are so many OEMs trying to make money off apps, and they have installed head units that are either less superior or less intuitive and harder to use than smartphones. Now we’re at a point where everything has to work 100% of the time, and the quality has to be extremely high.”

While the goal is to be able to pair and connect devices such as smartphones to vehicles, Tarnutzer admitted that this can sometimes be a source of friction: “People complain about needing a feature on a head unit when they already have it on their smartphone. It’s clear that we have to develop services that make sense to be in the vehicle and that add value to the consumer, as adding value to the consumer is often synonymous with saving them money.”
The Connected Car is here to Stay

Driving digital transformation in the automotive industry
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2 The Connected Car is here to Stay

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The Connected Car is here to Stay

The connected car has arrived and is here to stay! What will the impact be on the Dutch Automotive market? Fortune and increased safety, or job losses, disruption and privacy issues?

“There is no money to be made from building cars in the future.” This is one of the statements made in the 2017 Global Automotive Executive Survey of KPMG released in January 2017. What business model will become the next source of profit for car manufacturers? Customers, their data or the digital ecosystem?

Dieter Becker, KPMG’s Global Chair of Automotive, comments:

“The results of this year’s Global Automotive Executive Survey show in particular one fact: The auto industry is between two worlds, one is offline, the other online – and there will be no fusion of these two worlds in the long run. What we need is an additional dimension in which both worlds are coexistent and interlocked. It has not yet been decided who occupies which place in the new value chain. However, there is no doubt that the customer has to be the centre of this newly emerging orbit.”

“For the auto industry, this implies that pure product profitability is outdated. Carmakers’ success will not be evaluated solely on the quantity of vehicles sold, but on the customer value over the whole lifecycle, especially when the digital ecosystem will be ready for the market. Over the long term, only market players winning both customers and their data track will prevail. Because this is the way to succeed in the digital ecosystem. More than three out of four executives believe that one connected car can generate higher revenues over the entire lifecycle than 10 unconnected cars.”

The connected car enables platform based business models

The dilemma between the car and the digital world can be resolved by integration of all upstream and downstream elements in one digital platform, also called a virtual cloud ecosystem. This system should connect and unite all market participants - end consumers, ICT companies and traditional hardware providers. A virtual cloud ecosystem requires different competencies from organisations. The impact of these new technologies is enormous; however, in Europe the pace of change is still slow due to adjustments required in rules and regulations, the questions in relation to privacy and the legacy of a mature auto market (portfolio effect).

In new and upcoming countries, where changes are favoured by the government, such as the government of China does with Internet of Things, there are no limitations and connectivity is being favoured instead of being looked at with scepticism. Europe in that respect started out ahead, but risks being overtaken by these high flyers. It’s time for European organisations to act!

Although there is some production going on, the Netherlands is not a car manufacturing country. Therefore, future global changes in the automotive market will impact the Dutch market, while the Dutch market is too small to directly impact these changes by itself. This KPMG report focuses on the Dutch market and the impact the connected car will have on local players.
By conducting sector-wide interviews and asking interviewees their vision of nine specific themes that we have summarised in the questions below, we refine our vision of the impact of the connected car on the Dutch automotive industry:

- What data are currently being collected by and are available to different stakeholders in the automotive industry?
- Which analyses are currently being performed by Dutch organisations and what opportunities do they see?
- How are data privacy and security regulated and what are the main challenges?
- What is the impact of the connected car on current business models and what is the strategic response of the companies involved in the automotive market?
- What are the main challenges for automotive companies and what is the biggest challenge?
- What plan of action do automotive companies need to have in place?

Interviews have been conducted with local key stakeholders to gain an understanding of the typical issues and trends within the Dutch automotive market and to evaluate how market players are planning to adjust to further digitisation, the introduction of connected cars and, ultimately, autonomous cars. These local key stakeholders include companies such as original equipment manufacturers (OEMs), dealers, technology providers, leasing companies, insurance companies and other parties active in the automotive sector. Our report is built around the nine statements, which are combined in three main areas KPMG evaluated, being:

- Connected car data, which includes data collection, data analytics and data security
- Change of the automotive supply chain, including the retail network, which will influence business models and the introduction of platforms
- Recommendations to the automotive sector

A guide for reading this report
The insights of this study can be useful to executives in creating awareness and suggestions for a strategic response to these trends. The Dutch companies have limited experience with data captured from connected cars. As new regulations that open data platforms to different market players seem likely to be introduced in 2018, data will be more easy available. This might change the mind of the automotive manager significantly and a similar study will therefore result in different outcomes.

Why are the findings important?
As can be concluded from the interviews conducted as part of this report, company managers do not see the fast pace of the change. They are convinced that change will take place more gradually, which might be due to their existing conventional mind-set. In fact, the opinion of these managers confirms that they are conventional, and it is precisely the speed of the change that makes this shift in the market really disruptive. The findings are important for warning managers and creating a sense of urgency for change. The introduction of disruptive technologies has taken place in different industries already, and has had disastrous results for some established companies.

KPMG interviewed several players in the Dutch automotive market and discussed nine statements with respect to the impact of the connected car on the Dutch automotive sector with them. These statements and the responses to questions have resulted in the underlying report that provides the reader with an overview of the automotive players and their vision of the adoption and impact of the connected car on the Dutch Automotive market.

The Dutch automotive sector sees the car more and more as a data-generating unit that will impact their current business model. So far, all respondents are aligned. Differences arise when the impact is discussed and the role the players should take. As the cars are generating data, which will only increase, (big)data and data analytics are getting more and more important. The resources and capabilities to deal with and use that data require players in the sector to rethink their capabilities and the skills of their employees. That is, off course, if the player actually has access to the data. If access to the data is blocked by the OEM, we found that parties are creating their own solutions and data-gathering units. The OEM, however, is seen as the most dominant player in data collection, processing and storage and, therefore, a main contributor to creating and joining data and connectivity platforms.

By generating, storing and collecting data on cars, but more specifically on driver usage and driver behaviour, we run into a privacy issue, as personal data is protected by the Data Protection Act. The new European Directive states that data security and data privacy of both the car and the driver are essential. The Directive requires the original equipment manufacturers (OEMs) to take data protection into account during the design of the car; this is because essential elements in the EU Data Protection Directive are ‘Data protection by design’ and ‘Data protection by default’. Respondents see data privacy as an important aspect, as do consumers who are afraid that their car can be hacked. Therefore, because of the relevance of data privacy and security, KPMG proposes to add a new assessment area to the Euro NCAP test: a cybersecurity assessment for the connected car. It is important to have faith in the security of the car and your personal data.

The data being generated are expected to change business models, and managerial leadership is seen as key to avoid becoming redundant. KPMG and its interviewees see a big challenge in this respect; in addition, however, they believe that the Dutch automotive sector is not yet ready for full adoption of the connected car and the benefits it offers. To facilitate this, KPMG has prepared a plan of action that includes developing a digital strategy and defining an operating model ready for the future (including setting up or connecting to a platform). Additionally, we suggest taking data privacy and security to the next level. The latter is to ensure public confidence and brand reputation, which are often the building blocks for adopting innovations, new products and new services.

If the players do no act and address the identified issues/statements adequately, some of the automotive players will be out of business sooner rather than later.

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1. Connected Car Data

1.1 Data collection by connected cars

Statement 1: Cars are data-generating engines

The concept behind the connected car is that one can collect both car- and user-related data from a car. Car-related data include safety and security information (when airbags have been triggered, doors and windows are locked or opened), car functionality status (engine injection, transmission behaviour, fuel level, battery charging level, driver assistance systems, malfunctions), driving (fuel consumption, speed, use of brake and accelerator pedals, steering wheel movement), location of the car and surroundings (outside temperature). Furthermore, cars also contain user-related data, such as infotainment settings, convenience settings, navigation destinations and a mobile phone address book. The internet enables digital links to all other connected objects, including smartphones, tracking devices, traffic lights, other motor vehicles and even home applications. This way, new services for customers are possible; for example, a service station will be notified when a car is due for maintenance and/or a service.

Although it may not be known to the wider public, cars have already been generating data for quite some time. OEMs have been analysing these data to use for product improvement for over 10 years. However, in the beginning, these data were only collected when cars went in to a service station. Retrieving the data was bound to specific locations and only available to the OEM, or to a limited extent to others with access. However, this has changed in recent years. Nearly all car manufacturers now have frequent (online) data transfers with their cars. Soon, this will increase even more since the European Commission has introduced new regulations that make e-Call (emergency call) a mandatory functionality in every new car as from 31 March 2018. The e-Call system requires a SIM card that sends data to the emergency services. This SIM card can also be used for additional applications (information for or from the entertainment system, remote diagnostics, maintenance notifications). Our survey among car importers, car dealers, leasing companies and insurance companies reveals that 92% of them already has connected cars that generate data. However, in 50% of the cases, these data are captured at the OEM servers and are therefore not, or only to a limited extent, available to local players.

The reason for this is that the data that are automatically captured cannot be used automatically because the owner of the data (the owner/driver of the car) must first give permission to the OEM to use the data.

What is a connected car?

The connected car is a vehicle that is connected to the environment (often the internet) via a mobile data stream. The car includes a SIM card that enables a data stream from the car to cloud servers that capture the data, but also a data stream from cloud servers to the car. The concept of the connected car also includes vehicles that are connected to each other (V2V) via local range networks.
There are two approaches for obtaining this permission. First, dealers include this permission in the sales contract. Permission is then granted to the OEM automatically when signing the sales deal. Second, OEMs ask permission via an online portal when the car has been delivered. However, the process of registration and accepting privacy policies determines to what extent the full potential of connected car data can be realised.

The current connected cars may provide different levels in functionality and related services. The basic functionality is the connection of the car to the internet to send location data, car data and motor management data to the service provider (the OEM), which can be used for different purposes and services (monitoring). A next step is the ability to control the car from a distance, for example, to unlock the car using a smartphone app. It enables the driver to use and see the location, status and motor management data of the car. The third level is the ability to use algorithms from the cloud to optimise the car’s performance, for example, with predictive analysis in a maintenance notification system (the car warns the selected service station automatically when due for maintenance and/or service). Ultimately, the car can operate autonomously by interacting via the data connection. Possible applications, for example, include online maintenance (updating software remotely), self-diagnosis and navigation applications that are provided to the client via the cloud and include real-time information from other cars, as well as cars that communicate with each other. For example, on road intersections and an accident that needs to be avoided.

We started with the statement “Cars are data-generating engines” and we concluded after our investigations, research and interviews that the statement is definitely true and, although they are already generating a lot of data, cars will be even more data driven in the near future. Apart from generating data, more and more data will also be received and processed to support the driver and interact with his environment.

Key insight:

**What data does the connected car generate?**

In the automotive industry, the connected car is linked to telematics, a device that measures all kinds of activities and events in the car and sends this data via the internet to a cloud server. In addition, a connected car does not only generate data from the car itself, but also from the environment. For example, the road conditions and information about the actual traffic situation.

![Figure 1: The connected car is a data-generating engine, from: Your Connected Car is Talking, Who is Listening, KPMG 2016](image-url)
1.2 Usage of connected car data

As mentioned above, OEMs generally won’t share vehicle data they obtain for the benefit of the owner or driver of the vehicle. How can one work around that?

In 2017 nearly all new cars will be connected. The majority (67%) of the organisations that participated in this study do not currently perform analytics on the data of connected cars, as they do not have access to the data or they do not have the capabilities. This relates particularly to car importers that are owned by the OEM. However, independent car importers (in the Netherlands) are developing their own apps, which disclose connected car data to the driver and related dealers. In addition, other market players or stakeholders, such as car leasing companies and insurance companies, are connecting their own devices to (connected) cars to offer new services based on driver information. These parties use aftermarket installed GPS dongles for gathering specific driver behaviour as add-ons to the already installed data gathering units from the OEM. They also start setting up information and data analytics units (1 – 1.5 FTEs) to analyse the gathered data and use it to facilitate their new services based on the data gathered. However, as soon as they realise that they simply do not have the scale to build a big data capacity by themselves, they switch to contracts with specialised automotive analytics platforms that turn the data from their dongles into insights for them, and even allow other online services to leverage that.

“Companies don’t experience the benefits of the data from the connected car yet: the connected car ecosystems and related platforms are in an early stage.”

Statement 2: The road to data is blocked by the OEM. However, there is a way to by-pass it

As the gathered data and use it to facilitate their new services based on the data gathered. However, as soon as they realise that they simply do not have the scale to build a big data capacity by themselves, they switch to contracts with specialised automotive analytics platforms that turn the data from their dongles into insights for them, and even allow other online services to leverage that.

It is still quite expensive to install dedicated tools in cars, gather and analyse the data and be able to use it for an additional service by having a data scientist and information analyst working on the data. Companies that use an aftermarket onboard diagnostics (OBD) dongle to connect the car to a home database have access to the data. However, they still struggle to produce valuable information from it and “sell” it. Questions they have: For what service can I actually use the data, and why would or how much is a driver willing to pay for a service and information? What data can we ethically use and how can we make sure the data is secure?

The data that is generated by the connected car is only available to OEMs and/or their official partners. Other companies do not have access to the data and applications. That is also the reason why other parties involved, such as the lease companies, the insurance companies and/or dealerships, need to install a “box” themselves to be able to gather data. This currently blocks those parties from retrieving, analysing and using car, driver and motor management data.

If the OEM does not provide data from connected cars to other automotive companies in the supply chain, an OBD GPS dongle or box installed aftermarket to connect the car to the internet is a solution for other parties. However, this also has a number of disadvantages: extra costs, an increased risk of malfunctioning of both the car and the dongle, the build-in process is a logistical challenge and aftermarket dongles do not work for every car model. In addition, only one box can be installed in the OBD system. And what will happen when the OBD disappears, which we can imagine on short term? But these are rather minor operational issues.

The strategically more important implication is that, with OBDs, a car creates different data sets across different systems and platforms that are managed by different parties in the value chain. This opens debates about who owns what data and is allowed to derive services from them.

Although the interviewed executives know that data is captured, they often do not exactly know what actual data are retrieved by the OEMs. Our interviews confirm that the following information can already be made available and sent to all relevant parties:

- Service status: the current mileage and when the car is due for a service
- Check control: the status of the car, including error memory, motor management data, temperature, airbags, etc.
- Location: the GPS location of the car in case of an accident or when roadside assistance is needed
- Historic data about how the car is used: this data is stored in the car’s black box and explain what happened in case of an accident

The latter aspects have a huge impact on privacy. The local police has the ability to download data from the car after an accident, which can be used to decide the question of culpability. And what about tax authorities? Are they allowed to capture the data? A very relevant discussion, with caselaw currently still in the making.

