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# A Smart Maintenance Support System (SMSS) for Research Reactors

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## 1. Introduction

KAERI had constructed a 5-MWth research and training reactor in Jordan, called the JRTR, in 2016. During the commissioning the JRTR, it was demanded to use a mobile device for testing and calibrating instruments located inside the reactor building and maintenance works. The commissioning workers need to bring many documents and drawings inside the reactor building for their works. However, it was hard to bring them and took too much time to go back and forth between the office and the reactor building to carry other documents and drawings. There were pager phones on the walls inside the reactor building to communicate with staffs in the main control room in case of emergency. The pager phones are not proper tools for the works but for emergency alerts. Thus, we were motivated to develop a tool based on digital technology to assist and improve maintenance works such as test and calibration works inside the reactor building. We developed and named it a smart maintenance support system (SMSS) [1].

There were three considerations on the development of the SMSS: mobility and information sharing ability, remote digital documentation ability, and cyber security [2]. Top-tier requirements of the SMSS are shown in Table 1.

**Table 1 Top-tier requirements of the SMSS**

| |
|---|
| It shall be useful in both Korea and overseas. |
| It shall be operable when at least eight users are simultaneously accessing. |
| It shall support video conferencing. |
| It shall support electronic documenting. |

Based on these considerations and top-tier requirements, this paper introduces architecture and functions of the SMSS.

## 2. Architecture of the SMSS

The SMSS consists of server computer, electronic blackboard, network devices, and mobile devices as shown in Fig. 1.

The server computer contains all electronic documents and drawings for the works and database to store and retrieve data created during the works. It communicates with mobile devices to support video conference and electronic settlement process. It also takes real-time process values of reactor operation from the information processing system for displaying them in the mobile devices.

The electronic blackboard provides video conference between engineers in the main control room and workers in the reactor building. They can share electronic documents and drawings through the blackboard. They can simultaneously read and write technical notes and contents on the blackboard.

The electrical power line is used as a network communication line. For this, electrical power line modem is adopted to connect the devices. The electrical power line communication is not possible between the circuit breakers. In this case, the network switch hub are used to communicate between the electrical circuit breakers.

The mobile devices are used for the workers inside the reactor building. The workers bring the mobile device inside the reactor building, connect it to the electrical power line through the modem, and communicate with the server computer and electronic blackboard.

The electrical power line modem and network switch hub support the communications of the server computer, electronic blackboard and mobile devices. The private closed network is adopted in order to overcome cyber security problems. Thus, a wireless network is not used.

## 3. Functions of the SMSS

The SMSS is composed of three functions: maintenance work support, electronic documentation, and real-time display of process values as shown in Fig. 2.

The maintenance work support function contains three sub-functions: video conference, board share and paper share. The workers can simultaneously use the three sub-functions on their mobile devices. The video conference sub-function supports face-talk communication between workers. The board share sub-function supports the workers to simultaneously share contents by reading and writing letters on their mobile devices. The paper share sub-function supports the workers to simultaneously share contents by loading up and down documents and drawings onto their mobile devices. Thus, these sub-functions make the worker connect, communicate and work remotely together through the SMSS.

The electronic documentation function contains two sub-functions: operation report and maintenance report. The operation report sub-function supports the reactor operators to electronically generate the reactor operation daily report. The shift operators must log operation

history onto the operation daily report per shift. The operator can search the report to log the history and create his report and log operation history. After finishing the report, the operator can submit the report to his manager for approval.

The manager can reject or approve the applied works. When the manager approves the works, the worker can bring the mobile devices inside the reactor building and start the maintenance works.

