

Trends and outlook of the auto electronics industry



Contents

Abstract	4
Industry Development Overview	5
Industry Scale and As-is Analysis	8
Industry Segment Development Trends	10
Conclusions	20
Contacts	21

1. Abstract

Since 2010, the global auto market has featured quite a polarized development. The United States has begun to emerge from the economic crisis, while European countries are facing a debt crisis and excess production capacity. The major emerging markets have entered a stable stage after one or two years of explosive growth. (For these reasons,) the auto industry is experiencing a global capacity redesign to capture the new growth markets. At the same time, OEMs are looking for new growth opportunities through improving car performance, a trend that results from increasingly strict regulatory requirements as well as technological developments, more specifically a leap in automotive electronics technology.

Thanks to certain auto development trends such as lightweight materials, miniaturization, intelligence and electrification, the auto electronics market is experiencing rapid growth. The improved specialization of parts manufacturers enables them to play a more important role than OEMs in leading technological innovation in some segments. Meanwhile, penetration of cross- industry technology into the automotive industry has further intensified cross-sector competition. With the dual impact of industry-internal changes and the external economic environment, market concentration has been further accelerated.

Within the automotive electronics segments, ADAS, Connected Vehicles and electronic energy are considered as leading groundbreaking technologies, promising significant growth potentials and exerting a profound impact on the automotive industry chain.

- **ADAS**

- The development of sensor technology and signal processing algorithms has laid the foundation for a rapid development of the ADAS market. With the increased safety standards and consumer demand for safety performance, the ADAS market will become the fastest growing segment
- The technological barrier to entry to unmanned driving is relatively high, which provides an opportunity for high-tech companies (such as Google) to enter the automotive industry
- The development of unmanned vehicles may drive efficient automotive sharing and improve vehicle utilization to result in significant reduction of traffic accidents, which will exert a disruptive impact on OEMs, parts manufacturers, car financing and insurance

- **Connected Vehicles**

- Driven by the mobile internet, connected vehicles are experiencing quick innovation and increased penetration.
- Connected vehicles involve multi-functional and various resources. The different roles and positioning of the relevant companies need to be benchmarked using different success factors

- **Electric energy**

- Government incentives are considered an important driver for promoting the R&D and industrialization processes of electric vehicles
- Vehicle cost, as well as battery and charging infrastructure are major concerns for the popularization of electric vehicles
- The electric vehicle industry chain will involve more new companies, and the influence of traditional parts manufacturers will be further weakened

2. Industry Development Overview

2.1 Macroeconomic Environment

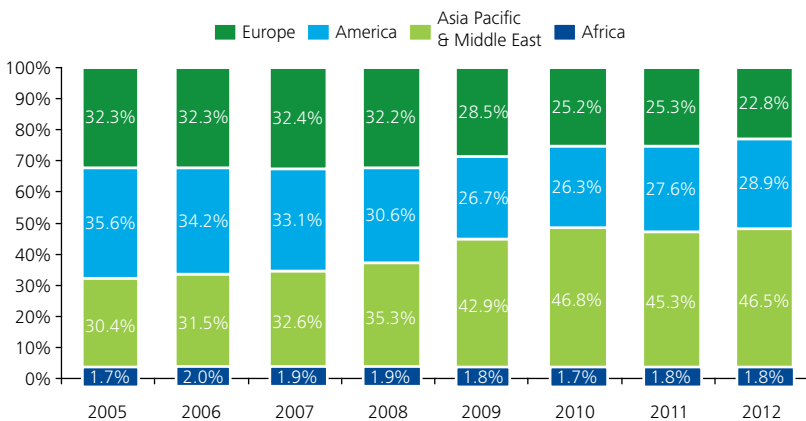
The global auto market has experienced ups and downs in the past few years, showing quite a polarized development. Generally speaking, the focus of the auto industry has shifted from the traditional manufacturing countries to the emerging markets, with sales increasing year by year (Figure 1). Rational choice of consumers has consolidated the leading market positions of the economic models with low energy consumption and low emission.

2.1.1 The traditional auto markets have a relatively gloomy outlook, and face transformation

The US auto industry has witnessed a year-on-year sales increase of 13% in 2012 (Figure 2), which is the largest since 2008. The release of pent-up demand, continued recovery of the stock and real estate markets, and enhanced consumer confidence will continue to drive the growth of auto sales in the United States in 2013, but the YoY growth will fall back to around 3%. Sustained high oil prices force consumers to pay more attention to fuel efficiency, while manufacturers also incorporate the concepts of light weight and miniaturization into their product designs. They rely on the adoption of new structures and materials, as well as small engines so as to reduce the vehicle weight and enable energy saving and reduction of emissions.

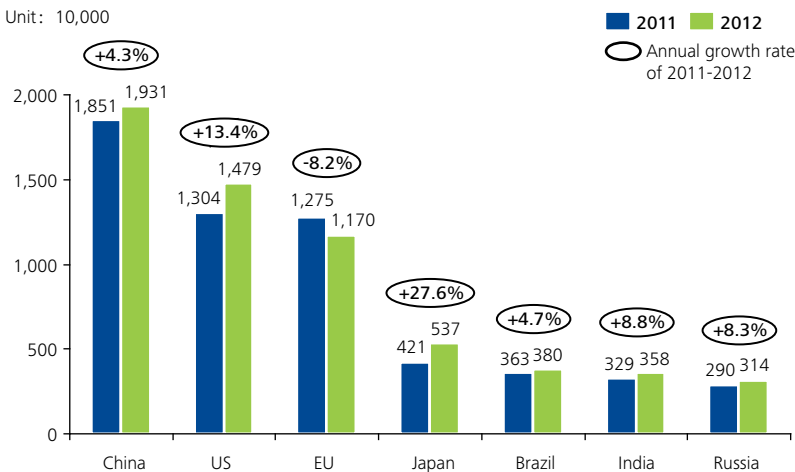
The European auto industry is still facing an economic downturn and excessive production capacity. In 2012, auto sales within the EU fell by 8.2% compared with the previous year, a record low since 1995. Same type auto sales will drop 2-3% in 2013. In the next few years, the stagnant European market will force some OEMs to adjust their strategies. The European market will focus on R&D and technology improvement to develop more economical vehicles with lower energy consumption and emission, adjusting to the European economic downturn and stricter policies on energy saving and environmental protection. In order to deal with the recession of the European car market, OEMs have shifted their attention to high potential emerging markets.

