Development of KNICS Architecture based on Domestic I&C Products

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1. Introduction

As a part of a Korea Nuclear Instrumentation and Control System (KNICS) project, we developed NPP integrated I&C system based on domestic I&C products for the purpose of practical use for the next generation NPP. The KNICS was developed according to the APR1400 design requirement that was approved in Korea several years ago and some functions are partially enhanced. We used cabinets of reactor protection system and control system as fundamental component, and those were fabricated with PLC (Programmable Logic Controller) and DCS (Distributed Control System) developed by KNICS Project. Also, we conceptually designed the network systems consisted of information networks, protection network and control network, and then performed the traffic load analysis for each network.

2. KNICS Constitution and Design Principles

KNICS is hierarchically levellized with 3 layers of system and each system is modularized. The top level is composed of control room, information processing computer system and indication system. The control system and protection system are located in the middle level. The bottom level is composed of various measurement systems and a few of monitoring system of equipments and systems. The network is widely used for the connection/ interface system with system and between the levels of the system, and hard-wired line was partially used.

The design principles for platform selection are to use domestic I&C components developing through the KNICS project and to use the third party stand-alone equipments and systems in consideration of economic cost and level of technology. The design of network systems that connect the systems with other systems in the digital based I&C system, adopted the concept of diversity and distribution to maintain the deterministic and real time processing characteristics and the fault tolerant design to minimize the effects of single failure of component or system

3. Equipments and Systems

a) Safety Class PLC : We developed the design requirement and specification to be required for the design of PLC as a platform of reactor protection system. POSCON is developing the qualified and fully demonstrated equipment in aspect of safety and performance.

b) DCS : The local I&C manufacturing company "WOORI Technology" is developing DCS that is able to be used control system and information and alarm processing system. The DCS is considered for the convenience of developers and operators. The control network is separated with information network not to compound control signals and information signals for the purpose of securing the deterministic characteristics of control signals.

c) KNICS System Platform : The system platform using KNICS equipment is reactor protection system (RPS), engineered safety feature and component control system (ESF-CCS), power control system (PCS) and the other non safety control system.

d) Network System : The network systems to integrate each system and equipment are consisted of commercial 100 Mbps Fast-Ethernet as a backbone, 12 Mbps Profibus which has been developed by POSCON as a protection network, 100 Mbps Token-Ethernet which has been developed by "WOORI Technology" as a control network designed to be secured deterministic characteristic, and system internal networks. The measuring systems use hardwired for the interface with other system, and is also considered the possibility of introduction of smart sensor and field bus.

e) Introduction of other designs : We introduced the design of control room and information processing system from APR-1400 design concept and partially improved some functions.

4. KNICS Architecture

The control, protection, indication and monitoring, and information processing computer system in KNICS are classified according to the function and safety class, and the networks interconnect them. Each system has its own internal networks. Figure 1 shows the KNICS architecture. The main features of KNICS are follows;

- Digital based control system
- Human-centered control room design
- Improvement of operability
- Security of the safety through the various design verification and validation
- Improvement of reliability by the diversity
- Enhancement of maintainability by the modularization and standardization
- Reduction of the design period through the previous design certification of equipment.

5. Network Traffic Load Analysis

The network should be designed to perform inherent system functions under condition of maximum load, and to satisfy transfer condition for the each requirement of systems. Thus, we analyzed the network traffic load of each network system to identify the validity of KNICS architecture. The results of analysis of each networks satisfied the design requirements. The load factors of each network system are follows;

Network	Load factors (Utilization)	Design Requirement
Information Network	14.52 %	20 %
Control Network	19.75 %	40 %
Safety Information Network (QIAS)	5.95 %	40%
Safety Network (Ch A,B)	11.4 %	40 %
Safety Network (Ch C,D)	7.96 %	40 %

6. Conclusion

The results of development will ensure the international competitiveness on NPP industrial areas in aspects of economy cost and level of technology. Thus, KNICS is useful for applying the next generation nuclear power plant, and/or upgrading of existing conventional plants.

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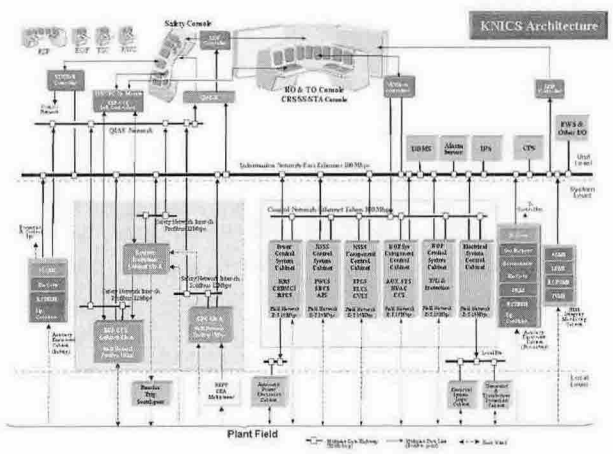

Figure 1. KNICS Architecture