

# Gateway Unit

Hiroyuki Fujiki,  
Kazuki Sugihira,  
Yuko Sato

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## Abstract

With the development and spread of cloud computing technology, it is possible to move corporate information systems to the cloud and use Global Positioning System (GPS) location information obtained by smartphones for disaster prevention. As the Information and Communication Technology (ICT) becomes more advanced, it is used in all aspects of social activities and has become an indispensable part of social and economic infrastructure. In response to this trend, we have developed a gateway unit that connects a monitoring server built on the cloud to an on-site Programmable Logic Controller (PLC). This gateway unit captures on-site network data via ETHERNET communication such as FL-net, an industrial communication protocol, and transmits the data to a monitoring server built on a cloud computing platform such as Meiden Cloud.

## 1 Preface

In recent years, the use of Internet of Things (IoT) devices has become widespread, and the use of Information and Communication Technology (ICT) is accelerating.

ICT is used for various purposes, such as disaster prevention or facility management. ICT can send location information and data acquired from sensor devices installed in factories to cloud services via IoT devices. When using ICT, a system that tightly integrates virtual space (cyberspace) and real world (physical space) is called a Cyber-Physical System (CPS).

A CPS requires a relay device that processes real-world data and communicates with the cloud, which is a virtual space. This paper introduces our IoT-compliant gateway unit equipped with a controller function that helps realize CPS.

## 2 Hardware

**Fig. 1** shows the external appearance of this unit. It is a metal case measuring  $W115 \times H140 \times D135$  mm (excluding protruding parts) and is equipped with six ETHERNET ports.

**Fig. 2** shows a schematic block diagram. This unit is configured with three boards and various interfaces optimally distributed to achieve a com-



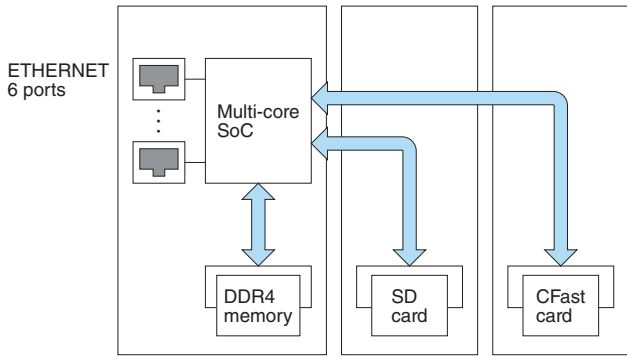
**Fig. 1** Gateway Unit

An external appearance of the Gateway unit is shown.

pact size. The design shape also takes into consideration ease of handling to aid in installation and cable connection, and heat dissipation. **Table 1** shows the main hardware specifications.

(1) Multi-core SoC: It uses a multi-core SoC FPGA by Arm Limited. Using different processor cores allows multiple operating systems to be executed in parallel.

(2) DDR4 memory: The main memory uses SO-DIMM-compliant DDR4 memory with ECC function. Together, with the multi-core SoC, it con-



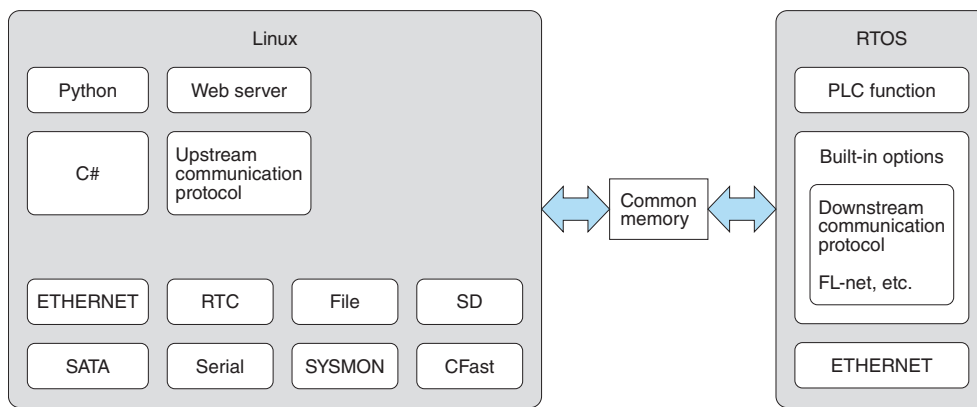
**Fig. 2 Schematic Block Diagram**

Schematic block diagram for Gateway hardware is shown.

**Table 1 Main Hardware Specifications**

Main hardware specifications of Gateway unit are shown.

<b>SoC</b>	Arm multi-core SoC FPGA
<b>Memory</b>	DDR4 conforming to SO-DIMM
<b>External storage</b>	One slot for CFast, one slot for SD card
<b>ETHERNET</b>	10BASE-T/100BASE-TX/1000BASE-T 6 ports
<b>DI/DO</b>	4 points each
<b>Conditions for resistance to environment</b>	Compliant with JIS B 3502 and Electric Power Standard B402 ※ where, contamination degree: 2 or below, EMC zone: B
<b>Operating temperature</b>	-10~+55°C Natural air-cooling
<b>Power source</b>	DC24 V (±10%)



**Fig. 3 OS Configuration of Gateway Unit**

Configuration of two types of OS (Linux and RTOS) for Gateway unit is shown.