Figure 1: Sales Proportion of Regional Segments (2005-2012)



Source: Gasgoo, OICA

Figure 2: Auto Sales in Major Markets (2011-2012)



Source: Gasgoo, OICA

2.1.2 The sustained growth of the emerging markets brings uncertainty to the expansion of production capacity

Emerging markets have fewer cars by population, which promises a huge potential. Economic growth has further increased the adoption rate of cars. In 2012, auto sales in Brazil, China, India and Russia have continued to grow. The major global manufacturers have increased their investment in emerging markets to update product lines and meet the needs of different consumers, which also bring with it risks such as heavy traffic, environmental pollution and oil supply security. These problems have imposed restrictions on car consumption, and may cause the new capacity expansion to exceed auto sales and lead to further price competition, at a time when OEMs need to invest heavily in new technology development.

2.2 Policies Related to the Auto and Parts Industry

2.2.1 Emissions and incentives policies for new energy cars

Under the pressure of environmental protection and non-renewable fossil fuels, exploring new energy sources will lead development trends in the auto industry. The strategy planning of various countries regarding new energy vehicles and industry supporting policies serves as an important driver for the development of a new energy auto industry. In recent years, the United States, EU and Japan have all launched a series of policies and laws to provide more support to the new energy industry.

The United States promote the development of the new energy auto industry mainly through the legislation

The legislation focuses mainly on improving the efficiency of energy use to ensure energy security and to reduce greenhouse gas emissions. In 2007, the Bush government launched several acts including the Energy Independence and Security Act, the Energy Advancement and Investment Act of 2007 and the Renewable Fuel, Consumer Protection, and Energy Efficiency Act 2007, which all aimed at reducing the country's dependence on imported oil, developing bio-fuels, reducing greenhouse gas emissions and improving energy efficiency. Covering a wide range of industries such as utilities, oil, renewable and alternative energy production, auto manufacturing, etc, these acts set up a fuel performance goal of 35mpg (14.8km/l) for the US auto industry for 2020 and other related incentive measures, and aimed to develop clean and alternative energy technologies and markets through tax means. In 2009, the United States passed the Clean Energy and Security Act. The act stipulated an average CO₂ emission level in the US of 250 grams per mile by 2016, which is the first time that the United States have set nationwide CO₂ emission standards. As for the discharge of harmful gases, auto emission regulations in the United States can be divided into the Federal Emission Regulations and the California Emission Regulations, with the former lagging about 1-2 years behind the latter. The US government approved the idea that California has the right to customize its emission standards and may roll out a stricter standard across the country. The latest T3 standard, equivalent to California's LEV III, is expected to be approved, which will help the United States to further reduce harmful gas emissions.

The EU promotes auto fuel performance through fuel taxes

The high fuel prices resulting from the European fuel tax has pushed European OEMs to develop vehicles with higher fuel performance. Compared with the United States, the EU has put more emphasis on strategies of reducing greenhouse gas emissions. In 2008, the European Commission approved a new CO₂ emission standard for passenger cars, which requires the average CO₂ emission of new passenger cars to be below 130kg/km, and all new cars are required to meet this standard by 2015. The EU's goal of the new energy development mainly focuses on biofuels, and targets to replace 23% of fuel by 2020 and reduce the greenhouse gas emissions by 20% (same as that of 1990) while renewable energy consumption is to increase to 20% of the total. In terms of exhaust emissions, the EU has formulated a European car emission standard and adopted the Euro IV standard as from 2005. The EU standard is relatively broad compared to the United States and Japan, and it is therefore used by most developing countries. The National IV standard we adopted in 2010 is equivalent to Euro IV.

Japan is committed to driving the auto industry towards environmental protection and sustainable development

At the Copenhagen Climate Summit in 2009, Japan committed to a 25% reduction in CO₂ emissions in 2020 compared with 2009, and to an improvement in the fuel performance to 21km/L. At the same time, with a view to the goal of enhancing industrial competitiveness, Japan has put forward several subsidy and tax incentives to actively promote the development of a new energy auto industry. The New Economy Stimulus Plan launched in 2010 proposes to strengthen the competitiveness of the auto industry with the help of the advanced technologies and the popularization of next-generation ecological vehicles, with a goal of 50% of total car sales by 2020 being made up of hybrid and electrical vehicles. Regarding exhaust emissions, Japan

has formulated the strictest standard for harmful gas emissions in the New Long-term Regulation 2009. OEMs will not be punished for a failure to meet the new standard, but the annual vehicle inspection is strictly implemented to push OEMs towards accelerating technological improvements and meeting the requirements of the new standard.

2.2.2 Safe driving regulations

The most influential regulations in the world regarding auto safety technology are the European ECE/EEC and the US FMVSS standards. The European ECE standard is widely used in other countries including Japan, South Korea and developing countries.

The EU issued regulations (EC) 661/2009 in 2009, which added the state-of-the-art security technology and imposed new technology requirements on vehicles. Meanwhile, it specified that some models must have an electronic stability control system, tire pressure monitoring system, advanced brake system, and lane departure warning system installed. The safety regulations in the United States also have similar provisions. Recently, the United States put more emphasis on safety risks during the car backing up. The Kids Transportation Safety Act has forced the vehicle to be equipped with back guide monitors, to be implemented probably in 2015.

In recent years, the US states of Nevada and California have approved road testing of unmanned vehicles along with the development of unmanned driving. Google has even obtained the first special license for unmanned cars in the United States. The National Highway Traffic Safety Administration (NHTSA) thinks it is high time to formulate regulations and laws for these advanced unmanned vehicles. At present, the NHTSA has carried out research projects for a period of two to three years to formulate laws and regulations for unmanned vehicles, which will exert a great impact on intelligent driving assistance and the technology development of unmanned vehicles.

