What we are expecting from this presentation:

A We want to inform you on the most important highlights from this topic

B We need you to take the time to explore the presentation carefully and with a critical mind

C We would like you to write down every comment or idea that emerges while reading this presentation

D We exhort you to share with us a constructive feedback for further improvements

E We invite you to dialog with us if you have any doubt or want to dive into some specific aspects

Connected Vehicles

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Content

- Connectivity as strong differentiation in the automotive industry
- Connected vehicles definition and product categories
- The Vehicle-to-Vehicle and Vehicle-to-Infrastructure communication opportunities
- Top OEM players on services offered through native systems
- Expected market growth & total production projection by 2020
- Tier 1 suppliers portfolio and partnerships
- Aftermarket players entering the connected ecosystem
- Cybersecurity as a potential roadblock to connected vehicles
- Design times and upgradability challenges for vehicles manufacturers
- Evolution phases for connected vehicles
- Takeaways and conclusions

Digitalization is crucial, anything not connected to the Internet will soon become a commodity. Connectivity is working as a potential differentiator among industries, automotive is no different

Connectivity Penetration

Over the last years, many companies witnessed revolutionary shifts on their industries due to disruption of traditional business models

- Companies need to establish some differentiators between their products and the intense competition
- Some industries are already being disrupted by connectivity, they have developed new business models to keep up the pace with digitalization

Telecommunication

- Smartphones have totally replaced old cellphones without internet connectivity
- Internet users in the United States have reached an 88% penetration rate in 2016
- Social media users increased from 7% in 2006 to 76% in 2016

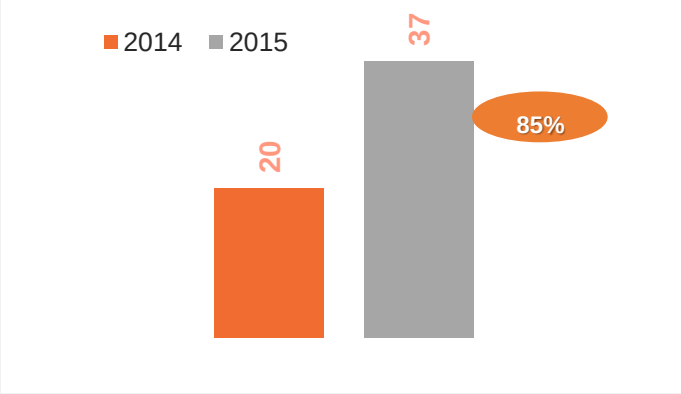
Retail Industry

- E-Commerce is replacing traditional retail stores by connecting dealers and warehouses worldwide
- Around 78.3% of the total US population has already adopted this technology

Automotive Overview

The automotive market is also being disrupted by connectivity. Vehicle consumers almost doubled their desire for in-vehicle connectivity in just one year

- This percentage is larger among younger drivers and in large cities due to their high technology adoption
- Brand loyalty is losing its potential, manufacturers have to redefine their strategies aiming for a digital business model



WILLINGNESS TO SWITCH TO ANOTHER MANUFACTURER OFFERING A CAR WITH BETTER CONNECTIVITY

Source: McKinsey & Company. 2016. Smart Insight

A connected car integrates communication standards among vehicles, their surroundings and the Internet. In-car connectivity will be the tipping point to achieve full autonomy on the road

Connected car definition

Vehicles equipped with communication technology that allows for the direct flow of data to and from the car, based on sensors and communication protocols

Difference between Connected cars and autonomous vehicles

- Connected car simply mean that it is connected to Wi-fi / cellular networks and other vehicles or infrastructure; autonomous features are not
- The access to vehicle and infrastructure data is the most remarkable subject regarding the additional services which could be offered through connectivity

Type of Communication

The cloud

Connects a vehicle to the Internet for route optimization, weather & road conditions and for finding a parking spot

V2X

- Vehicles-to-Vehicle (V2V)

Communicates with other vehicles to predict driving behaviors

- Vehicles-to-Infrastructure (V2I)

Coordinates vehicle density with city infrastructure to reduce traffic congestions

Current connected vehicles product categories

Mobility & Vehicle Management	Allows the driver to optimize their route and the vehicle operation costs ▪ Traffic information, GPS, vehicle mechanical conditions, fuel consumption
Infotainment & Driver assistance	Involves driver & passenger entertainment and partially driving automation ▪ Smartphone interface, music, video, cruise control, parking assistance
Safety & Well-being	Warns the driver of external hazards and monitors driver health conditions ▪ Fatigue detection, collision avoidance, hazard warnings, medical assistance

Source: McKinsey & Company. 2016. Competing for the connected customer

The opportunity to communicate on a V2X basis is leading well-established companies to the development of innovative platforms

Vehicle-to-Vehicle (V2V)

Cadillac is a division of US-based General Motors (GM), marketing luxury vehicles worldwide. A brand which historically has been fairly conservative is now embracing the disruptive technology of the automotive industry

