Creating sustainable IoT success

Making the Internet of Things smart, secure and power-efficient

www.infineon.com/iot

2020

5 Billion
connected people

28 Billion
installed IoT devices

40 Zettabytes
of data created

$7 Trillion
market potential

How the IoT will develop over the coming years (Sources: UN/ITU/IDC)

Emergence and potential of the IoT

The “Internet of Things” (IoT) is a major technology trend of our time – with the potential to radically impact the way businesses and consumers interact with each other and their surrounding infrastructure. It connects the physical with the virtual world as never before: Numerous “things” are being equipped with embedded electronic systems, software and sensors - from people and places through cars and computers to domestic appliances and production machinery.

This rise of intelligent connected objects will have profound implications for our society and economy. The IoT will allow us to predict errors in production settings long before they occur, it will make driving safer and more convenient, and it will lead to substantial energy savings in home and business. Across markets, innovative business models offering advantages for companies and new consumer experiences are rapidly emerging.

According to the UN/ITU Broadband Commission, there will be up to 5 billion connected people by 2020. The International Data Corporation (IDC) predicts that the installed base of IoT units and systems will grow at a 17.5% CAGR to reach 28.1 billion in 2020. And the amount of data generated annually is anticipated to reach 40 zettabytes that year. At the same time, the worldwide market for IoT solutions is expected to grow at a 20% CAGR from US$ 1.9 trillion in 2013 to US$ 7.1 trillion in 2020.

But the impact of the IoT reaches beyond just technical and economic figures. It also has the potential to tackle some of the enormous challenges facing society today. Consequently, the OECD in its “2015 Innovation Strategy” has identified the IoT as a key driver of future innovation, which “can help address pressing social and global challenges, including demographic shifts, resource scarcity and the changing climate”.

The right technology for IoT success

Now, we are starting to see the IoT become a reality. Every day, more objects get connected to the IoT and businesses bring innovative IoT applications to the market. Nevertheless, the IoT is still in its infancy and the true economic value has yet to unfold. The prerequisite for sustainable IoT success is industry-specific business models that generate true customer value.

The right technology brings IoT business models to life and ensures ease-of-use, reliable performance and security. From a technical perspective, IoT business models across industries rely on the smart aggregation and interpretation of data. On device level, intelligent objects equipped with sensors, processors, security and actuators collect and analyze data, issue actions and secure the system. On cloud level, the information of the individual intelligent devices is aggregated. A range of applications process the available information according to defined use cases.

"The Internet of Things is not a new market that is separated from others. Rather, it's a trend that will change existing markets and business models. With our understanding of systems, we can help our customers leverage the digital transformation to become even more successful. Because our semiconductors make the Internet of Things smart, secure and power-efficient."

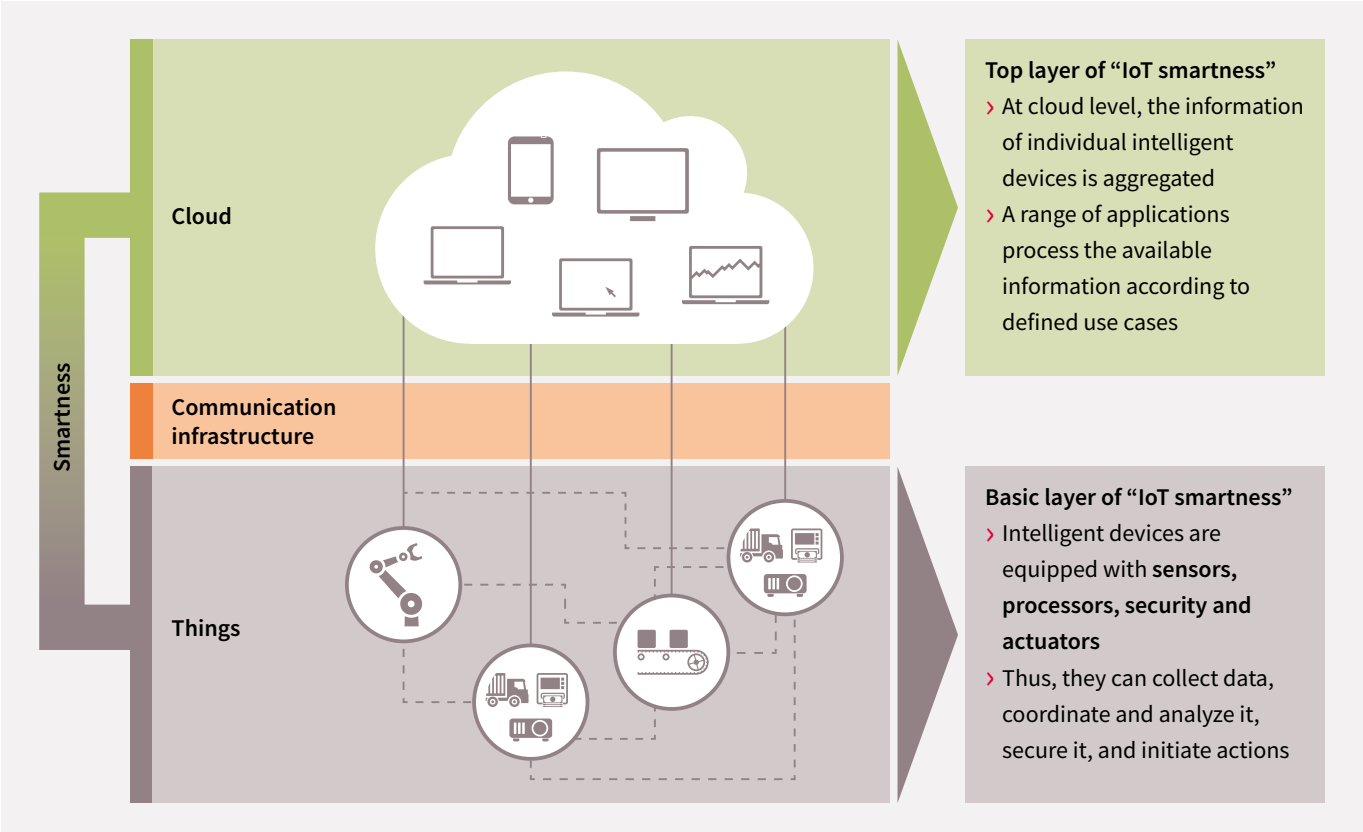
Reinhard Ploss, CEO

From a technical perspective, three essential ingredients pave the way to IoT success:

1. Smart, secure and power-efficient devices
2. Quality on component-level and beyond
3. Seamless interplay along the full IoT value chain

1. Smart, secure and power-efficient devices

Sustainable IoT success hinges on making the “things” connected to the internet smart, secure and power-efficient. Smart “things” deliver the desired data and react appropriately to the information they receive from internal and external sources. The right security is vital to win the trust of both businesses and end customers. It protects against security attacks, breakdowns and loss of data integrity, but also secures business models against considerable financial damages. Device protection, prevention of fraud as well as data and device integrity are key security concepts. Looking beyond security, power and energy efficiency also play a key role in the IoT. Always-on connectivity is a power drain. The power needed for such wide-scale device connectivity has to be produced, managed and delivered in the most energy-efficient way possible, and the performance of all these networked devices must be optimized.



The intelligent devices make the IoT „smart“

2. Quality on component-level and beyond

The IoT is all about integration. Hardware and software components are combined to build smart, secure and power-efficient devices. Communication interfaces extend this integration further. The quality of individual components directly impacts the quality the IoT solution overall, influencing ease of use, reliability and performance. Integrating the right hardware and software technologies into IoT solutions directly contributes to IoT success.

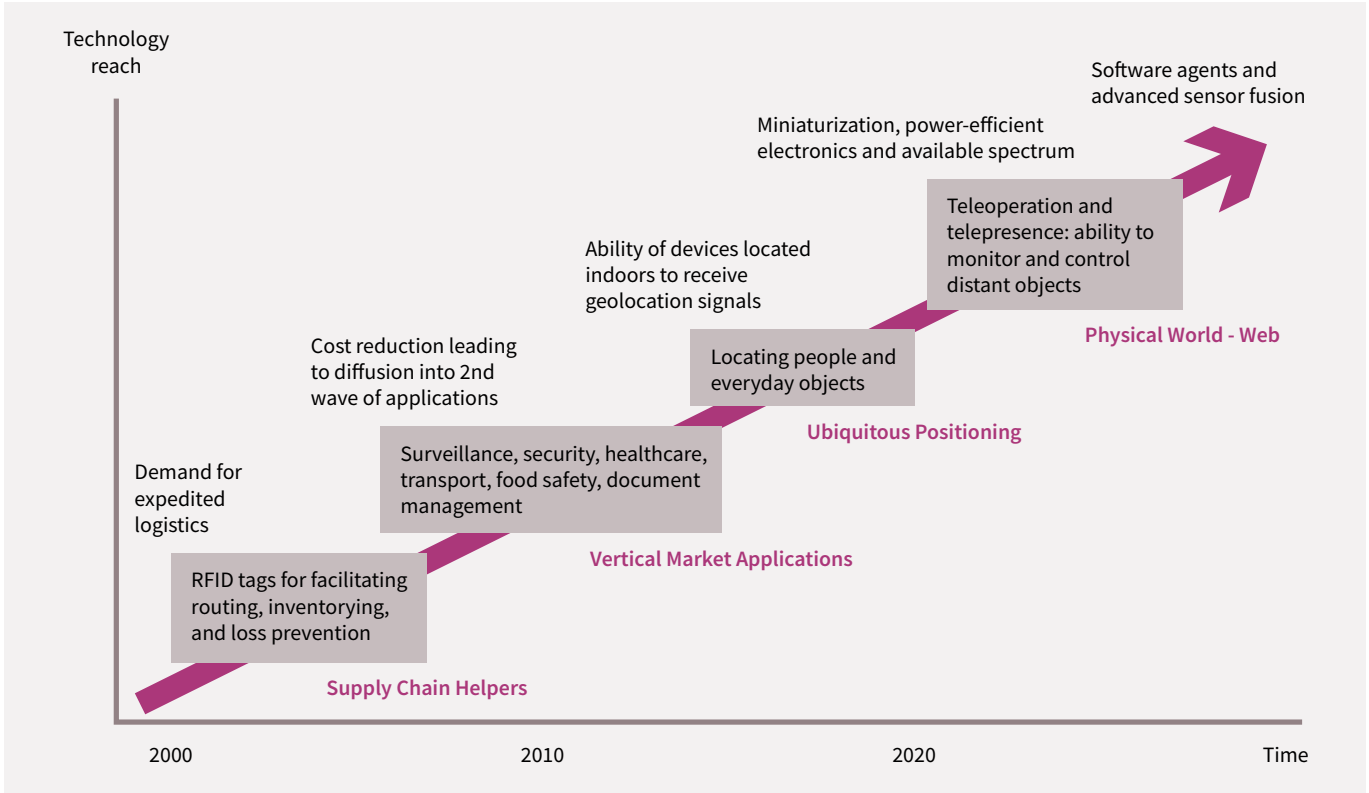
Seamless integration requires easy-to-use components. Building up IoT solutions from different hardware and software components helps to ensure fast time-to-market at the right cost.

Reliable and future-proof IoT solutions help to win customer trust. Businesses looking to benefit from from the opportunities offered by the IoT need smart, secure and power-efficient building blocks delivered by partners combining long-standing, trusted expertise with comprehensive testing and the highest manufacturing standards.

