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Application Story

WISE-4000 Wireless Device-to-Cloud Solution Creates a Lightweight Factory Machine Management System for Small and Medium-Sized Metal Processing Plants

Advantech has constructed a lightweight device-to-cloud factory machine management system by using WISE-4000 wireless I/O modules, which are compatible with Microsoft Azure Cloud Services. The solution helps traditional small and medium-sized processing factories upgrade their production lines, optimize transparent production management, and increase equipment utilization rates/management efficiency on an affordable budget.

Project summary:

By introducing industrial IoT (IIoT) technologies such sensors, network infrastructure, and cloud platforms, the manufacturing industry has been able to achieve equipment connectivity, facility monitoring, and other transparent factory management applications. However, since it can be relatively difficult to lay down new cables in most existing production lines and factory environments, making space for additional monitoring and networking devices can be even more challenging. To small and medium-sized manufacturing plants, if the desire to introduce a factory equipment management system requires the purchase of expensive hardware and software, such a large investment becomes a threshold that most small and medium-sized businesses cannot cross. Furthermore, if system integration and subsequent maintenance management processes are too complex, vendors with limited resources will be even more tentative to take the first step toward improving their current system.

Using WISE-4000 series wireless I/O modules and wireless sensor nodes, Advantech has created a lightweight IoT solution for small and medium-sized factories who wish to incorporate equipment management and facility monitoring systems into their existing operations. The WISE-4000 series offers data collection, data logger, data pre-processing, and IIoT cloud connectivity tools in addition to many other features. Advantages of this system include its compact size and easy installation as well as the fact that data cables and gateways do not need to be set up to achieve cloud platform integration. This not only lowers the complexity associated with the system architecture, but it also solves many problems faced by processing factories hoping to introduce IoT applications, allowing manufacturers to complete their upgrades and transformations more easily.

System requirements:

A manufacturer in Japan who specializes in making metal parts for the automotive industry offers services including product design/development, mold manufacturing, stamping, and assembly. Although the company is able to mass-produce premium quality products with its precision machining technologies, they are also actively developing new processing methods for manufacturing various types of components. On the production line, however, their mode of operation still follows the traditional method of reading and writing down data manually. Operators are then required to copy production information that has already written on a piece of paper into a computer system before their shift ends. This is not only time-consuming, but it also introduces the possibility of human error. From a managerial perspective, this also means that real-time plant production status information is simply unavailable, and as such the only option is to wait for regular reports from the production line. This makes it virtually impossible to obtain accurate data on the equipment utilization rate or material status. Consequently, management can only arrange work orders based on past experience. Even if they wish to increase production efficiency, it would be difficult to determine where to begin because they do not have access to accurate reference data.

For these reasons, the metal processing plant decided to enhance the transparency of its factory equipment management by incorporating communication and IoT technologies. In addition to being able to obtain real-time information on key production equipment, the solution also had to allow for monitoring various a range of equipment inside the factory in real time. After considering the available factory space, system construction costs, and human resources, the company decided on a solution that uses wireless transmission to collect data. Furthermore, to accelerate the introduction process and save on the initial costs of developing its own cloud system, the company also decided to adopt Microsoft's Azure public cloud platform. Finally, the solution had to be scalable so that system functions can be easily adjusted or expanded in the future.

System description:

Most on-site equipment was either stamping machines without PLCs or closed systems without open communication ports. Based on the varying condition of the equipment, multiple IoT wireless I/O modules were adopted from Advantech’s WISE-4000 series and EKI-6332GN Wi-Fi access points to meet the demands of the metal processing plant, which were to network the production equipment and enable monitoring of the equipment and overall facility.

