White Paper

Renesas RX65N Eases Complexity of IoT Development with Cloud Communications for AWS

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Abstract

The Renesas RX65N Cloud Kit is an evaluation kit for cloud communications that makes a Wi-Fi connection to Amazon Web Services (AWS) using the RX65N MCU. It provides the optimal evaluation environment for IoT equipment developers that need to connect existing applications to the cloud. This white paper provides a step-by-step overview of the key considerations that will help you meet the challenges of connecting your application to Amazon Web Services quickly and securely.

Introduction

Initiatives such as Industry 4.0 and the Industrial Internet of Things (IIoT) have become a fundamental part of delivering operational efficiency improvements across the industrial landscape. The broader Internet of Things (IoT) is also credited with providing a wealth of data for consumer-oriented services, whether delivering e-health, energy-saving for the smart home, or offering up your next movie based on your previous viewing trends. Whether it is determining when a maintenance routine needs to be made to an industrial process motor, or the optimal energy window to switch on your dishwasher, IIoT/IoT applications rely on cloud computing to deliver a hyper-scalable compute and storage infrastructure. These applications also power big data analytics that bring intelligence and predictability into the automated decision and insight process.

For the engineering team tasked with creating the hardware platform and developing the embedded software to connect an appliance or process to the cloud, there are many considerations to be taken into account. In some cases, particularly in the industrial process world, where capital-intensive manufacturing equipment has a much longer life cycle, the need to provision existing systems with cloud connectivity adds more complexity to the design process.

The Challenge of Connecting Applications to the Cloud

Provisioning a connection to a cloud service can take several forms. The choice is typically inter-dependent on several other product features, such as whether the equipment or device is battery powered or portable, and what environmental conditions it will operate from.

Initially, the engineering project team needs to review the way the equipment will connect to the internet and how secure the connection needs to be. Another key decision is the selection of the cloud service provider. Does the provider have a formal certification process that each piece of equipment needs to pass before it is approved to exchange data with its servers? Are special drivers, libraries, or firmware required to establish the connection and to communicate with the cloud service securely? Next up is the choice of the development platform on which to prototype and base the design. Project timescales are typically very tight, so any development or evaluation platform that can ease the pain of quickly developing and testing the initial design through to the migration to a certified and fully-deployed system will be extremely beneficial.

Making the Connection

The initial connectivity decision will be wired or wireless. A wired approach, typically using Ethernet, has several advantages for equipment that is operated in a fixed installation. With up to Gigabit communication speeds, and the potential to power the equipment using Power-over-Ethernet (PoE), this option is certainly a viable one; however, while this provides a very reliable and efficient communication method, there is a significant cost related to installing and maintaining such a wired infrastructure. Long-term installations such as an industrial production line would be a good example; however, once created it is costly to adapt to changing requirements.

Wireless communication provides a more attractive approach with several different protocols that offer different range, speed and frequency options – see Table 1. In contrast to a wired approach, wireless communication offers a more flexible alternative, with communication to the internet typically taking place through an internet gateway. The gateway is placed in a central point within the range of all attached equipment. Despite the advantages of a wired networking approach, the deployment of a wireless network still involves some degree of planning. Wireless signals are prone to reflection, which can cause signals to be received over multiple paths, potentially introducing interference. Walls, ceilings, and other solid surfaces have different absorption characteristics that can attenuate the signal, which can degrade link performance and reduce data throughput.

For the majority of most IoT applications, Wi-Fi is the ideal candidate, offering excellent data throughput and range attributes.

Type	Bluetooth	Wi-Fi
Nominal range	Up to 50 meters	Up to 100 meters indoor – up to 1 km outdoors
Frequency(ies)	2.4 GHz	2.4 & 5.0 GHz
Data rates	1 – 2 Mb/s (Bluetooth 5)	11 – 600 Mb/s
IEEE specification	802.15.1(1)	802.11 a/b/g/n
Typically used for	Short-range communications, connecting low data rate, low power sensors to a gateway device such as a smartphone	Transfer of large volumes of data and data streaming.
Power consumption	Low	High

(1) The Bluetooth specification is now maintained by the Bluetooth Special Interest Group (SIG).