System security also depends on high-quality components. As the volume of IoT devices grows, security requirements will become more stringent. The reason for this is simple: more connections mean more potential points of entry into a network. Each of these connections can open the door to cyber attacks, data loss and system breakdowns. The impact of security breaches for companies is huge.

"The importance of quality in the IoT ties back to the IoT technology roadmap itself. Several studies show that the Internet of Things will in future move more and more away from simple, low-cost applications to more sophisticated solutions, where aspects such as enhanced "ambient intelligence" and "autonomous control" will become more important. In this future scenario, the ability to rely on high-quality smart, secure and power-efficient IoT devices will become even more relevant."

Khuen Sin Lai,
Vice President Infineon Asia Pacific, IoT Project Lead Asia



IoT technology roadmap and the rising need for high-quality semiconductor solutions
(Source: SRI Consulting Business Intelligence, Disruptive Technologies Global Trends 2025)

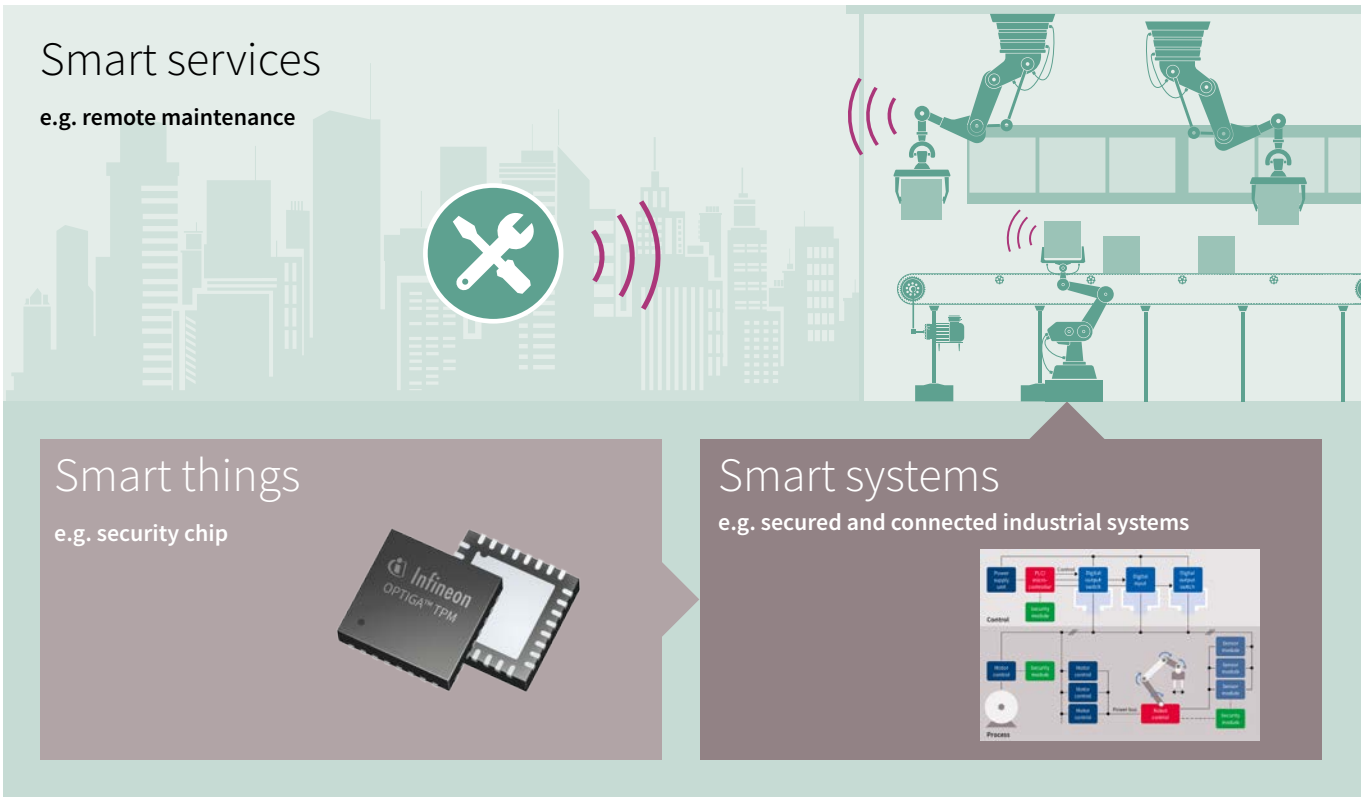
“The IoT revolution is not only about making things smarter on a hardware level. Devices need to be combined into smart systems. Most value-add comes from capturing and analyzing data for use in novel services. It’s semiconductors that form the interface between the physical world and the virtual data world. They are laying the foundation for smart systems and value-adding services. For the digital transformation of today’s business, semiconductors are what makes it all possible.”

Andreas Schumacher,
Corporate Vice President Strategy and M&A

3. Seamless interplay along the full IoT value chain

The third ingredient in enabling sustainable IoT success from a technology perspective entails the seamless interplay between all three levels of the IoT value chain: smart things, smart systems and smart services. This requires deep-rooted system know-how at component and application level.

For instance, in a smart factory environment (also known as Industry 4.0), smart devices such as RFID tags, PLCs, sensors, intelligent high-power modules and industrial microcontrollers are deployed to automate manufacturing and supply systems. These systems are now enabling new kinds of intelligent services such as machine self-monitoring and self-maintenance, seamless traceability of parts and components, just-in-time-production and performance-optimized power consumption. For best-in-class IoT solutions, the right components and systems have to be assembled to ensure the desired performance required by the envisioned smart service. The same applies in other settings, such as smart homes and cars. In all settings, smart, secure and power-efficient semiconductor devices are indispensable to build smart systems capable of delivering high-quality smart services.