The first V2V on the market

- V2V communication technology is now standard on every 2017 CTS Sedan model
- Through Dedicated Short-Range Communications (DSRC) and GPS can handle 1,000 messages per second from vehicles up to 1,000 feet away
- V2V-enabled data alerts drivers of potentially hazardous situations ahead, giving them additional time to react

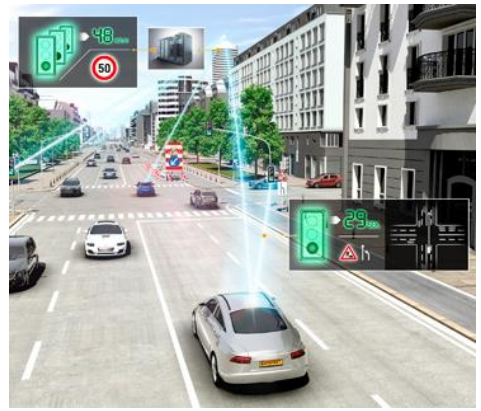
Vehicle to Infrastructure (V2I)

The multinational Continental has a strong presence in the automotive industry and is convinced that not just the vehicle but also city infrastructure is going to evolve towards a connected future

- Has delivered over 28 million telematic solutions since 1996
- Invested over $6.5M USD in startups to better understand the connected car platform

Cities have to be upgraded

- Continental proposes their eHorizon (V2X) concept, where intelligent vehicles interact most effectively with smart traffic signals
- By setting live traffic light data available to drivers, they are reducing traffic density and lowering the emissions
- The project is under way in Darmstadt, Germany & Audi has recently debuted a similar service in Las Vegas



Source: Cruchbase & Techcrunch

OEMs have been offering connected services for years, however, recently connectivity is becoming a key buying decision factor. Tesla is playing in every category and hence has acquired the leading position

Top players

- Tesla, BMW and GM are the current leaders in connectivity based on native operating systems
- Tesla's major strong point is due to over-the-air updates, which allow to keep the system at its maximum potential
- There is a need for improvement to insurance telematics, toll collection & real-time fuel prices

The pioneer

- General Motors has offered wireless connectivity since 1996, named OnStar
- GM has been tracking stolen vehicles since the early days of Verizon's 2G network, and nowadays 4G LTE has opened up a realm of new opportunities
- By the end of 2015, GM was already offering 40 models with wireless connectivity

Category	Services*	Audi	BMW	Ford	GM	Tesla	Toyota	VW
Safety & well-being	Stolen vehicle Assistance	○	◑	○	●	●	○	◑
	Geofencing/Speed Monitoring	○	◑	◑	●	●	○	●
	Roadside Assistance	◑	●	○	●	●	○	●
Infotainment & Driver Assistance	Internet Browser	○	●	○	○	●	○	○
	Wi-Fi Hotspot	●	●	○	●	◑	○	◑
	Social Media	●	●	○	◑	●	●	○
	App Store	○	●	●	●	●	○	●
	Toll Collection	○	○	○	○	○	○	○
	Remote Services	○	●	○	●	●	○	●
Mobility & Vehicle Management	Street View	●	○	○	○	●	●	●
	Traffic & Parking Info	●	●	●	◑	●	●	●
	Online Route Planning	●	○	○	●	●	●	◑
	Insurance Telematics	○	◑	○	◑	○	○	◑
	Real-Time Fuel Prices	●	●	○	○	○	●	●
	Predictive Maintenance	◑	●	◑	●	●	○	●

