QUECTEL

Build a smarter world

Smart modules white paper

Why smart IoT modules are the enabler for advanced, intelligent edge devices

made with Qualcomm Technologies

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Introduction

A smart IoT module, as the name suggests, is a module that brings greater intelligence and capability to an IoT device than a single-function connectivity modem, for example.

Smart IoT modules bring together functions, such as computing, graphics processing, data storage and connectivity, that were previously separate, into a single unified, highly compact item of hardware. The benefits for IoT developers are obvious because specifying smart IoT modules takes away the need to design-in multiple function-specific modules and integrate these into a finished product or device. This means faster development, fewer components, and smaller packaging.

The smart module concept is therefore highly appealing, but it comes with a series of challenges that developers need to overcome if they are to design advanced, intelligent edge IoT applications. Smart modules have emerged alongside breakthrough technologies in connectivity, power management and security as well as innovations in computing and graphics processing. These technological developments mean devices can now do more with less and advanced technologies such as edge intelligence and machine vision are rapidly democratizing, powering greater numbers of use cases than ever before.

The arrival of high-speed, low-latency 5G connectivity alongside cloud and edge intelligence expands the possibilities for devices, enabling applications as diverse as safety cameras and robotics and capabilities such as fixed wireless access and telemedicine. By combining privacy, security, reliability, low latency and the efficient use of network bandwidth, intelligent computing at the edge is being realized and smart IoT modules are playing a vital role in enabling devices, not only to provide connectivity but also to perform advanced device operations and functions.

> “ Smart modules have emerged alongside breakthrough technologies in connectivity, power management and security as well as innovations in computing and graphics processing

Quectel has been collaborating with Qualcomm Technologies, Inc. to develop a range of Qualcomm® IoT processor based smart IoT modules. These are bringing together low power consumption, high-performance computing, connectivity, security, and edge intelligence to power use cases.

These include:

- Market intelligence and customer personalization in business analytics
- Quality assurance and sensor fusion in industrial automation
- Self-checkout and smart carts in retail
- Predictive maintenance, energy and inventory management in operational intelligence
- Worker safety and theft prevention with safety cameras

Developers therefore need to carefully assess what they need from smart IoT modules and how they can develop devices that open new opportunities for their businesses. This new generation of devices must be power-efficient, high-performance, and secure in order to fulfil the promise and deliver use case advantages in the real world. This paper sets out the applications and use cases that rely on smart IoT modules and details key considerations for selecting the right module for a project. The paper specifically details the approaches developers can take with Quectel's range of Qualcomm IoT processor based smart IoT modules.