Smart services, smart things, smart systems – Addressing the entire IoT value chain

Trusted partner for sustainable IoT success

Semiconductors are the “backbone” of IoT technology: they link the digital and the real world. Sensors turn electronic impulses into data; actuators turn data into electronic impulses; microcontrollers control entire systems with a single chip; security controllers protect devices and data integrity; and smart power ICs regulate the production, distribution and consumption of energy.

To enable new business and service models, enhance system performance and reliability and shorten time to market, companies need a semiconductor partner that can combine technology leadership with cutting-edge system understanding and core capabilities spanning sensing, cross-application control, security and power efficiency.

“Our customers are looking for a trusted partner who can help them develop rock-solid IoT solutions that really pay off. Based upon our proven technology leadership in the areas of sensing, computing, actuating and securing things, we are enabling our customers to develop IoT products and system solutions which not only work, but also create sustainable value.”

Robert LeFort, President Infineon Americas

Why Infineon?

Leading semiconductor solutions for smart devices

Infineon is a leading global provider of all semiconductor ICs needed to create sustainable IoT success. Our automotive and cross-market microcontrollers are among the most advanced on the market. We are the number 1 manufacturer of power semiconductors, number 2 in smart card ICs and one of the biggest producers of sensor solutions in the world.

In addition, Infineon has the deep-rooted system know-how indispensable to create best-in-class application-specific IoT solutions. We have years of experience in all relevant IoT application areas – from cars to buildings, from consumer to industry, from energy to data infrastructure. This means we have the know-how to deliver a lot more than short-lived IoT gadgets; we offer rock-solid system solutions which are truly smart, secure and power-efficient. We also benefit from established partnerships with other innovation leaders.

Dedication to quality and manufacturing excellence

Our customers value the fact that we are a leading innovator in new semiconductor materials such as Silicon Carbide (SiC) and Gallium Nitride (GaN). These and similar material innovations help our IoT customers to achieve the highest performance levels with significantly higher power densities in the smallest form factors – all key success factors for IoT applications.

Internally, we are strongly committed to the highest performance levels in testing and manufacturing. Our test requirements are among the strictest in the industry and our manufacturing plants are designed to the highest quality standards.

Proven track record in major IoT markets

Infineon's IoT expertise is reflected by a proven track record. We were already fashioning, advancing and shaping the Internet of Things long before the term "IoT" was invented. Many of the new trends that now fly under the "IoT" umbrella were enabled by technologies developed or driven by Infineon: industrial automation and robotics, electromobilitiy and connected cars, smart homes, energy intelligence and big data infrastructures.

We are actively engaged in many key electronic industry associations and ecosystems, helping to establish a considerable number of new breakthrough standards in recent years and decades. We also have a rich partner ecosystem that includes collaborations with blue-chip companies and high-tech start-ups.

In short, we have the experience, know-how, technologies and reach to strengthen our customers' business models for sustainable success in the IoT. Our semiconductors make the IoT smart, secure and power-efficient.

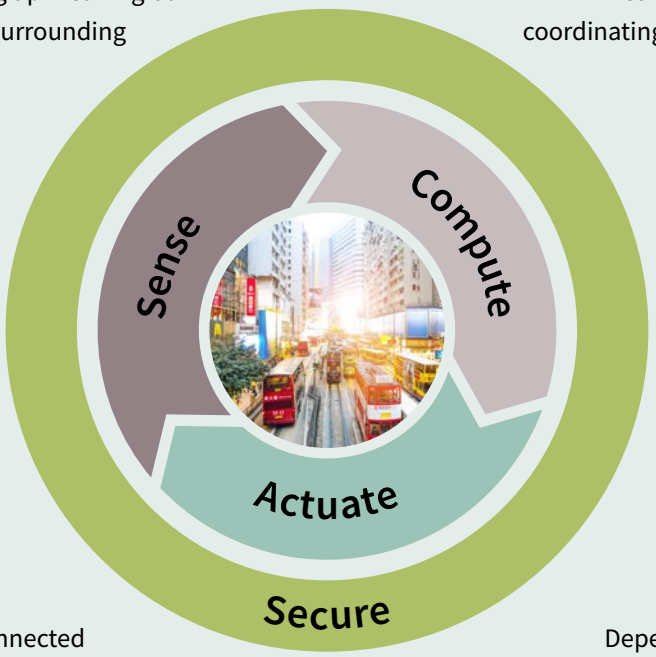
Our core competencies are essential to create sustainable IoT success for our customers

Advanced sensing capabilities

Ubiquitous **sensors** mark the "point of beginning" of the IoT, picking up meaningful data from the environment surrounding an IoT edge device

Cross-application control

Microcontrollers (MCUs) control and instruct IoT devices by collecting, coordinating, processing, analyzing, and communicating data – thus making them **"smart"**



Trusted security expertise

Security solutions shield connected systems and devices and protect personal privacy, intellectual property and public safety

Efficient power management

Depending on "smart" decisions, devices are **actuated**. This actuation is performed by **power semiconductors**

Making the Internet of Things smart, secure and power-efficient – based on our understanding of connected systems

