Research on efficient operation technology of ship general performance prediction app in complex environment

Weidong Qian[1], Yuan Xu[1], ZhiFeng Tian[1],Da Lin[1],GanJiang Sun[2]
[1]China Ship Scientific Research Center
[2] CSSC Orient Wuxi Software Technology Co., Ltd
Wuxi, China
e-mail: qianwd@cssrc.com.cn

Abstract: Aiming at the problems of real-time data transmission and system scheduling in complex environments such as ship general performances prediction app, operation system, software and hardware environment, operation time and task priority, this paper analyzes the operation status of heterogeneous app at home and abroad, and discusses in detail the key technologies of multi-threaded asynchronous execution and intelligent decision scheduling of heterogeneous app, so as to ensure the reliable, real-time and efficient operation of heterogeneous app, so as to significantly reduce the design cycle, Improving the operation efficiency of the ship general performances prediction app can effectively reduce the risk of subsequent physical tests.

Keywords- Ship general performances prediction; Real time data transmission; System dispatching; Multi thread asynchronous execution ; Intelligent decision scheduling

I. INTRODUCTION

Ship general performances [1-2] generally refers to the performance that plays a decisive role in the overall indicators of ships. A consensus has been formed in the industry that the core and basic connotation of the performance of three disciplines are hydrodynamics, structural safety and vibration and noise control[3]. With the rapid improvement of computer performance, the ship general performances prediction software based on physical laws and centered on computational science is highly integrated into the research and design of ships, and these performance prediction software has begun to be gradually app oriented[4]. The corresponding app software has been combed and formed around the performance of the three disciplines, and its operation involves calling a large number of self-developed solvers and commercial software, such as Abaqus, Ansys, Fluent, Starccm, etc., which is characterized by a large number, long computing time, and large resource consumption. How to better plan the relevant computing resources and schedule the operation of many heterogeneous apps has become a crucial problem.

At present, with the development of related software technology, data storage capacity and computing scheduling capacity have reached a new height[5]. Yunfeng Zhang designed a set of distributed real-time computing framework based on computing topology strategy, which not only has the characteristics and advantages of general distributed real-time computing framework, but also can flexibly build a computing environment according to user computing topology[6]; Zhihui Wang combines edge computing with intelligent manufacturing, and faces the manufacturing computing tasks located at the processing end of the edge platform. According to the urgency, importance and complexity of the manufacturing computing tasks, he establishes a manufacturing task scheduling model to ensure that the computing tasks obtain sufficient computing resources[7]; Xiande Zhu proposed the data center storage pool resource and resource scheduling strategy, heterogeneous resource management method, which provides support for the scheduling management of the data center[8]. This paper proposes an efficient operation environment for the ship general performance prediction appss in a complex environment. Through the research on the efficient operation technology of the ship general performance prediction apps and the related underlying architecture design, we can ensure that heterogeneous appss can operate reliably, in real time and efficiently.

II. DISTRIBUTED ARCHITECTURE IN COMPLEX ENVIRONMENT

The overall architecture design of the distributed system for the efficient operation of the app for predicting the general performance of ships in complex environments is shown in the figure below.

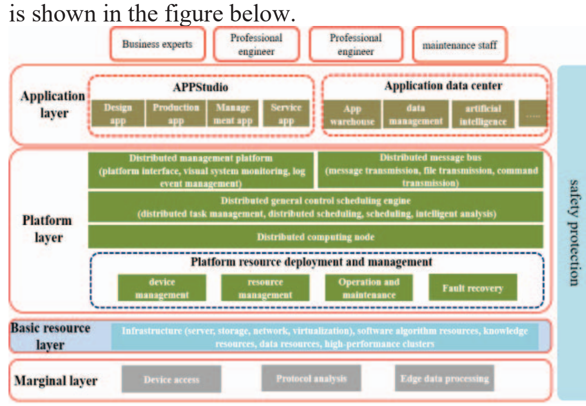

Figure 1 Distributed overall architecture diagram

The system is divided into three levels: application layer, platform layer and basic equipment layer. All levels are separated from each other and organically linked. The bottom layer acts as the support of the upper layer, and the upper layer invokes the services provided by the bottom layer, forming a hierarchical and scalable software platform architecture.

(1) Basic resource layer: including various software resources, data resources, knowledge resources, hardware resources, high-performance clusters, etc. that the unit already has, to provide the necessary basic support for the construction and operation of the platform.

2473-3636/22/$31.00 ©2022 IEEE
DOI 10.1109/DCABES57229.2022.00059

(2) Platform layer: it is the core of a large-scale distributed system that supports the efficient operation and data aggregation of heterogeneous apps. It consists of platform resource deployment and management subsystem, distributed node subsystem, distributed general control engine subsystem, distributed message bus subsystem, distributed management platform subsystem, etc.

(3) Application layer: it includes the interface and interaction logic of external application system, and can interact with external basic system and Application Center data center.

III. DISTRIBUTED BASIC MANAGEMENT PLATFORM

The distributed management platform is used to manage and view distributed systems and provide interfaces for external integrated systems. Its main functions include visual system monitoring function, statistical analysis function, log event management function and the interface of external systems.

