# Field Work Support in the Digital Transformation Era

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***When performing inspection and maintenance of important devices and equipment at plant factory sites including in explosion-proof areas, field engineers conventionally work in pairs. This is because it has not been possible while working on-site to obtain advice from experts in control rooms, or to directly refer to process values in DCS systems and manuals necessary for maintenance. However, with the progress in IT technology, operators in control rooms can communicate with on-site engineers while sharing images of display screens via mobile devices taken into the plant factory site, thus enabling the process data and state of equipment to be viewed in real time. This approach is greatly changing the procedures and forms of field work. This paper introduces technologies and solutions for supporting field work, as well as examples of such work.***

## INTRODUCTION

Nowadays, it is widely accepted that the integration of information technology (IT) and operational technology (OT) will bring about a management revolution in the manufacturing industry. Many conventional problems of OT still remain unresolved. Problems in field work make up a large proportion of OT, the detailed content of which depends on the timing and period and its focus is not easily determined. In combination with IT, there are also various problems in most companies, such as the whereabouts of the decision-maker and who will pay the cost of measures. The following items are examples of only some of the issues to be solved in field work, and even when one problem is solved, others quickly arise.

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- To check the value of other related instruments and the open/close status of control valves, when checking the status of a specific instrument at the site
- To check the progress of field work of a particular worker
- To check the work progress and completion history of the entire inspection items
- How to train new employees and employees who have been transferred from other divisions and have no experience in field work
- How to compensate for the decline in technical skills due to the retirement of aged, skilled employees
- How to implement safety measures by double-checking field work

Some problems will be solved by the development of the Industrial Internet of Things (IIoT), and through digital transformation in the field of OT, using both IIoT and IT technologies. However, it remains difficult to make full use of the available data because existing IT systems are becoming aged, complex, and difficult to understand, like a black box. Even new technologies cannot be fully effective if data is not fully used. Furthermore, a sophisticated new system that uses digital technologies may encounter strong resistance from field workers. Thus, the real challenge is how to make a system user-friendly and easy to use.

This paper introduces Yokogawa's IT/OT solution system for an enhancement of DCS control system, which are easy for users in the field to understand and operate, and which can operate effectively for a long time.

## REQUESTS FROM FIELD WORK SITES

Some actual requests and challenges for field work are summarized below.

In a chemical factory (Factory A), there was a strong request to speed up the DCS loop check during periodic maintenance, to improve the work efficiency of the maintenance division.

One solution is to make the control screens in the central control room viewable in the field using mobile devices. Checking the control screens while conducting loop checks in the field is expected to make the maintenance work more reliable and faster, for both periodic and daily maintenance.

There was also a strong request to install large-screen electronic boards in a maintenance stand-by room to display the real-time data of control screens, so that maintenance staff can discuss the operation status with related personnel outside the control room.

Furthermore, voice communication alone via personal handy-phone system (PHS) or other audio devices between the field and the control room is not sufficient to ensure safe field work during loop checks and device maintenance; video and audio real-time communication using augmented reality (AR) is expected to solve this problem. There was also a request for a system in which an expert operator can show the parts requiring care by writing on a screen with a stylus pen.

In another chemical factory (Factory B), field operators conduct daily inspection and maintenance work. After the inspection, they submit reports on the results to their field supervisors, but there had been cases of carelessly omitting a device to be inspected or excessive maintenance due to lack of inspection/maintenance records in the field. When there are no manuals in the field, field operators are unsure about the specifications of devices and piping, and must go back to the office or control room to check the manuals.

Field supervisors must grasp the plant status based on reports from field operators. However, there were so many inspection result reports that the supervisors had difficulty keeping up and grasping the current progress, and could not identify the device problems that had to be addressed.

One solution to such problems is to enable operators in the field to refer to device maintenance records, manuals, and design information on plant piping and others. The system should also allow maintenance operators and the field supervisors to share the progress of inspections.

In order to be effective, all such systems require a comprehensive wireless environment. Challenges for the wireless environment include ensuring communication stability and security, complying with explosion-proof specifications, and cost-effectiveness.

