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Connected Cars

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Introduction

The world is getting hyper-connected. Many factors are fueling this, such as the Internet, wired and wireless network connectivity and quality reaching far corners of the world, ubiquity of smartphones, as well as the emergence of Internet of Things. With such breakthrough advancements in technology along with societal demand, transportation is on the verge of a major transformation. Major technology players along with auto manufacturers are taking note. In a recent interview with the Wall Street Journal, Apple CEO Tim Cook stated that the auto industry is in for a “massive change” with software becoming “an increasingly important part of the car of the future.”¹ Connected cars are a key result of this industry disruption, and will become mainstream globally by 2025.

What is a Connected Car?

Connected cars have tremendous potential. Already some manufacturers offer drivers convenience services like emergency dispatch, concierge, connected maps, and Internet radio. More recently, Tesla Motors introduced semi-autonomous driving capabilities in their vehicles. It's easy to get wrapped up in the benefits, but it's important to define what makes a car connected to begin with. Simply put, a car needs a way to talk to the outside world. While there are numerous technologies distributed throughout the car, the telematics control unit is the core component in vehicles that enables the car to connect.

There are three primary integrations of connected systems: embedded, tethered, and smartphone. Embedded systems contain the hardware and software along with a SIM card; the automobile has everything equipped in order to connect, such as General Motors' OnStar system. A tethered system is similar to an embedded system, except that it lacks a SIM card and relies on the driver or passenger to provide one, typically with their cellular phone; Mercedes mBrace is an example of such a system. Finally, a smartphone system (also known

¹Claire Groden, *Tim Cook: The car industry is in for a 'massive change'*, Fortune, <http://fortune.com/2015/10/20/tim-cook-auto-industry-cars-apple/>

as integrated) is one that relies on the driver's smartphone to leverage or mirror its services and applications. As of 2015, MirrorLink is the dominant player offering auto manufacturers a smartphone connected solution, however this is expected to change over time with entrants into the market by Apple and Google.² Yet another channel of connectivity is via Onboard Diagnostics (OBD); new cars are getting equipped with standard OBD ports that allow drivers to plug-in modules to rapidly diagnose malfunctions by accessing the vehicle's instrumentated data.

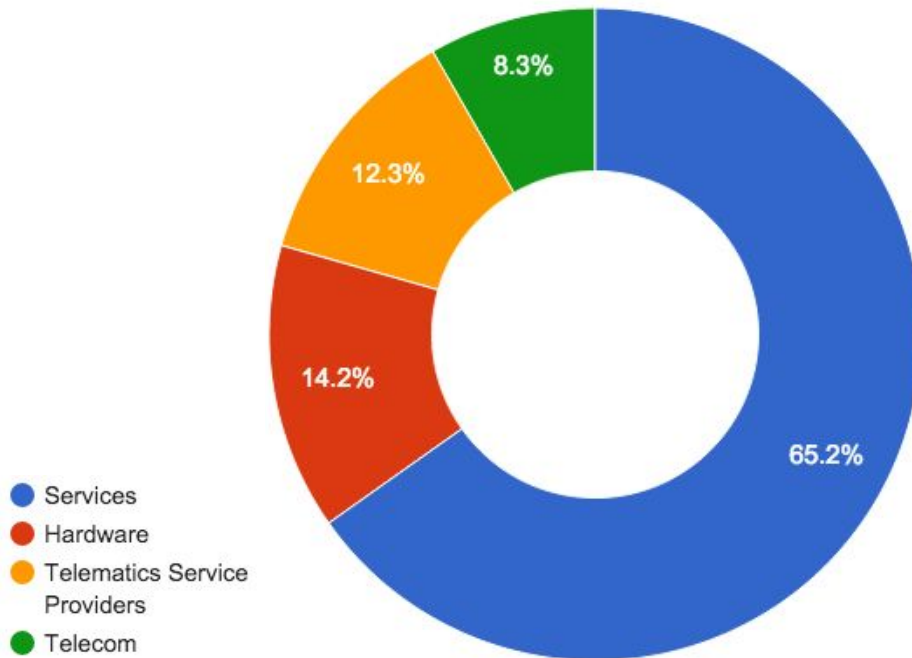
Landscape Today

For 2015, the Groupe Speciale Mobile Association (GSMA) expects more than 50% of vehicles sold worldwide to be connected, and revenues from the connected car market to reach \$27.8 billion dollars.³ Today's market is comprised of connected services, telematics service providers, telecom providers, and hardware manufacturers. Services expect to cash in the most garnering over 65% of the market; examples of services include traffic guidance, call center support, infotainment, and many more. Telematics services provide data from the car for customer relationship management, including dealers and insurance providers. Dealers can proactively notify drivers of vehicle health issues and remotely diagnose issues; insurance companies can offer lower-cost policies based on driving use. Telematics services also include fleet management to extend vehicle safety and diagnostics services to benefit rental car companies, municipal buses, taxis, and trucks. The hardware segment includes connected service platforms like MirrorLink, Apple CarPlay, and Android Auto. Finally, telecom providers such as AT&T and Telefonica play a key role in the market as they provide the data connectivity and network quality to host car communication.

