

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

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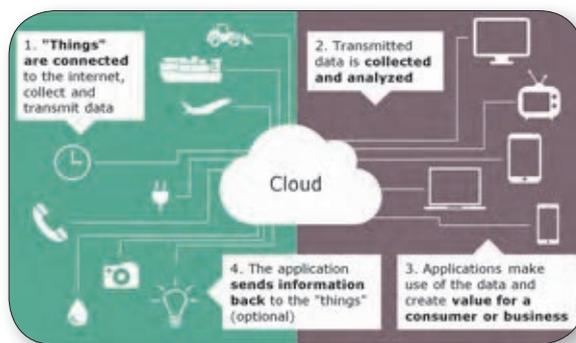


Figure 1. The Internet-of-Things and the flow of information

■ The Internet of Things (IoT) has become one of the most important technology trends of recent years. IoT devices are showing up everywhere and radically changing how we do business and interact with the world around us. Our offices, our homes, our factories, our automobiles, and the things we wear or carry in our pockets are all being equipped with embedded electronic systems, sensors, and even Artificial Intelligence (AI) software. These IoT devices that were once a science fiction dream are rapidly becoming an irreplaceable part of our daily lives.

Devices equipped with intelligent semiconductor components are forming the foundation of the smart, secure, and power efficient IoT that is developing around us. The “smartness” of these systems is achieved by stretching the boundaries of current design and technology. The intelligent devices (which were stand-alone in the past) are interconnected in ways that were not possible even a few years ago and AI algorithms are being used to process the vast amounts of sensor data that is being produced. This exciting marriage of IoT and AI requires state-of-the-art sensors, security, and power delivery to make it all possible.

IoT and AI in the real world

There are many varying definitions and opinions of just exactly what IoT is and how it is related to AI. When you filter through all of the details, you end up with a simple,

basic explanation. IoT is the networking of cyber-physical objects that contain embedded electronics to sense, compute, actuate, and communicate. The AI in IoT devices processes the sensor data from the embedded electronics, analyzes it, and attempts to understand the surrounding environment and events. Given the incredible potential behind this concept, it’s hardly a surprise that companies all over the world are taking steps to combine IoT and AI in new and creative ways. One interesting example is in the emerging “smart city.” It is rapidly becoming apparent to city administrators that smart networked infrastructure is playing an increasingly important role in defining the world we live in. Designers are rethinking common everyday objects and adding new functionality or completely redesigning them. Out of this are coming new IoT devices such as smart street lamps. These new street lamps are evolving into a highly functional, connected, energy-efficient portal that is forming the backbone of the smart city infrastructure. It is this marriage of IoT and AI that provides street lamps that can sense approaching vehicles and brighten or dim the light accordingly. The street lamps can sense empty nearby parking places and communicate this to navigation systems in cars. These street lamps can also do things like provide E-Vehicle charge ports and even monitor and analyze the performance of the light itself and inform a central monitoring systems when they are in need of preventative maintenance.

IoT Street lamps with built-in AI are not just fantasy though. This is a very real concept that has been born out of collaboration between Infineon, Intel, and a Munich based startup company, eluminocity. Street lights with this feature are already in place in various cities around the world such as Munich, Chicago, Oxford, and Eindhoven, with more installations to follow. IoT and AI is opening up new markets and even enabling markets that previously have not been possible or even imagined. The invention of the home computer, the development of the internet, the progression to cloud computing; each step along the way has paved the road to IoT. Combining IoT with AI is opening up a whole new world of possibilities.

Challenges and Solutions

While the devices themselves and the AI algorithms are key to this emerging technology, the increasing number of devices coupled with the growing power requirements and the critical need for security is presenting designers with some big challenges. The power levels required for this new AI technology for example are simply staggering. In order to match the processing power of a human brain which consumes roughly 20 Watts, an AI system would need to perform more than 38 thousand trillion operations per second (38 PFLOPS) consuming more than 15 Megawatts of power in the process. Simply delivering these levels of power is challeng-



Figure 2. The eluminocity LED smart street lamp (source: eluminocity)

ing enough. Efficiency is absolutely critical, not only as energy costs are rising, but also as every watt of waste energy dissipated as heat increases the air conditioning requirements in the datacenter, further increasing operational costs and carbon footprint.

The networked connectivity of these IoT devices is also raising some interesting challenges. The AI systems behind the devices need to transmit vast amounts of data, and do it in a secure way that protects not only the devices themselves, but also the data. It has been estimated by Gartner that over 20 billion IoT devices (not including smartphones, tablets, and computers) will be ‘connected’ by 2020. Data traffic and volume is at an all-time high - driven by the machine-to-machine communications of the IoT. All of these devices also need an increasing num-

ber of sensors – radar, temperature, pressure, motion, light levels, sound, proximity, the list goes on. All of these sensors have to be integrated into a smaller and smaller space.

Given the vast array of challenges facing today’s IoT designers and the AI programmers, what solutions can be considered? Infineon provides a large number of sensing devices which are perfect for use in IoT devices. Infineon’s BGT24LTR11 for example is the market’s smallest 24 GHz industrial radar chip solution. The BGT24LTR11 is a silicon germanium radar Monolithic Microwave Integrated Circuit (MMIC) transceiver. It operates in the 24.0GHz to 24.25GHz ISM band and it provides a very high level of measurement precision. With Infineon’s 24GHz radar portfolio, one can measure various parameters including Doppler-based object speed and velocity, and electromagnetic wave based distances. Additional receiving channels allow it to detect angle and direction based upon phase detection at the antennas. 24 GHz radar technology is found in multiple applications including UAV/multicopters, service robotics, industrial robotics, security systems, smart street lighting, and many other IoT-based applications.

