Dynamic Reconfigurable Integrated Management and Monitoring System for Naval Ship Combat Management System

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Abstract. In the existing naval combat system, management work is done independently on subsystems that make up the whole system. Since, however, the naval combat system is a large-scale distributed system made up of subsystems on the diverse heterogeneous environments, it is extremely difficult to integrate and manage as a single entity all subsystems. Therefore a new method is required to manage effectively all subsystems. The new method should consider characteristics such as the heterogeneous environments, distributed systems, dynamic changes to the system configuration, and so on. In this paper, the architecture of an integrated management system is designed and implemented. The system provides various services to control and monitor each of subsystems. Furthermore, the system has capabilities that can construct the configuration of the system dynamically.

1 Introduction

The naval combat system is an automated combat system with integrated command and armament features, designed to provide optimal combat capabilities. The naval combat system is made up of various subsystems, each of which is responsible for performing different functions, including detection, control, and combat. The overall functionality of the system is given by the combination of the functionalities of these subsystems [1]. However, subsystems of the naval combat system may be independently developed by different companies. In this case, management of these subsystems has to be dependent on the particular implementation. Therefore, each subsystem had to have its own management system, different from the rest. For a single environment system, it would be easy to integrate the subsystems or manage them in an integrated way. It is, however, not easy to do so for the naval combat system, as it is made up of heterogeneous subsystems. Therefore, a method is needed to effectively maintain and manage data generated in subsystems of the naval combat system (made up of heterogeneous systems in a distributed environment) under a single integrated management system. In this paper, architecture of the integrated management and monitoring system is defined using information models and a layered way. The sys-

tern provides various services to the user to control and monitor each of subsystems. Furthermore, the system has capabilities that can accept dynamic changes to the configuration of the naval combat system.

2 Related Work

Research on a system that manages all subsystems of a naval combat system in an integrated way has just recently got underway. Past management systems for a naval combat system managed each of subsystems independently. They could not show all subsystems in a single integrated way [2].

The paper [3] proposes a monitoring method for P2P-based distributed systems. In this paper, monitoring is done in the following way: a system called P2PMonitor is implemented and a module called Alerters is added to each subsystem so that the generated events are delivered to P2PMonitor. Note that in this paper, monitoring is done only on P2P applications that actually exist in the host. As the size of the system gets bigger and as the number of applications that need to be managed in a single host increase, Alerter needs to be extended. Moreover, there isn't a method proposed for management or monitoring in the case that applications are added in heterogeneous environments other than the P2P system. The paper [4] proposes an integration method and a control mechanism for heterogeneous distributed systems. In the paper, policies for assembling various heterogeneous distributed systems are proposed, as well as a control delivery method called Law-Governed Interaction.

Although the paper [4] focuses on system integration, our paper places the focus on both system integration and management. To this end, integrated management based on information models is performed.

3 Necessity of Integrated Management System for Naval Combat System

Combat systems installed on ships are huge and assembled on a variety of computing platforms. Research on management techniques and system monitoring for deploying and controlling countless applications to be used in a combat system, made up of hundreds to thousands of pieces of equipment, is still in early stages. In this paper an integrated management system based on information models is developed. The use of information models allows collection and maintenance of data from diverse subsystems that make up the naval combat system. Furthermore, the data are combined via services of various types.

4 Information Model

The integrated management system for the naval combat system proposed in this paper performs controlling and monitoring based on information models, which ex-

tract only the independently needed data regardless of the hardware platform or the type of software.

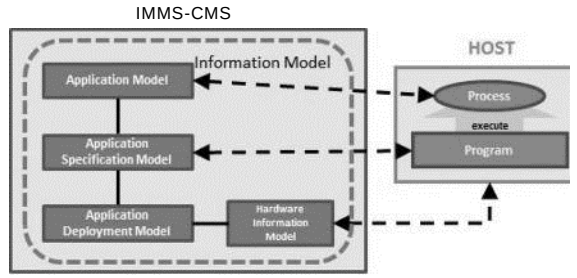

Fig. 1. Mapping between the Information Model and the Actual System

Fig. 1 shows the mapping between the information model and the system hardware and the running software being managed. Information models of the integrated management system are made up of the following: Application Model, which contains information of the actually running process; Application Specification Model, which contains information of applications that are not running; Hardware Information Model, which contains hardware information; and Application Deployment Model, which contains deployment information about on which hardware the application is running. Based on these pieces of information, information on the entire hardware and software running on the naval combat system can be maintained and managed.

5 IMMS-CMS

As the purpose of the integrated management system for the naval combat system implemented in this paper is the management and monitoring of subsystems that make up the naval combat system, it is called IMMS-CMS (Integrated Management and Monitoring System for Combat Management System).