3. Industry Scale and As-is Analysis

3.1 Scale of the Auto Electronics Industry

Thanks to the auto development trends focusing on lightweight materials, miniaturization, intelligence and electrification, the market of auto electronics is experiencing a rapid growth. Europe and the United States have improved energy-saving, emission reduction and safety performance of vehicles through mandatory regulations. The developments in consumer electronics has given rise to more demanding requirements for communications and entertainment functions of vehicles, so the development of safety control and communications and entertainment electronics are expected to experience rapid growth. In view of the current situation, major OEMs will also consider auto electronics as the key factor of competing through differentiation.

3.2 Impact of Technology Development/ Innovation on the Industry Landscape

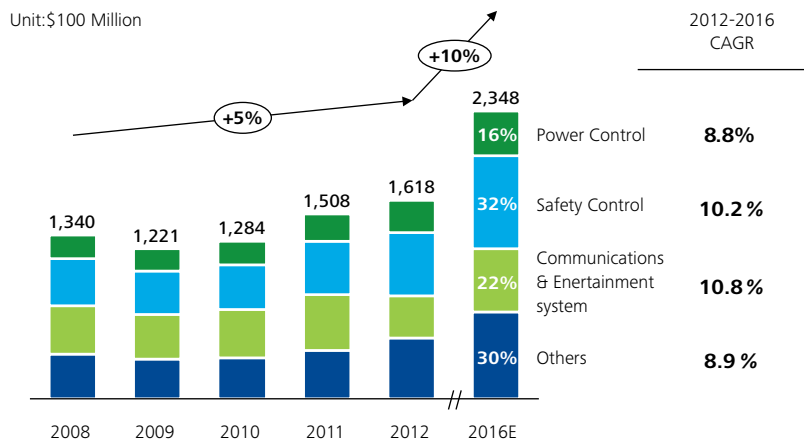
3.2.1 More Important Roles of Auto Parts Manufacturers

The technology innovation and development of auto electronics mainly focus on energy saving and environmental protection, safety and comfort, communications and entertainment, with an unprecedented speed and breadth of technological innovation. Meanwhile, innovation is becoming more and more interdisciplinary, involving industries such as materials sciences (light materials), the chemical industry (batteries) and Consumer Electronics (communications and entertainment systems). Meanwhile, high costs, the risks of all-round development and the technical complexity make it difficult for OEMs to carry out the R&D of some technologies on a stand-alone basis. More parts manufacturers are thus becoming involved fill in this gap of technology R&D of OEMs through heavy investment in the battery, positioning, navigation and other new technologies. OEMs therefore tend to outsource more and more parts, resulting in the rapid improvement of parts standardization and modularization, which is aligned with OEMs' platform strategies to reduce costs and enhance the flexibility of production lines.

3.2.2 Improved OEM Specialization

Along with the increased complexity of technological innovation, the parts or component modules have become increasingly complex and specialized, resulting in a less obvious synergy between OEMs' modules and parts development and production. Therefore, some well-known parts manufacturers rely on divesting non - core businesses and conducting horizontal rather than vertical acquisitions, so as to improve the specialization and competitiveness of their core business, which has facilitated the centralization of the segments.

Figure 3 Sales Scales and Growth of Auto Electronics Segments (2008-2016E)



Source: Industry Experts, Strategy Analytics, TechNavio, Deloitte Analysis

3.2.3 More Fierce Cross-industry Competition

With an increasing growth of information technology and consumer electronics adopted in the auto industry, the traditional auto industry is facing an attack from new industries such as the mobile Internet, the consumer electronics industry, etc. Internet companies want to enhance their existing business and cloud service abilities through the acquisition and increase of the customer flow, so as to speed up the layout of car terminals, and turn cars into an important entrance and platform of the Internet. Leveraging their technological advantages, many information technology companies have crossed over into the auto industry to promote the informatization and intelligent development of vehicles. Recently, Apple has released an "iOS in the car" application, which marks the official entrance of the mobile Internet and consumer electronics giant into the auto industry. "IOS in the car" can enable multiple functions such as map navigation, music play, sending and receiving messages, phone call making and surfing on the Internet, all without distracting the driver. Its advent will put an end to OEMs' traditional dominance over car-internal entertainment and navigation systems, further speeding up the integration of internal entertainment and navigation systems with the external equipment, including mobile phones, tablet computers, etc. In addition to Apple's practice of entering the auto industry via the entertainment and navigation platform, more and more Internet companies try to leverage the Internet-based services and their advantages in product R&D and in operational management of the mobile Internet platform (e.g.: mobile phones) to gain some market share in future telematics services. Another giant, Google, has turned to automatic driving and is trying to find a solution to free drivers from the drudgery of driving. Google's potential success would undoubtedly pose a threat to the traditional leading suppliers in the ADAS area.

3.3 Industry Restructuring & M&A Acceleration

3.3.1 Increased Centralization

Several factors combine to further increase the centralization of the auto parts industry. For one, parts purchasing of OEMs has a tendency towards modularization in order to reduce management costs and to improve efficiency. Another factor is that OEMs tend to depend on the parts manufacturers in terms of R&D. The parts manufacturers therefore seek to improve their all-round capability through M&As in order to meet the requirements of OEMs. The macro-economic gloom in Europe and US has worsened the marketing environment for parts manufacturers, and some manufacturers have therefore had to resort to bankruptcy, restructuring or mergers. Meanwhile, some companies experiencing a lack of funds but with advanced technology have become ideal target companies for some cash-rich companies. For instance, Autoliv enhanced its leading position in passive safety service areas through an acquisition of Delphi's passive safety assets in 2009.

