M2M Smart Network Solutions utilizing 920MHz Wireless Modules

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Networks people use have diversified to include fixed telephones, the Internet and mobile phones. However, a need for a new network that allows autonomous communication between things without human intervention is now apparent. The mechanism that enables this is referred to as M2M (Machine to Machine) or IoT (Internet of Things) and devices connecting to networks through such mechanism is said to reach several billion by the year 2020. The definition of M2M and IoT varies by researcher and organization, but they will be collectively referred to as M2M in this article.

Networking the various devices, which were previously unconnected, can lead to better work efficiency and new services. For example, an electric meter requiring a manual reading every month can be replaced with a smart meter that will automatically send readings taken at regular intervals over a network. This will not only reduce the labor of the meter reading personnel, but new services such as optimization of energy use and pricing on an unit-time basis can be provided.

In addition, using measuring instruments and sensors to record the various tasks and decisions previously performed from experience of experts, knowledge and events can be quantified for use in wider applications. For example, a building inspector determining deterioration from the sound made when knocking on structural surfaces or a farmer's decision to adjust greenhouse temperature/humidity can be measured with a sensor. Then the correlation between data and the actual event is analyzed and knowledge stored for sharing or lateral development. This can alleviate the shortfall of skilled workers or lead to business expansion through work efficiency. Proceeding with this process will help in the creation of a safe, secure and convenient ICT utilizing society.

A new wireless network suitable for connecting various devices is important for the realization of M2M. Centered on 920MHz wireless multi-hop modules that can be incorporated into a variety of “things” for connection to a network, OKI’s smart network solutions provide solutions that meet customer demands. This includes gateways for accommodating the wireless modules into the wide area network, M2M platform that enables applications to access the sensor network and system construction with industry-specific applications.

OKI’s M2M Solutions

(1) Solution Configuration

M2M is not a completely new concept. The mechanism is similar to traditional telematics and telemetry. However, unlike the previous vertically integrated individual systems designed for specific purposes, realization with open ICT technology is the feature of M2M. Through the integration of common features into a platform, M2M can be applied to purposes that do not justify the construction of dedicated systems.

OKI’s M2M solutions aim to create new added-value by connecting various “things” together through sensor networks including the 920MHz wireless network. The M2M solution configuration is shown in **Figure 1**.

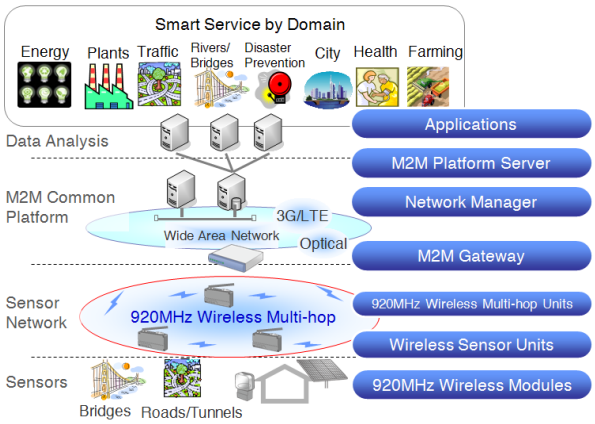

Figure 1. OKI’s M2M Solution Configuration

The components of **Figure 1** are described below.

1) Wireless sensor units

These units are 920MHz wireless-compatible measuring instruments/sensors used for various monitoring, measurement and control purposes.

2) 920MHz Wireless Multi-hop Units

These wireless devices aggregate various sensors with master and slave units to form a highly reliable but low-cost sensor network.

3) M2M gateway (M2M-GW)

M2M gateway collectively sends sensor information aggregated at the sensor network to the cloud-based M2M platform server via 3G or other WANs. Depending on the sensor or application specification, some intermediate processing may occur at the M2M-GW. In case of intermediate processing, a relatively high-functional GW is selected, but if data processing is not required, an inexpensive GW is adequate.

4) M2M platform server

Working in conjunction with M2M-GW's internal agent software, M2M platform server stores the data collected from sensors and provides information to various applications via API. It is often combined with tools that facilitate development of screen displays and with components required to analyze big data.

5) Network manager

Network manager manages/controls the sensor network, M2M-GW and other components that make up the M2M solution. It is useful in cases when the network reaches a large scale and reliability is required.

6) Applications

Applications use data provided by the M2M platform via API to implement a set of functions to solve end-user issues.

(2) Network Configuration

OKI's 920MHz wireless network can be configured as either a "transparent model" or "IP integration model." The transparent model transparently converts generic serial interfaces such as RS-485 and RS-232C to wireless. The model is suitable for accommodating existing devices equipped with such interfaces directly into wireless networks. In an IP integration model, applications connect individual sensor terminals to the network as IPv6 hosts. This model is suitable when monitoring/controlling large-scale sensor networks with cloud-based applications (**Figure 2**).

