Development of Protocol for the B-NSDN (Broadband-Nuclear Safety Data Network)

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1. Introduction

The characteristic of a nuclear safety data network is that the number of configured modules and a quantity of data is fixed. And the nuclear safety data network requires a short and periodic transmission function. Simultaneously the nuclear safety data network should satisfy hard-real-time characteristic [1] conforming to a strict transmission response time due to provide against an accident, also should satisfy the safety and the verification characteristic. In summary, the nuclear safety data network should satisfy a deterministic architecture, a clear separation and an isolated configuration, a high reliability, a verification. In this paper, as analyzing a data network in a plant protection system, a core protection system, and an engineered safety featured-component control system, the protocol based on time division multiple access is proposed

2. Architecture Design of B-NSDN

The nuclear safety data network is composed of 24 processes in plant protection system, 33 processes in core protection system, 106 processes in engineered safety features-component control system. As the result of analysis in the quantity of transmission connection, a data period is 50msec, 500msec. And as conforming to safety requirement, the grade of quality in safety data network is classified into the safety critical and the importance to safety. Also according to a multiple channel isolation requirement, a channel A, B, C, D, and common channel is isolated [2]. The table. 1 shows the summary of a configuration of safety data network.

Table 1: Configuration of Safety Data Network

	Safety-Critical	Safety-State
Individual channel net	Safety-critical channel net (SC-A)	Safety-state channel A(SS-A)
	Safety-critical channel net A(SC-B)	Safety-state channel A(SS-B)
	Safety-critical channel net A(SC-C)	Safety-state channel A(SS-C)
	Safety-critical channel net A(SC-D)	Safety-state channel A(SS-D)
Common channel net	Main Control Room safety-critical common channel net(SC-M)	Main Control Room safety-state common channel net(SS-M)
	Remote Shutdown Room safety-critical common channel net(SC-R)	Remote Shutdown Room safety-state common channel net(SS-R)

The table 2 shows the transmission connection specification of channel A in safety-critical and safety-state [3].

Table 2: Transmission Specification for SS-A and SC-A

Specification of transmission		Net of SS-A	Net of SC-A
Quantity of internal node		33	24
Quantity of external connection node	Transmission	9	4
	Receiving	3	7
Total quantity		195	198
Quantity of connection data(bit)	Min	1	1
	Max	19578	2401
	Average	1419	219
	Sum	286536	43417
Transmission period(msec)		500	50
Quantity of data transmission capacity		572872	869340

3. Design of protocol for B-NSDN

A topology of the B-NSDN is star. Individual data link is 1:1. From the Fig. 1, the configuration of B-BSDN is a hierarchy stat topology. The Guaranteed Time slot (GTS) is adopted in MAC layer of B-NSDN. And PHY layer is changed to the 100Mbps Ethernet specification.

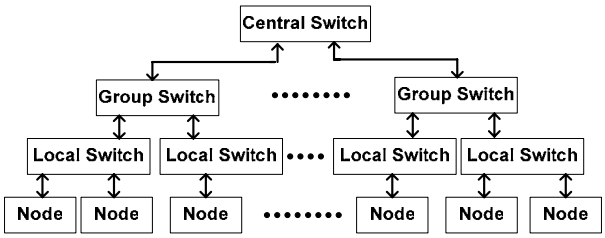
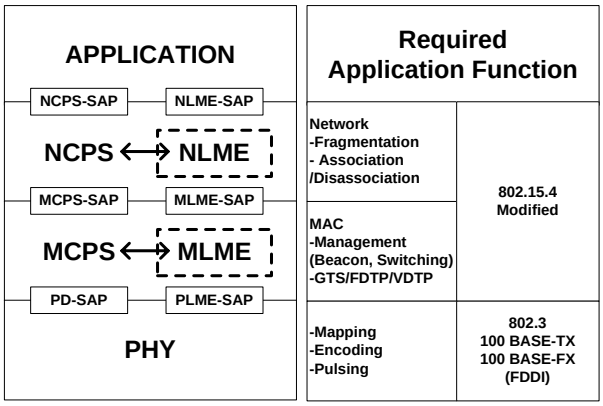


Fig. 1. A topology of the B-NSDN

Fig. 2 shows the hierarchy configuration of protocol for the B-NSDN. And an example of super-frame structure for the B-NSDN is Fig. 3. The super-frame is consist of BEACON, FDTP (Fixed Data Transmission Period), VDTP (Variable Data Transmission Period). The time for analyzing BEACON is guaranteed in the BEACON period. The periodic process data that is allocated to a unique GTS is transmitted in B-NSDN. All of the node can randomly access and the process data can be transmitted.



