Analysis of Delivery Performance of Maritime Cloud Messaging Server in Network without Alternate Route

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Abstract: The International Maritime Organization has defined e-Navigation for the purpose of providing safe and efficient maritime information and communication services. A maritime cloud is being developed as a network framework for e-navigation. The maritime cloud provides seamless information transfer service by using available network resources between heterogeneous communication links. In this paper, we analyze the message delivery performance of maritime cloud messaging server through simulation in a network environment without alternative route.

Key-Words: e-Navigation, Maritime cloud, Messaging server, Alternative route, Simulation, Link failure

1 Introduction

The International Maritime Organization (IMO) has defined e-Navigation for the purpose of providing safe and efficient maritime information and communication services. E-navigation is defined as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment."[1]

In order to provide e-Navigation service safely and efficiently, a communication infrastructure that can be effectively operated in a special environment of the ocean is needed. A developer forum called the Maritime Cloud Development Forum (MCDF) has proposed a maritime cloud as a secure and efficient communication infrastructure for e-Navigation services[2].

As a core service, the maritime cloud provides a maritime user identification and management service, a maritime user authentication service, a secure data delivery service, e-navigation service search and management service, a geocast service, and a seamless roaming service. In the maritime cloud, three servers, such as a Maritime Identity Registry (MIR), a Maritime Service Registry (MSR), and a Maritime Messaging Server (MMS), are defined to provide the above services[2-5].

In this paper, we focus on MMS server. The MMS server can provide seamless information transfer service using available network resources between heterogeneous communication links. Because the MMS server can use an alternate route in the event of a network failure, its network performance is very high without a doubt.

However, in a communication environment without an alternative route how the MMS server affects overall network performance is an issue. In this paper, we aim to analyze the message delivery performance of MMS through simulation in a network environment without alternative path.

The composition of this paper is as follows. In section 2, maritime cloud is introduced. In section 3, we analyze two communication methods, namely, Point to Point (P2P) and MMS communication methods. In Section 4, we compare and analyze P2P and MMS communication methods through simulation in network environment without alternative path. Finally, we conclude in section 5.

2 Overview of maritime cloud

A maritime cloud has been proposed as a secure and efficient network framework for e-navigation. As a core service, the maritime cloud provides a maritime user identification and management service, a maritime user authentication service, a secure data delivery service, an e-navigation service search and management service, a geocast service, and a seamless roaming service.

First, the Maritime ID identification and management service is a function of identifying, registering and managing objects existing in the marine cloud. The maritime user authentication service is a security function to protect illegal access to maritime cloud. The secure data delivery service aims to guarantee confidentiality and integrity of data transmitted through maritime cloud. The e-Navigation service search and management service enables users to use and register e-navigation service easily. The geocast indicates location-based broadcasting service. Finally, the seamless roaming service refers to the provision of seamless information transfer function using available network resources between heterogeneous communication links.

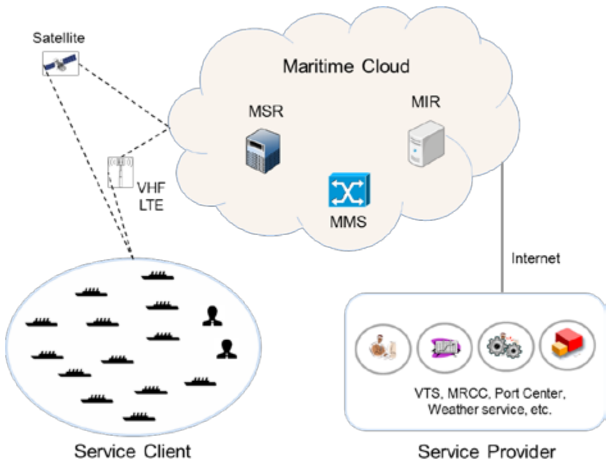

Fig. 1 the conceptual architecture

Fig. 1 shows the conceptual architecture of a maritime cloud. In the maritime cloud, three servers, such as a Maritime Identity Registry (MIR), a Maritime Service Registry (MSR), and a Maritime Messaging Server (MMS), are defined to provide the above services.

