Growth drivers

Megatrends create new areas of growth

In each of the growth areas we address in the semiconductor market – energy efficiency, mobility, security, and IoT and big data – there are numerous application fields with high growth potential for our semiconductor business. Driven by increasing demand for energy and the setting of global carbon reduction goals, the need to generate, transmit, store and use energy more efficiently is growing. Rising levels of traffic and transportation mean that sustainable, intelligent mobility solutions are crucial. The increasing digitalization of things enables energy to be used more efficiently. Electrification also requires more semiconductors in the end application, depending on the level of electrification. In a highly digitalized world, the number of interconnected objects increases and there is a rise in demand for secure processing, transmission and storage of data. Our solutions and systems serve all these application areas and help us achieve sustainable growth. In summary, Infineon is benefiting in equal measure from increasing electrification and from the digitization of end applications. C01

C01 Our growth areas and growth drivers are derived from megatrends in society

Megatrends	Demographic and social change	Climate change and scarce resources	Urbanization	Digital transformation
	Electrification, Digitalization			
Growth areas	Energy efficiency	Mobility	Security	IoT and big data
Growth drivers	› Renewable energy sources › Energy transmission › Energy storage › Usage and conversion of electrical energy	› Electromobility › Charging infrastructure for electromobility › Automated driving › Passenger and freight transport › Infotainment	› Security for mobile devices › Security for contactless payment › Secure authentication for the Consumer IoT and Industrial IoT › Security for connected vehicles › Integrity of devices	› Human-machine interaction › Consumer IoT › Industrial IoT › Data center › Cellular infrastructure › Edge computing
Profiting segments	Industrial Power Control, Power & Sensor Systems	Automotive, Industrial Power Control, Power & Sensor Systems	Connected Secure Systems, Automotive	Power & Sensor Systems, Connected Secure Systems

Infineon's growth areas are the source of its specific growth drivers

Energy efficiency

A new mindset on climate protection depends entirely on a new mindset on energy transformation. An energy transformation will only be viable if we take sustainable and climate-friendly action along the entire supply chain, from the generation of electricity to its consumption. Microelectronics play a decisive role here, helping to provide the growing population with energy in an efficient and environmentally friendly manner. For environmental reasons, it will no longer be possible in the future to meet the rising demand for electric energy by using fossil fuels to the same extent as we do today. Renewable energy sources, which do not emit carbon into the environment, are becoming more and more important. The use of wind power and solar energy is a key factor here. The fluctuating availability of energy from these sources can be balanced out by using electric storage systems but requires holistic management of the power grid.

Power generation from renewable energy sources

The renewable energy industry has been expanding fast for years and is gaining in importance as a result of the greenhouse gas reduction pledges made in various regions. According to estimates from the International Energy Agency, annual additions from renewables will need to more or less quadruple from their current figure of around 200 gigawatts by 2030, if the global goal of carbon neutrality is to be reached by 2050. Infineon benefits from the fact that wind turbines and photovoltaic (PV) power plants require multiple power semiconductors per gigawatt of electricity generated, compared with conventional power plants. In contrast to coal-fired, gas-fired and nuclear power plants, there is no turbine whose consistent movement can generate a constant alternating current of 50 or 60 hertz. Therefore, the electricity generated cannot be fed directly into the grid. Instead, power electronic systems are required for conversion and safeguarding. Infineon supplies all major manufacturers of wind power turbines and PV inverters.

Wind

When it comes to energy generation from wind, two trends in particular drive demand for semiconductors. First of all, older low-performance wind power turbines are being replaced by modern high-performance ones, a process referred to as repowering. Secondly, ever-stronger turbines are being used in initial installations. The performance of wind turbines has risen from around 100 kilowatts in the 1980s to present-day figures of up to 6 megawatts for onshore turbines and 14 megawatts for turbines in offshore wind farms. Depending on the type of wind turbine, semiconductors costing €2,000 to €3,500 per megawatt are required. Offshore wind farms in particular present major challenges in terms of the robustness and reliability of the components used, since they have to function in a harsh environment, at high humidity levels and in saline air over a long period, as well as needing to be low-maintenance.

