

Radio Technology for Integrated Platform for Facilities Monitoring

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Abstract

Maintaining the stability of steel-making facilities is important. In this report, we describe a part of facility management, the integrated platform for facilities monitoring. Especially, we introduce the NS-IoT, the Video Monitoring System on various locations using radio technology. We also discuss other remote monitoring systems using other radio infrastructure such as 5G and drones.

1. Introduction

Nippon Steel Corporation aims to accelerate decision-making and fundamentally strengthen problem-solving abilities by promoting DX. As one of its measures, we are making efforts to utilize digital technologies such as AI and IoT in our production processes.

Nippon Steel's production lines are implemented by a combination of multiple systems to operate, monitor, control, and automate a wide variety of processes. These multiple systems output data in a variety of formats. Wireless IoT sensors have also been installed on important equipment. In addition to processing data such as temperature, pressure, flow rate, and level, the sensing of vibration, current, etc., is performed for equipment diagnosis. In this way, in order to effectively utilize valuable assets of data output separately and in various formats from various units and systems, a data platform is required to aggregate centrally, organically collate, and freely ex-

tract, process, and utilize the data. Thus, a data platform that can do this is required. **Figure 1** shows the concept of Nippon Steel's data platform as one of its DX initiatives.

The data platform consists of the "NS-IoT" platform to collect and visualize data from wireless IoT sensors centrally, the "NS-Lib" integrated data management platform to collect, store, and manage the data from various units and systems, including wireless sensors, of the "NS-DIGTM" platform to develop AI models based on the data accumulated in NS-Lib, and the "AIRON-EDGETM" edge computing platform to enable the field application of AI models built by NS-DIG by using the container technology that allows AI models to be executed without affecting other programs.¹⁾

The data platform utilizes advanced information technology and the latest digital technology to enable advanced data utilization and overwhelming process control and automation for the stable opera-

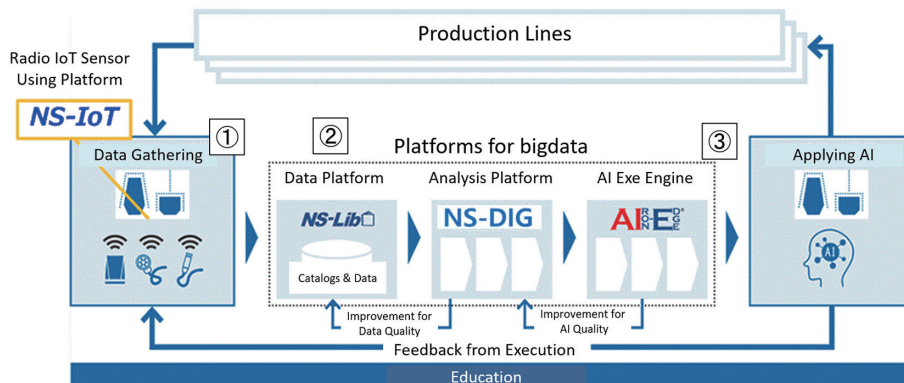


Fig. 1 Data platform for DX

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tion of production lines and facilities. In this report, we describe the integrated platform for facilities monitoring, which is a form of data platform that was built as a facility condition monitoring platform. The wireless utilization technology used in the platform is also described.

2. Need for and Response to “Integrated Platform for Facilities Monitoring”

To maintain stable production in the steel industry, it is necessary to maintain equipment in good health and keep production lines running. Once a problem occurs, there is a large loss both in energy and economic terms.

To keep equipment in sound condition, it is necessary to understand the condition of the equipment properly. In the current steel-making process, where various products are produced in relatively small lots, the load placed on the equipment varies depending on the product being manufactured. Up until now, damage has been estimated based on cumulative loads on equipment, etc., and based on control values for each piece of equipment. However, in the face of fluctuating loads, it may not be possible to understand the equipment state appropriately by simply analyzing the cumulative load value and control value for each piece of equipment. Therefore, we built an “integrated platform for facilities monitoring” that can collect various data from control systems and other systems, analyze the data integrated, judge the condition of equipment more properly, and perform maintenance on the equipment before its condition worsens.

As shown in Fig. 2, the “integrated platform for facilities monitoring” is designed to

- (1) Collect data from various locations and systems on-site ①.
- (2) Comprehensively manage and provide various data in different formats (DB) ②.
- (3) Study and construct an abnormal precursor detection function and other functions based on mechanisms and data, and visualize the equipment condition online ③.

The platform also furnishes information on equipment stabilization.

In this report, we describe the utilization of wireless technology such as NS-IoT ①-1 and a video monitoring system on various lo-

cations with secure wireless cameras ①-2 shown in Fig. 2. These are useful when acquiring new information on site.

