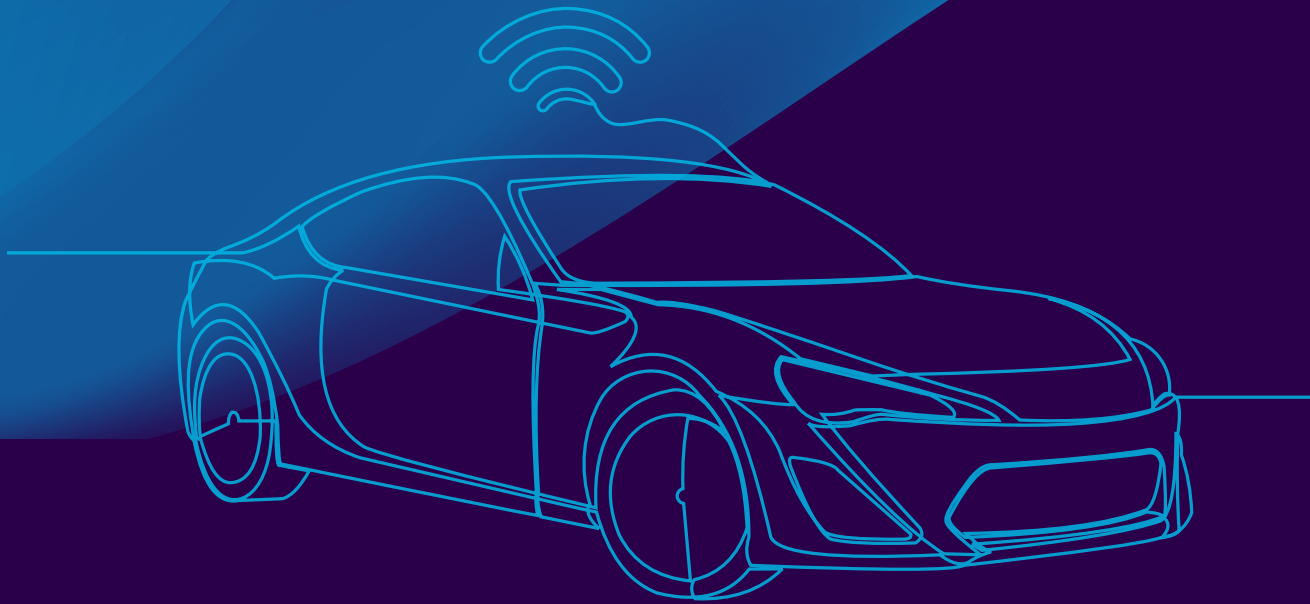


ISSUE 1 . 2019

# CONNECTED VEHICLE TREND RADAR

The drive to add value: lessons from China



Capgemini  invent





We're delighted to introduce Capgemini's Connected Vehicle Trend Radar, intended as the first of a series.

We will publish regular Trend Radars, each of which will be an entertaining and thought-provoking read for automotive experts but also everyone who's interested in automotive. The series aims to keep you abreast of some of our latest research and insights into this fast-evolving market in order to help you maintain your competitive edge. Each issue will highlight a specific topic, with deep dives into important aspects.



## MANAGEMENT SUMMARY

We've been monitoring four main aspects of connected vehicles: Markets, customers, technologies, and new players. For this first Trend Radar, we've concentrated on technologies and new players; markets and customer trends are discussed briefly at the beginning.

**Markets and customers:** Market trends and customer preferences will make China the most important connected car market.

- By 2023, about a quarter of all passenger cars in use worldwide will be connected, with most of them in Europe. However, China shows the greatest potential and will soon be exhibiting the fastest growth.
- Customers are more likely to entrust their data to OEMs than to newer competitors. Most customers don't see added value in current connected services. However, customer interest in using connected cars is already relatively high in China, where customers are more willing than those in the EU and the US to pay extra for connected features. Features that relate to autonomous driving or to safety and security are of interest to drivers in all markets, however.
- The typical connected car buyer is male, under 35, with middle to high income, and living in a town.

**Technologies:** Artificial intelligence (AI), blockchain, and 5G will combine to enable the sophisticated services customers value – and cybersecurity will determine acceptance.

- AI applications in vehicles will proliferate as cameras, smart sensors, and in-car systems transform human-to-vehicle interactions and make cars truly smart. AI-enabled driver experience and mobility services will create maximum future value. To realize AI's full potential, companies must monetize the resultant data.
- Blockchain will be vital for many connected vehicle use cases because it boosts data security and reduces the risk of data manipulation. For example, it enables the "Car CV," a tamperproof record that will increase trust in used vehicles. eWallets plus blockchain-enabled smart contracts will facilitate automatic secured payments on the fly.
- 5G communication technology will enable autonomous driving and connected ecosystems, plus new mobility formats and services. China will soon be leading 5G adoption in terms of both speed and numbers of connections. China also shows a determination to lead on standards.
- OEMs currently lack a clear agenda and structure for cybersecurity, yet this is a make-or-break factor for take-up of connected services.

**New players:** Big players and startups entering the connected vehicle market will act as both potential competitors and potential partners.

- Big players from industries such as technology and telecommunications are already active in the market. They are mainly working in the telematics segment, but also in remote services or infotainment and navigation.
- The many startups battling in the connected vehicle market are mostly adopting three roles within the value chain: they can provide technology and solutions for OEMs, data-matching platforms for use between OEMs and third parties, or direct B2B/B2C solutions. Most startups focus on artificial intelligence and autonomous driving solutions. Those with the highest funding are mostly based in China.

**Based on these observations, we recommend that automotive companies:**

- Learn from China, siting research and development facilities there and deploying the results to other markets. China already has the highest growth rates for connected vehicle adoption, the largest number of digital customers, and the highest levels of innovation in this area, and so it's the best place to develop connected services.
- Create services that customers will use, i.e., those that are relevant and add value. Companies need to use information about customer needs and preferences to identify the right offers, build them, and then scale them up fast and securely to reach a critical mass of customers.
- Open up to collaboration, providing and orchestrating a platform for third parties (large and small) to offer services that complement, and can be integrated with, the automotive companies' own. Working with carefully selected partners in this way will make it possible to give customers what they really want and thereby claim a central position in their lives.

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# INTRODUCTION

## THE FUTURE OF CONNECTED VEHICLES

Over the past several years, the automotive industry has seen tremendous changes, many of which are shaped by four major trends, collectively referred to as CASE (connected, autonomous, shared, and electric).

Of the four CASE trends, connectivity is the biggest single enabler of change. It is only through connectivity that the potential of the other three trends can be realized. That's why we've created this Connected Vehicle Trend Radar, focusing on different aspects of the connected vehicle.

We've been monitoring four main aspects of connected vehicles: market, customers, technology, and new players. For this first Trend Radar, we've concentrated on technology and new players; market and customer trends are discussed briefly following this introduction. In addition, we've focused mostly on connected passenger cars.