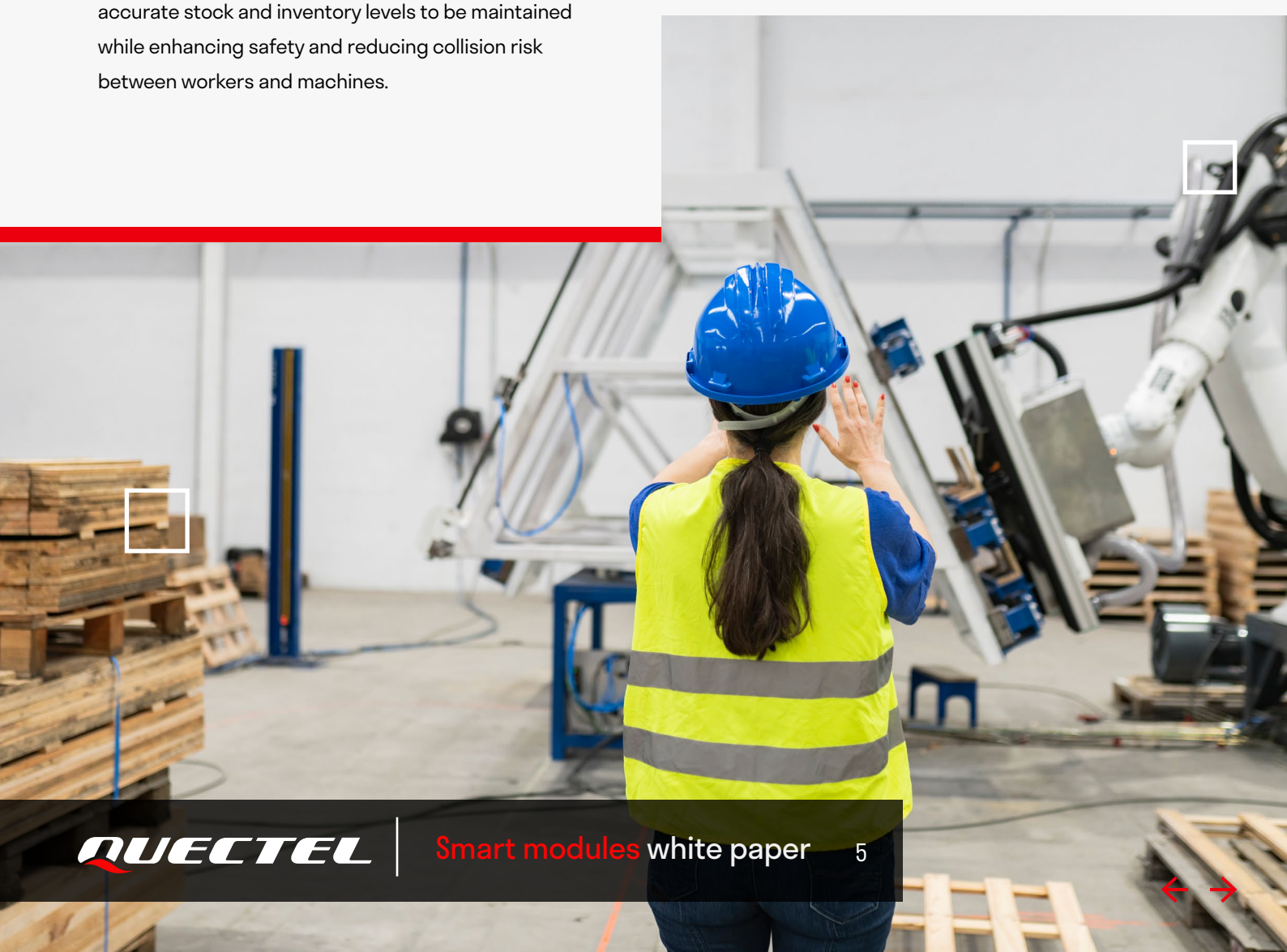
Transforming industries with smart IoT modules

Smart IoT modules are now poised to drive digital transformation across key industries including healthcare, manufacturing, public safety, retail, smart cities, smart homes, transportation and logistics and utilities. Qualcomm Technologies sees the next industrial revolution being driven by flexible manufacturing that is powered by 5G private networks, factory automation, autonomous guided vehicles (AGVs), machine vision, predictive maintenance and on-premise edge analytics and data storage.

In warehouse management, Qualcomm Technologies is enabling real-time asset monitoring with greater location accuracy within the warehouse. This enables more accurate stock and inventory levels to be maintained while enhancing safety and reducing collision risk between workers and machines.

The utilization of edge analytics and intelligence improves productivity and efficiency while enabling optimization of end-to-end delivery.

In retail, smart IoT modules are transforming experiences by enabling personalization through analyzing baskets, recommending products and delivering advertisements or coupons. In addition, sensor fusion enables information to be gathered from across the store to ensure customers are receiving optimized experiences.



Smart IoT modules build on firm foundations from SoCs

To support these innovations, Qualcomm Technologies has developed a purpose-built family of system-on-chips (SoCs) to help drive global acceleration and digital transformation for IoT. The benefits of a SoC include the ability to power edge intelligence for differentiated user experiences, integrated audio and camera support, integrated connectivity, and low power consumption alongside high performance.