Automotive electronics

No. 2 in automotive semiconductors

Industrial electronics

No. 1 in the overall market for discrete power semiconductors and modules

Information and communication technology

No. 1 in standard MOSFET power transistors

Security ICs

No. 1 in embedded security

Our key IoT application areas

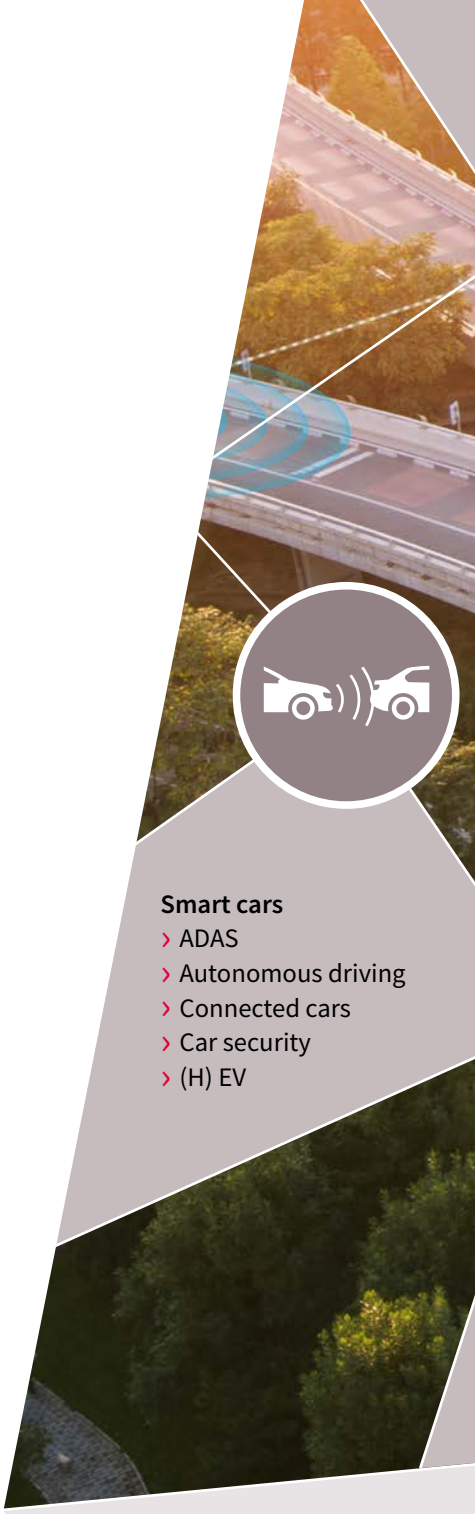
- Smart vehicles
- Smart city & energy
- Smart industry & business
- Smart home & consumer devices
- Smart ICT

Covering the full application spectrum

The IoT is not a new market, but a trend impacting mostly on long-established markets with a broad set of applications. In light of this, our customers need a trusted partner capable of covering all kinds of implementation requirements across the full application spectrum – from smart consumer devices through connected cars to smart factories and homes. One of our key strengths is our in-depth system know-how and long-standing experience across applications. This makes us a valuable partner for sustainable IoT solutions.

Smart vehicles

Already today, most cars are equipped with hundreds of electronic control units and semiconductors. Including microcontrollers, radar sensors, authentication devices and power switches. Altogether they enable enhanced driving data integrity as well as driver assistance features moving towards (semi-)automated driving and accident prevention functions. They also pave the way for enhanced services such as pay-per-use, automated maintenance (software-over-the-air (SOTA) and state-of-the-art infotainment. Such sophisticated services are not only relevant for private cars, but also increasingly for commercial, agricultural and construction vehicles (CAV), ships, aircraft and trains as well as for low-speed vehicles such as scooters and electric bicycles. We are system leader in automotive semiconductors and enhanced car security, and the global number 1 in power semiconductors and radar sensors.



Smart cars
- ADAS
- Autonomous driving
- Connected cars
- Car security
- (H) EV

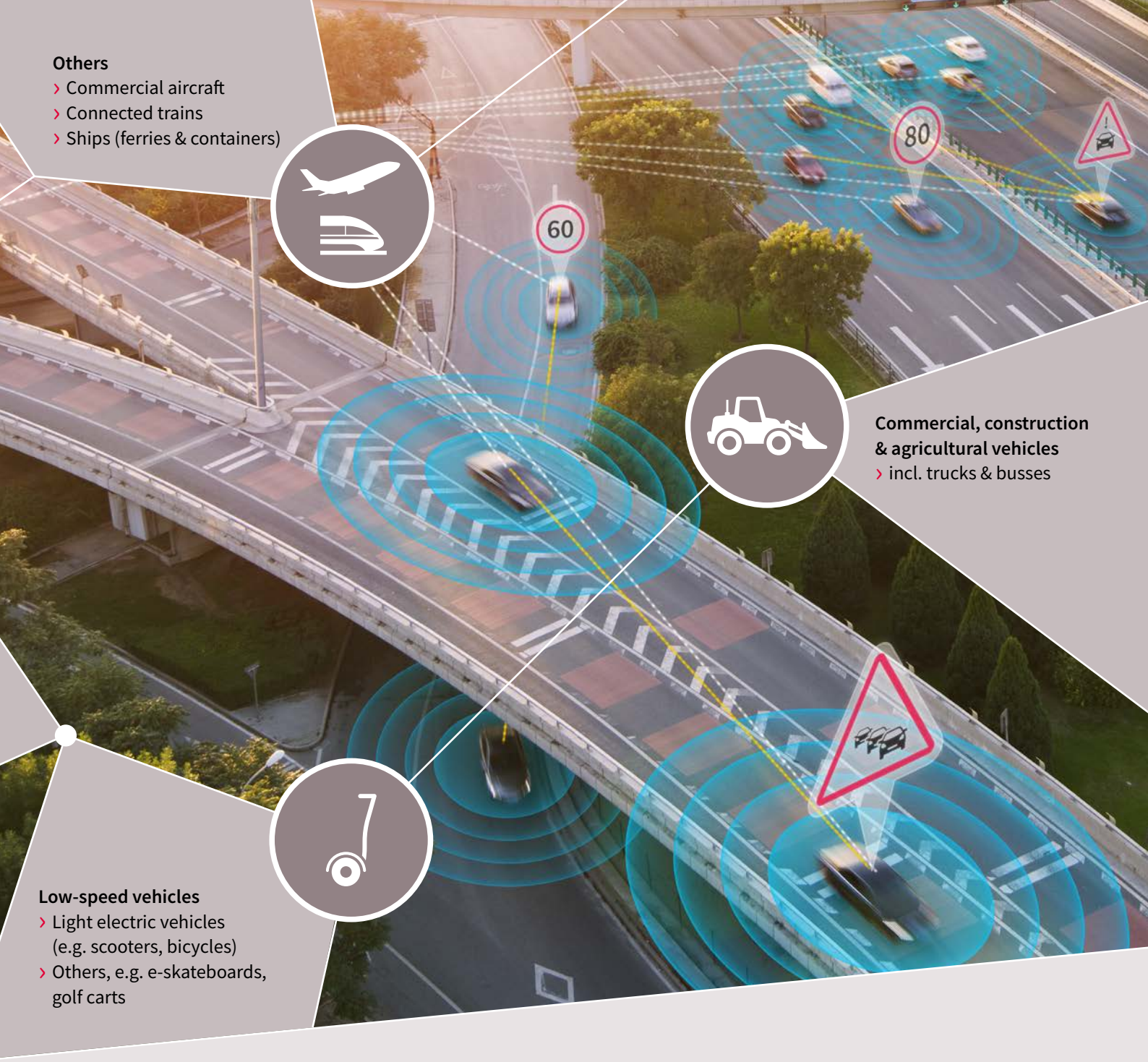
Infineon IoT solutions make vehicles safer, more secure and highly efficient while also enabling new and more services