With respect to establishing connectivity with the production equipment, the client's requirement was to be able to collect statistics on the number of presses performed by 130 stamping machines. Each stamping machine was thus equipped with a WISE-4050 Wi-Fi IoT wireless I/O module to achieve non-invasive, comprehensive equipment status data collection. The WISE-4050 modules first place a timestamp on the data collected from each machine and then perform a series of processes including data encryption, format conversion, and cloud authentication. Data are then uploaded to the Azure IoT Hub via HTTPS, where equipment operation status information is analyzed or visualization tools such as Power BI are used to present the data as customized reports as per client requests. Through this type of factory information transparency, management personnel will be able to manage all types of information through the Azure cloud platform, such as the number of presses performed by individual stamping machines, the time required to process each workpiece, and machine startup/shutdown times. Production work orders could also be arranged by using transparent production processes to increase the utilization rate of equipment and stabilize the line balance rate.

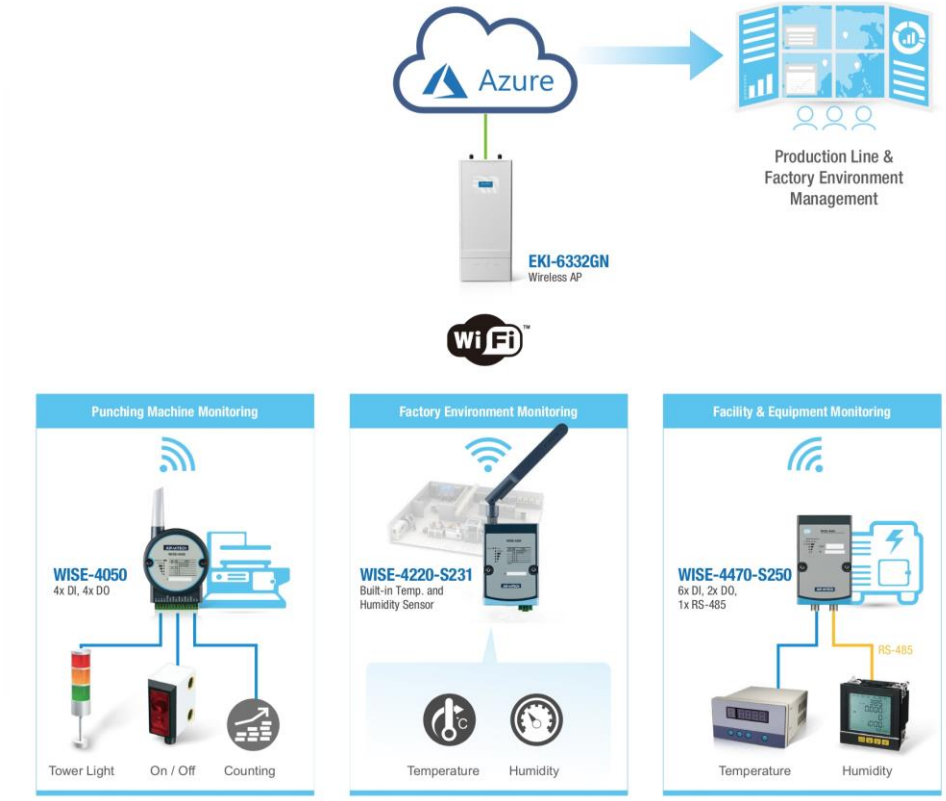
Because of pre-integration, WISE-4000 series wireless I/O modules can directly support Microsoft's Azure IoT Hub. Within a system such as this, it is not necessary to have a computer act as the gateway or write a data conversion program. Both the overall complexity associated with the system's architecture and the hardware costs are reduced significantly. In terms of the time-stamped data logger and break-point resume functions, even when the network connection is unstable, data can be temporarily saved locally in the module first. Once the network connection recovers, data can then be uploaded to the cloud to ensure data integrity and accuracy. Although the metal processing plant's requirement is to send data every second, stamping machines can be idle during non-production hours. Therefore, by modifying the data upload settings in the WISE-4000 module, data can be transmitted only when the machines' status changes, thereby conserving network bandwidth. In addition, if the network bandwidth is becoming insufficient due to large amounts of data being collected, the settings can be modified via the web interface so that the time-stamped data can temporarily be stored inside the module. Then, once the criterion for data accumulation has been met, everything will be uploaded together.