○ No product ◑ In development ● Already a product

*From Native Operating Systems

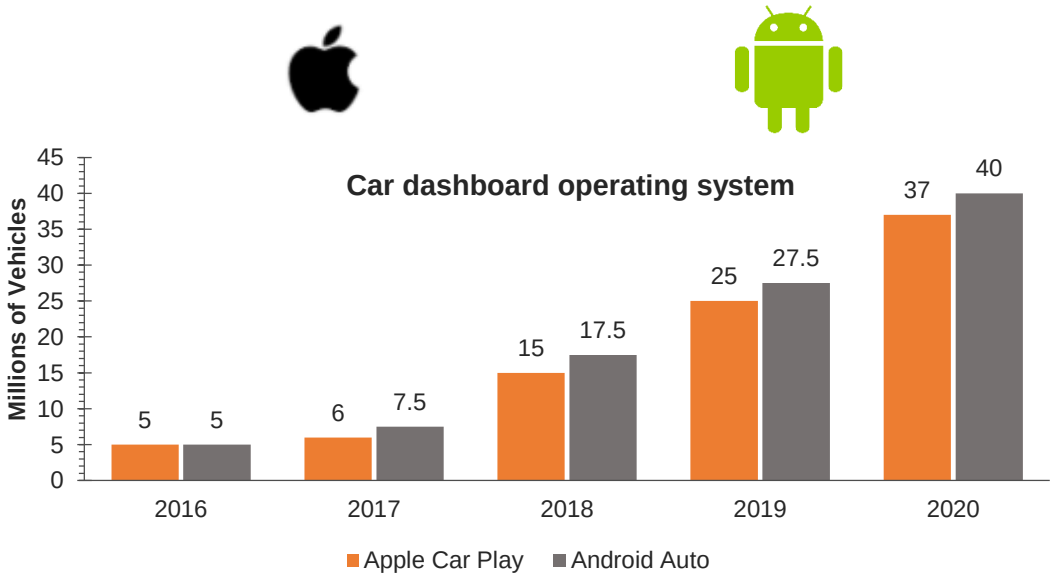
Source: Everis. Connected Car Report

Big tech players do not want to be left behind in the emerging connected vehicle ecosystem. Google's Android and Apple's iOS play an important role on the development of state-of-the-art connected platforms

The Connected Car Platform

Current infotainment systems are Linux, Blackberry-based or even custom branded operating systems; which complicates further development of applications as they have to be customized for each brand

- Google's Android and Apple's iOS already have 97% of market power in handheld devices platforms and are looking forward to dominate the Connected Car Platform
- Apple main focus is in the premium sector based on a closed-source model while Google looks after an open-source community to further develop its applications



The Open Automotive Alliance

Based on the previous Open Handset Alliance founded by Google in 2007, which propelled the Android Platform to its current leading status

- In 2014 Audi, GM, Honda, Hyundai and Nvidia joined forces around Google to create a common platform for the connected vehicle
- By 2016 they had over 47 companies from car manufacturers, software companies, electronics and semiconductors manufacturers
- They are dedicated on accelerating innovation through an open source development, allowing automakers and developers to bring cutting-edge technology more efficiently

Members:

BENTLEY, Ford, Audi, Buick, INFINITI, Alfa Romeo, Chevrolet, Cadillac, Citroën, Honda, Fiat, Abarth, GMC, Dodge, Chrysler, Lamborghini, Hyundai, Mercedes-Benz, Mazda, Volkswagen, Opel, Koenigsegg, Land Rover, Peugeot, Borgward, SEAT, Acura, Jaguar, Kia, Jeep, DS, Renault, Mitsubishi, The Lincoln Motor Company, Nissan, Volvo, Subaru, Skoda Auto, Holden, Maserati

Source: BI Intelligence Report. 2016

Global vehicle production is expected to maintain a constant growth in upcoming years, while the amount of vehicles shipped with connectivity is expected to grow ten times faster than the overall market

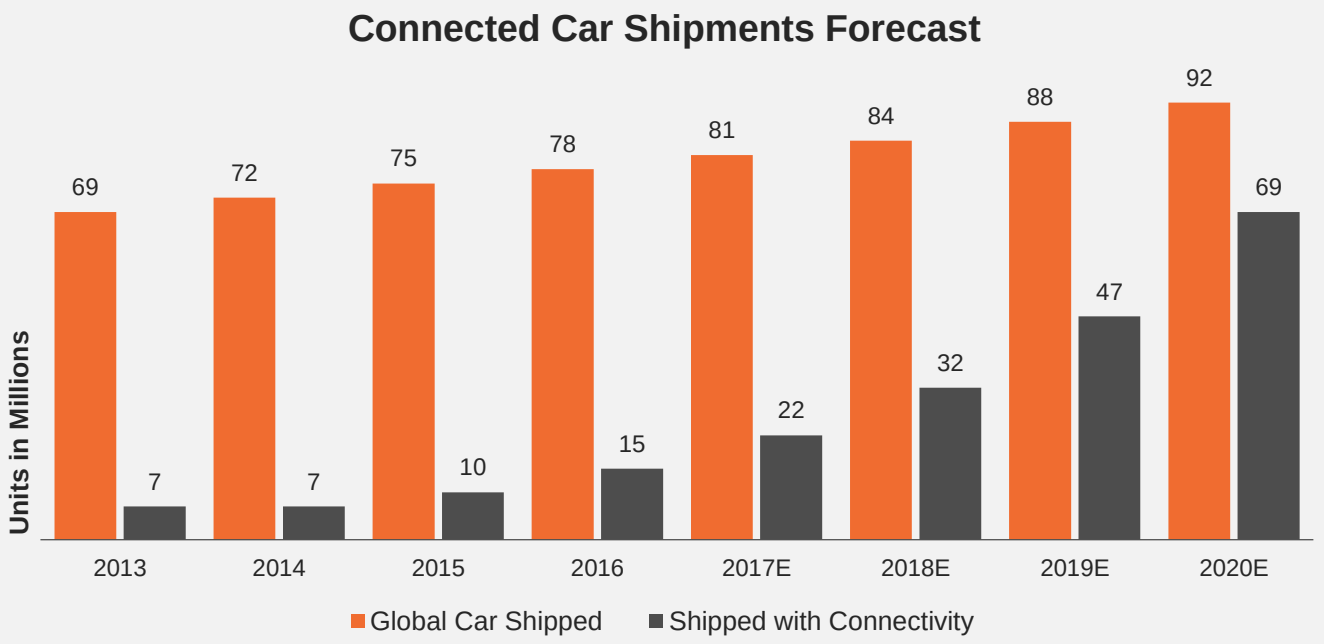
The connected vehicles are already in the market and providing remarkable revenues either for automakers and IT companies

