WHITE PAPER

Intel IoT
Solution Blueprint

Increasing Food Production with the Internet of Things

Abbaco Controls used IoT technologies from Intel and Kontron to deploy a water management system that helps increase rice production while optimizing water usage in Malaysia.

Driving innovation in agriculture

Water is an important resource that plays a crucial role in many aspects of our lives, especially in growing the food we eat. In Malaysia, for example, about 70 percent of the available water resources are consumed for rice production. Due to a rapidly growing population and water competition among different sectors, it is imperative that farms use water as efficiently as possible. Reducing water usage in rice production makes more water available for other sectors.

Rice is a staple food of Malaysians, and the country produces enough to meet about 80 percent of the need and imports the rest. Recently, Malaysian farmers started taking advantage of Internet of Things (IoT) technologies to boost rice production, with the goals of doubling yields and becoming a rice exporter. Providing technical assistance, Abbaco Controls, an automation systems integrator since 2009, deployed IoT technologies from Intel and Kontron to help farmers control irrigation water in real time, optimize water usage, lower system cost, and ultimately, increase rice production. The IoT solution replaced a SCADA-based control system.

Key Business Objective

Boost rice production by implementing a water management system that allows farmers and the Malaysian Ministry of Agriculture (MOA) to monitor water resource status and remotely control the water distribution to their farms.

Business Challenges

Rice is grown under various conditions, and typically the best case is to continuously submerge the crops in five to seven centimeters of water. This makes the irrigation infrastructure vital to rice production. Most areas do not have water dams to create reservoirs of stored water, so irrigation water is sourced directly from rivers.

In Malaysia, the MOA governmental agency had centralized control over the water gates that delivered water to the country's agricultural fields. This meant farmers had to call the MOA to request changes to the irrigation schedule in cases such as recent rainfall reducing the need for irrigation or warmer weather necessitating more watering. Farmers found contacting the MOA to be time-consuming or even impossible during off hours, like nights and weekends. The inflexibility of the manually steered system led to suboptimal use of water resources, and in turn, negatively impacted rice production.

Solution Benefits

Abbaco Controls, with help from Intel and Kontron, designed and deployed an IoT-based irrigation system that decentralized management of water gates, allowing farmers to control water supplies to their fields. In addition, this highly automated system makes real-time watering decisions based on a comprehensive analysis of sensor data (e.g., temperature, current water levels). The system uses IoT technologies to enable secure and cost-effective communications throughout the irrigation infrastructure, thus producing many benefits, including:

Real-Time Irrigation Control

In the event of any emergency situation or on-demand controlling of water level, the solution enables users to initiate immediate action by controlling a series of water gates. Furthermore, the solution can automatically trigger an alarm to alert users about any abnormal event (e.g., water levels too high from strong rains or too low from a lack of rainfall).

Optimized Irrigation Water Usage

The water management solution helps farmers determine the minimal amount of irrigation water needed for crops by generating recommendations based on water level trend charts, rain patterns, and temperature over months and years.

Lower System Cost

The previous system used SCADA to connect to devices, which was expensive due to SCADA software license fees. The new IoT-based system uses Modbus TCP protocol instead, allowing it to be about half the overall cost of the prior system.[1]

Increased Rice Yield

Early data shows the new water management system is increasing rice yields, with the expectation it will help double production.[1]

Solution Overview

The Abbaco Controls water management system presents farmers, the MOA, and other users with useful information from hundreds of sensors attached to water gates in the rice fields across Malaysia. This information includes water level, water flow rate, temperature, acidity, etc. Figure 1 illustrates how IoT technology is used to collect sensor data and send it securely to a back-end cloud server, where it is processed by Abbaco Control's data mining and analytic infrastructure. End users can view the results on user-friendly interfaces on PCs or cell phones.

Figure 1 also shows the architectural differences between the previous water management system and the new one based on IoT technology. The previous system was based on SCADA, whereas the new IoT-based system from Abbaco Controls connects to field devices using the open Modbus TCP protocol, which is a lower cost alternative. In addition, the new cloud-based system makes it easier to deploy data analytics software and develop interfaces for a multitude of wireless user devices.

