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Design and Implementation of IP-based Integrated Network Management System for Offshore Telecommunication System

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***Abstract*:** *In this study, an Internet Protocol(IP)-based integrated network management system(INMS) that can be managed on site and remotely was designed. To derive the requirements for an offshore plant INMS, the status of the offshore plant-related industries was analyzed, and the structure and functions of the system were designed by referring to the actual ship-owner specifications and shipbuilding yard POS. In particular, the communication environment and protocol, as well as the data structure, were designed for the telecommunication and network-based remote management of various system and devices in the offshore plant.*

Keywords: *offshore telecommunication, NMS(Network Management System), remote maintenance, offshore engineering, maritime satellite communication*

1. Introduction

Offshore plants are installed on the sea to find and produce marine energy sources, such as petroleum and natural gas. With the global economic recovery and the vitalization of energy resource development, the high growth of the offshore market is expected to continue[1]. Due to the large scope of work involved in offshore plant, various telecommunication system, including CCTVs, network equipment, and broadcasting equipment, are being used. Due to the nature of offshore plant, their distance to the land is more limited than from ship[8]. Therefore, various telecommunication systems using marine satellite communication are being utilized[6]. In particular, the propagation of offshore IT equipment is accelerating with the changing maritime satellite communication market, the effectuation of international conventions, and the changing social perceptions[2]. As the importance of automation system and network equipment is increasing compared to in the past, techniques for the integrated management of various network-based devices is required[5][7].

Therefore, in this study, an integrated network management system(INMS) that allows for on-site and remote capabilities of IP-based network devices in offshore plant, as well as on-site and remote monitoring and operation. This paper consists of the following chapters. In Chapter 2, the requirements are described. In Chapter 3, 4 the conceptual design based on these requirements are described. In Chapter 5, the conclusion presented.

2. Requirements for INMS

With the rapid convergence and integration of wired and wireless communication technologies based on IP, the communication networks of ships and offshore are changing. The IP-based wired and wireless communication environment in the sea is improving following the launch of Global Xpress by Inmarsat, which has a majority market share in maritime satellite communication[3][4]. Nowadays, the internal communication infrastructure of offshore plants is similar to that of the communication infrastructure on shore. However,

considering the special maritime environment of telecommunication system, the following requirements were derived for the development of an offshore INMS.

2.1. Optimization of Operating Environment

Offshore plant need a process and system for the unified management of an IP-PBX for Voice over Internet Protocol(VoIP) service, a network-driven equipment that is increasing recently, as well as traditional analog equipment, such as Public Address(PA) System, General Alarm(GA) System, and CCTVs.

Furthermore, as many people work in the dangerous environments of offshore plants, rapid recovery is .essential in the event of a problem.

2.2. Minimization of Human Errors

Compared to ship, offshore plants have various automation system and network equipment installed in them, which offer a variety of functions based on advantage technologies. Thus, such problems as operation errors and trouble recovery delays are occurring due to a lock of specialized skills. Therefore, user-oriented solutions must be developed to minimize human errors, and even maritime workers who have no expertise can easily use them.

2.3. Universality of System

As the use network devices is increasing and the importance of remote management is rising, leading makers, such as Kongsberg and JRC, have developed information management system, including the Kongsberg Information System(K-IMS) and JRC Remote Maintenance System(RMS), to support the efficient maintenance of offshore plants and ship. However, these systems can only support the devices supplied by their respective companies and can only use independent data formats. Therefore, a standard protocol for the integrated management of various network-based devices used in offshore plants must be established.

Fig. 1: Kongsberg Information System(K-INMS)

Fig. 2: JRC Remote Maintenances System(RMS)

To develop an IP-based INMS that supports the on-site and remote management of offshore telecommunication system, the following requirements were derived:

1. The design on a communication protocol and data structure based on the IP standard protocol
2. Support for the configuration and pre-test of telecommunication system and network devices
3. Monitoring and control of IP-based network devices, CCTVs, PBX and PAGA
4. Monitoring of the offshore plant through CCTVs on-site and onshore
5. Support for user-oriented, efficient operation
6. Integrated system that allows for management inside the offshore plant, as well as onshore

3. Functional Design of the INMS

To develop a system that allows for the configuration, monitoring and operation of IP-based telecommunication system from onshore and, the component of the INMS were derived, as shown in Figure1 and Table 1.

TABLE I: Component of INMS

INMS	INMS for offshore	Analog gateway for PBX, CCTVs Support for configuration and test of telecommunication systems Management and operation for IP-based communication devices
	INMS for onshore	Remote management system using a wired communication system Remote management system using high-speed maritime IP satellite network

3.1. Network Management

As there are many analog and digital devices inside the offshore plant, such as switches, APs, exchanger, PAGA, CCTVs, and clocks, interface modules that can digitalize analog communication devices and control each device were developed to enable IP-based control. Furthermore, the system was designed to allow for configuration, operation and fault recovery though a unified processor.

3.2. Internal and Remote Work Management

As there are many dangerous area difficult to access in an offshore telecommunication system including CCTV, PA, GA were interconnected to support the management of the offshore plant. Furthermore, submarine fiber-optic cables installed on a fixed platform and a high-speed IP maritime satellite network were used to management the internal work environment of the offshore plant from onshore.