- The connected car market is growing at a five-year annual rate of 45% CAGR, which is ten times faster that the overall market

- Besides the 220 million connected vehicles by 2020, only 40% will be actively connected

- So far, connectivity has been proposed for the luxury sector, but it will reach the volume market in a medium term

- It is estimated that by 2020, 75% of vehicles shipped globally would have embedded connectivity in their systems
- Which represent the strong potential to become a standard feature in the medium term
- We predict that in 10 years almost all shipped vehicles would be equipped with full connectivity

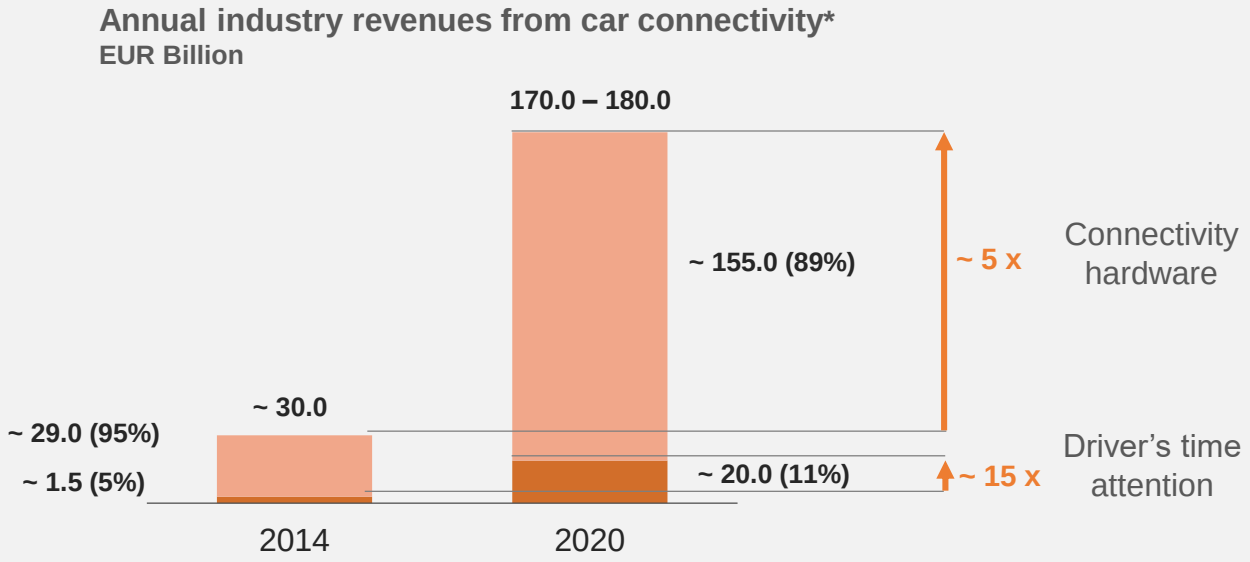


Source: Business Insider. The Connected Car Report

As connectivity acquires market share, revenue pools are being indirectly affected. The true value of a car is shifting from conventional auto parts to electronic devices which could add connectivity capabilities

Market Growth Projection

- It is expected that the overall lifecycle value will likely remain stable between now and 2020, as base prices decline and optional features become standards
- The connectivity-related share of revenues is expected to grow in the European car segment, expecting a market size of €170-180B by 2020
- Enabling a major driver's time attention, usage-based software and services are expected to have the biggest growth, acquiring some market share from the standardized hardware connectivity



*No inflation assumed all values in 2014 Euro

Impact on Car Lifecycle

Based on a German D-Segment vehicle and a connected car's five years life cycle, an average revenue stream of €56K has the following distribution:

- Vehicle price: 52%
- Connectivity features & services: 4%
- Maintenance: 6%
- Insurance :14%
- Operations: 24%

Despite connectivity's small percentage, it has a strong potential to indirectly affect other revenue pools

- **Vehicle price:** Given the claims to switch to another car brands for better connectivity
- **Operations:** Usage-based payment models will increase content-related revenues
- **Maintenance:** Has the potential to optimize services by a direct contact to car centers
- **Insurance:** Customer willingness to trade driving data for insurance benefits

Source: McKinsey & Company. The Impact of Connected Cars on OEM Market Shares

Top suppliers have already identifies the new scheme and are working hard to expand their portfolio for a digital world. Tier 2 producers may compete with their deep expertise on specific areas

