White Paper

Improving the Quality of Healthcare Delivery via Bluetooth® Low Energy and the Renesas RA4W1 MCU

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Abstract

Medical care, expensive and often relying on highly trained staff, entails state-of-the art equipment and facilities. Reducing time, costs, and labor expended on routine monitoring and tasks can allow healthcare facilities to allocate these resources to other areas of the healthcare continuum for greater impact and increased wellbeing. Connected medical devices enabled with Bluetooth® Low Energy (BLE) provide a valuable technology for automating certain medical-related tasks and responsibilities, meeting the strict regulatory requirements for security, reliability, and interoperability. The RA4W1 from Renesas is a fully compliant single chip BLE microcontroller (MCU) that is ideal for medical device applications requiring low power and high performance, robust security, large embedded RAM, high integration, and high precision A/D converters for sensor signals.

How BLE Supports 21st Century Medical Care

The demands upon medical care providers and support staff are continually increasing to offer patients the best quality care, but to also deliver it as reliably, cost-effectively, and immediately as possible. Streamlining laborious and time-consuming routine tasks can go a long way in boosting efficiencies while improving quality of monitoring and oversight.

The solution to achieving this goal is through wireless connectivity and the Internet of Things (IoT), which enables previously inanimate and isolated objects, and pieces of equipment to communicate with each other, sharing data in real-time while integrating with systems that monitor their output and act based on any number of pre-set parameters. These actions can be as simple as alerting an operator to a problem – or a potential problem – or they can be fully automated, for example switching off lights or adjusting temperatures or energy outputs.

The connected medical market is growing quickly and BLE has emerged as a highly versatile technology that helps to eliminate the need for healthcare providers and staff to carry out a range of routine functions. BLE is particularly suitable for use with medical devices because it can offer interoperability with other devices, as well as low-power control and secure data transfer.

Potential applications of BLE in the medical sector include:

Connected Home Health

A growing trend in healthcare is to migrate away from hospital-like environments and for patients to receive treatments in the comfort of their own homes. Connected medical devices can monitor the condition of patients remotely via the use of wearable wireless electronic monitors, and through data fed back instantaneously for analysis and possible action.

Examples of connected home health applications include weight scales, monitors for heart rate and blood pressure, monitors for new-born babies that check pulse, breathing and movement, as well as diabetes management devices like blood glucose monitors and insulin pumps. Combined, these can even create closed loop systems minimizing the required level of human interaction in treating diabetes.

Among the major benefits of using BLE in home health applications are convenience and substantial improvements in the comfort levels of patients. Since BLE combines low-power with robustness and ease-of-use, it offers an extremely attractive means of linking multiple monitoring devices to a local hub (such as a smartphone), making data sharing and analysis not only secure and rapid, but also user-friendly.

Connected Medication

BLE can also replace traditional hard-wired equipment in hospital settings that require patients to be physically attached to equipment and monitors. BLE removes the need for wires and cables to make the connection between the patient and medical devices much less cumbersome and more pleasant for the patient. At the same time, it also reduces the opportunities for errors to be made – mechanical or human – while setting up and attaching equipment.

For example, wearable monitors attached to the patient can direct equipment such as infusion pumps to deliver the correct level of fluids as well as the correct volume of medication at designated, timed intervals. This interconnectivity can extend to whatever healthcare devices the patient requires – such as electrocardiography monitors or blood pressure sensors – which are able to gather the latest vital sign data and send it wirelessly over the communications network to the hospital's central monitoring system.

Connected Inventory

Another application of BLE in the healthcare sector is the ability to track inventory, equipment and the movement of staff. For instance, by using tags and tracers that communicate with Bluetooth® beacons, connected inventory applications can track blood bags and monitor blood bank status in real-time, including monitoring blood storage temperature to ensure that blood is stored safely. The same BLE-enabled technologies can also help track and locate medical supplies, portable equipment and devices, and other tools to limit waste and streamline supply chains.

Connected Monitoring

As mentioned, management of a patient's health can take place in a range of environments and BLE-enabled devices can connect these environments to help ensure that vital information and data is shared. For instance, BLE-enabled technology is becoming more commonplace within ambulances, which ensures that paramedics have access to real-time information gathered by various monitors to give an accurate, up-to-the-minute snapshot of the patient's status. A gateway in the ambulance can also transfer this data to the hospital or emergency room medical staff so they are fully prepared to meet the patient's needs when the ambulance arrives at the hospital. Guesswork and repetition are eliminated with such a system, speeding up the patient's progress through the various hospital services, improving the likelihood that the patient receives the best care available in the shortest possible time.