3.3.2 A More Open Supplier System

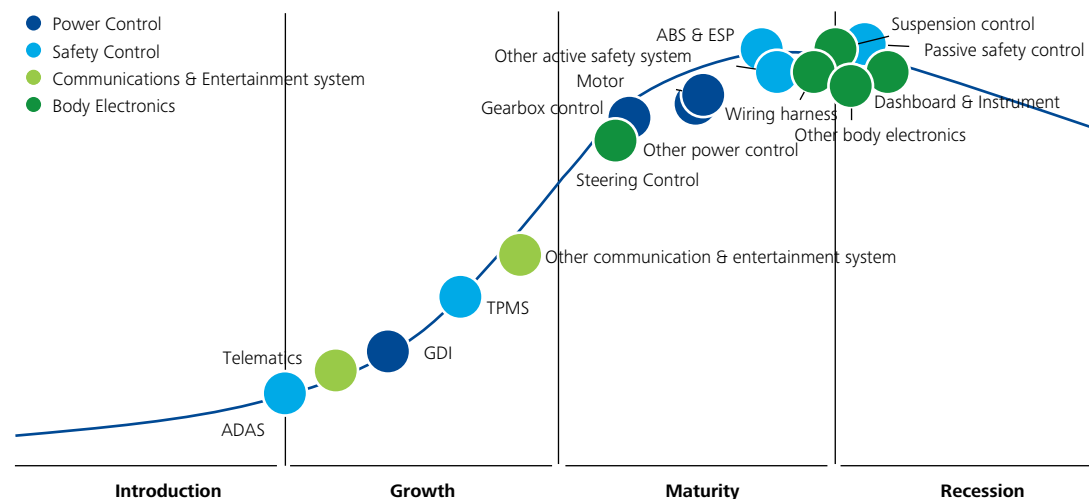
Traditionally, there have been three kinds of parts supply models: the American vertical integration model, the Germany independent supplier model and the Japanese consortium model. With increased specialization, more centralized segments and intensified market competition, the independent and self-contained supply pattern, however, is gradually broken down. The accelerated globalization of the auto industry also paves the way for manufacturers in the emerging market to step into the parts supply system. Take Toyota as an example, which has established cooperations with local Chinese suppliers. Parts manufacturers will therefore increase their independence with a more diversified client structure and a more open supply system.

4. Industry Segment Development Trends

4.1 The Product Life Cycle and Technology Development Trends of Various Segments

Auto electronics can be divided into four major categories: power controls, safety controls, communications and entertainment systems, and body electronics. At present, most products of the body electronics have entered the mature or recession period of the product life cycle. For power controls category, GDI is still growing, and its penetration rate in the European market is expected to increase by around 40% by 2018. As regards the safety controls category, the assistance system for safe driving which experiences the rapid development is still in the introduction and growth period, as it has only been applied to a small number of high-end cars. Future large-scale adoption depends on the maturity of the technology and a decline in costs. The penetration of tire pressure monitoring will increase rapidly in Europe and the United States, which has a relatively high population. However, due to the lack of mandatory rules of law, it is still in the introduction period in emerging markets such as China. Recently, OEMs have focused on communications and entertainment systems. Affected by European and US requirements for new cars to be equipped with emergency in-vehicle information systems, embedded in-vehicle information systems have seen rapid development, with adoption rates increasing by 17% from a level of 33% in 2010. With relatively higher potential, in-vehicle information systems will be more widely adopted in the mass market in the future.

Figure 4. Life Cycles of Auto Electronics Segments

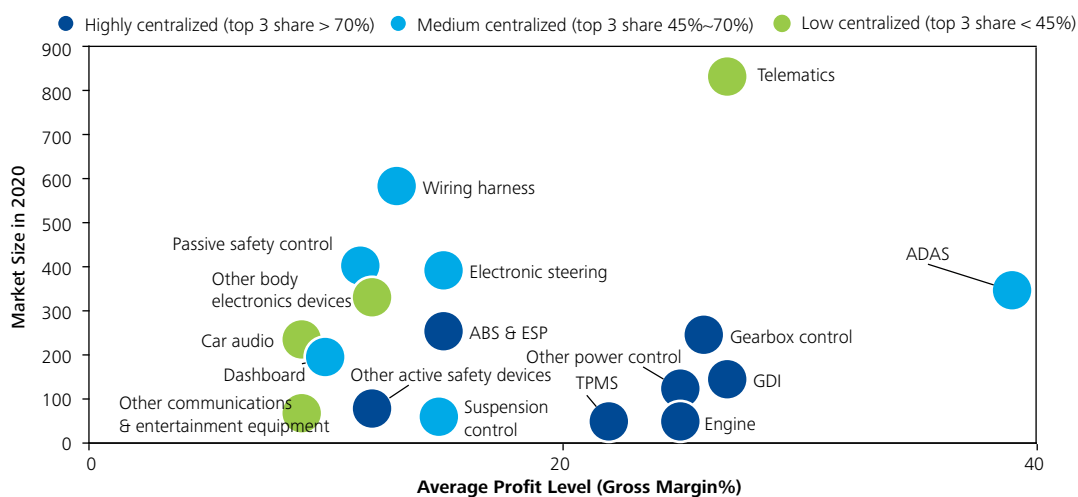


4.2 Market Scale and Average Profit Margin of Segments

Considering the product life cycle, market growth and profitability vary in different auto electronics segments. IVIS and ADAS have experienced rapid growth, with both traditional OEMs and cross-industry manufacturers involved. However, due to the dominance of the big manufacturers as well as technology barriers, market concentration is relatively low. Future technology development will be uncertain and variable, resulting in considerable amounts of capital invested in product development, and a high profit rate. On the other hand, other security controls and body electronics markets are experiencing steady growth.