Table 1: Comparison of different wireless communication methods (source Renesas Electronics Corp.)

Choosing a Suitable Cloud Services Provider (CSP)

Table 2 highlights the market shares of the most popular cloud service providers. Each has a comprehensive range of service offerings, and some have specific IoT functionality and features that ease the integration of connectivity into a new product design or legacy equipment.

As can be seen from the table, Amazon leads the market with its Amazon Web Services offerings that include everything from its Simple Storage Services (S3) to a complete IoT infrastructure as a service (IAAS) capabilities.

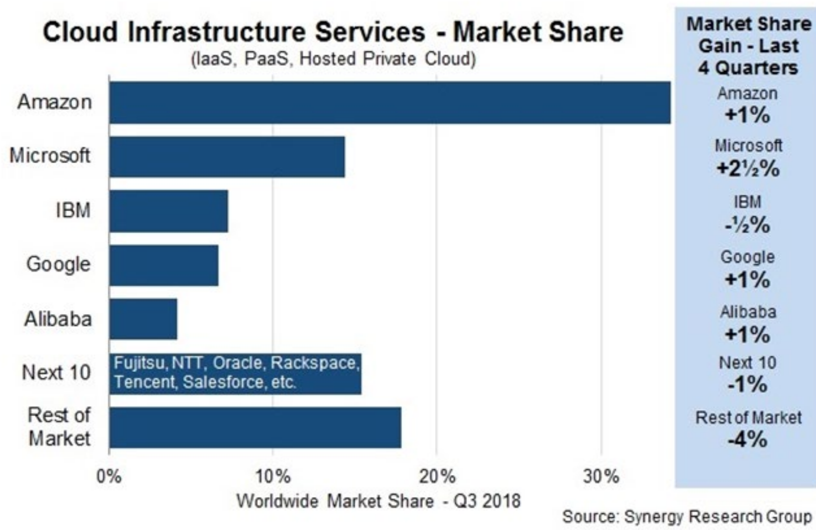

Table 2: Cloud Infrastructure Services – market share (source Synergy Research Group, 2018)

Selecting a suitable cloud services provider will come down to a number of factors: security, scalability, and reliability are just a few. The ease of integrating your hardware platform will also be a consideration, and several of the providers make that task straightforward by providing software for that purpose. For example, Figure 1 illustrates the range of different IoT-specific services and software that Amazon AWS provides. These include software for devices that enable data collection, deployment and management in addition to data analytics to extract insight from large volumes of collected data.

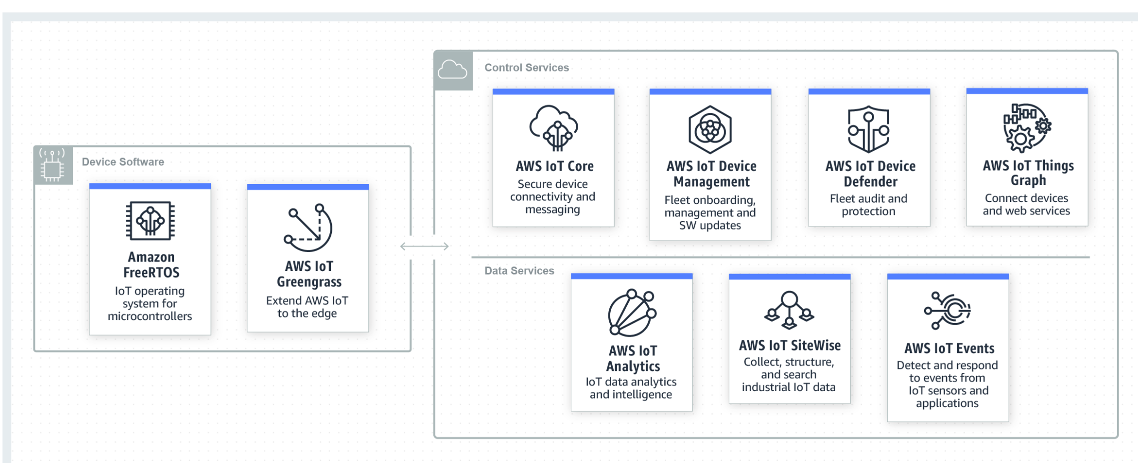

Figure 1: The Amazon AWS IoT services portfolio (source Amazon)