A. Visual resource monitoring

The visual resource monitoring module provides host status monitoring functions, including CPU utilization, graphics card utilization, memory utilization, video memory utilization, disk IO, network traffic, etc; Support one click login to the background windows and Linux server for management, login to the background windows and linux server for management; It supports IPMI management, monitoring indicator early warning, and can send early warning information by email.

B. Statistical analysis function

The statistical analysis function is used to make statistical analysis on the task operation, visual call and resource utilization of the distributed system, so that the distributed system managers and relevant personnel can troubleshoot the system, optimize the performance and maintain the system resources according to the historical situation.

C. Log event management

During the operation of the distributed system, its subsystems will produce a large number of operation logs, operation logs, maintenance logs, etc. the log event management module is used to manage all kinds of logs during the operation of the system, and can visually view the logs.

D. External system interface

Provide an external interface for the external system with standby authority to call, and the call form is to communicate and call through the distributed message bus.

At present, the external system interface has realized the connection with the basic system, application center and data center, with more than 30 interfaces, including system authentication, task initiation, task data submission, task data acquisition, task status feedback, task error reporting, operation log collection, app acquisition, app deployment, app information query and other interfaces.

The external system interface also supports the expansion functions of more external systems, and can be integrated with edge computing, digital twins, high-performance clusters, centralized monitoring, cloud servers, etc. as a part of large-scale distributed systems, so as to expand the functions of distributed systems.

IV. DESIGN OF EFFICIENT RUNNING ENVIRONMENT FOR MULTI-SOURCE HETEROGENEOUS APPS

A. Design of distributed message bus

The distributed message bus is the data exchange center between the modules. All kinds of control instructions issued by the computing resource scheduling module and all kinds of feedback messages of the simulation node interact through the message bus. Distributed message bus is the main channel for all nodes to exchange information, and provides support for transparent, convenient and safe data transmission between nodes. Functionally, the distributed message bus mainly includes communication management, message sending and receiving, and buffer management, as shown in the following figure:

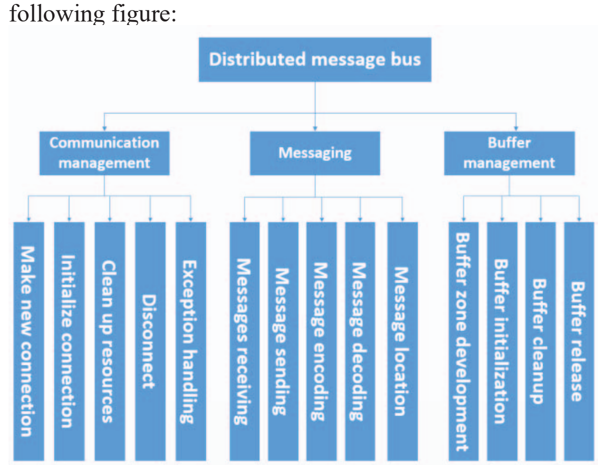

Figure 2 Functional structure of distributed message bus

As the transmission hub in the distributed simulation operation control system, the distributed message bus is responsible for handling the message interaction between various nodes. The data flow diagram between each sub module of data exchange soft bus is shown in the following figure:

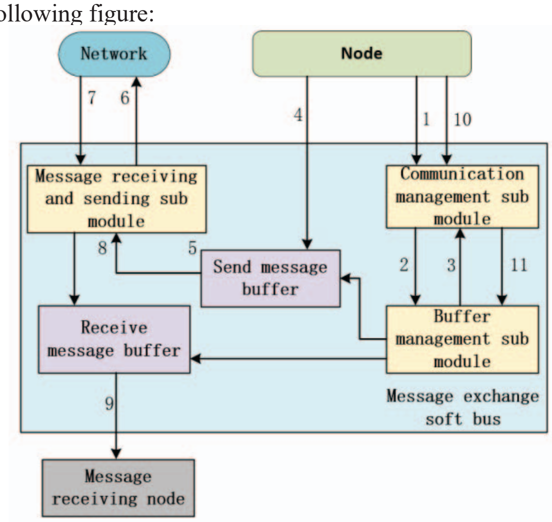

Figure 3 Data flow among sub modules of distributed message bus

B. Distributed general control scheduling and intelligent scheduling

Provide the distributed general control scheduling engine module, manage and schedule the tools, data, apps and application processes under different software and hardware environments, establish a complex heterogeneous app distributed operation environment, and automate the execution of apps and application processes in the whole distributed computing resources. At the same time, the engine provides external interfaces, which can realize the ability of mutual integration with external systems. The main contents of the distributed general control scheduling engine include: computing task scheduling module, distributed node control module, computing resource management module and log and error processing module.

