

A Grid Service Model of Network Centric Warfare Based on OGSA Framework

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Abstract—As the embodiment of the Information Warfare, NCW (Network centric warfare) is a networked and information Warfare concentrating on network. An OGSA (Open Grid Services Architecture) based three-layer grid service model for NCW is presented. In this work, in grid middleware, we regard the foundation grid, the detector grid, the decision grid and the engagement grid as the grid service layer, and employ the aggregator and the provider grid service in site collective layer to collect various kinds of information from the grid service layer. With the support of VO (Virtual Organization) technology, every VO in the VO layer receives information from the grid service of the site collective layer. In addition, we build our NCW grid service model with the help of GT3 (Globus Toolkit 3).

I. INTRODUCTION

OGSA^{[1][2][4][5][7]} integrates key Grid technologies with Web services mechanisms to create a distributed system framework based around the Grid service. OGSA defines mechanisms for creating, managing, and exchanging information among entities called Grid services. Succinctly, a Grid service is a Web service that conforms to a set of conventions that define how a client interacts with a Grid service. These conventions, and other OGSA mechanisms associated with Grid service creation and discovery, provide for the controlled, fault resilient, and secure management of the distributed and often long-lived state that is commonly required in advanced distributed applications.

As the embodiment of the Information Warfare, NCW^{[2][3][6]} is a networked and information Warfare concentrating on network, which was brought forward by the American Navy at first in 1998, catching widely attention of American DoD subsequently. NCW is not only a campaign idea but also a campaign system. It's the most primarily and important way battles are fought, centralizing Command, Control, Communication, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR), Electronic Warfare, Information Warfare, Campaign Support, and Firepower System altogether, making up of an information network system.

In this paper, Building on OGSA architecture, we propose a NCW architecture model.

II. LOGIC GRID ARCHITECTURE MODEL OF NCW

The real and specific problem that underlies the Grid concept is coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations^[11]. Grid mainly composes of six parts such as grid nodes, networks, expensive instruments, visual equipments, network software and database. Grid system includes the resource layer, the network operation system layer, the middle layer, and the application layer. The grid architecture of NCW based on grid technology is depicted in figure 1.

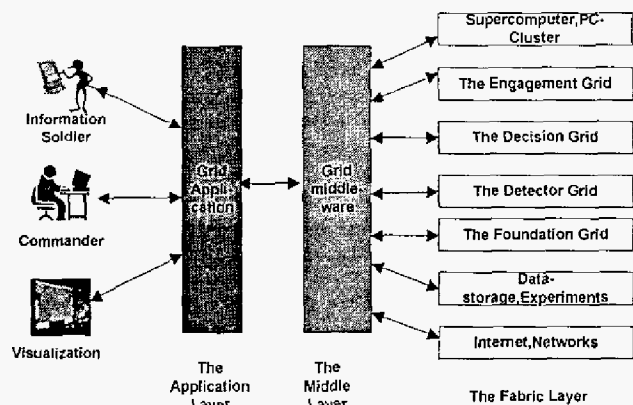


Figure 1 The architecture of NCW

The resource layer is the hardware base constituting grid system, including various of computing resource such as supercomputers, expensive instruments, visual equipments, and other computing resource nodes with different computing capacity. The resource layer only realizes the physical interconnection of computing resource, but in logic these resources are isolated all the same, and must use grid middleware to resolve the sharing problem of computing resources. The resource layer in NCW is a four-layer grids: the foundation grid, the detector grid (the

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battlespace awareness grid), the decision grid (the command and control grid) and the engagement grid (the firepower grid).

(1) The foundation grid is the network foundation establishment of NCW, and all of the resources (computing resources, storage resources, data resources, and software resources) in the network constitute a supercomputer. It provides powerful sharing function, and each operation unit may become the participant of the battlespace awareness, command and control, and accurate attack. Because the foundation grid integrates battlespace awareness, command and control, and accurate attack altogether as an incorporate coordinated campaign system, the military structure, command system, and information flow arise great change.

(2) The detector grid is the key of battlefield awareness and consistent understand of the campaign space, which is composed of sensors based on aircraft, at sea, on the ground, in space, and in cyberspace. Sensors may be found on dedicated platforms such as satellites, on weapons platforms such as the Abrams tank, may be employed by individual soldiers, and may be embedded, as in logistics containers. The sensor grid provides the Joint force with a high degree of awareness of friendly forces, enemy forces, and the environment across the Joint battlespace. Figure 2 shows The Sensor grid of the detector grid.

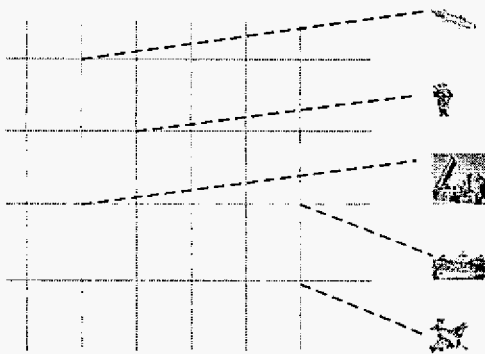


Figure 2 the Sensor grid

(3) The decision grid is the chiefly parts with high efficiency and collaborated command and control, and obtains decision superiority, which is composed of various kinds of command and control center based on aircraft, at sea, on the ground, in space, and in cyberspace. It also includes knowledge-based assistant decision system, and information foundation establishment with plug and play function.