Advanced sensing capabilities
- Radar sensors monitor the car's vicinity - basis for advanced safety features (e.g. adaptive cruise control, lane departure warning, collision avoidance), and hence autonomous driving
- REAL3™ 3D image sensor for gesture control and driver monitoring

Cross-application control
- AURIX™ microcontrollers
  - ensure secure data transfer within in the car's network through sensor fusion complying with the strictest safety standards
  - support advanced Ethernet connectivity and providing additional feature sets such as real-time capability and time synchronization, essential for reliable telematics

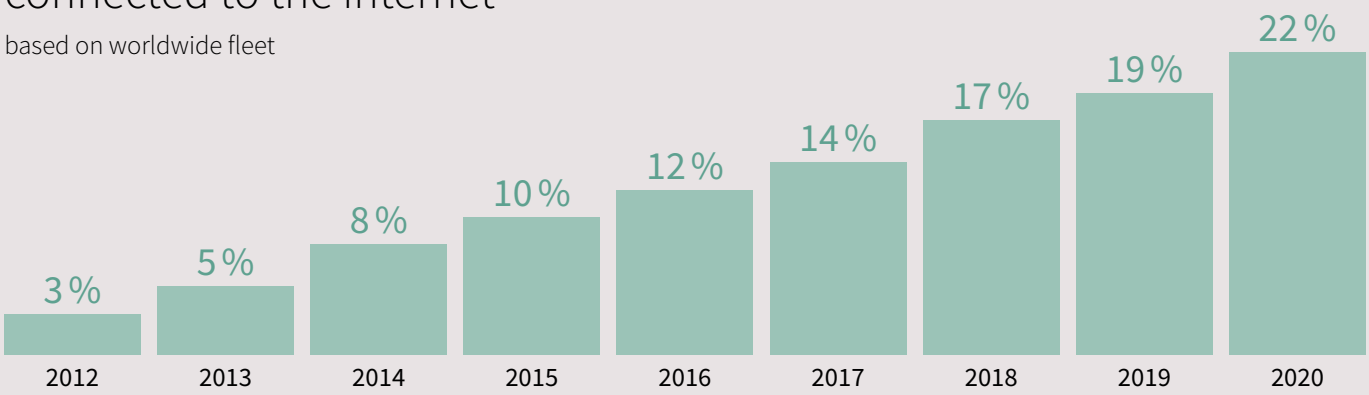
Smart power management
- HybridPACK™ IGBT module family for most efficient HEV powertrain solutions

Trusted security protection
- OPTIGA™ TPM for external communication between car and service provider/OEM, act as an anchor of trust in infotainment, telematics and software-over-the-air systems
- Secure element for e.g. system gateways for V2V communication



The percentage of cars connected to the internet

based on worldwide fleet



Source: Statista

Energy
› Generation (renewables)
› Advanced transmission & distribution
› Storage

Professional lighting
› Building lighting
› Street lighting

Building automation
› Automation
› Access control

Infrastructure
› Utilities (e.g. drinking/waste water), traffic (e. g. electronic toll collection), outdoors, government
› Environmental sensors

Smart city & energy

As more and more people migrate to cities, public administration bodies are looking for ways to make these urban infrastructures and their energy systems smarter, more secure and power-efficient. This requires embedded systems. Semiconductors from Infineon play an important role in achieving these objectives. Our solutions range from professional lighting systems based on state-of-the-art LED technologies through smart infrastructure and transportation systems enabled by environmental sensors and microcontrollers to smart and secure building technologies. We also support the power-efficient generation, storage, management and distribution of energy. Unlike other players, we are not new to this market – we have been innovating for years and even decades.