The Qualcomm Technologies range of SoCs includes the Qualcomm® QCS 8250, Qualcomm® QCS 8550 and Qualcomm® QCM8550, which are designed to deliver maximum performance for edge intelligence and compute intensive premium IoT experiences.

Qualcomm Technologies also offers the Qualcomm® QCS6490, Qualcomm® QCM6490, Qualcomm® QCS5430 and Qualcomm® QCM5430 SoCs which support accelerated edge intelligence based on global multimode, 5G mmWave and Sub-6GHz connectivity and ultra-fast Wi-Fi 6E.

For those seeking greater performance, better graphics and broader connectivity options, the Qualcomm® QCS4290 and Qualcomm® QCM4290 are Wi-Fi 6 ready and for those that need robust, entry-level performance, using LTE connectivity with enhanced GPS and advanced safety camera features, the Qualcomm® QCS2290 and Qualcomm® QCM2290 are ideal options. Certain Qualcomm Technologies SoCs form part of the Qualcomm Product Longevity Program, with support for longer lifecycles and support.

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Quectel smart modules vs. traditional approach (modem+uC)

Advanced application needs

- **Edge processing**
- **Connectivity**
  - Cellular modem
  - Wi-Fi
  - Bluetooth
  - NFC
- **Positioning**
  - GNSS
  - Cell-based positioning
- **Memory/SD card**
- **Displays**
- **Cameras**
- **Sensors**
- **Buzzer/vibration**
- **Touchpads**
- **Audio equipment**
  - Microphones
  - Speaker
- **Switches (program - in/out)**

Quectel smart module

- Single-sourced
- Scalable
- Highly integrated
- Tech supported
- Feature-rich
- Transparent longevity
- Globally approved

Customer benefits

Development
Co-working of different technologies, tools

Extra features
Security, device management

Support
Single entry point for all issues

Supply chain
Lower supply risk, simplified logistics

Lifecycle management

Costs
BOM cost-saving, efficient manufacturing

Fast time-to-market

Smooth project development

Cost saving

Why smart modules are needed

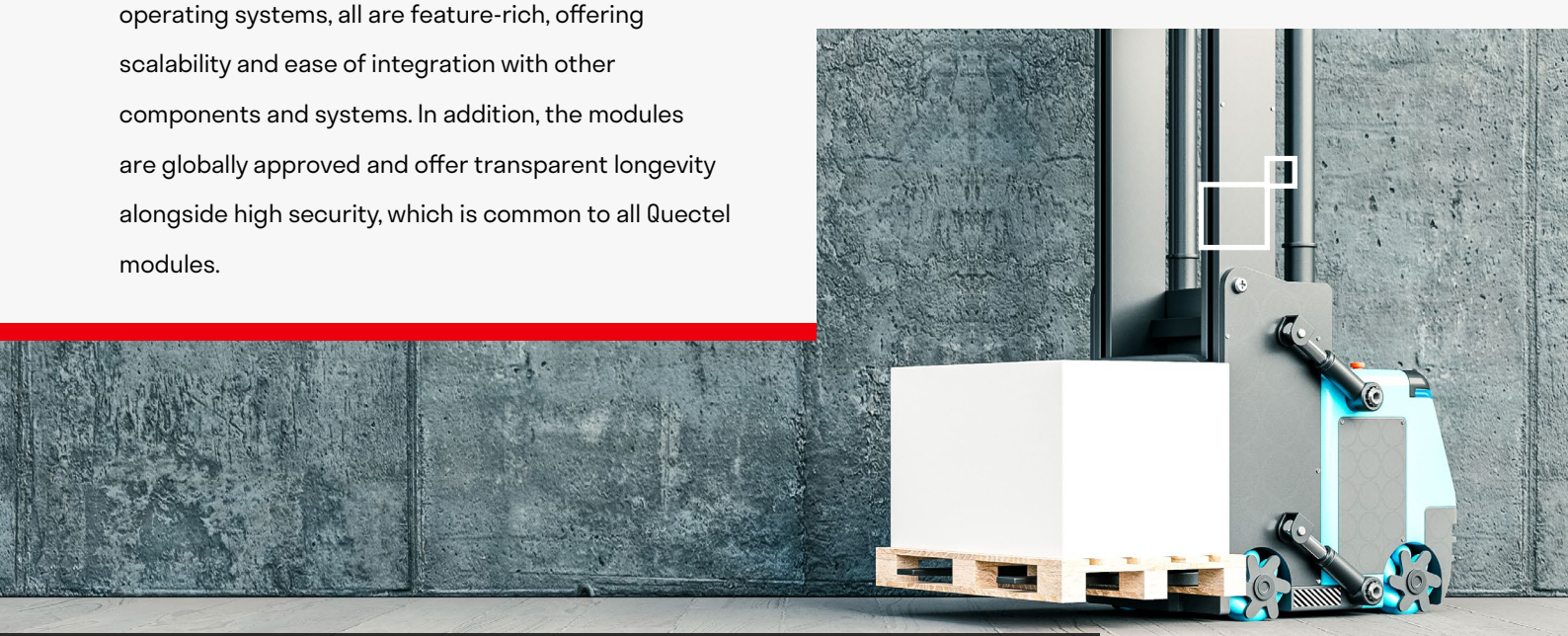
As mentioned in the introduction, smart modules bring together multiple functions in a single component. This means that an IoT smart module can contain edge processing, cellular modems, Wi-Fi, Bluetooth® wireless technology, and NFC capabilities and positioning technology either in the form of GNSS or cell-based positioning. In addition, a smart IoT module can support memory and SD cards, displays, cameras, sensors, buzzers, vibration alarms, touchpads, audio equipment and a variety of switches.