Project introduction:

Product	Description
WISE-4050	4-ch Digital Input and 4-ch Digital Output IoT Wireless I/O Module
WISE-4051	8-ch Digital Input IoT Wireless I/O Module with RS-485
WISE-4060	4-channel Digital Input and 4-ch Relay Output IoT Wireless I/O Module

WISE-4012	4-ch Universal Input and 2-ch Digital Output IoT Wireless I/O Module
WISE-4220-S231	Wi-Fi IoT Wireless Sensor Node with Built-in Temperature and Humidity Sensor
EKI-6332GN	IEEE 802.11b/g/n Wi-Fi AP/Client

System architecture:



Conclusions:

Achieving transparent smart factory management should benefit more than just large manufacturers. The production lines of traditional small and medium-sized factories can also be upgraded to smart facilities by using lightweight IoT system architectures. In such systems, external devices capable of automatic data collection can used to replace the traditional method of reading and recording data manually, allowing operators to gain a full understanding the operating status of individual equipment inside the factory.

By using Advantech's cloud IIoT solution, which offers wireless network transmission and savings in hardware construction costs, the customer was able to achieve complete control

over their production status and improve their operational efficiency. The metal processing plant's stamping machine utilization rate for the month when Advantech's solution was introduced exhibited a 26% increase compared to the previous year. In addition to the increased production capacity, the system also gave management personnel precise control over the factory's production status. This allowed the customer to optimize production and establish order acceptance policies, thus ensuring that products are delivered on schedule to improve customer satisfaction. This case study is a perfect example demonstrating that even small and medium-sized factories can cross the threshold to transform themselves into smart production facilities.

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Application Story

Utilizing the ADAM-3600 Edge Sensing Device-to-Cloud Solution to Build an Automated Wastewater Monitoring System with Multi-Point Station Data Transmission

Advantech has built an edge computing IoT system from the ADAM-3600 intelligent remote terminal unit, which has WISE-PaaS/EdgeLink built in and is compatible with Azure Cloud Services. It accomplishes data collection, preprocessing, and transmission in one unit and integrates a cloud management platform that enables the installation of many continuous monitor systems with widespread measuring points and high-volume data management, thus allowing real-time the monitoring of discharged wastewater and ensuring compliance with public standards.

Project summary:

To prevent environmental pollution from industrial and domestic sewage, environmental conservation agencies of many national governments have established laws aimed at preventing water pollution in order to enforce control over wastewater discharge. As an example, for many years in Taiwan, factories and industrial parks have been required to install automated wastewater monitoring equipment once their daily wastewater discharge volume reaches a threshold, as per the Environmental Protection Administration (EPA), which is the country's authority governing water pollution management. However, monitoring data might be subject to manipulation and fraud, and regular audits have proven insufficient for eliminating such wrongdoings. Moreover, with rising public awareness on environmental conservation, the EPA has further requested industrial and domestic sewage effluent water quality data to be linked online and posted in real time on the EPA's public platform in order to protect the environment and ensure corporate responsibility. In addition, some governments at the county and city level have established defensive monitoring systems in local rivers to monitor water quality and thereby prevent malicious wastewater discharge from entering the river systems.

For such continuous monitoring systems, which require widely dispersed measuring points and the processing of large data volumes, system integrators need to build an automated wastewater monitor system that has a concise system structure and can be managed from a single platform. Advantech's ADAM-3600 intelligent remote terminal unit (RTU) is an edge sensing system for data collection, preprocessing, and transmission forwarding. Its built-in

WISE-PaaS/EdgeLink intelligent IoT core technology enables preprocessing (e.g., data summarization and conversion) at the device end, so that only key data are uploaded to the cloud platform, which saves communication costs while reducing the volume of data on the cloud platform. Therefore, system integrators may more efficiently develop an automated wastewater monitor system that complies with both factory system and government bid requirements.