Photovoltaics
In photovoltaics, Infineon has been cooperating for years with the world's leading manufacturers of PV inverters. Among other things, we are benefiting from the growth of Chinese inverter manufacturers, both with regard to domestic expansion of photovoltaics in China itself and to the export of PV inverters to other regions. We are also working closely with leading European and U.S. manufacturers. Efficient conversion and low system costs contribute to reducing electricity generation costs in open-space photovoltaic plants and to creating grid parity compared with conventionally generated electricity. Using our SiC transistors enables manufacturers of PV inverters to achieve better systems performance in terms of efficiency, size and cost when compared with Si-based solutions.

High-voltage direct current transmission (HVDC)
HVDC systems are playing a key role globally by providing reliable, low-loss energy transmission over long distances. They are also used for the grid connection of offshore wind farms. It is to be expected that future growth in the use of renewable energy will result in a rise in demand for efficient transmission routes. The semiconductor products for HVDC applications must satisfy particular requirements: robustness, short-circuit resistance and dynamic performance. We have developed an IGBT module- and a diode module-family specifically for this purpose.

Energy storage
As a result of the energy transformation, 50 percent of Europe's electricity should come from renewable energy by 2030. The use of renewable energy is linked with specific requirements for the entire energy supply chain. In contrast to conventional electricity generation, which takes place centrally in a small number of power plants, the generation of electricity from renewable energy takes place decentrally in a large number of small power plants. In addition, fluctuating power generation does not always match the demand. Conventional power plants still have to substitute for or supplement renewable energy sources. This makes the expansion of battery-based energy storage necessary in the long run. With its semiconductors, Infineon provides the essential power components and subsystems for efficient energy storage.

Hydrogen
Over the course of the next decade, hydrogen will play a crucial role in energy supply. However, if we are to exploit the potential of hydrogen, solutions must be found for the challenges associated with its production, storage, transportation and use. Semiconductor solutions from Infineon can provide significant support in the development of a sustainable hydrogen economy along the value chain.

Very high direct current (DC) is needed for the electrolysis process to produce green hydrogen. Alternating current (AC) supplied by the power grid must therefore first be converted into direct current. High system output (> 50 megawatts) can be achieved efficiently through the interaction of several high-performance switches. In conjunction with photovoltaic plants, there only needs to be an adjustment to the directly-generated DC in the electrolysis process. The combination of renewable energy and efficient power semiconductors is a key lever for the large-scale production of green hydrogen, which could become a major growth driver for Infineon. If one day green hydrogen is available in sufficient quantity and at a competitive cost, fuel cell technology will be used in various applications to generate electricity, for example, in the transportation sector (cars, trucks, buses, trains, helicopters, small aircraft) and as an alternative to diesel generators (on construction sites and campsites, for instance, and especially in base stations in remote areas and mountainous regions).

Green hydrogen from renewable energy is due to be produced at the Villach site (Austria) from the beginning of 2022.

Using electric energy

Power supply

A power supply for electric devices consists essentially of two stages. First, the power unit converts the grid alternating current (AC) into generally much lower direct current (DC), a process referred to as AC-DC conversion. The second step, depending on the intended usage, is for the voltage of this direct current to be adapted precisely at the point of load to suit actual requirements, such as those of a server's processors. This second stage is referred to as DC-DC conversion. The devices in question usually have several DC-DC converters. Growth in the area of power supply depends on the power and complexity of the devices and, above all, on an increase in the number of units.

AC-DC conversion

In the area of AC-DC conversion, we see high growth potential in the medium term in servers and telecommunications infrastructure. Power semiconductor demand and the number of servers are determined above all by the increasing complexity of the various systems and the growing demand for power which is the result. Demand for computing power and DRAM/Flash memory has been boosted substantially by the coronavirus pandemic. Working from home and mobile working, video streaming, social networking and, increasingly, machine learning will keep demand high. IoT and Industry 4.0 will accelerate this trend in the future. In addition, we see growth opportunities for our business in the following areas: compact chargers, fast-charging features and wireless charging solutions for smartphones, tablets and light laptops (portables).

› Wireless charging

The number of devices that can be charged wirelessly is constantly increasing. Wireless charging gives users the chance to charge their devices almost in passing, wherever they are, in the car, at home or in a public place. A charging station can also be used for the wireless recharging of several devices at a time. User acceptance will continue to increase as opportunities for fast charging grow. Wireless charging has advantages in terms of space and design, especially for small devices, as there is no need for a charging port. Following on from the smartphone, wireless charging will also apply to many other devices. Using electromagnetic fields, energy will be transported from the charging station to the device and the battery will be recharged without requiring a physical connection.

