

Application of a Virtual Ovation System to the ShinKori-3 Simulator

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1. Introduction

The Ovation system for the Shin-Kori Unit 3 Simulator is essentially a non-redundant, repackaged subset of the actual plant I&C equipment, with additional interface computers (SimStations). This system also present in the simulator to provide communication between the plant model computer and the stimulated Ovation equipment [1]. The stimulated Ovation equipment in the simulator system includes Operator HMI (Human-Machine Interface) equipment and Ovation virtual controllers hosted by Virtual Controller Host workstations, which are not present in the actual plant DCS system. The simulator for the Shin-Kori Unit 3&4 is being developed by Korea Hydro & Nuclear Power's Central Research Institute (KHNP CRI). One of the features of the simulator is its application of a virtual Ovation system capable of simulated functionalities such as run, freeze, snapshot, backtrack and others required by ANSI/ANS-3.5 [2] in addition to the original functionality for the actual Ovation system applied at the plant. This is the first application of a virtual Ovation system to a full-scope simulator for a nuclear power plant in Korea.

The purpose of this paper is to provide the overall architecture of the communication system between the virtual system and the simulator model and to describe the current situation of the development of the system and recent relevant studies.

1. Architecture of the Interface System

TCP/IP Interface Software requires one plant model computer (PMC, simulator host) and one SimStation to work [3]. This allows transferring of the Ovation point data and commands as follows:

- From the PMC to the simulator system
- From the simulator system back to the PMC

The TCP/IP Interface Software includes two sets of programs:

- The server side launchers
- The client side launchers

The PMC is considered as the server while the SimStations are the clients. For each program set, there are two servers and two launchers, separated as follows:

- Data information
- Command information

Depending on the type used, a SimStation contains either a single Data launcher or a Data and Command launcher pair. The launchers start and monitor each respective TCP/IP Interface Software server and client on the current system.

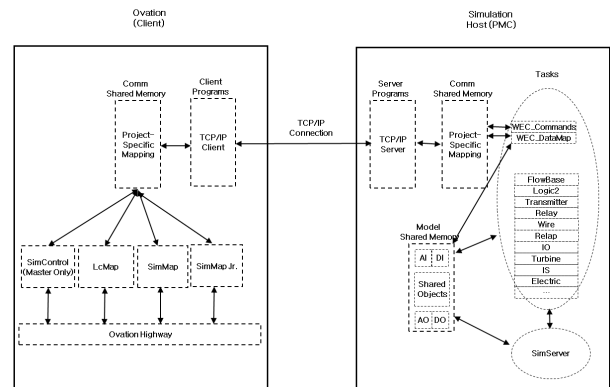


Fig. 1 Overall Architecture

TCP/IP Interface Software is similarly set up on each type of machine. The PMC contains both a Command launcher and a Data launcher. These are known as “server launcher pairs.”

Depending on its type, the SimStation contains either a single Data launcher or a Data and Command launcher pair. These are known as “client launcher pairs.”

The PMC and SimStation(s) also contain a copy of the memory mapping configuration files (token files), where the data linking occurs. The sample file is shown in Fig. 2.

```
# VCI TK01 LVL LO (CLOSE V501)
conn: 0, drop_num: 1, wdpf_pt: CV-LT0226H04-0P1, sim_pt: ovout_CV_LT0226H04_0P1, mem_offset: 0x1000, serv
# VCI TK01 LVL LO (OPEN V506)
conn: 0, drop_num: 1, wdpf_pt: CV-LT0226H04-0P2, sim_pt: ovout_CV_LT0226H04_0P2, mem_offset: 0x1008, serv
# CABINET DOOR OPEN ALARM
conn: 0, drop_num: 190, wdpf_pt: XFO-D01-DOOROPN, sim_pt: ovin_PO_D01_DOOROPN, mem_offset: 0x1010, server
# CABINET HI TEMP ALARM
conn: 0, drop_num: 190, wdpf_pt: XFO-D01-HITEMP, sim_pt: ovin_PO_D01_HITEMP, mem_offset: 0x1018, server_o
# PZR LVL ERROR (FROM PLC3)
```

Fig. 2 Sample of the token files

Regarding the mapping configuration, there are currently 9462 I/O (Input/Output) points between the PMC and virtual ovation system (1670 analog outputs and 7792 digital outputs) for the outputs and 2800 for the inputs (251 analog inputs, 2549 digital inputs).