- Bosch is the number 1 automotive supplier with sales over $44,825M USD worldwide in 2015
- They understand the IoT revolution and hence are developing a diversified portfolio

	Portfolio*	Bosch	Denso	Magna	Continental	ZF
Software	IoT Cloud Platform	X				
	Cybersecurity	X		X	X	
	Fleet Management Solutions	X	X		X	X
	Android Compatibility	X				
	Apple Compatibility	X			X	
Hardware	Updatable ECU	X			X	X
	Sensors & Actuators	X	X	X	X	X
	Cockpit Display Units	X	X		X	X

Bosch IoT Suite

BOSCH Invented for life

- Bosch IoT Suite is an open source cloud platform designed not only for the automotive sector
- The Platform-as-a-Service concept allows IoT developers to innovate on connected solutions

inmarsat

Continental

- Partnered Satellite Communication Inmarsat
- Enables updates of electronic control units across the entire vehicle from powertrain to infotainment systems

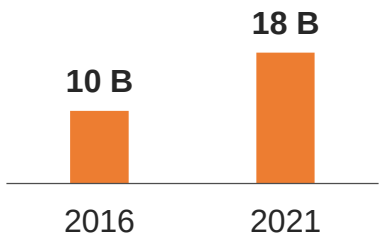
ARGUS CYBER SECURITY

MAGNA

- Partnered ARGUS Cybersecurity to bring their electronic components backed with an Intrusion Prevention System
- Offers an holistic package for the connected vehicles

Besides the strong “Mega-suppliers” dominance, which are the largest 20 Tier 1 companies, there is still place for small manufacturers

- There is an expected $8B USD growth just on the Cockpit Head Units market



- There are companies such as Sharp, LG and Kyocera, whose focus was as tier 2 supplier
- They have the expertise to build electronic displays and may now ship directly to OEMs

*Based on disclosed information

Source: PWC. Automotive News. Top Suppliers

Aftermarket devices have a strong near-medium term potential. However, we are not bullish on their long term prospects, as OEMs and IT giants like Google and Apple are working hard on embedded connectivity

What are they?

Aftermarket companies provide dongle devices to connect into the OBD II car ports which allows access to vehicle performance, driving habits and maintenance information

Statistics have shown that people are more willing to obtain in-car connectivity, which creates a strong potential for the aftermarket sector

- **Addressable market**

By 2015 only 25% of US light vehicle were connected

- **Consumer control of data**

Undercuts OEMs revenue by providing the owner control of its vehicle data

Product Distribution

Generic devices

- Infinite amount of devices on the market
- Budget devices start at $10 USD
- Works as Bluetooth transmitter for third party apps like Torque, HobDrive & Carista
- High risk of cybersecurity breaches due low hardware quality and ease to access

Platform devices

- Four brands on the market
- Around $140 USD + $5 to $10 USD monthly fee after the first free year
- Provides an App Marketplace but lacks on apps, support service and willing developers

mojio AUTOMATIC Zubie GLOBAL UBI PLATFORM vinli

In relation to aftermarket companies mainly doing dongles, they are expected to decrease considerably in a medium term and to totally disappear in 15 to 20 years because OEMs will embed this capability on vehicles. Platform players, like Zubie and Vinli, are betting they can survive that downturn due to their strong app marketplace and user base, enough to make OEMs to work with them

- In three years, 75% of worldwide shipped vehicles are expected to have full embedded connectivity, decreasing considerably the aftermarket potential
- Apple & Google are looking forward to dominate the connected car platform through smartphone integration. They have a well-established marketplace with better support services and experienced developers
- As the amount of connected vehicles increases, cybersecurity risk will increase too. Generic devices working through third party applications have considerable low security standards are more susceptible to hacker attacks

Source: Park Associates. The Connected Car

Developers are filling the marketplace with customer-oriented applications which provide an end-to-end user experience on vehicle maintenance, car-tracking and fuel economization

Beagle

- Keeps teen drivers safe
- Tracks their driving routes and speeds
- Sets up custom alerts to let parents know when they stray from their route

Meineke

- Lets users know what their car needs and when it needs it
- Makes it easily to schedule appointments, view the entire vehicle repair history
- Check out reward points earned

SpotAngels

- USA nationwide parking rules constantly updated
- GPS tracking to find free and paid parking spots
- Parking tickets alert to make it back on time when it is about to expire

UnMooch

- Splits the cost over carpooling from vehicles
- Charges the price per mile that users want to split
- Uses Venmo, a payment processor, to send the request for money

OBD Fusion

- Allows you to read OBD-II vehicle data directly from a smartphone or tablet
- Fuel economy monitoring
- Virtual dashboards for engine health management

HomeConnect

- Connecting users' smart vehicle to their smart home
- Thermostat setting
- Garage closing
- Turning lights on/off

Source: Vinil Marketplace. Mojio Marketplace. Automatic Marketplace

Cybersecurity, which wraps from data privacy to vehicle manipulation, is considered the major roadblock to successfully adopt connected vehicles. Consumers' confidence is leaning towards IT companies

