Cloud-Based Monitoring System for Drainage Pumping Stations in Tsu City

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Abstract

In recent years, frequent heavy rains caused by climate change have resulted in large scale flood damage. As a result, regional pumping stations that pump drainage of rain water have become vital infrastructure. In the event of rainfall, it is necessary to grasp promptly and accurately the conditions of the water level, facility operations, and conditions of the rainfall. In order to support these monitoring efforts of Tsu City Government, Mie Prefecture, Japan, we are providing Software as a Service (SaaS) for water and sewerage service providers. We also supplied transmission equipment to each monitoring facility. These units are connected via the Cloud. The SaaS allows users to connect to and use (1) the Cloud-based software on facilities management and (2) available rainfall information from anywhere using a PC or smart devices.

Since the user does not need to have hardware such as monitoring devices and servers, the user can reduce initial installation costs. We provide stable Cloud computing services via multiple highly reliable data centers.

1 Preface

There are many scattered pumping stations and drainage stations for rainwater drainage in Tsu City, Mie Prefecture, Japan. Such management of so many stations requires centralized management. Additionally, in the event of a heavy rain, a system that each facility maintenance manager can quickly check the rainfall status and on-site conditions of these facilities is required.

For Tsu City, we are providing a Cloud computing service for water and sewerage service providers called “AQUA SMART CLOUD (ASC)”. We also supplied transmission equipment (router for existing IoT telemetry unit) to each monitoring facility. This telemetry unit is called “TELEMOT VIEW”. In the past, we supplied such units to this project site that are connected to the Cloud. This paper presents an overview of this system and the details of ASC services.

2 Overview of System

This Cloud + Internet of Things (IoT) telemetry system uses computers and smart devices connected to the Internet to monitor the operational status and failure confirmation of drainage pumping stations and other pumping stations. The equipment consists of a Cloud data server installed at multiple data centers and IoT telemetry (communication terminal) units installed at each monitoring drainage station and pumping station. A Virtual Private Network (VPN) on a mobile network is used for the connection between the communication terminals at each site and the Cloud data server. Under the VPN on a mobile network, VPN is an encrypted connection over the Internet from a device to a network, while ensuring security and reducing communication costs.

2.1 Cloud Data Servers

Cloud data servers are installed in multiple data centers with strong security and robust natural disaster prevention measures. Such data servers are installed in the service areas of different power companies. The latter is for large-scale natural disaster prevention measures. We have also strengthened our security measures by developing our in-house Cloud computing platform. **Table 1** shows the main specifications of the data center.

Table 1 Main Specifications of Data Center

Main specifications of the data center are shown where the Cloud data servers are installed.

Item		Specifications
Prevention of unauthorized access	Login	Password authentication, biometric authentication, fixed IP authentication (optional)
	Encryption	TLS encrypted communication
	Functional restriction	User limit control
	Equipment configuration	Provision of firewall, our unique inner structure, local communication terminal connected to closed network
Acquisition of reliability	Server	Redundant configuration, load dispersion
	Database	Continuous data synchronization, data backup
	Network	Duplication by multiple communication lines
	Stable operation	Automatic around-the-clock monitoring
Common specifications of data center	Service interruption	Multiple system power receiving, Uninterruptible Power System (UPS) redundancy, 10 minute battery charging, redundant emergency generator configuration (Backup fuel for 48 hours)
	Earthquakes	Quake-absorbing structure, laminated rubber isolators, site on robust ground, resistance to seismic intensity above 6
	Fire and submersion	Ultra-high sensitivity fire sign detection system, nitrogen-gas fire extinguishing facility, selection of a site where flooding risk is low
	Room entry/exit	Around-the-clock manned guarding, monitor camera all-area photographing plus storage, IC card plus biometric authentication, tailgating prevention gate
	Authentication	Information Security Management System (ISMS), IT Service Management System (ITSMS), privacy mark

2.2 Communication Terminal

The communication terminal is a device that captures on-site data of conditions, faults, and measured signals and transmits them to the Cloud data server. Since TELEMOT VIEW supports various IP networks, it is possible to select a network according to the on-site and server usage conditions. In addition, since it supports data streaming of on-site images, the on-site conditions can be visualized. Table 2 shows the specifications of TELEMOT VIEW.

Table 2 Specifications of TELEMOT VIEW

Specifications of TELEMOT VIEW are shown.

