Development of Hybrid Type Supervisory Control And Data Acquisition (SCADA) System

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Abstract

For the stable availability and efficient operation of waterworks facilities, we are making on-premises Supervisory Control And Data Acquisition (SCADA) systems and cloud-based monitoring systems. We provide these products to our customers for centralized monitoring or remote monitoring.

Since the on-premises SCADA systems use a dedicated communication network, it features high stability and quick-response performance of supervisory control. It is not, however, connected to any external communication network and it is generally difficult to establish a highly convenient monitoring environment where the monitoring data can be checked even from the outside, like the case of cloud-computing.

As a result, we realized a method by which functions of the on-premises SCADA system – data collection and remote monitoring functions (except for the functions of control and operation) are linked to a cloud-computing system. We developed a hybrid type SCADA system offering the merits of on-premises and cloud-based system. Multiple customers of ours are already using this hybrid system.

1 Preface

Due to the Japanese trend of wider water supply service areas and a decrease of service-related personnel, the waterworks industry calls for efficient operation and control of waterworks facilities. The same requirements are applicable to the Supervisory Control And Data Acquisition (SCADA) systems which are a key system in operation and control. Further, as a result of the advent of better communication networks and expected.

To meet these requirements, we developed a hybrid type SCADA system that combines the merits of on-premises SCADA system and the cloud-based monitoring system. By making hybrid type SCADA system, we retained the safety and good response of the system, and can offer monitoring data access from anywhere.

This paper introduces the changing basic configurations when the SCADA system is changed from the on-premises SCADA system to the hybrid SCADA system and presents a case study.

2 Monitoring Conditions of the On-Premises SCADA System

Fig. 1 shows the basic configuration of the on-premises SCADA system. An on-premises system refers to the facilities that the customer owns and controls, as opposed to the third-party cloud-com-
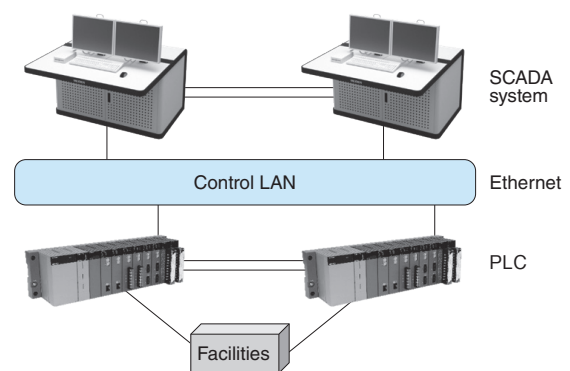

| Fig. 1 | Basic Configuration of the On-Premises SCADA System |

When this system is installed on the premises of the waterworks facilities, it becomes possible to realize real-time monitoring and control. Safety is secured as it is not connected with the external communication networks (public lines).

puting system where computing resources are made available for consumption on an as-needed basis. The on-premises system is equipped with a LAN for control. This system connects Programmable Logic Controllers (PLCs) widely distributed in waterworks facilities. It also connects with SCADA systems, and Visual Display Terminals (VDTs). The basic configuration is this connected state. This system is scalable from the basic configuration to flexibly reconfiguring the system to meet the various operating conditions for the customer when introducing the system. For example, a wireless telemetering unit TELEMOT can be connected to the LAN for control. In addition to local facilities, the system can monitor and control the facilities at a distant location. To enable the monitoring data access from outside the premises of the facilities, we put a web server in the premises to set up a Virtual Private Network (VPN) and this allows the access by a dedicated Visual Display Terminal (VDT). In doing so, you could see the monitoring data.

This system is made based on the policy that values stable remote monitoring, control performance, and quick response of the system. This system uses the dedicated communication network or private network for monitoring and control. Since this system is separated from a public network, it is possible to maintain security. While it excels in terms of safety, there are access restrictions such as monitoring locations and accessible display devices.

3 Connections with Cloud Servers (Hybrid Type)

We offer a cloud-based monitoring system with which the monitoring data can be checked from any place without limiting the type of visual display device.

