Design of Ship Information Transmission for Remote Fault Diagnosis

Bin Zeng, Lu Yao and Jin Zhang
Department of Management Engineering and Equipment Economics, Naval University of Engineering, 717 JieFang St., Wuhan, Hubei, China.
Email: zbtrueice@163.com

Abstract. It is important for an intelligent ship to collect the fault information and transmit them to the maintenance department or engineers onshore. Based on the advantages of Internet and related supporting technologies, a data management platform is proposed by utilizing the Internet and other technologies in transmission of fault detection information between ships and shores. Three components of the platform structure are presented in detail for different application scenarios including data transmission within shipyard, outside of shipyard and on the move. In the platform, commercial facilities are taken as examples, and issues of the structure performance are also discussed. The design of ship remote diagnosis platform can provide a reliable and stable application basis for the development of intelligent ship.

1. Introduction
As the booming of Internet, most people in developed or developing countries have access to Internet either at office or at home. It is the major and the most effective tool for information transmission nowadays. In addition, Web Browser type interface (for example, Internet Explorer or Firefox) are predicted to be the only interface between computers and human beings, and Internet Protocol will also be the major communication protocol for transmitting voice and digital data. Therefore, information will be loaded into the Internet, and it is used as the only means for transmission. With regard to ship information, it is thus predictable that the Internet transmission is the future trend [1]. This paper presents a corresponding mechanism on the basis of current Internet technologies.

In the following sections, Section 2 presents an overview of a mechanism composing three components. The first component is the ship’ data transmission within the shipyard, which is described in details in Section 3. Section 4 discusses the second component, at a fixed location outside shipyard. The last component is in the mobile condition, and is presented in Section 5. Section 6 discusses the challenging issues for the mechanism, and the conclusion is made in the Section 7.

2. Structure of the Mechanism
Figure 1 is the structure of the proposed mechanism of transmitting of ship diagnosis information. The mechanism composes of three components enclosed by the dot lines, and the connections between components are Internet. The detailed discussions of each components are presented in Section 3–4.

The arrows connecting each block in figure 1 indicate the flow direction of ships’ data. The component, “Inside shipyard”, is for ship maintenance specialists or ships within the shipyard or in the area of maintenance facilities. Moreover, if they are on a remote site which is a fixed location. They can access the Internet through access optical fiber or ADSL, and this condition is referred to the component of “fixed pier” in figure 1. The last component is as ships or specialists are on the move.
For example, when the ships equipped with Inmarsat equipment or automatic identification system are in a navigation. Besides, thanks to the popularity of wireless or personal communication system, such as 4G Network for Mobile Communication in China, the service of wireless data transmission is available in inland lakes.

The proposed mechanism is designed to make the flow of ship data bi-directional. This means that through the Internet, the ships’ information can be delivered to the Data Server in the shipyard from any components. By the same means, the specialist can access current ships’ data anywhere in the world, at his/her home through fixed network, or in a vehicle through 4G network.

3. Data Transmission within the Shipyard
A detailed structure of the data transmission within the shipyard is shown in figure 2.

The Ship Monitor (or ship data source in figure 1) collects ship’s information, such as its noise detection images of the diesel engine (NDI), vibration frequency, or line pressure. Several ship monitors are connected to the collection center, where stores all ships’ data. The database server
accesses the ships’ data through an interface with the collection center. The ship’s data in diagnosis network is accessed by the database server through an Interface board installed inside the server. In addition to storing ships’ data, the database server also serves as a Web server to deliver ships’ data through Intranet to specialists within the shipyard or through Internet to specialists on remote sites or in vehicles as long as they have access to the Internet.

A Ship Monitor Center (SMC) in the mechanism can monitor all ships’ status. With comprehensive ship’s data, the monitor center can provide an active and instant monitoring service instead of waiting for an alarm in a passive manner. The SMC also provides a centralized and professional monitoring service for all ships within the shipyard.

4. Data Transmission for Fixed Location outside Shipyard

![Figure 3. Component outside shipyard with a fixed location.](image)

In the proposed mechanism, even specialists or ships on a remote site, they still can access the Internet through fixed network such as access optical fiber or ADSL. The specialist can view the ship’s data or the ship can deliver his/her data to the Data server in the shipyard through the Internet. An example of a fixed ship monitor shown in figure 3 is composed of a Ship Monitor and a Personal Computer [2]. The PC is connected to Ship Monitor via RS232. The program in PC accessing ships’ data is developed by C language with the aid of Ship Monitor’s software development kit. Being connected to Internet through access network, the fixed Ship Monitor can deliver ships’ data to data server in the shipyard.