The vast array of ancillary and adjacent capabilities, functions and hardware that smart IoT modules enable means there are complex design decisions to be made regarding which smart IoT module attributes to prioritize. Quectel has developed a comprehensive portfolio of smart modules so developers can select the most suitable module for their use case. However, there are common benefits across the entire range.

Quectel smart IoT modules offer a broad choice of operating systems, all are feature-rich, offering scalability and ease of integration with other components and systems. In addition, the modules are globally approved and offer transparent longevity alongside high security, which is common to all Quectel modules.

For customers, this feeds through to benefits in development that come in the form of smooth co-working of different technologies and access to tools to accelerate and simplify development. Additional features such as device management and security further streamline and simplify the process and Quectel's excellent customer support provides a single point of entry for all issues, thereby facilitating rapid response and resolution.

Further advantages include Quectel's robust supply chain which ensures lower supply risk and simplified logistics alongside lifecycle management support. Costs are also tightly managed with smart IoT modules delivering both bill of materials (BOM) cost savings and Quectel's efficient manufacturing ensuring maximized value is delivered. Quectel's smart IoT modules enable customers with all the advantages of edge intelligence as well as fast time-to-market, a smoother project development process and cost savings.



Opportunity knocks for smart module-enabled systems

Quectel sees a broad range of use cases for smart IoT modules with additional features further augmenting and adding to the capabilities of certain types of devices. In the EV charging sector, for example, currently utilized smart IoT module features include cellular connectivity, edge processing, onboard memory, NFC, a display interface, and peripherals. Additional smart module features to address future needs include camera and audio interfaces, Wi-Fi, Bluetooth and a touch panel interface. Ultimately, smart IoT modules support video, object detection, voice calling with an operator, payment support and digital signage and advertising within EV charging poles. The smart IoT module can be the central enabling component of all of this.

Numerous other opportunities are emerging with smart IoT modules being designed into industrial handheld devices for use in retail, field mobility, transportation, warehouse management, manufacturing, and hospitality. Another example is the vehicle aftermarket in which smart IoT modules ensure flexible, reliable, safe and secure integration with applications such as real-time navigation, reversing cameras, voice recognition, multi-view and infotainment. A further category is robotics, in which Quectel is seeing smart modules used to power receptions, lawnmowers and guide robots at airports, hospitals, hotels and banks.