System requirements:

A Taiwanese system integrator who provides environment wastewater monitoring solutions was recently awarded an automated wastewater monitoring contract with a local government in northern Taiwan. The tender stated plans to monitor water quality in rivers and factory wastewater effluents under jurisdiction, and this included volume, temperature, pH, conductivity, chemical oxygen demand, and suspended solids. According to the EPA's requirements, data were to be transferred to the local environmental conservation authority's monitoring center at specific intervals (chemical oxygen demand and suspended solids data were to be transferred once every hour, while the other monitor data were to be transferred every five minutes). The system also had to be linked to the EPA's public platform in order to provide real-time data on water quality.

In contrast to the customary multi-layer structured automated monitor system, this system integrator introduced cloud IoT technology and, with the currently market-preferred device-to-cloud solution, set the system to transmit data via MQTT from nearly 20 types of water quality sensor at various test stations to a unified management Azure cloud platform. Data filtering and multi-point transmission features were implemented on the cloud platform to meet the information publication requirements of various governing authorities. The concise structure of the device-to-cloud configuration reduced not only the hardware cost of individual stations but also the hassle of testing for hardware compatibility. By utilizing a public cloud service, the system integrator was spared the expense of building a data storage environment as well as the trouble of system maintenance; moreover, this setup offers greater flexibility with regard to scalability for future system updates. Furthermore, as the measuring points are widely dispersed, the data are transmitted wirelessly via a 3G network, and so the base-layer equipment were selected to meet the requirements of outdoor applications while possessing edge computing and data preprocessing features to minimize data transmission over the long term and thereby cut future costs for system transmission.

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System description:

With only the ADAM-3600 intelligent RTU, which comes with WISE-PaaS/EdgeLink intelligent IoT technology built in, Advantech was able to meet the system requirements for continuous automated monitoring and cloud management. Water quality data are collected from various sensor brands at different measuring points and linked by the ADAM-3600, and then summarized, averaged, resized, or otherwise preprocessed through WISE-PaaS/EdgeLink. Finally, the processed key data are transmitted together via MQTT to the Azure cloud platform at the designated interval.

Using a low power processor and supporting a wide temperature range (-40 to 70 °C), the ADAM-3600 is extremely suitable for outdoor installation and effortless remote monitoring and management via a cloud platform. In addition to the unit's 20 analog and digital I/O channels, it has four scalable slots that allow users to install additional I/O modules. For example, the current project required both analog and digital input as well as digital output channels, and so the number and type of channels can be expanded with the optional ADAM-3617, ADAM-3651, and ADAM-3656 in order to handle data acquisition requirements under different environments. The flexibility of two Ethernet ports and two Wi-Fi/3G/GPRS/Zigbee-compatible wireless communication mini PCIe slots enable users to select the most suitable transmission method for device-to-cloud connections.

WISE-PaaS/EdgeLink plays a key role in device-to-cloud applications; specific to this project, its various practical features provide easier wireless communication for data forwarding. For instance, it supports multiple communications protocols (e.g., Modbus, DNP3, RESTful, MQTT, and IEC 61850-5-104) to connect with currently installed PLCs and the various sensors employed for physical signal collection. MQTT is also supported for seamlessly linking to third party public cloud platforms such as Microsoft Azure. In addition, before sending data to the cloud platform, it preprocesses data according to user settings, thus reducing the data transmission volumes. Previously, time-consuming software programming would have been required in order to accomplish this complex task, but now all it takes is simple setup process. For data transmission, the transfer resume feature can be employed to collect data in the ADAM-3600 SD card in the event of an unstable or interrupted wireless connection; should this occur, the data are then actively uploaded after the connection has been resumed, thus preventing data loss.

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Application Story

Project introduction:

Product	Description
ADAM-3600	Wireless intelligent RTU with 8 analog inputs, 8 digital inputs, 4 digital outputs, and 4-slot expansion
WISE-PaaS/EdgeLink	Smart protocol conversion software

System architecture:

Conclusions:

Stopping water pollution is a vital job for environmental conservation, but treatment methods and strategy development both require the long-term collection of water quality data to establish a basis for analysis and development appropriate remedies. Device-to-cloud unified monitoring and on-site detection enables the direct transmission of data from work sites to back-end management platforms, thus preventing data manipulation and allowing environmental conservation agencies to learn about pollution discharge conditions in a comprehensive, real-time manner.

