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A Design of High Performance Simulation Platform

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Abstract. Complex system is in high demand for a high-proficiency simulation system to support its simulation use case. In this paper, we design a high proficiency simulation platform and develop related technical structure, so as to provide a full-cycle of modeling and simulation (M&S). This architecture are divided into four layer: hardware system layer, parallel operation system layer, simulation service layer and simulation portal level. In each layer, M&S technology, which tends towards "networking, virtualization, coordination, service-oriented", are applied in prototype system. It bring super computing power, storage power and interaction power, and can give researcher a hint to reconstruct new generation simulation platform.

Introduction

Today, we are pacing toward "WWW+" age, when the internet are extended from current social web to "internet of things". Moreover, artificial intelligence technology are sweeping the global word, and leading to a "AI+" age. In so-called "WWW+ AI+" age, the simulation platform need to have a high performance one so that it can handle variety of complexities in simulation area, especially for military domain.

The military simulation system can be seemed as a complex system since it has a multitude of nodes and a bunch of various relations. Modeling such system should support vast nodes and provide huge resource and information, it was a great challenge to current modeling platform. Recent studies give some solution to give common structure, using cloud computing, big data, and artificial intelligence and such novel technology[1-4], yet those architecture cannot satisfy the demand of specific military domain.

In addition, the platform in future should take various purpose into account, such as training, manufacturing , SoS experiment, that add the complexity and difficulty to construct a simulation platform to satisfy the future demand.

As we concluded, future simulation platform has following objective:

1) System characteristics: autonomous, controllable, intelligent and high performance.

2) Support user group: high-end users and net users.

3) Application Use case: SoS (System of System) confront, intelligent cloud manufacturing, intelligent training & Studying system.

4) M&S modeling method: Support innovative simulation pattern, method in "WWW+ AI+" age.

In this paper, we designed a plan for constructing simulation platform. This paper are constructed as follows, in section 2, the overall plan and a hierarchy is given, Section3 give details of each layer. Section 4 analyze related technology, lastly, a brief summary is given.

Overall Plan

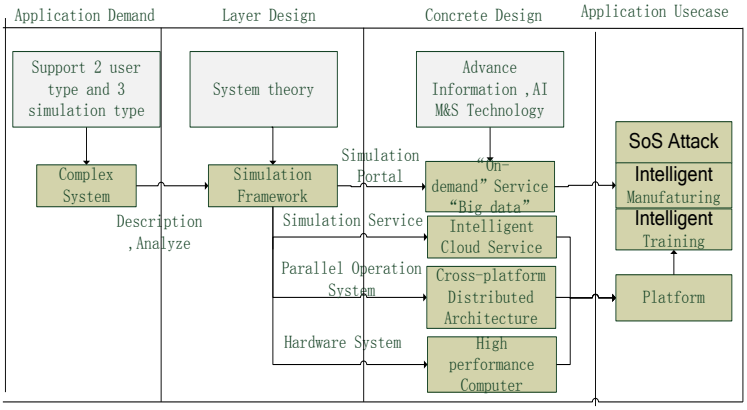

Figure 1. Overall plan.

As Fig1 shows, Aiming at providing high performance simulation platform for "WWW+ AI" age, we apply the system theory in overall design, and plan to use the synthetic thought to build key technology framework. After analyzing the application demand, we design the simulation framework by system theory, the system design will cover several hierarchical levels: hardware system level, parallel operating system, simulation service level, simulation portal level. In each layer some technology, such as advance information technology, AI technology, and M/S technology are utilized to pursue its goal.

