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Research of dynamic scheduling method for the air-to-ground warfare simulation system based on grid

Yanfang Fu [a,*], Fengju Kang [b], Jianghua Qi [c], Shimei Duan [d]

[a] Computer Science and Engineering College, Xi'an Technological University, Xi'an, Shaanxi Province, China
[b] Collage of Marine, Northwestern Polytechnical University, Xi'an, Shaanxi Province, China
[c] Xi'an Technological University, Shaanxi Province, China
[d] China Flight Test Establishment, Shaanxi Province, China

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ABSTRACT

The military field has been a strong demand for automatic management of the running of simulation, and the sharing of simulation resources and so on. Aimed at the puzzles in current HLA-based simulation system, and with the combination of a new grid idea, a framework of simulation grid has been presented. This article is absorbed in the aim how to schedule the task under simulation grid environment and explore the dynamic dispatch to the parallel tasks in the federation entity level. Finally a mended heuristic scheduling algorithm has been designed. This algorithm dynamically adjusted decision-making through using the information of systematical real-time operating status, be able to making a timely response dynamically according to the changes of the characteristics of simulation system, re-achieve balance and improve the system performance, fault-tolerant and load-balance ability according to the adjustment of the dynamic fluctuations of the loading. Taking the air-to-ground warfare simulation system as an example, simulation results verify that the method is effective and useful, and it could contribute to enhance using resource quotient and construct the large-scale military simulation applications.

1. Introduction

HLA (High Level Architecture) is an open object-oriented supported system. The most famous characteristic is separated into three segments, i.e., the detailed realization of the simulation function, simulation operation management and communications. It offers relative and independent supporting service program, which hides its own realization details [1]. It enables large-scale distributed simulation with more compatibility and expansion capacity according to the development of the simulation application requirement.

RTI (Run-Time Infrastructure) basically ensures the interconnection, exchange and interoperability among all the simulation nodes. But the simulation-based HLA still exist certain shortcomings, i.e., the lack of the capabilities management, the flexibility and the scheduling of simulation resources [2]. Each of simulation tasks has been bundled up with the store resources or the computing resources before simulation, which will lead to the emergence of the following problems [3]:

(1) In simulation, the computing capability of nodes is similar to each other. If its load varies widely, the overload node will become the bottleneck in the entire simulation system, thus affecting the overall system performance.

* Corresponding author. Tel.: +86 29 83208084.
E-mail addresses: fuyanfang3000@yahoo.com.cn (Y. Fu), kangfengju@sina.com (F. Kang), qijianghua54@yahoo.com.cn (J. Qi), duanshimei2002@sina.com (S. Duan).

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(2) During the running of the simulation task, the resources fault, such as the sudden crash of the computer, will lead to failure, and it may lead to the failure of the entire simulation tasks.
(3) During the model processing, the creation of the federation and the federate members are based on the systematically physical model or mathematical model, where there are serious hidden dangers of the unequal distribution. HLA/RTI is lack of load-balancing mechanism, which will cause the entire simulation system getting slow or even paralyzed.

Since the birth of grid technology in 1990s, its technical development has never stopped; its application area is getting wider and wider. Simulation grid is the introduction of grid technology against the limitations of HLA, which will improve the former shortcomings greatly [4]. Simulation grid system is able to schedule parallel tasks and resources on the basis of the mainstream simulation agreement, such as automatically finding, resources selection, automatic activation for federate execution, dynamic scheduling for simulation entities and automatic collection for simulation results. This technology has not only solved the traditional simulation system grid problems, but also overcome the shortcomings that HLA-based system does not support dynamic resource management and task scheduling. This essay is based on the study of the dynamic scheduling algorithm; it transforms the inspiring algorithm against the feature of simulation grid tasks, improves the efficiency and fault-tolerant ability of the simulation application, and realizes the transparency of the simulation process [5]. The deployment and application of simulation system in the grid are the two main intentions in this paper. Thus, the structure will be designed for simulation grid system.

2. The structure design of simulation grid system

The efficiency of resource management and task scheduling is enhanced in the simulation grid from two levels, i.e., simulation method level and the software design level. Simulation grid system needs to improve the method of the simulation development flow, and propose the method of simulation task submission and the task distribution. Simultaneously it also needs to design the optimized algorithm to choose the grid resources and implement task scheduling [6]. Using the protocol standard of the network management service in the software design, it has realized the deployment of simulation system in the grid and its application.

Simulation grid system is composed of many grid nodes. The various simulation tasks are assigned to the grid node once the implementation started [7]. Both the physical entity and the logical relation of these grid nodes in the distribution are independent and parallel through the communication mechanism or network interaction [8,9].

2.1. Simulation Grid System Framework (SGSF)

SGSF designs are shown in Fig. 1: when a user submits the simulation task, the user is required to submit many information for simulation entities, the number of entities, the simulation initialization parameters and the time parameters, once this task is demanded to decompose to several sub-task queue, which is based on the different needs of different users (such as users grades and urgent task level), to sort.

This framework is designed for the improvement and expansion of the advantages of HLA management, and grid computing is used to share resources for users to create, manage, implement and operate with simulation entities [10]. The entities can real-time interact, and automatically withdraw from simulation federation. The simulation system should be able to

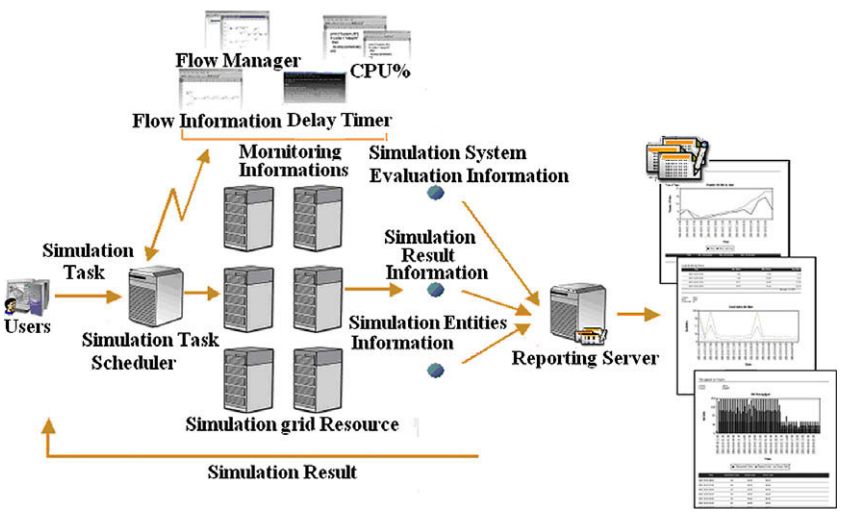

Fig. 1. Simulation grid system functional framework.