²IHS Automotive Identifies Consumer Trends for Apps and Technology in New Vehicles, according to New Global Report,

<http://press.ihs.com/press-release/automotive/ihs-automotive-identifies-consumer-trends-apps-and-technology-new-vehicles->

³GSMA, Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years, http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl_ma_forecast_06_13.pdf



Source: GSMA, [Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years](#)

Technology

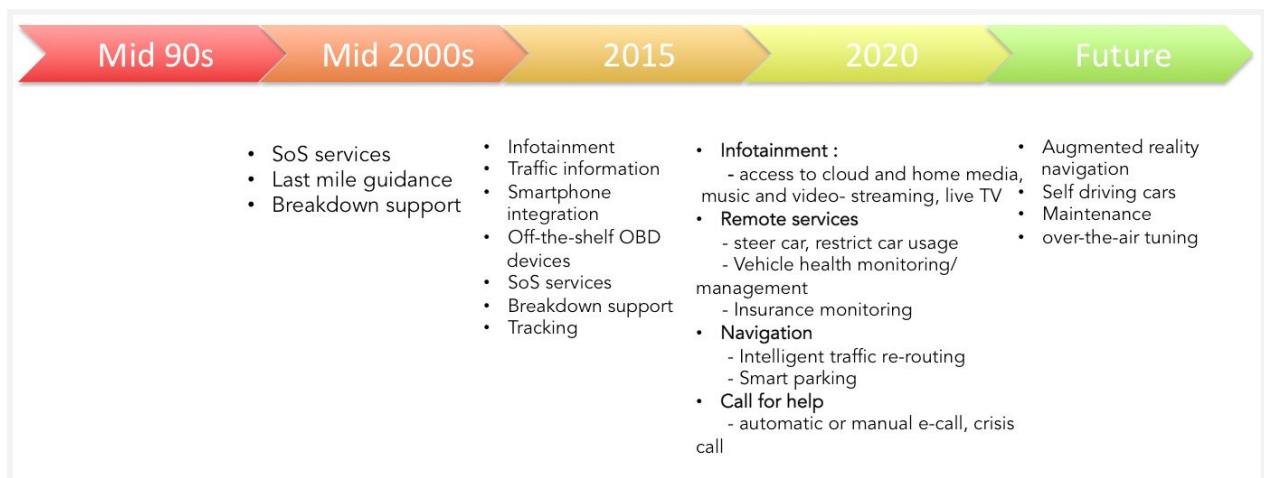
Today's car has the computing power of 20 modern PCs, features about 100 million lines of code, and processes up to 25 gigabytes of data per hour⁴. As the computing capacity of cars develops further, not only is programming becoming more complex and processing speed getting faster, but also the entire nature of the technology is shifting. While automotive digital technology once focused on optimizing the vehicle's internal functions, the computing evolution is now developing the car's ability to digitally connect with the outside world and enhance the in-car experience. This is the connected car – a vehicle able to optimize its own operation and maintenance as well as the convenience and comfort of its passengers using onboard sensors and internet connectivity.

⁴Cisco Internet Business Solutions Group (IBSG) - http://www.cisco.com/web/about/ac79/docs/mfg/Connected-Vehicles_Exec_Summary.pdf

As the car's overall lifecycle value is likely to remain constant, the perceived value of the cars will be determined by in-car experience that a new generation car provides. From current Internet-based infotainment systems to more advanced driver assistance systems in the medium term and ultimately to fully autonomous driving, the trajectory of the technology-enabled car points to even greater connectivity.

Starting from the modern era [90s] of automobiles, cars have evolved to a great extent from being purely mechanical machines to more digitally integrated systems. In the mid 90s to 2000s, cars evolved in styling and luxury; the value of cars was associated to those features. Beyond 2000, when the Very large Scale Integration[VLSI] technology became extremely efficient, car manufacturers started adding intelligence to the car. This was the start of a new wave.

Evolution of Car Connectivity and User Perceived Value



According to the McKinsey Connected Car Consumer Survey 2014⁵, car connectivity features are becoming a critical purchasing factor for more than half of new car buyers. 28 percent of new car buyers prioritize car connectivity features over other features such as engine power

⁵ McKinsey Connected Car Consumer Survey 2014, http://www.mckinsey.com/insights/manufacturing/whats_driving_the_connected_car

or fuel efficiency, while 13 percent would not buy a car that is not connected to the Internet today.

In-Car Content and Services

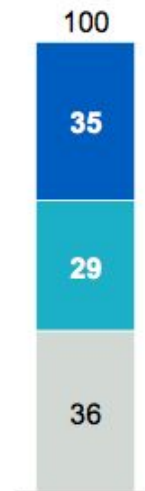
In-car services include seamless delivery of various content forms at any time. Today, this mostly comprises navigation systems, smartphone integration, and entertainment, but the functionality is expected to advance over the next few years. For example, Bluetooth connectivity currently makes for easier in-car voice conversations via smartphone. In the near future, smartphone apps will be more fully integrated, allowing drivers to have the day's scheduled events in their smartphone calendars displayed on the on-board display. Cars will link user data such as calendar entries with other relevant information. For example, navigation systems will be able to automatically set a destination based on the address associated with the next appointment in the driver's calendar. Moreover, navigation systems that currently provide basic routing will likely predict traffic soon. Augmented reality will take navigation services even further by overlaying real- world images with digital information at the appropriate place in the driver's field of vision, providing additional traffic information, including alerting the driver to imminent hazards.

Percent of new-car buyers, n (overall) = 1,917

Statement: I am willing to pay for connected services in my car in a subscription-based model



Statement: I would pay an extra USD 100 for a new car if it offered a standardized mount for connectivity devices



SOURCE: McKinsey's Connected Car Consumer Survey 2014

Vehicle Relationship Management (VRM)

Drivers are offered double the value⁶ of additional monitored security with remote services and active maintenance through continuous monitoring. Remote services today allow drivers to lock and unlock their cars, but by 2020 GPS tracking and customized usage restriction could become standard remote VRM services. Current maintenance services include alerts when mechanical problems arise, while more connected service of the future will likely offer an “over-the-air” tune-up as needed.

