ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 3, Issue 5, May 2017

Design of Integrated Ship Equipment System Based on Ethernet

Bharath[1], Jeya Sutharson S[2], Kannadasan S[3], Vignesh Kumar S[4], Kathiravan G[5]

UG Scholar, Department of Marine Engineering,

PSN College of Engineering and Technology, Melathediyur, India

***Abstract* — The integrated ship equipment measuring and controlling network is composed of PLC, PC Station and Web Server etc., which is based on Industrial Ethernet technology and can be accessed via the Internet. We developed PLC Intelligent Control Units to implement local control of ship equipments, mean while, we mapped the PLC and gateway parameter data to the OPC Server by utilized their characteristics of Ethernet Communication Protocols supported. We also combined with the ASP. Net Framework and Flash Technology, and integrated OPC Clients into the Web Server to accomplish monitoring and controlling ship equipment measurement.**

Index Terms— Monitoring System; PROFINET; OPC; Web Server; PLC

I. INTRODUCTION

In September 2014, at the 23rd China, Japan, South Korea, Europe, and the United States (JECKU) shipbuilding expert preparation meeting, the Shipbuilders' Association of Japan Pointed out that the global shipbuilding capacity contradiction was still serious. In recent years, the development of international shipbuilding industry continuing slows down, seller’s market changed into buyer's market rapidly, which resulted in increases the technology competitive. Experts pointed out that the key way to sustain the development of the shipbuilding industry is innovation and cost control. Developing of intelligent control unit and using of standard communication network has become an important way to enhance the competitiveness of ship control system, thus, the intelligent controller and industrial Ethernet technology is increasingly applied to the ship automation. This project aimed at the reliability of ship automatic control requirements and shipbuilding cost control. In control layer, we used miniaturized PLC intelligent control unit to develop the distributed Ship equipment controller, which is developed as a distributed control mode to ensure the reliability and robustness of the system operation. In monitoring layer, according to PROFINET's characteristics of TCP/IP communications well supported and the current field bus compatible, we connected miniaturized PLC intelligent control unit and gateway device
to the industrial Ethernet, we also use the OPC technology to realize data interaction, on base of which, we developed

centralized Ship equipment monitoring system in form of Web.

II. NETWORK LEVEL ISOMORPHISM

Ship equipment network system comprises Infrastructure Networks, Intranet and Internet, which is the foundation of ship equipment monitoring and management. Among them, the Infrastructure Networks is mainly used for equipment monitoring and automation controlling, and is an important part of this project. The ship system network physical topology is shown in figure 1:

Network level isomorphism is commonly used method to solve the network structure and the communication protocol of heterogeneous. The Ethernet network is good for integrating information, and it has good openness and been widely used, thus, in this paper, the network level isomorphism is mainly based on support Ethernet TCP/IPprotocol and its protocol conversion.

As an Implementation Pattern of industrial Ethernet, PROFINET provides automation control system with complete communications solutions, PROFINET is compatible with industrial Ethernet and other bus network, only the proxy server is needed to connected PROFINET with existing field bus, which can offer the connectivity and real-time communication between the control units, and also refers to implement of network level isomorphism. From this way, it can greatly protect the investment of equipment manufacturers, complete sets of equipment or machine manufactures and end users. PROFINET makes all level’s users use the same mechanism for communication and coordinated operation.

The communication capacity and real-time performances of the PROFINET are both better than Field Bus in corresponding parts. So, we set up an basic network for local data transmission based on industrial Ethernet, which connected the distributed intelligent control units with the distributed field devices through PROFINET interfaces or proxy servers. In this way we accomplish the local control of Ship Equipments. By using wireless or satellite transmission which can finish Ship-Shore data interaction, from that way, we can also accomplish the remote control of Ship Equipments. The control network of this system is shown in figure 2:

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 3, Issue 5, May 2017

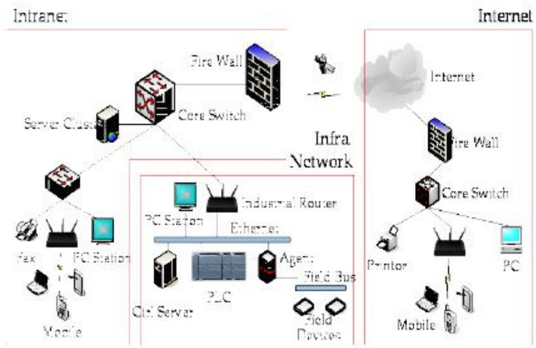

FIG. 1 SHIP SYSTEM NETWORK PHYSICAL TOPOLOGY

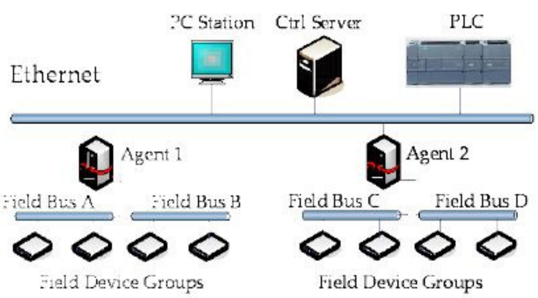

FIG. 2 NETWORK LEVEL ISOMORPHISM TOPOLOGY

III. SYSTEM ARCHITECTURE DESIGN

ISCS (Integrated Ship Control System) can be developed quickly and easily once the Network level isomorphism is completed. This ship equipment system is divided into 4 levels as following: executive layer, control layer, data management layer and application layer. This scheme mainly concerns control layer, data management layer and application layer of ISCS. The control layer includes decentralized, scalable equipment control group, which mainly includes PLC and gateway modules, provides data interaction interface of bottom layer for the data management. The data management layer is an interactive system that based on OPC technology, on which the OPC server provides communication driver which aims at sending operation instructions, receiving data from bottom layers, parsing the received data, completing the local field devices parameter data storage by using data persistence framework, sharing data with other systems through interfaces. The application layer includes Ship Equipment Monitoring and Controlling System in B/S mode, and provides the human-computer interaction interface. The ship equipment system architecture design is shown in figure 3:

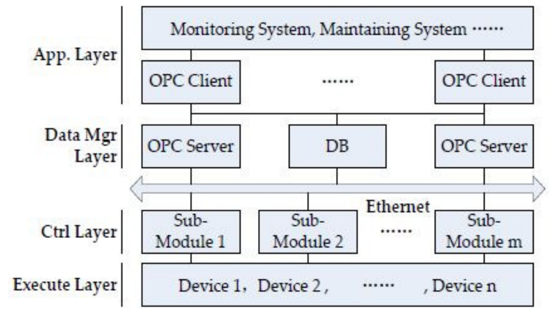

FIG. 3 SHIP EQUIPMENT SYSTEM ARCHITECTURE

IV. SHIP DATA INTERACTION DESIGN BASED ON OPC

OPC (OLE for Process Control) is wildly used in industry control systems. The drivers of OPC server set up a bridge between applications and field control system hardware, which plays a pivotal role in system data interaction. As the OPC specification launched, it used OLE/COM mechanism as application of the communication standard to unified data sources (OPC servers) and data users (OPC client integrated applications) between the software interfaces. OPC specification has advantages as follows: 1) TCP/IP protocol supported, so we can connects each subsystem as network nodes which had been physically separated; 2) remote call supported, so there is less concern about application and system hardware distribution in geographic, which makes systems been wildly used; 3) interface functions are specified, makes systems more open, and easy to realize the interaction with other systems; 4) it makes the system configuration more convenient, reduces the complexity of systems, helps to improve the reliability and stability of software operation etc..

Ship equipment system integrates Multi-subsystems and Multi-information layers, which make itself complex. To separate subsystem data processing from application layer, and simplify the system structure, we developed a system data interaction core module by using OPC specification. OPC Servers/Clients are used to accomplish interaction between control layer and application layer, which calls us to map the device controller I/O variables to the OPC server objects and use integrated OPC clients in application layers. To well support different kinds of transport protocol standards in ship equipment system, we designed OPC servers correspondingly. In the Web application, we integrated OPC clients, developed Web application internal data processing module and data protocol, established internal data pool to make interaction between Web application and OPC server works. Interaction between application layer and data management is designed is shown in figure 4:

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 3, Issue 5, May 2017

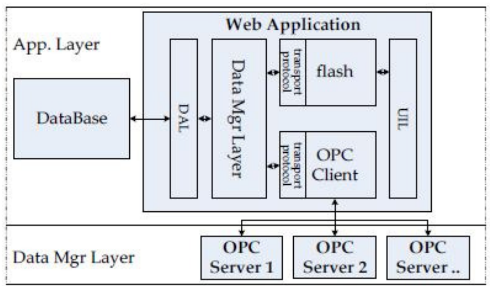

FIG. 4 INTERACTION BETWEEN THE APPLICATION LAYER AND THE DATA MANAGEMENT LAYER

V. Ship Equipment Monitoring And Control System Design

Ship Equipment Monitoring and Controlling System is designed in B/S mode and based on ASP .Net Framework, the main principle is: gathering data in control layer into the OPC server through industry Ethernet, combined with the Data Persistence Technology to put Data Base and data transfer station in this layer, integrated OPC clients to the Web application to fulfil data interaction between remote client and control layer. Ship Equipment Monitoring and Controlling System include modules as follows: parameter display, equipment control, trend display, alarm prompt, fault tracing and other modules. The functions of each module are list as follows:

- Parameter Display: equipment operation parameter interfaces, real-time refresh of operation parameters of corresponding ship equipment, checking ship equipment operate state on Web site.
- Equipment Control: adjusts ship equipment operate parameters through Web browser, which improves the efficiency of equipment operation.
- Trend Display: history and real-time data can be checked out from persistent data management server in data management layer and be displayed in curve to show the dynamic trend.
- Alarm Prompt: scans equipment alarm symbol of corresponding parameters in Real-time, displays alarm list according to users alarm level classification.
- Fault Tracing: queries historical data of ship equipments, fault description, alarm information and processing result.
- Other Modules: provides User Authorization and Access Right management, which improves the confidentiality of Ship Equipment Monitoring and Controlling System and the safety of operation. It also provides reports, database management.