Figure 5 Market Scale, Profitability and Market Concentration Overview of Major Auto Electronics Segments

Unit: \$100 Million



Source: Strategy Analytics, TechNavio, ABI Research, Visiongain, Deloitte Analysis

4.3 Development Trends of Target Segments and Implications for the Auto Industry

4.3.1 Safe/ Unmanned driving

Safety is considered the most important topic for modern auto science. With the development of auto technology, consumers have developed increasingly high requirements in terms of car safety. Most OEMs regard safety as one of the key factors for the competitive differentiation. Let's have a look at the safety technology products of selected OEMs:

- The Mercedes 2014S has the Distronic Plus steering assistance system, including a 360o sensor system based on 6 radar systems and a stereo camera, as well as 12 ultrasonic sensors
- Safety City, the Volvo's automatic braking system can avoid low speed rear-end accidents which account for 75% of urban traffic accidents

- Nissan's Safety Shield system is controlled by an intelligent acceleration pedal based on camera sensors
- Cadillac's safety alert seat system will be directionally tactile in the way they vibrate the drivers' seat pads

Regarding the development of auto safety technology, the overall trend can be summed up as follows:

In this chapter, we will focus on the evolutionary history and current state of active safety technology, discuss the possibility of unmanned technology—a representative of future predictive safety technology--- and its impact on the industry.

Evolutionary history and current state of Active Safety Control Technology

ABS (Anti-skid Brake System) is one of the three most important inventions in auto safety history (the other two are the airbag and the safety belt), ABS is also the foundation of other safety devices (such as ESP, the Electronic Stability Program). The first civilian ABS put into mass production was launched by the end of 1978. Mercedes-Benz and BMW decided to equip a variety of models with ABS systems produced by Bosch. With the whole system becoming lighter and cheaper, more and more OEMs adopted ABS systems in their assembly. By 1986, Bosch sold 1 million ABS units. During the first half of the 1990's, the ABS system has become more widely used for mass-produced models.

ESP (Electronic Stability Program) was launched by Bosch in the 1990's and was firstly adopted by Mercedes-Benz in 1995. In 1999 Mercedes-Benz announced that all its cars will adopt ESP in their standard configuration. Developed on the basis of ABS, ESP is the most advanced solution for current auto anti-slip and stability-enhancing, which is known as "the technology with the highest potential for life-saving in the auto safety area since the safety belt".

Figure 6. Development of Auto Safety Technology

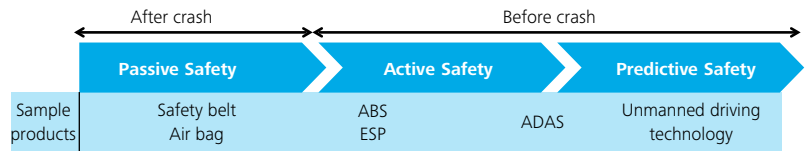
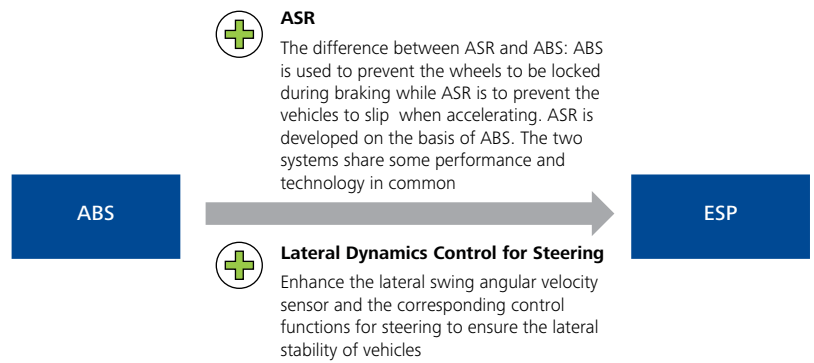
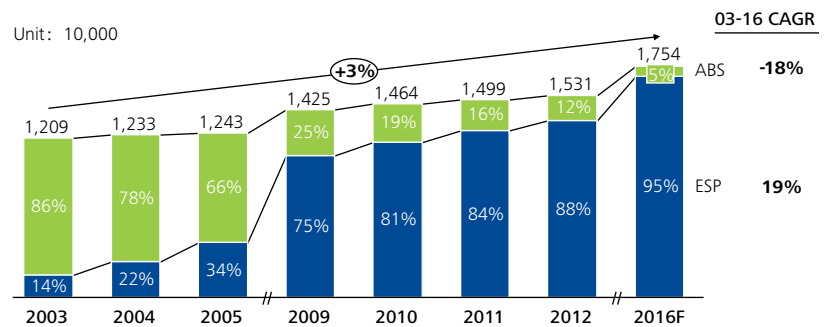


Figure 7. ABS to ESP Evolution



As an upgrade solution to ABS, ESP has begun to gradually replace ABS during the past ten years and has become the mainstream technology of active safety control, especially in Europe and the Americas. Take North America as an example:

Figure 8. ABS/ESP Shipment in North America (2003-2016F)

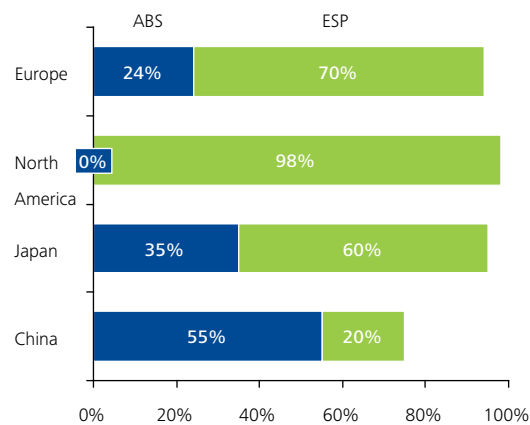


Source: TechNavio, Deloitte Analysis

The development trend is mainly created by the governments in Europe and the US, which are deeply impressed by the outstanding performance of ESP in reducing traffic accidents caused by vehicles that are out of control. These governments have formulated laws and regulations for the mandatory installation of ESP.