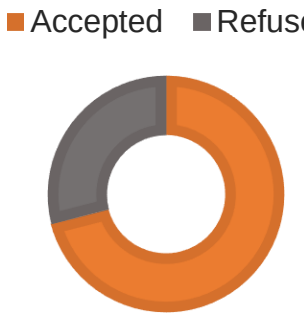
Major Threats

Every car from the 21st century has an internal Control Area Network (CAN), which manages the flux of data from every working element inside the vehicle

- Current vehicles have over 100 million lines of code, a malicious cyberattack could leave vulnerable critical areas like the braking system and even the engine

- US Department of Transportation is leading a $25M USD pilot program in Michigan from 2017 to 2020 to strengthen cybersecurity infrastructure

On the other hand, data privacy may not represent a roadblock as a cybersecurity issue, consumers are more willing to share they data

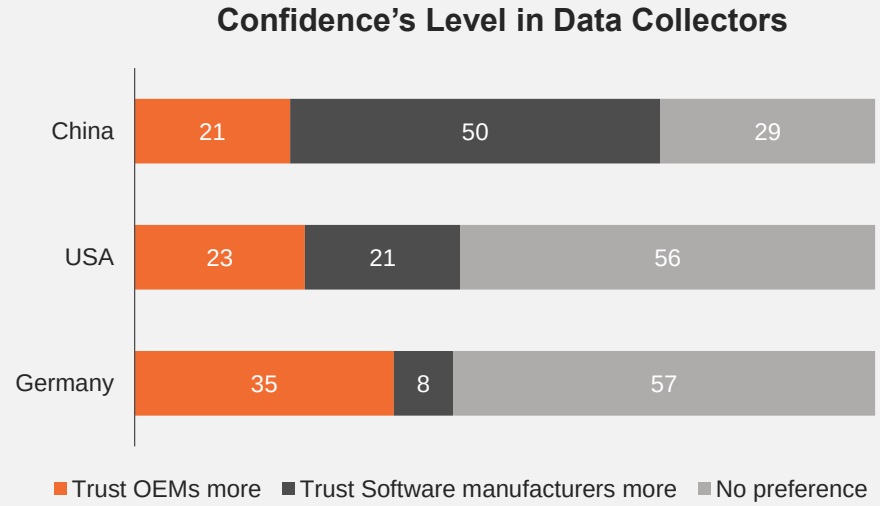


- Consumers are more educated about the use of their data

- From over 3000 recent car buyers 71% consciously granted access to their personal data in exchange of better services

Consumers' Point of View

- Germany is a well-known automaker while China has a close relationship with software manufacturers, leaning their trust to each category. However China has an 18.7% of global population while Germany humbly reaches 1.1%
- The indifference is a crucial factor, as more than half of the USA and Germany citizens do not have a special preference and are potential users for both OEMs and IT companies



Source: McKinsey & Company. Competing for the Connected Customer

Besides the privacy concern, there are many other issues that need to be solved. Most of the challenges are deep-rooted in current OEMs' business models, waiting for adjacent players to redefine them

Challenges	Current Situation	Shift on Business Models
Design Cycles 	▪ The automotive lifecycle takes between 5 and 7 years to bring new models into the market ▪ Consumers change vehicle less often than they change mobile devices ▪ By the time a new car comes into the market its connectivity features may already be obsolete. People don't keep smartphones for 5 or more years	▪ Rapid advances in technology, forces the reduction in time required to bring products into the market ▪ Designs have to be made so that they do not become obsolete in a near term ▪ A redefinition of vehicle design is needed, where improvements are made around an standard upgradable platform
Upgradability 	▪ Vehicles currently not built to require updates, nor having a native operating systems or defined characteristics ▪ Basic aesthetics modifications could be made, but will barely affect the user driving experience	▪ Consumers expect their cars to accommodate their latest gadgets and automatically update when necessary (over-the-air) ▪ Over-the-air updates will require further improvements on processing and memory capabilities ▪ An upgradable platform is required

Source: Deloitte. IoT Who Owns the Road

The automotive evolution demands new vehicle standards. As we have seen, software is dominated by Google & Apple but hardware has a growing amount of components which need to be standardized

The Evolution

Major disruptors form the last decade are the PC and the smartphone, both share a similar background to what the automotive is experiencing nowadays

The PC

Smartphone

Evolved from room-sized computers and wired telephones into customizable connected devices

- Their software and hardware is upgradable
- Greater amount of processing power in a small space

Car manufacturers are evolving from traditional into connected ecosystems, but they are still facing two main integration problems:

- Software integration
- Hardware integration

Software Standards

In-vehicle connectivity already has some standard-based approaches such as:

- **Controller Area Network (CAN),** the communication protocol for every device

- **MISRA C (C++),** the programming guidelines for automotive systems

Google & Apple have already 98% market share of handheld devices and are creating strong alliances with OEMs to embed their software in recent models