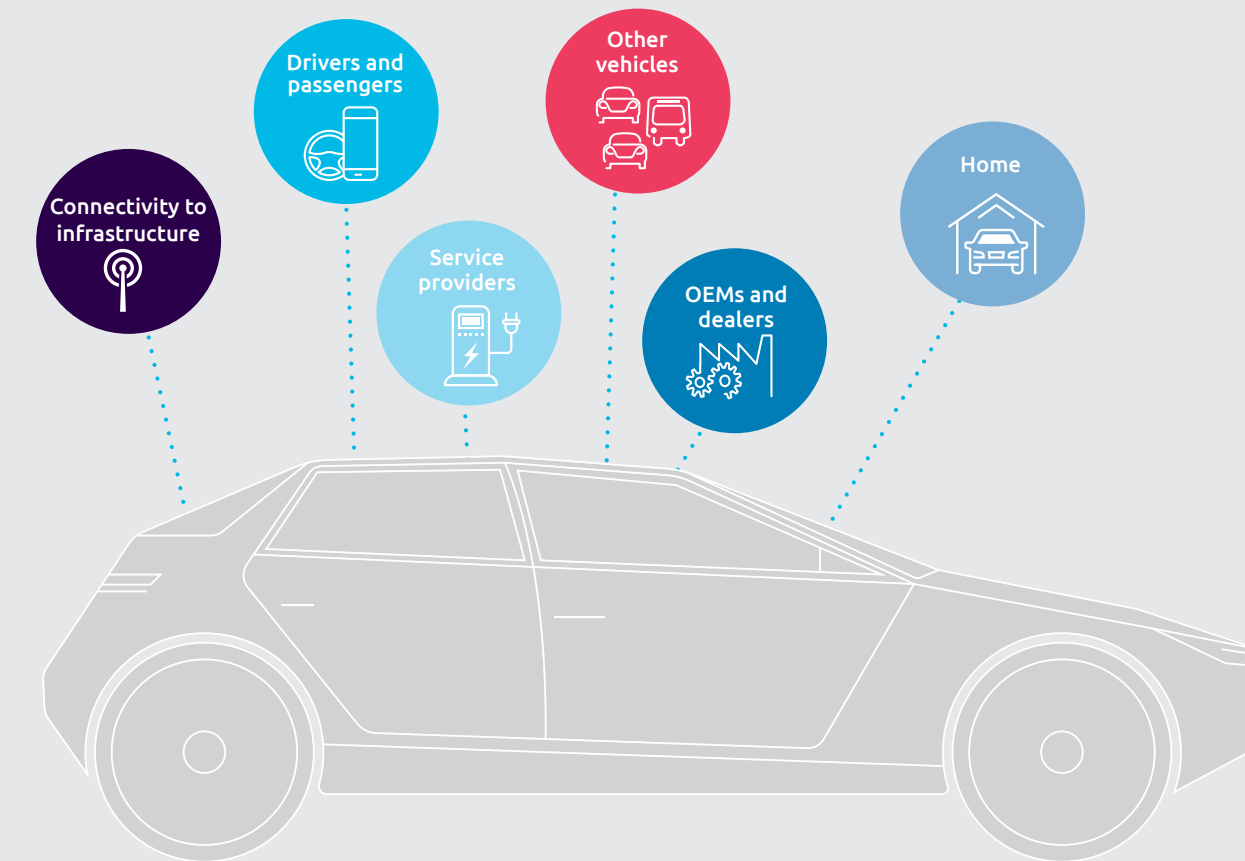
In the Technology chapter, we focus this time on three key areas – artificial intelligence (AI), blockchain, and 5G – as well as taking a brief look at the vital topic of cybersecurity. We've drawn on recent Capgemini studies on AI and 5G. The New Players chapter looks both at large entrants to the market

from other industry sectors and at innovative startups. For the latter, we've drawn on our startups research database.

Throughout our discussion, we'll be tackling key questions about the future of connected vehicles:

- What do global market dynamics look like today, and how will they change in the future?
- Do we have the right view of our connected car customer base?
- Which technology will foster the next stage of digital services, at last satisfying customer demands?
- Besides OEMs, which other players will take part in the battle to create customer value around connected cars?
- OEMs versus startups – should we expect symbiosis or fierce competition?

We are convinced you will find this Connected Vehicle Trend Radar entertaining and useful. Please contact [connectedvehicles@capgemini.com](mailto:connectedvehicles@capgemini.com) if you would like to discuss any of the issues covered.



## CONNECT TO YOUR VEHICLE

We define connected vehicles in terms of six ways they are connected to the environment via touchpoints in our daily lives: connectivity to infrastructure, to service providers, to drivers/passengers, to other vehicles, to the home, and to OEMs and dealers.



# MARKETS

CHINA IS THE NUMBER ONE CONNECTED CAR MARKET OF THE FUTURE

China may not be the biggest connected car market now, but there's little doubt that it will become the biggest – so whichever OEM gains leadership of the Chinese market will be the global market leader. In this chapter, we discuss the likely changes in the market and some of the implications for the industry.

### A valuable global market

Connected cars are becoming a key market sector for the automotive industry globally. In 2018, there was a carpark of 119.4 million connected cars worldwide.<sup>1</sup>

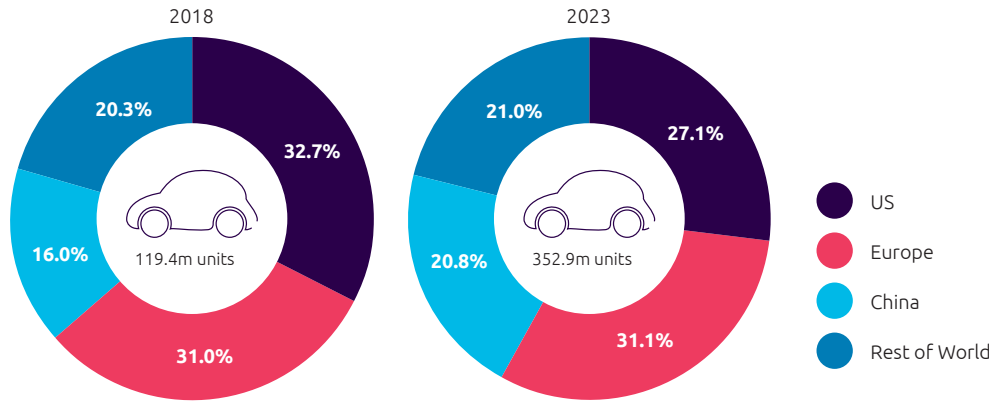
Over the next few years, the global market is expected to grow fast, with a compound annual growth rate (CAGR) of 24.2% for quantity. In 2023, there will be 352.9 million connected cars on the road – around 24% of all cars worldwide, compared with only about 8% in 2018.<sup>1</sup>

### Activity will shift from the US to Europe, then China

In 2018, the US was the most valuable single market, and also the one with the highest penetration – i.e., the proportion of connected car sales in relation to potential customer households. Penetration in the US was 31.1% compared with Europe (13.6%), Rest of World (6.4%), and China (4.8%).<sup>1</sup>

FIGURE 1

CHINA WILL REPRESENT AN INCREASINGLY IMPORTANT SEGMENT OF THE MARKET SHARE OF CONNECTED CARS (CARPARK)<sup>1</sup>



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019



The relatively low penetration in China merely reflects China's exceptional market potential. Only a small percentage of the population there currently own cars, but as the country achieves an increasing economic momentum, more people will buy them – and, given the characteristics of Chinese customers (which we'll discuss in the next chapter), they may well opt for connected cars. This potential is one reason why the relative distribution of connected cars in different regions is expected to alter dramatically, with the most valuable market shifting from the US now, to Europe in the mid term, and finally to China in the long term.

Between 2018 and 2023, China will achieve the highest CAGR of 30.9% while the rest of the world will also exhibit rapid growth. The quantity of connected cars sold in Europe will grow in line with the global market (CAGR of 24.3% for Europe versus 24.2% globally). The US will be the only one of the four markets with a growth rate below the global average (CAGR of 19.6% between 2018 and 2023).

#### MARKET CONCENTRATION IN EUROPE

In 2018, Germany, the UK, and France together accounted for slightly more than half of connected car ownership, and this share isn't expected to change much between 2018 (53.6%) and 2023 (51.3%).<sup>1</sup>

#### Recommendations: Get ahead in China

It's critical to invest now in the Chinese market, the market with the highest long-term value. Leadership in this market will mean global leadership. To get ahead in China, automotive companies should:

- Consider the market dynamics and the shifting importance of the different regions as well as connected car market potential of emerging markets.
- Concentrate research and development (R&D) in China, putting your facilities there if you haven't already done so. That way, you'll be on the spot when market demands start to build up.
- For penetrating markets, your product portfolio should reflect the specific customer preferences of the regions – a topic we'll discuss in the next chapter.







# CUSTOMERS

UNDERSTANDING CUSTOMERS IS THE KEY TO SUCCESS

Customer centricity is a matter of the highest urgency for the industry. If you don't understand your customers, you won't survive, because you won't be offering relevant, value-adding digital services and products. As discussed in the previous chapter, China is the most valuable connected car market for the future, and this is also true from the customer perspective. Therefore, the preferences and needs of Chinese customers are going to be especially important.