Quectel has been working with Dareesoft, a specialist provider of road hazard information services and road data for enabling connected driving in real time. The company has selected modules from Quectel to power its AI Road Analyzer (ARA) offerings. The company, which was established in the Republic of Korea in 2020 seeks to improve road safety by providing road hazard information services and data using its award-winning Roadhazard Information as a Service (RiaaS) system. RiaaS consists of the road analyzer, the RiaaS cloud platform and the RiaaS monitoring dashboard.

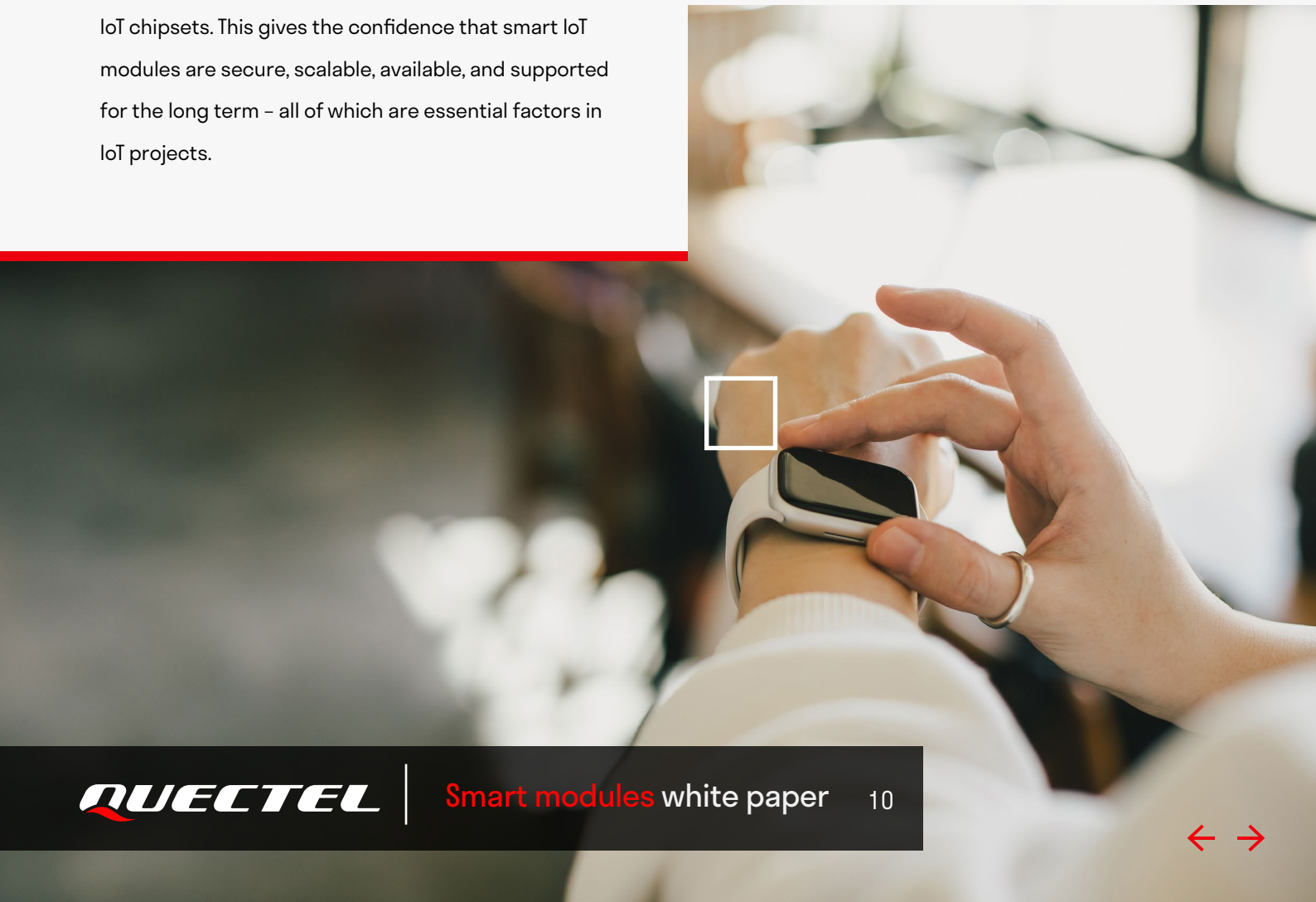
Among the Quectel modules adopted by Dareesfot, the Quectel SG865W is used as the main CPU for the ARA-30 for running six-channel cameras. The solutions are currently deployed in the Republic of Korea, Japan, Thailand and the USA. The SG865W is a Wi-Fi and Bluetooth module supplied in an LGA package measuring 46.0mm x 42.0mm x 2.95mm. Based on Qualcomm QCS8250 flagship IoT chipset and with built-in octa-core high-performance Qualcomm® Kryo™ 585 CPU, Qualcomm® Adreno™ 650 GPU, Adreno 995 DPU, Adreno 665 VPU, Qualcomm® Hexagon™ DSP, and Qualcomm Spectra™ 480 ISP, the module supports Wi-Fi 6, Bluetooth 5.1 and 2 × 2 Wi-Fi MIMO technology. Featuring powerful performance and rich multimedia functions, it is ideal for both industrial and consumer applications requiring high computing power and multimedia functions.