Fig. 2 shows the basic configuration of the cloud-based monitoring system. The hybrid type SCADA system becomes available when an on-premises SCADA system is connected to the cloud servers of the cloud computing platform over the private network. This is for the cloud-based monitoring system. **Fig. 3** shows the basic configu-

Fig. 3 Basic Configuration of the Hybrid SCADA System

Monitoring data are transmitted to both ① the SCADA system installed in the premises of waterworks facility and ② the cloud servers. Monitoring is possible from the outside while security is maintained in a cloud-based environment.
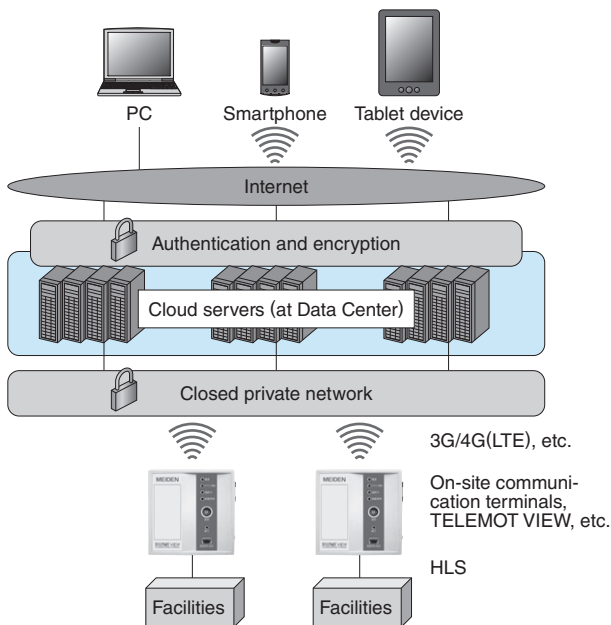
Fig. 2 Basic Configuration of the Cloud-Based Monitoring System

A cloud server is installed at the Data Center and facility's monitoring data are transmitted from on-premises communication equipment to the cloud servers. Monitoring is possible from the outside of the facility through the Internet.
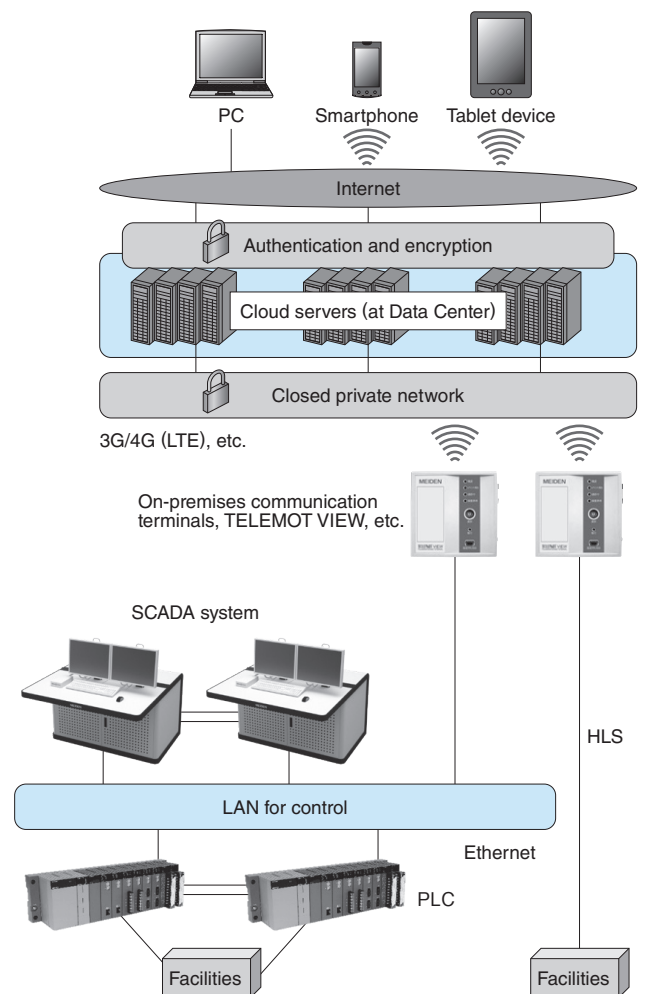
ration of the hybrid SCADA system. For the on-premises SCADA system, monitoring data are transmitted from the PLC to the SCADA system. While in the case of the hybrid type SCADA system, monitoring data after removing the control and operation signals are also sent to the cloud servers. The reason why the control and operation signals are removed is to ensure the system safety. TELEMOT VIEW is used when making a connection to the cloud server. TELEMOT VIEW is provided with multiple means of connection to collect the monitoring data. The connection can be made through the High-speed Link System (HLS) to connect with the remote I/O. It can be connected to the Ethernet to allow the connection with a remote I/O used in the Meiden PLC or Modbus/TCP. When this TELEMOT VIEW is connected to a LAN for control, it becomes easy to collect the data from Meiden PLCs. On-premises communications equipment is con-

nected to a cloud server through a closed private network. For Internet security, our cloud services are arranged to make authentication and encryption. For the on-premises SCADA system, periodic system maintenance is needed in order to maintain system security. When the monitoring data collection is made through the Internet server of the cloud-computing platform, remote monitoring by any device can be realized under the latest secured IT environment.