- tributes to high performance and reliability.
- (3) ETHERNET port: It is equipped with six 1000BASE-T -compliant ETHERNET ports on the surface. It can collect control device data and uses international standard protocols.
- (4) CFast slot: CFast is used as a highly reliable non-volatile external storage function and internal data is retained in the event of a power outage. The slot is located on the back of the case. To prevent misuse, it is designed so that it cannot be inserted or removed while power is applied.
- (5) Achievement of natural air-cooling: In order to achieve a compact size while adopting a multi-core SoC and DDR4 memory, which generate a lot of heat, this unit achieves natural air-cooling with an optimal layout based on thermal simulation.

### 3 Software

#### 3.1 Multi-OS

**Fig. 3** shows the OS configuration of this unit.

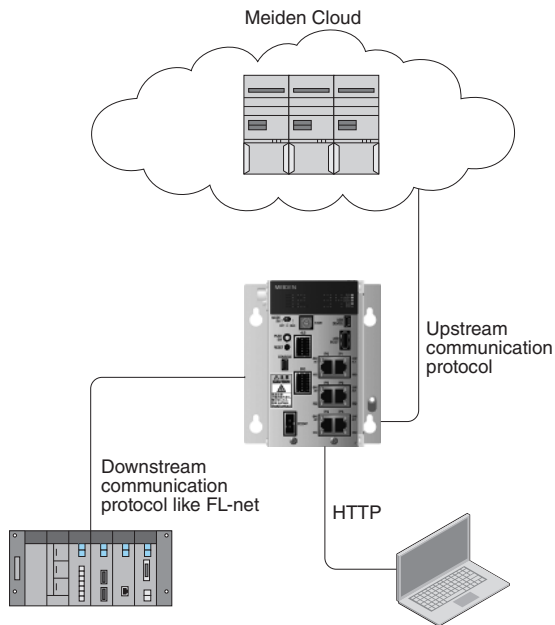
This unit is equipped with two types of OS [Linux and RTOS (Real Time Operating System)]. Application functions, file systems, and Web servers are processed by Linux, while real-time processing, such as device control and data collection, is processed by RTOS. Data transfer between OSs can be easily performed via shared memory. This unit is equipped with not only a communication gateway function, but also a controller function, and the two OSs run in parallel to control field devices while collecting data.

#### 3.2 Communication Protocol

**Fig. 4** shows the protocols used by this unit. The upstream devices (e.g., cloud devices, servers) use OPC UA (OPC Unified Architecture). For the control devices (PLC (Programmable Logic Controller), sensors, etc.), it uses FL-net.

#### 3.3 PLC Function

This unit is equipped with ladder program proc-



**Fig. 4** Protocols Used by Gateway Unit

The protocols used by the Gateway unit are shown.

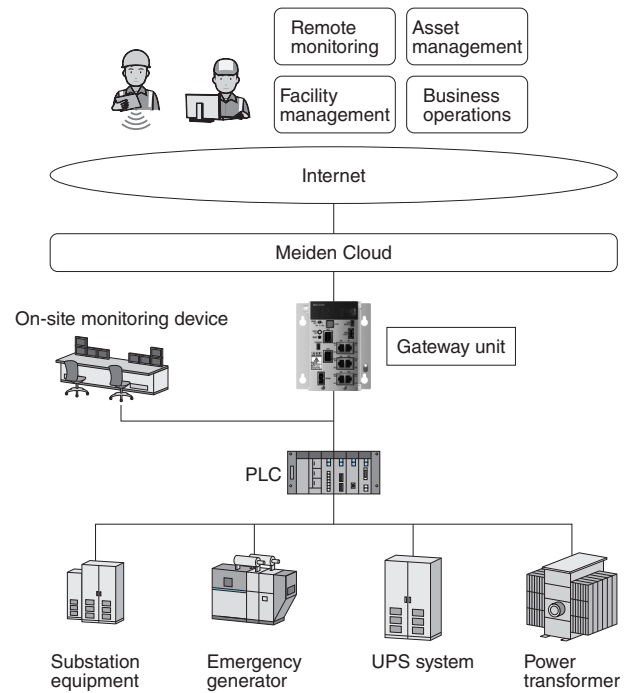
essing function and transmission function such as FL-net in the RTOS. The transmission function is implemented internally in the RTOS, which eliminates the need for an optional transmission module compared to conventional PLC products, contributing to the compact design. Data processing can process data acquired by the PLC using ladder program processing and send it to the upstream device.

### 3.4 Whitelist-Based Security Function

A whitelist-based security function can be installed as an option. The whitelist-based security function can prevent operations other than those permitted in advance. This prevents unexpected unauthorized operations and the execution of malicious software, improving security performance.

### 3.5 Gateway Unit's Connection Function to Meiden Cloud

This unit is equipped with a function to connect to Meiden Cloud. In addition, since it can use the main communication protocols used in conventional PLCs, it can connect the water supply and sewerage treatment plant monitoring and control system to our cloud without updating existing on-site equipment. Fig. 5 shows an overview of the gateway unit's connection function to Meiden Cloud.



**Fig. 5** Overview of Gateway Unit's Connection Function to Meiden Cloud

An overview of the gateway unit's connection function to Meiden Cloud is shown below.

## 4 Postscript

We have introduced the main functions of our gateway unit. It has the IoT functions necessary for building a CPS, uses a wide range of communication protocols, and has the ability to connect to multiple cloud platforms. It also has PLC functions and whitelist security functions. These are expected to help realize a CPS for ICT utilization.

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