PARTNER CONTENT

From Presence Detection to Vital Sensing: How to Develop Your IoT Solution Quickly

By Alessandra Fusco, System Application Engineer, Infineon Technologies AG

The Internet of Things (IoT) is on the rise. Smart devices are unlocking the benefits of technology that help to create added value for people and increase productivity in the industry. However, the IoT also presents many challenges, like the complexity of working with new technologies and the need to acquire and process data to make smart decisions. In other words, it is challenging to transform product features into system solutions. Infineon is addressing such challenges by offering ready-to-deploy solutions based on the XENSIV™ connected sensor kit, a prototyping platform for simplifying and accelerating the development of new applications and innovative use cases.

While there are many ways to define the Internet of Things (IoT), it is most commonly referred to as a network of "things" connected to the internet. "Things" are physical objects equipped with sensors, actuators, processing capabilities, and connectivity. The devices populating the IoT world are often defined as "smart". The smart part can largely be the result of collected and interpreted sensor data, used to trigger actions. A connection to the internet or a dedicated cloud is required so that devices can interact with each other, exchange data within the network, and be controlled remotely. In this way, IoT technologies can help address social challenges, add benefits for people, and increase productivity in the industry.

Billions of connected devices are already in use and this number is expected to grow steadily in the future (**Figure 1a**). The IoT infrastructure is one of the most significant drivers for smart home market growth. According to Statista, the number of smart devices populating our homes will double globally by 2027 (**Figure 1b**).[1]

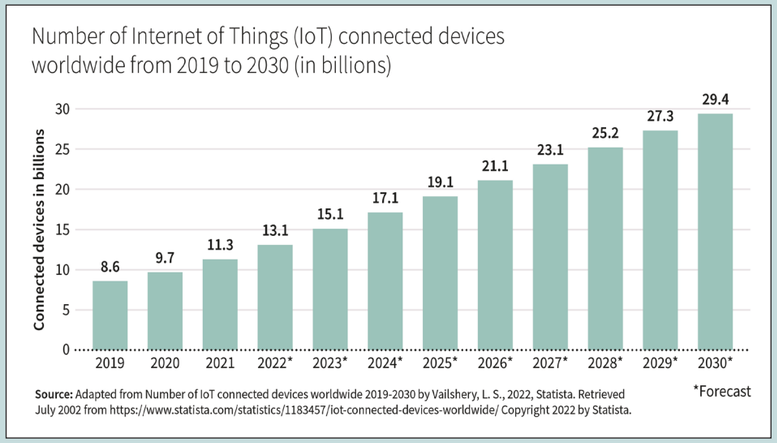

Figure 1a: *Number of IoT connected devices worldwide 2019–2030 (in billions)*

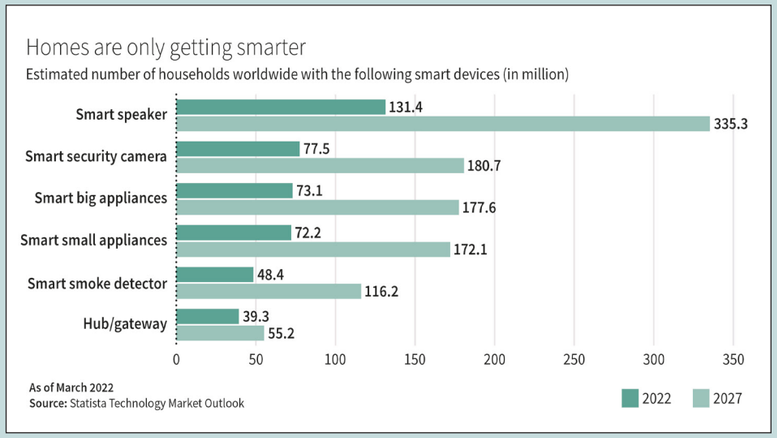

Figure 1b: *All product types included in the smart home analysis are set for huge growth in the near future.*

UNLEASHING THE POWER OF THE IoT

At the heart of every IoT solution, you find microelectronics: sensors, actuators, microcontrollers (MCUs), communication modules, and security components. These components enable the system to measure and process the relevant environmental data and connect to the internet. To build a successful IoT device, however, it is not enough to have access to the physical modules. These must be integrated into a network quickly and efficiently, a large amount of data has to be processed in an intelligent way, and a stable and secure connection to the cloud has to be established.