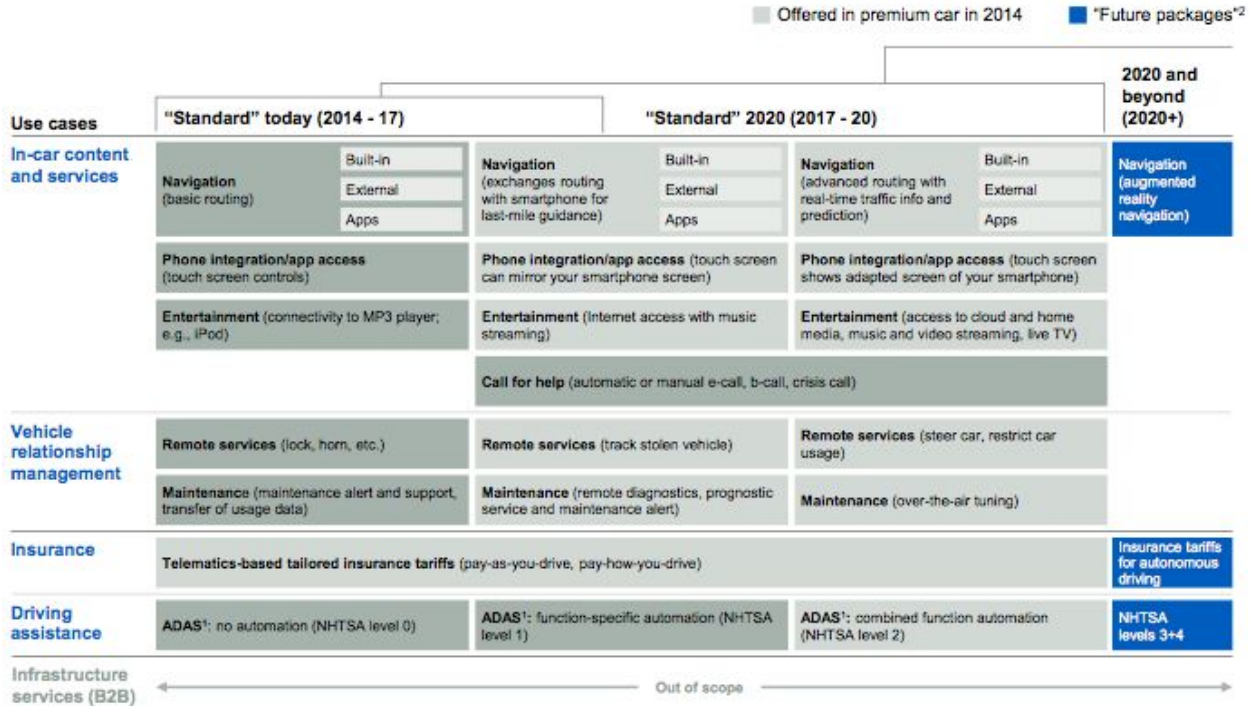
The number of connected features on cars is growing and in line with consumers' expectations. As the five to seven-year development cycle with cars is much longer than it is in the often less than two-year software development cycle, connected car innovations are

⁶ Connected car, automotive value chain unbound :

http://www.sas.com/images/landingpage/docs/3_McKinsey_John_Newman_Connected_Car_Report.pdf

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usually introduced step by step, often fueled by developments outside of the car industry. Thus, the proliferation of the connected car will happen steadily over time.



1 Advanced driver assistance systems
 2 Advanced/future packages include all features of less advanced packages
 SOURCE: McKinsey

Insurance

Data regarding driving behavior is already stored onboard the vehicle to some extent, but greater connectivity will create an immediate feedback loop giving select third parties access to data such as driving speed, route, and time. This will significantly reduce the hurdle to offer telematics-based tailored tariffs like “pay-as-you-drive” and “pay-how-you-drive.” Already today, despite the need to install an external device in the car, telematics car insurance has started to gain a foothold especially in the United States.

Driving Assistance

Advanced driver assistance systems[ADAS] today is making driving safer and more convenient with features such as blind spot object and pedestrian detection, lane assist, active city safety, active cruise control radar, collision warning with full auto brake, and active park assistance. These options are expected to become increasingly standard over the next six years. ADAS's longer-term evolution is predicted to be autonomous driving.

By removing human error from the equation, fully autonomous driving promises nearly 100 percent safety and greater commuting efficiency, allowing the person in the driver's seat to do whatever a passenger may want to do, including working, reading, watching video, or sleeping. Ultimately, autonomous driving will allow for the entire redesign of the human-machine interface (HMI) and interior layout of the car.

Societal Benefits

Hands-free driving, vehicle to internet and vehicle to vehicle communication capabilities provided by connected cars lead to a number of benefits to the society at large. National Highway Traffic Safety Administration (NHTSA) has also recognized these benefits and states in their website⁷ that "vehicle-to-vehicle (V2V) communication technology shows great promise in transforming the way Americans travel. Using V2V technology, vehicles ranging from cars to trucks and buses to trains could one day be able to communicate important safety and mobility information to one another that can help save lives, prevent injuries, ease traffic congestion, and improve the environment."

In this section, we will discuss these benefits.

Increased Safety and fewer accidents

⁷ NHTSA Safer car web site - <http://www.safercar.gov/v2v/index.html>

In US, in 2013, 3,154 were killed in distracted driving crashes.⁸ Connected cars provide inherent hands-free driving capabilities, which reduce driver distraction. New driver assistance and safety systems can park the car autonomously, maintain a safe distance between cars at highway speeds, and warn drivers of hazards ahead.