A smarter world

The benefits of smart IoT modules are clearly understood today as IoT organizations seek to add features to their devices without destabilizing fundamental design. Smart IoT modules offer significant efficiencies in terms of power consumption, space occupied within a device, the BOM cost and the simplified integration and vendor relationships of a minimized number of components. These attributes are critical to the success of IoT deployments, but they cannot come at the cost of delayed time-to-market.

It's therefore essential that developers select mature SoMs from experienced vendors that have the knowledge of obtaining global certifications and have developed their smart IoT modules based on market leading SoCs such as Qualcomm Technologies' IoT chipsets. This gives the confidence that smart IoT modules are secure, scalable, available, and supported for the long term – all of which are essential factors in IoT projects.

Smart IoT modules are an enabler of the next wave of digital transformation and the confluence of machine vision, edge intelligence and advanced technologies that span cloud, communications, compute resources, graphics and data processing, plus an ever-growing range of video, audio and display-related features. By providing additional features and functionality all in a single component and ensuring that future needs can also be addressed, Quectel is delivering on its promise to help build a smarter world.



APPENDIX I: How Quectel helps

Quectel offers a comprehensive range of modules, smart modules, antennas and services to help customers develop optimized IoT solutions. Among its range of smart modules is the Quectel SG885G smart IoT module.

The SG885G is Quectel's new generation of flagship Android smart module. Based on the Qualcomm QCS8550 chipset with built-in octa-core high-performance Kryo CPU, Adreno740 GPU, Adreno 1295 DPU, Adreno 8550 VPU, HexagonDSP, and Qualcomm Spectra ISP, the module supports Wi-Fi 7, Bluetooth 5.3 and 2 × 2 Wi-Fi MIMO technology. The module is ideal for industrial and consumer applications that require high computing power, edge intelligence and multimedia functions.

Another high-end Quectel smart IoT module is the SG865W which comes in Android and Linux variants. Based on the Qualcomm QCS8250 chipset, this module also offers built-in octa-core high-performance via the Kryo 585 CPU, Adreno 650 GPU, Adreno 995 DPU, Adreno 665 VPU, Hexagon DSP, and Spectra 480 ISP. In addition, the module supports Wi-Fi 6, Bluetooth 5.1 and 2 × 2 Wi-Fi MIMO technology, making it well-suited for applications such as video conference systems, live streaming devices, gaming, edge computing, robots, drones, AR/VR, intelligent retail and smart safety.