3. Wireless Utilization Technology Composing “Integrated Platform for Facilities Monitoring”

To understand the soundness of equipment, it is necessary to understand its condition. To understand the equipment’s condition, some type of monitoring infrastructure is required. Steelworks have a variety of production lines within a vast site, and each line is composed of many pieces of equipment. In view of this characteristic, we describe the NS-IoT and video monitoring system on various locations we have developed to utilize wireless technology to realize inexpensive and multi-point deployment.

3.1 NS-IoT¹⁾

A system for controlling production is introduced into a steel production process. The process is already equipped with sensors for process control and equipment management. The sensor data can be collected using a wired network installed on the premises. For example, this data corresponds to data sensed by a control system. However, in the case of data necessary for control or equipment management, most of this data was data from sensors installed only on equipment important for production.

Conveyors that transport raw materials are important equipment to secure logistics. To accommodate a vast number of sensor installations, it would be extremely costly to import data from individual sensors using conventional wires. This high cost limited the implementation of wired sensors.

In addition, when adding control sensors, wiring was retrofitted from controllers. When controllers were replaced, interfaces other than control interfaces were added. Furthermore, an additional database was installed to store sensor data. The sensor data was used by an analyst operating a business intelligence (BI) tool on a business computer.

As described above, data collection via conventional wired networks posed dilemmas, such as the cost of installing sensors and the time required to use monitoring and analysis software. These dilemmas had to be solved. In other words, when retrofitting or temporar-

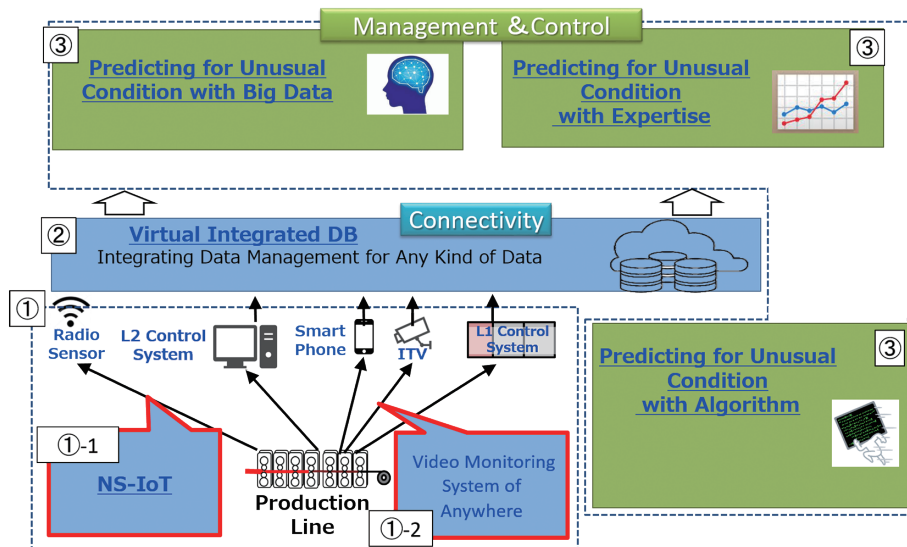


Fig. 2 Integrated platform for facilities monitoring

ily installing sensors, it is necessary to develop an infrastructure for easy and low-cost use of sensors, such as the elimination of wiring and cost reduction of sensors. It is also necessary to improve the usability of sensors. As an initiative to achieve this, we built the NS-IoT platform that can collect and handle data from wireless IoT sensors (Fig. 3). For the sensors to be used in this NS-IoT, we focused on the Low Power Wide Area (LPWA) sensors that are inexpensive and can cover wide areas wirelessly, and we placed particular focus on sensors compatible with the Long Range Wide Area Network (LoRaWAN), which is a highly standardized standard sensor. LoRaWAN is based on general-purpose standardized technology that allows sensors to be introduced without being tied to manufacturers' proprietary protocols and equipment, as is often found with wireless IoT sensors. Data from equipment at multiple locations and wide areas can be easily and integratedly handled, being used multi-vender sensors.

Such general-purpose standardization technologies use wireless communication LoRaWAN to standardize data items and data management. Through this standardization, we have developed middleware that allows data locations unique to each type of LoRaWAN wireless IoT sensor to be stored in a standardized database by specifying them in definition files. This has made it possible to increase the usability of data.

By introducing the wireless IoT sensor utilization platform "NS-IoT," we can centralize the management of data obtained from sensors installed at plants at each steelworks. We can use the inte-

grated big data collected from multiple sites to monitor equipment condition trends.