Technical Requirements for Wireless Devices in Connected Medical Scenarios

Medical applications have specific needs and requirements and any wireless system that is used to connect these devices to each other and to larger systems must meet this criterion.

Analog-to-Digital Conversion (ADC) Versus Resolution

In a healthcare setting, medical devices generate a great deal of analog data (from measuring temperatures, heart rate, blood sugar, etc.) and these data feeds must be digitized before being transferred wirelessly. A device utilizing wireless technology for medical applications must not only include very robust analog-to-digital conversion functionality, it must also be able to register and measure very small changes in signals.

In a connected medical scenario, the best A/D conversion results are achieved by using a high-resolution digitizer that has a large dynamic range and is capable of measuring small and large signals at the same time. It isn't sufficient to use a low-resolution instrument with a smaller full-scale range because many of the signals that are being converted in such a scenario contain both small and large voltage components. The resolution capabilities of an analog-to-digital converter are governed by its bit value.

Hardware-Based Security with Encryption and Secure Key Management

Maintaining the highest level of security is vitally important when dealing with medical data and personal patient information. To attain this level of security it must be designed into the system from the beginning and cannot be bolted on later. It should also be irrevocably linked to the underlying hardware. In addition, it should provide hardware acceleration to minimize execution times and reduce power consumption levels for symmetric encryption of data. Built-in security also makes isolated operation possible and provides secure key management.

Other Key Requirements for Wireless Connectivity in Healthcare

Many medical devices that will be connected in healthcare scenarios are portable, or even wearable, and are powered by batteries. For instance, some medical monitors may be expected to operate for lengthy periods – for several years if required – on small coin-cell batteries. The wireless solutions for these devices must offer low power operations to minimize battery draw. Interoperability is also critical so that products supplied by different companies or legacy systems can communicate with each other, while compatibility is essential in order for radio devices to operate alongside other radio transceivers without generating any issues around electromagnetic interference (EMI) in nearby electronics devices.

These are precisely the benefits that BLE provides for connected medical devices. Having low-power control, for example, means enabling running costs and maintenance overheads to be minimized. Other key requirements include the ability to operate within multiple data rates and to interact seamlessly and reliably with sensors as well as the IoT and the Cloud through a smart hub or gateway.

Introducing the RA4W1 MCU from Renesas

Designed to meet the exacting requirements of wireless connectivity for medical devices, the Renesas RA4W1 is a 32-bit Bluetooth 5.0 Low Energy single chip MCU that is an optimal solution for medical and healthcare applications where wearable sensors and devices communicate in real-time via wireless networks. The RA4W1 offers 2Mbit high throughput (HT) and long-range support, and has been designed

specifically for use in IoT applications that demand low-power consumption, high levels of integration, superior performance, large embedded RAM and a 14-bit A/D converter for precise measurement of sensor signals. The RA4W1 is powered by a 48MHz Arm® Cortex®-M4 core with a range of low-power modes.

Advanced levels of security for use with IoT medical devices are also designed into the RA4W1 through its Secure Crypto Engine 5. The SCE5 uses Advanced Encryption Standard (AES) 128 or 256, as well as a GHASH authentication component and a True Random Number Generator (TRNG), to protect confidential patient data via hardware-accelerated symmetric encryption.

Other key features of the RA4W1 make it ideal for healthcare solutions that rely on wireless connectivity. Included for added communications versatility are a full-speed USB 2.0, a CAN 2.0B controller area network bus, and interfaces with such communication protocols as SCI (Simple I2C, Simple SPI [Serial Peripheral Interface]) and SPI/I2C. A Universal Asynchronous Receiver/Transmitter (UART) transmits and receives serial data. In addition, the RA4W1 has been designed to be easy to use and to reduce bill-of-materials (BoM) costs through a human-machine interface (HMI) that features a capacitive touch sensing unit (CTSU) and a segment LCD controller for effective and reliable integration. Other features include a 0.5% high accuracy internal oscillator, high-current IO drive ports, 96kB SRAM and 8kB Data Flash Memory.