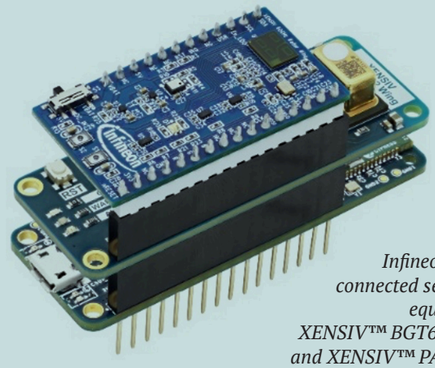

Figure 2: *Infineon's XENSIV™ connected sensor kit (CSK) equipped with the XENSIV™ BGT60TR13C radar and XENSIV™ PAS CO2 sensor. For more information, visit* www.infineon.com/connectedsensorkit

To overcome such fundamental challenges and further accelerate development, Infineon offers a dedicated development platform that enables engineers to implement their IoT ideas quickly, easily, and securely. The XENSIV™ connected sensor kit (CSK) is Infineon's first IoT sensor platform (**Figure 2**), enabling fast prototyping and development based on Infineon's radar, environmental sensors, and other sensors. Customers who want to quickly design and deploy IoT solutions can access Infineon's all-in-one development ecosystem with comprehensive sensor libraries and application code examples for sensor and connectivity use cases.

All of these features enable customers to significantly reduce the time from proof of concept to fully developed IoT design for smart home or smart building applications.

THE BUILDING BLOCKS FOR INFINEON'S IoT PLATFORM

The XENSIV™ connected sensor kit (CSK) includes four fundamental building blocks (**Figure 3**):

- **Sense:** Sensors give IoT devices human senses, building situational awareness. Among Infineon's wide sensors portfolio, the XENSIV™ DPS368 barometric pressure, XENSIV™ BGT60TR13C 60 GHz radar, and XENSIV™ PAS CO2 sensor are already integrated into the CSK. Additional sensor implementations will be added at a later date. The sensing elements are featured in a reference design including all the necessary components such as voltage regulators, voltage converters, and oscillators.[2] This saves considerable time and resources in design and testing phases, reducing technical risks as well as BOM cost.
- **Compute:** MCUs process the acquired data, take decisions, and coordinate the communication of the device. The requirements for MCUs in the IoT space are as diverse as the IoT applications themselves. The CSK features the PSoC™ 62, a low-power and high-performance 32-bit Arm® MCU designed for the IoT. Application code examples are provided via the ModusToolbox™ software environment to facilitate the evaluation and development on the PSoC processing platform. The code examples offer three distinct layers: the board-support package (BSP), which includes the configuration instructions for clock, peripherals, and pins of the reference board; the sensor driver, which includes the functions for interfacing with the XENSIV™ sensors; and the algorithm layer, which includes the entire signal-processing chain from sensor raw data to processed application output.
- **Connect:** In order for devices to communicate with each other and with the cloud, modules need to connect to the IoT. For IoT designs with a small-form factor, Infineon's CSK offers the AIROC™ connectivity combo module integrating dual-band 2.4 GHz and 5 GHz Wi-Fi 4 (802.11n) and Bluetooth® 5.0 in a single-chip solution. Regarding software assets, the MQTT client implementation is demonstrated using the CSK. MQTT is an open-source publish/subscribe communication protocol highly popular in IoT, as it can be used across platforms while consuming minimal bandwidth. Publisher and subscriber are spatially decoupled. The client connects to the configured MQTT broker: The client sends messages (publisher) to communicate sensor events and receives messages (subscriber) from the broker. The user is not required to generate certificates and keys for client identification; Infineon takes care of this.
- **Secure:** Security is fundamental to the IoT because only with sufficient security and privacy in embedded systems is it possi-