› USB power delivery (USB PD)

USB ports are widely used around the world, for example, in laptops, vehicle cabins and planes, or in numerous public places as wall sockets. They are used primarily for the transmission of data but can also supply power to a limited extent to connected devices. The USB PD standard was created to increase significantly the maximum power that can be transmitted. Behind the standard lies the idea of a universal power supply for various devices, in which the power supply on offer is more flexible, while allowing data to be transmitted through a cable at the same time. This means that devices such as laptops, which require more power than a smartphone, can be supplied with power and charged via this interface. USB PD is on its way to becoming the new universal charging standard.

DC-DC conversion
As with AC-DC conversion, rising demand for more computing power and storage capacity is also driving demand for DC-DC converters. Special processors such as AI accelerators, FPGAs, ASICs and GPUs require high power at very low voltages. In addition, energy requirements change considerably depending on load and at extremely short notice. As a result, the electronic systems are supplied with higher voltages that are then precisely stepped down to the required low voltage directly in the processor. The same applies to PCs and communication devices, which sometimes require a large number of different voltages. This voltage conversion system is known as point of load. Requirements placed on dynamics, efficiency and stand-by consumption are increasing all the time. Customers are looking for simple, reliable high-performance solutions, necessitating the change to digital regulation of point of load systems and driving the trend towards all-in-one solutions.

Drives and automation
Electric drives are at the heart of a large number of systems, such as cranes, conveyor belts, automation systems and robots. We find them wherever something moves or is transported or cooled. Drives are also found in pumps, ventilators and compressors. According to the European Commission, electric motors account for almost 50 percent of the electricity consumed in Europe. Accordingly, there is great potential for savings if efficiency is improved. We provide our customers with all-in-one solutions for the efficient control of their electric motors, comprising microcontrollers, driver ICs, power switches and configuration software. These enable us to support fast times to market of our customers' products and to ensure their simple operation.

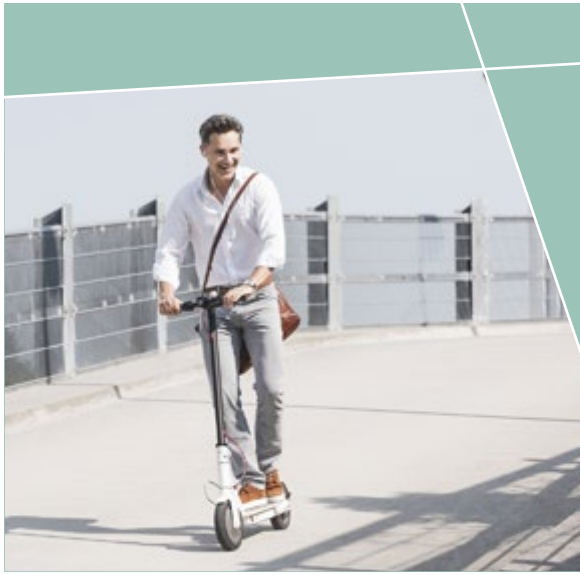
› Industrial automation
One way to reduce the energy consumption of an electric motor is to use an electronic control unit for speed control, which adapts performance to the load required at that time. Electronically controlled motors are also a key element in automation. Without them, it would be impossible to coordinate the various motion sequences efficiently. The market penetration of speed-controlled motors will increase. Such a motor control unit requires a large number of the power semiconductors we supply. The number and value of these power semiconductors depend on the power range of the motor. Industry 4.0 will trigger a new investment cycle, not only for automation in factories, but also for general transport and handling systems as well as for collaborative robots (see "IoT and big data" in this chapter, p. 31 ff.).

› Home appliances
Ever-stricter energy efficiency requirements are being imposed on home appliances. The new rules are intended, among other things, to create incentives to design products that are more efficient and have longer service lives. As a result, manufacturers of major home appliances are turning to highly-efficient motors with modern variable-speed control. These motors are significantly more energy-efficient, low-noise and have longer service lives. They are used, for example, in washing machines (drums and water pumps), dishwashers, refrigerators (compressors) and air-conditioning systems (fans, compressors).