- They will be the software standard in the upcoming years

Hardware standards

To digitalize cars, a growing amount of microprocessors, sensors and wiring connections have to be implemented. Vehicle complexity is more closely-related to electronic devices than it is to mechanical units

In modern vehicles we can find:

- Around 150 Electronic Control Units

- Hundreds of sensors, switches and actuators

- Over 100kg of wiring connections

- Built one at a time on the assembly line

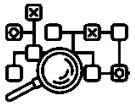
Even though current vehicles have over a hundred sensors and actuators, their needs are increasing rapidly. Packaging and wiring modern vehicles are areas of improvement

Current wiring assembly is tedious and not automated

- A premium class sedan has over 3.5km of cooper cable

- OEMs employ harnesses which are gripped by hand to the car infrastructure

- Due different car categories and complexity, wiring cannot be automated



Wire maker Yazaki understands the potential for improvement and has some proposals:

- Migrating from cooper to lighter and cheaper aluminum cables

- Going wireless, saving weight and space

- Multiplexing systems allowing to use the same cable to transmit different signals

Besides Yazaki interesting proposals, we still believe that the whole system needs to be redefined for the current digital era:

- Aluminum wires have low conductivity levels
- Not everything could go wireless, with coming EV technology like high-voltage systems require thicker cables
- Multiplexing requires extra electronic devices to decode signals

We need to look further than just the wiring system, there are elements in the vehicle which could reach every corner and are already essential for vehicle infrastructure

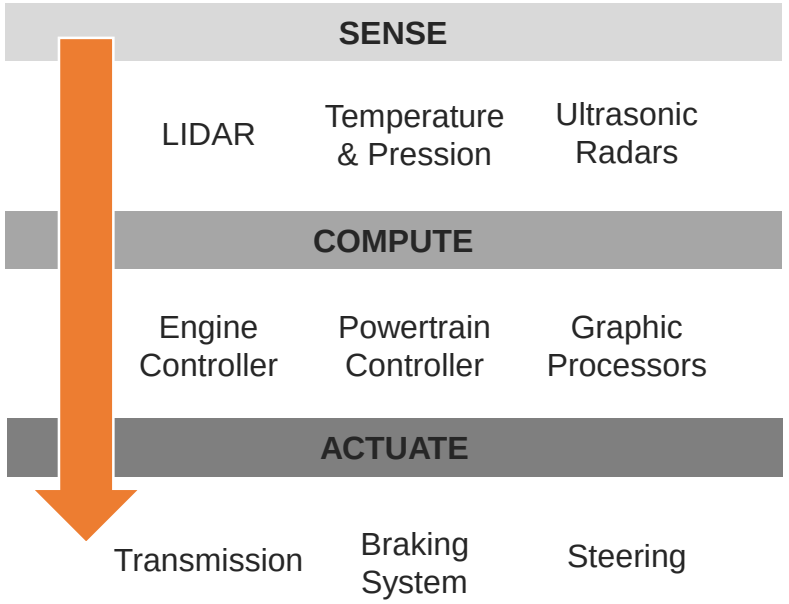
Source: IEEE. Automotive News. Yazaki

Such wiring is required due to the constant growth on vehicle connectivity which demands more sensory capabilities. Basic sensors are simple measure devices but complex ones require specific receptors

Current Sensors

Modern vehicles require an immense amount of sensors to provide an optimal user experience, most of them are also essential for the car to keep working

Advanced Driver Assistance Systems (ADAS)

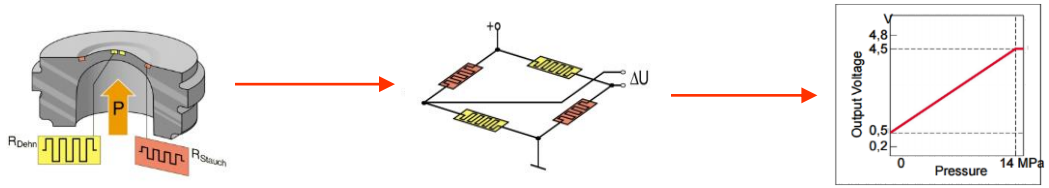


Upgradability

Regarding the sensing capabilities, there are different types of technologies. Basic sensors work as measuring devices and more complex ones require lenses and sound receptors

Basic Sensors

- Temperature and pressure sensors employ basic impedance elements to measure changes on voltage and current, and hence create continuous (analog) signals
- These sensors do not require further upgrades, as the functionality remains the same despite the device brand