## FIELD WORK SUPPORT SOLUTION TO ACHIEVE DIGITAL TRANSFORMATION

IT technologies and the concept of digital transformation are used to solve the problems and meet the requests described above. Digital transformation was defined in 2004 by Prof. Erik Stolterman of Umeå University, Sweden, as "the changes that the digital technology causes or influences in all aspects of human life[(1)]." Among the changes for a better human life, user-friendliness in the field is also important.

In other words, merely satisfying the functional requests of each system is not enough for solving customers' problems. The user-friendliness of each system, the safety of the systems and communication infrastructure, and expandability for long-term operation, must also be addressed.

Wireless communication will be convenient for forthcoming systems, because wireless communication infrastructure is spreading worldwide. In designing a system based on wireless communication, tight security measures are essential.

Yokogawa offers several products to support field work, incorporating the idea of digital transformation while taking both functions and user-friendliness into account. The features of these products are described below.

### TSE Client

Yokogawa offers a TSE server that transmits the human interface station (HIS) screens of CENTUM Distributed Control Systems (DCSs) via a TCP/IP open network and enables the screens to be viewed on general-purpose PCs running Windows or other OSs, tablets and other mobile devices. The connection from a TSE client (general-purpose PC) to the TSE server uses the remote desktop protocol (RDP). The functions of the TSE client can be controlled to prohibit direct operation of the control system. Thus, the TSE server is designed to enable beginners and unskilled control engineers to view the screens.

However, when this viewing operation is conducted from a TSE client by connecting it to a user information network or a wireless LAN, such as Wi-Fi, the security of the connection requires special care. Allowing a TSE client to connect directly to a TSE server working on a control LAN to capture data would be highly risky in terms of information security. Therefore, such direct connection is prohibited and data can be captured from a TSE server only via a VTS Portal. In other words, communication is only allowed through a firewall to logically separate the control network and ubiquitous (wireless) networks. The communication between the VTS Portal server and the TSE server is based on the RDP, while TSE clients and the VTS Portal server communicate with each other via HTTPS. Thus, requests from TSE clients are converted by the VTS Portal to communicate with the TSE server. In this way, security in this communication system is strengthened. Figure 1 shows the configuration of this system.

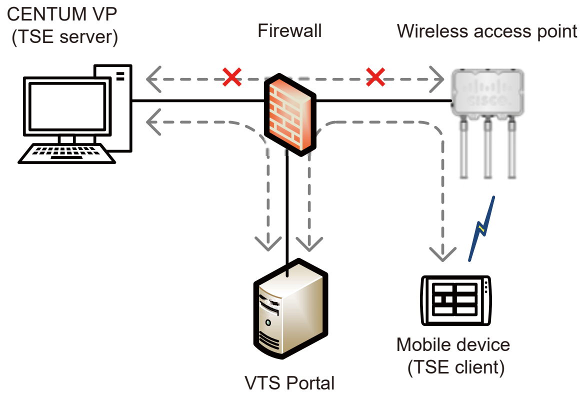


**Figure 1** Configuration of VTS Portal system

**Real-time Communication**

A real-time communication system delivers video and audio contents in real time. For this system, Yokogawa uses V-CUBE Collaboration by V-cube, Inc., whose products for Japan have captured the largest market share in Japan. Although this system is available in a cloud version, Yokogawa recommends its on-premises version that is used only on local networks without relying on carrier lines, taking into consideration the security measures and the increasing running cost due to increasing communication volume.

V-CUBE Collaboration has various functions including for delivering field videos in real time, allowing operators in the control room to identify the field status by viewing photographs taken in the field and to clarify matters with field operators by writing on the photographs as well as by voice communications, and enabling both one-on-one and multi-party communications.

However, delivering real-time video data requires far greater communication bandwidth than sending normal data. Most monitor camera systems with wired networks require gigabit-class network devices, because they use the UDP protocol to send data and hence require a broad communication bandwidth. Thus, users may be concerned about many issues when using a communication system in a wireless environment. Yokogawa's system eliminates such concerns even for wireless communication using Wi-Fi or carrier lines, by transmitting audio data preferentially and compressing and converting video data into HTTPS packets before transmitting them using the TCP protocol.