(4) The engagement grid effectively exploits battlespace awareness to give the commander new capabilities for force employment. These new capabilities enable the emerging operational concepts of precision engagement, dominant maneuver, and full-dimensional protection. The engagement grid is composed of various

kinds of weapons based on aircraft, at sea, on the ground, in space, and in cyberspace. It also includes information foundation establishment with plug and play function providing location service.

The middle layer includes a series of tools and protocols. The function of the middle layer is to provide transparent and concurrent interface for the grid application layer by shielding the distribution and heterogeneous characteristics of computing resource and the user can't feel the different of the computing resource in location and capacity. The middle layer must provide user programming interface and corresponding environment at the same time in order to support the application development of the grid.

The grid application layer is the embodiment of the user's demand. With the help of grid operation system, the user can utilize the tools and environments it provided to design application system.

The user includes commanders and information soldiers.

III. OGSA-BASED NCW GRID MIDDLEWARE

A. NCW grid service based on OGSA Service Model

A basic premise of OGSA is that everything is represented by a service: A network enabled entity that provides some capability through the exchange of messages. Computational resources, storage resources, networks, programs, databases, and so forth are all services. This adoption of a uniform service-oriented model means that all components of the environment are virtual. Grid service is a Web service with specified interfaces and behaviors, including Interfaces for managing Grid service instances such as Factory, registry, discovery, lifetime, etc.

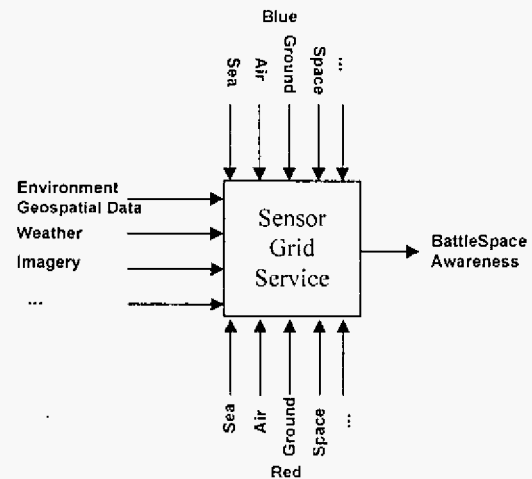


Figure 3 Interface of the sensor grid service

In NCW, the foundation grid, the detector grid, the decision grid and the engagement grid are all grid services. For example, the sensor grid compose of sensors based on aircraft, at sea, on the ground, in space, and in

cyberspace, providing the Joint force with a high degree of awareness of friendly forces, enemy forces, and the environment across the Joint battle space. The sensor grid service includes interfaces such as receiving and dealing with the information from the sensors, sending information to VO, etc. Figure 3 depicts the interface of the sensors grid service.

B. VOs in NCW

Virtual Organization (VO) is a set of individuals and/or institutions defined by sharing rules. This sharing is, necessarily, highly controlled, with resource providers and consumers defining clearly and carefully just what is shared, who is allowed to share, and the conditions under which sharing occurs. VOs vary tremendously in their purpose, scope, size, duration, structure, community, and sociology. The following are examples of VO: the application service providers, storage service providers, cycle providers, and consultants engaged by a car manufacturer to perform scenario evaluation during planning for a new factory; etc.

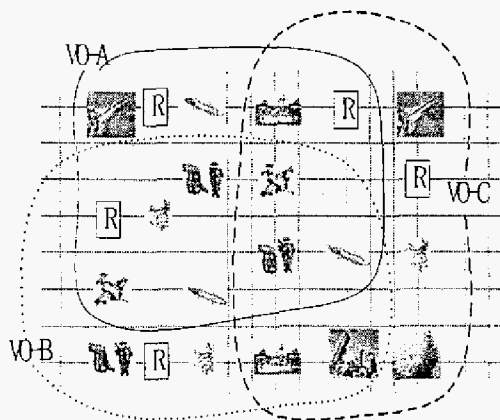


Figure 4 The constitutes of the VO in NCW

When the enemy navy attacks, we must regard the distributed resources everywhere such as warships, missiles, and air forces as a VO, strike the enemy concertedly; If the enemy shoots cruise missiles from the ground, we must regard the distributed resources everywhere such as spying and tracking information from satellites, aerial defense system, missiles, and air forces as a VO. The missiles and the air force of the two VOs are the same army, which is irresolvable for traditional distributed computing. The constitutes of the VO in NCW are depicted as Figure 4.