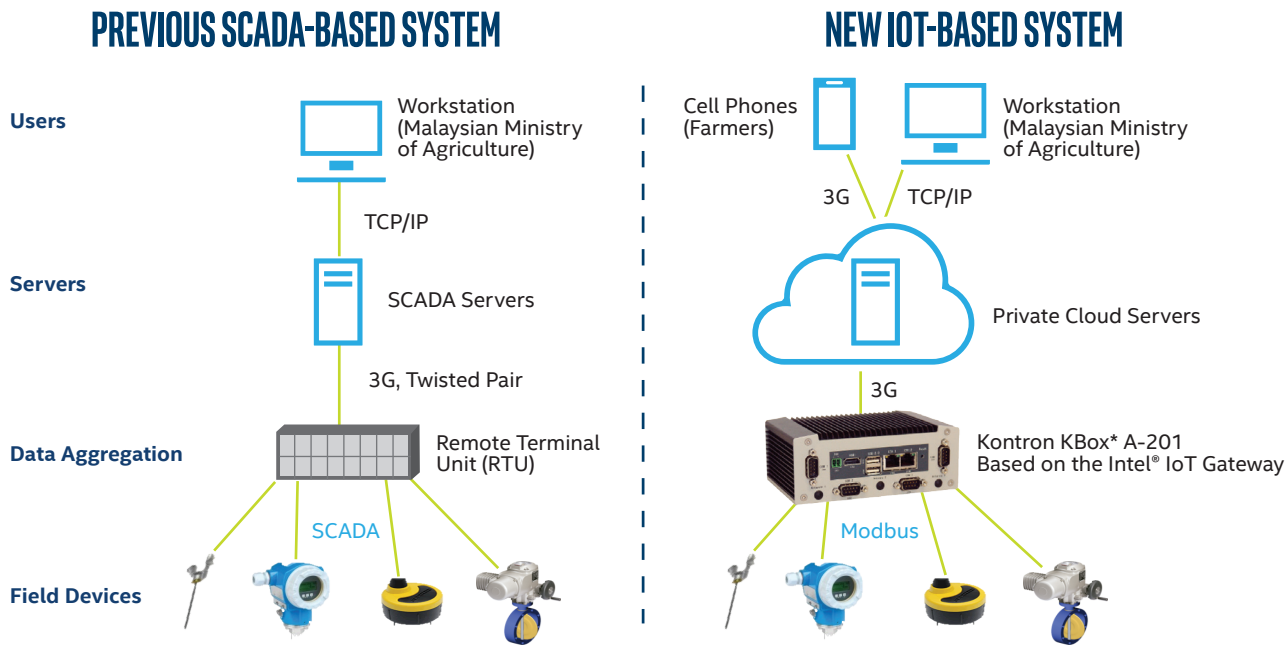

Figure 1. Simplified Architectural Diagrams (Before and After)

Key Solution Features

The Abbaco Controls water management solution has many advantages, including the following:

Remote Control: Users can remotely monitor and control the system from anywhere and at any time. This is a big step forward over the prior system that required MOA personnel to drive to each water gate in vast open fields, which was time-consuming, expensive, and schedule dependent.

Low Maintenance: The solution requires minimal or no ongoing service since it employs a robust, industrial-rated IoT gateway designed to be maintenance-free.

Fast Deployment and Scalability: The use of Intel IoT building blocks allows the solution to be deployed quickly and easily expanded by adding I/O modules, which may be sourced from different vendors.

Data and System Security: The solution protects user data and software updates with security features such as whitelisting and integrity monitoring.

Technology

Technology ingredients from Intel and Kontron are available to deploy a water management solution like the one previously described. Such a solution can also be used whenever there are distributed field devices, as in water recycling, aqua-agriculture, and flood management applications.

High-Level Architecture

Figure 2 shows a detailed view of the IoT architecture utilized by the Abbaco Controls water management solution. In the bottom right quadrant, field devices connect to the Kontron Industrial Computer Platform A-201* IoT gateway via the Modbus TCP protocol, as previously described. The Abbaco Controls solution uses the protocol for reading and controlling sensors and devices.

The Industrial Computer Platform A-201 also runs an Intel® IoT Gateway software stack that supports device management and configuration, and an MQTT client as a data agent, as shown in the bottom left quadrant.