Additionally, it is possible to monitor equipment at multiple locations together rather than at individual locations. This also contributes to improvement in labor productivity. The effectiveness of the "NS-IoT" system in reducing the workload of on-site inspection tasks was verified by the demonstration tests conducted aimed at the early detection of equipment abnormalities in the Kimitsu district of Chiba Prefecture and the Kashima district of Ibaraki Prefecture, where the "NS-IoT" system was introduced earlier.

3.2 Video monitoring system on various locations

There is a need to understand changes in process and equipment conditions by looking at on-site situations and to perform visual detection using existing ITVs. To solve the inability to acquire on-site conditions with sensors (or numerical data), the video monitoring system on various locations (Fig. 4) was developed as a video camera system that is easy to use anytime and anywhere and that facilitates the low-cost retrofitting and temporary installation of cameras to monitor on-site conditions. Using closed LTE (Long Term Evolution) technology, a camera and an LTE router are implemented together as a set. By simply turning on the power of the camera, the on-site conditions can be observed on a monitoring PC installed at another location.

Vision-related data may be intermittently transmitted wirelessly over a narrow band system like that of LPWA in the form of snap-

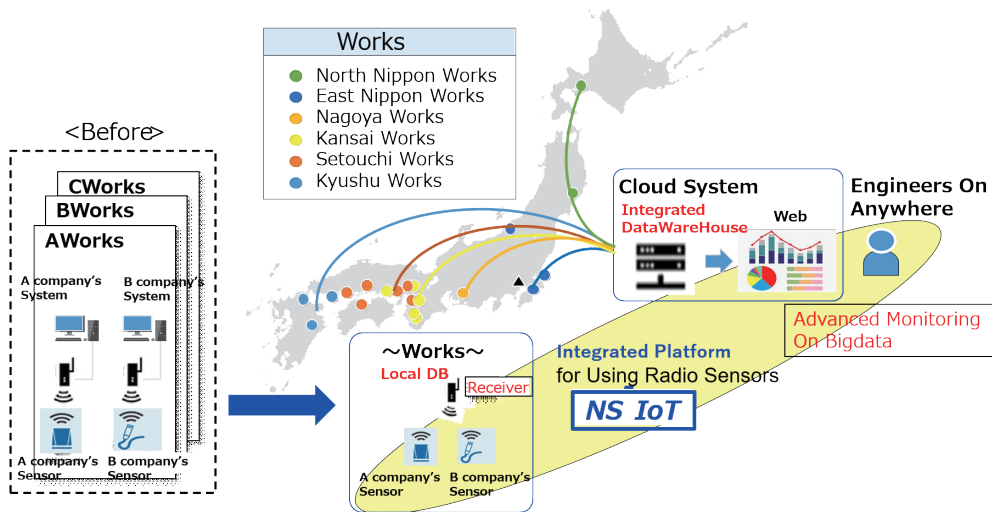


Fig. 3 Concept of NS-IoT

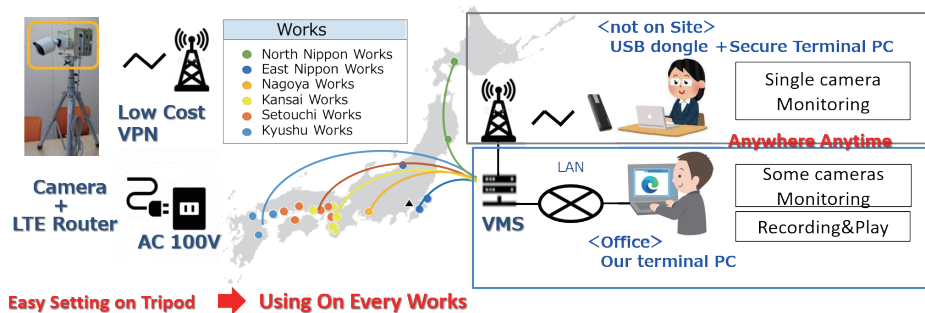


Fig. 4 Video monitoring system on various locations

shot images with the number of pixels reduced to that of analog camera images. However, this way of wireless transmission is limited in applications. For temporary use in problem monitoring, for example, it is desirable to monitor problems in real-time video images in many cases.

In a case like this, conventionally, a camera is installed, and signals from the camera are transmitted by wire. To install cameras in temporary locations or at high places, wiring routes to the cameras may not be available. Systemization is often difficult to implement.

In recent years, an environment has been established for the easy and wireless use of video images by using high-speed and low-cost LTE technology, for example. The video monitoring system on various locations is not a wired system like existing control sensors and operation cameras. Still, it is a wireless system that has achieved easy installation and low cost.

