Stimulation interfacing method in APR1400 simulator

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1. Introduction

A project for the localization of nuclear digital I&C system has been carried out on the initiative of Korea Nuclear Instrumentation & Control System (KNICS) for several years. Before a newly developed system is applied to nuclear power plants (NPPs), it should satisfy the proven technology requirements.

EPRI-URD requires the 'proven technology' which should have at least three years experience of documented and satisfactory service as modules of subsystems in the NPP or other plant applications similar to that of NPP [1]. However, it is not easy to satisfy the requirements actually because the newly developed system has some risks for safety and operation rather than the existing system that plant managers are reluctant to introduce it.

Fortunately, as an alternative option, EPRI-URD requires that it should be completed satisfactorily, a 'well defined program of prototype testing' to verify its performance by using the stimulated full scope simulator [2].

Korea Electric Power Research Institute (KEPRI) and Doosan Heavy Industry (DHI) have developed together the KNICS Integrated Performance Validation Facility (IPVF) which could evaluate the performance of the newly developed control and protection system.

There are two methods for applying a system to simulator. One is emulation method which simulates the system virtually in computer, and the other is stimulation one which simulates it using real device and Input/Output (I/O) points connecting the simulator and the device.

In this paper, stimulation interfacing method is introduced by stimulating a system in APR1400 simulator which is modeled by 3KeyMaster™, a simulation tool of Western Services Corporation.

2. Stimulation interfacing method

2.1 Interfacing System Structure

A Simulator Sever loaded with simulator model connects to Master Node which exchanges I/O signals with I/O system and delivers them to Clients. Simulator Sever and Master Node share mutual memories through a connector in Master Node. Master Node communicates with I/O system through Hub which accommodates all connections to I/O modules in the stimulated system. The Master Node and the Hub also share memories through a connector in Master Node. All communications use TCP/IP networking protocol.

I/O system is developed with Compact Field Point (CFP) system of National Instrument. CFP system is highly expandable programmable automation controller composed of rugged I/O modules and intelligent communication interfaces.

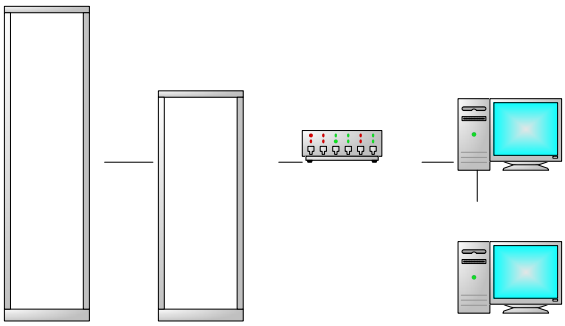

Figure 1. Interfacing system outline

2.2 Work procedure in simulator model for interfacing

Before interfacing simulator model and stimulated system, the procedure should be done in the simulator model as follows.

1) List up 4 types I/O variables which consist of analog and digital I/O for stimulation. The input variables in simulator model correspond to the output variables of stimulated system and vice versa.
2) Make a mapping table for interfacing. At this stage, the unit and range of interfacing variables should be checked for matching. In case of different unit or range, the conversion of unit or range should be done.

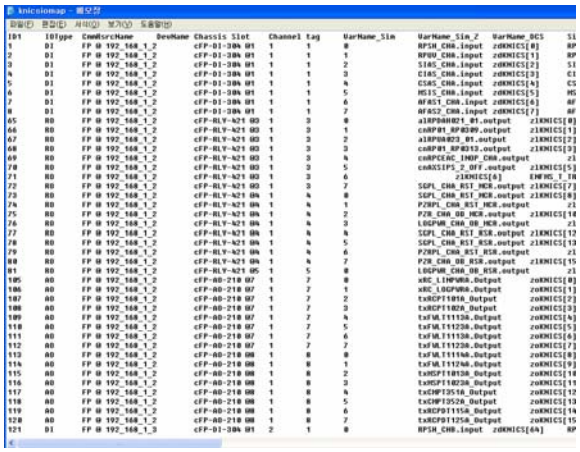

Figure 2. Mapping table for interfacing

Mapping tables with the same name in Simulator Server and Master Node should keep consistency.

