CONNEXIVE Ionizing Radiation Measurement Solution

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Abstract

NEC is continuing to expand the CONNEXIVE M2M service solutions activities to achieve an innovative ubiquitous network society where "things" of the real world will be allowed to connect to safe and secure network systems. Anyone is thereby enabled to collect device data and control devices freely. This paper introduces the "CONNEXIVE Ionizing Radiation Measurement Solution" case study that has supported reconstruction of the communities damaged by the 2011 Tohoku Earthquake.

Keywords

CONNEXIVE, M2M, environmental sensing, ionizing radiation measurement, air dose, reconstruction support

1. Introduction

NEC continues to expand the CONNEXIVE M2M service solutions activities that universally collect information from "things" and data generated from sensing devices in order to analyze such information as "big data." The CONNEXIVE solutions are provided to support a variety of domains such as environment, energy, agriculture, machinery industry, transportation and commodity distribution.

As a case study of environmental sensing solutions employed in environment domains, this paper describes the "CONNEXIVE Ionizing Radiation Measurement Solution" that is achieving high precision and real-time air dose measurement.

2. Outline of the CONNEXIVE Ionizing Radiation Measurement Solution

This solution comprises "CONNEXIVE Ionizing Radiation Measurement Cloud" that enables users to easily view data collected by ionizing radiation sensors and "CONNEXIVE Monitoring Post B," an air dose measurement device (**Fig. 1**).

The "CONNEXIVE Ionizing Radiation Measurement Cloud" provides a service which displays the latest air dose data on a map. The cloud also displays variations in the dose levels at different measurement points according to data measured at the "CONNEXIVE Monitoring Post B." This service allows users (1) to download the collected air dose data as

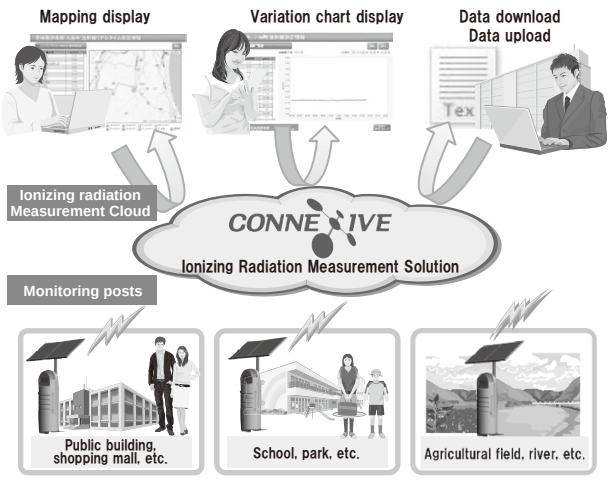

Fig. 1 CONNEXIVE Ionizing Radiation Measurement Solution.

CSV format text data, (2) to upload collected air dose data measured by other devices and (3) to synthesize uploaded data with existing data in order to display the results on screen.

The "CONNEXIVE Monitoring Post B" is an off-grid power type air dose measurement device equipped with a large-capacity solar power generation and storage device. Measured air dose data is transmitted to the "CONNEXIVE Ionizing Radiation Measurement Cloud" at specified intervals via 3G telecommunication lines or wireless networks such as Wi-Fi. Moreover, the "CONNEXIVE Monitoring Post B" is capable of significantly low power consumption levels. Due to adopting CsI (TI) scintillation and high sensitivity optical semiconductors employed for the sensor, the "CONNEXIVE Monitoring Post B" features strong resistance against environmental influences, such as temperature variation and magnetic fields. Energy compensation using the G (E) function also achieves a high precision measurement performance.

3. Features of the CONNEXIVE Ionizing Radiation Measurement Cloud

3.1 CONNEXIVE M2M Service Platform

The "CONNEXIVE Ionizing Radiation Measurement Cloud" conducts collection, accumulation and statistical calculation of the air dose data on the CONNEXIVE M2M service platform (**Fig. 2**).

The CONNEXIVE M2M service platform is equipped with several interfaces designed to cope with a variety of devices, so that any device may be connected without performing complicated procedures. By customizing the device interface components as required and connecting them to the data collection board, collection and accumulation of air dose data of different formats can be carried out with air dose measurement devices of different venders.