Item	Specifications
External dimensions	W100 × H100 × D40 mm ※Battery module is not included. ※It does not include a mounting screw and a connector with insertion plug (pin insert).
Mass	Approx. 300 g
Interface	100BaseTX × 2 USB × 1 Serial × 2 Composite × 1 SDHC × 1
Applicable power source	DC24 V
Power consumption	10 W or less
Ambient temperature	−10～+50℃ (excluding operation during power failure)
Ambient humidity	20～95%RH (no dew condensation)
Cooling method	Natural air-cooled
Atmosphere	Freedom from corrosive gases, explosive gases, and dust
Installation conditions	Panel inside or indoor installation
I/O points	DI: 512 points, AI: 128 quantity, PI: 128 quantity DO: 128 points, AO: 128 points
Upper-level transmission	Ethernet
Lower-level transmission	HLS: 63 nodes Max. Modbus/TCP: 16 nodes Max. Meiden PLC: 4 nodes Max.
Constant period transmission	10 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 6 h, 8 h, 12 h, 24 h (270 samples accumulated at the maximum)
Event transmission	Failures, upper/lower threshold deviation, signal source error causing a service interruption (accumulation of 2000 items together with operation log)
Operation log transmission	Transmission of equipment run/stop history once a day (accumulation of 2000 items together with events)
Real-time data transmission	Present-value transmission at the intervals of 5 seconds
Ledgers	Hour data aggregation, accumulation, transmission (accumulation for 10 days) Day data aggregation, accumulation, transmission (accumulation for 10 days)
Video	Format: MPEG4 Transmission image quality: VGA 4 Mbps 30 fPs, etc.

3 Monitoring Function

3.1 Wide-Area Monitoring Service

The wide-area monitoring service, which is the basic service of ASC, is mainly aimed at (1) condition monitoring and information management of the operation, failure of equipment distributed over a wide area and (2) the monitoring and information management of the same. It provides the same services as conventional monitoring equipment. Table 3 shows the functions of the wide-area monitoring service, and Fig. 1 to 4 show the wide-area monitoring graphic screens. The event log display shows failures that occurred in the past in chronological order, and the trend function enables different trends to be compared and displayed. This function also makes it useful for data analysis. The

Table 3 Functions of Wide-Area Monitoring Service

Functions of various wide-area monitoring service are shown.

Function	Contents
Graphic screen	・The present situation of plant facilities is checked in visual expression. ・The equipment status and measured values are displayed in symbol colors and numerals.
Trends	・Trend data are checked by line graphs. ・Different trends are compared, examined, and saved in files.
Data list	・The present situation of plant facilities is displayed in a list. ・The equipment status and measured values are displayed in names and figures status.
History display	・In addition to the operation, failure, and error information of the key equipment that makes up the plant, it displays the information in a list such as the operation of the system and the operation of the equipment. ・Past messages can be examined.
Alarm	・It displays in a list the failures and error data of equipment and measuring devices. ・In the case of an alert, a prompt alarming report is displayed on the monitor screen together with the alarm sound.
Alarm announce-ment	・When a failure occurs, an alarm mail is sent to previously designated mail addresses.
Ledger	・Ledger display and print-out together with reference to past ledgers can be carried out.
Equipment failure monitoring	・It activates an alarm or shows alarm windows based on the process device failure information.
Upper/lower limit deviation monitoring	・Based on process data deviation information for preset upper and lower limit values, alarm activation, and alarm display are performed.

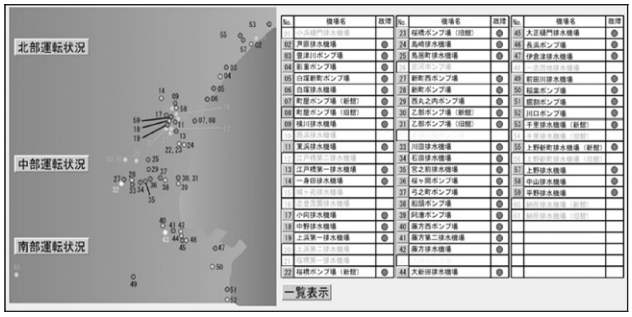

Fig. 1 Overall Monitoring Screen

On the screen depicting the entire city, the overall locations of the pumping station, drainage pumping stations, and the operational status can be checked.