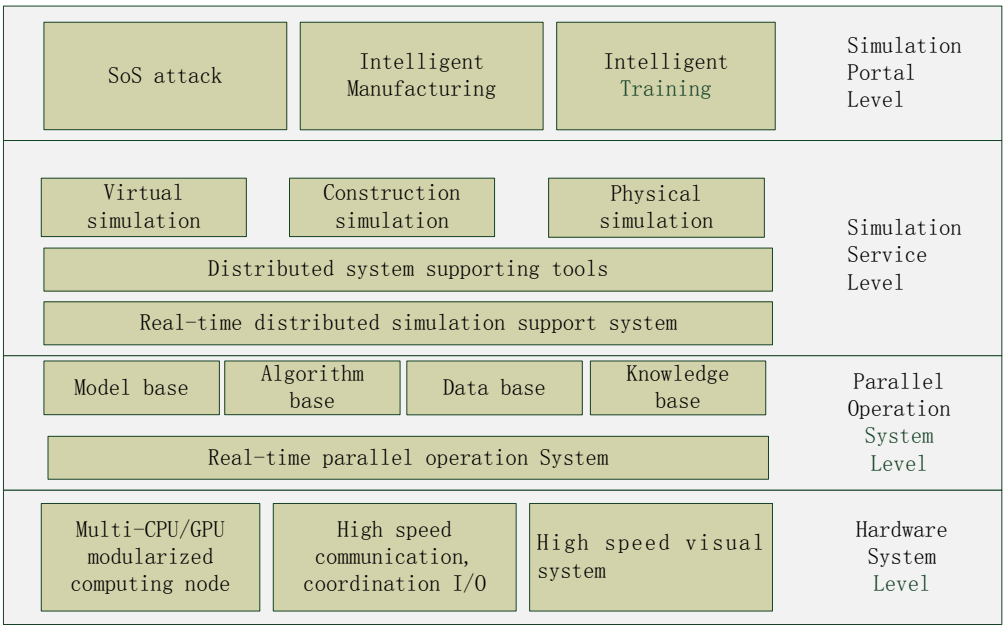

Figure 2. Layered framework.

Layered Framework

As Fig2 shows, the platform has four layers:

(1) Hardware system layer

Hardware in this platform contain multi-CPU/GPU modularized computing nodes, high speed communication and coordination I/Os and high speed visual sub-systems, that can make hardware system having high performance, scalability, and security, so as to provide good multi-user support, high coordination and computing ability.

(2) Parallel operation system layer

This level keen on distributed deployed, loose coupled, inquire\response, concurrency support technology and by those technologies, a parallel operation system came true. Accompanied with the system, model base, data base, knowledge base, algorithm base and other common resource are provided. Through JADE+FPGA modeling language, model is modeled and several service (data, algorithm, knowledge) is provided for different units in higher layer to use. This layer aim at promoting the efficiency of time using and resource using.

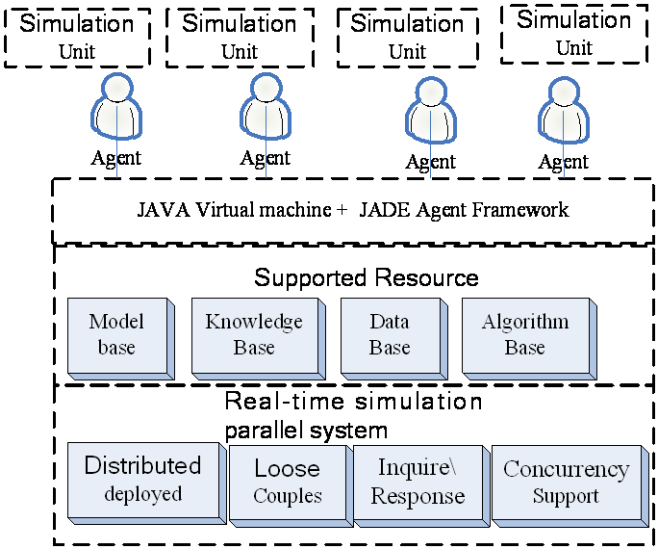

Figure 3. Parallel operation system layer.

(3) Simulation service layer

We use cloud computing, internet of things, new generation of network, service computing, artificial intelligence, and other burgeoning information technology to construct service-oriented simulation service level.

Importing "cloud-computing" idea, physical resources are virtualized and been unified distributed information resource into a virtualized resource pool to provide good service. Furthermore, a networked cloud simulation system is structured as prompt and real-time distributed simulation system supporting tools, to help end user get easy accessible, on-demand, trusted and inexpensive intelligent cloud service in whole M&S life cycle. It runs across simulation developing, simulation deployment, simulation running, assessment and suchlike phase, and support three simulation type(virtualized simulation, physical simulation, constructed simulation), and three service type(virtualized table environment, standalone, networked), thus, a networked, intelligent, service-oriented simulation supporting platform architecture can be build.