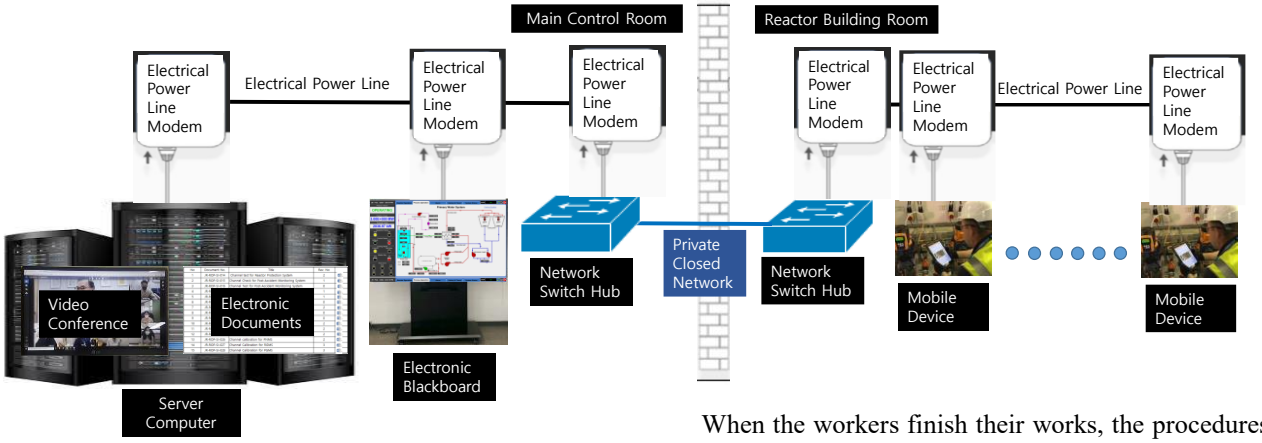


**Figure 1 Architecture of the SMSS**

The maintenance report sub-function makes the workers input field data into the maintenance procedure after loading the procedures down onto their mobile device from the server computer inside the reactor building. They also load down necessary manuals and drawings onto their mobile devices from the server computer. In order for them to work, the electronic settlement process is required to apply, execute, finish and approve the works. The workers first search the procedures in the server computer and then apply the maintenance works with the procedures to their manager.

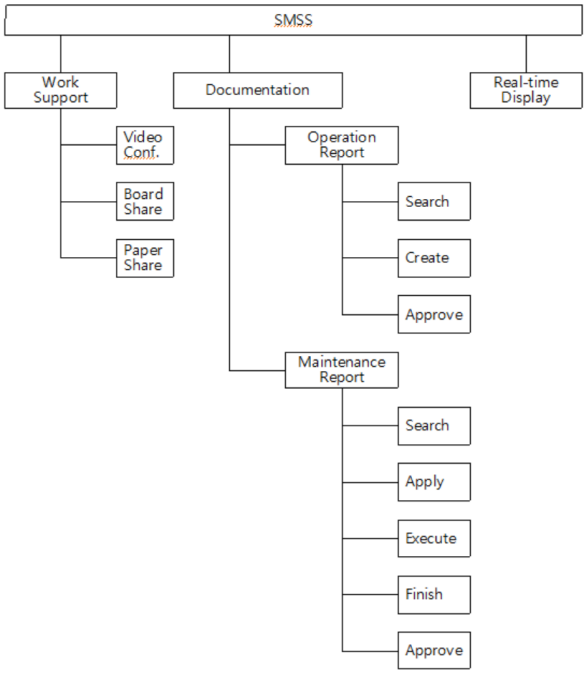


**Figure 2 Functions of the SMSS**

When the workers finish their works, the procedures are saved in the server computer and apply the finished works to their manager for approval. The manager can reject or approve the finished works.

The SMSS supports the real-time display of process values of reactor operation. The workers can monitor the process values on their mobile devices anywhere through the SMSS. Thus, they can evacuate from their work areas inside the reactor building by monitoring the process values under emergencies.

## 4. Conclusions

This paper presents architecture and functions of the SMSS. The SMSS consists of server computer, electronic blackboard, network devices, and mobile devices. The SMSS provides functions of maintenance work support, electronic documentation, and real-time display of process values. The SMSS can support the maintenance workers to bring the mobile device inside the reactor building and to communicate the engineers in the main control room through the video conference, and to perform electronic documentation during the reactor operation and maintenance works. The SMSS also provide real-time display of reactor process values.

The efficiency of maintenance works inside the reactor building will increase and the human errors will be reduced using the SMSS. This will increase the safety of research reactors by reducing the probability of device defects. Further study is needed to calculate the probability by applying the SMSS to research reactors.

The SMSS can be applied to the Ki-Jang research reactor (KJRR) construction project if the budget is affordable.

The SMSS has been registered as a patent (Patent No. 10-2606978, 2023. 11. 23) in Korea.

## Acknowledgement

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