The PMC also contains a static library that is used as an Application Programming Interface (API) to connect to the TCP/IP server.

2. Network Layout

A TCP/IP Interface Software network consists of one PMC and at least one SimStation. The network may consist of many more SimStations, though each SimStation must have its own copy of the TCP/IP executable file.

If multiple SimStations exist on a PMC network, one SimStation is designated as the “Master” that accepts commands from the PMC for the simulation. Because it also performs data mapping, the Master SimStation

must have both Data and Command client launchers. (It is the only SimStation that has a Command client launcher program on it.) All other SimStations in the processing group are "Slave" units that contain only Data client launcher programs.

The PMC sends both Ovation point data and the simulator commands. Therefore, the PMC must have both a Command and Data launcher server pair.

For any PMC with more than 5000 Ovation points, the network must have a dedicated network switch for the SimStations. This switch must have a different subnet in relation to the Ovation system and the simulator.

3. Server-Side Communications

Communication on the server (PMC) side of the TCP/IP interface uses token files – as does the client side – to inform the PMC of the location of the data in the server shared memory. As data comes into the server from the SimStations, it is put into TCP/IP server shared memory based on the server offset in the token files. Once in TCP/IP server shared memory, a project-specific mapping program accesses the data. This mapping program transfers data between the PMC memory and the TCP/IP server shared memory. After the data is matched with its model equivalent, the operation continues. The process is similar for outgoing data.

4. Client-Side Communications

Communication on the client (SimStation) side of the TCP/IP interface uses token files, like the server side. These files list both:

- The PMC shared memory offsets
- The SimStation shared memory offsets

Values are read from or written to the SimStation shared memory at the addresses specified in the token files. Buffers are built with the data from shared memory for data designated as "write" in the token files and sent to the PMC. Data designated as "read" in the token files are received from the PMC in a buffer and are written into shared memory.

LcMap, SimMap, SimMap Jr., and SimControl (available only on the Master SimStation) also have the ability to read or write data in and out of shared memory on the SimStation. These programs interface with the Ovation Highway program. This is where the data:

- Originates when a signal is sent to the PMC
- Terminates when a signal is sent from the PMC

5. Current and Further Works

From Aug. 15th of 2011 to Aug.19th of 2011, factory acceptance tests (FAT) were carried out at the Emerson Korea site (EPMK). The result was satisfactory. The test included:

- The Windows Ovation DCS simulator command-and-control features of run, freeze,

the saving of initial conditions (IC), and the loading of ICs.

- Ovation DCS tests, including the drop malfunction test and the IO channel malfunction and override test.

The site acceptance test (SAT) will be held at the Kori Training Center. It will include the following: [4]

- Plant operation from hot standby to 100 percent power conditions using the plant operating procedure.
- Transient tests for a reactor trip and a turbine trip without a reactor trip using plant abnormal operating procedures
- Selected simulator malfunction tests
- 120-hour continuous operation test
- Domain Controller Security assessments
- Other assessments

REFERENCES

- [1] NPBU-DS-00087-GEN, Rev. 8, "Westinghouse I&C Simulator Design Specification," Westinghouse Electric Company LLC.
- [2] ANSI/ANS-3.5-2009, "Nuclear Power Plant Simulators for Use in Operator Training and License Examination", American National Standards Institute, 2009
- [3] WNA-DS-02406-GEN, Rev. 0, "Standard Simulator TCP/IP Interface Software Design," Westinghouse Electric Company LLC.
- [4] WEC, "Shin Kori 3 Simulator Test Plan", WNA-PT-001470SHIN-K3 Rev. A, June 2011