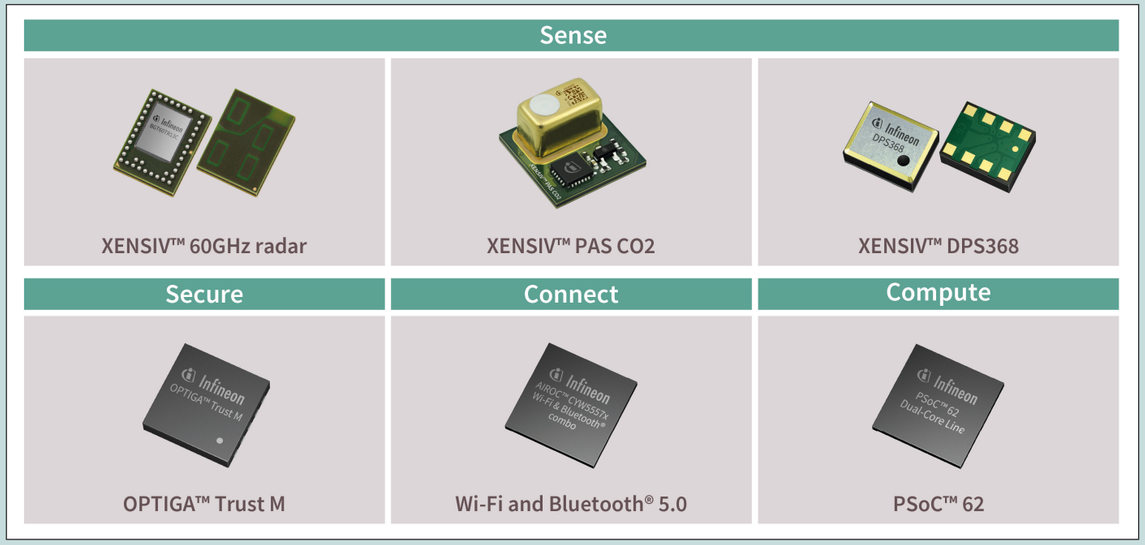

Figure 3: *Components featured on Infineon's XENSIV™ connected sensor kit*

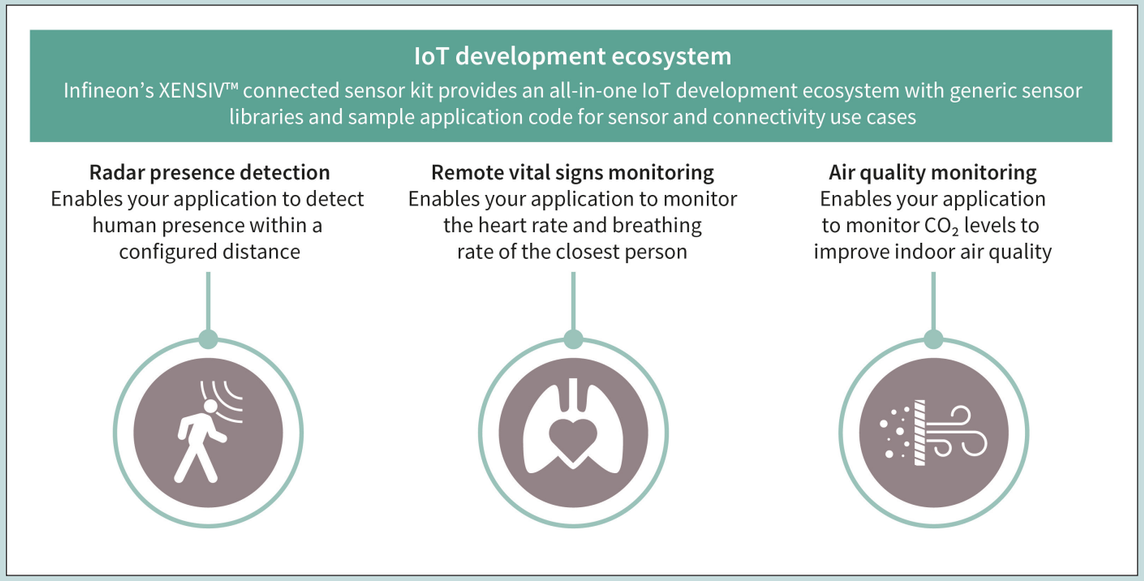

Figure 4: *Examples of innovative use cases enabled by the XENSIV™ connected sensor kit*

ble to create the trust necessary to enhance and fully explore the possibilities of the IoT. This is where Infineon's OPTIGA™ Trust M comes in, offering an ideal solution for embedded security solutions and secure mobile connectivity when using the CSK. When running the OPTIGA™ Trust M setup, you can benefit from the host library, which implements a dedicated API to interact with the security chip, and from exemplary applications like mutual authentication, secured communication, data-store protection, and secured OTA software updates.

CSK-ENABLED USE CASES

The capability to acquire, process, and interpret data, paired with the capability to communicate and interconnect with other devices, is becoming a powerful tool to reduce power consumption, increase safety in multiple environments, and even make our daily life more comfortable.

As an example, one highly requested feature for smart devices is presence detection, to notify whether a human target is nearby. Lighting, sound, heating, cooling, ventilation, and access systems can all benefit from such information and can be activated in a timely manner, increasing user comfort but also saving energy. Infineon's high-sensitivity radar-based presence solution provides the ability to detect not only macro movements but also micro movements. The user interaction with the devices becomes more spontaneous, as the user no longer has to wave in front of the sensing element to ensure a reaction. Sensor integration as well as algorithm development constitute major challenges, but this is where Infineon's CSK can help, providing a reference design and ready-to-deploy use case for presence detection.