OEMs do have access to more detailed data, e.g. for product improvement applications. However, they currently provide only a limited number of services/solutions to the official dealer channel and SOS services. Limitations to why companies do not use the data (yet) include:

- Lack of approval from the customer/driver to use/gather the data
- Lack of business case in relation to services based on the data and, therefore, investment in additional service creation and sharing data is slow
- Data are gathered and sent to the OEM’s home country and not shared with dealers afterwards
- Different owners in the value chain with multiple business models that are currently in conflict, for example, car leasing companies that ask the car data from the OEM to reduce costs for maintenance, and the OEM (and affiliated dealer) does not want to share this data as this might reduce their revenues

Do you have data specialists for analysis of connected car data?

- Yes: 33%
- No: 67%

Figure 2: 33% of the automotive companies has data analytics
So, although data are already being gathered and stored, it cannot always be used and is not always readily available to all the relevant market players.

Off course, sharing all car data among all market players would be the ideal situation. Dealers would love more access to detailed information, but sharing data of connected cars will probably also be a balancing act between conflicting interests from different parties involved. We suggest to develop customer focussed value propositions and collaborate within this new ecosystem.

New regulations in 2018 could possibly open the platform of the connected car to other non-OEM parties (like the PSD2 regulation in the financial sector forces banks to provide external parties access to a client’s transaction data if this client so desires).

Although using Data Analytics on car data seems very difficult, companies can start with one or two cases to test the relevance to their company and gain experience in this field. We suggest that, instead of doing in-house analytics with one or two officers, you open up your data in a controlled way to (small) external innovative parties that will do the analysis for you under a partnership contract. Organisations should investigate what type of partnership would best fill their needs (e.g. joint venture, acquisition).

In addition, connectivity of cars provides a broader range of opportunities. The data signal from the car is monitored in a maintenance notification system and an emergency assistance system. These systems are developed by the OEMs and are accessible to different parties. The maintenance notification system offers the possibility to increase client loyalty and retention, as the dealer can contact the client when the car is due for a service.

Emergency assistance systems provide an increased level of safety because emergency services can locate the car and know the status of the car and its passengers. This application can reduce road deaths and it would therefore improve road safety significantly.

We have seen organisations struggle with the integration of these new systems of the OEM and are figuring out how to capture the data in their existing customer relationship and dealer management systems. Privacy issues arise when driver behaviour is being gathered as this can be linked to an individual.

The statement “The road to data is blocked by the OEM. However, there is a way to by-pass it” provides the reader with the idea that data can be retrieved, processed and used without the OEM. Our opinion, however, is that instead of having data split by different parties, all data gathered and created should be made available to multiple partners on a defined platform. If not done so by the business itself, we expect legislation to drive such an open data interchange.

People have reason to be concerned about privacy issues when driving a connected car (as shown in the 2016 ANWB survey referred to below); after all, privacy issues arise when gathered driver behaviour can be linked to an individual. Examples of driver behaviour are capturing data of locations, destinations, telephone calls etc. Privacy and data security is top of the agenda of automotive companies. Privacy will become an issue when something goes wrong and the data are exposed to the public environment. Therefore, companies must be clear about their intentions. This can be done with a privacy statement, in which the organisation explains what data will be used and for what purposes. This is not limited to the automotive industry, but applies to all industries where personal data are gathered, stored and exposed.

Data privacy is seen as a high priority by the OEMs as leaks or issues will have a negative effect on the reliability and reputation of the brand. That is the main reason why OEMs are still hesitant about data gathering and requesting approval from the driver before using data from connected apps.

Although data are already being gathered and stored, it cannot always be used and is not always readily available to all the relevant market players.

Privacy and data security measurements that have been taken by Dutch automotive companies

<table>
<thead>
<tr>
<th>Privacy measures that have been taken</th>
</tr>
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<tbody>
<tr>
<td>Informed customers about data usage, storage and privacy</td>
</tr>
<tr>
<td>Have hired / trained people with specific knowledge of data security</td>
</tr>
<tr>
<td>Have data framework / policy in place (overview of the captured data)</td>
</tr>
<tr>
<td>Provide the possibility to swipe data (on cars/systems)</td>
</tr>
<tr>
<td>Have audited the systems on data security</td>
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<tr>
<td>Have developed a privacy statement</td>
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What about drivers’ concerns? The Dutch automobile association, ANWB, has launched a ‘data-driven’ car insurance (drive safely – pay less). The discussion about privacy concerns needs to be continued. Linking personal privacy to a price can provide the wrong signal. Is privacy only for the rich?

The statement: “Connected cars are no danger to personal privacy” is rejected as data are the new gold that can be stolen and misused. There are many ongoing debates regarding privacy. If the vehicle generates and/or stores personal data, the Personal Data Protection Act applies in the Netherlands and, as such, the collection, storage and use of data are subject to restrictions. In addition, the OEM or service provider must facilitate insight for the user into the data and correct the personal data where necessary. We will discuss some of these aspects in more detail in the next section.

Key insight:

**What is Data Analytics?**

Data Analytics are the activities and methodologies that are needed to analyse large volumes of (unstructured) data in order to better understand business and markets and make timely business decisions.

**What opportunities do managers see?**

Data Analytics can be used to gain greater and better insight into customers, improve current services, be more specific with marketing and make better predictions. For example, more information about the customer can help improve the customer relationship, and information about maintenance and status of the car provides the possibility to increase customer loyalty.

**How can these opportunities be utilised?**

Car manufacturers have the data available and are developing applications to analyse and use the data to improve and change the services they offer and to communicate with their customers. It is very difficult for other parties to distinguish because external resources are needed to retrieve the data and data cannot be collected easily by themselves. Companies often struggle with the first attempt. Some companies work out one or two cases to test the relevance and gain experience.
1.4 Cybersecurity requires a new security assessment area for car security

Statement 4: Cars need to be assessed against cyberthreats

So far, the emphasis on security with respect to cars is mainly to prevent personal injuries to car passengers. Cars are tested and given a safety rating by Euro NCAP (New Car Assessment Programme) that has created the five-star safety rating system to compare cars. The assessment currently covers four key areas: adult protection (for the driver and passenger); child protection; pedestrian protection and safety-assist technologies (driver-assist technologies, such as speed control and lane support).

When we’re talking about connected cars, we refer to connectivity and data, neither of which is safeguarded by the assessment areas as performed by Euro NCAP Car security, however, is getting a new dimension. As others have pointed out before, the possibility to hack a car to gain access and take over the control of the car is not unthinkable. In addition, there is a possibility that while data generated by connected devices stored in the car can be accessed unauthorised. Since the car will not be the only connected device in the internet of things, other connected devices can be accessed via the car, e.g. the alarm of your house. What happens if your car is the weakest link?

Needless to say, the car requires a new assessment area, for example, performed by Euro NCAP: cyber security. Cyber security is the body of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorised access. In our case, the protection of the connected car and the digital platforms through which the data generated by connected cars flow.

The impact on car makers is substantial as OEMs are no experts in cybersecurity, and one of the most problematic elements of cybersecurity is the rapidly and constantly evolving nature of security risks. This requires working together with parties that are in a position to do so.

Legislation is being drafted in response to the cyber threats that are linked to connected cars, such as the so-called Security Privacy in Your Car (SPY Car) in the US. As the Dutch market is subject to EU regulations, new legislation is on its way and has arrived from Brussels.

What we need now is legislation that makes cybersecurity part of the set vehicle aspects to be tested and rated. The legislation should require governance and process transparency by the OEMs through the enforcement of the following assessment areas:

- Cybersecurity standards, including protection against hacking, data security, and hacking mitigation
- Privacy standards, including transparency, providing an opt-out for the consumer, and a marketing ban
- Cyber dashboard, which informs consumers how well a car performs against national security and privacy standards

A 2016 survey by the ANWB (“De ‘connected’ voertuig en uw data”) shows that Dutch people are worried about the commercial use of their personal data (88%), revealing private information (87%), hacking (84%) and car tracking (76%). More than 84% believes there should be specific legal guidelines for the collection and use of personal data.

During our interviews, we asked some questions with respect to security, e.g. the relevance of certain issues. Respondents see the possibility of a car being hacked as low importance to their businesses (64%).

The respondents answered positive to the statements regarding actions already taken to overcome privacy issues and security breaches. In this context, the OEM branches often refer to their headquarters that set the rules.

In the European Union, the Data Protection Regulation was passed in April 2016. This was welcomed by the car manufacturers as they view the legislation especially from the perspective of the connected car, in which data security and data privacy of both the car and the driver are essential. The law requires the OEMs to take data protection into account in the design of the car; essential elements of the EU Data Protection Regulation are ‘Data protection by design’ and ‘Data protection by default’. Data protection safeguards must be built into products and services from the earliest stages of development, and privacy-friendly default settings will be the norm – for example, apps on social networks or mobile for opting out. The EU regulation applies to all member states; therefore, companies in the Netherlands, for example, that are building an app to interface with the connected car must take the principles of the law into account. In addition, data collected by the different parties for one or more purposes may not be further processed in a way that is incompatible with the original purposes. The data can be used in analytics based on fairness, which considers factors such as the effects on the privacy of individuals (e.g. specific and targeted decisions about identified persons), and whether an individual has a reasonable expectation that their personal data will be used in the new way. So, in the example of the driverless cars, raw data can be used to analyse where most accidents take place and how future accidents could be avoided. It can also be used to analyse traffic flows to reduce traffic jams.

This section started with the statement “Cars need to be assessed against cyberthreats.” Based on our analysis, reports in the public domain, the relevance of data privacy and security in relation to the connected car, cars are lacking a generally-accepted cybersecurity assessment. We suggest including a new assessment area to the Euro NCAP test: a cybersecurity assessment for the connected car.
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2. Change of business model?

2.1 Technology changes the existing supply chain

Statement 5: The automotive industry is shifting from asset based to a service and software driven business model. In 2025 we drive on data and data drives us.

It is clear that the connected car is going to have major future implications for companies and organisations in the automotive chain. That said, the interviewed companies find it very difficult to predict what exactly the future organisation will look like and are not aligned on the outcome. They all agree that the connected car will have an impact on the business model of organisations; however, the magnitude and speed of change is perceived differently. The current automotive industry lacks experience and skills and operates in a market where competition is intense and includes players outside of the automotive industry. The outcome for the traditional automotive industry is very uncertain. KPMG foresees a disruptive effect on existing automotive companies due to these elements (see Figure 7 above).

The primary goal for OEMs is to get into contact with the customer, whereas previously this was done by the dealer. The core business model of the OEM (see Figure 7) was to build and sell cars: product and technology driven to keep the production facility running. In response, other organisations will increasingly change into network organisations by using and exchanging data.

In general, the creation, usage, storage and exchange of data are increasing across a modern organisation. The respondents see a shift in revenues in the longer term to more digital services. In order to accommodate the necessary changes, organisations have to increase the investments in technology and data analytical skills to make use of this opportunity and be able to survive.

The respondents do not think the impact is underestimated, but they do believe the potential of data is underused. Finally, the respondents consider data analytics as complex and difficult to understand and see proven concept applications.

People in automotive companies need to utilise different activities in the digital automotive organisation. They perform complex analysis and have to sell this in the organisation. More knowledge needed to aggregate data and make this available to the right people.

Competences in the organisation that are needed to utilise data are also different. Integration of different departments is needed to work and think less in silos and be more integrated.

Based on the characteristics of the automotive market and the introduction of new technologies that accelerate platform-based business models, complete and radical change is expected. However, the interviewed managers do not see the urgency of the change; they expect the change to come gradually. “In 10-15 years, an automotive company will look different.” These managers think there is time to change; we believe this change will come fast and is unexpected.

The statement "The automotive industry is shifting from asset based to service and software driven. In 2025 we drive on data and data drives us" stands as it is. The reaction in the sector, however, is not congenial and different time scales and impacts are mentioned by the different parties. KPMG sees an inevitable change and shift to data-generated services and products and, as such, business models will change; looking at current developments and innovation in the automotive sector, we foresee this shift sooner rather than later although, due to legacy (unconnected / older cars), a dual model will continue to exist for quite some time.
2.2 Platforms to enable new business models and services

The rise of the connected car will likely push the digital platform business model as one of the dominant business models for the automotive industry. Recent history has shown that when a sector that is characterised by many smaller players becomes more information intensive, the digital platform model can quickly become dominant in that sector. The connected car will make the fragmented automotive sector much more information intensive, thereby creating large opportunities for digital platform business models. Other automotive characteristics, such as low asset utilisation (19% for cars) and uneven distribution of information between parties (for example, OEM’s know much more about the car and way of driving than insurers do), act as further accelerators.

Data provided by devices such as a connected car can be valuable to a single user, but only to a limited scale. Only when this data are used on a digital platform to foster new interactions between different parties in the automotive landscape, it will create entirely new services and value. Furthermore, it can allow other parties to build new services and businesses on top of that data. Over the last years, enterprises in other sectors (such as Airbnb, Uber, BlaBlaCar, Alibaba) have been very successful in building businesses that use digital technologies to facilitate new interactions on a massive scale and allowing others to build their business on top of the platform (i.e. app developers, taxi drivers, hosts, ride sharers). When the platform concept is applied to the connected car, the value of the data it generates will grow exponentially and this will in turn disrupt the entire competitive landscape in the automotive sector (as the aforementioned examples have proven in their respective sectors).

Since the beginning of the 21st century, cars are optimised on the technical side of car production. Better mileage, higher safety ratings and customisation were focus areas of the sales pitches of many OEMs. Tomorrow’s customers of the connected car are the millennials, who are born as digital natives with digital technologies embedded into their way of living from the very start. As they plan, organise and travel with the help of digital products and services, this has become the new norm of doing business and living. A key reason why this consumer shift is taking place is the recent widespread availability of the technical infrastructure (e.g. mobile coverage), cloud infrastructure, and the delivery of a user-centric experience through smartphones with common operating systems. Employers in urbanised areas, like the Zuidas in Amsterdam, offer a car-sharing subscription instead of a lease car to their new joiners. The millennial population will help push the connected car into a mainstream product over the coming years, so the time is now for the automotive sector to consider how this will change the business models and competitive landscape.

The new kinds of interactions that will be possible with connected cars go beyond the focus on in-car services provided by OEMs. The sensors and data output in most cars are standardised per car, brand or year it is built. The sensors mostly focus on speed, oil/fuel/electricity consumption or temperature, which can be extracted through the OBD port or even an app. However, none focuses on the style of driving, passengers, infrastructure or environments, let alone share this data beyond the OEM boundaries. With a diligent data governance structure in place that secures privacy and fair use of the data, such data can be used by a range of companies acting as a network, such as government, insurance, lease and maintenance companies. Examples one could imagine include:

1. **New interactions between connected cars can vastly improve machine learning of the autonomous cars with use of a platform.** The goal of the platform is to interact with the connected car and send and receive data from the connected car to improve the behaviours of the other cars, even of cars from different brands.
   **Example:** Technology to support the platform by NVIDIA (Drive PX)

2. **Imagine interactions between cars and infrastructure to continuously inspect the quality of the roads.** Smart traffic lights will inform drivers/autonomous cars when the lights will go green to save fuel/energy.
   **Example:** Talking Traffic in the Netherlands

3. **In 2015, car manufacturer Daimler launched Moovel, an urban mobility platform which combines offers from various mobility service providers into one platform.** Daimler shifted from being primarily a car manufacturer towards an urban mobility platform as well. The platform is open to suppliers like car2go, Flinkster, mytaxi and Deutsche Bahn, and makes it possible for the customer to compare and book different transportation options for a ride from A to B.
   **Example:** Moovel from Daimler

4. **Currently, hybrid models bridge existing business models with platforms.** Parkflyrent, for example, offers car owners the possibility to rent their car to strangers, while the car normally was idle and parked at the airport.
   **Example:** Parkflyrent
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In the last example, supply and demand are brought together in a marketplace platform, one of the most widely implemented types of platform models today. This type of platform works extremely well in a fragmented market where the focus of the platform is to create reliability and/or create an easy way to unlock assets for better utilisation. 