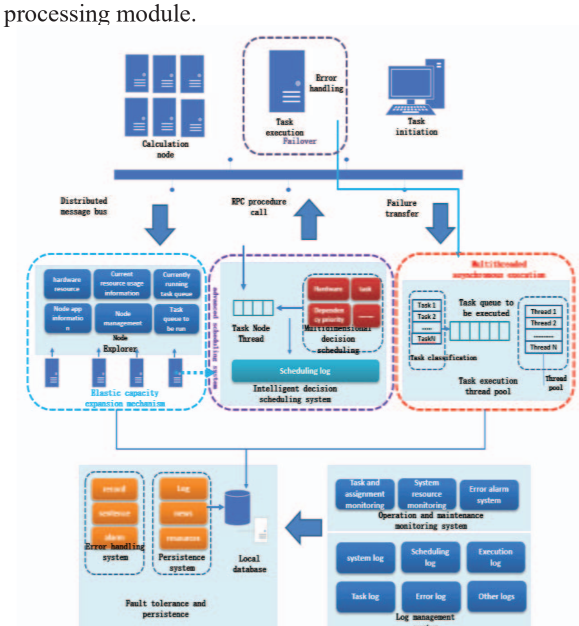

Figure 4 Distributed general control scheduling

In the intelligent decision scheduling system, the received execution tasks are identified, the current computing resources are obtained from the computing resource management module, multiple resources that meet the task are found, and the task information is read at the same time, including but not limited to the priority of the task, the resource occupation of the task, the dependency of the task, and the resource occupation, This kind of information is sent to the distributed scheduling system to schedule tasks.

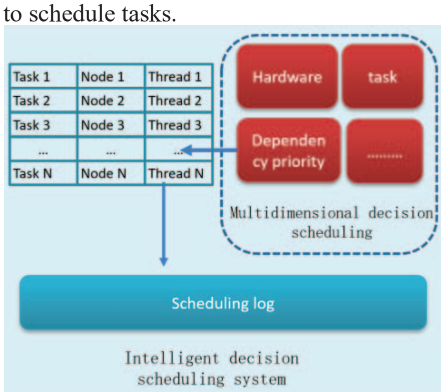

Figure 5 Intelligent decision scheduling system

C. Hardware resource scheduling design

The large-scale distributed system with efficient operation of heterogeneous apps and data aggregation has a large number of infrastructure, software algorithm resources, knowledge resources, data resources and high-performance clusters. The resource deployment and management module is used to deploy and manage these resources.

At the same time, it has resource management and scheduling software to support heterogeneous cluster environment. It supports common operating system platforms, such as Linux, windows and other versions, and multiple distribution product platforms; It supports dynamic expansion of servers and resources, and can adjust resources in real time according to users' needs.

Provide CPU scheduling function, which can bind user visualization tasks or computing tasks with the specified CPU core as needed to avoid mutual interference between tasks among users and resource occupation of single application over request.

```
$ jhosts attrib
HOST_NAME type  model  ncpus  maxmem  maxswp nsocket ncore
nthread RESOURCES
host2     LINUX64  x86_64  4    1824M    2048M  2     2
1  -
```

Figure 6 CPU resource scheduling

It provides the function of dynamic security settings of tasks. The security settings of nodes related to task calculation are only effective for the task during its operation. To enhance the security of the system.

V. CONCLUSION

Research on the efficient operation technology of ship general performance prediction app in complex environment, which is designed from three aspects: distributed architecture, distributed basic management platform and multi-source heterogeneous app efficient operation environment in complex environment, and focuses on the methods of distributed message bus, distributed general control scheduling, intelligent scheduling, hardware resource scheduling and so on. By developing the operation environment, the scheduling and hardware resource planning of many ship general performance analysis apps are effectively solved, and the reliable, real-time and efficient operation of heterogeneous apps is guaranteed.

REFERENCES

[1] Gjb4000-2000 general specification for ships [S] General Armament Department of the Chinese people's Liberation Army, 2000

[2] Kaiwen Shao, Yunyi Ma.Introduction to ship technology and design [M] Beijing: National Defense Industry Press, 2014

[3] Feng Zhao, Weizheng Chen, Xizhong Wei, Yihong Chen Practical thinking of system engineering in the research and development of ship general performance [J] China shipbuilding, 2021,62 (02): 275-283

[4] Xizhong Wei, Jianhai Jin, Mowei Wang, Feng Zhao. GJB 5000A Application Scheme for APP Development of Facing to Ship General Performances Prediction [J] Ship Standardization Engineer, 2020,53 (04): 5-10

[5] Runhua Wang, Jianjun Wu, Jialu Hou.Distributed real-time computing engine -- Storm Research [J] China Science and technology information, 2015 (06): 68-69

[6] Yunfeng Zhang Design and Implementation of Distributed Realtime Computation System Framework Based on Strategy [D] Shandong University, 2019

[7] Zhihui Wang. Study on the Dispatch Mechanism of Manufacturing Task and its Relia bilityDistributionfor Edge Computing [D] Hangzhou University of Electronic Science and technology, 2020 DOI:10.27075/d.cnki. ghzdc. 2020.000335.

[8] Xiande Zhu, Yongsheng Bi.Research on pool expansion and intelligent scheduling management of storage resources in cloud computing data center [J] Communication management and technology, 2013 (05): 32-35