## Chinese customers are already extremely interested in connected cars

As already noted, China will soon be the number-one market for connected cars, overtaking the US and Europe. Survey findings at an individual customer level support this prediction. The demand for connected cars is very high in China, with 79% of respondents saying they plan to buy one, whereas the figures for Europe (53%) and the US (52%) suggest that customers still have concerns – some of which also exist even in China.<sup>2</sup>

The main overall barrier to adoption of connected cars is that customers do not yet see the added value they could get from connected services. There are two main reasons for this. First of all, the industry has not been very good at communicating the benefits so far. Secondly, some of the services currently offered do not actually add much value. The net result is a lack of interest and awareness. Research suggests that 11% of drivers don't even know whether their car has any connected features.<sup>3</sup>

## Features customers want

Safety and time saving (e.g., smart navigation) are major interests in all markets. Premium car owners in particular are willing to pay for such services. On the other hand, hardly anyone seems willing to pay for infotainment at present.<sup>3</sup> However, infotainment may become more important with the rise of certain technological capabilities we'll discuss in the Technology chapter, since these will mean that drivers will have more time available and will want to make better use of it.

Customers are keen to embrace autonomous driving, with 75% of Chinese respondents saying they'll accept it (compared with 24% in the US and 36% in Europe). Unsurprisingly, Chinese respondents are often the most willing to pay extra for autonomous driving features.<sup>2</sup>

Two major concerns in all markets are cyber resilience and data privacy, and it's encouraging to find that in both these areas, 40% of customers would trust car brands and only 10% would trust new entrants, such as tech companies. These findings suggest an important area of opportunity for OEMs, which also extends to cybersecurity – a topic we'll return to in our chapter on Technology.<sup>2</sup>



## TYPICAL CONNECTED VEHICLE BUYER

What distinguishes Chinese customers from their counterparts in other countries? One important difference is that the Chinese population has an exceptionally high percentage of young people, especially millennials, who are more willing than average to use technological solutions, starting with consulting online information channels (especially via mobile) rather than dealers when they want to buy a vehicle. These “digital natives” will make up a significant proportion of the market for connected cars – once they can afford them – and so their habits and preferences should strongly influence any OEM’s decisions about the connected service portfolio.<sup>4</sup>

### Recommendations: Let Chinese customers be your guide – especially the digital natives

It’s vital to design the services portfolio based on real customer needs, so we advise evaluating it from a customer perspective. And, given the huge relative value of the Chinese market in the future, we recommend considering the needs of Chinese customers first. Automotive companies should therefore:

- Produce digital applications using the Chinese market as a test-and-launch environment.
- Exploit customers’ trust in car brands as a competitive advantage by investing in areas such as data governance and security and cyber resilience.
- Be aware of the target customer group, especially the digital natives who are, and will continue to be, the

main future customer segment with a high demand for mobile content.

- Use targeted communication through online advertisements and dealers to make customers aware of digital service innovations and their value.

To give customers relevant, value-adding services, companies must exploit and combine some key technologies. To satisfy the demand for value-adding services, it’s essential to give customers what they want in areas such as entertainment, cybersecurity, and seamless connectivity. And the only way to do that is through technology, our next topic.

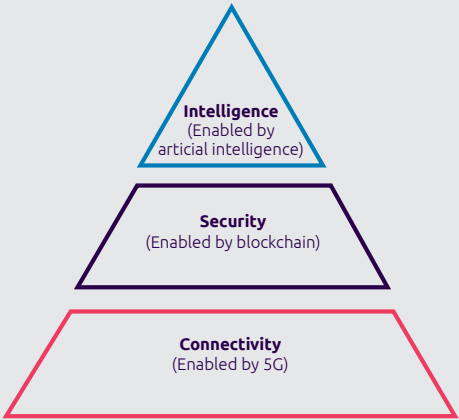
MALE  
UNDER 35 YEARS OLD  
MIDDLE-HIGH INCOME  
URBAN

# KEY TECHNOLOGIES

ENABLE VALUE-ADDING SERVICES

## TECHNOLOGY PYRAMID

CREATE RELEVANT AND VALUE-ADDING SERVICES WITHIN A CONNECTED, SECURE AND INTELLIGENT ECOSYSTEM



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

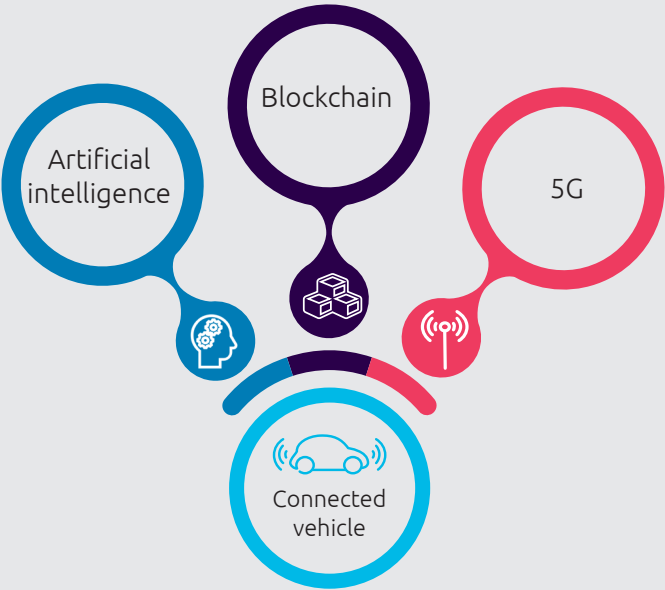
Standalone services are not usually very valuable to customers; it's in combination that they become powerful. The same is true of technologies. AI sensors can only have major impact if you have fast data transfer (both vehicle to vehicle (V2V) and vehicle to everything (V2X) through 5G. Instant payments through

the eWallet (which needs blockchain) can also only be done via a fast data connection (which means 5G).

This chapter discusses three key technological enablers of the connected vehicle ecosystem: AI, blockchain, and 5G, shown in Figure 2.

FIGURE 2

THREE KEY ENABLING TECHNOLOGIES

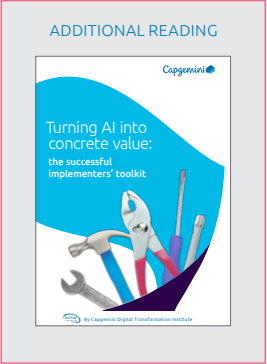
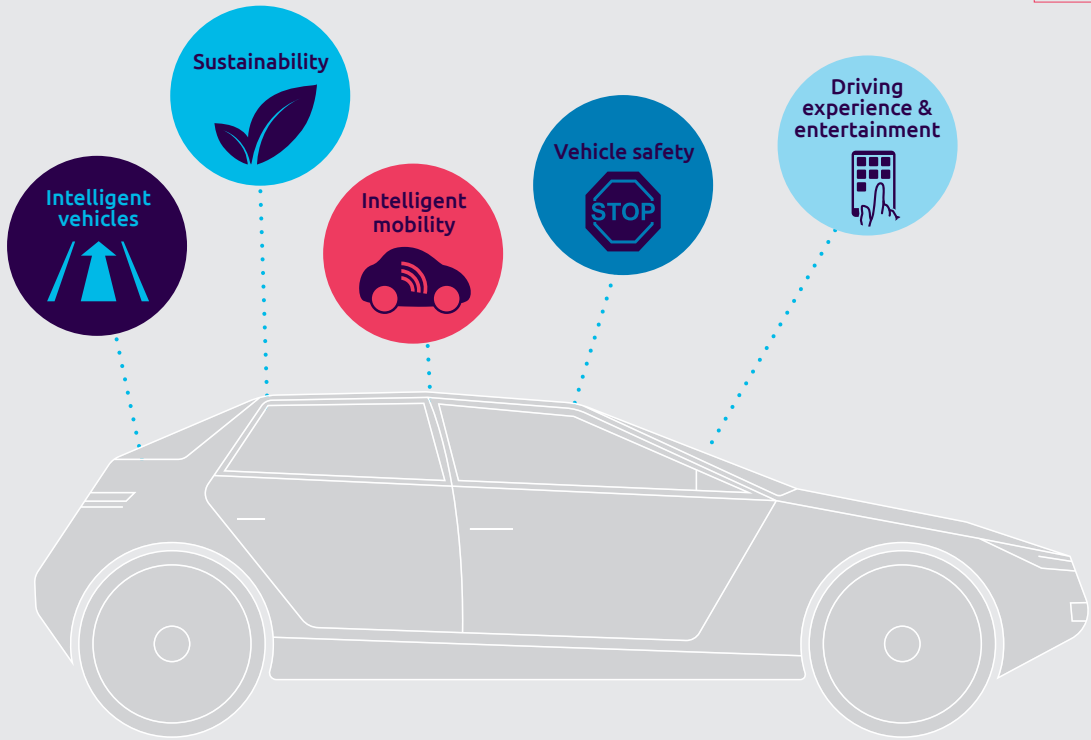


Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019



The chapter will also include a short discussion of the important general topic of cybersecurity, which needs to be tackled if we want customers to value, rather than fear, connected vehicle services. We'll discuss technology use cases – examples of areas where each technology can add value – grouping them into the following five categories:

FIGURE 6  
FIVE CATEGORIES OF USE CASES



## AI IS MAKING VEHICLES INTELLIGENT

Artificial intelligence is a key technology for connected vehicles, as it affects so many aspects and features. When AI is mentioned in the context of this industry, many people think of self-driving vehicles, but it will be a few more years before fully self-driving cars and trucks become a reality.<sup>5,6,7</sup>



Meanwhile, many AI applications are already being used by OEMs. Current initiatives are often aimed at enhancing vehicle security and safety systems. For example, AI cameras facing the inside can monitor drivers for distraction, drowsiness, and fatigue, which could drastically reduce accidents and bring down insurance costs. Such cameras could identify if a child or dog is left behind in the car to prevent heat-related deaths.<sup>6,8</sup>

AI is also being used within the vehicle to improve driver experience. Through gesture recognition and natural language understanding, vehicles can learn and remember what people are saying, so that drivers can achieve their desired outcomes faster and with less

effort: For example, they could book airport parking and be automatically guided to the right parking lot. Vehicles will be able to recognize individuals from their voice and, for example, immediately put their seats in the right position. AI will also enable support functions such as self-parking and GPS-based speed control.<sup>9,10</sup>

AI is particularly powerful when combined with sensors. We can expect to see a revolution in the use of sensors, particularly – but not exclusively – on the vehicle exterior. Currently, the cost of sensors is decreasing while their capabilities are rapidly increasing, so

adoption is likely to happen fast. They can be applied within the vehicle (e.g. to track driving behavior as a basis for insurance offers) and under the hood (to predict engine failure as a basis for predictive maintenance and service).<sup>7</sup>

### Creating maximum value in the future: driver experience and mobility services

Increasingly, the emphasis of industry AI activity is on these two areas: driver experience and mobility services. According to our recent AI study, 33% of OEMs already have AI-based use cases in place in the driver experience segment. For mobility services, the figure is 53%.<sup>11</sup>

AI-powered use cases have high impact on driver experience and mobility services

Applications to enhance driver experience will include voice assistants to access customer service and support, emotion detection via facial analysis, and much more. Early initiatives by premium OEMs, particularly in the area of enhanced driver experience, are already demonstrating some of the possibilities. Examples include the Mercedes-Benz User Experience (MBUX) or BMWs Intelligent Personal Assistant (IPA), an infotainment system that drivers can initiate with the wake-up word “Hey Mercedes” or “Hey BMW,” and then interact via natural language. The system continuously learns the needs of drivers and provides personalized recommendations.<sup>12</sup>



For operators of mobility services, AI again offers a wide range of opportunities, from demand prediction to intelligent and dynamic pricing. Capgemini’s AI study<sup>11</sup> identified improved fleet management as one of the most important and impactful use cases for the industry. In the context of fleet management, AI can be used to:

- Optimize dispatch: Monitor a fleet and decide where each vehicle should go next, and then identify the fastest route to each destination based on predicted traffic conditions, weather, and road conditions.
- Manage disruptions: Recognize if a vehicle will arrive late for a customer appointment and allocate alternative vehicles if required.
- Automatically count passengers (for example, in buses).
- Schedule predictive maintenance: Predict engine failure and route the vehicle directly to the workshop.<sup>13</sup>

Recommendations: Next AI steps for companies

Although AI is already being used extensively, companies need to do more if they are to use AI at scale for competitive advantage. They should:<sup>7,8,10</sup>

- Evaluate the full range of potential use cases and invest early on in those with high benefits and low complexity. Fleet management for B2B is a good example of a high-benefit and low-complexity use case.
- Invest in AI applications within the vehicle, which have high impact on driver experience.
- Build infrastructure to use and monetize the data collected from smart sensors.

The use of AI to make vehicles intelligent requires increasing the use of sensors, cameras, and voice recognition, meaning that more and more data is being collected every day. Blockchain is one of the most important technologies for helping to process this data safely and build use cases and future offerings around it.

BLOCKCHAIN CAN BUILD TRUST AND SPEED UP TRANSACTIONS

Blockchain is becoming increasingly important in the connected vehicle sector because of the amount of data and transactions that OEMs must process. Keeping that data and transactions safe from cyber attacks is one of their biggest challenges.<sup>14,15,16</sup>

Since customers expectations’ and demands are changing, there is an increased willingness to share data, together with an increased demand for enhanced customer experience: For example, customers expect future vehicles to have their software updated over the air. There’s also a demand for rapid (and secure) financial transactions. As customers become ever more digital and connected themselves, they expect easy payments, and personalized offers regarding insurance and finance. They also expect car-sharing services to manage their contracts quickly and easily.

Blockchain (see sidebar) holds the key to meeting these expectations and demands. It can solve many current problems relating to securing vehicle data, and can make that data more reliable and trustworthy by protecting it from manipulation.<sup>16,17,18</sup>

Blockchain also enables smart contracts, which execute automatically once the parties have satisfied predefined conditions. Smart contracts could be used, for example, for ride-sharing agreements with mobility providers, helping to satisfy customer demands for easy contract management.<sup>15</sup>



Blockchain is a distributed ledger technology. It’s defined by Merriam-Webster as “a digital database containing information (such as records of financial transactions) that can be simultaneously used and shared within a large decentralized, publicly accessible network.” It was originally associated with bitcoin, the cryptocurrency.

ADDITIONAL READING





The biggest advantage of blockchain in the connected vehicle context is the decentralized storage of data, which makes the data safer because there is no single point of failure. All transactions are transparent to all participants, making them immutable and irreversible. In addition, the newest technologies facilitate near real-time transactions that are digital from end to end.<sup>17</sup>

Connected vehicle use cases for blockchain

One important use case in the connected vehicle context is the eWallet, a digital assistant within the vehicle that can automatically make payments without driver intervention. These could be payments for parking, battery charging, or tolls, for example. The associated contractual relations can be handled via smart contracts.<sup>19,20</sup>



Another important use case is the “Car CV.” Using blockchain, a vehicle’s history – distance driven, accident record, owner history, service history, and so on – can be documented in a tamperproof manner, preventing odometer fraud (for example). This will improve trust in used vehicles.<sup>21</sup>



There are many other possibilities, such as the creation of a mobility ecosystem – a digital environment for sharing data and managing transactions. Blockchain could also store driving behavior data for personalized insurance offers, as discussed in the AI section of this chapter.<sup>17</sup>

Finally, blockchain can be used to transfer connected vehicle data securely, helping to allay customer concerns about potential cyberattacks.<sup>18</sup>

Recommendations to leverage blockchain in the connected vehicle

Blockchain will play an essential role in delivering services that customers will value, and can transform products, services, and processes across the connected vehicle.

Although there is already some activity, blockchain is a topic that we believe the industry needs to take more seriously. With more connected vehicles on the road, there is the risk of more cyberattacks on vehicle, driver, and usage information, yet customer confidence and trust are vital to the future success of connected vehicles.<sup>14</sup>

We therefore recommend that companies increase their investment in this area. To create maximum value for their customers and themselves, they should invest in using blockchain:

- For transactions via smart contracts and payments using eWallets, to meet customer expectations of instant and safe transactions and payment solutions.<sup>17,22</sup>
- Around the Car CV, as it will revolutionize the used vehicle business, and also boost new sales by increasing overall trust in the brand.<sup>21</sup>





## 5G – THE KEY TO CONNECTIVITY

Connectivity of and between vehicles is a prerequisite for automotive industry progress, especially in two areas:

- Development of connected and autonomous vehicles, which depends on real-time or near real-time availability of data and information.
- Launching the next level of digital services, such as high-quality streaming of music and video, which will significantly expand the opportunities for in-car experiences.