Another use case can be found in health care and well-being: Infineon's XENSIV™ 60 GHz radar sensor can detect the subtle movements of the human chest induced by cardiorespiratory activity. Infineon's radar solution guarantees continuous monitoring of breathing and heartbeat, without the need for direct contact with the user or the recording of privacy-sensitive information. Continuous vital sign tracking can be used to increase our health awareness but can also enable health-care professionals to study how vital signals correlate with age, gender, and lifestyle habits. The solution provides timely information on the health and well-being of different population groups: Seniors can be monitored continuously in their home, potentially reducing the number of visits to hospitals and doctors' clinics; infants can be monitored overnight, bringing convenience and reassurance to parents, who do not need to remain constantly close to the nursery.

When the CSK is coupled with the XENSIV™ PAS CO2 sensor, continuous air-quality monitoring can be enabled. Poor ventilation can result in lower oxygen levels and a buildup of carbon dioxide (CO_2). Even moderate levels of CO_2 can have a negative impact on health and productivity: Already at 1,000 ppm, people begin to experience drowsiness and have difficulty concentrating. It is certainly good if the CO_2 sensor issues a warning as soon as the quality of the air in a room deteriorates. However, to take full advantage of the possibilities of the connected world, the CO_2 sensor is expected to stream such warning to the automation system, which would then react accordingly by regulating the ventilation system or automatically opening the windows. Smart homes equipped with real-time CO_2 monitoring systems can benefit from improved air quality and greater comfort thanks to demand-controlled ventilation systems, air purifiers, and thermostats.

One aspect to consider is the enormous potential for energy savings, as the connected devices are active only when the user is within range. About 50% of energy consumption in the EU is attributable to heating and cooling systems in buildings and industry.[3] For example, a ventilation system equipped with Infineon's CO_2 sensor can save up to 55% of energy consumption.[4,5] The effect is even higher when the buildings are additionally equipped with smart thermostats and building-automation systems.