For deployments relying on 5G connectivity, the recently released Quectel SG560D offers great versatility. Based on Qualcomm QCM6490 chipset, this module delivers powerful system performance for multimedia via sub-6GHz 5G, LTE Cat 18, Wi-Fi 6E with 2 x 2 MIMO, Bluetooth and GNSS connectivity options. The SG560D has multiple regional variants, a series of memory configurations and a long lifespan through to 2028.

The smart IoT module is machine learning capable and equipped with CDSP, a hardware computing unit of the Qualcomm Technologies platform used for image and video processing and machine learning. The module can perform 14 trillion operations per second (TOPS) and can perform instance segmentation, object detection, text recognition, semantic segmentation, image generation and even face recognition.

SG885G-WF
Wi-Fi & BT Smart Module

The SG560D is utilized in Quectel's Changzhou automatic production line for industrial visual inspection and Quectel sees applications for the module in smart industry for use cases such as color sorting, panel defect detection, wind turbine blade rust detection and soldering defects. Further applications are expected in smart transportation, smart homes and smart cities. With a weight of 17.5g and dimensions of 42.5mm x 56.5mm x 2.95mm, the module can operate in an extended temperature range of -35°C to +75°C, offering maximum connection speeds of 2.5Gbps downlink and 900Mbps uplink. The SG560D is available in four variants: SG560D-CE, SG560D-EM, SG560D-NA and SG560D-WF.

For less intensive use cases, Quectel offers the SC200R, SC200E and SC206E smart modules. The Quectel SC200R is based on the Qualcomm® QCM2150 chipset and offers Wi-Fi, Bluetooth, LTE Cat 4 and GNSS connectivity.

Featuring a 13MP camera and video capability of 30fps at 1080 pixels, the module is ideal for edge computing devices, smart POS, smart cash registers, smart home gateways, smart robots, smart wearables, smart safety, PDAs and tablets, vending machines, delivery lockers, audio and video recorders, as well as in-car video streaming and entertainment systems. The module weighs 10.2g, measures 40.5mm x 40.5mm x 2.8mm and offers maximum speeds of 150Mbps downlink and 50Mbps uplink.

The Quectel SC200E, based on the Qualcomm® QCM2290, is an Android OS smart IoT module that offers similar features and functionality to the SC200R but with a 25MP camera and is available in five regional variants. Also in the family is the SC206E which is also based on the Qualcomm QCM2290 and offers the same features as the SC200E but utilizes Linux as its operating system.

In addition to its comprehensive range of smart modules, Quectel also supports customers with a full range of antennas.

These include combo, cellular, Wi-Fi/Bluetooth and GNSS antennas, all of which can be supplied pre-integrated with Quectel modules. This uniquely enables the smart module and the antenna be provided by one vendor with all the benefits of single-sourcing and unified support that entails.

Quectel's combo antennas that are especially well-suited for smart module deployments include the YEMN0016AA. This 5G, screw-mount low profile 5-in-1 combo antenna box supports ultra-wide-band 5G/4G providing broad coverage from 600-6000MHz whilst also offering backward-compatibility to support 3G/2G networks as well at Cat-M and NB-IoT. The combo antenna is designed to work with various GND plane sizes or in free space for ease of integration, with connection via five cables of customizable length between 300-5000mm, terminated with SMA connectors.

Alternatives include the YB0014AA LTE/GNSS screw mount 3-in-1 combo antenna and the YEMA004AA LTE/Wi-Fi and Bluetooth screw mount combo antenna.

The YB0014AA has one main and one diversity antenna for LTE and is designed to work with various GND plane sizes or in free space for ease of integration with connection via three 3000mm cables, terminated with SMA connectors. The YB0014AA comes with durable IP66 rated ABS casing which provides maximum durability. The YB0014AA is compatible with Quectel's 2G, 3G, NB-IoT, LTE and GNSS modules, as well as those that combine LTE and GNSS technologies.