First, the MIR server manages the ID information of all the communication objects on the maritime cloud. Such ID information managed by MIR includes information such as a communication object ID, contact information (e.g., VHF channel number, e-mail address, and etc.), and digital certificate. The MSR server manages service specifications necessary to access the e-navigation service. The service specifications includes information about service contents, service interfaces, and service access methods. Finally, the MMS server provides the seamless roaming service and the geocast service. For this purpose, the MMS server has a message queue management function and a protocol-level acknowledgment function, and a location information collection function of communication objects.

3 Communication methods

As communication methods between the service client and the service provider in the maritime cloud, there are two methods, a point-to-point (P2P) and a MMS communication. The P2P communication method is one in which a service client and a service provider communicate directly with each other without an MMS server. The MMS communication method is a method by which a service client uses MMS server when communicating with a service provider

3.1 Point-to-point (P2P) communication

The P2P communication method is shown in Fig. 2. First, the service client connects with the MSR server and requests information about the desired service (e.g., weather service). The MSR server connects to the MIR server to authenticate the service client. If the authentication of the service client is successful, the MSR server returns information about the requested service (e.g., the server address and the method for accessing the server) to it. The service client connects to the service provider using the service information received from the MSR server and sends a service request message. The service provider connects the MIR server to authenticate the service client. If the authentication of the service client is successful, the service provider returns the requested service to it.

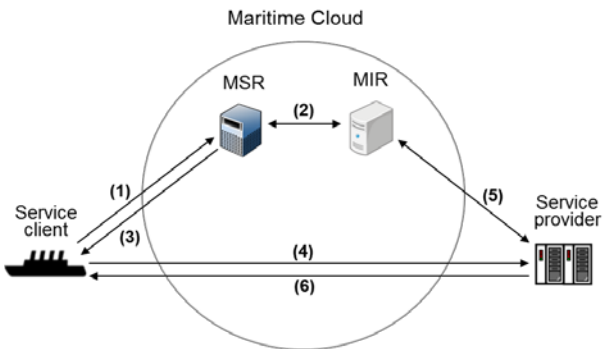

Fig. 2 P2P communication scenario

3.2 MMS communication

The MMS communication method is shown in Fig. 3. First, the service client connects with the MSR server and requests information about the desired service. The MSR server connects to the MIR server to authenticate the service client. If the authentication of the service client is successful, the MSR server returns information about the requested service to it.

Then, the service client connects to the MMS server and send a request for a service provided by the service provider. The MMS server connects to the MIR server to authenticate the service client. If the authentication of the service client is successful, the MMS server forwards the request of the service client to the service provider. The service provider connects the MIR server to authenticate the service client. If the authentication of the service client is successful, the service provider returns the requested service to the MMS server. The MMS forwards the service result received from the service provider to the service client.

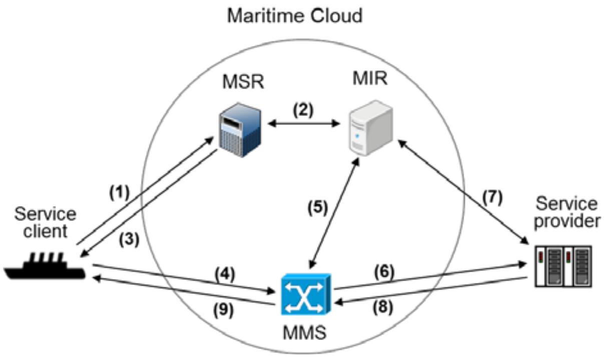

Fig. 3 MMS communication scenario

4 Analysis of MMS performance

In a maritime cloud, MMS servers support heterogeneous network communications, such as satellite networks or wireless networks, enabling communications to effectively respond to network failures. For example, if the wireless network is broken between the service client and the service provider, the satellite network can be used as an alternative network. Therefore, we can intuitively know that using MMS server can improve safety and efficiency of communication netork.

However, when the network between the service client and the MMS server is in a stable state, or has no alternative communication link, how the MMS server affects the overall network performance is an issue. In this paper, we analyze the communication performance of MMS server through simulation. As an network simulator for this, we used NS3 simulator[6].

4.1 Simulation environment

Fig. 4 shows a simulated newtork for marine cloud. There are six network nodes. Three are routers, and the rest are service clients, MMS servers, and service providers. In the simulated network, all network links have a bandwidth of 10Mbps and a delay of 25ms. In this paper, we simulated P2P and MMS communication methods.