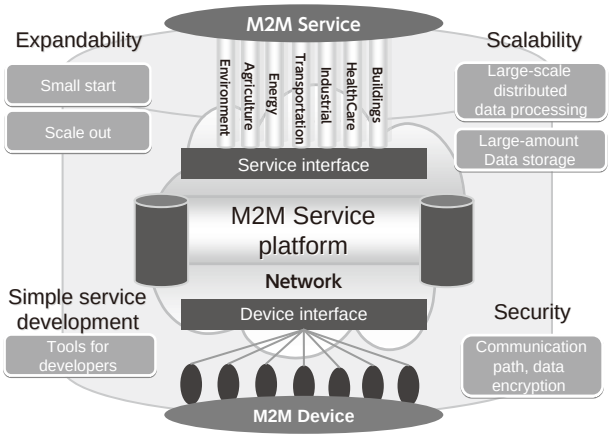

Fig. 2 CONNEXIVE M2M service platform.

Customizing components for statistical calculation enables users to use the CONNEXIVE M2M service platform as a multi-functional database collection platform. Accumulated and statistically calculated air dose data can be acquired from various applications by accessing the database collection platform via the service interface.

3.2 CONNEXIVE Ionizing Radiation Measurement Applications

The "CONNEXIVE Ionizing Radiation Measurement Cloud" provides two major functions; (1) mapping real-time air dose on a map, and (2) displaying a past air dose data variation chart.

The mapping function displays the results measured automatically by the "CONNEXIVE Monitoring Post B" on the map by classifying air dose rate with different colors. Moreover, an exclusive function allows system administrators to upload the air dose data measured by other devices or those measured by other organizations in order to collate such data and display the results on the map. In order to let us show that the air dose data has been collated, the design of the markers to be displayed on the screen be customized according to the different measurement methods chosen.

The chart function displays the variation for each monitoring point of the air dose per day, week, month, or for a two-year period. Moreover, the chart will also display the estimated air dose amount to be accumulated per-year for the specified monitoring point.

These mapping and chart display functions are available for use with PCs and smartphones. For conventional feature phone users, the function to display the latest air dose data is provided.

The collected air dose data can be downloaded as a text file in CSV file format. Such electronic data allows users to print out the data and distribute it to people who are not familiar with PCs, or to analyze the data on a PC using appropriate software. Another function prepared exclusively for administrators is the alert notification function. With this function, an alert email can be dispatched to specified email addresses when any abnormality occurs to the "CONNEXIVE Monitoring Post B," such as low voltage status or communication errors, etc.

The application platform employs a multi-tenant system so that the display screen appears as contracted companies construct their own server systems. Functions mentioned above are installed on the application platform as common functions. Therefore, companies that introduce "CONNEXIVE Monitoring Post B" do not have to develop the required systems by themselves. This means also that companies can use services quickly and without waiting for a long time before the system is constructed.

4. Features of CONNEXIVE Monitoring Post B

4.1 Highly Precise Measurement Method

"CONNEXIVE Monitoring Post B" employs a survey meter which uses a scintillation counting system.

This survey meter incorporates a CsI (TI) scintillator and an integrated compact optical semiconductor element; the CsI (TI) scintillator converts the incident gamma (γ) ray emissions into visible light, and the integrated compact optical semiconductor element detects very low light to count the scale of the luminescence. A wide detection range gamma ray beam is available in the range between 30 KeV and 2 MeV. When a spectrum analyzing function is used, gamma ray spectra can be acquired close to both 662 KeV and 32 KeV, which occur when 137 Cs (caesium) is decayed. It confirmed thereby that such spectra are derived from 137 Cs.

In general, the scintillation system strongly relies on the energy of incident photons more than other systems such as the Geiger-Mueller counter or an ionization chamber do. However, the energy compensation using the G (E) function method enables wide ranging measurements of 0.01 to 100 μSv/h. When measuring wave height spectra, external component materials absorb and disperse the spectra, which influences the measured results. However, the energy compensation of the G (E) function method achieves high precision measurements. With regard to the measurements conducted around the Fukushima-1 plant, a monitoring vehicle was used to mount an Nal (TI) scintillation system survey meter for detecting low air dose rates and an ionization chamber survey meter system for detecting high air dose rates. However, these survey meters have been replaced by the CsI (TI) scintillation survey meter employing the G (E) function compensation method.

Both the luminescence amount generated by the scintillator using incident gamma rays and the performance of the photo-sensitive element have temperature-dependent properties, so the detected energy rate can be shifted according to the ambient temperature. The air dose measurement section employed for our product mounts an architecture featuring a highly stable temperature control characteristic. The section also mounts temperature compensation circuitry. Therefore, superior temperature stability performance is achieved, and the detected energy shift due to temperature shows +/-5% or less in the ambient temperature at 0 to 50°C, and +/-10% or less in the ambient temperature at -10 to 0°C (137 Cs, 662 KeV standard).