› Battery-powered devices
In battery-powered devices, efficiency is particularly important, so that a battery

charge lasts as long as possible. As a result, more and more brushless direct current (BLDC) motors are being used. In BLDC motors, all the commutation (i.e., the polarity reversal of the direction of the current to produce electromagnetic fields) is electronic, depending on rotor position, rotor rotation speed and torque. This calls for appropriate power semiconductors and also, depending on the configuration, components for diagnostic and security functions. This type of motor requires high-performance electronic control units, compared with conventional electric motors. In addition to their high levels of energy efficiency, BLDC motors are particularly well-suited for use in battery-powered systems due to their low power-to-weight ratio. Examples include cordless home appliances such as robot vacuum cleaners, cordless screwdrivers and electronic lawnmowers. In addition to the electric motors, batteries are also becoming more and more efficient, enabling longer operating times, which is continuing to drive forward the transition from wired devices to battery-powered devices. Furthermore, all the examples cited also require additional power semiconductor components for the chargers. With battery-powered devices, we benefit both from unit growth and from the higher number of semiconductor components used.

Mobility



World population growth and increasingly global value chains as well as urbanization are driving demand for all types of transportation, ranging from mass transportation, such as trains and buses, to vehicles for private use, such as cars, eBikes and eScooters. Towns and cities in particular are confronted with the challenge of making transportation cheaper, more efficient and more sustainable.

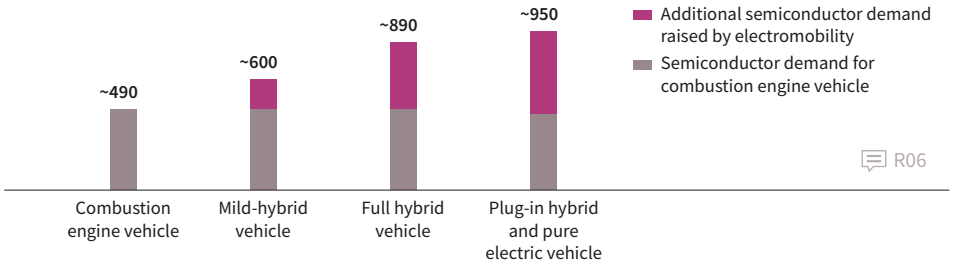
Electromobility

The automotive industry is working continuously to reduce pollutant emissions. European Commission rules require, for example, a reduction in fleet average emissions from new cars to 81 grams of carbon per kilometer by 2025. The reduction target for 2030 is 59 grams of carbon per kilometer, a reduction of 37.5 percent compared with 95 grams of carbon per kilometer in the 2021 calendar year. This will increase demand for semiconductors. Optimization of the combustion engine is in itself no longer enough to fulfill legal requirements and to satisfy customer demand for sustainable mobility. Instead, systems consuming energy in the vehicle will increasingly have to be made more efficient, while hydraulic or mechanical solutions will need to be replaced by more efficient electromechanical systems based on semiconductors.

In order to reduce the fleet average to the mandated carbon target value, many vehicle manufacturers are expanding their product ranges to include models such as hybrid vehicles or pure electric vehicles. These have a significantly higher semiconductor content than conventional vehicles. Infineon offers a wide range of power semiconductor components for these vehicles. Of interest here is 48-volt technology, which is used in addition to the 12-volt onboard network. The vehicles that use this technology

C02 Additional semiconductor demand per vehicle raised by electromobility

in US$



are known as mild-hybrid vehicles. On the one hand, this technology means that the vehicles can recover a certain amount of braking energy. On the other hand, pollutant emissions can be reduced by more efficient systems. Mechanical functions are increasingly being replaced by electric functions. The 48-volt part of the onboard network handles the power supply for high power consumers, such as the electric turbocharger, electric power steering and electronic stability control.

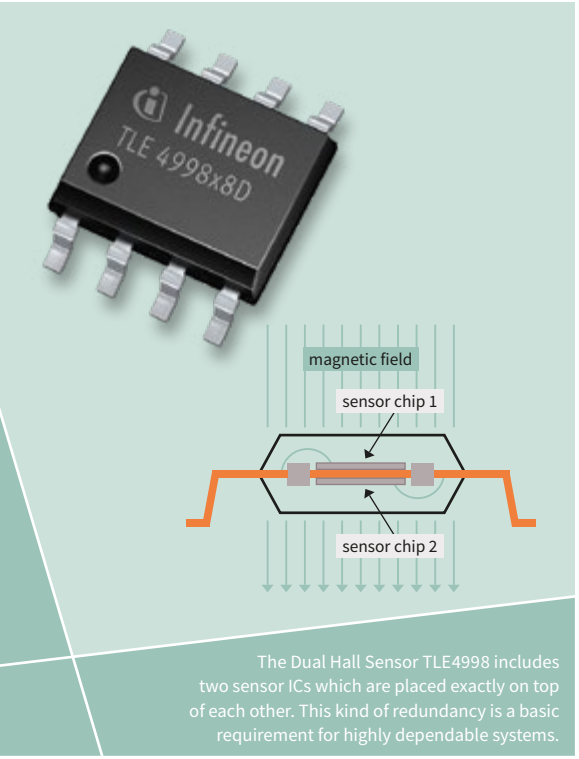
While the current average semiconductor content of a car with a conventional combustion engine is about US$490, the amount in mild-hybrid vehicles is about US$600, while for full hybrid vehicles it is about US$890 and for plug-in hybrid as well as pure electric vehicles, it is about US$950. Here, power semiconductors make up the vast majority of the additional semiconductor content per vehicle. C02