Yokogawa's system also has a communication band control function that automatically detects the effective band of the communication partner and transmits/receives data accordingly. The system can deliver videos at the transmission rate of 256 Kbps for the lowest case (the normal default value is 2 Mbps). Thus, the problem of data delay and data interruption is alleviated substantially, making the system user-friendly. However, low bandwidth is not necessarily preferable. Especially for Wi-Fi wireless infrastructure, it is also important to optimize the wireless environment such as the arrangement of wireless access points and avoiding interference between neighboring channels. This system also takes such points into account.

For mobile devices, Yokogawa adopts tablet PCs and hands-free smart glasses by RealWear, Inc. (model name: HMT-1, or HMT-1Z1 for explosion-proof product in Japan). These smart glasses dramatically improve the work efficiency of field engineers. Operated by voice commands and allowing voice recognition in noisy places such as near boilers and turbines, as well as communication using earphones, these smart glasses are highly valued by many end users.

Figure 2 shows the configuration of real-time communication, in which still images, videos, documents, and inspection data can be viewed anytime, anywhere using smart glasses within the range of wireless communication, while voice communication with persons at monitoring PCs is also possible.

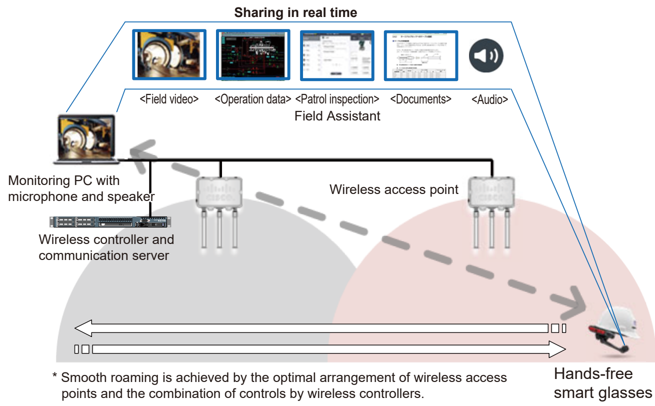


**Figure 2** Configuration of real-time communication system

**Field Assistant**

As a solution to achieve digital transformation in the field, Yokogawa offers Field Assistant using mobile devices (Figure 3). By using digital technology, Field Assistant not only supports maintenance divisions in daily maintenance inspections and legal inspections but also makes it easier to reuse the previous inspection data.

This solution offers the following functions to field operators and field supervisors, who are responsible for inspection in the field, to support their inspection work.

- Has an interface that ensures the inspection results can be input quickly and thoroughly without omission.
- Can check documents related to equipment and devices on the spot whenever needed.
- Can record and report field workers' findings with pictures, videos, and audio data.

The solution also offers the following functions for management work.

- Can extract and verify important information about the progress of field work as well as about the field.
- Can compile daily reports and other result reports easily based on specified periods and conditions.