Increasingly, V2X cellular technologies (C-V2X), and in particular 5G – being the latest cellular standard – look like the best answer to providing this connectivity. We believe that 5G, which is currently in the process of becoming available globally, has the potential to create change across the entire value chain of any industry, as Figure 3 shows. 5G is of major importance to the automotive industry – and particularly to the connected vehicle segment – because of its ability to provide fast connectivity to cloud services. However, it is important in many other areas as well.





















### There are strong reasons to focus on 5G

5G is revolutionary because it provides broadband access with low latencies, high reliability, and high bandwidth, up to several Gbit/s (possibly 100 times faster than 4G). OEMs are already exploring the possibility for product line automation within manufacturing projects such as Mercedes Factory 56 or BMW 5G plants in China – but the possibilities are much wider than currently realized. We believe it’s the enabler for a whole range of connected vehicle services that customers will value and pay for, and probably the single biggest technology enabler for connected vehicle trends.

Currently, 5G mobile networks are seen by the industry as one of two candidates for providing vehicle connectivity, the other being wireless local area networks (w-lan based). We believe there are strong advantages to choosing 5G. Technical benefits relate to speed, latency, security, and reliability – all of which contribute to the prospect of continuous coverage, an important future prerequisite – as well as the ability for partners to participate in app development via application programming interfaces (APIs). Further questioning the future relevance of WLAN in the automotive landscape, 5G

FIGURE 3

5G’S POTENTIAL TO CHANGE ANY INDUSTRY

PRIMARY ACTIVITIES	INFRASTRUCTURE			VALUE ADDED APPLICATION	
	BASIC EQUIPMENT	CONNECTIVITY & CARRIER	END DEVICE	SOFTWARE & APPLICATION	CLOUD SERVICES
DETAILS	<ul style="list-style-type: none"><li>▪ Base station</li><li>▪ Chips</li><li>▪ Machines (processors, routers)</li></ul>	<ul style="list-style-type: none"><li>▪ Network</li><li>▪ Connectivity/ device management</li></ul>	<ul style="list-style-type: none"><li>▪ Mobile phone</li><li>▪ Mobile routers</li></ul>	<ul style="list-style-type: none"><li>▪ Tools</li><li>▪ Software</li><li>▪ Application</li></ul>	<ul style="list-style-type: none"><li>▪ Cloud services</li><li>▪ Storage services</li><li>▪ Big data analytics</li></ul>
RELEVANT VENDORS (SELECTED)	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
SUPPORTING FUNCTIONS	TECHNOLOGY DEVELOPMENT				
	FORWARD LOOKING COOPERATION				

Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019



CHINA’S INVESTMENT PLANS

In January 2019, the Beijing Municipal Bureau of Economy and Information Technology published its 5G development action plan for 2019–2022. During that period, investment in 5G carriers will exceed \$724m. Although unlikely to entail a complete 5G transformation, this results in coverage for important locations.<sup>27</sup>

additionally demonstrates a much broader range of use cases, from safety-concerning incidents (collision avoidance) to over-the-air download of firmware/middleware upgrades and 4K movie streaming.<sup>23,24</sup>

At least as compelling, though, are the business reasons to adopt 5G, starting with the amount of support it’s getting from governments. For example:

- In China, planned investments (see sidebar) aim to achieve national coverage by 2023, and there is also a determination to lead on standards.
- The European Commission is targeting 5G availability in at least one major city within the EU by 2020. By 2025 the EU is planning on providing all urban areas and all major transport paths with uninterrupted 5G coverage.<sup>25</sup>

- The FCC’s 5G FAST Plan is helping to facilitate national 5G coverage in the US.<sup>26</sup>

Rollout is gathering pace

Rollout is still in the early stages, but progress is likely to be fast, with major mobile operators launching first pilots globally throughout this year and with further commercial 5G launches planned in 2020. In terms of different regions, the US will be one of the first countries to launch commercial 5G services, while the EU is still at the stage of assigning contracts to telecommunication companies (telcos). China is currently behind Europe and the US, but will lead adoption in the future.

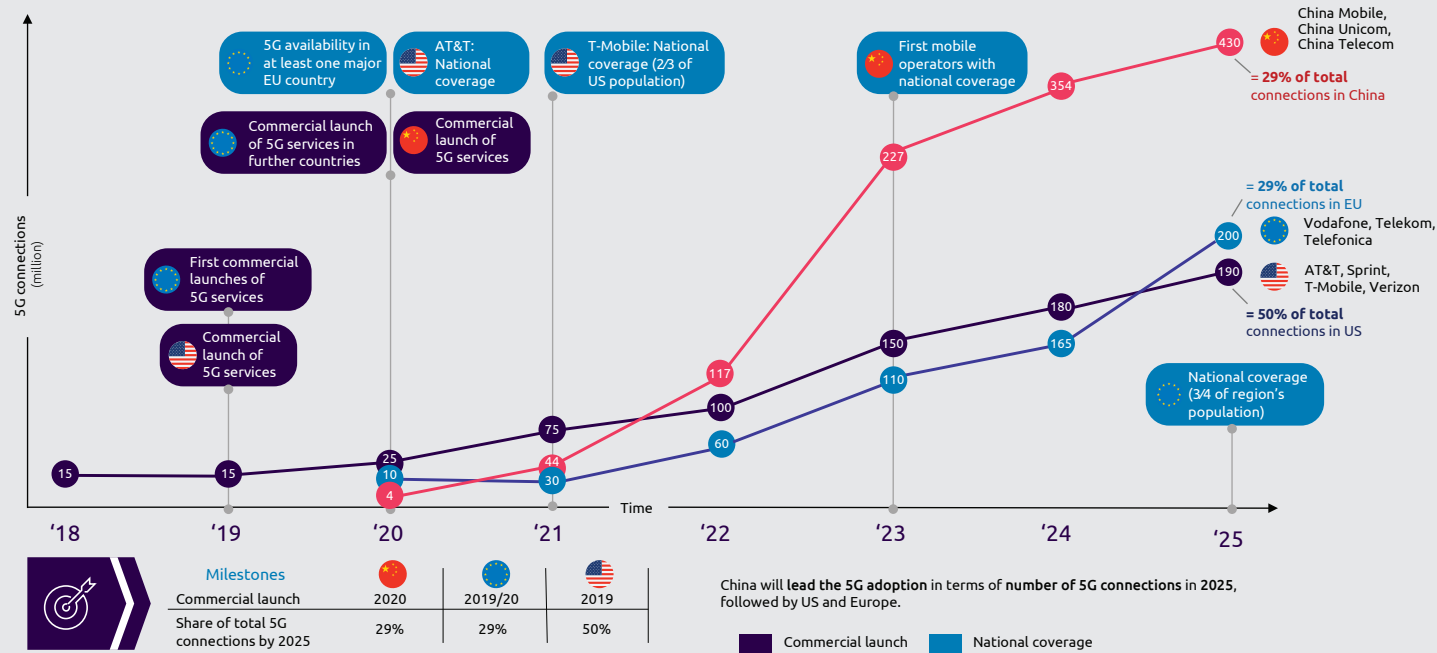
As well as availability, another indication of rising demand for 5G is the number of 5G connections between devices. And the higher the number of connections, the more feasible it becomes to exploit the technology for connected vehicles. Once again, China will take the lead: It’s expected to have 430 million 5G connections by the end of 2025, compared with 190 million in the US and 203 million in Europe.<sup>28,29,30</sup>

In all regions, it’s likely that the 5G network will be deployed initially in the cities, then on major roads, and later in the countryside. 5G can handle large numbers of users, so rolling it out in this sequence means that a high proportion of the population can receive 5G coverage as soon as possible. That said, delivering the infrastructure to the countryside will likely require more effort and investment by governments, and hence take more time.

We’ve constructed the tentative timeline (Figure 4) based on the feedback we are receiving from the marketplace.