The way Uber has transformed the taxi business can become a template for universal car (maintenance) providers. Through Uber it has become extremely easy for a customer to order a taxi; it lowers a significant barrier to get from A to B. On top of that, the customer and taxis fill the platform with all kinds of data. In the future, the connected car can request maintenance by itself, even before an actual problem has occurred. The universal (maintenance) providers need to be organised on a platform where a service catalogue can be consulted, a schedule is available to be able to determine when and where the car can be serviced and whether the right certificates are in place. The best supplier can be selected based on the parameters of the car and the owner’s preferences. This approach can only work if the users trust the platform; therefore, it depends heavily on the shared data where knowledge about technical wear and tear, driving style and the schedules of maintenance providers are available.

Based on the data these interactions generate, such a platform can be expanded to include more types of users. For example, insurance providers and other platform users can all create and make use of apps and services facilitated by the platform. The platform will get more possibilities for interactions all based on the shared data from the connected car and maintenance service providers.

For each player in the automotive sector, various strategies are available to respond to the rise of the platform model brought about by the connected car. Ranging from e.g. transforming your entire organisation into a platform model versus specialising in a sector niche that is hard to enter for platforms. The latter will be a challenge to the automotive sector as the whole sector will become a platform.

Three main characteristics of the automotive sector that will indicate the entry of the platform business model:

1. The sector will become more information intensive than ever before, the connected car will be one of the main drivers for this due to the sharing of data
2. There are currently extreme information asymmetries, current knowledge of the car remains mostly with the OEMs. Shared data will make a difference in the future and can tear down the information asymmetries with the use of platforms
3. Current production and maintenance is extremely rule-based work. Maintenance and production is heavily standardised to focus on efficiency. A platform can exploit the rules to apply them on a larger scale.

The universal car (maintenance) providers will be one of the first to notice an impact in the near future; it is up to them if they want to be in the driver’s seat creating the platform or ride along and react to the platforms which are managed and controlled by other parties.

The primary function of a platform is connection; therefore, the statement: “The connected car will boost the platform business model for the automotive sector” is true as perceived by the respondents as it is by KPMG. To use the connected car to its full potential, connections, interchange and the storage of data are perceived most efficient when a platform is used to connect new parties and create the single source of truth to which parties connect. A platform limits the number of direct connections and when more and more are linked, it increases in relevance and impact.

Figure 6: Ordering the interactions of a marketplace platform
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3. The impact on automotive companies

3.1 Challenges for the new automotive industry

Statement 7: The Dutch automotive industry is not ready for the connected car

There is no question of not being ready as there is no possibility to ignore and avoid the upcoming change. Even though not all cars are connected or drive autonomously and communicate via the internet of things with all elements of a city, the electronic roads are starting to get paved. The digital automotive industry is already here. Improved telecom infrastructure, tech companies that link themselves to cars, the possibility to store large volumes of data and improved capabilities to analyse the data are prerequisites that are already being rolled out.

Although some of the prerequisites are being rolled out, the execution and usage is still not at the required level. As mentioned in the previous section, the parties involved need a beneficial business case as they are investing or already have invested a lot. An old economic rule states that economies of scale reduce cost, so the trend of centralisation becomes more important. As a result, the interviewees also see other parties getting involved in data gathering and analytics, not only the usual suspects.

The fact that organisations struggle with many different systems in the chain does not support the necessity to increase the integration of data from cars with existing customer relationship and dealer management systems. As such, data management parties can be expected to step in, retrieve all the gathered data (since they are not limited by the template/data structure of the OEM) and, by gathering all the data, they are better equipped to provide new services.

To facilitate services and/or safety, the European Commission may demand that OEMs use one fixed format for data gathering to disclose the data to other parties as well, as we have also seen in software, electronics and accessories (such as the standardisation of the battery charger).

A change in mind-set is required as data analytics on data from cars is not yet the top of the agenda at the companies. As the Netherlands is not a car-producing country (besides the Mini) and Dutch organisations are not directly involved in the development of the applications (basically not invented...
here), it retains a follower instead of an inventor profile. However, some importers already have integrated connected cars into a maintenance notification process, which alerts the preferred dealer that the car is due for a service. An officer from the customer service centre gets in contact with the driver and schedules the maintenance job. Another benefit is an improved relationship with customers. Organisations have the opportunity to know what is going on with the car (see it from a distance) and offer comfort to customers in the case of road assistance or an accident.

Organisations have the opportunity to know what is going on with the car (see it from a distance) and offer comfort to customers in the case of road assistance or an accident. Experiences from the Opel OnStar services in the United States show that this leads to significantly improved customer retention ratios.

KPMG agrees with the statement: “The Dutch automotive industry is not ready for the connected car” as there is no overall vision and strategy within the Dutch automotive industry and parties are not (yet) working together. Dealerships struggle and there is no clear vision on the changing need for maintenance – it will be limited and required competencies will change. The future might well be big network hubs where you also share your car, in addition to the limited maintenance.

With the connectivity of cars, OEMs have the opportunity to have direct digitised contact with the customer. The interviews revealed that the increased dominance and powerful position of the OEM in the value chain is perceived as a big threat. The OEM can remotely control the car and predict the driver’s behaviour. This might result in a different role for the dealer and the importer, or possibly in the redundancy of these parties. This threat can be mitigated as dealers and importers develop new value propositions and concepts that deliver tangible returns. In the short term, dealers can increase their scale of operations to profit from economies of scale and have a stronger negotiation position.

The lack of change capabilities of the automotive industry itself was also mentioned as a threat. The automotive industry has a very long history, with a conventional mind-set. For some importers, the change will come unexpectedly. Therefore, companies need to change the existing organisation to mitigate these threats.

1 Bovag Branch Barometer 2016

**Statement 8: Local representatives are becoming redundant due to the introduction of the connected car**

The role of the importer and the dealer will change due to the changing need for maintenance – it will be limited and different. In addition, the customer relationships will become more digital. The experts who were interviewed are debating the roles of the OEM, importer and dealer and foresee a change due to the centralised activities. There are some other changes in the automotive industry that make it difficult to earn money as a dealer in the future, such as reduced maintenance due to the introduction of electric cars, as well as conventional cars requiring less maintenance. The direct interaction between the car and the driver via technology reduces the interaction with the dealer even further. In combination with the millennial, who tends to shift from car ownership to carpooling, we expect a significant change in demand. If we look at the current dealer landscape, some have a net return on investment of 1-1.5%, but an increasingly larger group of car dealerships is structurally not strong enough to ensure the continuity of their business. The number of dealers has declined to about 1,000 in 2015, down from around 1800 in 2010. Scaling is strongly encouraged by the importers, partly due to the changing market. The number of outlets will also decrease, as will the number of people employed in the industry. That number is now at approximately 60,000. And not only the number of people, but also their personnel skills and required competencies will change. The future might well be big network hubs where you also share your car, in addition to the limited maintenance.

With the connectivity of cars, OEMs have the opportunity to have direct digitised contact with the customer. The interviews revealed that the increased dominance and powerful position of the OEM in the value chain is perceived as a big threat. The OEM can remotely control the car and predict the driver’s behaviour. This might result in a different role for the dealer and the importer, or possibly in the redundancy of these parties. This threat can be mitigated as dealers and importers develop new value propositions and concepts that deliver tangible returns. In the short term, dealers can increase their scale of operations to profit from economies of scale and have a stronger negotiation position.

The lack of change capabilities of the automotive industry itself was also mentioned as a threat. The automotive industry has a very long history, with a conventional mind-set. For some importers, the change will come unexpectedly. Therefore, companies need to change the existing organisation to mitigate these threats. This is risky for some automotive players in the Dutch market, as they are not used to change, have a conventional mind-set and have limited change capabilities. These capabilities are needed to change the organisation and improve cooperation with external stakeholders, for example, with OEMs, consultants and universities/students.

Indeed, the statement “Local representatives are becoming redundant due to the introduction of the connected car” will be true to many dealerships. There will always be a niche, however, for those customers who want personal attention and are prepared to pay for it. In general, however, the added value of a dealership for buying a car is non-existent if we remove the emotion and we only look at mobility. In other words, dealers need to reconsider their current offering to the customer and determine why the client should do business with them (add value to customer). This also applies to amongst others like independent service workshops, insurance companies and leasing companies.
The Connected Car is here to Stay

Data from the connected car are a large set of data that not only contains information about the car itself, but also from its environment. The definition of big data analytics is not clear to the interviewed managers, as they are currently not analysing data from connected cars. However, they do some analytics mainly on data from their customer relationship management system and dealer management system.

Looking at managerial challenges, the statement “The implementation of data-driven organisations is mainly a leadership challenge” has been confirmed by scientific research. Based on the answers from our respondents, we recognise that management plays an important role. When management does not understand the impact and/or necessity to act, the organisation is doomed to be become obsolete.

Technical challenges such as exotic technologies and the complexity of the necessary statistical techniques are real, but the managerial challenges are even greater. In our research, we examined four managerial challenges of the application of big data: Leadership, Talent Management, Technology, and Company Culture.

Generally, all four managerial challenges are relevant, as most respondents rate the challenges as relevant. Companies struggle to create “leadership teams that set clear goals, define what success looks like and ask the right questions”. As there is an increasing importance for data-driven decisions, it does not erase the need for vision or human insight. Business leaders who can spot opportunities, understand market developments and think creatively are still needed. Successful companies are the ones that make the change in decision-making but still provide an environment in which human insights and vision are important. Ninety per cent of the respondents in the automotive companies surveyed recognise the challenge of establishing a leadership style needed to change to the required data-centric organisation focus.

Data analytics is new for most automotive organisations and finding and recruiting data scientists is difficult.
- Current employees have other capabilities (commercial or technical). Data scientists need to deal with very large sets of data, but at the same time speak the same business language.
- New employees might not recognise automotive companies as an attractive place to work (except Tesla and the large OEMs).

In addition, there is an increasing amount of technology available for analysing these large sets of data. Existing IT departments do not have much experience with these new data analytical technologies; they also lack experience with different sources of internal and external data. IT departments have difficulties to integrate these different sources of data. The introduction of data analytics requires a significant mind shift across the organisation. For the traditional automotive companies the step to a ‘data-driven’ culture is a big step. In fact, organisations need to change their culture from ‘gut feeling’ to evidence-based decision-making.

Which threats do managers foresee?

The biggest threat is the increasing dominance and powerful position of the car manufacturer, which can shorten links in the value chain (importer and dealer). Another threat is the risks of breaching data privacy versus getting valuable information from the data. Successful application of big data is difficult. Conventional car retailers don’t have the required sophisticated technologies and often lack the required capabilities to analyse the data.

How can these threats be mitigated?

Mitigating the threats from the connected car is not easy as the OEM has increased power over importer and dealer. Some importers and dealers create their own value propositions and concepts.

In the short term, dealers can create scale with acquisitions. A dealer that sells a larger part of the total volume of a brand has a stronger negotiation position than the importer. However, in the long term, we expect the OEM to increasingly control the relationship with the customer via a digital connection in the car and on their smart phones.

Key insight:

Managerial Challenges

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Figure 7: Framework from: McAfee and Brynjolfsson, 2012, adapted by KPMG.
As mentioned in the previous sections, automotive companies need to adjust to a new reality. The connected car has arrived in their showrooms and service workshops. Connected cars provide OEMs, importers, dealers, suppliers and owners with different opportunities and threats. These new types of functionalities in the car increase the need to renew the business strategy as the market becomes more dynamic and the organisation needs to respond. Therefore, companies tend to change their business strategy from a defensive strategy (based on creating economies of scale and reacting to competitors) to a more offensive strategy (creating the capability to respond quickly to dynamic market circumstances). Organisations need to spot and explore new market opportunities.

From the interviews, it was found that radical change is needed, and activities and competencies that are needed to incorporate big data applications are new to the firm. Second, competition in the Dutch automotive market is perceived as strong. Therefore, it seems likely that the change will be rapid.

Surprisingly, we found a different view during the discussions we had with experts. The interviewed automotive companies agreed with the extent of change, but thought this change will take place more gradually. In other words, this is risky: changing too fast will cause an overreaction, but changing too slowly will create a gap between the required strategy and the actual strategy needed to survive. In fact, start-ups and companies from outside the industry can step into this gap.

A fundamental transformational change is needed to use the full benefits of new information technologies. According to this theoretical framework, it means a business scope redefinition. Automotive organisations will change into network organisations. There will be a shift in revenues to more digital services. This business scope redefinition brings different managerial challenges, which are very relevant to the automotive market in the Netherlands, most importantly, creating a different leadership.
Disruptive technologies drive organisations to dramatically redesign their business, as we have seen in many other industries, like the hotel and taxi industry (Airbnb and Uber respectively). We expect this radical change to come to the automotive industry as well; actually, we have described the first signs in this report.

Key trends in the automotive industry are the connected car, the electrification of the drive-train, the societal shift from ownership to carsharing and the transition to sustainable energy. However, even more important are changes in society in the new digitised world:

- Customers are more empowered through social media and the prevalence of information giving them an information edge over automotive companies
- Millennials will become the largest age cohort in spending in the next five years and shift from car ownership to carpooling
- High cost of legacy investments in real estate by the traditional automotive market players that creates competitive disadvantage relative to digital businesses (do not have high costs for real estate)
- New entrants: IT companies like Google, NVIDIA and start-ups like Snappcar are joining the market and competing in innovative ways
- Market saturation as there is still a surplus of sales and service outlets in the Dutch automotive market, which drives increased price-based competition, which could drive higher levels of commoditisation, as well as reduced returns on investments that might lead to bankruptcies.

A car importer, dealer, universal service station, leasing company, insurance company or body repair shop needs to be aware of this change and innovate. We suggest developing additional streams of income to have an alternative for the decreasing income from the conventional automotive business. In addition, we have suggested starting with one or two concrete data applications to see what the impact is on the organisation. As we have seen in the interviews, Dutch companies have difficulties translating the digital developments to a concrete plan of action in their organisation. Therefore, we suggest thinking about the following actions that need to be taken, instead of waiting and becoming obsolete.
4.1 Develop a digital strategy

To have a clear answer to the changing market, organisations need to focus on the required changes in the organisation’s operating model. As can be seen in Figure 9, this requires more than simply digitising existing core business processes. New technologies really do change the current business scope and core business process is the next step. For most organisations, this means changes in the IT organisation.