Some of these use cases (**Figure 4**) are already implemented in the CSK as ready-to-deploy IoT solutions. However, Infineon's IoT development platform is ready for new use-case implementation: Engineers can simply make use of the available code examples to explore the countless future applications to bring users more comfort and convenience while becoming more environmentally friendly.

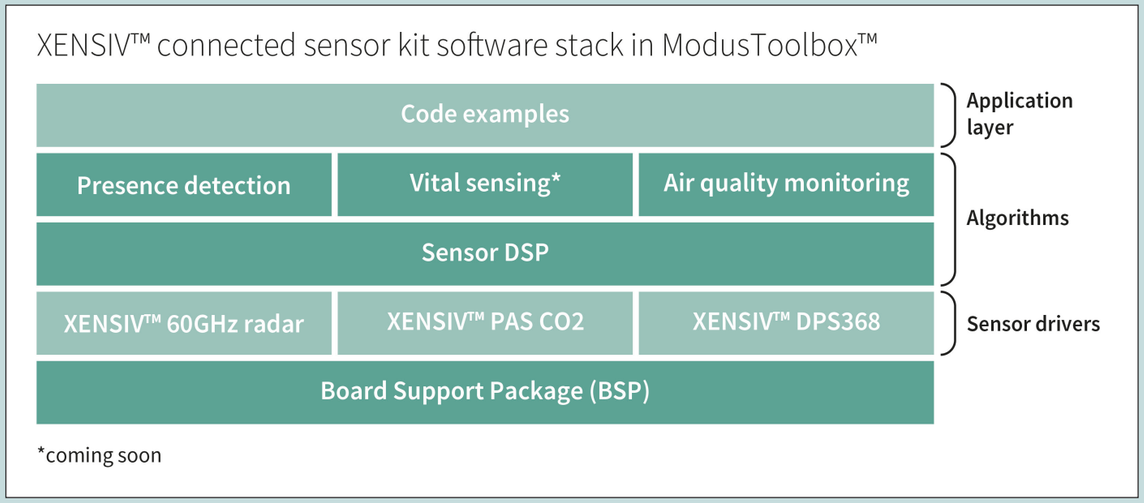

Figure 5: *XENSIV™ connected sensor kit software stack in ModusToolbox™*

CONCLUSION

The development of reliable smart solutions requires multiple components to work well together — a real challenge for engineers, especially given the huge choice of manufacturers and the in-depth knowledge required to master each component. The interplay of wireless and embedded systems cannot be ignored, nor can security, cloud integration, and energy management. In addition, environmental data must be collected, merged, and processed to control how connected devices act and react. Tackling all of these challenges is time-consuming and requires significant expertise. The development of IoT devices can be accelerated using Infineon's XENSIV™ connected sensor kit: The kit not only enables the collection of accurate and diverse data but also puts situational awareness to good use. ■

REFERENCES

[1] Statista. (April 26, 2022). "Homes Are Only Getting Smarter." *bit.ly/3QcbpdB*
[2] Further details can be found in the user manuals for KIT_CSK_BGT60TR13C (*bit.ly/3SeelYW*) and KIT_CSK_PASCO2 (*bit.ly/3PTqZLj*).
[3] European Commission. "Heating and cooling." *bit.ly/3vB0tya*
[4] Jin et al. (2016). "Occupancy Detection via Environmental Sensing."
[5] Wang et al. (2020). "Energy saving impact of occupancy-driven thermostat for residential buildings."

ModusToolbox™

Infineon's ModusToolbox™ software is a modern, extensible development environment supporting a wide range of Infineon's MCU devices. It provides a flexible set of tools and a diverse, high-quality collection of application-focused software. These include configuration tools, low-level drivers, libraries, and operating-system support, most of which are compatible with Linux-, macOS-, and Windows-hosted environments.

Figure 5 summarizes the entire ModusToolbox™ software stack for the connected sensor kit, from the BSP to the application layer.

Learn more at *www.infineon.com/cms/en/design-support/tools/sdk/modustoolbox-software/*.