Advantech's ADAM-3600 with WISE-PaaS/EdgeLink is a leading device in the field of environmental conservation and can satisfy the needs of environmental monitoring. System integrators may achieve device-to-cloud connectivity with simple settings on this compact RTU and shorten program development times. The RTU also handles many configurations of hardware products and thus simplifies maintenance work while the transfer resume feature ensures data accuracy and completeness. Multiple interface and modularization designs provide users with expansion options according to the intended application.

Further demonstrating the reliability of the ADAM-3600, but water utility companies in China have also adopted the same system structure as the one used this project to build domestic wastewater discharge monitor systems in villages in suburban Beijing, thus confirming the suitability of this unity in the field of environmental conservation monitoring.

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Application Story

ADAM Industrial Ethernet Solution for a Device-to-Cloud Remote Asset Management System for Electric Generators

Using ADAM-6000 series remote I/O modules, Advantech has developed a compact device-to-cloud cloud IoT system that is compatible with Microsoft Azure Cloud Services. This system can aid power generator maintenance service suppliers with installing remote management systems. Real-time generator status can be monitored for predictive maintenance and instant debugging can be performed to prevent serious breakdowns. High-value, zero-tolerance equipment operation and maintenance service can thus be realized.

Project summary:

Development of smart edge sensing devices has made it possible for increasingly more conventional equipment to be applied in IoT applications through the concise structure of device-to-cloud systems, thus enabling companies to remotely control widely distributed key equipment. For power generators, as an example, many maintenance or rental service suppliers have units installed in such locations as factories, bus/train stations, airports, banks, hospitals, and office buildings. In the after-sales service of such equipment, the conventional routine patrol method is often adopted, which requires the vendor to spend large labor costs to maintain generator units over a wide area. In the event of an error that cannot be resolved in time, equipment can suffer substantial damage. Once the optimal maintenance time has passed, a complete breakdown has occurred by the time the problem is addressed, and the high maintenance fee and losses due to downtime invariably results in low customer satisfaction. Therefore, by remotely monitoring the operational status of each generator via a cloud management system, suppliers can respond immediately in should an anomaly occur, thus having the means to boost their clients' confidence in their vendor's products and services.

For such wide-area remote management applications, the key points of consideration for installing a system are compliance and data connection methods. Typically, a gateway is installed beside the generator as a relay station for data collection, and programs are written for data conversion, encryption, and validation, after which data are transmitted to the management system. This solution has a complex system architecture that not only increases the installation cost per data collection point but also introduces a considerable amount of maintenance work for the supplier. To simplify the device-to-cloud system architecture,

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Application Story

Advantech offers the ADAM-6000 series solution that integrates an industrial Ethernet I/O module and a 3G cellular router. This system is easy to install and maintain while providing ample options for future expansion system; moreover, it requires neither a relay station nor programming, making it substantially easier for users to install a remote asset management system.

System requirements:

A German power generator supplier who provides generator, emergency power supply device, and diesel engine equipment and maintenance services is renowned for its high service standards. This reputation is largely due to its consideration that supplying continuous power is a zero tolerance task. Accordingly, it has long provided a 24-hour after-sales service hotline to address customer problems any time. With the development of IoT technology, status monitoring and preventive maintenance applications have been trending upward in recent years and are in line with the company's commitment to serving its customers. Thus, the company decided to utilize this concept and introduce a remote asset management system for the widely dispersed power generator units it has sold.

However, the company does not employ developers specializing in IoT technology. To avoid the need for software development and minimize the cost of both hardware installation and subsequent maintenance, the company sought to adopt Microsoft Azure Cloud Services as its management platform; also, they planned to install a docking system at the device end in order to add device-to-cloud equipment management capability. To simplify system installation, maintenance, and expansion, the required power generator docking system had to have a compact structure. Additionally, base-layer equipment had to be designed to be able collect various generator signals for real-time monitoring, to provide control features for immediate reporting, and implement emergency procedures when an anomalous situation occurs. In addition, since power generators are generally widely distributed, all uploading and downloading of data must be transmitted via a 3G wireless network.