The YEMA004AA is a 2-in-1 screw mount antenna that is designed to work with various GND plane sizes or in free space for ease of integration with connection via two 900mm cables, terminated with SMA connectors. YEMA004AA comes with durable IP66 rated ABS casing which provides maximum durability. YEMA004AA is compatible with Quectel's 2G, 3G, NB-IoT, LTE and Wi-Fi/BT modules.

YB0014AA LTE/GNSS Screw Mount Combo Antenna

Quectel's cellular antenna range includes the YC0017DA, the YF0017GA and the YE0007AA. The Quectel YC0017DA 5G SMD antenna which covers 5G NR Sub-6GHz frequency bands is also compatible with 4G/3G/2G and LPWA bands. Ground plane dependent, it's designed to be mounted directly to the device host PCB using a conventional PCB reflow process. Supplied tape and reel for high-volume pick-and-place assembly, this SMD antenna can be tuned specifically for the final device environment with a simple PI matching circuit. Used with other 5G antennas, it can achieve MIMO (multiple input, multiple output) antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The Quectel YF0017GA is an embedded 3.55GHz flat patch RF antenna that operates in the 1.1GHz – 6GHz frequency range and features adhesive mounting and a 201mm cable length.

The YE0007AA is an ultra-wide-band 5G/4G terminal dipole antenna that provides broad coverage from 600-6000MHz whilst being backward-compatible to support 3G/2G networks as well at Cat M and NB-IoT. The antenna is designed to work with various GND plane sizes or in free space for ease of integration with a hinged SMA male connector to achieve the optimum position. This omnidirectional antenna is ideally suited for access points, terminals, industrial products and routers, offering great performance with its high gain and efficiency.

For Wi-Fi and Bluetooth deployments, Quectel antennas include the YXU00A0AA, YF0027AA and YC0010AA. The YXU00A0AA is a very small, highly efficient ISM embedded SMD FR4 antenna for Wi-Fi and Bluetooth. By using the main device PCB as its ground plane, this IoT antenna is extremely efficient despite its small size. Ideally mounted on the center edge of a ground plane, it can be tuned for different PCB sizes and environments by changing the matching circuit values at the feed point and at the GND. It is compatible with Quectel's Wi-Fi, Wi-Fi 5 and Wi-Fi 6 modules.

The YF0027AA is an FPC embedded antenna and offers excellent performance for Wi-Fi 6E applications in the 6GHz band (5.925GHz to 7.125GHz) plus 2.4GHz and 5GHz Wi-Fi/WLAN solutions. The flexibility and adhesive backing makes this antenna easy to mount in any non-metallic standard or custom enclosures. Highly efficient and ground plane independent, connection is made to the radio via the 100mm cable, terminated with an IPEX MHF I connector. Optional cable lengths and connector types are available upon request.

The Quectel YC0010AA is a 2.45GHZ Bluetooth and Wi-Fi antenna with a solder surface mount. Available in tape and reel, cut tape of digi-reel variants, the antenna has a maximum height of 1.2mm and operates in the 2Ghz to 3Ghz frequency range.

Finally, for GNSS antennas for smart modules, the Quectel range offers the YC0013AA, YG0062AA and YB0017AA. The YXC0013AA is a very small GNSS embedded SMD ceramic antenna. By using the main device PCB as its ground plane, this antenna is extremely efficient despite its small size. Ideally mounted on the center edge of a ground plane, it can be tuned for different PCB lengths and environments by changing the PI matching circuit values at the feed point.

The Quectel YG0062AA is a GNSS L1 embedded ceramic antenna, mounted via pin and double-sided adhesive for ease of installation. By using the main device PCB as its ground plane, this antenna is suitable for many tracking applications. The Quectel YB0017AA is an active patch antenna which supports GNSS L1/L5 BD B1/B2 GLONASS L1. The antenna is designed to work with various ground plane sizes or in free space and is connected to the device by a cable and SMA male connector. Offering great performance with its high gain and efficiency for tracking, fleet management, navigation, RTK and many other tracking applications.

For more information please visit quectel.com