5.1 IMMS-CMS System Architecture

In this chapter, the architecture for the implementation of IMMS-CMS is proposed (see Fig. 2). The architecture was designed in a way suitable for managing multiple systems that exist in diverse distributed environments under a single system. To this end IMMS-CMS is made up of different layers, each responsible for a specific kind of task. In addition, various services were made that use information models, so that services can be provided to the user in an effective way. The client layer is where various services are provided to the user from the IMMS-CMS. In the service layer, various pieces of information about diverse software and hardware are provided to the user in the form of services. In the management layer, software and hardware systems managed by the IMMS-CMS are managed in a substantial way. The information model layer maintains information of hardware and software systems managed by the

IMMS-CMS. This layer is realized by the information model stated in Section 4. The communication layer provides communication functions with the host computer being managed. Using various communication methods according to the type of the interface of the communication layer, control and monitoring data are exchanged between the IMMS-CMS and the host.

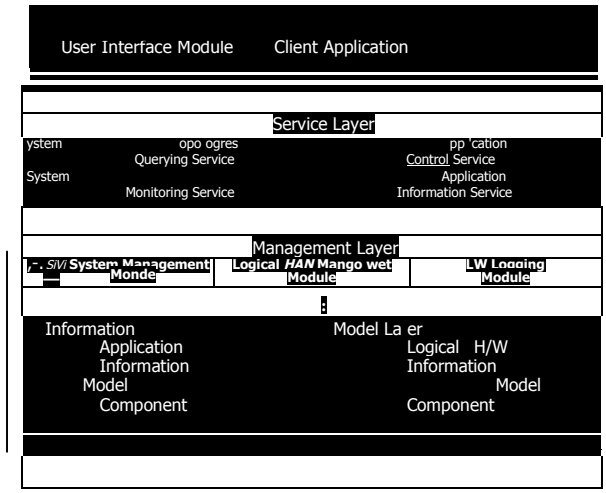

Fig. 2. IMMS-CMS System Architecture

5.2 Information Model Construction Scenario for IMMS-CMS

The IMMS-CMS builds the information model using the hardware specification and the application specification received from the host computers. Those specifications can be changed due to the situation of the participating hardware and/or applications. When receiving the specifications from the hosts, the configuration manager creates/deletes/updates some classes related to the specifications and adjusts the relationships between the changed classes and the affected classes in the information model dynamically. Construction method of the information model is as follow:

1-3: When the host starts, it sends a discovery message to IMMS because it wants to register itself and applications deployed on itself. Once it receives the response message from IMMS, it sends the hardware specification and the application specification to IMMS.

4: At first, the IMMS builds the entire information model according to the received specification. The next time, however, it creates, deletes, or updates some parts in the information model and incorporates those changes into the model.

5-7: The IMMS generates some classes which keep the static information and the dynamic information about the host. If those classes are created successfully, these changes should be reflected to the user interface, too.

8-13: The sequences show the construction processes of the information model for applications deployed on the host.

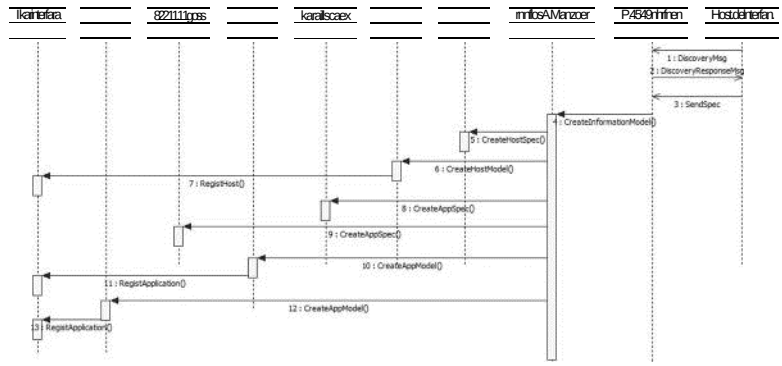

Fig. 3. Sequence Diagram for Constructing Information Model

6 Conclusions

As the size of the naval combat system gets bigger and as a number of subsystems are installed, it is increasingly becoming more important to manage each of the subsystems in an integrated way. Such a large-scale naval combat system is not made up of a single system but rather of various heterogeneous subsystems. Therefore, a standardized integrated management system is needed to effectively manage them. In this paper, an integrated management system for the naval combat system is implemented, called IMMS-CMS, which uses information models for hardware and software being managed in the naval combat system. As the information models are managed in a way independent of the actual system, they are not affected by heterogeneous environments and an integrated management can be done for all subsystems in the naval combat system.

Acknowledgement

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