Infineon IoT solutions make cities smarter, greener and more liveable

Advanced sensing capabilities

› Radar sensors for motion detection enable, for example, ultra-efficient lighting control (indoor and outdoor)
› Silicon microphone for emerging IoT applications controlled by voice

Cross-application control

› XMC™ microcontrollers for control, communication and sensor management in a variety of building automation applications

Smart power management

› Power ICs and modules
  – for building a reliable and highly efficient energy infrastructure
  – for building energy management and building automation

Trusted security protection

› OPTIGA™ family for secure communication and trusted computing in critical energy infrastructures
› Chip card ICs enable secure e-payment of EV charging
› M2M SIM for secure connectivity via GSM, GPRS, EDGE, UMTS, LTE

Smart industry & business

Smart factories supporting advanced automation and robotics is one of the areas where the impact of the IoT is most evident. More intelligence is also being built into mining, payment, logistics and medical equipment. Microelectronics is the key enabling technology for these industrial scenarios. Our industrial sensors, microcontrollers, power modules and switches along with our industry-specific security chips enable high-level responsiveness, best-in-class system control and integrity as well as the ultimate in power efficiency even under the most demanding networked production conditions. Our long-standing experience in industrial automation enables us to deliver industrial-grade IoT semiconductor solutions along with a range of proven reference designs to make automation design as simple, efficient and reliable as possible.

Infineon IoT solutions bring sustainable success to the fourth industrial revolution

Advanced sensing capabilities

› Hall sensors and pressure sensors for speed, position, angle and pressure measurements

Cross-application control

› XMC™ microcontrollers for factory automation applications

Smart power management

› Intelligent power module MIPAQ™ Pro assure high quality and reliability of the original system in IoT set-ups
› CoolSIC™ power semiconductors based on Silicon Carbide reach the ultra-high efficiency levels in power density and form factor which are key for industrial IoT applications
› Power ICs for efficient power management for industrial controllers and smart robotics

Trusted security protection

› OPTIGA™ family for IP protection, secure communication, authentication and trusted computing in critical industrial installations
› M2M SIM for cellular wireless connectivity
› NFC tag enable smart asset tagging (smart manufacturing)

Other business

› Banking & securities, education, mining, retail and wholesale, transportation and logistics, etc.

Factory automation

› Industrial automation
› Industrial robotics

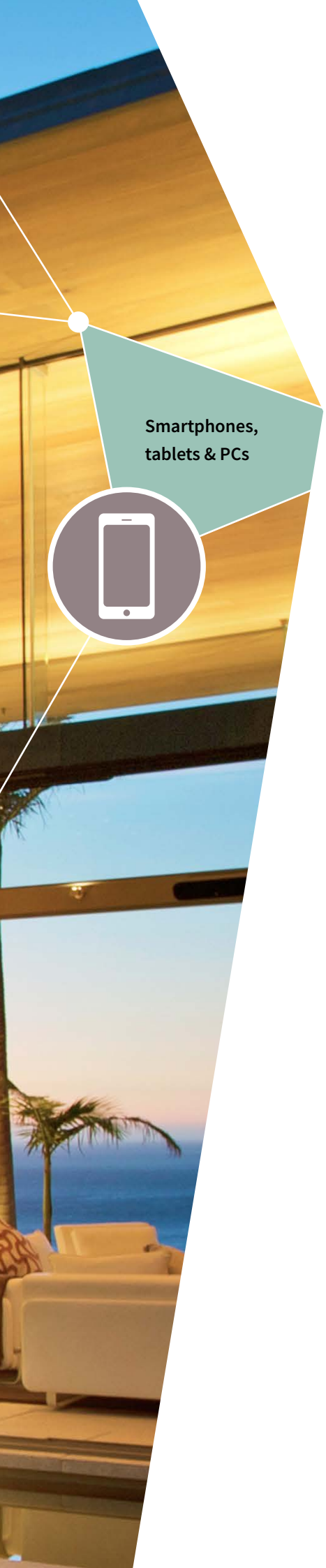
Medical equipment

Smart home

- Home automation incl. home appliances
- Home energy management
- Home security & safety
- Lighting

Consumer electronics & wearables

- Media players, smart glasses, smart watches, etc.
- Well-being (health & fitness, assisted living, etc.)
- Gaming



Smart home & consumer devices

Smart consumer devices range from smartphones, tablets, PCs and gaming consoles to new intelligent consumer gadgets like smart watches and wearables. Smart homes support a growing range of intelligent functions such as automation, home energy management, home security and safety and intelligent lighting. Our advanced semiconductor solutions play a key role in enabling connectivity across smart homes and devices. We deliver a complete line of electronic components to manufacturers of home and consumer products; components which are indispensable for making the personal IoT smarter, more secure and more power-efficient.

Infineon IoT solutions facilitate the creation of smart homes, state-of-the-art appliances and next-generation consumer devices

Advanced sensing capabilities

› REAL3™ 3D image sensor for gesture control, e.g. smart TVs
› Barometric pressure sensor delivers a new level of accuracy for wearable gadgets and IoT devices

Cross-application control

› XMC™ microcontrollers for control, communication and sensor management in a variety of smart home applications, e.g. lighting

Smart power management

› Power management ICs for smart high-density chargers

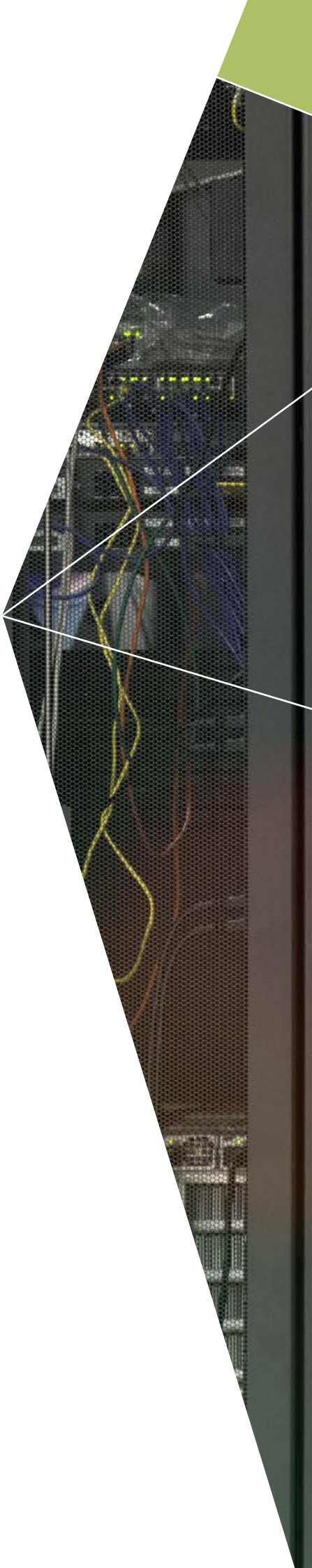
Trusted security protection

› OPTIGA™ Trust for authorized connection of intelligent objects to smart home environments
› OPTIGA™ family ensures secure communication, e.g. as part of a Home Energy Management System (HEMS)
› NFC security controllers for mobile payment services