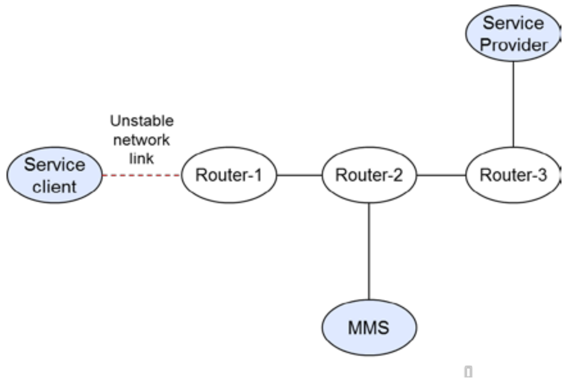

Fig. 4 Simulated network

In case of P2P communication method, the service client transmits a service request message directly to the service provider. In case of MMS communication method, the service client sends a service request message to the MMS server to request a service with the service provider. The MMS server forwards the received service request message to the service provider. If the MMS server receives a service result from the service provider, the MMS serer forwards it to to the service client.

4.2 Simulation results

Fig. 5 shows the simulation results of when the network between the service client and the MMS server is stable. In the Fig. 5, the orange line with rectangle indicates the communication performance of P2P method and the blue line with circle indicates the communication performance of MMS method. The X axis is the time and the Y axis is the number of service messages received by the service client. The total number of service request messages sent by the service client for 99 seconds was 1,981. Both P2P method and MMS method delivered all the messages without any message loss.

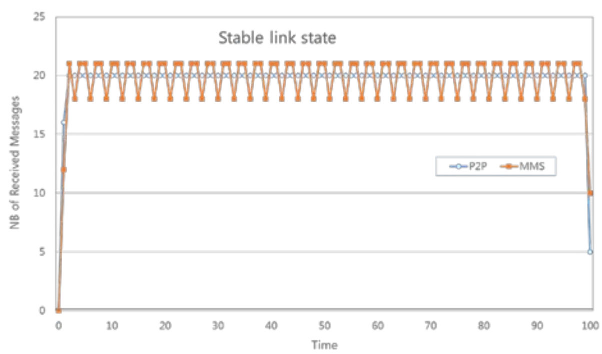

Fig. 5 Simulation results under stable newtork state

As shown in Fig. 5, although the MMS communication method has some fluctuation, overall there is no significant difference in communication performance between MMS and P2P communication methods.

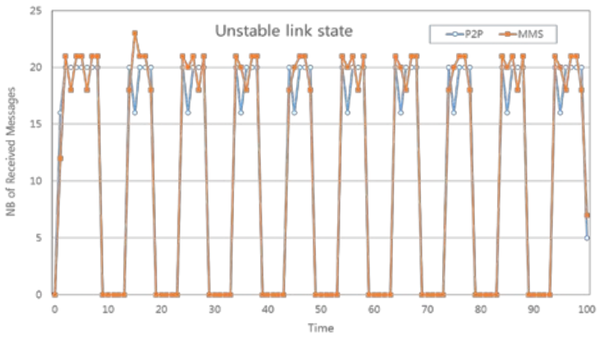

Fig. 6 Simulation results under unstable newtork

Fig. 6 shows the simulation results of when the network between the service client and the MMS server is unstable due to link failure. As shown in Fig. 6, MMS server method is better than P2P method in case of unstable network between service client and MMS server even though it is not big difference. In this simulation, the P2P method has delivered 1,045 of 1,981 service request messages sent by the service client. The MMS method has delivered 1,081 out of 1,981 service request messages. Therefore, the MMS server method is superior to P2P by about 1.8% ((1,081-1,045) * 100/1,981). The reason why the MMS communication method is better than the P2P is that the MMS provides the message queue storing the messages that cannot be transmitted to the service client due to the link failure.

5 Conclusion

The maritime cloud is being developed as a secure and efficient communication framework for e-Navigation defined by IMO.

In this paper, we have analyzed the performance of maritime cloud messaging server through simulation in a network environment without alternative route. Simulation results show that P2P and MMS communication methods are almost the same in network performance when the network between service client and MMS server is stable. However, in the unstable network between the service client and the MMS server, the MMS communication method is better than the P2P in the network performance, though not a big difference.

Our Future research is to analyze the performance of maritime cloud in various communication environments.

Acknowledgement

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