Function and Performance Test of Hardware based Display Sharing System Using APR1400 MMI Validation Facility

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1. Introduction

We have developed display sharing system design for Saeul units 1&2 digital Main Control Room (MCR). This function enables MCR operators to easily oversee the other operator's operational behavior like soft control action. Also, this function can improve the situation awareness and team work in the environment of the sit-down operator console. We developed the hardware based design architecture to be applied in the Distributed Control System (DCS) of the Saeul units 1&2 while minimizing the effects of DCS network load and Operator Workstation (OWS) CPU load. This paper introduces hardware based design architecture and function & performance test of display sharing system through the APR1400 Man Machine Interface (MMI) validation facility.

2. Hardware Based Display Sharing System

We developed hardware based display sharing system considering APR1400 MMIS architecture and DCS network load and CPU load of operator workstation. To simply design display sharing function, we have introduced video extender, video scaler, and video matrix as shown in Figure1[1].

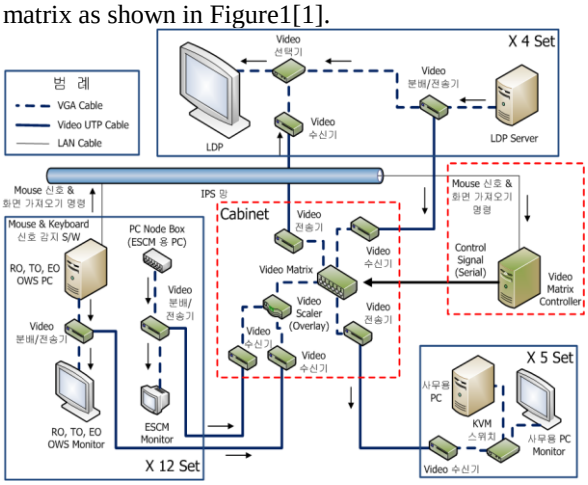

Figure 1 Hardware based display sharing system architecture

Video extender such as video sender and video receiver has the function to send each operator's display to LDP variable area and receive shared display from the other operators. Video matrix has all of three (RO, TO and EO) operators' current displays. Also, video matrix controller has the function to manage the shared displays which video matrix are storing from each operator's operator console. This hardware method has the characteristics not to affect DCS network load and OWS CPU load at most. But EQ tests have to be performed to the additional H/W component to be applied in the plant.

3. Validation Facility for Display Sharing System

We designed MMI display to manipulate display sharing function in the operator console[1].

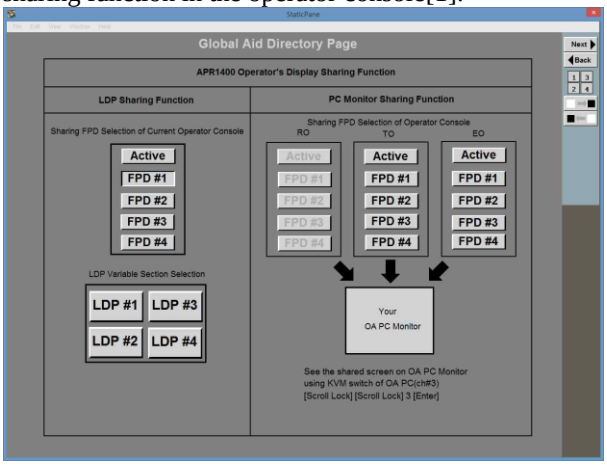

Figure 2 MMI display for display sharing function

As shown in Figure 2, there are two types to use display sharing MMI. One is fixed sharing function and another is automatic sharing function. An operator can also use fixed sharing function to share one fixed FPD of the other operators. Shared display is also shown on the LDP variable area or OA monitor through fixed sharing function. For automatic sharing function, the event on each OWS can be detected and the display used recently should be checked. When automatic sharing option is on, the display used recently should be displayed on variable area of LDP or on OA monitors of the other operators. Figure 3 shows the APR1400 MMI validation facility where is constructed in the Central Research Institute of KHNP. This validation facility

for display sharing function is composed of video senders & receivers, video scaler, KVM switch, video matrix and video matrix controller with the APR1400 simulator.

Figure 3 Validation Facility for display sharing function

4. S/W Development for Display Sharing System

S/W consists of system software and MMI software. There are two kinds of System S/W such as MODS (MCR Operator's Display Sharing) agent and control. MMI S/W is implemented with Procsee S/W as MMI tool of validation facility as shown in Figure 2. When applied in the plant, MMI display has to be implemented with Ovation DCS graphic tool. Table 2 shows the role of the S/W for display sharing function.

Table 2 S/W for display sharing function

No	S/W Type	Function
1	MODS Agent	MODS agent S/W is installed in the OWS of RO, TO and EO. The role is that monitor information of PC which operator wants to share with mouse information is transmitted to the Video Matrix Controller through the DCS network
2	MODS Control	MODS control S/W is installed in the Video Matrix Controller and communicates with video matrix. The role is that transmitted information by the MODS agent makes MODS control S/W connected among display which operator wants to share and LDP variable area 4 sections or OA PC monitor for five operators.
3	MODS MMI	MODS MMI S/W is installed in the OWS of RO, To and EO.

4. Function and Performance Test

We established test requirements to perform function and performance test of display sharing system design. Table 3 shows the sample of test requirements. These test requirements were established considering the detailed function of hardware based display sharing system [2].

Table 3 Main Test Requirement

No	Test Requirement
1	OWS CPU load and DCS network load test: when performing display sharing function, change rate of each load has to be within 5%.
2	Time difference of transmission has to be within 1 second between original display and copied display.
3	Fault tolerance test: although ESCM video sender/receiver or video matrix will be broken, the function of conventional MMIS has to be maintained.
4	Prevention test of common mode failure: LDP variable section display can be disabled due to video matrix failure. Bypass function to prevent this state has to be maintained.
5	Display Sharing Function Test through LDP
6	Display Sharing Function Test through OA PC Monitor
7	Manual and Automatic Display Transfer function
8	S/W Reliability Test including consecutive operation more than 24 hours

169 test items were performed including above test items in the validation facility and all of test results are successful [3]. If field test will be performed in the plant, we recommend that integrated system test should be performed adequately with more than 100 hours when considering the conventional experience.

6. Conclusions

We developed display sharing system design and performed function & performance test using APR1400 MMI validation facility. Hereafter, when applying display sharing system, we think that design and test results are very useful. Also, display sharing function is very useful to easily detect operators' errors and enforce safe operation. We look forward to applying display sharing system in APR1400 Nuclear Power Plant and UAE BNPP.

REFERENCES

[1] Study on the Application Method of Display Sharing System for the APR1400 Digital Main Control Room (2017 Korean Nuclear Society Spring Meeting)
[2] Integrated Test requirement Report of validation facility for Display Sharing System (KHNP/FNC, 2017)
[3] Integrated Test Report of validation facility for Display Sharing System (KHNP/FNC, 2017)