- United States: In 2005, the United States Highway Traffic Safety Administration (NHTSA) conducted a comprehensive study on the performance evaluation of ESP, which resulted in the regulations issued by NHTSA in 2007: all vehicles under 4.5 tons need to be equipped with ESP from 2012
- Canada: On March 13, 2009, the Canadian government planned to launch new safety regulations mandating that from September 1, 2011, all passenger cars, commercial vehicles, trucks and buses under 4.5 tons sold in Canada must adopt ESP systems
- Europe: In February 2009, Euro NCAP, the authoritative certification body included ESP into its updated evaluation process. Since 2010, only vehicles with ESP can obtain a five-star rating. On March 10, 2009, the European Parliament stipulated all new passenger cars and commercial vehicles registered in the EU must be equipped with ESP from November 2011

Figure 9 Electronic Braking System Penetration (2012)



Source: Continental Fact Book Fiscal Year 2012

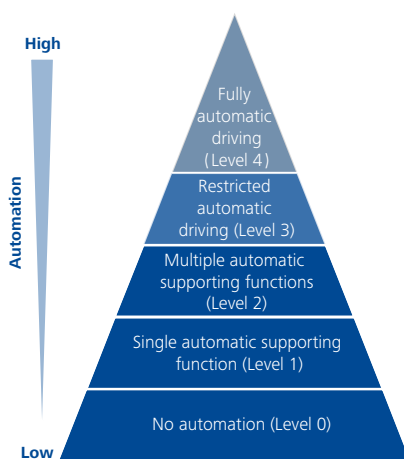
However, due to the lack of corresponding mandatory laws and regulations, as well as poor consumer awareness, ESP is still considered as a relatively high-end configuration in the Chinese market, with an adoption rate of only 20%.

Due to more demanding safety standards and increasing consumer safety requirements, as well as more sophisticated safety technology of major OEMs/first-class suppliers, the ADAS (Advanced Driver Assistance Systems) technology has experienced considerable development. At the same time, the development of sensor technology and signal processing algorithms have laid the foundation for the ADAS market development. It is expected that the overall ADAS market scale will exceed \$30 billion by 2020, with a CAGR of over 40%.

Rapid development of unmanned driving technology

With the development of the ADAS technology, the development of automatic driving vehicles has been put on the agenda. On May 30, 2013, the United States Highway Traffic Safety Administration (NHTSA) announced it would carry out a detailed and thorough study of the safety applications of unmanned driving technology and provide guidance to individual states for the authorization and management of unmanned vehicles. At present, three states (California, Florida, Nevada) have approved unmanned vehicles on the road for testing purposes. According to the NHTSA definition, automatic driving can be divided into 5 levels:

Figure 10. 5 Level Automation Driving Defined by NHTSA



Source: NHTSA

Fully automatic driving (Level 4): Vehicles can run all relevant safety driving functions and monitor road conditions during driving. On this level, drivers only need to provide the destination or navigation information and do not need to make any control operation.

Restricted automatic driving (Level 3): Under specific traffic and environmental circumstances, restricted automatic driving relies on vehicles to detect the changes of the external environment. While the control is returned back to drivers, vehicles will free drivers from all safety-related functions. Drivers may need to make occasional operations, but there are enough time for comfortable transition.

Multiple automatic supporting functions (Level 2): There are at least two major basic functions of automatic control, which are designed for joint collaboration to reduce drivers' control. For example, the adaptive cruise control combined with lane central positioning.

Single automatic supporting function (Level 1): One or two specific control functions, for example, electronic stability control or pre-charge electric brakes

No automation (Level 0): Drivers have the full control at all time on the major control units of vehicles.

Traditional OEMs followed an incremental development course and considered unmanned driving technology as an add-on to existing driving modes. They adopted some functions according to routine practices, with automatic control being enabled in certain circumstances (such as between automatic driving level 1 and level 2). On the other hand, Google took the unprecedented route of targeting restricted automatic driving at the very beginning of R&D and are planning to launch unmanned driving vehicles in 2018. Generally speaking, with the joint efforts of various OEMs, parts suppliers and non-conventional players, automatic driving is bound to experience rapid development in the next decade.

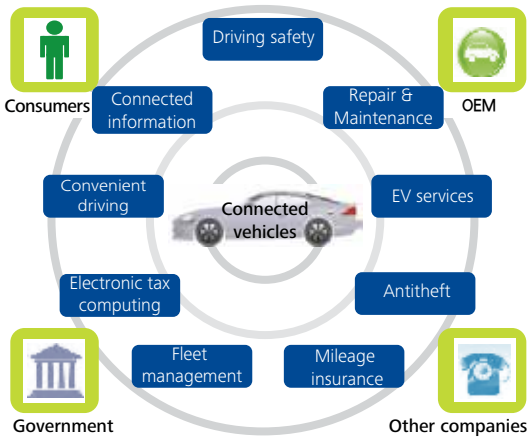
Completely automatic driving vehicles may exert a significant impact on the industry chain

- Considering the relatively high technological threshold, OEMs may rely on high-tech companies such as Google, for close cooperation in the development of unmanned vehicles
- Since automatic driving technology is freeing drivers, OEMs can cooperate with electronic and Internet companies for various entertainment systems, looking for underlying business opportunities
- Development of unmanned cars may promise more efficient sharing of vehicles and improve vehicle utilization, thus reducing total demand for cars. With the decrease in demand, the decline in new car sales will directly affect OEMs' sales and profits in the after-sales market, such as second-hand cars, spare parts, car financing, insurance, etc.
- Unmanned vehicles will greatly reduce or even eliminate traffic accidents, exerting a disruptive impact on the auto insurance industry

4.3.2 Connected Vehicles

In-Vehicle Information System (IVIS) is a service system that transfers information inside and outside a vehicle via wireless communications technology. Its numerous functions could provide services for many users such as drivers/passengers, OEMs, governments, insurance companies, vehicle leasing companies and so on. The most popular function so far are the driving safety system (For example: eCall), internet information (For example: navigation and in-vehicle information services), etc.