System description:

For this project, Advantech utilized three industrial Ethernet remote I/O modules, namely the ADAM-6017, ADAM-6050, and ADAM-6266, as well as a SmartFlex 3G/4G cellular router. All products were installed in a case beside the generator unit. The ADAM-6017 was utilized to collect temperature and power signals from the generator unit; the ADAM-6050 was employed to control on-site switch signals and warning lights; and the ADAM-6266 was adopted to trigger the motor's emergency switch. Following data encryption, conversion, and processing by the

microcontroller unit in the ADAM modules, power generator status data were transmitted via the 3G router to Microsoft's Azure Cloud Service, which is compatible with the ADAM modules, and data could then be visualized in real time through the Power BI visualization tool powered by Azure. This output could then be applied for condition monitoring and preventive maintenance.

Since Advantech's ADAM-6000 series support various communications protocols, no additional procurement of a PC as a gateway is required, nor is does data conversion software need to be developed in order to achieve seamless integration with Microsoft Azure or other public cloud services. Concerning transmission security, ADAM-6000 series modules support data encryption, after which all data are uploaded to the cloud platform for analysis and remote asset management via HTTPS.

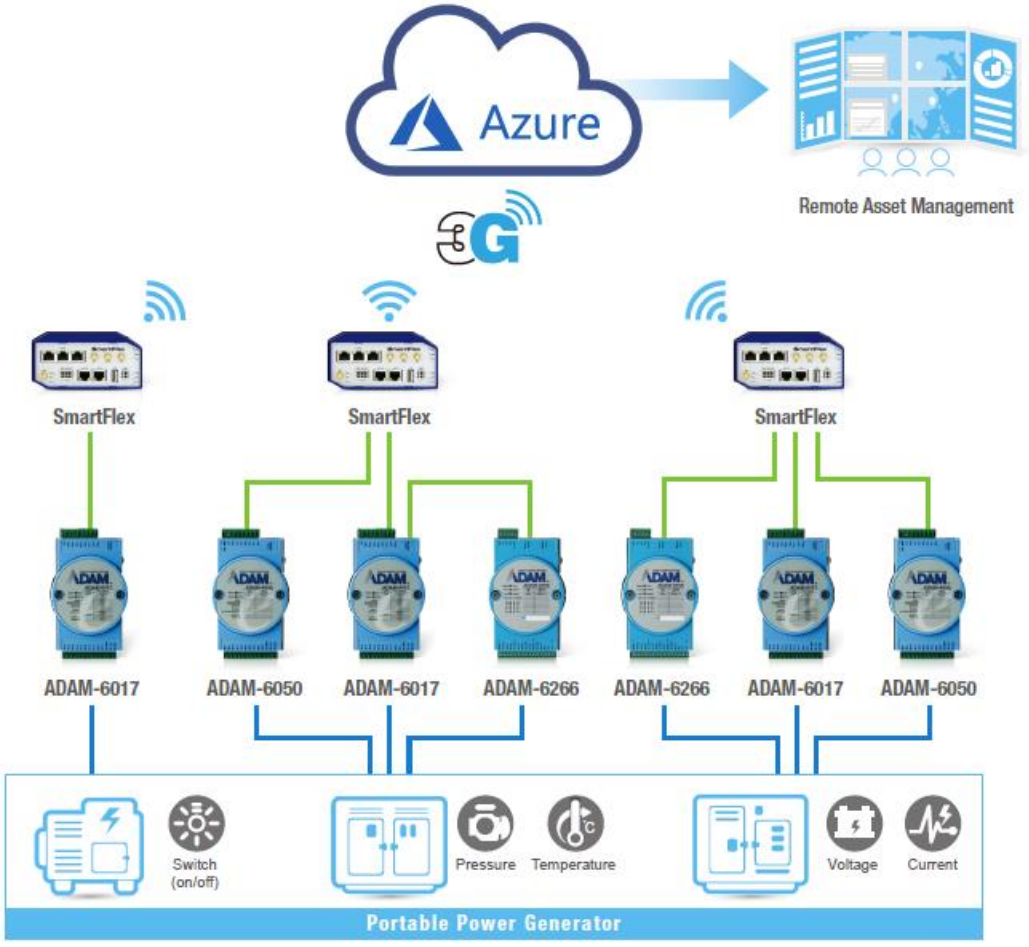
This series of modules also comes with Graphic Condition Logic (GCL), which circumvents the needs for software development. This allows users to determine the logic rules by using Advantech's Adam/Apax .NET Utility, and they can then simply download the output to the designated module for it to act as a controller, automatically implementing the preset logic action. As an example for the current project, in the event of an anomalous data event, a warning is immediately sounded and the system can directly control the power generator motor and stop the motor to prevent overheating, which would otherwise cause a coil or wire burnout or some hazardous incident such as a fire.