FIGURE 4

CHINA WILL SOON LEAD 5G ADOPTION IN TERMS OF BOTH SPEED AND NUMBERS <sup>31,32,33,34</sup>



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

Industry initiatives are already showing what’s possible

Undeterred by the lack of 5G infrastructure and sometimes standards to date, the industry is forging ahead with exploration of the use of 5G for connected vehicles.

The 5G Automotive Association (5GAA) consisting of Audi, BMW, Daimler, etc., has been set up to advance the cause of 5G. Individual initiatives are taking place in most major markets. They range from Huawei and Audi’s Smart City Wuxi, which uses real-time traffic management information based on Cellular Vehicle-to-Everything (C-V2X) to help drivers optimize their behavior and test autonomous driving, through to the integration of C-V2X into vehicles by Ford Motor Company in the US starting in 2022, with a commitment by Ford to put 5G into 100% of its vehicles. Players such as Audi and SEAT are conducting 5G pilots.<sup>35, 36</sup>

There are many potential use cases for 5G in the industry, across the categories we identified at the beginning of this chapter. Here we focus on three of the most exciting use cases.

**Cloud data processing** – Autonomous driving requires real-time decision-making. Performing the underlying processing in the cloud reduces the need for in-car hardware, with valuable savings of space and weight. But that option requires real-time, low-latency V2X communication – which 5G provides. Among other initiatives in this area:

- Ford is testing a fully autonomous 5G-connected vehicle in the US.



ADDITIONAL READING  
E-car – the 20min challenge



- Baidu and DiDi Chuxing are testing 5G-based autonomous vehicles in China.
- Tests of 5G-connected driverless vehicles are being conducted in New Zealand.<sup>37-43</sup>

**4K video streaming** – With an increase in self-driving capabilities and autonomous driving, high-quality in-car entertainment becomes especially valuable; it can also help to make the most of e-vehicle charging time. 5G provides the necessary high network throughput needed to stream high-quality video to vehicles. A 5G for automotive trial in the center of Seoul has already demonstrated successful 4K video streaming from and to the vehicle – something that the trial showed 4G could not achieve. This quality of video streaming can also support additional features such as video calls from the vehicle.<sup>44</sup>



**Optimization of in-car navigation services**

– Ultra-accurate positioning and instant updates will transform in-car navigation, saving time, money, and importantly CO2 emissions, while simultaneously reducing safety hazards. Huge volumes of data collected by connected vehicles regarding current traffic, road conditions, accidents, etc., will be analyzed to compare possible routes, and drivers will be able to opt for the route with the lowest environmental impact. That analysis will be done in the cloud, with 5G again providing essential support for V2X communication. Early initiatives include:

- Real-time navigation updating developed by Hyundai with South Korean telco provider KT<sup>45</sup>
- Lane-level navigation accuracy work by Qualcomm.<sup>46</sup>



Recommendations: Act now to get the best out of 5G

If automotive companies are to succeed in the high growth markets of the US and China, they need to act now to better understand 5G, in order to derive and locate needs for actions within the automotive value chain and business models, while launching pilots, and readjusting their connectivity strategy along with related roadmaps. Our recommendations are:

- Assess key connectivity requirements and identify limitations. Organizations need to know how well their current technology portfolio would support new connected products and autonomous driving, and then must make plans to fill any gaps.
- Build 5G use cases and pilots. In order to explore the possibilities and potential use cases of 5G, the technology needs to be tested now. Challenges can be overcome by working with organizations specializing in 5G technology and infrastructure.
- Identify a 5G implementation model. Considerations will include strategic fit (private versus public network), geographic focus, capability (your ability to maintain the network), and total cost.
- Ensure your connectivity strategy is flexible. Connectivity requirements should be frequently re-examined to identify pain points and solutions. ROI depends heavily on 5G’s evolutionary path and so it’s important to monitor that path along with emerging standards, adjusting plans in line with any changes.



ADDITIONAL READING





Recommendations: Three technologies are key enablers of the connected vehicle ecosystem

In this chapter, we’ve discussed three technologies that will be key enablers of the connected vehicle ecosystem: AI, blockchain, and 5G. Figure 5 summarizes some of the most important use cases for these three technologies, grouped into five categories.

It’s often when these three technologies are combined that they achieve their full potential. For example:

- Driver experience can be enhanced tremendously through AI-powered convenient voice assistants and assisted parking and driving, blockchain purchasing services with smart contracts and eWallets on the fly, and 4k streaming of infotainment to the vehicle made possible by 5G.

- Intelligent mobility and sustainability solutions get to the next level once you combine AI-based fleet management, a blockchain-powered mobility ecosystem, and optimization of in-car navigation services based on ultra-accurate positioning and real-time updates via 5G.

The combination of technology required will be different for each use case, and so OEMs will need to

build an ecosystem of partners who can collaborate in a flexible way. Services add value through the combination of data from different sources. Much of that data will come from outside the vehicle, and may be provided by partners within a connected ecosystem – an idea that we’ll discuss in the next chapter.

Figure 6 relates the different numbered use cases to different parts of the ecosystem. Ecosystem players may include workshops; other cars, trucks, and buses; smart cities or infrastructures; one or more OEMs; and mobility providers.

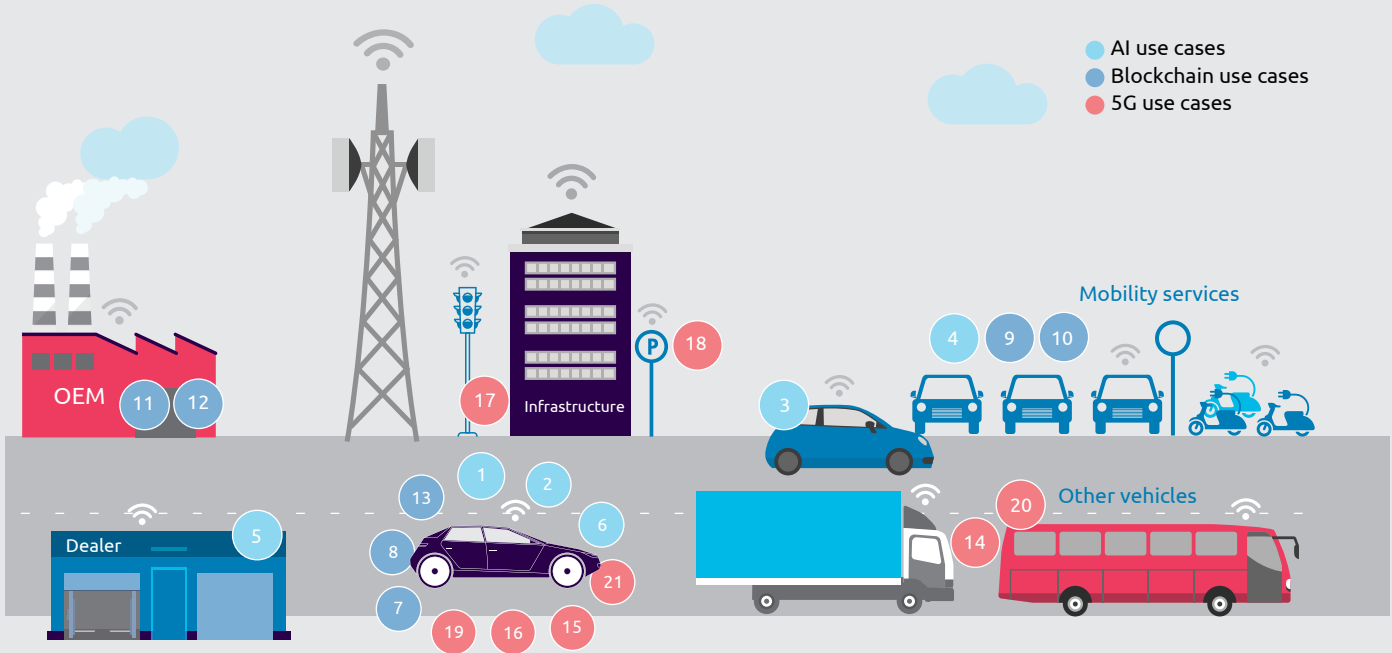
In building the ecosystem, it’s important to be aware of all the important potential partners in each area. In the next chapter, we’ll discuss some of the major players that are already in the business, and also some of the interesting new players that are coming along with innovative technologies.