Figure 11. Main Functions and Service Targets of Connected Vehicles

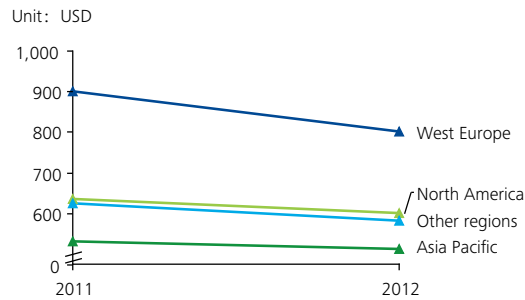


Penetration of connected vehicles is about to increase with the rapid development of the market

IVIS has developed rapidly in the past few years, especially in the area of embedded in-vehicle information systems, which have become the

standard configuration for many high-end manufacturers, including Mercedes, BMW, Audi and so on. The comprehensive yet humanized function setting has gradually become one of the major difference makers regarding auto sales. In terms of the market opportunities, the adoption rate of connected vehicles is still comparatively low (around 10 to 20%). With the continuous decrease in hardware prices, increased consumers' demand and the technology improvements, the coming few years will still be considered as a high-speed development period for IVIS. At present, most international OEMs have extended connected vehicles from high-end models to general models. From the perspective of the local market, domestic brands like Roewe and Geely have piloted the installation of connected vehicles systems in their models.

Figure 12 Development Tendency of Hardware Price of Connected Vehicles (2011-2012)







Source: Technavio, Deloitte Analysis

Driven by the mobile internet, the connected vehicles market has experienced rapid innovation

Since connected vehicles integrate many functions, they need to be connected to a telecommunications network, vehicle driving and safety systems as well as real-time map information systems for multiple source integration. The entire ecological chain consists of cross-industry enterprises that cover telecommunications, vehicles and connected vehicles. The four particular major targets are equipment suppliers, telecoms solution providers, platform service providers and content providers.

Figure 13. Role Definitions & Critical Success Factors

	Targeted service	Critical success factor
 Equipment suppliers	Integrate the hardware and software of IVIS based on OEMs' requests	<ul style="list-style-type: none"> • The integration capability of software and hardware • Development ability • Relationships with OEMs
 Telecom solution providers	Provide wireless Internet connection and communication service	<ul style="list-style-type: none"> • Communication website source (mainly are telecom operators)
 TSP	Provide daily operation and maintenance for platforms	<ul style="list-style-type: none"> • Continuous innovation ability • Customer service ability
 Content providers	Provide the contents for consumers on the platforms, such as map information, weather forecast and etc.	<ul style="list-style-type: none"> • Software development capability

In the context of Multimedia and Big Data, consumers prefer the synchronization of multiple devices to improve user experience and align user awareness. Information users themselves tend to leverage the integrated platform to collect and process information from multi-data sources. Therefore, the growth of connected vehicles will be affected by the rapid development of the mobile internet, thus moving traditional hardware

like computation and memory elements onto the cloud. Compared with the traditional model of single vehicle information systems, the model of connected vehicles relying on smart phones and the internet (For example: Sync of Ford, iOs in the car, etc.) will provide more flexibility for information updates and product renewal.

Consumers from each region have different preferences about the functions provided by connected vehicles. Besides navigation, consumers in the US and Europe think highly of functions such as eCall, weather forecast, anti-theft and tracking capabilities, in-vehicle local search, etc. In contrast with overseas consumers, domestic consumers prefer more information services such as news, stock and sports information, POI searching, transportation information, etc. Content integration and development of connected vehicles therefore have to be adapted to the needs of local consumers.

Connected vehicles enhance road safety

Connected vehicles are not only promoted by the spread of the internet, their popularization is also be supported by governments because of their promotion of road safety. European regulations require that all vehicles in the EU shall be equipped with eCall after 2014. To reduce interference with the driver, some U.S states have legislated against checking text messages and using PNDs while driving. Some countries, including Brazil, have also legislated to make it mandatory to have Stolen Vehicle Tracking (SVT) installed in vehicles. Laws and regulations of this kind will drive OEMs to pre-install IVIS on a large scale. The effect of scale brings about a drop in costs of hardware and the popularization of connected vehicles.

In the future, connected vehicles will be gradually integrated with ADAS. Based on the processing algorithms of the data from the cloud to the vehicle, vehicle to vehicle and the signals captured by sensors, commands can be given to automotive brake systems. With the maturing of connected vehicles, ADAS will be further improved to receive signals in an all-round way, and process them afterwards.

4.3.3 Powertrain Technologies and Electric Vehicles

As various countries around the world are attaching more importance to energy security and global climate change, electric vehicles are experiencing rapid development. In particular since 2009, the incentive policies of each country have significantly accelerated the R&D and industrialization processes of electric vehicles. The global sales of electric vehicles have reached 110,000, up by 133% compared with last year. According to a prediction of the Electric Vehicle Initiative (EVI), there will be 20 million owners of electric vehicles by 2020. Consequently, the CAGR of electric vehicle sales will reach 72%. In terms of global market distribution for electric vehicles, the US and Japan claim a respective market share of 70% and 12% of Plug-in Hybrid Electric Vehicles (PHEV) in 2013, as well as 26% and 28% of the pure electric vehicle market. China occupied a share of 16% in this market segment and has become the third largest BEV market in the world.

Hybrid Electric Vehicles and Blade Electric Vehicles are the major current electric vehicle models

Electric vehicles can be divided into three kinds according to power type: Hybrid Electric Vehicle, Blade Electric Vehicle and Fuel Cell Electric Vehicle. The battery capacity of HEVs is usually lower, with a more reduced driving range and little energy saving and emission reduction. In addition, it has a complicated structure which leads to high costs. However, as it does not fully depend on the charging infrastructure, it is easier to promote. BEVs fully depend on battery energy. Since BEVs have no internal combustion system,

the vehicle structure is simplified, which makes up for the high cost of cells. The popularization of fully electric vehicles relies on the development of battery technology and the spread of the charging infrastructure. Fuel Cell Electric Vehicles directly convert hydrogen fuel into electricity through an electrochemical reaction. It has high energy conversion efficiency and causes no pollution. But the technical challenges of the fuel cell remain a problem. High cost and dependence on the hydrogen fuel supply network constrain the promotion of Fuel Cell Electric Vehicles. For now the mainstream electric vehicle market is still being led by HEVs and BEVs.