4　A Case Study of the Hybrid Type Application

For a case study of the hybrid type SCADA system, we introduced an actual case we conducted for a certain city in Japan, – here we call it "City T," where its centralized monitoring system was updated to the hybrid. At City T, operation and control
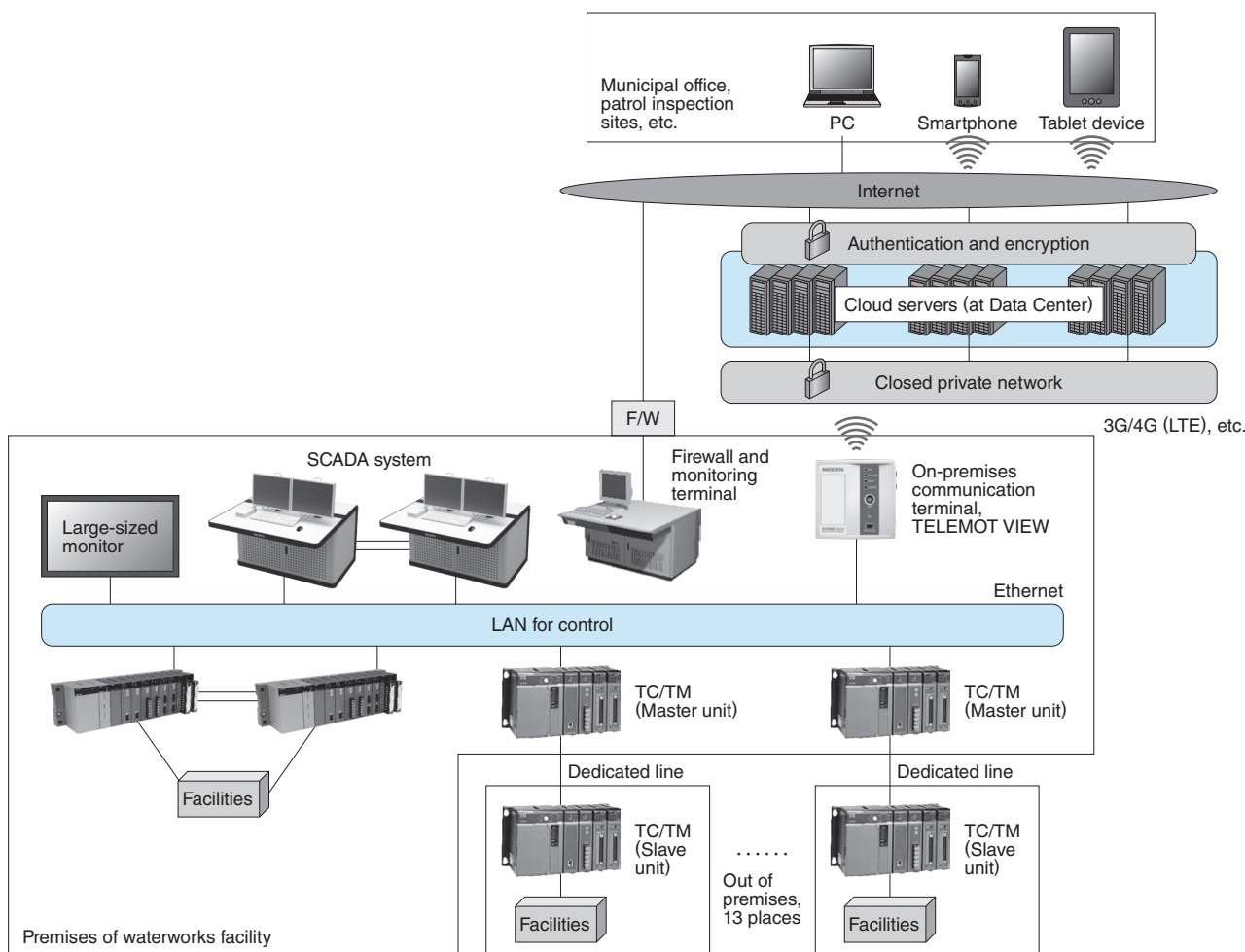

Fig. 4　Example of a Hybrid Type SCADA System in City T (Outline Diagram)

At the time of the renovation of existing SCADA system, we made a hybrid type SCADA system for City T. Monitoring data of major facilities are transmitted to the cloud system so that we could realize the centralized monitoring on premises and the remote monitoring from the Municipal office or patrol inspection sites.

of waterworks facilities are carried out by City T. In the day, several city staff members oversee monitoring work. For the night, this work is outsourced to a private security service firm. In this case, one person is monitoring the work. When an alarm is generated from the monitoring system at the site, the person monitoring calls a supervisory city staff member. The staff member who received the telephone call will go to the site to check the cause of the alarm to solve the problem and restart the system. At the site, the city staff member must evaluate the situation based on the monitoring person's visual inspection results and his oral reporting. The city staff member be on site for the reality check.