MQTT is a publish-and-subscribe protocol built on top of TCP/IP protocol and is commonly used for machine-to-machine (M2M) communications. The two main components of MQTT are the MQTT clients and the MQTT broker. The MQTT clients publish messages to a particular topic, or subscribe and listen to a particular topic. The MQTT broker receives all published messages from MQTT publishers and forwards the relevant messages to all MQTT subscribers.

The Industrial Computer Platform A-201 communicates over a TCP/IP connection (wired or wireless) to a private cloud (upper left quadrant) running the Intel® Broker Module, which includes an MQTT broker server responsible for subscribing the data coming from all gateways. It sorts the data before storing it in a data warehouse, making it available for data mining and data analytics by applications running in a public cloud. The module also performs device provisioning, diagnostics, event management, and broker web services.

In the upper right quadrant, the public cloud (web application servers) performs real-time data analysis, generates trend reports, and pushes information to user applications over the Internet via HTTP. Abbaco Controls does not host the servers, but instead uses a renowned cloud service provider to provide reliable and consistent service. The web application server hosts Abbaco Controls' IoT solution portal, which is powered by ASP, .NET, and HTML5. The portal supports all the user-accessible functionalities, including the ability to remotely control the water gate (e.g., open gate), check the water gate and alarm status, and view historical data.

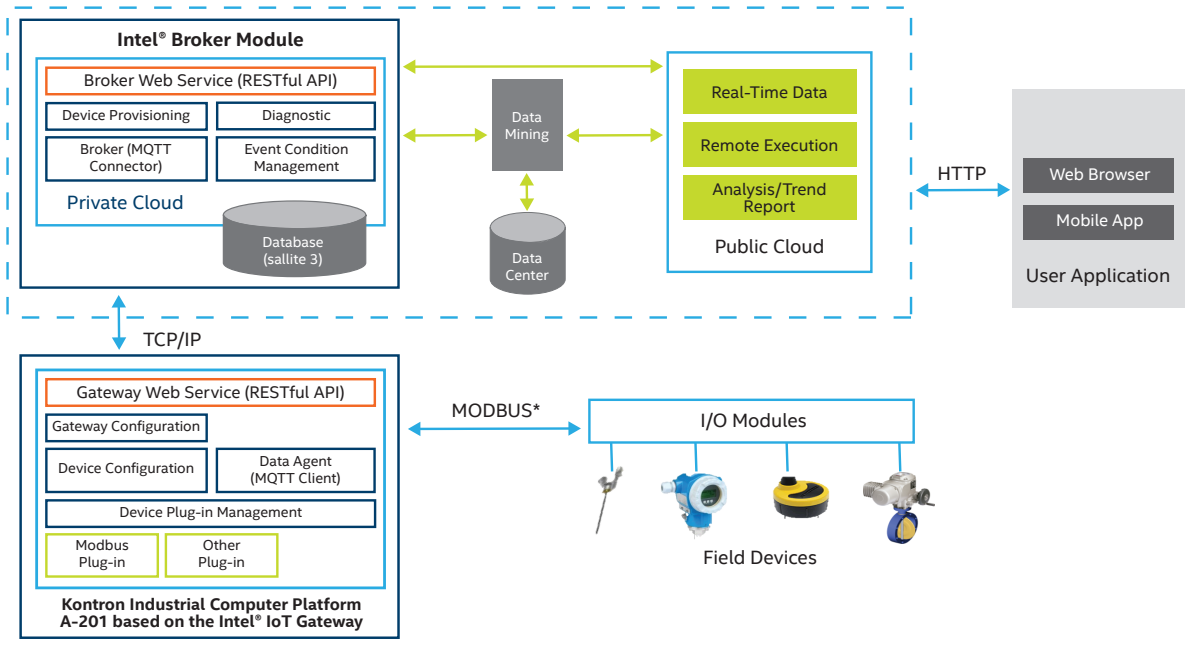

Figure 2. Detailed IoT Architecture

IoT Gateway

The Kontron Industrial Computer Platform A-201 is fanless and has IoT gateway capabilities, such as the ability to connect machines to the cloud. Based on the Intel IoT Gateway, the PC combines Wind River Intelligent Device Platform XT* 2.0 and McAfee Embedded Control*. Shown in Figure 3, this product is available with either the Intel® Atom™ processor E3800 product family or the Intel® Quark™ SoC X1000.