Restrictions and drivers of electric vehicle development

The development of the electric vehicle market is mainly driven by two factors. The first is cost, and the cost of the battery in particular. At present, the battery cost accounts for a large proportion of the total cost of BEVs. Lithium batteries cost about \$500-650 /kWh. The battery capacity of a BEV Nissan Leaf is 24kWh, costing about \$12,000, accounting for nearly 1/3 of the sales price. Due to their expensive hybrid power system, HEVs are even more expensive. For example, the battery capacity of a Chevrolet Volt is only 16kWh, but it costs \$5,000 more than a Leaf. Secondly, consumers have their own concerns about the driving range. Due to the high cost of batteries, electric cars have to make a trade-off between driving range and cost. The Leaf's battery capacity can cover 100km, which is the equivalent of 1/5th of traditional vehicles. At present, the largest driving range is claimed by the Tesla Model S, which can cover 480km, but its sales price of \$87,400 keeps ordinary consumers away. Market research in the US shows that for about 75% of consumers, the shorter driving range is the most important concern for them in buying electric cars.

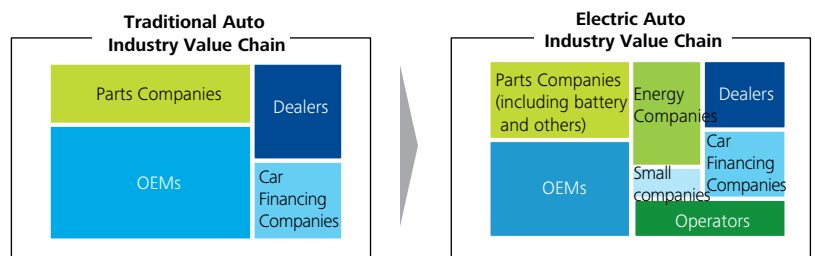
In view of this, the future development mainly depends on the battery R&D and charging infrastructure development. Of the total global investment in electric vehicle R&D during the period of 2008 to 2012, the investment in battery R&D amounts to around \$3.3 Billion, accounting for 56% of the total. The large investment in R&D has brought about a reduction in battery cost. According to the Department of Energy of the United States, the cost per kilowatt hour (kWh) dropped from \$1,000 in 2008 to about \$485 by the end of 2012. According to conservative estimates of Deutsche Bank, the annual reduction in battery cost will reach an average 7.5% in the future, and fall to \$235 /kWh by 2020. Taking the Tesla Model S as an example, the decrease in battery cost is expected to reduce the vehicle cost by 30%. At the same time, the construction of a charging infrastructure plays an important role in removing consumers' concerns about the driving range. The construction of the charging infrastructure should keep pace with the development of the electric car market. For 100 electric cars, there should be 8-30 charging points. Since 2008, various countries increase their investment in electric vehicles, allowing a rapid increase in the number of electric vehicles. The growth is expected to continue this year and next. By 2020, there will be more than 2.4 million public charging stations around the world.

The impact of electric vehicle development on business models and industry chains

The development of electric vehicles may drive an innovation in business models. Blade Electric Vehicles can work without an complex internal combustion engine and transmission mechanism, simplifying vehicle maintenance. OEMs can carry out routine examination and software upgrades to the cars through the Internet, so there is no need to set up a nationwide network of repair and maintenance. In addition, Tesla's solar self-charging facilities can provide charging services free of charge for the customer, which reduces customers' total cost of ownership in the product life cycle. Besides the charging, OEMs or charging stations can also provide battery replacement or leasing and other value-added services, reducing customers' charging waiting time and improving their experience. For example, in a recent new product release conference, Tesla showed its full automatic battery replacement service, which only needs 93 seconds to complete the whole process, which is about 1/3 of the refueling time for traditional vehicles.

The development of electric vehicles will also have a certain impact on the overall industry chain. (Figure 14)

Figure 14. Electric Vehicles Development Drives the Reconstruction of Industry Value Chain



- For parts suppliers upstream along the industrial chain, electric vehicles simplify the power and transmission parts. The internal combustion engine is no longer required. Besides, the transmission mechanism and gearbox will be greatly simplified or may even disappear. With the technology development, Blade Electric Vehicles and Fuel Cell Vehicles will dominate in the future. These parts suppliers will face the shrinking market share. However, the suppliers of battery, motor, battery management system and others will play an important role in the industrial chain.
- For OEMs, the traditional competitive differentiation model with a focus on the performance of power and gearbox will be challenged. Environmental performance and endurance may become the focus of OEMs. In addition, the power system revolution also allows more possibilities for traditional exterior design and interior parts layout, which may result in some breakthrough models and become the key differentiation to obtain competitive advantages in the market.
- For distributors downstream along the industry chain, traditional dealers' models may be challenged. OEMs will have lower dependency on after-sales services of traditional dealers. The disappearance of repair and maintenance services for engines, gearboxes and driving systems also threatens an important source of profit for dealers. The popularization of electric vehicles will further promote the business development of battery leasing and battery replacement services.



5. Conclusions

Considering the fast development of auto electronics and intelligence, automotive electronics has become the fastest growing segment of auto parts with an increasing demand on safety and security, telecommunications, environmental protection and energy-saving. More and more OEMs have begun to adopt electronic systems and have integrated semiconductor circuits in vehicles. Automotive electronics has become a major differentiated indicator for vehicles. A major feature of the development of automotive safety is active safety while active safety technology development is mainly represented by electronics control with reliability as a top priority. Mobile Internet technology has further promoted the development of automotive intelligent interconnected applications, which can be combined with vehicle safety through a combination of big data to improve reliability. As connected vehicles involve different aspects of the industry chain, various parties are seeking more benefits. Realising how to make a tradeoff regarding the interests of all parties is an important prerequisite to promoting the development of Connected Vehicles. No matter in which sub-segment, improving products and the cost performance of the technology from the perspective of consumers is imperative for making a quick win in the market.

In the mainland Chinese auto parts industry chain, automotive electronics remains a weak link. Most automotive electronics enterprises do not have the core technology, and are hampered by a limited R&D scale. Automotive electronics enterprises will continue to focus on independent R&D and M&A for future development. However, how to combine their ability to make selective investments is a problem worth studying in-depth when facing a maturing of the industry as well as coexistence, stability and changing patterns of emerging technologies.



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