FIGURE 5  
FIVE CATEGORIES OF USE CASE FOR THE THREE KEY TECHNOLOGIES

	AI	Blockchain	5G
Intelligent vehicles	Intelligent navigation 1	Telematics & V2X Communication 7	Real-time decision making 14
Driving experience & entertainment	Enhanced driver experience 2	Purchasing Services 8	4k video streaming 15
Intelligent mobility	Car sharing/ride hailing 3	Ride sharing/on demand mobility (smart contracts) 9	Remote driving 16
	Improved fleet management 4	New mobility ecosystem 10	Real-time traffic management 17
Vehicle safety	Predictive maintenance/repair 5	Trusted car 11 Cybersecurity 12	Automated traffic law enforcement 18
	Smart sensors 6	Usage-based insurance 13	AR dashboards 19
Sustainability			Platooning 20
			Connected car navigation 21

Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

FIGURE 6  
THE NEW TECHNOLOGIES ARE KEY ENABLERS FOR THE CONNECTED CAR AND ITS CONNECTED ECOSYSTEM



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

## EXCURSION: CYBERSECURITY

Connected vehicles raise multiple security concerns. On the road, they're vulnerable to hacking. A modern vehicle is effectively a data center containing 100+ interconnected servers, control units, sensors, and so on with many of the connections being wireless ones; telematics and infotainment modules may be linked to safety-relevant modules. All this connectivity provides many opportunities for hackers.<sup>46,47,48</sup>

As a leading OEM told Capgemini researchers, *"While car manufacturers are currently focusing mainly on infotainment-related connectivity, in the coming years we will see many more developments in the field of car-to-car communication and remote diagnostics. But this also means that we will be more and more vulnerable to malicious attacks."*<sup>47</sup>

Media coverage of hacks makes some customers afraid to use connected vehicles. For example, in one case a hacker accessed the GPS tracker apps of 27,000 vehicles, gaining the ability to shut down the engine of a vehicle in motion. This fear could substantially reduce the

value that customers see in connected services.<sup>48,50</sup>

OEMs need to ramp up their cybersecurity initiatives

Even though cyberattacks have already happened, few OEMs have so far established a cybersecurity agenda or structure within their organizations. Yet the growing number of end-user devices, networks, and user interfaces is increasing the attack surface, with the result that respondents to a recent Capgemini survey were often unable to cope. More than half of the companies say their cybersecurity experts are overwhelmed and 23% say they cannot investigate all identified incidents.<sup>48, 49</sup>

OEMs know they need to act. Security isn't something they can delegate to suppliers. Instead, they must take responsibility themselves, making security central to their business. OEMs that gain and fulfill customers' trust will gain competitive advantage, and will be able to grow confidently as digital enterprises.

But what exactly do they need to do? We recommend the following actions:<sup>47,48,49, 51-55</sup>

- **Develop a whole-system view.** For example, software flaws can make connected vehicles vulnerable, and so they must be detected before the software is deployed to vehicles.
- **Protect the entire fleet.** Address security in terms of each vehicle's whole lifecycle. To keep a fleet of vehicles safe until the last one is retired, it's vital that only genuine software updates are accepted.
- **Design security in from the start.** Establish security early in the construction process to ensure that the necessary resources and capabilities are available. Consider developing the security layer first, before starting on any services and software. The increasing complexity of connected vehicles will make it expensive to add security layers afterwards.

- **Harness AI.** This will lower the cost of detecting and handling breaches and make companies faster to respond, reducing possible negative effects. Using AI to identify threat patterns and new threats also reduces the time and effort required to identify, investigate, and address threats. Our AI study suggests several areas to target, such as behavioral analysis and malware detection.







# NEW PLAYERS

PROVIDING AN OPEN PLATFORM FOR THIRD PARTIES

For OEMs, gaining access to the technologies that we have just discussed is going to mean forming a range of new partnerships and collaborating in new ways. Both in order to select partners and to understand competitive threats, OEMs need to have an up-to-date view of the competitive landscape for connected vehicle services – a challenge at a time when there are many new entrants to the marketplace.

These new entrants include big, established players from six industries: automotive (tier-one suppliers), technology, energy and utilities, financial services, and increasingly, telcos and retail. Other potential players are startups. New entrants, large or small, may be not only competitors but potential partners. In this chapter, we look at both categories of new entrants and make recommendations for competing, and where appropriate, collaborating with them. We’ll argue that OEMs should seek to provide and orchestrate an open platform where third parties can develop and offer services that will be seamlessly integrated.

Big players from other industries already pose a threat

Capgemini Invent has identified six service clusters in relation to connected vehicles:

- Telematics, e.g., fleet management, virtual tachographs, emergency calling
- Remote services, e.g., remote diagnostics, over-the-air software updates, theft alerts

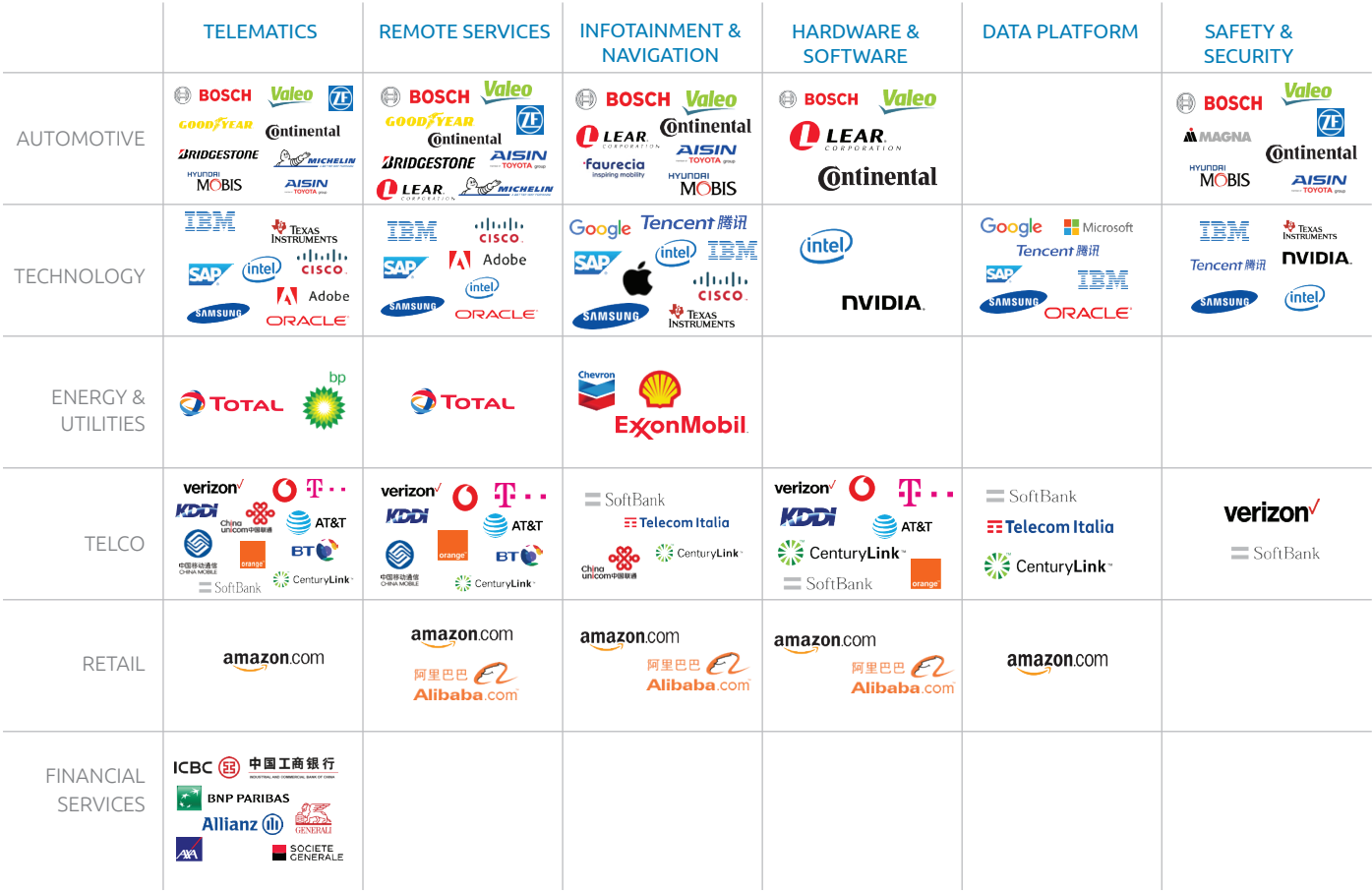
- Infotainment and navigation, e.g., music streaming, communication via instant messaging, parking lot locators
- Hardware and software, e.g., devices such as diagnostic readers, SIM cards, microchips, hardware-plus-software products
- Data platform, e.g., operating systems
- Safety and security, e.g., advanced driver assistance systems (ADAS), preventing hackers from remotely taking control of vehicles.