Easing the Connectivity Challenge with CSP-Supplied Software

In the above example, Amazon provides a free, downloadable real-time operating system for use with its cloud services called Amazon FreeRTOS. Based on the popular FreeRTOS kernel, it has a number of extensions that provide direct access to Amazon's IoT services. These services encompass the Amazon IoT Core; enhanced transport layer security TLS v1.2 support; secure, code-signed over-the-air software update capability; and Wi-Fi and Bluetooth wireless networking libraries. It is available for a wide range of microcontrollers, evaluation kits, development boards, and suites used in a wide range of industrial, consumer and B2B applications.

To maintain a high degree of confidence for users of Amazon IoT services, the company operates a qualification scheme for all new Amazon FreeRTOS-based microcontrollers and designs. This involves sending hardware and software to Amazon to demonstrate that it can reliably pass a number of different tests. There are two different certifications that a product can be compared and approved against. One relates to a basic connection to the Amazon AWS IoT Core service, and the second – a more complicated test process – involves the certification of a microcontroller running a set of Amazon FreeRTOS tests. In this second and preferred method, any end-product designed using the vendor's microcontroller is pre-qualified, meaning no further qualification or approval testing is required. Furthermore, this approach means less time having to certify your application, allowing a design to be brought to market faster, saving valuable engineering resource time and the associated costs. Any microcontroller vendor that has taken the time and effort to undertake this second more detailed set of tests would be a viable contender for your project's supplier short list.

The Need for End-to-End Security

As your choices for cloud connectivity method, cloud service supplier, and hardware/software becomes more defined, engineering teams are advised to make security a priority. This applies across the whole IoT deployment, from edge device to the cloud and back again, including any equipment in between, such as internet gateways and data aggregators. This not only applies to the data sent to the cloud for analysis and control data coming back to the equipment, but also to over-the-air methods used to update equipment firmware across the whole IoT deployment. All Amazon IoT communication is encrypted to TLS v1.2 standard which supports a wide range of cipher suites, of which ECDHE-ECDSA-AES128-GCM-SHA256 and ECDHE-RSA-AES128-GCM-SHA256 are recommended.

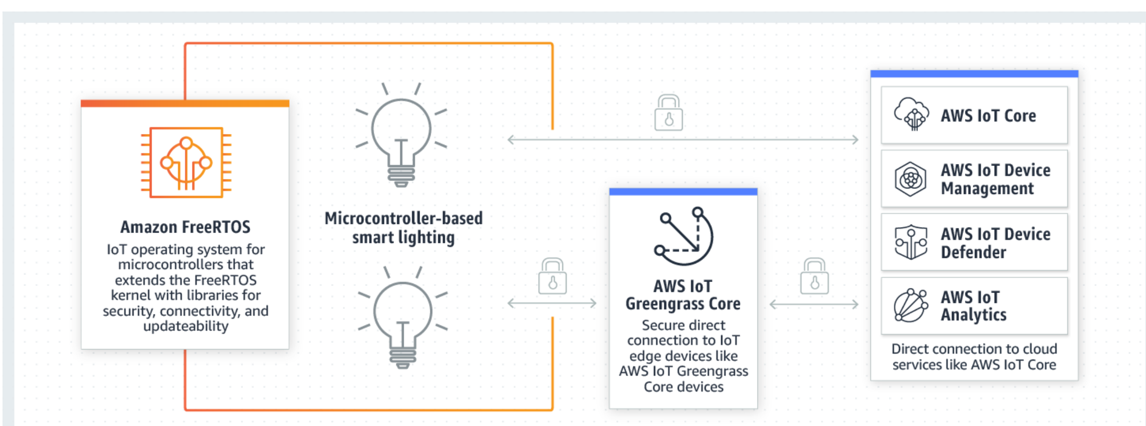

Figure 2: Using Amazon FreeRTOS on a microcontroller for a smart lighting application showing the secure communication flow (source Amazon)

Selecting a Prototyping Solution that Meets all the Criteria

The Renesas RX65N Cloud Kit is an evaluation kit that simplifies making connections to the AWS IoT Cloud. Amazon FreeRTOS has been ported to the Renesas RX65N microcontroller family, is qualified by Amazon, and is available as a free download from the Amazon FreeRTOS website.