All three ADAM-6000 series modules are compact and thus optimal for flexible on-site arrangement and expansion. For example, ADAM-6266 modules were deployed with a daisy chain with auto-bypass protection, which reduced the wiring costs and eliminated the need for additional switches. Thus, when multiple ADAM modules are required, nearby modules can simply be connected as a daisy chain topology, sharing a router and cutting down on unnecessary hardware costs. Should one of the modules experience power failure or breakdown, the auto-bypass protection will prevent interruption of the entire chain.

Project introduction:

Product	Description
ADAM-6017	8-ch isolated analog input Modbus TCP module with 2-ch digital output
ADAM-6050	18-ch isolated digital I/O Modbus TCP module
ADAM-6266	4-ch relay output Modbus TCP module with 4-ch digital input
SmartFlex	3G/4G cellular router

System architecture:



Conclusions:

Advantech's ADAM solution can easily be utilized to connect with third-party public clouds and in real time continuously monitor and control a high number of widely distributed equipment. Direct connection of encrypted data to the cloud platform also protected critical user data. GCL offers simple logic processing, allowing the modules to achieve direct control of equipment features. Moreover, the compact size of the products and daisy chain connection ability allowed for flexible and simplified wiring arrangements.

Advantech's ADAM solution helped this supplier complete its remote monitoring management system quickly and saved them a substantial amount on software and hardware costs.

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Application Story

Convenient and innovative applications of increasingly more ubiquitous IoT equipment are changing conventional practices in many industries. However, to simplify the compliance of device-to-cloud data connection, reduce system installation costs, and shorten system implementation times, choosing a compact device-to-cloud structure that can connect with public cloud services is key to ensuring efficient remote management of critical equipment such as power generators, water pumps, air conditioner units, and elevators.

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Application Story

Advantech LoRa Private Solution for Flood Monitoring and Warning System

Challenge:

According to Munich RE, one of the world's leading reinsurers, overall losses from natural disasters in 2016 was approximately US$175 billion worldwide. Among all disasters, floods were ranked sixth, accounting for US$40 billion. Thus, determining how to precisely predict flood events and efficiently minimize resulting losses has become a high priority.