Charging infrastructure for electromobility

The steadily increasing number of electric vehicles makes an appropriate charging infrastructure necessary. A well-developed network of charging stations increases the incentive to buy an electric vehicle. To promote acceptance of electromobility, most countries are continuing to expand their networks of publicly accessible charging stations. Depending on the system topology, the charging stations use different types of power semiconductors. SiC solutions are increasingly being used for ultra-fast charging stations which can deliver over 150 kilowatts of power.

Automated driving

"Vision Zero" describes one of the major objectives of the automotive industry, which is that vehicles should become so safe that there are no longer any serious or fatal accidents. Around 90 percent of such accidents today are attributable to human error. Active safety systems can either completely prevent an accident or at least significantly reduce its consequences by directly intervening in the driving process. Examples of such systems include pedestrian detection, adaptive cruise control and blind spot detection. Many of these functions are no longer reserved for luxury cars but have become standard features in mid-range vehicles.



The Dual Hall Sensor TLE4998 includes two sensor ICs which are placed exactly on top of each other. This kind of redundancy is a basic requirement for highly dependable systems.

Active safety systems are increasingly developing into driver assistance systems. By supporting the driver with the tasks of driving, they increase both comfort and road safety. Among other things, they assist in critical situations or help correct a driver error where appropriate, for example, with automatic emergency braking maneuvers. The main systems for partially and fully automated driving comprise, firstly, sensors (such as exterior cameras, radar, and 3D ToF cameras for in-cabin surveillance), and secondly, a central high-performance computer to evaluate sensor data and determine the driving strategy (in a sense, the system's intelligence). The third element is additional secure memory IC solutions and the fourth is actuators (steering, brakes, engine control and transmission), while the fifth is a reliable power supply for all these control units, sensors, memories and actuators, R07. Our competence in providing solutions illustrates the potential edge computing holds for us.

A high degree of reliability is required for driver assistance systems in vehicles. Unlike humans, they are expected to be 100 percent reliable. Functional safety and the quality of products, software and systems are therefore very important, placing challenges on the whole industry. For Infineon, this falls under the umbrella of reliability or "dependability" and the Company has a significant competitive lead in this field.

Transport of people and goods

Sustainable and optimally networked mobility within metropolitan areas as well as between large cities is one of the key topics of the 21st century. Today more than ever, rapid and reliable public transportation determines the quality of life in many regions and cities worldwide and the ability of those regions and cities to compete with others. The trend towards electric trains has been with us for some time and is set to continue. Our components (mainly power semiconductors, but also microcontrollers and sensors) are used not only in local passenger trains, metro trains and trams, but also in high-speed trains. Moreover, electrification is becoming increasingly common for the locomotives of freight trains, as well as for buses, trucks, construction equipment and farm machinery. Power electronics also play a key role here.

Security

The increasing degree of interconnection between humans, machines and devices demands greater IT security: from the manufacturing industry and smart home applications to information and communication technologies. We provide our customers with robust, future-oriented embedded security hardware for electronic devices, computer systems, network components and industrial facilities. These security technologies make it possible to authenticate people and machines, protect confidential data and detect unauthorized changes to networked machines and devices. In industry, this trend is already evident. With increasing digitalization, the desire for reliable IT security that is also easy to use is growing.