Based around the Renesas RX family of high performance, low-power-consumption 32-bit microcontrollers, the kit comprises three boards. The main board hosts an RX65N family microcontroller, the R5F565NEDDFP, a 176-pin 120 MHz device that has 2 MB code flash memory, 640 kB SRAM, and a host of analog A/D and D/A converters. Peripheral interfaces include Ethernet, SPI, JTAG, I2C, USB2.0 Full Speed, and CAN. A 4.3-inch, 480 x 272 TFT color display with capacitive touch controls is also mounted on the main board. An E2 Lite debugger is also included in this kit, and the Renesas e2studio integrated development environment can be downloaded from the Renesas website.

Also included is a Cloud Option Board that consists of three sensors, a USB port for serial communication and another USB port for debugging. The sensors measure temperature and humidity (a Bosch BME680), ambient light (a Renesas ISL29035) and acceleration forces (a Bosch BMI160). The final board, a Pmod module, hosts a Wi-Fi module to facilitate wireless communication. These two boards plug into the main microcontroller board, completing the hardware prototyping platform.

Figure 3: The Renesas RX65N starter kit with cloud option board and Pmod Wi-Fi module (source Renesas Electronics Corp.)

Getting started with the Renesas RX65N Cloud Kit couldn't be simpler. First, download a copy of Amazon FreeRTOS and then, using the Renesas Smart Configurator tool, you can configure the FreeRTOS code, the board's clock settings, and the microcontroller pin-out parameters as necessary to suit your design – see Figure 4.

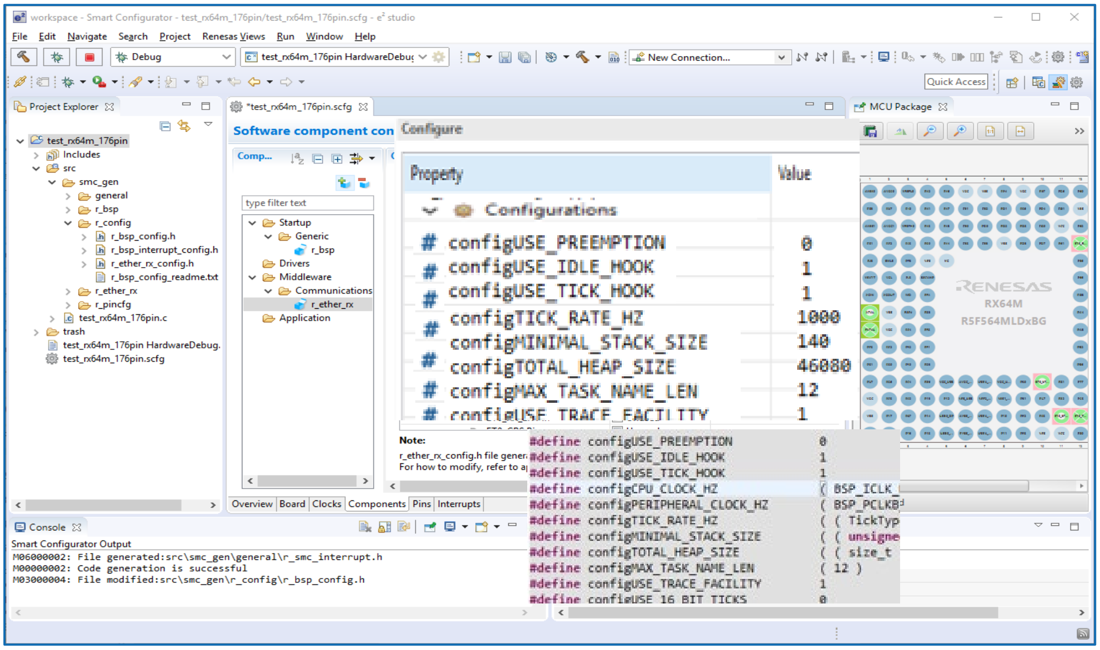

Figure 4: Renesas Smart Configurator is used to configure the Amazon FreeRTOS, adjust the microcontroller clock rate and pin-out assignments (source Renesas Electronics Corp.)