3.3. Operation Support from User's Perspective

It is practically impossible for people who have no background knowledge or experience with networks to operate the L3 switch, which is basic component of the IP network inside the offshore plant, but there is no IT or network specialists in offshore plants. Therefore, the system was configured to allow for the easy setup and monitoring of telecommunication system using the operation program developed in accordance with the process. Furthermore, equipment configuration and pre-test features were implemented to support the installation and test operation of the equipment.

4. Design of the INMS

The IP-based offshore INMS that allows for on-site and remote management, as well as satisfies the required system functions, was designed as shown in fig. 3

Fig. 3: Conceptual diagram of IP-based Integrated Network Management System(INMS)

5. Design of the INMS's Data Protocol

To Support the remote monitoring of the PAGA, IP-PBX, CCTVs, and network devices of offshore plants, TCP/IP communication was implemented using submarine fiber-optic cables between offshore plant and onshore and the maritime satellite system. The composition of devices is shown in Fig. 4 and 5.

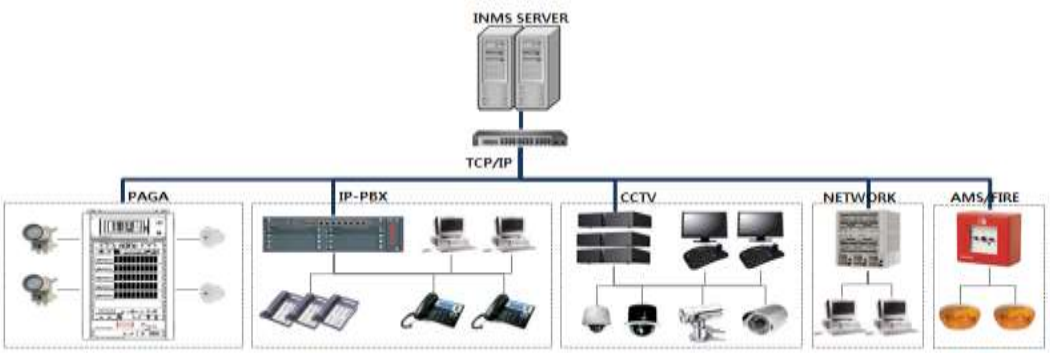

Fig. 4 : Composition of INMS

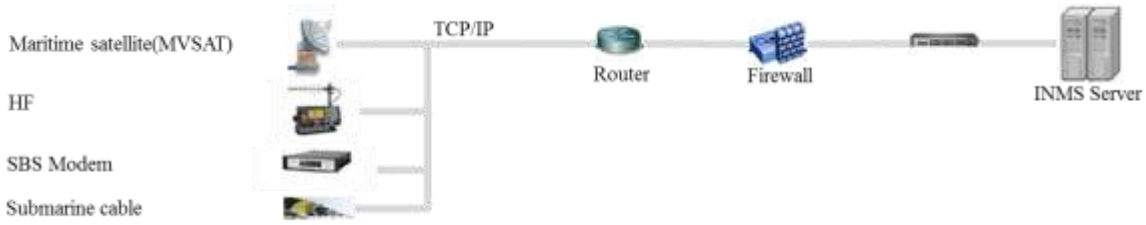

Fig. 5: Communication system of INMS

5.1. Data Synchronization

For data synchronization between the offshore and onshore, DB, event logs, and other data are compressed and encrypted to provide the best communication condition in the submarine fiber-optic cables and maritime satellite environment. Furthermore, data synchronization is supported through bidirectional communication based on TCP/IP. For the data synchronization protocol, data format in Table 2 is used to exchange large data between the offshore and onshore.

TABLE II: Data Format for Data Synchronization

Name	Length	Description
NETCOMMAND	4	REQUEST/RESPONSE COMMAND
REQCOMMAND	4	REQUEST COMMAND(ORIGINAL)
ID	16	ID FOR DATA SYNCHRONIZE(OPTION)
SIZE	4	LENGTH OF DATA
DATA PART	N	SYNCHRONIZED DATA

5.2. Real-time Communication for Operation

For real-time interoperation between the offshore and onshore, the remote management of the offshore telecommunication System are support though the server/client architecture and real-time data are supported through TCP-IP-based bidirectional communication. For the real-time operation, Data format in Table 3 is used to exchange data in real time between the offshore and onshore.

TABLE III: Data Format for Real-Time Operation

Name	Length	Description
ID	4	ID NUMBER
COMMAND	4	COMMAND NUMBER
SIZE	4	LENGTH OF DATA
DATA PART	N	SYNCHRONIZED DATA
CHECK SUM	1	EXCLUSIVE OR BYTE(ID~ DATA PART)

6. Conclusion and Future Studies

In this study, a conceptual design was developed for an offshore INMS. The results of this study are summarized as follows :

1) To develop a system that allows for configuration, monitoring and operation of offshore telecommunication, the system requirements were analyzed and the functional design of the offshore INMS was developed based on the analysis results.
2) As IP-based offshore INMS that satisfies the functional requirements and allows for in-site and remote management was designed.
3) For on-site and remote management of offshore telecommunication system, the protocol and data format of the INMS were designed.

In future studies, the development of INMS will be completed by establishing the management process of the design INMS, developing the individual interface modules and operation program, performing test and verifying the performance.

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