The Kontron Industrial Computer Platform A-201 implements Intel's secure boot feature, which is built to recognize and boot only from Abbaco Controls' signed image. It prevents any unknown source from corrupting or replacing the PC's operating system. For additional device security protection, McAfee Embedded Control stops any unrecognized program or script from executing. It automatically creates a dynamic whitelist of the "authorized code" on the system. Once the whitelist is created and enabled, the system is locked down to the known good baseline, and no program or code outside the authorized set can run. Whitelisting prevents viruses, spyware, worms (like the Stuxnet worm), and other malware from executing illegitimately on IoT systems.

For local data acquisition, the mini Box-PCs support a broad range of industrial interfaces such as 2x Gbit Ethernet, 2x USB 2.0, as well as an optional CAN bus and/or PROFIBUS* interface, whereas legacy installations benefit from two serial interfaces (RS232/485). For wireless connection to the cloud or the local network, the Kontron K-Box A-201 mini can be equipped with LTE (4G) and GSM (2G/3G) or Wi-Fi. Three external antenna connectors enable high signal quality. The integrated solid-state drive (SSD) with up to 64 gigabytes capacity delivers rugged and fast storage capacity for the operating system and data, and a trusted platform module (TPM) is integrated for increased data security, all in a compact footprint (Figure 3) of only 56.8 mm x 150 mm x 95 mm.

Figure 3. Kontron Industrial Computer Platform A-201*

IoT Tenets

The Abbaco Control water management system was designed to provide security and interoperability from edge to cloud in keeping with five key tenets defined by Intel:

World-Class Security as the Foundation
The IoT gateway is protected by Intel® secure boot architecture and Intel® Security software.

Automated Discovery and Provisioning of Edge Devices to Ease Deployment
The service running on the IoT gateway supports automated discovery of all Modbus devices within its range, thereby reducing the time a systems integrator needs to configure the device during deployment.

Data Normalization through Protocol Abstraction to Improve Interoperability
The IoT gateway and MQTT broker collaborate to ensure data collected from field sensors and devices is translated into a human-readable format. All data normalization processes are abstracted through a series of protocol conversions, from Modbus to MQTT, and from TCP (data center) to HTTP (end users).

Broad Analytics Infrastructure to Realize Customer Value
Users can view analytics data and reports generated by Abbaco Controls' water management solution.

Infrastructure to Monetize Hardware, Software, and Data Management from Edge to Cloud
Systems integrators can choose from a wide range of edge devices that use open protocols such as Modbus and MQTT.

Summary

With the goals of doubling rice production and transitioning from a rice importer to exporter, the Malaysian government found it necessary to revamp its agricultural water management system to make better use of the country's water resources. It selected the Abbaco Controls solution because it gives farmers more control over how their farms are irrigated while also making the process more cost-effective and time-efficient for everyone involved. In collaboration with Intel and Kontron, Abbaco Controls provides a secure and scalable solution that allows farmers to control water gates in real time, optimize water usage, lower system cost, and increase rice production. By partnering with systems integrators like Abbaco Controls, Intel and Kontron are enabling scalable IoT solutions across the world in support of truly transformational ideas. The possibilities are endless, and Intel looks forward to working with partners like Kontron to drive economic value and social change with the IoT.

Resources

Intel® Internet of Things Solutions Alliance

Kontron is a Premier Member of the Intel® Internet of Things Solutions Alliance. Members of the Alliance provide the hardware, software, firmware, tools, and systems integration that developers need to take a leading role in IoT.

Intel® IoT Gateway Development Kits

Intel® IoT Gateway development kits enable solution providers to quickly develop, prototype, and deploy intelligent gateways. Available for purchase from several vendors, the kits also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and data center servers.

To learn more about products and services from Abbaco Controls, go to abbacocontrols.com.my.

For more information about the Kontron Industrial Computer Platform A-20, visit kontron.com/downloads/catalogues/kbox-family_folder.pdf.

For more information about Intel solutions for the IoT, visit intel.com/iot.

1. Source: Abbaco Controls estimate.

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