The IT organisation needs to support business value-adding activities, and must contribute to the innovation ambitions. In practice, this means an increased speed of response to changing priorities, the ability to scale up if required, and the flexibility in architecture to add interfaces with other market players and for new requirements from the business. In addition, data management should have a priority as data loss and poor data quality will kill your success. Without data quality, data analytics is impossible.

As we said in our recent publication “Agile project delivery - How to increase project success in a hybrid world”, digitised organisations do their projects differently. As the volatility of our business environment increases, organisations are looking at ways to respond to these changes more effectively. One of the responses has been the introduction of agile methods. This approach is deemed more suitable to uncertainty and changing circumstances than the traditional stage gated approaches. Over the past years, agile methods for software development have been embraced by many organisations. It is claimed that agility radically improves the success rate of projects. On the other hand, adoption does not always seem easy and agility is probably not a silver bullet. The agile approach also has an impact on project and programme management, making it a topic for both IT and business.

1. Improve customer experience
2. Develop new business models
3. Optimise existing channels
4. Achieve an excellent service performance

In addition, the different questions for digital strategies has to be answered: ‘how to become a digital leader’, as can be seen in Figure 9. First, the organisation should determine ‘where to play’. This means the organisation must determine which markets they need to focus on. Is the automotive market in the Netherlands still an attractive market to focus on? Do we serve the right region? Then, the organisation should think about the differentiating propositions that can be offered to these markets and clients. What is the perceived value the customer expects? Finally, the organisation has to target specific client segments and defines the most effective channels to reach out to those client segments.

Business Model
Where to Play

- Markets
  - What are attractive markets to focus on?
- Propositions & Brands
  - What propositions are needed for these markets and clients?
- Clients and channels
  - Who are my clients and what digital expectations do they have from my company?

Operating Model
How to win

- Core business processes
  - Are my end-to-end processes suitable for online usage?
- Operational and technology infrastructure
  - What technology, methods and frameworks do we need to enable digital operating models?
- Organisational structure, governance risks and controls
  - What is the right governance model? How to enable effective collaboration and knowledge sharing?
- People and culture
  - How do we attract and retain the right talent, skills, and diversity for effective digital innovation? How do we adapt our culture to allow teams to innovate and learn quickly?
- Measures & Incentives
  - What does success look like? What are the right metrics? How do we measure results?

Figure 9: KPMG framework: Key questions for digital strategies, ‘how to become a digital leader’

4.2 Create an operating model that is ready for the future

When the business model questions have been answered, we suggest performing a readiness check to determine the required changes in the organisation’s operating model. As can be seen in Figure 9, this readiness check should include questions on processes, technology, structure and governance, people, culture and measures and incentives (performance management).

First, the organisation needs to think about how the desired markets and clients will be served. A digital transformation is not simply the digitisation of existing core business processes. New technologies really do change the current business scope and create a business network of players that interact via digitised data exchanges. An awareness that digital companies work significantly different compared to conventional companies is critical.

Then, the new business design should have flexibility to interact with new platforms. Finding the right technologies and systems that support the desired business model and core business process is the next step. For most organisations, this means changes in the IT organisation.

So far so good, but how do I get my organisation on my side? When it comes to the real digital transformation, culture and people play a big role in this game. How do we attract and retain the right talent, skills, and diversity for effective digital innovation? How do we adapt our culture to allow teams to innovate and learn quickly? These questions are absolutely key to success in a digital transformation.

Innovation means doing things differently; a new idea, method, product or service. As the digital world is new to most automotive players, most companies have limited capabilities themselves to facilitate change all by themselves. Collaboration can be established by building a new ecosystem or leveraging existing partnerships/business ecosystems. We have seen companies already collaborating with external experts, start-ups and communities, but also with science and research. We suggest making innovation part of the management agenda. In addition, approach the shortlist of strategic partners for collaboration or assistance in the execution.

Finally, the organisation needs to define what success looks like, how this success can be measured and what key metrics need to be developed. An appropriate performance management system shows the tangible return of our digital transformation investment.
4.3 It becomes all about platforms, platforms, platforms...

We expect the rise of the connected car to drive the automotive industry increasingly towards the adoption of digital platform business models. Increasingly, the value from cars will stem from the data they generate, and the capturing of this value will be done by the winning digital platforms that best utilize this data to the benefit of all parties involved. It is all but certain that these winning digital platforms will be run by the incumbents that are leading the automotive sector today. Technology-savvy ‘platform-natives’ such as Google’s Waymo, Apple and nVidia will be among the outside contenders to keep an eye on. One thing is certain: the winner will be the party that best uses that data from the connected car to create new, valuable and seamless interactions between market parties that will benefit both sides of that interaction.

Following sectors such as software and travel, the automotive sector will undergo a fundamental shift in the basis of competition and success. When the digital platform model becomes dominant in automotive, succeeding will no longer be about adding value to resources you control, but about who is able to attract and mobilise the best ecosystem of resources that you do not control. This shift will turn entire business and operating models inside out, as managing non-linear ecosystems at scale requires entirely different capabilities and focus than managing complex but still linear supply chains.

As in other sectors that have experienced platform disruption, classic intermediary parties in automotive will also be replaced by new digital ones that transparently aggregate products and services for the consumer. The result will be a constant battle of which party will become ‘the app’ in the hand of the consumer for his / her needs around mobility. The travel sector already has experienced this with the rise of aggregators in a specific vertical first (e.g. Booking.com), followed by the rise of meta-aggregators across all verticals (like Kayak) following suit. In mobility, Daimler is already trying the meta-aggregator role with its Moovel platform.

4.4 Take data privacy and security to a next level

From our work with clients on responding to platform disruption, we have identified seven possible strategies for existing organizations to deal with this development. These range from more aggressive strategies such as transforming your entire organization to become a digital platform business (1) to defensive strategy of doing nothing (7). These extreme approaches are equally risky; most organizations would like to consider some of the more intermediate strategies.

Society is becoming addicted to analysing data and that is not surprising. After all, data analyses makes our lives better and easier every day. The condition is that there be sufficient attention to a careful application of these analyses. This should not be limited to privacy and security. It is all about ethics: organisations need to test whether the applications fit in our modern values.

In a digitised world with an increasing amount of data, data privacy and security go hand-in-hand. These topics will be increasingly important for safeguarding consumer trust. We strongly recommend creating transparency of what data have already been captured. First, with a privacy statement in which the organisation explains what data will be captured and for what purposes. Second, we advise providing clear opt-in and opt-out processes to the customer.

An example in the automotive is the working of a navigation system. To guide the driver from A to B, it is essential that the system meet the following conditions:
- The quality of the (card) data needs to be good
- The algorithm – the instructions given – must be correct and
- The route advice should serve the interests of the driver: it should be an independent advice. Of course, it should not be the case that the algorithm has a preference for a route along a particular brand of fuel stations.

As we have seen, automotive players in the Netherlands are already changing their portfolio investment strategy. Whereas investing in creating large retail companies was common practice, nowadays they’re looking for smaller parties to complete their new business portfolio. As a result, automotive enterprises should expand their innovation capability by integrating the right platform-oriented start-ups into their ecosystem.

Figure 10: Seven levels of platform integration to react to the upcoming platformisation

| 1 | Transform your entire organisation to a platform model |
| 2 | Build your own platform for a new business |
| 3 | Participate in a consortium to build a joint platform |
| 4 | Leverage an existing platform as an additional sales channel |
| 5 | Leverage an existing platform to enrich your current business model |
| 6 | Specialise into a sector niche that is harder to enter for platforms |
| 7 | Do nothing |
Digital is not a thing, but simply a word that describes our world today. Advancements in technology have blurred the lines between physical and virtual, creating an emergence of digital disruptors that provide new pathways for organisations to create value.

Believe digital is broad in its impact, but also industry specific. It goes far beyond the front office to facilitate true enterprise-wide business transformation so organisations can build sustainable competitive advantage. While we understand that embracing digital may present its own challenges, we view disruptors as enablers rather than inhibitors, allowing businesses the opportunity to innovate, transform and thrive.

**Digital as defined by KPMG**

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CONNECTED CAR: CONNECTED HARDWARE
## Overview

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<td><strong>Detailed overview</strong></td>
<td>The global(^1) market was worth US$15.0bn in 2016 with 10.0 million new Connected Cars added, totaling 27.2 million Connected Cars in the same year. Potential is huge due to a growing number of vehicle owners and increasing demand for in-car connectivity.</td>
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<td><strong>KPI-Comparison</strong></td>
<td>The US was largest single market with revenue of US$5.2bn. China had the highest revenue growth with a 55.0% CAGR(^2). 80.7 million Connected Cars will be driving on Europe’s roads by 2021.</td>
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<td>Legislations regarding connectivity standards will boost in-car connectivity pervasion in the EU, Russia and Brazil. BMW is a global leader with regard to in-car connectivity. AI(^3)-software might replace conventional touch-interfaces.</td>
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\(^1\): Only includes countries listed in the Digital Market Outlook  
\(^2\): CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-21  
\(^3\): Artificial intelligence
CONNECTED CAR MARKET

Market focus on Connected Hardware

Connected Hardware
- eCall Technology
- Embedded Telematics

Infotainment Services
- Advanced Navigation
- Entertainment
- Comfort

Vehicle Services
- Safety & Security
- Maintenance & Diagnostics

Focus Segment
Other Reports
The definition of a Connected Car from our perspective is a car that has a permanent internet connection based on an embedded SIM card (eSIM). The Connected Hardware market in this report covers all hardware products, enabling connectivity and is divided into two segments: eCall Technology¹ and Embedded Telematics².

**eCall Technology** is characterized by a permanent, but only basic in-car connectivity. It enables the automated initiation of an emergency call or supports locating a stolen car. Dependent on further arrangements with retailers or OEMs, owners can subscribe to additional security and maintenance services. **Embedded Telematics** in contrast are more sophisticated devices which act as the interface between car and driver. Touchscreens or head-up displays facilitate the use of entertainment services and online apps. Connected Hardware enhances the driver’s and passenger’s safety before and after an accident. The automated eCall for example shortens the time until rescuers reach crash sites. It can further provide information with regard to coordinates or in certain cases the number of affected people. The incorporation of this technology in newly registered cars is or will be mandatory in many countries by law.

**Embedded Telematics** generate driver specific added value. They create a more interesting and convenient driving experience. Drivers and passengers can control internet based content like real-time traffic information (RTTI) or media streaming via a user-friendly control panel. In this case, the content is not dependent on a mobile device, as it is an inherent part of the Connected Car.

Another benefit is likely to take off in the future, should insurance companies use driver data profiles comprehensively to optimize and personalize insurance quotes and policies (e.g. pay-when-you-drive and pay-how-you-drive).

Global³ revenue in the Connected Hardware market was US$15.0bn in 2016. The major share of revenue in this market corresponded to Embedded Telematics. In Europe, these systems cost between US$900 and US$3,000, depending on the new car prices, and were much more expensive than the basic eCall Technology, which was available for approx. US$400. Of course, actual prices showed country-specific variations in all countries covered, due to price levels and currencies.

Comparing the three biggest car markets, the US, Europe and China and their global shares, Europe was the biggest market for Connected Hardware in 2016.

In Europe, the number of Connected Cars grew to 10.0m vehicles in 2016. With 4.0m newly registered Connected Cars in this year, revenue of US$5.3bn was generated in the Connected Hardware market. Germany was the biggest single market with US$1.8bn revenue and 3.0m Connected Cars.

Second biggest market was the United States with revenues of US$5.2bn in 2016. There were 2.6m Connected Cars newly registered, leading to 10.2m Connected Cars on US roads in total. The US is considered a pioneer with regard to in-car connectivity, as GM has already been offering its OnStar in the US market since the mid 90s.

The Chinese Hardware market showed revenue of US$1.7bn in 2016. The 1.3m newly registered Connected Cars led to a total number of 2.9m Connected Cars in this year. These lower values compared to the mature markets had their origin in numerous facts. The Chinese car market for example was still emerging and OEMs did not offer the same features and services as they did in western markets. Also, in Europe and the US the share of premium value cars of all newly registered cars was much higher. In this segment, connectivity adaption was higher than in the lower price segments.

1: Every car with eCall Technology is permanently equipped with an eSIM and considered as a Connected Car
2: Cars equipped with an additional, connected Embedded Telematics system are a subset of all Connected Cars
3: Only includes countries listed in the Digital Market Outlook
IN-CAR CONNECTIVITY IS A MAJOR DRIVING FORCE IN THE GLOBAL AUTOMOTIVE INDUSTRY

Future developments

The outlook for in-car connectivity of all kinds reveals huge potentials. A CAGR1 of 37.1%, leading to a revenue of US$72.8bn in 2021, is expected in the Connected Hardware market.

Looking at the three major regions again, the Chinese Connected Hardware market has the biggest growth rates. A CAGR of 55.0% will result in revenues of US$15.5bn in 2021. Due to this growth rate regarding Connected Hardware, the number of Connected Cars will increase to 32.2m by then.

Although being a mostly mature car market, huge growth rates can also be observed in Europe. With a CAGR of 37.5%, revenue of US$26.1bn will be generated in 2021. In terms of Connected Cars on Europe’s streets, 80.7m in total are expected by 2021, compared to only 10.0m in 2016. A significant share of this development roots in the EU Parliament’s approved eCall regulation, which will come into effect in April 2018.

Double-digit annual growth rates of 24.1% are expected in the US Connected Hardware market. US drivers want their cars to also support their so-called “always on” experience, and are therefore eager for embedded connectivity. This explains a market size of US$15.3bn and a total of 35.6m cars being connected by 2021.

Next to alternative propulsions, the sharing economy and autonomous driving, in-car connectivity is one of the major driving forces in the automotive industry. When eCall Technology becomes mandatory in numerous countries, many OEMs will most likely utilize this development to sell more of their expensive Embedded Telematics systems. This is likely as the technology for its functionality already exists in form of eCall and eSIM. OEMs are then complying with governments’ regulations and also incorporate features in order to try to differentiate from competitors in a maturing industry.

Assumptions and sensitivity

Baseline of our model is the global2 development of passenger car sales. We expect sales to keep following their recent growth path in emerging economies and only experience moderate market growth in developed economies.

Another assumption is that OEMs unchangingly promote in-car connectivity all over the world.

“In-car connectivity is going to be an as strong argument to the customer’s buying decision as it is a car’s design or brand.”

Harald Krüger, CEO of BMW AG (2015)

Future Embedded Telematics will perform more functionalities and enable countless webbased services and completely new business models. This improvement is supported by expanding 5G coverage which is enhancing bit rates.

We further assume all approved government regulations in this context coming into effect as planned. However, here is some uncertainty left, as regulations in Russia and Brazil have already been postponed in the past. It is furthermore possible that more countries will establish safety laws utilizing in-car connectivity. This may lead to yet unpredictable shifts in the market development.