Just recently, Tesla Motors introduced semi-autonomous driving capabilities in their vehicles as it already benefiting drivers by avoiding accidents. A potentially fatal incident was witnessed by one driver's dashboard camera that recorded the scene on a pitch dark and wet early morning in Seattle. The driver had Autopilot mode engaged on his Tesla Model S and didn't have time to manually react when the car suddenly stopped to avoid a head-on collision with another vehicle that cut him off with a sharp U-turn.⁹ Since Tesla cars are connected to each other and as one vehicle learns from its driver, that feeds the collective network intelligence of the fleet week over week. The system's driving algorithm improves week over week.¹⁰

The picture below from [Global Automakers](#) shows the connected car technologies that will help with safety in the future.

⁸ Official U.S. Government Website for Distracted Drivers -

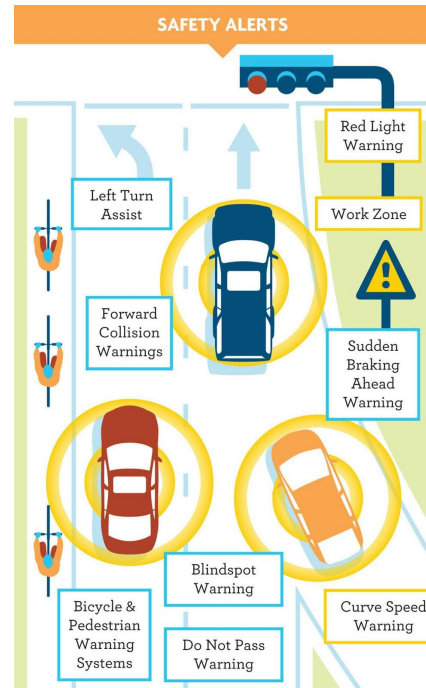
<http://www.distraction.gov/stats-research-laws/facts-and-statistics.html>

⁹Jen Wieczner, *Watch Tesla's autopilot stop an Uber driver's head-on collision*, Fortune,

<http://fortune.com/2015/10/29/tesla-autopilot-uber-crash/>

¹⁰Fred Lambert, *Tesla reveals all the details of its 'Autopilot' and its software v7.0*, electrek,

<http://electrek.co/2015/10/14/tesla-reveals-all-the-details-of-its-autopilot-and-its-software-v7-0-slide-presentation-and-audio-conference/>



Reduced Traffic Congestion and CO₂ Emissions

Connected vehicles are becoming information hubs that generate, process, send and receive vast amounts of data while on the move. Connected cars send information about their locations and velocities and this data can be used to make roadways more efficient by re-routing cars in real time to less congested routes, or timing traffic lights to interrupt the flow of traffic as little as possible. Globally, we waste more than 90 billion hours in traffic jams, generating 220 million metric tons of carbon equivalent and wasting at least \$1 trillion, or 2 percent, of the global gross domestic product (GDP)¹¹

Connected cars wouldn't waste gas idling in traffic or circling for parking spots. Instead, they would be re-routed to traffic-less routes and communicate with parking spots ahead of time to

¹¹ Cisco Internet Business Solutions Group (IBSG) - http://www.cisco.com/web/about/ac79/docs/mfg/Connected-Vehicles_Exec_Summary.pdf

find an open spot. This increased mobility could also increase fuel efficiency and reduce CO₂ emissions.

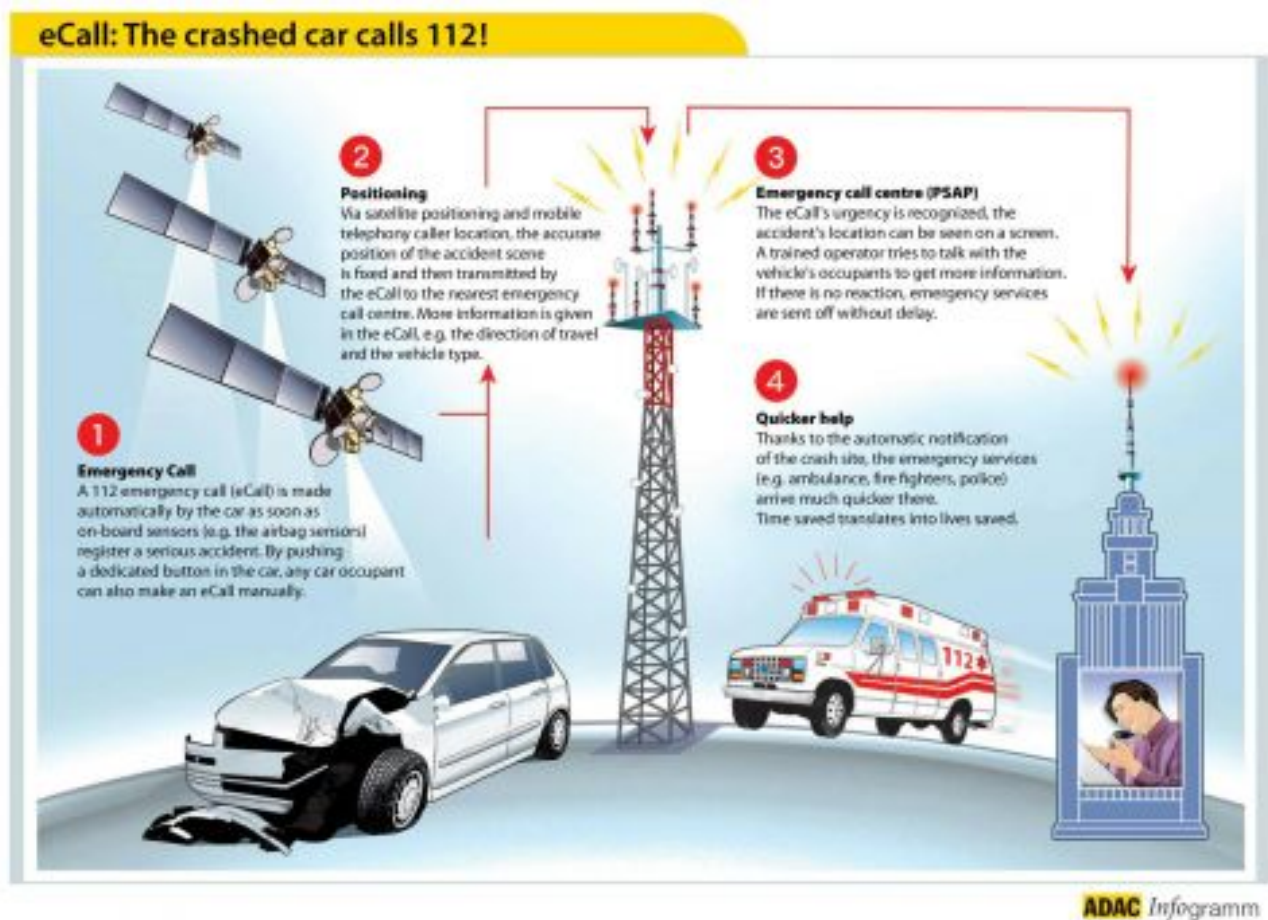
Faster Emergency Response and Increased Efficiency of Road Operators