For this time of SCADA system renewal at City T, we considered the aforementioned factors and made the system as hybrid type SCADA system. **Fig. 4** shows an example of a hybrid SCADA system (outlined diagram) and **Fig. 5** shows the results after the introduction of the system to City T. For operation and control of waterworks facilities during the day, the monitoring system is used according to the same conventional on-premises previous SCADA system. For the nighttime operation and control of the same, the designated city staff member in charge at home will receive the phone call from the contract operator, the city staff member can then check the monitoring data or image by a smartphone based on e-mail showing the error code message through the cloud system. In this way, the city staff member can judge if an on-site inspection is needed, and if so, s/he can make prior arrangement before making an on-site inspection by using the monitoring system. Even in regular time, by using a smartphone, one can check the present water level at a simplified waterworks facility at a distant location. This is the case when such a facility became the site of monitoring and control after the integration of water supply services with nearby local governments – cities or towns.

Further, City T uses our cloud-based facility management service for managing their facility ledgers or for patrol facility inspection time. For daily inspections of facilities, patrol inspection was formerly carried out by using paper ledgers. It has now changed to the patrol inspection using a tablet device. As a result, data transfer from daily inspection reports to the system has become unnecessary. This contributed to laborsaving facility management. In addition, the new method is also useful in early discovery of any abnormality through the
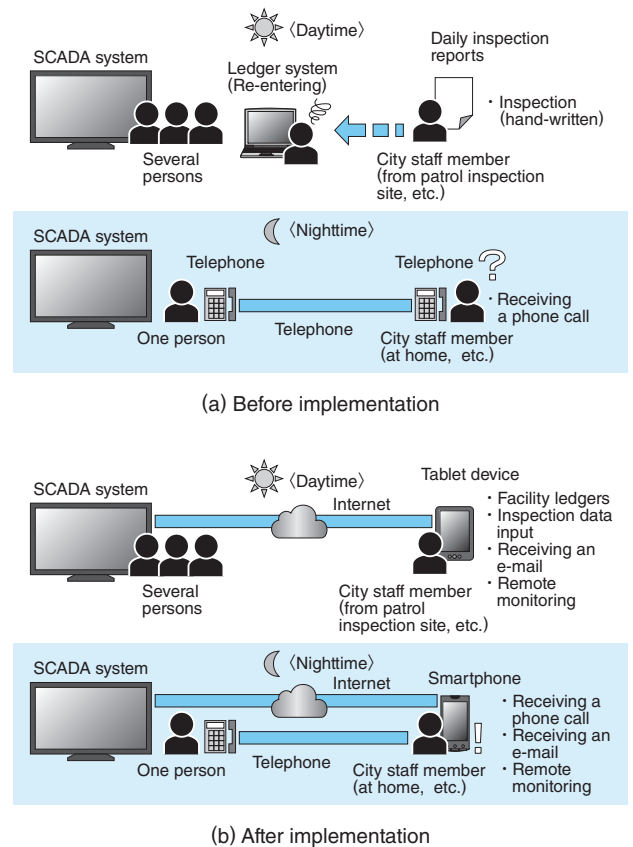

(a) Before implementation

(b) After implementation

During the day, systems are efficiently used for operation control and patrol inspections. During patrol inspection, the latest monitoring data can be compared with previous data and remote monitoring is also possible. At night, even in the event of the contract operator calling a city staff member in charge, s/he can decide immediately if an on-site inspection is needed by checking the monitoring data & images from home.

comparison of latest measured data with previous data. When unusual values and/or failure signs are discovered, a present monitoring data can be checked on the spot to examine the presence of any related abnormality. Going forward, we are working on realizing functions to support asset management, such as equalization of facility renewal plans. This will be done on the cloud-stored data obtained from daily inspection reports and daily operation reports.

5 Postscript

We realized the development of a hybrid type SCADA system by combining the merits of the conventional on-premises SCADA system and a cloud-based monitoring system. The hybrid type SCADA can maintain high reliability and high functions of an on-premises SCADA system while offering convenience, versatility, and scalability of the cloud-based

monitoring system without sacrificing the stability and fast-response performance of the on-premises SCADA system. The data backup for ledgers is realized by the cloud-based monitoring system. This will be advantageous in the business continuity plan during a large-scale natural disaster. It is also useful for planning facility renovation, and the data trend output of statistics.

Going forward, we would like to meet the needs of our customers in water supply services. We would like to make proposals on effective operation of the waterworks facilities and better SCADA systems. In doing so, we would like to improve sustainability and betterment of water supply services.

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