Our model additionally depends on the driver’s willingness to pay for in-car connectivity. The development cycles of passenger cars and mobile devices differ, as the latter one’s is much shorter. If mobile device technologies and applications outperform those of in-vehicle ones, drivers might prefer using their mobile device inside their cars, e.g. utilizing Apple CarPlay or Android Auto.

Moreover, concerns centered around data security, e.g. motion profiles or remote access, become increasingly important. If these issues should be neglected in the future, drivers may avoid embedded in-car connectivity for data security and privacy reasons.

---

1: CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-21
2: Only includes countries listed in the Digital Market Outlook
3: Source: IAA 2015 (English translation)
CONNECTED HARDWARE IN MAJOR REGIONS

Market KPI comparison by region

Revenue forecast

in million US$ by region

United States

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>5,224</td>
<td>1,112</td>
<td>6,336</td>
</tr>
<tr>
<td>2021</td>
<td>15,343</td>
<td>4,112</td>
<td>19,455</td>
</tr>
</tbody>
</table>

+24.1% p.a.

China

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>1,739</td>
<td>553</td>
<td>2,292</td>
</tr>
<tr>
<td>2021</td>
<td>15,534</td>
<td>3,798</td>
<td>19,332</td>
</tr>
</tbody>
</table>

+55.0% p.a.

Europe

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>1,515</td>
<td>1,186</td>
<td>2,691</td>
</tr>
<tr>
<td>2021</td>
<td>23,687</td>
<td>5,313</td>
<td>29,000</td>
</tr>
</tbody>
</table>

+37.5% p.a.

Revenue per Connected Car

in US$ by region

United States

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>109</td>
<td>865</td>
<td>974</td>
</tr>
<tr>
<td>2021</td>
<td>27</td>
<td>677</td>
<td>904</td>
</tr>
</tbody>
</table>

China

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>188</td>
<td>1,261</td>
<td>1,449</td>
</tr>
<tr>
<td>2021</td>
<td>51</td>
<td>1,071</td>
<td>1,122</td>
</tr>
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</table>

Europe

<table>
<thead>
<tr>
<th>Year</th>
<th>eCall Technology</th>
<th>Embedded Telematics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>152</td>
<td>1,063</td>
<td>1,215</td>
</tr>
<tr>
<td>2021</td>
<td>30</td>
<td>729</td>
<td>759</td>
</tr>
</tbody>
</table>

Source: Digital Market Outlook 2017
### Market KPI comparison by region

#### Revenue

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>United States</strong></td>
<td>mUS$</td>
<td>5,224</td>
<td>7,304</td>
<td>9,765</td>
<td>12,059</td>
<td>13,954</td>
<td>15,343</td>
<td>+24.1%</td>
<td>1,739</td>
<td>2,852</td>
<td>4,594</td>
<td>7,248</td>
<td>10,994</td>
<td>15,534</td>
<td>+55.0%</td>
<td>5,313</td>
<td>8,261</td>
<td>16,066</td>
<td>20,454</td>
<td>23,388</td>
<td>26,094</td>
<td>+37.48%</td>
</tr>
<tr>
<td>eCall Technology:</td>
<td>mUS$</td>
<td>1,112</td>
<td>1,325</td>
<td>1,390</td>
<td>1,233</td>
<td>1,059</td>
<td>971</td>
<td>-2.7%</td>
<td>553</td>
<td>850</td>
<td>1,111</td>
<td>1,264</td>
<td>1,412</td>
<td>1,637</td>
<td>+24.2%</td>
<td>1,515</td>
<td>2,211</td>
<td>3,753</td>
<td>3,265</td>
<td>2,662</td>
<td>2,406</td>
<td>+9.70%</td>
</tr>
<tr>
<td>Embedded Telematics:</td>
<td>mUS$</td>
<td>4,112</td>
<td>5,979</td>
<td>8,375</td>
<td>10,827</td>
<td>12,895</td>
<td>14,372</td>
<td>+28.4%</td>
<td>1,186</td>
<td>2,002</td>
<td>3,483</td>
<td>5,984</td>
<td>9,582</td>
<td>13,897</td>
<td>+63.6%</td>
<td>3,798</td>
<td>6,049</td>
<td>12,314</td>
<td>17,189</td>
<td>20,726</td>
<td>23,687</td>
<td>+44.21%</td>
</tr>
<tr>
<td><strong>China</strong></td>
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</tr>
<tr>
<td><strong>Europe</strong></td>
<td></td>
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#### Connected Cars*

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>eCall Technology:</td>
<td>m</td>
<td>10.2</td>
<td>13.6</td>
<td>18.2</td>
<td>23.6</td>
<td>29.5</td>
<td>35.6</td>
<td>+28.5%</td>
<td>2.9</td>
<td>5.1</td>
<td>8.8</td>
<td>14.3</td>
<td>22.0</td>
<td>32.2</td>
<td>+61.4%</td>
<td>10.0</td>
<td>16.7</td>
<td>30.6</td>
<td>46.9</td>
<td>63.6</td>
<td>80.7</td>
<td>+51.95%</td>
</tr>
<tr>
<td>Embedded Telematics:</td>
<td>m</td>
<td>4.8</td>
<td>6.8</td>
<td>9.5</td>
<td>13.0</td>
<td>16.9</td>
<td>21.2</td>
<td>+34.9%</td>
<td>0.9</td>
<td>1.6</td>
<td>2.8</td>
<td>4.9</td>
<td>8.1</td>
<td>13.0</td>
<td>+69.0%</td>
<td>3.6</td>
<td>5.8</td>
<td>10.4</td>
<td>16.7</td>
<td>24.1</td>
<td>32.5</td>
<td>+55.52%</td>
</tr>
</tbody>
</table>

* Cars equipped with eCall Technology correspond to the TOTAL number of Connected Cars; cars equipped with an additional Embedded Telematics system are a subset of all Connected Cars.

---

1: CAGR: Compound Annual Growth Rate/ average growth rate per year
2: Revenue expected to decline as the strongest adoption phase is over and the market by then will be mainly driven by replacement sales

Source: Digital Market Outlook 2017
## KEY TAKEAWAYS BY REGION

### Market sizing subjects for Connected Hardware

<table>
<thead>
<tr>
<th>Region</th>
<th>Market size</th>
<th>Growth rate</th>
<th>Trend signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>With US$5.2bn and a global(^1) share of 34.8% it was the second biggest region with regard to total revenue</td>
<td>Embedded Telematics generated most of the market value with US$4.1bn and a share in this segment of 78.3%</td>
<td>2.6m newly registered Connected Cars led to 10.2m Connected Cars in total</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>Smallest of the three major regions in 2016 with a revenue of US$1.7bn and a global share of 11.6%</td>
<td>Major share of revenue in the segment corresponded to Embedded Telematics with 68.2% and US$1.2bn respectively</td>
<td>Total number of Connected Cars was 2.9m with 1.3m new Connected Cars</td>
</tr>
<tr>
<td>Europe</td>
<td>Biggest of the three major regions accounting for 35.4% of global revenue corresponding to US$5.3bn</td>
<td>71.5% of the Connected Hardware value worth US$3.8bn respectively was generated with Embedded Telematics</td>
<td>4.0m new Connected Cars led to 10.0 Connected Cars on European streets</td>
</tr>
</tbody>
</table>

---

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-21
Source: Digital Market Outlook 2017
CONNECTED HARDWARE

Top 5 Connected Car markets¹

Number of Connected Cars (16 – 21)
in million cars

1: Base year: 2016
Source: Digital Market Outlook 2017
Global\textsuperscript{1} Connected Car Revenue

in million US$ by segment

\textbf{CAGR\textsuperscript{2} 16 – 21}

\begin{itemize}
\item +38.4% p.a.
\item +37.1% p.a.
\item +58.6% p.a.
\item +49.5% p.a.
\end{itemize}

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/ average growth rate per year
Source: Digital Market Outlook 2017
GOVERNMENT LEGISLATIONS

Regional and national connectivity related requirements

**eCall (European Union)**

In 2014, the European Parliament approved a legislation affecting the entire automotive industry in order to enhance safety on Europe’s roads. By March 31st 2018, every newly registered car throughout Europe has to be equipped with an automated emergency call system (eCall). Based on this legislation, the number of road fatalities in Europe is supposed to be reduced by 10% p.a..

To perform and ensure full operability of the automated eCall in case of a severe accident, OEMs need to equip all new cars with numerous different technology parts. These specific parts are:

- Control device
- Aerial
- GPS-receiver
- Accident sensors
- Manual button
- Backup power supply
- Database
- Microphone and speaker

A vehicle equipped with the above mentioned can collect all accident related data (time, location, severity, type of car and propulsion as well as number of affected people) and send the eCall to the Europe-wide standard emergency number 112. Incoming eCalls will be classified as high-priority calls in order to reduce response time and accelerate on-site operations of rescue forces. The underlying satellite navigation system is the Galileo system.

With regard to data security and concerns about privacy issues, the technology does explicitly not record any kind of motion profile of a car or may pass any information to third parties.

**ERA-GLONASS (Russia)**

The Russian counterpart to the European eCall legislation is the **ERA-GLONASS Accident Emergency Response System**, which came into effect in January, 2017. The installation of the ERA-GLONASS navigation communication terminal is intended to reduce the rescuers’ time-to-arrival at an emergency scene and improve the provided information in case of an accident. In contrast to the European eCall, the Russian system is compatible with the national satellite navigation system GLONASS, which is an alternative system to GPS and has been released to civil use in December 2006.

**SIMRAV² (Brazil)**

The Brazilian government has been trying to deal with the huge problem of vehicle theft for several years. With the law initially passed in 2007, nationwide known as **CONTRAN 245/07 legislation**, all newly registered cars, regardless of being manufactured in Brazil or imported, are required to be equipped with an anti-theft system. This system is supposed to track, localize and remotely immobilize vehicles in case of robbery. Although the deadline for its implementation has been postponed for a couple of times, new guidelines intend the legislation to come into effect in a gradual process. By March 2017, 50% of new vehicles and by July 2017 every new vehicle sold in Brazil must be equipped with such a technology device.

1: Declaration of intend has also been signed by Iceland, Norway, Switzerland and Turkey
2: Sistema Integrado de Monitoramento e Registro Automático de Veículos

CONNECTIVITY IN THE MASS MARKET

Pioneer: The BMW Group

Facts

<table>
<thead>
<tr>
<th>Fact</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>US$102.3 billion</td>
</tr>
<tr>
<td>CAGR 06-15</td>
<td>7.27%</td>
</tr>
<tr>
<td>Vehicle Sales</td>
<td>2.25 million</td>
</tr>
<tr>
<td>Connectivity ratio</td>
<td>95% of new cars</td>
</tr>
<tr>
<td>Employees</td>
<td>122,244</td>
</tr>
<tr>
<td>Headquarters</td>
<td>Munich, Germany</td>
</tr>
<tr>
<td>Founded</td>
<td>1916</td>
</tr>
</tbody>
</table>

Availability1 BMW ConnectedDrive

ConnectedDrive

The Bayerische Motorenwerke AG is one of the leading companies when it comes to in-car connectivity. Next to their technology leading Embedded Telematics systems, which are available and widely distributed in all vehicle types and trim levels, their ConnectedDrive package offers multiple connectivity based services. These include particular vehicle related services, e.g. remote control, as well as services focusing on the driving experience, e.g. real time traffic information or media streaming. Customers can simply chose a specific service via the BMW online store and customize their desired service package on a modular basis.

Analyst opinion

In-car connectivity is a main driving force in the automotive sector and of huge relevance. There is growing evidence that drivers are not shy of changing brands for connectivity related features. Against this background, BMW is very well positioned as they have been promoting in-car connectivity from technology and service perspective for many years. Furthermore, collaborations with tech companies reveal their strategy to further connect mobile devices and services with each other in order to create a seamless connectivity experience, regardless of a particular device. Paragons of this are the planned Cortana2 integration and the availability of Amazon Prime Now and Apple CarPlay in most of BMW car types.

1: Coverage of 45 markets; actual availability depends on trim level and specific services
2: Digital smart assistant from Microsoft
Source: www.bmwgroup.com
When looking at the current technology level of Embedded Telematics in the mass market, again BMW appears as one of the leading manufacturers. Current generations of Embedded Telematics systems enable drivers to control particular functions with simple gestures. Cameras recognize when the driver swipes or points in an area above the center console. Based on these gestures the car will realize, if the driver wants to take a call or go ahead with navigation, just to name a few functionalities.

When applied correctly, the Gesture Control System is expected to avoid the driver’s inattentiveness and to ensure the direction of sight to the street. This would improve the passengers’ safety.

Without any doubt, connectivity will disruptively change the automobile industry. There is also no denying that improvements in Embedded Telematics technology will also enable new opportunities.

While OEMs are insistent on further developing Embedded Telematics, the actual benefit for customers is questionable. The main function they carry out is to control software. The added benefit by doing this via a hologram instead of a touchscreen, as presented at this year’s CES, appears to be minor. Especially when AI, in the form of smart virtual assistants, is introduced as standard equipment in cars, the improvement brought about by touch technology may become obsolete.
Automotive OEMs and technology companies alike have been trying to make cars much smarter for several years. Although huge progress can be observed on both sides, a massive obstacle has existed for a long time: as technologies were developed separately, it is difficult to merge them and make them compatible with each other. This paradigm changing would be the key to developing more, smarter and more device-independent services.

In this context a shifting mindset, especially from automotive sight, can now be observed. The willingness to integrate virtual personal assistants into new cars will offer new services and moreover new business models.

For example, in the future, Renault-Nissan will incorporate Microsoft’s virtual personal assistant Cortana into new Nissan cars. Voice controlled Cortana, which can also be connected to

Office 365, may assist with information and productivity enhancing tasks inside the car, e.g., scheduling based on the Outlook calendar, alternative routing due to RTTI1, automated personalization of in-car settings, controlling of entertainment software etc.

“When you enter the vehicle, Cortana could act as your doorway to a wide range of services to make your life easier and your drive more exciting.”

Ogi Redzic, Senior Vice President, Connected Vehicles and Mobility Services at Renault-Nissan Alliance (CES 2017, Las Vegas)

When AI in the form of virtual assistants will be installed into new cars as a standard, the car industry will change disruptively. Especially in light of autonomous driving, cars will likely transform into the so-called “third space”, next to home and office, where people enjoy spare time and can also be productive.

Virtual personal assistants

A virtual personal assistant is a voice recognition software that is incorporated into a technology device, e.g., smartphone, personal computer or car. The software is equipped with a human voice. It interacts with its owner, respectively user, via voice control and can hence understand questions or commands and may respond or execute a task accordingly. The software is able to learn, is “always on”, and enables the execution of automated tasks without the user being present at the area of activity.

For further reading

Our report “Smart Home: Home Automation” is having an in-depth look at the overall market and functionalities of home automation as well as virtual assistant technologies.