Ship Equipment Monitoring and Controlling System is developed in accordance with the MVC architecture, it can be released to either ship within network or WAN through Web Application Server. There is restriction such as real-time monitoring, controlling and alarm prompt when been accessed from WAN while there is no restriction when been accessed from ship within network. Ship Equipment Monitoring and Controlling System Testing Platform are shown in figure 5:

Fig. 5 Ship Equipment Monitoring and Control System Testing Platform

VI. Conclusion

This design is mainly aims at reducing the difficulty of ship system network integration by using Network level isomorphism. To improve the ship equipment reliability and robustness of the system operation, we developed decentralized, scalable equipment control group. The integrated monitoring and controlling system is developed to improve ship equipment operation and management efficiency, and to save costs on ocean operating. This system has characteristics of decentralization, simple and short cycle on development. It also has characteristics of operating with high efficiency and low cost, which is already applied in Guangzhou Wenchong Shipyard Co., Ltd and achieved expected.

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE)
Vol. 3, Issue 5, May 2017

REFERENCES

[1] Jin Zhu, Xiumei Zhang, Wei Kang. Application of OPC Technology in Supervisory System of Marine Electrical Propulsion[C]//2011 Third Pacific-Asia Conference on Circuits, Communications and System (PACCS), Wuhang, China, 17-18 July 2011. Piscataway, NJ, USA: IEEE, 2011: 3 pp

[2] Jundong Zhang, Huiji Yan, Jianxiang Yu. Design of Ship Monitoring and Control System Based on CAN. Measurement & Control Technology, 2003, 10:24-27

[3] Kangjian Ren. Design and Realization of Multi-bus Gateway for Integrated Bridge System. Harbin: Harbin Engineering University, 2013.

[4] Paik BuGeun, Cho SeongRak, Park BeomJin, et al. Development of real-time monitoring system using wired and wireless networks in a full-scale ship. International Journal of Naval Architecture and Ocean Engineering, 2010, 2: 132-138

[5] Qing Liu, Cheng Xing, Jianming Guo. Distributing and Heterogeneous Network Control Systems Integration Based on Ethernet and OPC Technology. Journal of Hunan University of Technology. 2007, 06: 47-51

[6] Rong Sun, Li Su, Shuping Lv, et al. The Design and Research of PROFINET Control System. Research and Exploration in Laboratory. 2014,04:103-107.

[7] Xun Zhang, Hailong Ye. Ship data communication system based on CAN bus. Mechanical & Electrical Engineering Magazine, 2010, 27:89-92

[8] Xianfeng Liu, Hongliang Liu. Architecture Design of Ship Monitoring and Control System Based on OPC SERVER. Ship Engineering. 2013,S2:122-124.

[9] Ying Xiong, Jian Xu, Liqiang Luo, et al. Application of OPC Technology in Ship's Integrated Platform Management System. Chinese Journal of Ship Research. 2009, 6:58-61+65

AUTHORS BIOGRAPHY

Bharath was born in 1995. He is currently a UG Scholar in PSN college of Engineering and Technology Tirunelveli, in the Department of Marine Engineering. His research interests include Based on Integrated Ship Equipment Monitoring and Controlling System Based on Ethernet.

Jeya Sutharson S was born in 1995. He is currently a UG Scholar in PSN college of Engineering and Technology Tirunelveli, in the Department of Marine Engineering. His research interests include Based on Integrated Ship Equipment Monitoring and Controlling System Based on Ethernet .

Kannadasan S was born in 1995. He is currently a UG Scholar in PSN college of Engineering and Technology Tirunelveli, in the Department of Marine Engineering. His research interests include Based on Integrated Ship Equipment Monitoring and Controlling System Based on Ethernet .

Vignesh Kumar S was born in 1996. He is currently a UG Scholar in PSN college of Engineering and Technology Tirunelveli, in the Department of Marine Engineering. His research interests include Based on Integrated Ship Equipment Monitoring and Controlling System Based on Ethernet .

Kathiravan G was born in 1994. He is currently a UG Scholar in PSN college of Engineering and Technology Tirunelveli, in the Department of Marine Engineering. His research interests include Based on Integrated Ship Equipment Monitoring and Controlling System Based on Ethernet .