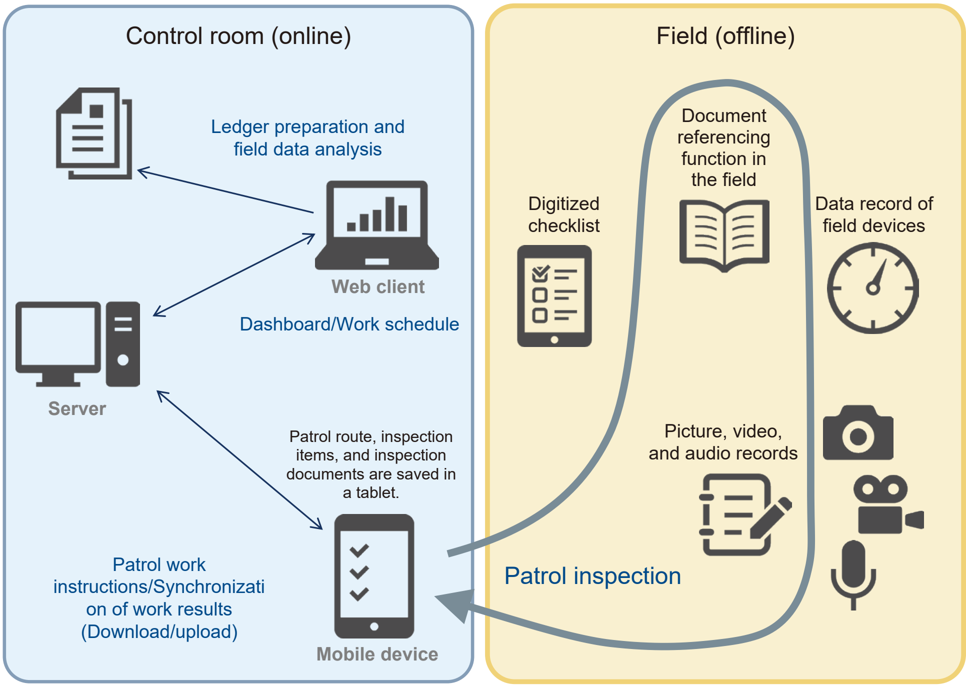


**Figure 3** Block diagram of Field Assistant

## EXAMPLES AND BENEFITS OF INTRODUCTION

Two examples of introducing the above solutions into customers' factories are described below.

### Introduction into Factory A

The DCS in Factory A was replaced in the autumn of 2018. The loop check in this factory covers nearly 600 single IO points and 20 critical loops with multiple IOs, out of about 6,000 IO points in total. The loop check used to take 14 days with the previous method.

In the previous method of loop checking, field operators checked the reading of each device while talking by PHS with an operator in the central control room who was watching the operation data. When the DCS was replaced, a Wi-Fi wireless environment was installed in the factory including in explosion-proof areas, to enable the operators to view the DCS operation data anywhere in the field on their explosion-proof tablet devices.

For the loop check after DCS replacement, each field operator carried an explosion-proof tablet, and cross-checked the reading of each meter with the operation data shown on the tablet placed next to each field device. They did not need to contact the operators in the control room, and could complete the loop check alone following their own schedule. As a result, the loop check took just 10 days, a saving of 4 days, and was highly cost-effective.

Besides reducing the time and labor cost, the new system also helps ensure safety because the field operators can conduct the loop check while confirming the operation data with their own eyes and have time to double-check the results. Furthermore, the new system also brings synergy effects by allowing abnormalities to be detected earlier even in daily operations.

In addition, a large-screen electronic board has been placed in the office of maintenance staff to always display the operation data, so they can check the operation status at any time. As a result, they do not need to visit the field so frequently and can respond to abnormalities more quickly.

The real-time communication system using explosion-proof smart glasses or a combination of explosion-proof headset and explosion-proof tablet has yielded the following benefits mainly for calibration inspections by maintenance staff.

- More efficient training of young employees
  Traditionally, expert employees visited the field together with young employees. In the new system, experts can train young employees remotely, without needing to accompany them.
- More efficient work using explosion-proof smart glasses (hands-free)
  Mounting and adjusting a vibration sensor involves very delicate work, in a case of value reading system at the remote location, and used to take a whole day. With the real-time communication system, it now takes just 2 hours.
  Also, operators no longer have to work in unstable, awkward postures while talking by personal handy-phone system. Hands-free communication greatly improves safety.
  For areas where explosion-proof tablets cannot be used for some reason, smart glasses can be used instead.

**Introduction into Factory B**

Field Assistant was introduced into Factory B as a mobile solution for maintenance, bringing the following three benefits.

- Improved reliability and efficiency of field inspection work
  Using Field Assistant, operators can conduct inspection and maintenance simply by following the check list shown on their tablets. This prevents omission of check items and inputting check results. Operators do not need to return to the office or control room so frequently because they can check the documents for the devices and piping in the field whenever needed.
- Reduced burden on field supervisors
  Field Assistant not only improves the efficiency of management work of field supervisors, but also helps them make quick, appropriate decisions through real-time recognition of the progress status.
- Improved maintenance work by using field data
  Analysis results of field data accumulated over a long period can be used for scheduling the maintenance of each equipment and device. The results can also be used effectively for identifying points where maintenance is not needed.

## CONFIGURATION OF WIRELESS COMMUNICATION AND SAFETY MEASURES

Wireless technology is essential for solutions to achieve digital transformation, allowing communication among persons and things regardless of the location. However, security measures are imperative, including for preventing illegal access and eavesdropping through wireless communication infrastructure.