As noted in the [Intelligent Transportation Systems](#)¹² article, connected cars will enhance the abilities of road operators and the emergency services. Intelligent Transport Systems will be able to pinpoint an accident, help determine the extent of injuries sustained, direct emergency vehicles to the accident site more quickly and find the best route to hospitals, allowing the flow of traffic to return to normal conditions more quickly.

This particular advantage is already being recognized by the European Union. Recently, European parliament has voted in favour of eCall regulation which requires all new cars be equipped with eCall technology from April 2018¹³. In case of a crash, an eCall-equipped car automatically calls the nearest emergency centre. Even if no passenger is able to speak, e.g. due to injuries, a 'Minimum Set of Data' is sent, which includes the exact location of the crash site. Shortly after the accident, emergency services therefore know that there has been an accident, and where exactly. The picture below describes how eCall would work in case of an accident.

¹² Intelligent Transportation Systems - <http://www.intellimec.com/intelligent-transportation-systems-next-wave-connected-car/>

¹³ European Commission site on eCall - <http://ec.europa.eu/digital-agenda/en/ecall-time-saved-lives-saved>



Source: [European Commission site on eCall](#)

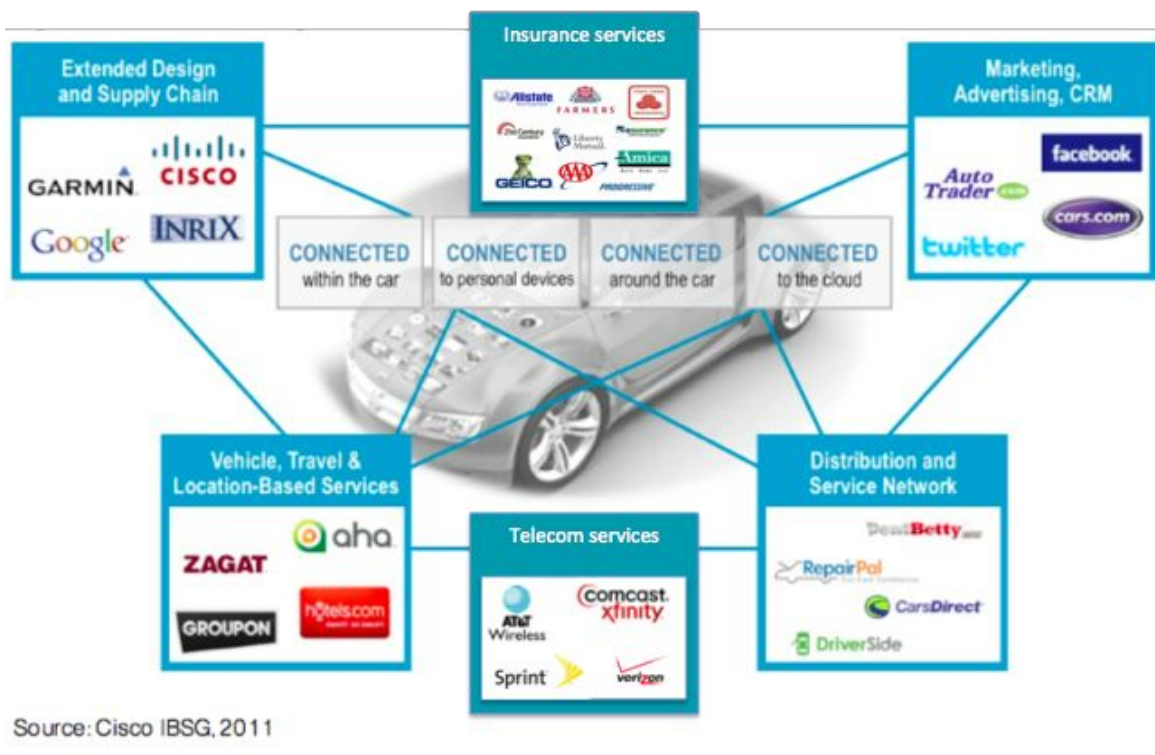
Future Value Chain

Today, the value system of personal mobility is being challenged by a new generation of drivers that cherishes social media and technology more than a car. This is scary news for an industry whose products have typically represented the second-largest expense (after home purchases) for an average household over the last century.