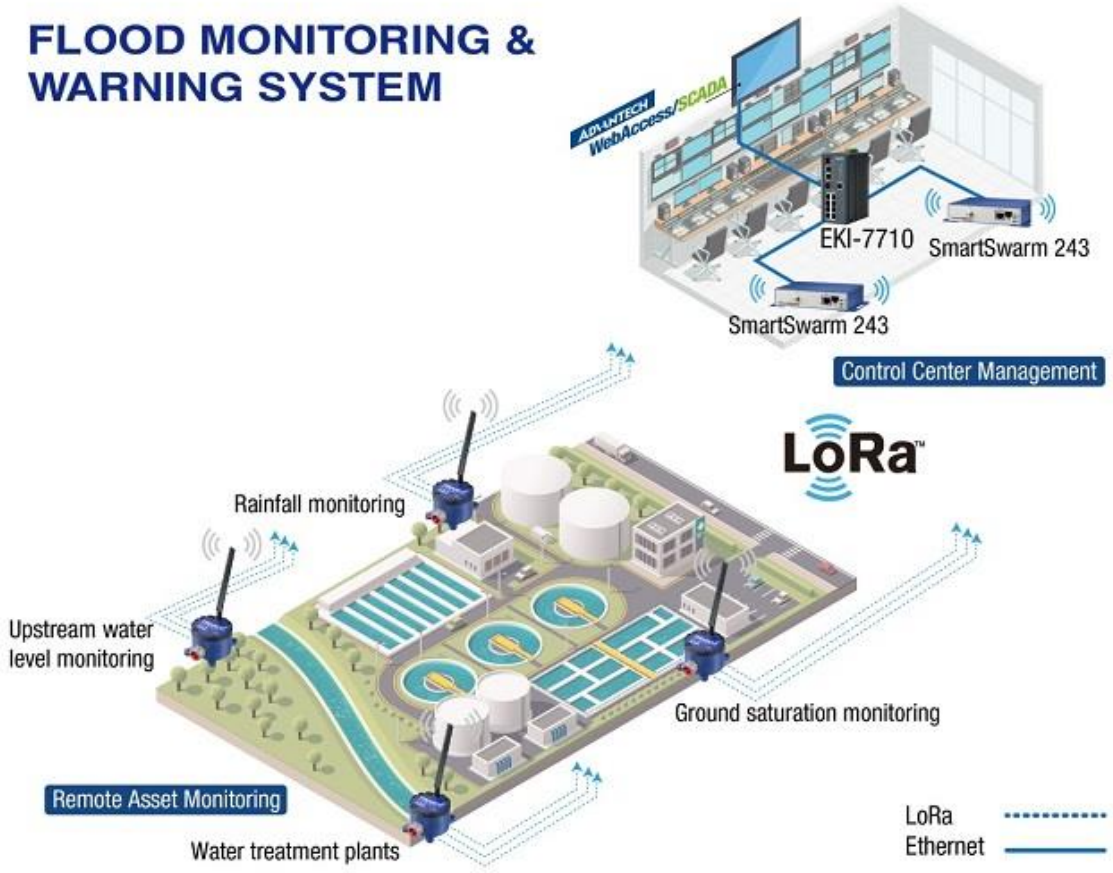
Flooding and excessive rainfall can cause considerable disruption or damage to critical assets and infrastructure. Water treatment plants, for example, are typically located near water bodies, and many of them are situated on flood plains. Thus, implementing an effective FMDS at such facilities requires overcoming challenges in network deployment, particularly because the system must be able to function under high humidity and handle acute changes in temperature in order to provide timely reporting on environmental conditions.

The Solution:

The ability to track data such as rainfall, ground saturation, and upstream water levels enables companies and utility services to receive early flood warnings and take preventative action. Even for the many similar systems that are already in place, their effectiveness can be improved by adopting the Wzzard LRPv series of products.

Advantech's Wzzard LRPv Nodes and SmartSwarm 243 Gateways can be used to establish low-power wireless sensor networks with LoRa technology, and this can enable the reporting of data to your computer or cloud application via a central network gateway. The most useful gateways can utilize both wired and wireless data connections, meaning that that you can position them in most locations.

Your software can then combine your data with third-party information such as weather reports from national weather services. This enables your system to make intelligent decisions such as issuing in-time SMS notifications to the public for evacuation, signaling and broadcasting disaster warnings, and convening emergency response teams.



Conclusion:

Advantech's Wzzard LRPv solution, a highly integrated LoRa sensing platform for applications ranging from I/O sensor data management to network protocol conversion, can be utilized to form a private sensor network, paying immediate dividends by cutting maintenance costs while increasing overall productivity. Wzzard LRPv network gateways connect to your application server or SCADA for data access using the MQTT protocol via either an Ethernet or wireless data network.

The described features make it possible to place sensors and Internet gateways in locations where AC power or wired Ethernet is unavailable, and the high flexibility of the dual power-saving modes and alarm system can minimize costs by conserving power and preventing disasters.