In network architectures conforming to the ISA99 [2] or IEC62443[3] global standards, the Office Network and the Control Network correspond to Level 4 and Level 3, respectively, in principle, and it is recommended to place a firewall between Levels 3 and 4 to separate the network hierarchy. In the present case, the group of wireless devices is called a Ubiquitous Network, and is placed between Levels 3 and 4. Each server placed in the demilitarized zone (DMZ) segment of the firewall can be accessed only from a qualified device in the Office Network, Ubiquitous Network, or Control Network (Figure 4).

The communication method in the Local area of Figure 4 is either Wi-Fi or long-term evolution (LTE/4G). Although LTE/4G uses mainly the carrier lines supplied by communication providers, private LTE/4Gs that do not depend on providers are now being developed.

Wi-Fi and LTE/4G networks have their respective advantages and disadvantages. A Wi-Fi network for communication can be freely designed to cover a predefined area, but is costly to install. In contrast, an LTE/4G network allows a wireless network to be constructed inexpensively, but communication stability could be a problem if there is underground plant in the communication area.

## CONCLUSION

This paper described Yokogawa's solutions to support field work and digital transformation. It has been shown that these solutions improve the efficiency and quality of inspection work in the field and management work in the control room.

To offer digital transformation tailored to each customer,

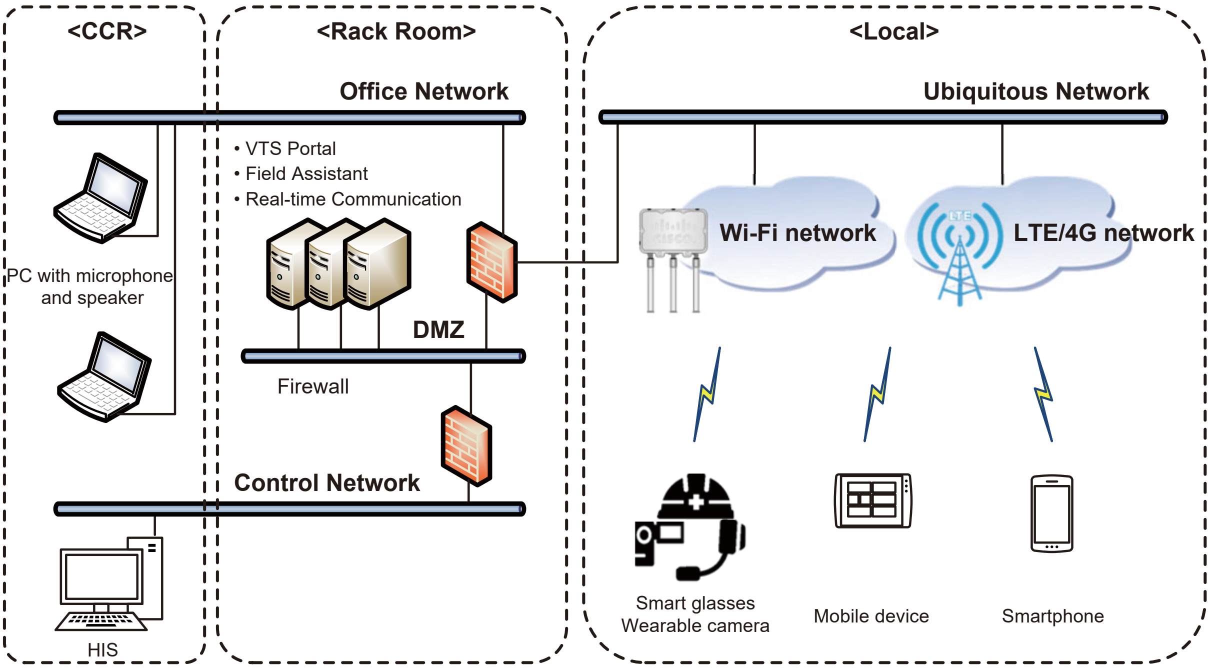


**Figure 4** System configuration

it is necessary to carefully consider the applications to be used, number of employees, plant scale, links with other factories, and security policies including their future vision. As a solutions company, Yokogawa will continue to offer solutions to support customers in their field work.

## REFERENCES

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