It is no longer enough to sell personal transportation; people want a personalized driving experience that keeps them connected to everything that is important to them — friends,

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information, music, maps, schedules, and more. Connected cars could do for the automotive industry what smartphones have done for the phone industry. By integrating smartphone capabilities into vehicle ergonomics with an intuitive, voice-controlled user interface, automakers will not only enhance the in-vehicle experience but also will promote a hands-free approach that reduces the risks of driver distraction. Future cars will augment our driving capabilities and make our travel experience safer and more convenient. While enroute, cars will proactively propose to visit friends nearby, restaurants with special lunchtime deals, hotels at nighttime, and alternate options to use time more productively when congestion is unavoidable. Ubiquitous vehicle connectivity not only allows automakers to ride the wave of smart mobile technology but also enables a fundamental strategy shift from merely building cars to selling personal travel time well-spent. It is not enough to merely connect vehicles to the Internet. To provide the full benefits of vehicle connectivity, the automotive industry needs to connect the extended value chain.



Some of the major areas of added value from vehicle connectivity include:

- **Connected vehicle care:** By providing a direct link to vehicles and their owners, automakers can offer remote vehicle health monitoring, maintenance, and customer services.
- **Business-to-business (B2B)** or business-to-government (B2G) service platforms can deliver access, data, customer relationship management, and payment services for a captive audience, offering a multitude of opportunities for new business models.
- **Third-generation navigation and location-based services (LBS)** provide real-time traffic guidance, eco-routing, and driver support through an integrated service interface.
- **Connected safety and security** enables monitoring of speed and drive time to enhance safety for inexperienced drivers and to facilitate “pay how you drive” insurance models. Integrating advanced driver assist systems with vehicle-to-vehicle (V2V) and vehicle to-infrastructure (V2I) communication has the potential to prevent 80 percent of reported crashes, according to National Highway Traffic Safety Administration
- **Usage and behaviour** based insurance will gain popularity. An increasing number of insurance companies have started to track mileage to better calibrate premiums with driver risk, and to offer “pay as you drive” (PAYD) policies. The next frontier will be “pay how you drive” (PHYD) models that correlate driver behavior with driver risk.
- **Connectivity** will also enable innovative, new business models. It will offer the flexibility to move from rigid, bundled packages to services on-demand, and will also allow completely new pricing models such as micropayments on a per-feature, per-use, per-mile, or per-minute basis. For example, vehicle connectivity will accelerate penetration of new business models for car sharing and on-demand driving pioneered by companies like Zipcar, iCarpool, CarBuddy, Zingo Taxi, and car2go¹⁴.
- **Telecom services** needs to enhance their capabilities with advanced connectivity to support this transitional market. Ultimately, vehicles will need to connect via multiple

¹⁴ Cisco Internet Business Solutions Group (IBSG) - http://www.cisco.com/web/about/ac79/docs/mfg/Connected-Vehicles_Exec_Summary.pdf

complementary technologies, including 3G/4G/5G, LTE, WLAN, Wi-Fi, and Dedicated Short Range Communication (DSRC). Connected cars might actually unleash the next wave of growth for mobile operators. 36 million cars with pre-installed SIM cards are estimated to be sold worldwide in 2018¹⁵. SBD research projects a potential revenue opportunity of EUR 4 billion for telecoms players globally as a consequence of this automotive-telecoms convergence.

Barriers

As seen from the previous sections, connected cars have a bright future, but the road ahead has some hurdles too. In this section, we will discuss these hurdles.

Hacking

Recent Wired news article¹⁶ reports that a few hackers were able to control a Jeep Cherokee by hacking and sending commands through the Jeep's entertainment system to its dashboard functions, steering, brakes, and transmission. This attack has signaled legislators to start setting new digital security standards for cars and trucks. This security risk will be a barrier to the connected car industry as it will take time to come up with the technology standards and implement them. If an acceptable solution is not proposed soon, it will raise public fear and reduce adoption of connected features in the car.

Automotive and Technology Industries - Contrasting Heritages

The success of the Connected Car requires technology companies and automotive OEMs to work in harmony. However, the two have radically different heritages and different approaches.

¹⁵ Connected car connects automotive and telecoms:

<http://www.rcrwireless.com/20150507/europe/emea-connected-car-connects-automotive-and-telecoms-tag11>

¹⁶ Wired news article on hacking, <http://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/>

Development Methodologies

Automotive companies have well-established supply chains and long development cycles (5-10 years). Technology companies are more agile and provide new features and operating system upgrades almost constantly to the device. This difference in development cycles leads to complicated dynamics in the development of a connected car.

Global versus Regional

The structures of automotive and technology sectors are very different. The auto industry is basically global in nature with virtually all automotive OEMs selling in almost every country. The mobile industry, by contrast, is still evolving from a national focus (often based on issued licenses) to a more global approach. All mobile network providers can nominally serve any device in any country in the world through roaming or the slightly more sophisticated MCC-901 global SIM. This was acceptable for roaming handset users, but is not sufficient for the demands of the Connected Car. Existing roaming rates are simply incompatible with the high-bandwidth applications envisaged for the Connected Car. Furthermore, in some countries (Brazil, China, India and much of the Middle East) the use of permanent roaming SIMs is prohibited for a variety of reasons¹⁷.