A sophisticated approach to power management and design is required to meet the electrical demands of IoT and AI. In order to address this, Infineon has introduced advanced digital control techniques, replacing the legacy analog-based solutions. Digital control brings many benefits when designing high-end power solutions, not least overall system flexibility and adaptability. With digital technology, controllers can be customized without the need for expensive and time-consuming silicon spins. The customization extends to defining the configuration, telemetry for gathering system performance data, setting fault management and calibrating the device. As power systems become more integrated into the overall solution, communication between the power solution and the main CPU / GPU / TPU is a new requirement.

Infineon’s mature digital controller technology facilitates market-leading solutions and includes a GUI that enables real-time system design, configuration, validation and monitoring.

Digital solutions simplify building the scalable power solutions required for AI. Yet with all of the included functionality and precision delivery of power, they are now price competitive with the analog solutions they are ultimately replacing. Infineon’s complete portfolio includes huge breadth of products including digital controllers, integrated power stages, integrated power management ICs, Point-of-Load (POL) converters as well as discrete solutions including driver ICs, power blocks and discrete MOSFETs. The range is built upon Infineon’s long history of innovation and comprises multiple market-leading technologies such as OptiMOS™, DrMOS™ and μ DrMOS™.

The connectivity that provides the core of the IoT comes with some potential security vulnerabilities. Infineon’s OPTIGA™ family of reliable security solutions addresses this issue and helps secure the IoT networks. These standardized security controllers provide a broad range of security functions for embedded platforms. All OPTIGA products are based on Infineon’s advanced hardware security technology that gives you as a designer or end user, confidence that your data is secure and protected. Embedded security functions include system and data integrity, authentication, secured communication, secured data storage, and secure updates. Each of these functions is essential to protecting the data integrity as data is collected and analyzed by AI. The OPTIGA family, built around a 16-bit state-of-the-art security controller, is easy to integrate into a wide range of IoT systems. Support for both Microsoft Windows and Linux (and its derivatives), and integration support for proprietary systems make OPTIGA an ideal choice. The family also contains TPM devices that are the first to support the latest TPM 2.0 standard from

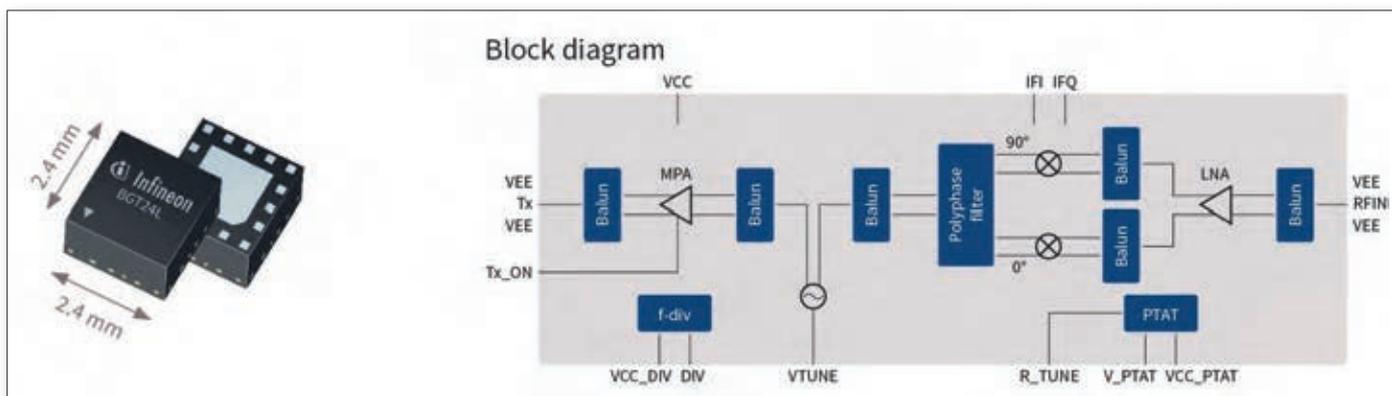


Figure 3. Block diagram and package size of the BGT24LTR11 24 GHz industrial radar chip



Figure 4. Efficient power management and data security

the TCG, making it easy to implement the very latest security protocols. While IoT and AI is still early in its development, it is already being recognized to be an important and rapidly growing technology trend with expected substantial impacts on the world around us. These pioneering IoT devices coupled with newly imagined AI algorithms are challenging designers on many fronts. The traditional hardware designs are rapidly migrating from their humble beginnings as stand-alone single use devices, to highly advanced smart tools that are networked together in ways that we

only imagined in science fiction stories and movies. The combination of IoT and AI will reshape and redefine our lives and businesses in ways we cannot yet imagine. We cannot wait for the full impact of this change before we react. Instead, we must move forward together, developing and innovating, finding ways to secure the IoT communications, improving the power efficiency, and inventing new ways to sense the world around us. The IoT and AI revolution is on our doorstep and now is the right time to step up and prepare for it. ■