To further speed the initial testing and familiarization with the RX65N Cloud Kit, a set of demonstration software routines are provided. To use, import them into the Renesas e2studio IDE, compile and then program the Renesas RX65N target device on the development board through the debug function.

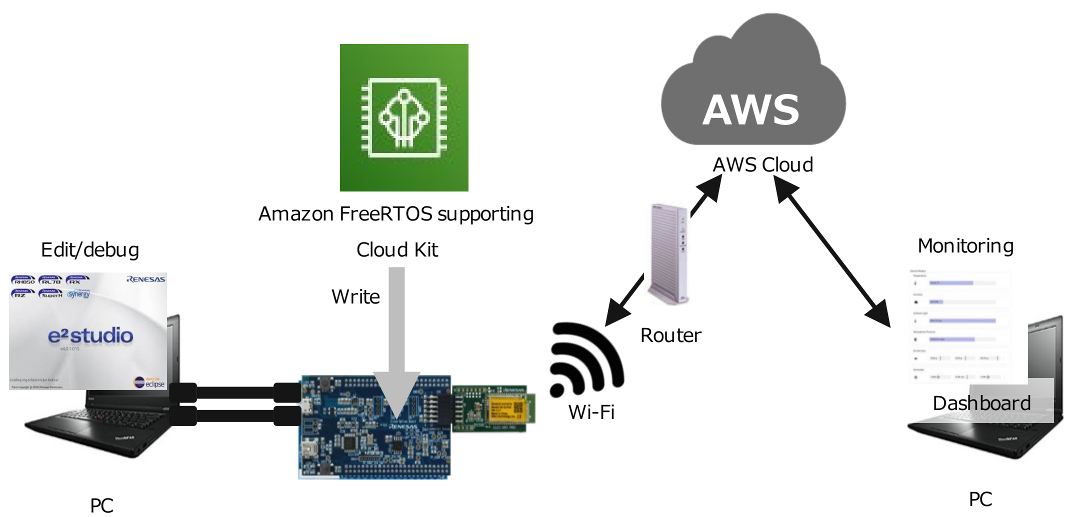

Figure 5: Setting up and testing the RX65N Cloud Kit using Amazon FreeRTOS and Amazon IoT services (source Renesas Electronics Corp.)

The two sample programs perform different functional tests. The first is a simple 'Hello World' style program that sends the text to the Amazon AWS IoT Core service. Confirmation of receipt can be made by accessing the MQTT messages within the IoT Core dashboard.

The second demonstration program sends data from the Cloud Option board's sensors to the Amazon Cloud where it can be viewed within the Amazon AWS IoT console by subscribing to the MQTT topic feed.

Detailed technical information and application notes on the use of the Renesas RX65N Cloud Kit with Amazon FreeRTOS can be found on GitHub, the Renesas website and at Amazon AWS.

Conclusion

The Renesas RX65N Cloud Kit is the ideal platform on which to base your next IoT-connected design. With its Amazon FreeRTOS certification, developers can immediately focus on the functional design priorities rather than spending significant time and effort putting the communication basics in place. It is ideal for creating any type of IoT/IIoT solution, whether for industrial, consumer or business-to-business applications.

Reference Links

- Renesas FreeRTOS GitHub Page ›
- Getting Started with Amazon FreeRTOS and Renesas RX65N Cloud Kit ›
- Amazon FreeRTOS Home Page ›
- Amazon Partner Device Catalog Entry for Renesas RX65N ›
- Renesas Cloud Starter Kit Page ›
- Renesas RX65N Starter Kit + RX65N-2MB User's Manual ›