Excerpt: The use of Home Automation systems is made much easier by the integration of smart assistants and contributes to the intuitive management of the Smart Home. This puts an end to the complicated configuration and operation of devices using graphical user interfaces....
## CONNECTED HARDWARE REVENUE STREAMS

### Market structure and definition

<table>
<thead>
<tr>
<th>Segment</th>
<th>Sub-segments</th>
<th>Out of segment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connected Hardware</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eCall Technology</td>
<td></td>
<td>The so-called eCall Technology includes devices that enable the triggering of an emergency call while simultaneously transmitting relevant data such as the location of the vehicle or the direction of travel. Baseline for this technology is a permanently embedded SIM card when leaving the OEM’s assembly line.</td>
</tr>
<tr>
<td>Embedded Telematics</td>
<td></td>
<td>Embedded Telematics systems include extended, integrated telematics solutions like infotainment systems, connective navigation devices etc., which are permanently connected to the internet via an embedded SIM card.</td>
</tr>
</tbody>
</table>

All monetary figures refer to annual gross revenue and do not factor in shipping costs.

### Connectors related Services
- All services related to general vehicle-connectivity and their corresponding fees are included in the segments Vehicle Services and Infotainment Services.

### Aftersales Market
- Hardware for updating non connected cars to networking vehicles, e.g. connected OBD2 devices or subsequent infotainment solutions.

### Tethered Connectivity
- Touchscreens or Displays and other interfaces using an external device, like a tablet, smartphone or laptop, to connect to the internet.
ABOUT DIGITAL MARKET OUTLOOK

9 Markets, 34 segments & 85 sub-segments

**Digital Media**
Video-on-Demand, Digital Music, Video Games, ePublishing

**FinTech**
Digital Payments, Business Finance, Personal Finance

**eTravel**
Online Travel Booking, Mobility Services

**eServices**
Event Tickets, Fitness, Dating Services, Food Delivery

**eHealth**
Diabetes, Hypertension, Heart Failure

**Connected Car**
Connected Hardware, Vehicle Services, Infotainment Services

**Smart Home**
Home Automation, Security, Home Entertainment, Ambient Assisted Living, Energy Management

**e-Commerce**
Fashion, Electronics & Media, Food & Personal Care, Furniture & Appliances, Toys, Hobby & DIY

**Digital Advertising**
Banner Ads, Video Ads, Search Ads, Social Media Ads, Classifieds

Details

› 50 countries
› Direct access & downloads
› 7-Year coverage: 2015 – 2021
› Revenue forecasts

**User count & penetration**

**Comparable data**

Exclusive part of the Statista Corporate Account

**Access to more than 1,000,000 statistics and all digital markets**

more information
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Analyst
Felix Wegener graduated in Geography and Economics. He gained comprehensive knowledge of digital technologies and their disruptive character from numerous consulting projects and business transformations in several industries.

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Disclaimer
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For the presented survey data, estimations and forecasts Statista cannot assume any warranty of any kind. Surveys and forecasts contain information not naturally representing a reliable basis for decisions in individual cases and may be in need of further interpretation. Therefore, Statista is not liable for any damage arising from the use of statistics and data provided in this report.
CONNECTED CAR:
INFOTAINMENT SERVICES
**Overview**

<table>
<thead>
<tr>
<th>Pages</th>
<th>Subject</th>
<th>Essentials</th>
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</thead>
<tbody>
<tr>
<td>03 – 05</td>
<td>Detailed overview</td>
<td>- Market scope</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Customer benefit, market size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Future developments, assumptions and sensitivity</td>
</tr>
<tr>
<td>06 – 09</td>
<td>KPI-Comparison</td>
<td>- Global(^1) market size was US$1.1bn with 13.4 million service subscriptions in 2016</td>
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<td></td>
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<td>- Global potential is huge with a 49.5% CAGR(^2) to 2021, due to a growing pervasion of embedded in-car connectivity</td>
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<td>- US market was the biggest in 2016 with revenues of US$513.7m</td>
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<td>- China shows the biggest growth rates with a CAGR(^2) of 66.4%, exceeding revenues of USD$1.1bn by 2021</td>
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<td>- With US$3.0bn, Europe will be the largest market in 2021</td>
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<td>10 - 12</td>
<td>Deep Dive</td>
<td>- Real-time traffic information</td>
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<td></td>
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<td>- Advanced Navigation features</td>
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<tr>
<td></td>
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<td>- Third party mobile device integration</td>
</tr>
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<td>13 – 15</td>
<td>Structure, contacts and imprint</td>
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</tbody>
</table>

1: Only includes countries listed in the Digital Market Outlook  
2: CAGR: Compound Annual Growth Rate/average growth rate per year; base years: 2016-21
CONNECTED CAR MARKET

*Market focus on Infotainment Services*

**Connected Hardware**
- eCall Technology
- Embedded Telematics

**Infotainment Services**
- Advanced Navigation
- Entertainment
- Comfort

**Vehicle Services**
- Safety & Security
- Maintenance & Diagnostics
INFOTAINMENT SERVICES WILL BE A KEY REVENUE SOURCE IN THE AUTOMOTIVE MARKET

Customer benefit

The ongoing maturity of the car industry and technology convergence will lead to an inevitable rise of Connected Cars, and subsequently further pervasion of connectivity in the automotive sector.

“We are at the start of a new era of technology convergence and hyper-connectivity.”
Chung Eui-sun, Vice Chairman of Hyundai Motor, (CES 2017, Las Vegas)

These days, the car is more than just a machine driving people from one place to another. In fact, the car has developed into a moving space for everyday activities. Drivers’ car buying decisions are shifting towards value-adding technology and services. Expectations center around media continuity across devices, personalization, and context awareness.

Taking a close look at for example navigation services, drivers nowadays want more than simply be navigated from A to B. Internet connectivity is bringing real-time information into the car, from traffic-information via alternative routing to learning software. These functionalities result in active driver support, may generate added value and increase the ease of driving a car.

Also, the car is further developing into a more secure and more convenient space than ever before. Embedded Telematics systems contain a lot of those applications that drivers and passengers are already utilizing in their spare time. Media streaming subscriptions for example are increasingly replacing classic in-car radio, as on-demand streaming online content is more personalized and passenger-centric.

In addition, when the installation of virtual assistants, e.g. Echo 1 or Cortana 2 will take off, productivity related services are likely to do as well. Cars will then develop into rolling offices, where e-mails and administrative tasks can be performed over voice control while driving.

Market size

The market for Infotainment Services, including the segments Advanced Navigation, Entertainment and Comfort Services was worth US$1.1bn with 13.4m subscriptions globally 3 in 2016. Biggest segment was Advanced Navigation with a revenue of US$646.0m and 7.7 m subscribers.

It needs to be considered that the number of subscriptions in Infotainment Services in total does not equal to the number of Connected Cars subscribed to Infotainment Services. Here, overlappings have to be taken into account, as an owner of a Connected Car is very likely to be a subscriber in more than one particular segment of Infotainment Services.

When comparing the major regions, the US, China and Europe, the US had the highest revenue and most subscriptions in 2016.

The US Infotainment market in total showed a revenue of US$513.7m and 5.6 million subscriptions in 2016. The major revenue share in the US market with 59.8% corresponded to Advanced Navigation with a revenue of US$307.1m.

Second biggest region was Europe with 4.6 million subscriptions and a revenue of US$336.3m covering all three market segments. Advanced Navigation services accounted for US$200.1m which corresponded to a share of 59.5% of the European market for Infotainment Services.

The Chinese market was the smallest of the major regions in 2016, generating a revenue of US$88.9m and approx. 1.0 million subscriptions. These considerably small numbers are rooted in the lack of in-car connectivity-based online service provisions of many OEMs in China. In the near past, proprietary OEM connectivity-based Infotainment Services were mainly offered in the huge developed markets in Europe and North America where connectivity and network coverage had been pervasive for a longer time.

1: Digital smart assistant from Amazon
2: Digital smart assistant from Microsoft
3: Only includes countries listed in the Digital Market Outlook
THE PROSPECT IS POSITIVE BUT WILL BE AFFECTED BY THIRD PARTY SOLUTIONS

Future developments

The future prospect for in-car connectivity related Infotainment Services shows high double-digit growth rates in the three major regions and the three segments Advanced Navigation, Entertainment and Comfort Services. From a global perspective, the overall market size is expected to result in 107.9 million subscriptions and exceed a revenue of US$8.0 billion in 2021. Advanced Navigation services account for the highest revenue shares in all three major regions.

A comparison of the US, Europe and China will reveal Europe as the biggest region in 2021, when it comes to Infotainment Service subscriptions as well as revenue.

The European market projection in total shows 42.9 million subscriptions and a market worth US$3.0bn in 2021. Although being a mature automotive market, the average annual growth rate to 2021 will be 55.3%. The global market share will rise to 37.8% from 31.3% in 2016. This development is in particular fueled by the European eCall legislation, which will come into effect in April 2018.

Although China is expected to remain the smallest of the three regions, the market is developing very fast and shows the highest growth rates regarding revenue and number of subscriptions. The market is expected to generate revenues of US$1.1bn in 2021, which corresponds to a CAGR of 66.4% to this year. As a result, the Chinese global market share will increase to 14.1%, from only 8.3% in 2016.

With a CAGR of 35.5% to 2021, the US market shows a considerably lower growth rate than Europe or China. The US share in global Infotainment Services revenue will decrease from 47.9% in 2016 to 29.2% in 2021. Nonetheless, the number of subscriptions is expected to reach 29.1 million, generating a revenue of US$2.3bn with Infotainment Services in the US market in 2021.

Assumptions and sensitivity

Infotainment services are one of the hot topics when it comes to after-sales revenue sources and value added services in the automotive market.

“We are currently at an inflection point within the auto industry, where the passenger experience is becoming just as important to consumers as speed and performance.”

Michael Mauser, President, Lifestyle Audio at Harman (CES 2017, Las Vegas)

However, if and moreover to what extent the automotive OEMs are going to gain a profit from services for a better driving experience, highly depends on the development of aftermarket and respectively third party solutions.

Drivers prefer infotainment services that are as comprehensive and good as they are on their mobile device; easy to control, seamlessly integrated into their car and in the best case they are already familiar with them. Their willingness to pay for additional in-car services is expected to depend on the above mentioned factors. To name only an example: If real-time navigation of Google's competitors TomTom or Here does not remain competitive compared to Google Maps, which comes at no charge, it will not be easy for OEMs to get their customers to subscribe to their own proprietary, fee required navigation services.

Furthermore, due to the expected increasing competition in fields like advanced or real-time navigation and media streaming, prices for these services may even decrease despite a still growing overall market. The development for navigation services is also affected by the OEM’s ability to accelerate Vehicle-to-Vehicle Communication. If there is a comprehensive technology ready for the market, navigation services will undergo a radical change.

1: Only includes countries listed in the Digital Market Outlook
2: For further reading, see the Statista Report "Connected Car: Connected Hardware"
3: CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-2021

© Statista Digital Market Outlook
Infotainment Services in Major Regions

Market KPI comparison by region

Revenue forecast

in million US$ by region

United States

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<thead>
<tr>
<th>Service</th>
<th>2016</th>
<th>2021</th>
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<tr>
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<td>32</td>
<td>175</td>
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<tr>
<td>Entertainment</td>
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China

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<tr>
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<tr>
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<td>61</td>
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<tr>
<td>Entertainment</td>
<td>89</td>
<td>1,136</td>
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<td>Comfort Services</td>
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Europe

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<td>Entertainment</td>
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<tr>
<td>Comfort Services</td>
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Revenue per Connected Car

in US$ by region

United States

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<tr>
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China

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Europe

<table>
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<td>Comfort Services</td>
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Source: Digital Market Outlook 2017
# INFOTAINMENT SERVICES IN MAJOR REGIONS

## Market KPI comparison by region

### Revenue

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<td>182</td>
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<tr>
<td>Entertainment Comfort Services</td>
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<td>536</td>
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<td>903</td>
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<td>47</td>
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<td>Total</td>
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<td>71</td>
<td>107</td>
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<td>+58.0%</td>
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### Connected Cars

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<td>5.1</td>
<td>7.2</td>
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<td>2.6</td>
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<tr>
<td>Entertainment Comfort Services</td>
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<td>+41.9%</td>
<td>+124.1%</td>
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1: CAGR: Compound Annual Growth Rate/ average growth rate per year
Source: Digital Market Outlook 2017
KEY TAKEAWAYS BY REGION

Market sizing subjects for Infotainment Services

<table>
<thead>
<tr>
<th>United States</th>
<th>China</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>‣ 5.6 million subscriptions in the Infotainment Services market generated revenues of US$513.7m in 2016</td>
<td>‣ Smallest of the three regions in 2016 with regard to revenue and subscriptions</td>
<td>‣ Second biggest region in 2016 with a revenue of US$336.3m and 4.6 million service subscriptions</td>
</tr>
<tr>
<td>‣ Advanced Navigation was the biggest segment with a revenue of US$307.1m</td>
<td>‣ 1.0 million subscriptions generated a revenue of US$88.9m</td>
<td>‣ Biggest segment was Advanced Navigation with 2.6 million subscriptions and a revenue of US$200.0m</td>
</tr>
<tr>
<td>‣ US market share accounted for 47.9% of the global market size</td>
<td>‣ With regard to the global market share, the Chinese market accounted for 8.3%</td>
<td>‣ The global market share corresponded to 31.3%</td>
</tr>
</tbody>
</table>

Market size

| Revenue is expected to grow to 2021 with a CAGR of 35.5%, and subscriptions at 36.1%. | Fastest growing major region to 2021 with a CAGR of 66.4% in revenue and 67.7% in subscriptions | Biggest major region in 2021 with a global market share of 37.8% |
| Advanced Navigation will remain biggest segment with a revenue share of 57.9% in the domestic market | Revenue will exceed US$1.1bn in 2021 with Advanced Navigation being biggest segment with US$750.2m | Market is expected to grow in revenue and subscriptions with a CAGR of 55.2% and 57.3% respectively |
| Highest growth is projected in Comfort Service subscriptions with 41.9% CAGR | Global market share will increase to 14.2% in Infotainment Services in total | Biggest segment will be Advanced Navigation with 13.0m subscriptions generating US$1.7bn revenue |

Growth rate

| Interest in mobile and in-car connectivity leads to further development of merging experiences (e.g. adds for local coupons or augmented reality for point-of-interest discovery) | Increasing number of OEMs and technology companies offer Infotainment Services in the Chinese market | Car manufacturers collaborate with technology companies in order to generate added value and integrate mobile devices |
| Global technology players’ third party software is more extensively incorporated into new Connected Cars | New, domestic players rise and compete with foreign OEMs | Automatic sharing of traffic-specific data and road-conditions between connected vehicles |

Trend signals

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate / average growth rate per year; base years: 2016-21
Source: Digital Market Outlook 2017
Global Connected Car Revenue

in million US$ by segment

Connected Car: ●
Connected Hardware: □
Vehicle Services: ◯
Infotainment Services: ▲

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/average growth rate per year
Source: Digital Market Outlook 2017
Real-time data enhances navigation quality and offers new services

Real-time traffic information

Of all lately developed trends regarding navigation services, real-time traffic information is probably the most prominent and has the greatest lever for improved navigation.