Security for mobile devices

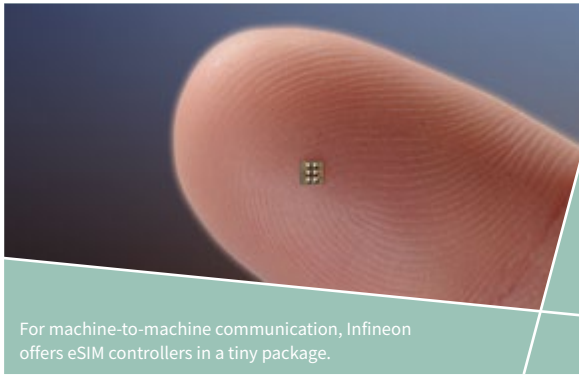
The development of smartphones and wearables, the mobile internet and Near Field Communication (NFC) technology has made it possible to integrate payment services into today's mobile devices. During the coronavirus pandemic, people have particularly valued this function. However, cashless payment is just one of many of the functions of mobile devices requiring the storage and processing of sensitive data. Travelers on public transportation, for example, enjoy the convenience of using mobile tickets instead of coins or physical tickets. These applications require special security solutions such as a security chip called a Secure Element (SE). The SE can either be built into the smartphone (when it is referred to as an embedded SE, or eSE) or integrated into the SIM card.

Security for contactless payment

Contactless payment has been common for several years in many countries and regions, such as the U.S. and Canada, and Europe, but also Asia, especially China and Singapore. The coronavirus pandemic ensured greater acceptance of this type of payment, even in previously hesitant countries such as Germany. Behind contactless payment transactions, there is generally a transmission standard that transmits the data over a short distance of four centimeters at the most. This small range, in conjunction with encrypted data transmission, makes contactless payment transactions secure. Infineon is one of the world's largest manufacturers of security chips and antennae for payment cards.

Secure authentication for the IoT

Security plays a key role in IoT. The rising number of hacking attacks underlines the need for appropriate precautions. In order to secure electronic systems, it is important to connect only authorized and authenticated devices with each other and to protect them against manipulation and cyber-attacks. This means that security must be integrated into every end-point whenever possible. The electronic components central to security are typically assembled on the printed circuit board, which is why these components are referred to as embedded security. Infineon offers various embedded security controller families adapted to meet specific security requirements.



For machine-to-machine communication, Infineon offers eSIM controllers in a tiny package.

Security for industrial applications (smart factories)

In the era of Industry 4.0, companies are using the latest technologies to make their manufacturing faster and more cost-effective, to reduce rejection rates and to minimize

disruptions and downtime through predictive maintenance. However, the networking and digitalization of factories create points of attack for hackers. To protect themselves, companies must therefore take security into account from the very beginning of Industry 4.0 projects. A combination of software-based and hardware-based security solutions can protect connected machines and communication nodes. Examples are OPTIGA™ TPM chips from Infineon, which can be integrated into routers, industrial PCs or complex control units and which serve to identify devices to communicating partners in the network. They thus authenticate themselves in the network while securing transmission of the data. At the same time, they also help protect the devices against manipulation, for example by helping to secure software updates. They act in a way like vaults for the encryption certificates.

Security for connected vehicles

The ever-increasing connectedness of vehicles creates opportunities for many new services but also carries the risk of unauthorized access. This makes it necessary to guarantee the secure exchange of data both between the various onboard systems and with other vehicles and the infrastructure. Vehicle safety and personal safety, on the one hand, and data security and IT security, on the other hand, can no longer be considered in isolation from each other. The vehicle is becoming a networked computer on four wheels and part of the IoT. The demand for data security and IT security in the vehicle is rising. We see our opportunity here in the hardware-based security provided by our security controllers – either as a separate component or integrated into our automotive microcontrollers.

Integrity of devices

The integrity of devices has to be ensured as they become increasingly interconnected. In principle, this means that no unauthorized modifications can be made to programs and data by third parties. A Trusted Platform Module (TPM) can be implemented here. This special security chip can protect keys, passwords and digital certificates and store them separately from the CPU. In this way, sensitive information and security-critical data are locked away in a “data vault”. At the same time, the integrity of the data can be checked, making it possible to detect attacks promptly and ensure the correct functioning of a system.