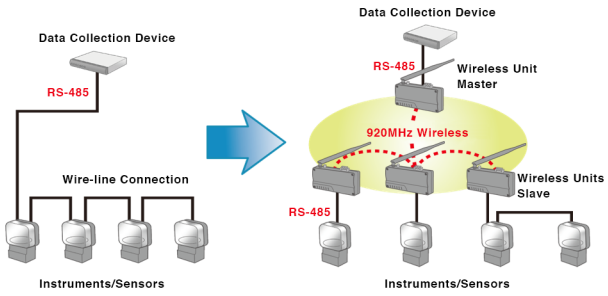

Figure 2. RS-485 Connections Replaced with Transparent Model

By using the wireless unit's "IP integration model," connection from upper-layer applications down to the sensor terminals can be unified with IP. The ever-growing number of sensors will increasingly be used in applications such as smartphones and clouds, which have high affinity with IP. It is considered the sensors will gradually become IP compatible. In the future, IPv6 can be used for data collection as well as sensor monitoring/control eliminating the need to pass through an IP conversion GW, thereby hold down solution construction cost. Additionally, as sensor networks grow larger in scale, the integrated management of sensors and communication equipment will be easier.

920MHz Wireless Modules

(1) Wireless Module Overview

The 920MHz wireless multi-hop is a strong candidate for the sensor network required in a M2M system. OKI has been selling 920MHz wireless modules for incorporation into M2M equipment since November 2013. The module has the following three features that allow customers developing sensor equipment to introduce 920MHz wireless solutions with little development investment.

1) Implemented up to upper layer applications of the wireless communication, thus eliminates the customers' need to develop communication protocol

2) Interconnectivity with OKI's wireless master/slave units is assured to allow immediate construction of a network system

3) End device modules have excellent power-saving performance and can be operated for long periods on batteries

Regarding feature 1), use of generic wireless modules frequently involves development work on the user side since the modules do not come implemented with the network layer or even if they do, require external controlling. In contrast, OKI's 920MHz wireless module comes fully implemented with multi-hop functionality in the network layer. Additionally, the module includes signal strength measurement tool and network setup tool, which are standard in OKI's wireless units, as well as upper layer applications to communicate with the host CPU. Therefore, only a simple connection with the user's motherboard is required to construct a 920MHz wireless multi-hop network.

Feature 2) allows OKI's wireless module to be interconnected with OKI's 920MHz wireless multi-hop

unit. Customers who imbed OKI's wireless module can use OKI's wireless unit as is and the need to develop master or relay devices is unnecessary.

Power-saving performance 3) is a feature of the end device module. When there is no communication, the module powers down entering a standby mode to significantly reducing power consumption. This enables long operation on batteries. Although dependent on the power consumption of the connected sensor, a sensor device capable of operating ten years on commercially available batteries (CR123A: 1400mAh) is achievable.

(2) Sensor Coordinated Model

OKI's 920MHz wireless module is available in two models. One is the transparent model and comes pre-loaded with application for transparent serial communication. This model connects with the user's host CPU via serial port (UART). It performs data communication and API communication for wireless setup. The other is the customized model, which offers software tailored to the customer's system. **Figure 3** shows a configuration example using the transparent model.

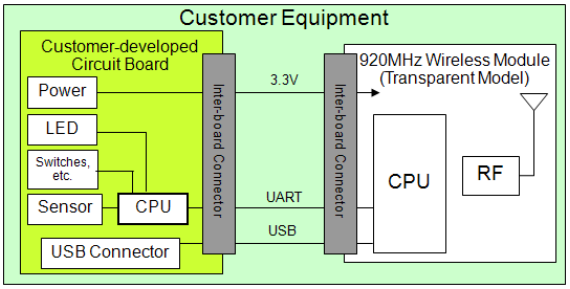

Figure 3. Configuration using Transparent Model

These two models enable customers to equip their devices with 920MHz functionality without spending large efforts in development.

Examples of 920MHz Wireless Solutions

This section describes the types of solutions that OKI can provide.

(1) Energy Management System

Growing consciousness for the need to reduce CO2 emissions to counter global climate change and the need to use less energy since the aftermath of the Great East Japan Earthquake has led to the implementation of energy management systems in buildings and factories. OKI's wireless unit converts generic RS-485 and RS-232C to wireless allowing them to be integrated into existing systems as communication paths. The benefit is cost reduction in sensor network construction due to less amount/period of construction compared with wired connections. In energy management systems implemented at buildings and factories, the networked power sensors are frequently connected in a RS-485 multi-drop configuration using the single master/multi-slave Modbus specification. When networking the sensors, there are cases where buildings or roads need to be straddled, which are physically difficult for wired connections or cases where the sensors are scattered over a wide area, which increases wiring cost. In these cases, the problems can be resolved with wireless connections.