NCPS: Net sublayer Common Part Sublayer
NLME: Net sublayer Management Entity
MCPS: Mac sublayer Common Part Sublayer
MLME: Mac sublayer Management Entity
SAP: Service Access Point

Fig. 2. The hierarchy configuration of protocol for the B-NSDN

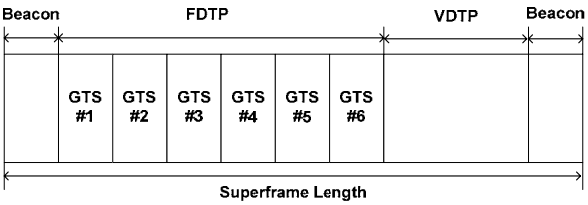


Fig. 3. An example of super-frame structure

4. Formal specification of protocol for B-NSDN

In this section, the protocol for the B-NSDN is specified using SDL. The used tool for specifying and analyzing is Tau SDL suite.

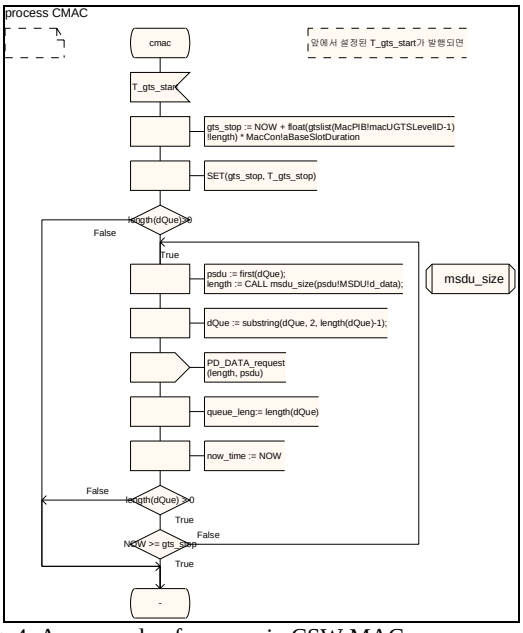


Fig. 4. An example of process in CSW MAC

To simplify the formal specification for the protocol, association/disassociation, VDTP is excluded, and the data communication between node and CSW(Central Switch) is specified excluding GSW(Group Switch), LSW(Local Switch) The Formal specification for the protocol is consist of MAC, Network of CSW and Node. Fig.4 shows an example of process in MAC of CSW

The specified protocol in SDL is verified using the Analyzer that is static analyzing tool provided by Tau SDL suite. And the Simulator that is dynamic analyzing tool provided by Tau SDL suite [4]. Fig.5 shows MSC Simulator Trace.

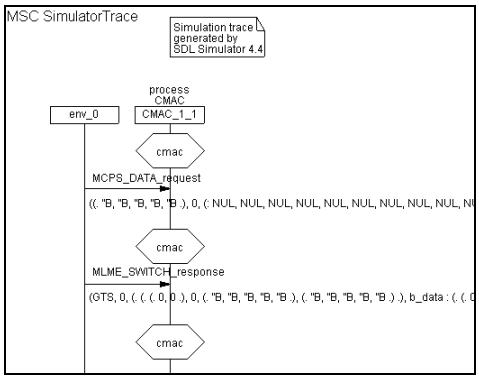


Fig. 5. MSC Simulator Trace

5. Conclusions

To develop the protocol for the B-NSDN, the configuration of B-NSDN is designed and the protocol for B-NSDN is formally specified. Also the protocol is verified using Analyzer and Simulator. To complete the protocol, an additional function that means association/disassociation, VDTP needs to be specified. After CSW, GSW, LSW Node system is integrated into one system, the static and dynamic including a validation analysis should be performed in point of view of one system.

REFERENCES

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