Figure 7 charts the activities of the top 15 players of the six industries listed above into the six service clusters. The service clusters are descending ordered by the competitive intensity which is measured by the number of active industries.

While many of the new players discussed above are tier-one suppliers to the automotive industry, other technology and telcos are heavily active in the connected services market.

It’s important to understand that all these players from other industries – particularly technology companies – are already very active in the market, and cover large parts of the value chain. They already present OEMs with a significant competitive threat in the connected vehicle market. However, the technology and telcos, in particular, are also potential partners in providing the open platform – something that OEMs cannot do by themselves.

FIGURE 7  
BIG PLAYERS FROM OTHER INDUSTRIES ARE ENTERING THE CONNECTED VEHICLE MARKET



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019



Startups getting into the connected services market

When it comes to the startups that are entering the connected services market, we’ve identified around 250 companies. OEMs are increasingly investing in these startups although their investment levels are low compared to investments by other players, such as Intel and Softbank.

We evaluated some of these startups using a funnel process. We started with the list of six service clusters already used for the big players, together with a longlist of connected vehicle startups selected by our Capgemini Research Institute from a range of industry sources, including the Crunchbase business information database.

We assigned the startups on the longlist to the clusters and then selected the most promising ones in each cluster using several selection criteria, including the Crunchbase ratings, funding levels, and references from big players. Of the six clusters, we found that safety and security accounts for the largest share of the startups studied, followed by data platforms, then hardware and software, telematics, and remote services. Figure 8 shows some of the key startups in each cluster.

For each cluster, we analyzed startup roles within the value chain to produce a business model, an example of which is shown in Figure 9. This example shows the roles of specialist providers of technology and solutions for OEMs, data matching platforms, and providers of customer solutions.

**Technology solution providers to OEMs** apply expertise in specific fields and in innovative technologies such as AI, collecting data through sensors or GPS, etc. For example, SenseTime is an artificial intelligence company specializing in deep learning technologies and innovative computer vision. Their face-recognition technology can be used for picture and payment analysis.<sup>56</sup>

**Data-matching platforms (B2B)** combine data sources (e.g., telematics service providers, smart mobility providers) to provide advanced analytics such as personalization, prediction, and location-based services for insurance, finance leasing, traffic, mapping, etc. Wejo, for example, provides a cloud-based automotive data exchange platform to share and access connected car data. Their insights and data are designed to drive innovation across several marketplaces.<sup>57</sup>

**B2B/B2C solution providers** offer end-customers solutions for specific use cases (e.g., devices to make vehicles smart and connected), though they may also monetize the data gathered through sharing with insurers, fleet managers, and other service providers. WayRay, for example, provides directions and points of interest for drivers by superimposing augmented reality images on vehicle windshields.<sup>58</sup>

FIGURE 8

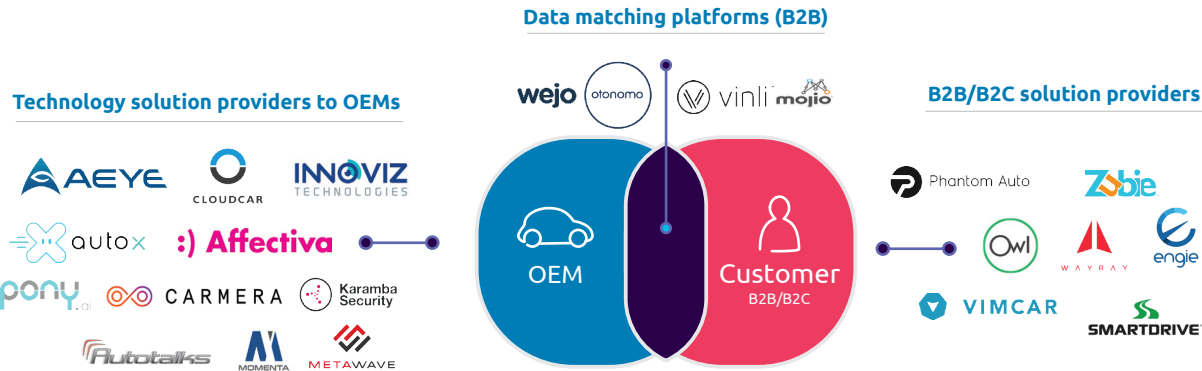
KEY STARTUPS BY CLUSTER



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

FIGURE 9

STARTUPS ROLES WITHIN THE VALUE CHAIN



Source: Capgemini Invent, Connected Vehicle Trend Radar, Issue 1.2019

### The need for collaboration

To select the right partners, it's valuable to keep an eye on the most successful entrants. When it comes to startups, it's worth looking to see who the best-funded player in each sector is. Applying that approach in three of our clusters points to three very interesting companies:

- Telematics: Vimcar – A digital vehicle logbook uses an on-board device to gather trip data which is then stored in the cloud.<sup>59</sup>
- Remote Services: Phantom Auto – Teleoperations technology enables remote operation and monitoring of autonomous vehicles.<sup>60</sup>
- Hardware and software: Innoviz Technologies – Sensors and perception software help to create smart 3D sensing, mapping, and other enablers of autonomous driving.<sup>61</sup>

### Recommendations: Collaboration is the key to success

Collaborating with the right partners – big players, startups, and other OEMs – will be critical for success with connected vehicles. Companies need to appreciate that they're already facing strong competition in this market from a wide range of new entrants, particularly major players from the technology industry. Therefore, they should:

- Create their own unique ecosystem and use complementary strengths of other players to jointly develop the best possible customer experience and value proposition.
- Use partnerships to master the technologies needed to meet future customer requirements. Particularly in the crucial technology areas, such as AI or blockchain, companies need to partner with specialist startups.
- Together with strong technology partners, provide, orchestrate, and act as gatekeeper for an open innovation platform where third parties can grow the service portfolio, creating an ecosystem where new services can be integrated seamlessly and fast.
- Consider entering alliances with competitors to innovate more effectively and share the costs.

The question isn't whether to partner – it's when, with whom, and how. And this isn't a one-off decision. As more and more new players enter the market, it will be vital to keep updating the company's knowledge of the competitive landscape and adjust the ecosystem accordingly.







# OUR RECOMMENDATIONS

## FOR CONNECTED VEHICLE SUCCESS

Our key recommendations to automotive companies are based on the information presented in this Trend Radar and on our other research and discussions with clients and industry experts, both inside and outside Capgemini.

### Make China the epicenter of your digital services revolution

China is the future. It has the highest growth rates for connected vehicle adoption, the largest number of digital customers, the most up-to-date pilot projects, and the most heavily funded startups using the most innovative technologies. Start your digital service journey – from test to implementation – in China and then expand your activities globally.

### Realize that customers will only use services that are relevant and add value

It's not enough to offer brilliant standalone services with a strong business case. You also need to combine data to create relevant and value-adding services. Then you need to scale these services fast, within a connected, secure, and intelligent ecosystem, so that you can reach a critical mass of customers.

### Provide and orchestrate an open platform for third parties – and think beyond it

An important element of future mobility is an open service platform, managed by automotive companies in cooperation with strong technology partners. The owner of the platform will act as gatekeeper, deciding which services should be included and seamlessly integrating those services, including third-party ones. This is about much more than maintaining your own digital ecosystem – it's about claiming a central position in your customers' lives.

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