Smart ICT

(Information & Communication Technology)

All IoT solutions and services are built on a smart ICT infrastructure. As the IoT becomes ubiquitous, ICT providers are challenged to support rising data volumes, higher transmission speeds and increased data storage/processing capabilities. Furthermore, modern ICT has the potential to considerably reduce overall emissions by enabling new environmentally friendly solutions such as smart vehicles, smart buildings and smart factories. As a leading provider of smart ICT network technologies as well as semiconductor solutions for servers and data centers, we are ideally placed to help customers achieve their goals for energy efficiency, security and reliability. As the long-standing market leader and innovator in trusted computing, we offer a broad portfolio of standardized and certified security solutions for networking equipment, including routers and gateways. In addition, as the number 1 provider of power semiconductors, we offer a comprehensive portfolio of leading-edge semiconductors to enable industry-leading PUE (power usage efficiency) and DCIE (data center infrastructure efficiency). We are also a key provider of the RF power devices needed to power the communication networks of tomorrow.



Infineon IoT solutions meet the rising demands of future ICT networks and data warehouses

Smart power management

- Power management ICs for smart high-density chargers
- IGBT power modules and drivers ensure ultra-reliable and highly efficient uninterruptable power supply

Trusted security protection

- OPTIGA™ family as anchor of trust for interaction between devices and networks

Other IoT enablers

- RF chip sets enable gigabit wireless backhaul solution, pave the way to 5G


Communication networks
Data centers / server farms

Teaming up for sustainable IoT success

To fulfill our vision of a sustainable IoT, we are constantly working together with leading global organizations and business partners to push innovations further to make life easier, greener and safer.

Industrial Internet Consortium (IIC)

Since January 30, 2015, we have been part of the highly respected Industrial Internet Consortium (IIC). One of the most influential industrial consortia, IIC is developing requirements for collaboration and security in the internet used by industry. Through the IIC, we are supporting the development of globally oriented integrative production technologies. Here we assume that generally applicable standards will contribute to secure networking of production technologies across the board.

European Cybersecurity Industry Leaders (ECIL) workgroup

Created in early 2015 following a suggestion from the then European Commissioner Neelie Kroes, the ECIL workgroup brings together selected industry experts from across Europe to advise the European Commission on its cybersecurity strategy. In January 2016, ECIL presented its first report “Recommendations on Cybersecurity for Europe” to Günther H. Oettinger, European Commissioner for Digital Economy and Society.

Trusted Computing Group (TCG)

The Trusted Computing Group (TCG) is a non-profit organization which defines, develops and promotes open and vendor-independent global industry standards for compatible trusted computing platforms. We are one of the founding members and have been contributing our expertise to the development of standards via various working groups since 2003. In our role as chair of the TCG, and as the first company to offer a product with the new TPM 2.0 standard, we have a major influence on a market that extends from conventional PC applications to the IoT.

PI4.0, Germany (Plattform Industrie 4.0)

Plattform Industrie 4.0 has over 250 participants from more than 100 organisations, by thus forming the largest Industrie 4.0 network worldwide. Infineon is an experienced user of and a supplier for Industrie 4.0 technology, at the same time. Being a member of the steering committee and in several working groups, Infineon contributes actively bringing sustainable success to the fourth industrial revolution.

industrial internet® CONSORTIUM

TRUSTED COMPUTING GROUP™

fido alliance member

Plattform INDUSTRIE 4.0

FIDO (Fast IDentity Online)

We are a board member of the FIDO Alliance, which currently has more than 150 well-known members. FIDO promotes improved authentication technologies in order to enhance security and usability in login processes in the connected world. We play an active role in drawing up specifications and standards, while at the same time offering specific reference designs on the basis of hardware-based security controllers.

"Globally accepted security standards are key for developing sustainable IoT solutions. With active participation in international alliances such as the Industrial Internet Consortium , Trusted Computing Group or the FIDO Alliance we make sure that security measures are well defined and easy to use."

Joerg Borchert, Vice President of the Chip Card and Security Division at Infineon Technologies Americas Corp.

AIOTI Association (in foundation)

The more informal Alliance for Internet of Things Innovation (AIOTI) was launched by the European Commission (EC) and various key players in IoT in 2015. The goal is the creation of a dynamic IoT ecosystem to unleash the potentials of IoT. The formal foundation of the AIOTI Association will now ensure sustainability by assisting the EC in the preparation of future IoT research as well as innovation and standardization policies. Infineon concluded to actively contribute to those activities by becoming one of the first members of this association.

Infineon Security Partner Network

Given the rising need for security in a connected world, security solutions must be end-to-end, easy to implement, transparent and tailored to the applications' cost constraints.

The Infineon Security Partner Network is a place for security players to deliver security solutions to providers of connected devices and applications. This network conveniently enables you to understand security needs in the context of their application and offers tailored support for the implementation and deployment of security solutions. It supports the use of hardware-based security as trust anchors for connected devices.

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