When looking at the former TMC-based navigation systems, the shortest or fastest way from departure to arrival point was calculated, depending on what the user preferred, and the route was only updated when traffic news were transmitted via radio data. The accuracy was rough and the systems were not able to consider events as they occurred.

The quality of navigation in general is dependent on the extent and quality of available data to calculate the route. When drivers use navigation systems which are connected to the internet and able to process real-time data, the quality of routing and navigating will increase.

The functionality of real-time navigation is as follows: In order to guide the driver to the selected destination in the fastest or shortest way, dependent on what the driver prefers, the initially calculated route will be updated permanently on the basis of real-time data. Most connectivity based navigation systems rely on multiple data sources, e.g.

- GPS-navigation systems
- Smartphones / cellular signals
- Fleet management devices
- Road sensors

The collected data is anonymized, processed, steadily updated (e.g. every two minutes), sent to the connected navigation system and utilized to permanently optimize the route, if applicable. The driver will be informed about traffic jams and alternative routes as soon as possible. Hence, this avoids waiting time.

German OEMs’ acquisition of HERE

With the pervasion of Embedded Telematics enabling Advanced Navigation services in most of new premium value cars, access to reliable and accurate map data is becoming more and more important for OEMs.

Therefore, in 2015 an alliance of German premium car brands1 acquired one of the biggest providers of map data in the world, for an approx. US$3.0bn: HERE. HERE is widespread especially in mature car markets. It provides digital map data for more than 190 countries.

The acquisition secures the involved OEMs independence from Google data, the biggest competitor in this field, and also avoids the transmission of vehicle data to third parties.

Vehicle-to-Vehicle-Communication

In a project that is scheduled for the first half of this year, HERE-equipped vehicles will start communicating with each other.

The data which certain in-car devices e.g. street sign cameras, rain sensors or braking systems, collect will be anonymized and automatically shared with other vehicles equipped with HERE’s software. In this way, drivers will be informed about icy roads or black ice, temporary speed limits or the end of traffic jams before reaching relevant road passages.

This technology again relies on embedded connectivity. It will further improve passenger-safety and prevent road users from accidents caused by circumstances which other drivers were already aware of.

1: Audi, BMW, Mercedes-Benz
Sources: www.cio.de, www.syfic.com
**ADVANCED NAVIGATION FEATURES 2/2**

*Alternative route guidance, on-site assistance and device communication*

**Picturebook Navigation**

Audi’s Picturebook Navigation allows all customers to enter any destination into the Embedded Telematics systems in the form of a digital picture which contains geolocation information. If an Audi Connect customer finds a photo on the internet or receives a picture of a friend, this file can be send directly to the Telematics system via the Audi Connect app. The provided information replaces the classic entry of a destination via the embedded touchscreen.

**Remote destination input**

Another feature in the Audi Connect service package is the opportunity to plan a trip with multiple stops or even a complete journey on your mobile device or personal computer. The chosen destination and route is then communicated to the car via the Audi Connect app. Once the driver gets into the car, the necessary information is already available and can be selected in the Embedded Telematics systems touchscreen.

**AtYourService**

General Motors’ OnStar package is offering an app that connects cars and smartphones to merge road navigation and on-site discovery.

With the AtYourService app drivers can look for interesting spots nearby or browse for specific offers, e.g. discounts in restaurants or retailers. For an additional subscription fee, OnStar customers can furthermore consult an Advisor just by pressing a button in the car. The advisor can then personally help to find points of interest within the locality, and give advice, e.g. book a hotel room.

**Context awareness**

In a Microsoft vision, future cars and manufacturers being connected offer potentials which are not yet possible to exploit.

Assuming a car is monitoring its working parts, a service check is required and data is shared with a local manufacturer. Context awareness is coming into effect, when an earlier appointment is spontaneously available and the customer is nearby by chance: The connection between car and manufacturer enables an alert in the car offering this appointment. As a result, there would be an earlier fixed car and no unproductiveness for the manufacturer.

Although this scenario is a long way off, connectivity is clearly setting the direction for this development in after sales services.

**Utilization of third party content**

**Smartphone integration**

OEM-developed connectivity related service subscriptions are affected by the development of third party solutions and their incorporation into new cars, as already mentioned before. Understandably, car manufacturers want customers to use their technology and accompanied services, as they would be the profiteer of corresponding revenue sources. However, selling points for manufacturers would be limited, if drivers could comfortably utilize services and apps inside the car which are already available on their smartphones.

Nevertheless, OEMs have no choice than collaborate with technology companies in order to bring smartphone contents to Embedded Telematics interfaces, as this is what customers increasingly demand. Apps will be mirrored to the touchscreen of the car and can be controlled without touching the smartphone. This means numerous advantages (e.g. well-known GUI, available passenger content) for customers and drivers respectively which are of course offset by certain disadvantages, especially a more extensive smartphone dependence.

Against this background it remains to be seen if proprietary OEM-developments or those of third party technology companies will prevail for the utilization of apps, infotainment services and podcasts.

In this context, there is not only competition between car manufacturers and tech companies but also between the big technology players Apple and Google, as both of them want to be the provider of seamless device connectivity in the automotive industry. The question of particular interest is also, if OEMs will decide to collaborate with only one of them or incorporate both solutions inside their cars in the long run.

**Google (Android Auto) vs. Apple (CarPlay)**

Google (Android) and Apple (iOS) are the globally leading providers of smartphone operating systems and biggest competitors when it comes to the connection of cars and smartphones.

Google developed its Android Auto to connect Android phones with cars and furthermore partnered with numerous other technology and automotive companies in the Open Automotive Alliance. The goal is to develop software in close cooperation.

In contrast, Apple wants to keep control over its CarPlay, the interface showing Apple contents in the car. It is more or less the iPhone interface extended to the in-vehicle embedded touchpad. The GUI is the same in all cars and does not allow adjustments.

**The race for customer data**

Alongside the competition for direct revenues from service subscriptions, access to driver specific big data will be another lasting competition.

The large scale of the data (e.g. mobility and driving data, movement profiles) is highly valuable to its owners. Considering data security and privacy policies, this data will likely be worth more than a US$100 fee from a direct service subscription.

Third party players like insurance companies or hotels are eager for this data. They enable multiple additional service offerings, e.g. location-based advertising or customized insurance policies. In this context, it is quite obvious that who owns the data generates the revenue.
## INFOTAINMENT SERVICES REVENUE STREAMS

### Market structure and definition

<table>
<thead>
<tr>
<th>Segment</th>
<th>Sub-segments</th>
<th>Out of segment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infotainment Services</strong></td>
<td><strong>Advanced Navigation</strong></td>
<td>Services included are those that contain map updates on a regular basis containing information about traffic jams or real-time traffic information (RTTI) and route optimization.</td>
</tr>
<tr>
<td></td>
<td><strong>Entertainment</strong></td>
<td>Includes all kind of services related to streaming offers (audio and video) or other paid entertainment software integration to the car.</td>
</tr>
<tr>
<td></td>
<td><strong>Comfort Services</strong></td>
<td>Included are services with primary focus on remote control or localization of the vehicle, as well as services that are focusing on productivity (e.g. e-mail).</td>
</tr>
</tbody>
</table>

**Connected Hardware**
Hardware, which enables the general networking of vehicles like eCall Technology or sophisticated Embedded Telematics systems.

**Aftersales Market**
Hardware for updating non connected cars to networking vehicles, e.g. connected OBD2 devices or subsequent infotainment solutions.

**Tethered Connectivity**
Touchscreens or Displays and other interfaces using an external device, like a tablet, smartphone or laptop, to connect to the internet.

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All monetary figures refer to annual gross revenue and do not factor in shipping costs.

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ABOUT DIGITAL MARKET OUTLOOK

9 Markets, 34 segments & 85 sub-segments

**Digital Media**
Video-on-Demand, Digital Music, Video Games, ePublishing

**FinTech**
Digital Payments, Business Finance, Personal Finance

**eTravel**
Online Travel Booking, Mobility Services

**eServices**
Event Tickets, Fitness, Dating Services, Food Delivery

**eHealth**
Diabetes, Hypertension, Heart Failure

**Connected Car**
Connected Hardware, Vehicle Services, Infotainment Services

**Smart Home**
Home Automation, Security, Home Entertainment, Ambient Assisted Living, Energy Management

**e-Commerce**
Fashion, Electronics & Media, Food & Personal Care, Furniture & Appliances, Toys, Hobby & DIY

**Digital Advertising**
Banner Ads, Video Ads, Search Ads, Social Media Ads, Classifieds

Details

- 50 countries
- Direct access & downloads
- 7-Year coverage: 2015 – 2021
- Revenue forecasts
- User count & penetration
- Comparable data

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more information
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Analyst
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Disclaimer
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CONNECTED CAR: VEHICLE SERVICES
Overview

<table>
<thead>
<tr>
<th>Pages</th>
<th>Subject</th>
<th>Essentials</th>
</tr>
</thead>
<tbody>
<tr>
<td>03 – 05</td>
<td>Detailed overview</td>
<td>- Customers benefit in cost and time savings as well as less avoidable vehicle breakdowns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The global(^1) market is currently worth US$193.8 million, as the market is rather cost than revenue driven</td>
</tr>
<tr>
<td>06 – 09</td>
<td>KPI-Comparison</td>
<td>- Biggest market in 2016 was the US, with revenues of US$78.7 million</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- With 74.4%, China showed the highest CAGR(^2) to 2021</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Europe will be biggest market in 2021, showing revenues of US$805.3 million</td>
</tr>
<tr>
<td>10 – 12</td>
<td>Deep Dive</td>
<td>- Real-time analytics and diagnostics will change the maintenance process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Revenues and costs both come with huge potential</td>
</tr>
<tr>
<td>13 – 15</td>
<td>Structure, contacts and imprint</td>
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</tr>
</tbody>
</table>

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/average growth rate per year; base years: 2016-21
CONNECTED CAR MARKET

Market focus on Vehicle Services

Connected Hardware
- eCall Technology
- Embedded Telematics

Infotainment Services
- Advanced Navigation
- Entertainment
- Comfort

Vehicle Services
- Safety & Security
- Maintenance & Diagnostics

Focus Segment
Other Reports
CUSTOMERS MAINLY BENEFIT IN TERMS OF SECURITY AS WELL AS COST SAVINGS

Customer benefit

The landscape for fee-based, vehicle related service subscriptions covered in this report is divided into Safety & Security Services and Maintenance & Diagnostics. The first includes service offerings that assist drivers, subsequently customers, in case of a breakdown. If for example broken working parts or damaged tires need to be serviced, a straightforward process ensures the handling of the breakdown and continuation of the journey, e.g. via including a car rental company. Further included are service extras that go beyond an automated eCall and provide additional benefits to driver and customer.

Maintenance & Diagnostics are beneficial to customers in three different ways:

Prevent avoidable breakdowns: In the past, maintenance appointments were usually foreseen after driving a certain distance. Recording the actual condition of car parts leads to a maintenance notification as soon as any damage can be expected, even though the distance that would require the next maintenance appointment has not yet been driven.

Cost savings: As working parts are monitored permanently, severe damages causing very expensive repair services (e.g. a breaking V-belt) can be avoided before actually happening.

Time saving: Remote, in essence over-the-air activities, e.g. software updates, make many on-site appointments with manufacturers obsolete. Furthermore, the customer is always driving with the latest vehicle software.

The key for the latter mentioned benefits is once again big data analytics. As this topic is a hot one in the Connected Car landscape, further insights regarding in-vehicle, operating data and their transmission will be given in the Deep Dive of this report.

Market size

Global market size for connectivity based Vehicle Services that are liable to costs accounted for US$193.8 million in 2016. The major share of approx. 85% of this amount resulted from Maintenance & Diagnostics services, which was a major segment in all regions.

It should be noted that a significant share of OEMs’ vehicle related services come at no charge or are already included in the purchase price of the car. Some aspects in this field of services are already regarded as mandatory standard equipment. Opportunities to differentiate from competitors are hence quite limited, especially in the premium value segments.

A close look at the three major regions Europe, the US and China with regard to Vehicle Services revealed the US as being the biggest market in 2016.

The US Vehicle Services market was worth US$78.7 million in 2016, corresponding to a global share of 40.6% in the same year. Maintenance & Diagnostics generated most of the market value, totaling in US$65.8 million. One reason for the high global market share is of course the United States being the home market for GM’s OnStar, which is one of the leading companies with regard to Connected Car services subscriptions.

Second biggest region was Europe with revenues of US$70.4 million and an estimated fee-based service subscriptions of approximately 1.5 million in 2016. Europe’s global market share accounted for 36.3% this year.

China was the smallest region with regard to market value and service subscriptions. An estimated 0.3 million subscriptions generated revenues of US$15.9 million in 2016. This considerably small market can be explained by the limited regional coverage of proprietary OEM service offerings.

1: Only includes countries listed in the Digital Market Outlook
IN A GROWING MARKET, EUROPE WILL PUSH THE US FROM THE TOP SPOT

**Future developments**

The expected development in vehicle services is promising from the global perspective. In 2021, total market volume in this segment is expected to reach almost US$2 billion. However, although revenues are growing all over the world, the regional shares are expected to shift.

In the future, the major revenue share in this segment will be generated in Europe, pushing the US from the top spot. Subscriptions for vehicle related services in the European car market will exceed 20 million and result in a total revenue of US$805.3 million in 2021. This corresponds to a global share of 41.4%. By far, most of the revenue will account for Maintenance & Diagnostics services with US$675.2 million.

Second biggest major region, having a global share of 23.4%, will be the United States with more than 10 million fee-based subscriptions in 2021. US subscribers are expected to generate revenues of US$455.5 million in this year, which corresponds to a CAGR\(^2\) of 42.1% from 2016 to 2021.

**China** remains the smallest of the three regions with total revenues of US$255.1 million in 2021. Despite having the lowest revenue in total, China is expected to show the highest average annual growth rate to this year with regard to revenue and registered customers, showing a CAGR\(^2\) of 74.3% and about 80% respectively. China's global market share is predicted to increase to 13.1%, from only 8.2% in 2016. These huge growth rates can, as for other car-related service offerings, be explained by the deepening pervasion of OEMs' service offerings in China in general.

However, it should be noted, that car-related services performed OTA\(^3\) and remote included in these numbers do by far not contain all services in this field. Their actual extension will be much bigger but will in many cases come at no additional cost or subscriptions to customers.

**Assumptions and sensitivity**

**Key assumptions** in our forecasts with regard to the Connected Car development are further improvements of the general internet connectivity infrastructure (4G pervasion, 5G development) and increasing customer demand for embedded devices, which enable the seamless utilization of this technology in new cars.

In this report, the examined Vehicle Services revenues (vehicle related, connectivity based services of manufacturers) appear to be quite low at first glance. Particularly, when thinking about the US market (home market of GM's 1996 launched OnStar) with its millions of registered subscribers, one would expect much higher figures.