This component can alleviate the shipyard crowded space by discharging the ship who can stay pier but needs to be monitored regularly. In addition, it can collect more fault judgement or assessment from specialists outside the shipyard by sending the ship’s data to them and then collect their opinions.

5. Data Transmission for Mobile Condition

![Figure 4. Mobile condition of proposed mechanism in transmission of ships’ data.](image)
The idea of transmission ship information through a wireless network can be found in [3] back to 2002, when MacGregor developed a remote monitoring system (CC2000) for cranes on general cargo ships. However, the remote monitoring system mainly transmits text data through a conventional alphanumeric paging system. In recent years, the launch of the digital wireless network, such as 4G network makes the transmission of digital data available for a mobile user. With the development of General Packet Radio Service in delivering Internet Protocol (IP) based Packets through 4G network, the idea of transmitting comprehensive ship information through a wireless network becomes more practical and feasible [4]. Therefore, the author includes the component of the Mobile condition in the proposed mechanism. Figure 4 shows a detailed structure of component of the mobile condition.

The transmission routes in the component of mobile condition are so-called “wireless Internet” and “mobile Internet”. The wireless Internet refers to that specialists or ships utilize the wireless network to transmit data through a mobile phone. Here the mobile phone plays a role similar to a modem, by which PC accesses the Internet through fixed network. The configurations of portable ship monitor are similar to the fixed ship monitor in figure 3.

For the case of the mobile Internet, the User agent (web browser) in WAP handset accesses the Internet through WAP gateway, and displayed web pages written in Wireless Markup Language (WML) instead of general ones like Hypertext Markup Language (HTML). As shown in figure 4, the mobile Internet is used for specialists to receive simplified ships’ data on the current stage due to the limited screen, CPU, and the memory of mobile phone.

The major benefit of this mobile component in the proposed mechanism is when the ship’s is in a navigation; its urgent data can be delivered to specialists through the mobile or wireless Internet. According to the received data, specialists can monitor ship’s status and instruct the emergency crew to give ship’s adequate treatment before their arrival of shipyard.

6. Challenging Issues in the Mechanism
Since the majority of technologies implemented in the proposed mechanism are well developed except the Mobile and wireless Internet mentioned in Section 5. In this section, the discussion will focus on issues of displaying and transmission of voluminous ship graph data, NDI, in the Mobile and wireless Internet.

One of the difficult in mobile Internet is displaying the ship vibration graph image [5]. Especially as NDI needs to be displayed on the limited screen of WAP handset.

The standard NDI wave has 10 bits resolution, quantity range of 1024. The WBMP in old WAP handset has only quality range of 35, and it can only afford around 1/30 resolution of NDI wave. Higher resolution can be achieved by Personal Digital Assistant (PDA) or newer mobile phone with larger display screen. However, instead of enlarging the display screen, another means is to display part of NDI, which is sufficient for specialists to make relevant clinic judgement. For example, in figure 5, a specific syndrome only shows abnormal curves in the base band in NDI. Therefore, only the graph in base band needs to be sent to the specialists who view it with WAP handset’s limited screen.

![Figure 5. Vibration noise detection graph](image)

In addition to the issues of displaying graph image, the transmission rate of data is another factor affecting the quality of proposed mechanism, especially in the mobile component. For an NDI with 12 cycles, if the sampling rate and resolution are 500Hz and 10bits for each lead, it needs the
transmission rate of 60 Kbps to deliver the comprehensive NDI wave. In GSM network, the transmission rate is 9.6Kbps for Circuit Switched Data, and up to 115.2 Kbps for GPRS with 8 channels available for transmission. Therefore, the transmission of NDI wave is affordable to GPRS only in GSM network.

In addition to utilizing system with higher transmission rate, the strategies for solving the above problems involve data compression, syntactic pattern recognition [6], and intelligent detection and processing at the sending point of transmission system. For example, in syntactic pattern recognition, the NDI wave patterns are identified and classified as several classes marked by character symbols. Instead of storing the graphic data, the character symbols representing certain NDI waves are stored and delivered. A more sophisticated system is the computerized NDI system [7], which recognizes the NDI waveforms, extracts contours for interpretations or comparative analyses, and reports the ship statement.

7. Conclusion
A mechanism implementing Internet as a backbone in transmitting ships’ data is proposed. It includes three major components, within a shipyard, on a remote site with fixed location, and in a mobile condition. The coverage area of proposed mechanism equals to the coverage area of Internet, which includes the wireless Internet and the mobile Internet. In regard to the data transmission in the proposed mechanism, two challenging issues in transmission rate and display screen of voluminous graph data are discussed, and they are believed to be overcome by the future technologies.

8. References
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