It was possible to configure wireless in the past with equipment using the unlicensed 2.4GHz or 429MHz band. However, from a reliability standpoint, interference and signal reach issues made the equipment difficult for use as communication paths in an actual system. The signal reach of OKI's 920MHz wireless unit is approximately 1km and together with the multi-hop technology, which performs multistage relay, a wide area network can be configured. In an actual adopted system, power use at cubicles scattered throughout a customer's factory was measured and all networked with wireless. The ability to use existing power sensors and the excellent signal reach were the decisive factors for adoption.

(2) Factory Equipment/Facility Monitoring System

It is often problematic to lay down wiring at a large factory site since various equipment and sensors are scattered throughout the entire factory. The use of wireless is particularly effective in such situations.

The measuring points spread out across the large factory site can be set up with a sensor and wireless unit. Then using the wireless units' multi-hop function, a sensor network covering the entire site can be constructed without hardwiring.

Besides the above-mentioned power sensors for visualization of power, many other sensor needs are present within a factory as shown below (**Figure 4**).

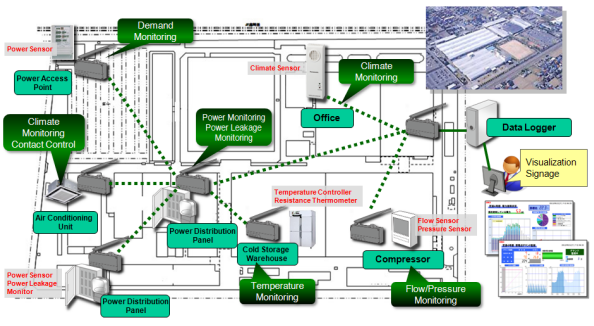

Figure 4. Placement of Various Sensors at a Factory

- Detect amount of leaked air and reduce waste
- Manage the factory's water usage
- Manage temperature history of warehouse and refrigerator (traceability)
- Remotely monitor operation of equipment such as pumps without workers making the rounds
- Remotely control multiple air conditioning units
- Prevent workers from entering danger zones

In order to meet these needs, it is necessary to install flow sensors, climate sensors and other sensors in accordance with the application. The sensors have a variety of interfaces such as analog (4~20mA, 0~5V) and contact (pulse). These interfaces can be passed through a digital converter or pulse counter/PLC for conversion to a RS-485 interface then accommodated into 920 MHz wireless for centralized management (**Figure 5**).

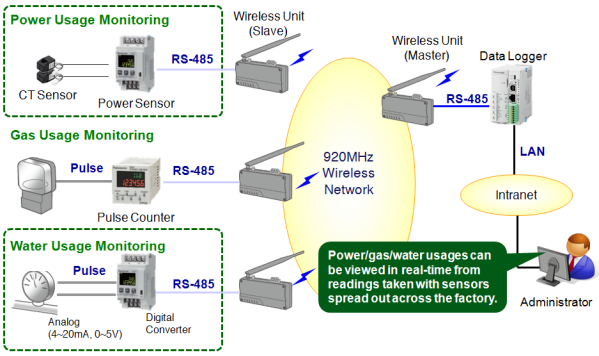

Figure 5. Conversion of Various Sensor Interfaces to Wireless

(3) Social Infrastructure

There is a growing demand for monitoring the structural integrity of bridges, roads, tunnels and their ancillary facilities using sensors. As aging infrastructures increase, long-term collection/analysis of data from vibration sensors installed on structures, prediction of structural deterioration and efficient performance of maintenance operations such as repairs become important.

When introducing a system to collect information from structure-attached sensors via a network, reduction of equipment/construction costs and reliability of information collection are issues that need consideration.

Using the low-power 920MHz wireless multi-hop technology, OKI has developed a complete wireless sensor terminal that eliminates the need for wired communication and power supply lines. The terminal is being used in an operation test for this field (**Figure 6**).

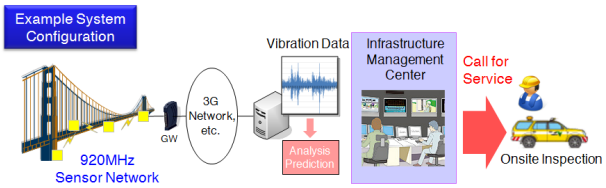

Figure 6. Structure Monitoring System using Wireless Sensors

Conclusion

Wireless sensor network to be used in the M2M systems is beginning to be applied in various fields. Its use will likely be an important factor in the future development of industries.

OKI is committed to providing M2M systems that match business characteristics and customer needs. OKI will continue to contribute to the realization of a more safe, secure and convenient society. ◆◆

References

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【Glossary】

Modbus-RTU
A serial interface commonly used in the industrial arena. It is a binary data communication standard envisioned for the connection of a remote terminal unit (RTU).

Cubicle
A facility encasing equipment to receive power at high voltage.

PLC (Programmable Logic Controller)
Device used to control automated machinery. It has a mechanism for programing input/output of a relay circuit and circuit combination.