Wireless Communication Technology for i-SMR

You-Rak Choi [a], Do-Yeob Yeo[a*]
[a] *Nuclear System Integrity Sensing & Diagnosis Division, Korea Atomic Energy Research Institute (KAERI), Daejeon, South Korea*
All authors are equally contributed
[*] *Corresponding author (E-mail): yeody@kaeri.re.kr*

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1. Introduction

Research on accelerating construction is being prepared for rapid construction permission acquisition along with i-SMR design progress in Korea. Globally, efforts to find ways to improve the safety of SMR and reduce O&M costs are continuing, and wireless communication technology is being proposed as one of this measures.

The application of wireless communication technology to i-SMR requires a wireless communication network infrastructure with the concept of a backbone dedicated to wireless communication that transmits wireless data. This infrastructure can be used as a channel to deliver voice and video data in i-SMR fields and surveillance data collected through the wireless sensor network to control and diagnostic systems for monitoring device status.

Building a wireless network infrastructure in a built nuclear power plant creates regulatory and high cost problems, so the technology related to this must be reflected in the design stage to apply wireless communication technology to nuclear power plants.

2. Wireless Network Infrastructure

KHNP is introducing wireless communication infrastructure using integrated antennas and coaxial cables to wirelessly transmit voice and camera image data using wireless communication technologies such as PS-LTE and WiFi at large nuclear power plants.

The pilot application of wireless communication technology to Hanbit Nuclear Power Plant Unit 6 was carried out, and Shin Kori Units 5 and 6 reflect the wireless communication network infrastructure at the design stage and are applied as shown in Figure 1 during the current construction process.

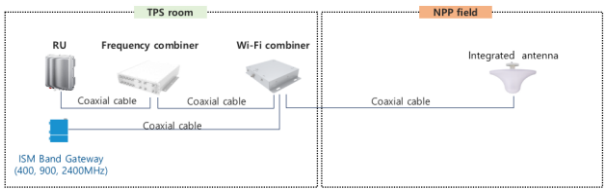

Figure 1. Overview of wireless communication network infrastructure at large nuclear power plants

The video communication data at the Hanbit Unit 6 site is collected through the integrated antenna installed at the site and is linked to the power plant network through the wireless communication network.

Large nuclear power plants in Korea under construction have begun building wireless communication network infrastructure for wireless transmission of voice and video data, but they have laid the foundation for applying the fourth industrial revolution technology to nuclear power plants by providing wireless technology application system functions for wireless monitoring of nuclear power plants.

Efforts are being made to apply wireless communication technology to Shin-Kori units 3 and 4 in operation, but they are facing very difficulties due to regulations on the installation of wireless communication network infrastructure, construction problems, and rapid cost increases in operating nuclear power plants.

A plan for applying wireless communication technology should be included in the process of obtaining a construction permit in order not to experience this problem in i-SMR

3. Wireless Communication Technology for i-SMR

3.1. Wireless communication Network Infrastructure

The i-SMR initial exhalation construction plan differs between the Ministry of Industry and KHNP. The ministry plans to complete the Standard Design Approval (SDA) by January 2029 and receive the Construction Permit (CP) by January 2031. KHNP plans to complete the Standard Design Approval (SDA) and the Construction Permit (CP) by December 2028. In any case, the justification that the construction permit should include the information on the construction of wireless communication infrastructure is already known through the difficulty of applying the additional wireless communication technology to Shin-Kori Units 3 and 4, which are nuclear power plants in operation.

The i-SMR is specified in Top-Tier-Requirements to operate four modules by three people, which requires systematic and automated monitoring technology for i-

SMR configuration devices. Ultimately, monitoring of all i-SMR configuration devices other than wired monitoring is required, and wireless technology should be applied for this. The basis for implementing these technologies is the wireless communication network infrastructure, and support for broadband communication technology for more types and more data transmission is needed in addition to voice and video data.

3.2. Wireless Sensor Network

Wireless monitoring of nuclear power plants requires smart wireless monitoring devices for monitoring nuclear power plants and wireless communication technology that can transmit nuclear power plant surveillance data to gateways connected to wireless communication network infrastructure using wireless sensor networks. According to NRC R.G. 1.180 [1] and EPRI TR-102323 [2], electromagnetic waves generated by all wireless devices in nuclear power plants are regulated to be less than 27 dbm at a distance of 1 m from existing measuring devices. Wireless devices in the wireless sensor network operate at low power due to a battery replacement cycle problem and are protected by a case, so significant electromagnetic waves are generated from antennas protruding outside the case. Therefore, the regulation of electromagnetic waves emitted from the antennas of wireless devices is evaluated as the most important factor in the application of nuclear power plants in wireless devices.

A systematic and automated monitoring plan for i-SMR devices is not possible through passive monitoring activities offline. Low-power smart radio monitoring devices and low-power radio communication technology that can wirelessly transmit data collected from these devices are essential to implement this plan. Although there are many radio communication technologies applicable within the regulations of the NRC, they must be selected according to the structure of the nuclear power plant and the characteristics of the monitoring data collected.

3.3. Conceptual diagram of i-SMR wireless communication technology design

Figure 2 shows the concept of wireless communication technology for i-SMR that can perform on-site device monitoring of i-SMR by applying the wireless communication network infrastructure technology of large nuclear power plants currently implemented.

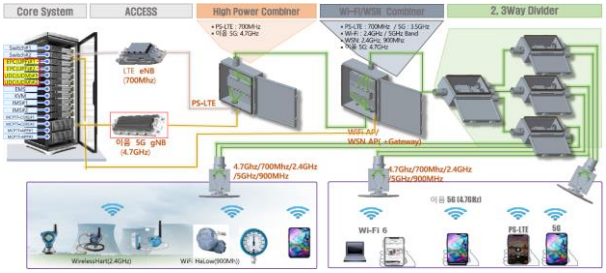

Figure 2. Conceptual diagram of i-SMR wireless communication technology design

Figure 2 proposes to increase data transmission by adding 5G communication technology to the wireless network infrastructure, including 700 MHz PS-LTE and 2.4 GHz Wi-Fi communication, which are applied to large nuclear power plants for voice and video data transmission, and to include 2.4 GHz Wireless Heart and 900 MHz Wi-Fi Hallow wireless communication technology in the wireless sensor network. As a way to alleviate the RFI problem, building a wireless sensor network using different frequencies is used.

4. Conclusion

Despite the IAEA's request for digital I&Cs to actively utilize wireless communication technology through NuPIC 2023, and the establishment of wireless communication network infrastructure in large domestic nuclear power plants, the consensus on the application of wireless technology to nuclear power plants in Korea is still very poor. The application of wireless communication technology must be included in the construction permit in order to strengthen the competitiveness and safety of i-SMR after the construction permit.

REFERENCES

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