IoT and big data

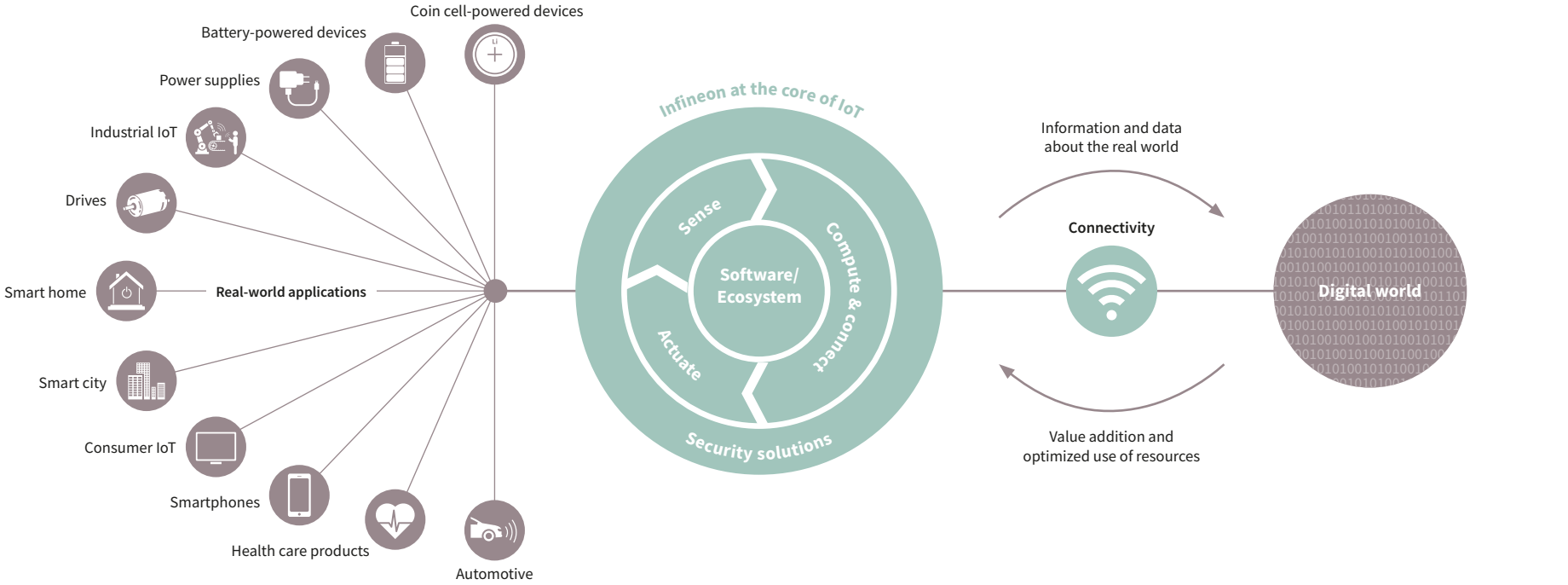
IoT connects the real world and the digital world. A wide variety of physical things – ranging from smartphones, watches and cameras to cars and computers and even to home appliances and industrial machinery – are equipped with embedded electronic systems, sensors and software. The possibilities are huge: greater convenience and security in the smart home, higher productivity together with better ecology in farming, greater productivity in manufacturing, new services, and support for older people. These examples show that IoT has the potential to effect radical change in the interaction not only between companies and consumers, but also between companies as well as between consumers.

Our semiconductor solutions drive the IoT. Sensors record mostly analog information from their surroundings and transform it into digital data. Then microcontrollers process this data and generate control signals, actuators convert the control signals into actions (in most cases motion, but also light or heat) and security solutions protect the integrity of devices and data, while connectivity chips are the link between the real world (the end device) and the digital world (the digital twin in the cloud). C03

Human-machine interaction

Human-machine interaction is concerned with how humans and systems interact and communicate with each other. For a long time now, the focus has no longer been on traditional industrial machines but on computers, digital systems or IoT devices: i.e., the connection between the real world and the digital world. More and more devices are connected and perform their tasks automatically. The operation of all these machines, systems and devices has to be as intuitive as possible, as if the user were communicating with a human.

C03 We are linking the real and the digital world



Wearables

Wearables are continuing to offer new innovative functions, such as health and fitness monitoring. They are practical and comfortable to wear and can, depending on the application, be used for a variety of purposes. Factors to consider in the design of a wearable are size, comfort for the wearer and ease of use. Other success factors are accuracy of measurement, a long service life, stability, and security functions. Our products and system solutions fulfill these requirements. Small energy-saving sensors enable, for example, high-quality monitoring of health, physical movement and sporting activities. Our radio frequency solutions support connectivity and location tracking. Our solutions for wireless charging also make it easier for the user to recharge the devices. As wearables collect user data about health, a high level of data security is essential in order to protect the user's privacy.