Coping with Network Technology Upgrades

One of the major challenges with built-in connectivity in cars is future-proofing the radio access network (RAN) technology. Automotive OEMs do not want to rely on a technology that may be switched off. Mobile network providers are increasingly indulging in 'refarming', for instance switching spectrum to a higher bandwidth technology (typically moving from 2G or 3G to LTE). There is no simple solution for this problem¹⁸.

Uncertain Economics for Car Manufacturers

¹⁷ Telefonica Digital report, <http://en.blogthinkbig.com/connected-car-report-2014/>

¹⁸ Telefonica Digital report, <http://en.blogthinkbig.com/connected-car-report-2014/#>

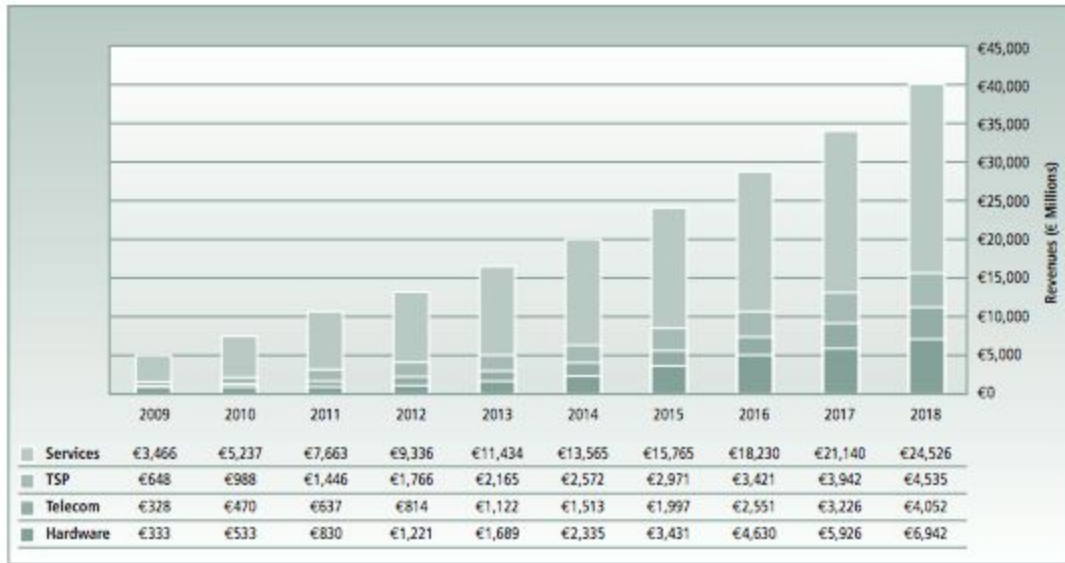
Automotive companies use a transaction-based business model based on one-time car sales. It is unclear how car manufacturers can reap the rewards of the connected car. Building a connected car is necessary to stay competitive and avoid price dilution, but will not boost overall vehicle selling prices — at least not in the way new product features have in the past¹⁹. Many automakers are examining how to make money on connected car features. They need to consider offering subscription-based business models including bundling of services with other service providers. Most of the value-added services will be offered as apps to the driver. Car manufacturers will need to evaluate if they should invest in their own app ecosystems or participate in well-established app ecosystems like Apple and Google.

The Road Ahead

As of 2015, the global connected car market is still in its infancy though is getting rapid traction and has a promising future. Despite the unpredictability of emerging innovation reaching maturity, we expect some winners and losers over the next 10 years.

As the market is expected to grow dramatically, all segments will benefit from increased revenues. The GSMA and SBD organizations forecast each segment to generally to maintain their market share proportionally over time. Services in particular will continue to dominate revenues as they get more adopted and some become ubiquitous.

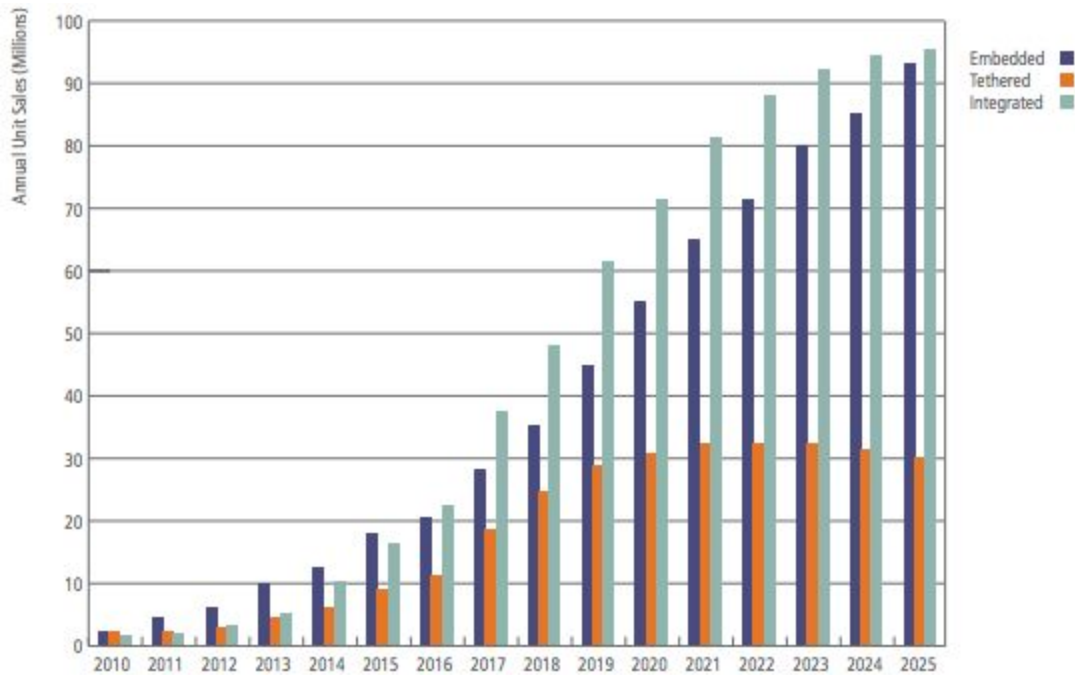
¹⁹ PWC study on connected cars, <http://www.strategyand.pwc.com/global/home/what-we-think/reports-white-papers/article-display/connected-car-2015-study>