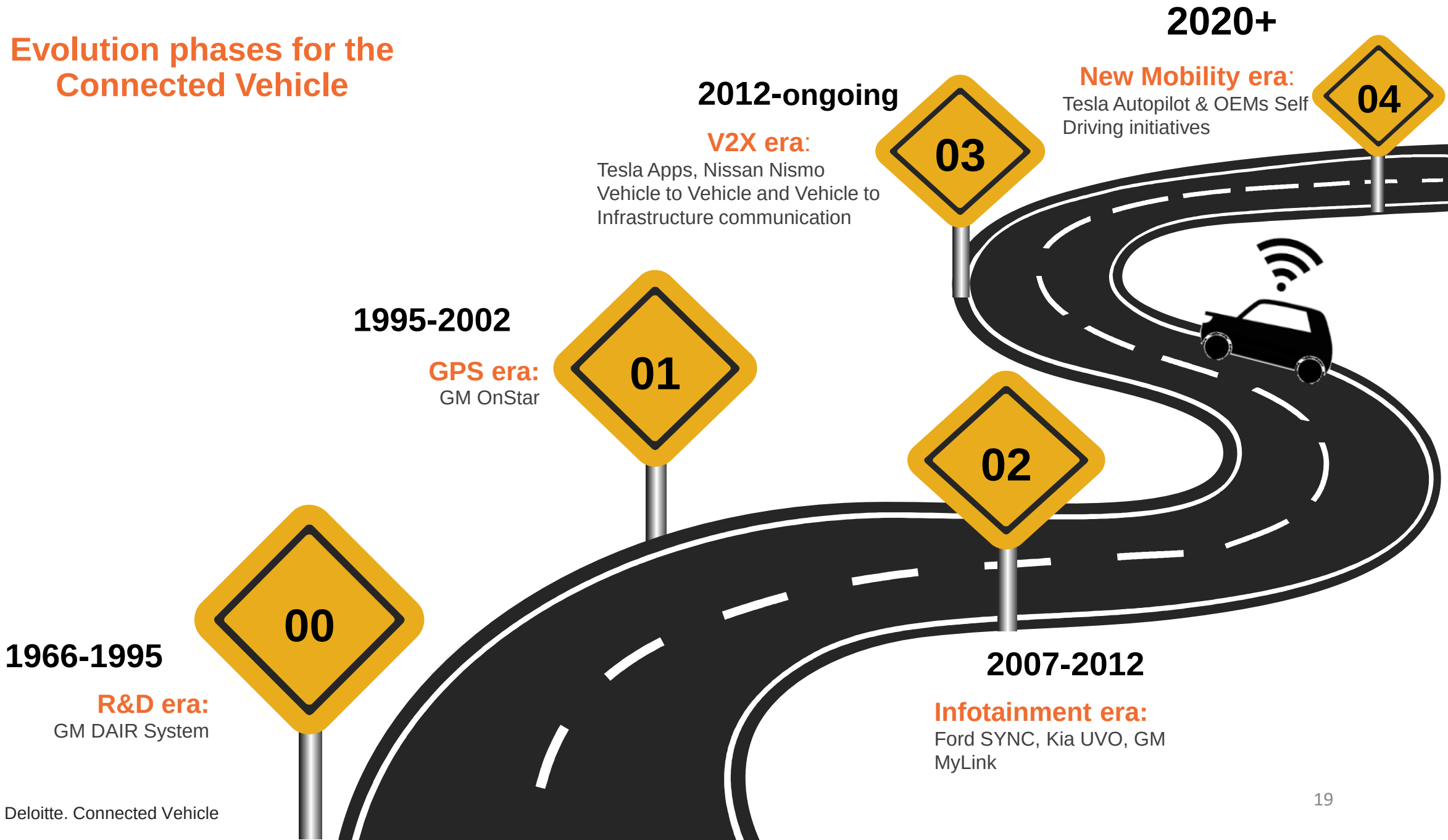


Complex sensors

- Camera- and radar-based sensors require specialized lenses and sound receptors
- They might be upgradable to more recent and better designed devices to achieve improved vision and sound recognition

Source: Frost & Sullivan. Connected Cars

Evolution phases for the Connected Vehicle



1966-1995

R&D era:
GM DAIR System

1995-2002

GPS era:
GM OnStar

2007-2012

Infotainment era:
Ford SYNC, Kia UVO, GM MyLink

2012-ongoing

V2X era:
Tesla Apps, Nissan Nismo Vehicle to Vehicle and Vehicle to Infrastructure communication

2020+

New Mobility era:
Tesla Autopilot & OEMs Self Driving initiatives

Source: Deloitte. Connected Vehicle

Connectivity is disrupting many companies worldwide and the automotive industry is next on the list

Takeaways

- Connected cars open a world of opportunities through the use of personal information to create valuable apps for consumers

- V2X Communication transforms the vehicle into an active and dynamic system, interacting with other connected devices and expanding the network

- Software standardization is being held by companies such as Google and Apple, who look at the connected car as an extension of the smartphone

- Cybersecurity is a key issue for connected devices, a big investment focus for the community. It has the potential to create new market opportunities

- The car value is shifting from structural elements into intelligent ones, major revenue streams are being achieved through connected services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