Collaborative robots

The area of robotics has been attracting great attention for some years. In addition to the continuing development of conventional industrial robots, more and more areas of industry are using collaborative robots (cobots). Cobots work together with humans in the manufacturing process and are no longer separated from their human colleagues by protective equipment like typical industrial robots. They are therefore required to meet high standards of safety and reliability, as they have to be able to perceive their surroundings well enough to work effectively together with humans without endangering them. Cobots will be able to relieve and support humans performing hard and dangerous tasks. In the long term, cobots will also support elderly people in living independent lives, helping to solve the challenge of an aging population. As cobots develop, the trend will be towards intuitive robot programming and self-learning robots. Infineon offers not only the necessary sensors, microcontrollers, connectivity solutions, power semiconductors and security solutions, but also provides numerous start-ups in this market with knowhow in the areas of motor control, sensor systems and security.

Smart home

"Smartification" is also happening in the home and involves the use of pioneering technology to make our daily lives easier and more convenient. Today's growing range of technologies includes home appliances and interconnected mobile devices. To be "smart" in this sense, these devices and systems need to be equipped with the right semiconductor solutions. These enable smart devices to perceive their surroundings and to adapt to changing situations through connectivity. Sensors, control units and actuators enable real-time data to be properly captured, interpreted and processed and for the appropriate action and/or reaction to be triggered. In times of increasing connectivity, cyber-attacks present a security risk that can be reduced by including security solutions as an integral part of the devices.

Smart buildings

Smart buildings improve the comfort of their occupants and are set to become an integral part of the energy transformation. According to the German Federal Ministry for Economic Affairs and Energy, buildings are currently responsible for around 35 percent of Germany's energy consumption. By 2050, however, the Federal Government wants to reduce the energy requirements of its building stock by 80 percent. That goal could be achieved if smart buildings were to generate their own electricity (using solar systems, for example, as part of a smart grid) and, at the same time, were much more energy-efficient than conventional buildings. They can, for example, use sensors to detect how many people are in a room at a particular time and, based on that information, automatically regulate the lighting or heating. Maintenance costs are also reduced. Sensors that measure and monitor the condition of components are included in the building installations, such as elevators. If there is the risk of a defect as a result of wear and tear, technicians are notified. They then carry out predictive maintenance before the elevator breaks down. Expensive outages can thus be avoided. Last but not least, smart buildings improve safety. If there is a fire in the building, sensors are able to detect how the smoke is spreading, enabling escape routes to be identified.

Industrial Internet of Things (IIoT)

The IIoT describes the digital transformation of industrial production. Sensors, microcontrollers and actuators make machines smarter. They can monitor themselves and their surroundings and optimize their actions. In manufacturing, machines are connected with each other to form an intelligent network that enables comprehensive optimization of processes, material flow and capacity utilization. This makes the supply chain and manufacturing more efficient. By involving customers and suppliers, demand-related changes in capacity utilization or a breakdown in the supply chain can be offset faster. Predictive maintenance means that expensive machine downtime can be avoided. Infineon is both a user and provider of IIoT solutions. We supply microcontrollers, sensors and security solutions for smart factories. At the same time, we have adopted Industry 4.0 approaches to a great extent at our own manufacturing sites.

5G mobile communications infrastructure

The advent of the new 5G mobile communications standard has greatly increased potential applications when compared with previous standards. Above all, 5G's high data transmission rates and considerably shorter reaction times and/or response times make new applications and devices possible. Network providers are continuing to expand their 5G infrastructure so that they are prepared for the increase in data volume and can offer their customers good network coverage. The network architecture has to migrate to smaller and more numerous cell sites to enable better exploitation of the available frequency spectrum and especially the use of higher frequency ranges. Our radio frequency components are used for communication between mobile devices and/or edge computing end devices (see next paragraph) and the base station, as well as for wireless backhaul from local networks to the core network.

Edge computing

IoT and the related explosive growth in devices with an internet connection, as well as other new applications that require real-time computing, will drive the growth in edge computing systems. In edge computing, data are processed where they arise, on the edge of a network. They do not first need to be sent to a central computer server, the cloud. This means that edge devices need to have sufficient capacity. High levels of capacity combined with limited system resources and energy budget require optimized concepts. This is where our products and systems come into play, for example, microcontrollers, power semiconductors and sensors, as well as connectivity ICs and security ICs. Our hardware, algorithms and system solutions are optimized for these tasks.