Source: GSMA and SBD, [2025 Every Car Connected: Forecasting the Growth and Opportunity](#)

Over the coming years, connected car integration types will experience varied growth. Embedded forms are expected to become prevalent. Smartphone (or integrated) forms will also be popular, though as software becomes increasingly cloud-driven, that could reduce the need for this form of integration in the long term; meanwhile, in just 5 years Apple CarPlay is expected to be in 37 million cars, Android Auto in 31 million, and MirrorLink in 17 million.²⁰ Tethered, however, is expected to lose out to the other forms and flatten out.

²⁰ IHS Automotive Identifies Consumer Trends for Apps and Technology in New Vehicles, according to New Global Report, <http://press.ihs.com/press-release/automotive/ihs-automotive-identifies-consumer-trends-apps-and-technology-new-vehicles->



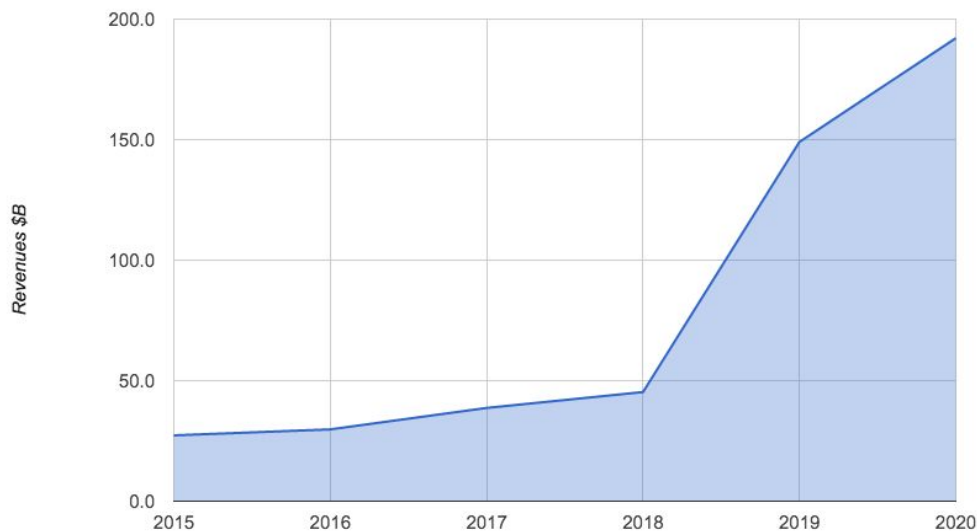
Source: GSMA and SBD, [2025 Every Car Connected: Forecasting the Growth and Opportunity](#)

Traditional automobile manufacturers will tap into the connected market but will face numerous challenges to figure out if and how they can offer valuable subscription services as well as partner or compete with technology companies offering a mature software ecosystem. It is ironic that the companies that create connected cars to meet customer or legislative demand may not be able to benefit the most financially from the connected car market. In fact, car makers themselves are already being disrupted by new entrants to their field, as the barrier to entry has dramatically changed. Tesla entered the market as a startup, Google is publicly testing a self-driving car, and rumors are abound of Apple and Uber each working on their own self-driving car. As the value of a consumer car will include the connected services it offers, Google and Apple as car makers would own the entire chain of hardware and software to offer drivers new differentiated services.

Car connectivity based solutions are gaining traction in the market and the forecast to grow rapidly over the next ten years as a reflection of the growing importance of smartphones and

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apps. It is expected that within a decade the fitment of these solutions on new passenger cars will approach 100% by 2020 in markets such as USA.²¹ With the European Union²² mandating connectedness for safety, improved environmental standards and communications, this market will see a steep upward curve in investments and revenues starting 2018.



Sources: [GSMA](#), [PR News](#), [McKinsey & Co.](#)

Despite any challenges and risks, ultimately everyone wins. Society will benefit from increased safety as that is the “killer app” in connected cars, increased driving efficiency, cheaper insurance, increased fuel efficiency, and of course a vast range of convenience services. As every new car in 2025 will be connected in multiple ways²³, the road ahead looks bright with innovation.

²¹ GSMA and SBD, *2025 Every Car Connected: Forecasting the Growth and Opportunity*, <http://www.gsma.com/connectedliving/wp-content/uploads/2012/03/gsma2025everycarconnected.pdf>

²² Europe's Connected Cars - market analysis, <https://www.whatech.com/market-research/transport/106309-research-report-explores-europe-s-connected-cars-market-analysis-segments-growth-and-value-chain-2014-2020>

²³ GSMA, *Connected Car Forecast: Global Connected Car Market to Grow Threefold Within Five Years*, http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl_ma_forecast_06_13.pdf