However, many OEM-reported offerings in this field of service are not included in our numbers. For example, **many connectivity based service packages are automatically included** for up to five years when buying a new car and they do not come with any charges. Assumption here is that OEMs want to lower the bar for customers to subscribe to those services and win new customers in this field. Hope is that fee-based services are added to cart or the subscription will be extended after the free “trial version”.

Also, we **exclude offerings based on voice controlled interaction between driver and a personal assistant**. The way they are utilized (similar to a telephone service) does not correspond to our definition of a connected service. Besides, the **industry shift toward single fee embedded virtual personal assistants**, such as Microsoft Cortana or Amazon Alexa, further question the potential of monetization via fee-based subscriptions.

What will further boost vehicle and working parts related services that come at no charge is the fact that they **help OEMs to save a lot of money on e.g. product development, quality assurance or marketing**.

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-21
3: Over-the-Air; services can be performed without a physical connection to a certain device
VEHICLE SERVICES IN MAJOR REGIONS

Market KPI comparison by region

Revenue forecast
in million US$ by region

United States

China

Europe

Revenue per Connected Car
in US$ by region

Source: Digital Market Outlook 2016
## VEHICLE SERVICES IN MAJOR REGIONS

### Market KPI comparison by region

#### Revenue

<table>
<thead>
<tr>
<th>Segment</th>
<th>Unit</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>CAGR 16 – 21</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>mUS$</td>
<td>78.7</td>
<td>127.4</td>
<td>197.3</td>
<td>282.0</td>
<td>370.1</td>
<td>455.5</td>
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<td>mUS$</td>
<td>12.9</td>
<td>22.4</td>
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<td>51.8</td>
<td>68.7</td>
<td>85.5</td>
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<td>mUS$</td>
<td>65.8</td>
<td>105.0</td>
<td>161.5</td>
<td>230.2</td>
<td>301.4</td>
<td>370.0</td>
<td>+41.3%</td>
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<td>15.9</td>
<td>32.5</td>
<td>62.5</td>
<td>110.2</td>
<td>175.4</td>
<td>255.1</td>
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<td>1.2</td>
<td>2.7</td>
<td>5.5</td>
<td>9.8</td>
<td>15.7</td>
<td>22.9</td>
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<td>29.8</td>
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<td></td>
<td></td>
<td></td>
<td>+62.2%</td>
</tr>
<tr>
<td><strong>Connected Cars</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Safety &amp; Security</strong></td>
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<td>0.4</td>
<td>0.8</td>
<td>1.3</td>
<td>2.0</td>
<td>2.8</td>
<td>3.5</td>
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<tr>
<td><strong>Maintenance &amp; Diagnostics</strong></td>
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<td>1.1</td>
<td>1.8</td>
<td>2.8</td>
<td>4.1</td>
<td>5.6</td>
<td>7.1</td>
<td>+45.1%</td>
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</table>

#### Connected Cars

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<thead>
<tr>
<th>Segment</th>
<th>Unit</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>CAGR 16 – 21</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety &amp; Security</strong></td>
<td>m</td>
<td>0.4</td>
<td>0.8</td>
<td>1.3</td>
<td>2.0</td>
<td>2.8</td>
<td>3.5</td>
<td>+85.7%</td>
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<tr>
<td><strong>Maintenance &amp; Diagnostics</strong></td>
<td>m</td>
<td>1.1</td>
<td>1.8</td>
<td>2.8</td>
<td>4.1</td>
<td>5.6</td>
<td>7.1</td>
<td>+78.6%</td>
</tr>
</tbody>
</table>

1: CAGR: Compound Annual Growth Rate/average growth rate per year

Source: Digital Market Outlook 2016
KEY TAKEAWAYS BY REGION

Market sizing subjects for Vehicle Services

**United States**
- Biggest single market with revenues of US$78.7 million in 2016
- Global market share was at 40.6% due to a comparably huge stock of Connected Cars on US roads
- Major share of revenues corresponded to Maintenance & Diagnostics with US$65.8 million and a share of 83.6%
- Double digit annual growth rates of more than 40% are predicted up to 2021
- Safety & Security Services show higher growth rates due to increasing customer attention
- Further incorporation of technologies that utilize 4G by the biggest connectivity provider (OnStar)
- Increasing number of cars that are capable for proactive maintenance alerts (compared to only describing condition reports)

**China**
- Smallest region in 2016 with a total Vehicle Services revenue of US$15.9 million
- Only 8.2% of global market share was generated in the Chinese market
- Highest growth rates of the three major regions with a CAGR\(^2\) of 74.3% in the period between 2016 to 2021
- By 2021, subscriptions exceed 5 million and result in revenues of more than US$255 in the same year
- Growing number of customers and drivers who are interested in value adding connectivity related services
- Customers’ increasing willingness to pay for safety features and to switch brands due to better connectivity options

**Europe**
- Second biggest region in 2016 with a global market share of 36.3% worth US$70.4 million
- 1.5 million subscriptions showed a similar value to the US market
- Safety & Security services accounted for 14.4% and were way behind Maintenance & Diagnostics
- By far the biggest major region in 2021 with total revenues of US$805.3 million
- Main driver is the mandatory eCall legislation which comes into effect in April 2018
- Subscriptions are expected to exceed 20 million by 2021
- EU Commission’s 5G action plan in order to further increase high speed mobile data transmission
- Increasing number of OEMs offering OTA software updates

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1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/ average growth rate per year; base years: 2016-21
Source: Digital Market Outlook 2016
VEHICLES SERVICES SHOW HIGHEST GROWTH

Global segment size and growth rates

Global\(^1\) Connected Car Revenue

in million US$ by segment

<table>
<thead>
<tr>
<th>Segment</th>
<th>2016</th>
<th>2021</th>
<th>CAGR(^2) 16 – 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected Car</td>
<td>15,020</td>
<td>82,707</td>
<td>+38.4% p.a.</td>
</tr>
<tr>
<td>Connected Hardware</td>
<td>1,073</td>
<td>72,747</td>
<td>+37.1% p.a.</td>
</tr>
<tr>
<td>Vehicle Services</td>
<td>1,945</td>
<td>8,015</td>
<td>+58.6% p.a.</td>
</tr>
<tr>
<td>Infotainment Services</td>
<td>194</td>
<td></td>
<td>+49.5% p.a.</td>
</tr>
</tbody>
</table>

1: Only includes countries listed in the Digital Market Outlook
2: CAGR: Compound Annual Growth Rate/average growth rate per year
Source: Digital Market Outlook 2016
Differences in Car-related Big Data

Overview

General types of car-data

From an overarching perspective, car-related data can be divided into **two different data sources**.

On the one hand, there is **operating data**, generated from a car itself and its monitored **car-sensors** (A). Operating data excludes all kind of information that is brought into the car by users or passengers. However, with the ongoing trend of vehicle connectivity, the number of connected and monitored working parts is continuously increasing, and subsequently leads to rising amounts of data.

Most interesting is information that contains suspicious values relating to working parts that are stored in the form of a **Diagnostic Trouble Code** (DTC). Many DTCs have been diagnosed in the past and the solutions are stored with OEMs and repair shops. However, there still is a huge number of problems which have not yet been clearly diagnosed. In this case, the code indicates which car parts in particular are affected and should be examined. Typically, the code is read via the OBD II interface. In this context, frequency, amount and type of data recorded and stored vary between OEMs.

On the other hand, there is **information about vehicles from manufacturers, retailers and repair shops** (B). Generally speaking, this information is expected to be quite structured (compared to much of the real-time operating data). It relates to specifics of the cars, like engine or fuel type.

Also, historical data, especially when combined from multiple repair shops, contains useful information with regard to past issues. Hence, when a DTC is read out, the solution to this problem might already be apparent to the mechanic.

It is quite obvious that the more structured and integrated data is available, the better is their utilization and incorporation in predictive processes.

(A) – Operating data

- Recorded in **real-time**
- Related to the **actual condition** of the car / working parts
- Stored as **Diagnostic Trouble Code**
- Indicating **defective functions** and their origin
- Baseline for in-car **alerts**
- Referring to actual **car-usage** (only where applicable)

(B) – Retailer and repair shop data

- **Historically** stored
- **Structured** nature
- Containing **vehicle specifics**, e.g. engine and fuel types, year of construction, vehicle section
- **Infers relationships** to DTCs^2
- Collected and separated per **product series**

1: On-Board Diagnostics  
2: Diagnostic Trouble Code
### CASE STUDY PREDICTIVE MAINTENANCE

#### Utilizing car-related big data

**A shift towards real-time decisions**

In the future, the most advanced connected cars will be extensively equipped with **three features**, which are expected to change the whole maintenance process:

- **Connected working parts**
- **Computing power**
- **Learning ability**

Traditionally, service appointments are scheduled according to a certain distance travelled. The mechanic reads out operating data and the car will be checked or repaired accordingly. However, such a static process leaves many gaps for avoidable car failures. Here comes **predictive maintenance** based on big and real-time data into effect.

In use, connected working parts produce massive amounts of data\(^1\). Analytics and diagnostics are permanently performed inside the car. Hence, **decisions and corresponding actions** are based on the car’s real-time condition. This leads to **smart handling of irregularities**, which have not already caused failure, as an alert is sent immediately, even if a defective function is only expected to occur.

When cars will further incorporate **historical data** by retailers and repair shops, identify **recurring patterns**, infer **relationships**, and share all generated **insights** again, diagnostics will become even more precise and predictive.

Nevertheless, in order to do so, cars need a lot of computing power and **smart management** of all available data. This is because the amount of data is too big as all of it could go to the cloud.

Also, disregarding the customers’ willingness to pay extra money for such services, OEMs will likely pursue this technology anyways, as **“the new oil”**\(^2\) is of such **great value to them**. And despite any privacy concerns, customers may benefit from the utilization of vehicle-data, too.

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1: McKinsey predicted connected cars creating 25 gigabytes of data per working hour
2: “Data is the new oil. It’s valuable, but unrefined it cannot really be used [...]” Clive Humby, UK Mathematician (2006)
3: In the form of a Diagnostic Trouble Code (DTC), a numerical code for identified defective vehicle functions
### BENEFIT OPPORTUNITIES FOR MANUFACTURERS

**Monetizing car-related big data**

#### Third party sales

| Impact | Large scale car data is valuable to its owners. If privacy concerns and third party utilization have been sorted out, OEMs’ revenue sources are almost infinite. Many players are able to generate revenues from vehicle-data. Insurance companies can offer customized policies, repair shops get early customer access, gas stations knowing a car nearby needs fuel can offer promotions, just to name a few of them. OEMs can generally make a profit of the data in two ways, either sell data packages or get a share of data-driven turnover. And the good news is: data privacy does not seem to be a huge obstacle for this development from the drivers’ side, as a McKinsey study has revealed. |

#### Product development

| Impact | Operating data is a good source in order to further improve a car. For example, manufacturers get to know their customers better:  › How do they drive the car?  › What limits their experience?  › Are there obsolete features?  › etc.  Of course, market researchers could generate much of this information too, but unbiased first-hand data with a sample size of hundreds of thousands is nearly impossible to collect or would come at very high costs. Also, vehicle modifications could be tracked immediately after their market launch. This may shorten development lifecycles in the long-term, which is crucial when considering the further digitization of the car. |

#### Quality assurance

| Impact | Untapped potentials lie in wait with regard to long-term quality improvements. On-board root cause analytics can identify recurring quality issues the moment they occur. If necessary, related tier-one/two suppliers can be informed about the existing issues and may help solve them immediately. This ensures a permanently rolling quality improvement process. Furthermore, Connected Cars could save OEMs a lot of costs when it comes to recall actions related to software issues. Those could be sorted out via OTA-updates which are more convenient for the customer and more cost and workload efficient to the manufacturer. |

#### Customer bonding

| Impact | According to a recently published KPMG survey, customers seem to be more willing to give away vehicle operating data than personal, consumer related data. Utilizing this data may lead to a closer connection between OEM and customer. An optimized customer touchpoint for the entire aftermarket could be designed more proactive (instead of waiting for the customer to have an issue). Getting in touch with the customer before there is an issue, offering a preventive or additional service that may be required, is valuable and may result in increased customer satisfaction and a good reputation. Connectivity is once again key to a seamless driving experience covering the vehicle life cycle. |

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1: McKinsey study “Competing for the connected customer” (2015)  
2: KPMG survey “Global Automotive Executive Survey 2017” (2017)
## VEHICLE SERVICES REVENUE STREAMS

### Market structure and definition

<table>
<thead>
<tr>
<th>Segment</th>
<th>Sub-segments</th>
<th>Out of segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety &amp; Security</td>
<td>Safety &amp; Security includes services in addition to an emergency call service,</td>
<td>Connected Hardware&lt;br&gt;Hardware, which enables the general networking of vehicles</td>
</tr>
<tr>
<td></td>
<td>requiring an extra fee and offering additional services, e.g. roadside assistance or breakdown management services.</td>
<td>like eCall Technology or sophisticated Embedded Telematics systems</td>
</tr>
<tr>
<td>Maintenance &amp; Diagnostics</td>
<td>Maintenance &amp; Diagnostics includes services that constantly check vehicle data and, e.g. inform about optimal test intervals. Also included are services at cost which run software updates over-the-air and approximate the remaining service life of wearing parts based on their expected life-duration as well as sensory data.</td>
<td>Aftersales Market&lt;br&gt;Hardware for updating non connected cars to networking vehicles, e.g. connected OBD2 devices or subsequent infotainment solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tethered Connectivity&lt;br&gt;Touchscreens or Displays and other interfaces using an external device, like a tablet, smartphone or laptop, to connect to the internet</td>
</tr>
</tbody>
</table>

All monetary figures refer to annual gross revenue and do not factor in shipping costs.

**In scope**

**Other segment**

**Out of scope**

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ABOUT DIGITAL MARKET OUTLOOK

9 Markets, 34 segments & 85 sub-segments

- **Digital Media**
  Video-on-Demand, Digital Music, Video Games, ePublishing

- **FinTech**
  Digital Payments, Business Finance, Personal Finance

- **eTravel**
  Online Travel Booking, Mobility Services

- **eServices**
  Event Tickets, Fitness, Dating Services, Food Delivery

- **eHealth**
  Diabetes, Hypertension, Heart Failure

- **Connected Car**
  Connected Hardware, Vehicle Services, Infotainment Services

- **Smart Home**
  Home Automation, Security, Home Entertainment, Ambient Assisted Living, Energy Management

- **e-Commerce**
  Fashion, Electronics & Media, Food & Personal Care, Furniture & Appliances, Toys, Hobby & DIY

- **Digital Advertising**
  Banner Ads, Video Ads, Search Ads, Social Media Ads, Classifieds

Details

- 50 countries
- Direct access & downloads
- 7-Year coverage: 2015 – 2021
- Revenue forecasts
- User count & penetration
- Comparable data

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