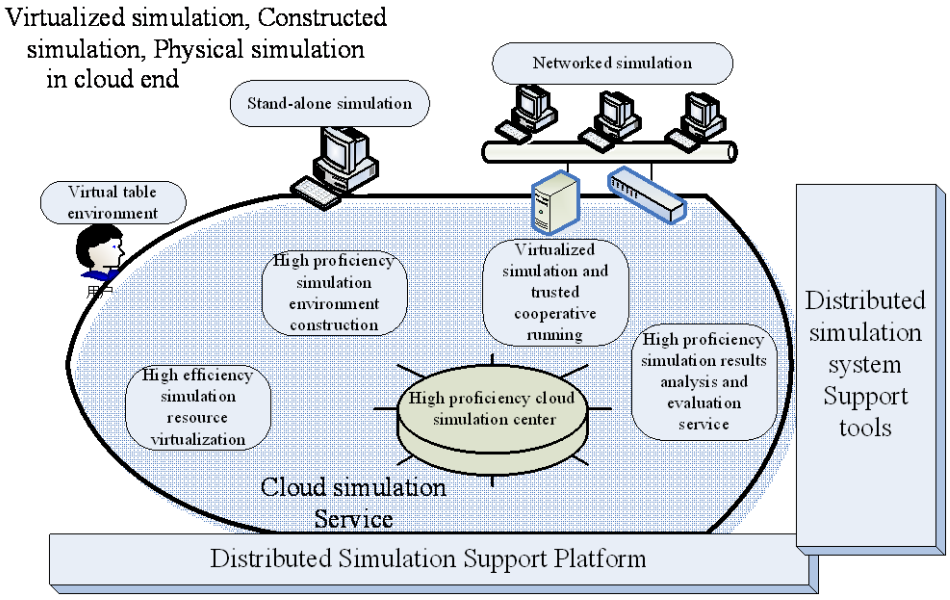

Figure 4. Simulation service level.

(4) Simulation portal level

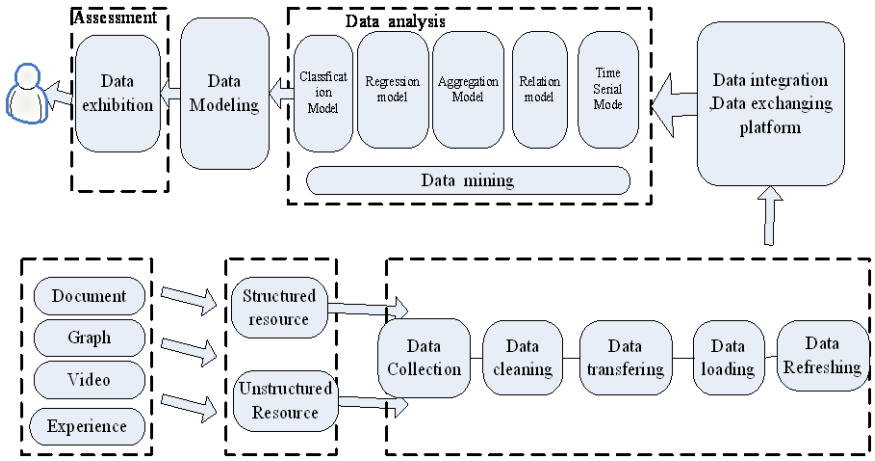

Figure 5. Data management progress of simulation portal level.

Through data ware house technology and big data technology all kinds of application system are joined together, and various data collecting interface are provided, also with the data management tools[5].

The data processing follow the below process, firstly, structured and unstructured resource including document, graph, video etc. are handled by data cleaning, data transferring ,data loading and data refreshing for further use, secondly, by data mining the data warehouse, the information is exploited, mined, analyzed, implicit model and knowledge are extracted and recognized by classification, aggregation and other models. Lastly, based on integration of diversified heterogeneous data, the data model for emerging data in SoS is naturally formed.

Those service, accessing through internet, are applied in constructing an experiment system including modeling and simulation, evaluation and analysis, discussing, counter-act drafting.

Key Technologies

In above framework, there are several related technology can be used:

(1) High proficiency computing technology

High proficiency computing is a kind of driving force to solve difficult problem and characterized by “high proficiency, high reliability, high energy-saving, high available”. It contains parallel I/O

system technology, hardware optimization technology, operation software support technology, resource virtualization technology, service environment construction technology, high-proficiency cloud computing technology and virtualized believable coordination technology.

(2) SoS structure description & integrated interaction technology

Aiming at fulfill the demand of scalable and configurable simulation of SoS, SoS structure description technology combines quantity and quality description to give a vivid portrait of SoS structure, and based on which, SoS architecture, hardware and software composition, hardware optimization and software support plan is well planned, and interface standard is well designed to provide universal, serialization, modularized simulation interface.

Integrated interaction technology promote interconnection and interoperability of SoS by unifying support digital simulation, semi-physical simulation and real-equipment simulation into a united one, and manage the model resource and data resource synthetically for better sharing and reuse of this resource and data. It contains time-frame control technology, real-time control technology and interaction interface technology.

(3) Complex system high proficiency simulation technology

On account of the huge scale, complex behavior , lack of knowledge, and fuzziness, uncertainty of complex system, complex system modeling technology is studied, which contains layering modeling technology, interactive interface modeling technology, simulation VV&A technology, and multi-resolution modeling technology.

(4) Big data analyzing technology

The complex system has a difficult composition with difficult relation. Aiming at solve that, the complex system based big data analyzing technology, containing data gathering technology, big data storing technology, big data management technology, experimental data analysis technology, evaluation technology and so on.

Summary

With above framework and architecture, we built a prototype system for fighting method experiment. As for those experiment who need vast resource, the traditional experiment system are always in dilemma between resource demand and complexity scale, while this prototype can bring super computing power, storage power and interaction power, so it benefit our application which need high performance.

Acknowledgement

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