3) Remove input nodes which are selected to get values from stimulated system in simulator model.

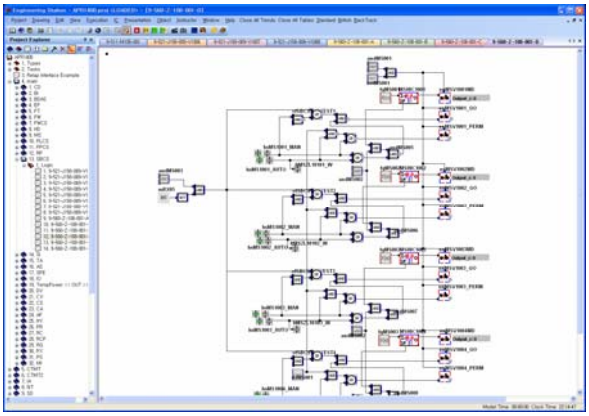

Figure 3. APR1400 simulator model

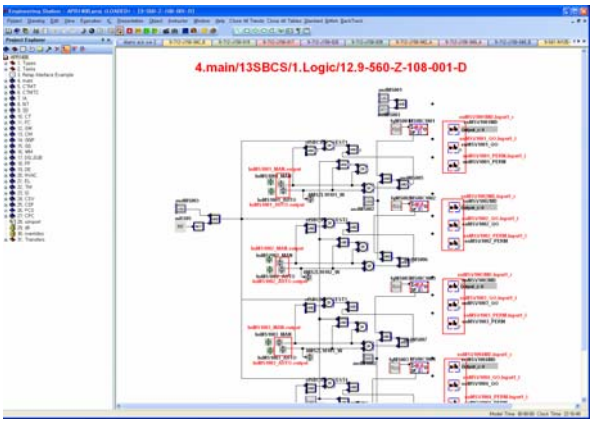

Figure 4. APR1400 simulator model after removing input nodes for interfacing with stimulated system

4) Check whether the simulator model maintains the steady-state using 100% Initial condition (IC). If not, check the input variables of which the connecting nodes were removed for interfacing with stimulated system whether they have values at 100% steady-state. In case that they don't have values at 100% steady-state, insert 100% values using overriding function.

Figure 5. Overriding function

2.3 Interfacing with stimulated system

The steady-state is checked in simulator after the work described in [2.2], then the interfacing between simulator and stimulated system is performed. The interfacing between simulator and stimulated system should be done one I/O point by one I/O point connected each other for the convenience of checking errors. It should be also considered that the response time about RESET function in stimulated system is much longer than in simulator model.

3. Conclusions

It is in progress an interfacing between simulator model developed by KEPRI and proto type system for stimulation developed by DHI [3]. As DHI develops a system, KEPRI revises simulator model for stimulation and integrates with the system. The stimulated scope will be expanded into a full-scale integration test. It is important to get know-how about full-scale stimulation integration because it may cause problems as the scope of stimulation becomes broader, although it is right at each unit test

The stimulation interfacing method will be useful for the Verification & Validation (V&V) of domestically developed systems to satisfy the proven technology requirements before applying to NPPs.

REFERENCES

[1] EPRI-URD Chapter 11-10-3. 2. 1, Criteria for Proven Technology.
[2] Dong-Gyun Kim et al., "Integrated Performance Validation Facility for KNICS", Proceedings of the ANS Winter Meeting, pp1164-1169, ANS, DC 2006.
[3] Myeong-Soo Lee et al., "Integrated Performance Validation Facility for KNICS MMIS, the Korean Nuclear Society Spring Meeting, 2007