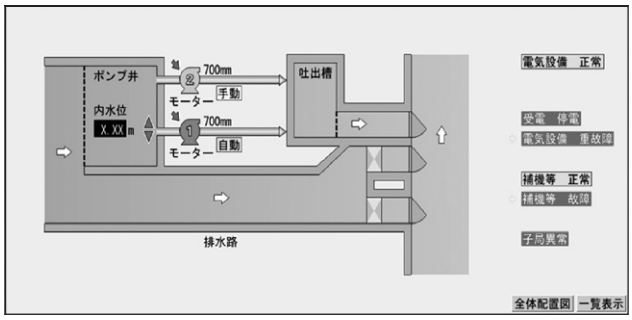

Fig. 2 Pumping Station Monitoring Screen

The operating conditions of each pump at the respective pump stations and the related measured data can be graphically checked.

Fig. 3 Pumping Station and Drainage Pumping Station List Screen

The operating conditions of each pumping station or drainage pumping station are shown in a list style.

Fig. 4 System Monitoring Screen

The system conditions at each pumping station or drainage pumping station are shown in a list.

equipment list screen provides an at-a-glance view of the operating status of the entire facilities.

3.2 Rainfall Status Display Function

In addition to displaying the operating status of drainage pumping stations and pumping stations on the map screen, the rainfall status is also displayed on 250 m mesh screen in different colors according to rainfall intensity. Accurately grasping meteorological information is essential for taking flood disaster prevention measures, and we made it possible to monitor local rainfall in almost real time. Fig. 5 shows the rainfall status display screen.

3.3 Pipeline Water Level Monitoring Function

This is a function to display the water level in

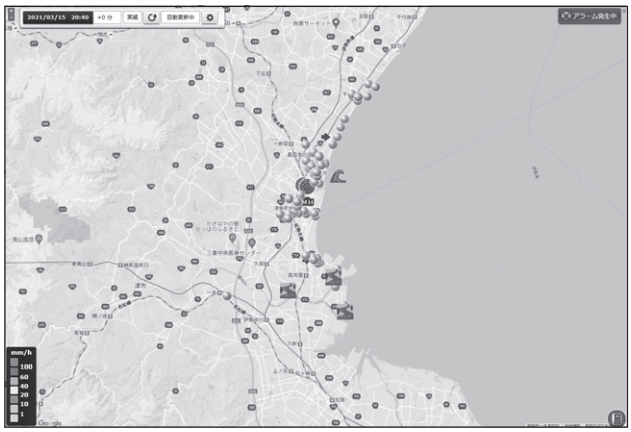

Fig. 5 Rainfall Status Display Screen

The operation status and rainfall status of drainage pumping stations and pumping stations are shown on the map screen.

Fig. 6 Task Information Sharing Service Screen

An example of a task information sharing service screen is shown.

the storm sewer pipe in real time. When the water level in the pipe exceeds the threshold, the color changes on the screen to call attention and display an alarm. The water level in the pipe can be visualized, and it can be managed together with the rainfall situation and the operation status of the pumping station and drainage pumping station on the Cloud. It makes it possible to centrally manage disaster prevention information.

3.4 Task Information Sharing Service

The task information sharing service implements a Social Networking Service (SNS) function within the Cloud service. It aids the efficient sharing of the information required for operation and maintenance tasks among users. Fig. 6 shows the task information sharing service screen. Table 4 shows the functions. This service provides a communication function on the portal screen that serves as the gateway to each service. SNSs are also effective for sharing information in emergencies, and by using these functions daily, information can be shared smoothly in emergency or disaster case.

Table 4 Functions of Task Information Sharing Service

Functions of the task information sharing service are shown.

Function	Contents
Conditional contact	Site conditions, operating instructions, and such reports with photos are shared among site personnel.
Announcement bulletin board	Announcement of management personnel and worker groups is posted for information sharing.
Common calendar	Information about work plan and event schedule information of individuals and groups are shared on the calendar.

4 Postscript

We introduced facility monitoring and rainfall monitoring using a Cloud computing-based service for water service providers (water supply and sewerage). This is a SaaS (Software as a Service) type Cloud service. By combining rainfall information and pipeline water level monitoring in addition to conventional facility monitoring, we built a system that is useful for flood control activities against inland water.

Going forward, we will continue to propose and build systems that meet the needs of our customers.