In order to avoid the ionizing radiation shielding influence of the electric storage capacitors, communication units and wiring, the ionizing radiation measurement section is located at the front of the unit. A strict calibration test is conducted before shipping the product by providing a similar environment to that in which the product will be installed. Even the exterior equipment to be mounted at the "CONNEXIVE Monitoring Post B" is installed in the calibration test room in order to create an environment similar to that of the actual site as much as possible.

In order to maintain a high degree of precision, a calibration test should be carried out once a year after introducing the device to the actual site. Such a calibration test is carried out at our laboratory, so the ionizing radiation measurement section should be detached from the main unit and brought back to our laboratory for testing. The laboratory is strictly controlled and severe operation checks and calibrations are conducted in the same way as when the product is shipped for the first time. A calibrated product of the same model is available for loan to the customer so that measurements may be continued during the calibration maintenance period.

4.2 Safety Conscious Product Design

It is assumed that "CONNEXIVE Monitoring Post B" will be installed at schools or parks where children often gather, so the product is designed with safety consciousness in mind in order to avoid injury and accident.

The housing is designed in a cylindrical shape that eliminates risk of injury to children as much as possible, and also the electroluminescence display section is installed inside the front of the housing to avoid any projection of parts. Moreover, the lowest edge of the solar panel is designed to be located 180 cm above the ground so that the edge is above the height of most children. Bolts to fix the supporting column and housing should be installed at a height of 150 cm or lower and protected with resin caps (**Fig. 3**).

4.3 Achievement of Large Volume Power Generation and Low Power Consumption

The "CONNEXIVE Monitoring Post B" is designed to perform ionizing radiation measurements continuously, even when installed in a mountainous area such as the Tohoku region where much snow can be expected. The post is

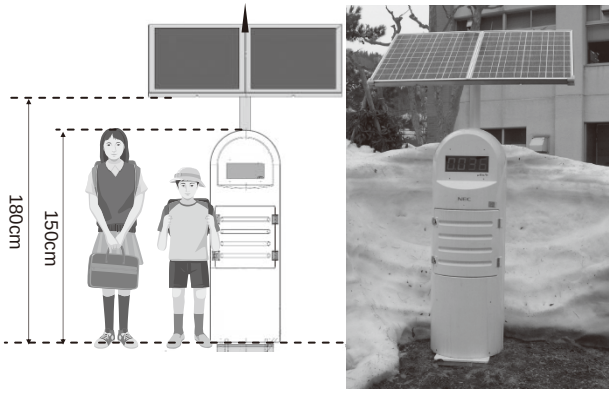

Fig. 3 Exterior appearance of CONNEXIVE Monitoring Post B.

equipped with a large-volume solar power generation panel and a large-capacity storage battery and the post is designed to achieve low power consumption so that continuous measurement operation is guaranteed, even if sunshine is absent for 10 consecutive days.

Power must be supplied continuously to the ionizing radiation measurement and controller sections. However, a low power consumption system is provided to these sections and their power consumption is a small percentage compared to the entire unit. On the other hand, if the unit is installed where the 3G wavelength reception conditions are inadequate, the 3G communication equipment attempts to increase wavelength output, which consumes a lot of electricity. In order to avoid such an event, the system is designed to switch on power for the communication equipment only when communication is carried out, thereby decreasing the power consumption of the entire unit.

4.4 Design Supporting Quick Installation

The "CONNEXIVE Monitoring Post B" employs a solar power generation system and a wireless communication system. Therefore, the post does not require the labor of laying power sources and telephone lines. Moreover, an exclusively designed and manufactured base is provided for the main unit so that the product installation can be completed just by digging a suitable hole and assembling the base in-situ. It is not necessary to cast and cure concrete, so installation work from the base installation to the completion of product installation can be performed in approximately six hours.

5. Conclusion

In 2011 the "CONNEXIVE Monitoring Post B" was employed as a real-time air dose measurement system by the Ministry of Education, Culture, Sports, Science and Technology. Over 500 such devices are currently at work all over Japan. Some of them were introduced by municipalities and some by private entities which chose and introduced the products according to their own judgments. The product has achieved preferred status for its accurate and stable measurement performance. In addition to "CONNEXIVE Monitoring Post B" introduced in this paper, NEC is also able to provide "Desktop-type Monitoring Post A," which is suitable for indoor measurements and "Compact Monitoring Post C," for outdoor measurements.

NEC continues to develop more innovative products in order to provide solutions not only in the ionizing radiation measurement domain but also for the agricultural and commodity distribution domains. NEC aims thereby to contribute to supporting the reconstruction of disaster affected areas.

* Wi-Fi is a registered trademark of Wi-Fi Alliance.

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