There are well-known wireless cloud services. General wireless cloud services are open. The video images shown in-house may show company expertise. A wireless cloud service cannot be used in-house simply because it can easily send video images at high speed. Major carriers offer secure services, but a high-capacity broadband service that can send video images is expensive. The cost of such services is expected to increase further. For this reason, we studied secure and inexpensive services and built a system that utilizes these inexpensive and secure lines.

If video images can be recorded and played back, they can be used for real-time monitoring and reviewing. An environment was thus built to share video images between plants or steelworks and play them back by importing them into the server of a Video Management System (VMS) through its LTE lines. The VMS server can be used to share the video images at plants (locally), between plants, and between steelworks and to distribute them as required. This can minimize the amount of data transmitted through an in-house LAN.

Furthermore, for temporary use, there is a need to strengthen monitoring for a short period even though there is no power supply. In response to this need, we will be increasing the number of variations, such as battery-powered cameras.

In this way, we have created an environment in which video information that could be previously seen only on camera video monitoring screens on the production line or in the on-site operator's room can now be viewed anywhere and at any time. Of course, in the field, there are five other sensory elements, such as sound and smell, but images contain an overwhelming amount of information. For this reason, we are promoting this system with the belief that it will not only improve the efficiency of conventional work, but also lead to future business reforms, such as making operations themselves location-free.

3.3 Wireless-related technologies expected to be applied to integrated platform for facilities monitoring

Nippon Steel has a high need for the latest technologies not only for equipment stabilization, but also for the automation and labor-saving of inspection tasks. The latest wireless-related technologies that meet these needs are summarized below.

(1) Local 5G (5th Generation Mobile Communication System)

In the NS-IoT above, we built an infrastructure from LPWA wireless IoT sensors to on-site base stations. The data from the IoT sensors is transmitted from the on-site base stations to the in-house cloud through the existing steelworks network and the in-house network.

The existing network infrastructure at the steelworks is only

wired to some of the centers that manage the respective manufacturing processes within the steelworks and of the operator platforms of the respective plants. Not all infrastructures are necessarily within the reach of wireless IoT sensors. At large sites, LTE is temporarily used now because it costs to wire to places without network wiring.

In such cases, if local 5G can be installed as a steelworks infrastructure to cover the steelworks area, base stations can be constructed with top priority given to reachability from the wireless IoT sensors. This can be achieved without any infrastructure investment. In that sense, great expectations are placed on secure wide-area wireless systems like local 5G.

In addition, the video monitoring system on various locations can also be applied as a steelworks distribution infrastructure if local 5G can be successfully utilized.

Furthermore, the usability of the video monitoring system on various locations can be expanded if power-saving wireless IoT sensors and on-site cameras with local 5G compatibility are developed.

(2) Remote operation by using mobile devices for on-site data collection tasks

The wireless IoT sensors and video monitoring system on various locations described so far have more flexibility in on-site applications as compared to conventional fixed or wired installations. However, they have been used in stationary mode.

On the other hand, not installing stationary devices may be considered. Particularly in the field of Nippon Steel, there are some places such as elevated, hot, or noisy places that workers should avoid as much as possible. For places where workers come and inspect with their five senses (e.g., images), instead, it is considered possible to operate drones automatically or remotely and collect on-site video images and data.

As wireless communication infrastructures such as local 5G advance in the future, we will become able to transmit in real-time on-site information to the in-house system by using drones to inspect equipment at elevated places remotely from safe places, to import the video information and analyze it, and to shift to tasks that use even more data.

In this way, technologies that contribute to the remote performance of on-site data collection tasks have evolved. While automation is the base, we will consider the use of technology in the form of remote operations in areas where human sensitivity is required.

4. Conclusions

In this report, we have described the use of wireless technology, including the introduction of the NS-IoT and video monitoring system on various locations built on the integrated platform for facilities monitoring constructed to realize Nippon Steel's DX strategy. We have just begun to apply these technologies on-site, and we plan to apply them to a wide variety of production sites in the future.

Furthermore, for the information necessary for diagnosis and monitoring, we will use data from commercially available sensors and develop software sensing methods that process data by using image processing and AI. In this way, we will expand the data of the integrated platform for facilities monitoring so that the platform can contribute more to the stabilization of equipment operation.

Reference

- 1) Website of Nippon Steel Corporation, News releases, <https://www.nipponsteel.com/news/>, 2022/04/27 "Nippon Steel Group has developed the "NS-IoT" platform by utilizing wireless IoT sensors, merge the sensor data at the steelworks and to detect abnormalities and monitor trends by using integrated big data."



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