Research and Application of Data Filtering Technology in High Level Architecture

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Abstract: High-level architecture provides a general technical framework and an open standard for modelling and distributed simulation. It represents the latest development direction of distributed simulation. This paper mainly introduces the basic knowledge of HLA and two methods of data filtering mechanism. Two classical data filtering methods are discussed. Mixed data filtering methods can effectively reduce the allocation and matching calculation of multicast groups, and improve the efficiency of data filtering.

1. Introduction

With the rapid development of computer technology, the application field of computer simulation has been widened, and the strong impetus of national economic development, especially military demand, has promoted computer simulation to a rapid development in both theory and practice. At the same time, the problems that need to be solved in computer simulation are becoming more and more complex. Many problems cannot be solved by a single simulation system, and need to rely on multiple simulation systems to carry out joint cooperative simulation. The development of distributed interactive simulation technology has gone through four stages: SIMNET, DIS, ALSP and HLA. HLA provides a data filtering mechanism based on multicast communication, namely data distribution management (DDM). Data distribution management algorithm is one of the key factors affecting RTI performance. It has been widely studied and applied in combat simulation, weapon research and development, virtual manufacturing and other fields. It has positive significance to support simulation research of large-scale complex systems and reduce economic costs.

2. High Level Architecture

2.1 Distributed interactive simulation

Distributed Interactive Simulation (DIS) refers to the use of a coordinated structure, standards, protocols and databases to interconnect simulation devices scattered across the local area network (LAN) or wide area network (WAN) to form a participatory integrated simulation environment. Computer simulation can usually be divided into three types: virtual simulation, construction simulation and real simulation. Distributed interactive simulation is the result of the progress of computer technology and the development of simulation requirements. Its characteristics are shown in five aspects, namely, distribution, interaction, heterogeneity, space-time consistency and openness, as shown in Figure 1 below.
2.2 Main characteristics of HLA

In HLA, interoperability is defined as the ability of a member to provide services to and receive services from other members. The key to building federations from members is to require interoperability among members. HLA defines the architecture and mechanism to implement federate member interoperability. In addition to facilitating interoperability among members, HLA also provides a flexible simulation framework for federates. In the framework of HLA, the logic structure of a typical simulation federation is shown in Figure 2.

The main feature of HLA is an open and object-oriented system. Its most remarkable feature is that it separates the application from the underlying supporting environment by providing a general and relatively independent supporting service program.

2.3 HLA Interface Specification

The key component of HLA is interface specification, which defines standard services that support interoperability among federates during the running of simulation system. These services can be divided into six categories, namely, federated management services, declaration management services, object management services, time management services, ownership management services and data distribution management services. Federal enforcement must exist before a member joins a federation. Once a federated execution already exists, federate membership can be joined and withdrawn in any order that is meaningful to Federated users, but Federation revocation must take place after all members have withdrawn. Figure 3 illustrates the process of all state transitions in the federation's execution life cycle.
The purpose of time management in HLA is to ensure that events can be executed in the right order among federates. Maintaining the sequence of events becomes an important issue when federates run on computers with different computing speeds.

3. Data filtering mechanism in HLA

3.1 Two kinds of data filtering

By ordering the attribute values of an object class, federates can limit the type of attributes they receive. RTI will ensure that federates ordering the attributes of an object receive the updated values.
of those attributes of all such objects in the whole federation, while the attribute values of objects that are not of interest to federate will not be sent to the federate members. This class-based data filtering mechanism does not only update specific object instances, but only applies to smaller federations or federations with a small number of entities of each class. For large-scale distributed interactive simulation, because there are many entities of each kind of object, more elaborate filtering mechanism is needed. For this reason, DDM provides a value-based data filtering mechanism. DDM services allow federates to selectively receive ordered attribute values based on publishing the values or characteristics of federate.

3.2 Data distribution management
HLA defines data filtering mechanism at class level and instance level respectively. In RTI, the class-level filtering mechanism is implemented by the declaration management service, while the instance-level filtering mechanism is implemented by the data distribution management service. Data distribution management provides a more sophisticated and flexible mechanism, which further reduces the publishing and federates ordering requirements, thus effectively expanding data distribution capabilities.

4. Conclusions
Grid-based methods need to generate channel and information consumption, so large grids should be avoided as far as possible. The region-based method will generate too much matching computation. This method should be used when the update frequency is relatively low, otherwise, the matching consumption will be particularly large. A hybrid data filtering mechanism is much less computationally expensive than the region-based method, and produces much less irrelevant data information than the grid-based method. At the same time, it reduces the allocation of multicast addresses and improves the transmission efficiency.

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