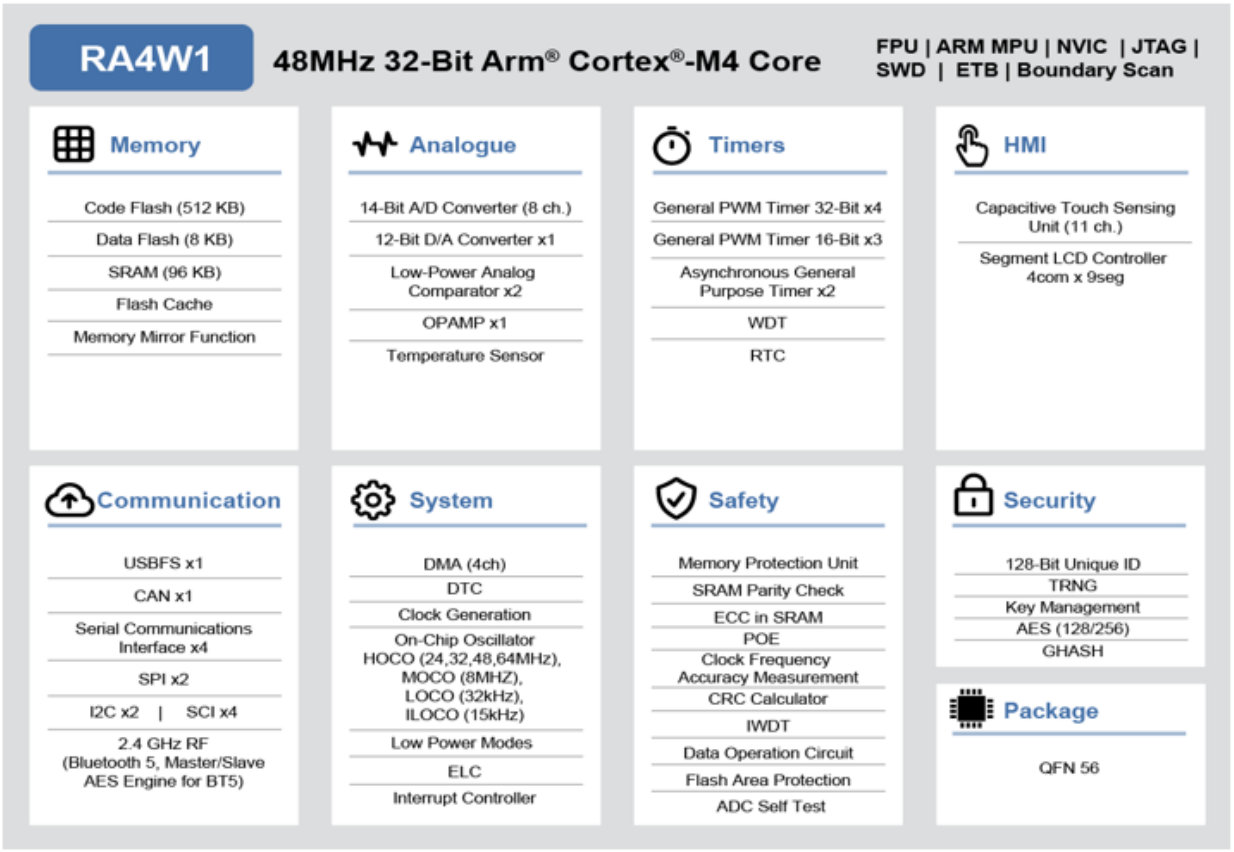

Figure 1: RA4W1 MCU Group Features & Benefits

Conclusion

The Renesas RA4W1 is especially well suited for use in healthcare and medical applications in which remote devices use BLE and IoT networks to monitor the health and wellbeing of patients. The RA4W1 combines robust connectivity with low-power, ease of use, high-precision sensor data conversion and superior levels of device security powered by a Secure Crypto Engine and is an ideal solution for connected healthcare edge devices. The RA4W1 with integrated BLE can be used to automate a vast range of medical monitoring functions to improve patients' level of care and relieve healthcare workers of routine tasks so their skills can be more effectively applied elsewhere.

Learn More

1. RA4W1 Product Page
2. RA Partner Ecosystem
3. Flexible Software Package (FSP)
4. RA Family of MCUs