In the complex environments of NCW, the resources associated with a VO will span heterogeneous, geographically distributed "hosting environments". A simple hosting environment is a set of resources located within a single administrative domain and supporting native facilities for service management: for example, a J2EE application server, Microsoft .NET system, or Linux cluster. The Virtual hosting environment of VO is illustrated in Figure 5, these resources span two simple hosting

environments. Nevertheless, this "virtual hosting environment" can be made accessible to a client via exactly the same interfaces as were used for the hosting environment just described. We create one or more higher-level factories that delegate creation requests to lower-level factories. Similarly, we create a higher-level registry that knows about the higher-level factories and the service instances that they have created, as well any VO-specific policies that govern the use of VO services. Clients can then use the VO registry to find factories and other service instances associated with the VO, and then use the handles returned by the registry to talk directly to those service instances. The higher-level factories and registry implement standard interfaces and so, from the perspective of the user, are indistinguishable from any other factory or registry.

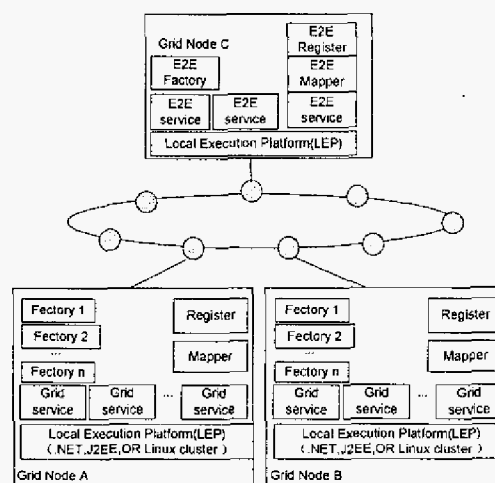


Figure 5 The Virtual hosting environment for NCW

C. NCW grid middleware

According to the OGSA information model, using Globus Toolkit 3, we design and simulate a OGS-compliant NCW grid middleware, which include three layers: the grid service layer, the site collection layer, and the VO layer, as depicted in Figure 6.

(1) The grid service layer composes of a set of grid services. The function of this layer is to provide transparent and concurrent interface for the grid application layer by shielding the distribution and heterogeneous characteristics of computing resource. The foundation grid service, the detector grid service, the decision grid service, and the engagement grid service provide interface for the relevant grid respectively. These information include battlefield awareness, center of command and control, assistant decision system, and The engagement grid is composed of various kinds of weapons based on aircraft, at sea, on the ground, in space, and in cyberspace, etc.

(2) The site collective layer consists of a series of OGS-compliant services that belong to multiple administrative domains. These services communicate with the information supplier in the resources layer. Each of

services and information suppliers has aggregator grid service and provider grid service to collect various kinds of information from the resources layer. The aggregator grid service can subscribe and cache Grid Service Data (GSD) of specific Grid services. It is used to aggregate resource information of the lower level in the form of GSD. All of the information suppliers at the resources layer must be able to perform notifications as every OGSi standard. The Provider grid service allows generating GSDs by invoking Java-based or/and other executable programs that collect local resource information from existing system modules like local schedulers.

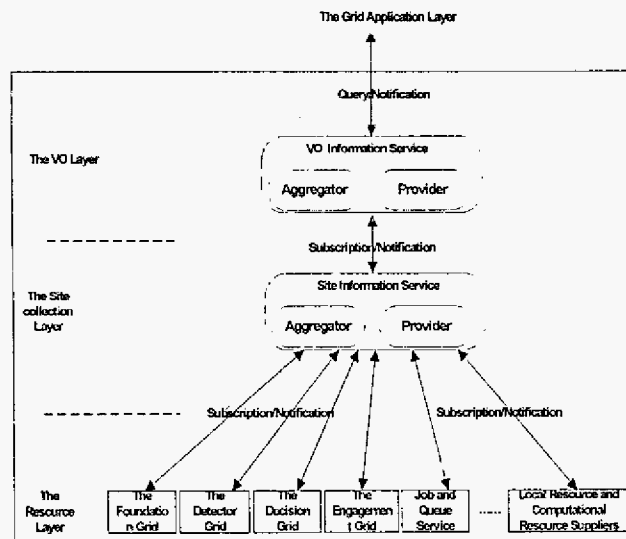


Figure 6 NCW grid middleware

(3) In VO layer, each VO receives information from the grid services of lower layers and provides interfaces for the Grid Application layer.

(4) Subscription/notification is the basic mechanism to communicate between different layers”.

IV. SIMULATION OF NCW MIDDLEWARE

The simulation of NCW grid middleware was based on Globus Toolkit 3 (GT). GT3 implements a container for OGSi-compliant services and provides lifetime management, service discovery, notification mechanism, and so on.

NCWGridAggregator is a Java class realization of the aggregator. It inherits from the NotificationServiceSkeleton class provided by GT3. The aggregator mechanism is employed to collect the information provided by the suppliers and to expose them as the service data in our Information Service. Several interfaces are implemented in the class including RegistrationPortType, AggregatorPortType discover computational resource and monitor system ProviderExecutionPortType, NotificationSinkCallback, status, FoundationgridAggregatorPortType, DetectorgridAggregatorPortType, DecisiongridAggregatorPortType and EngagementgridAggregator-PortType are the interfaces of The foundation grid, the detector grid, the decision grid, and the engagement grid respectively.

NCWGridProvider is also a Java class, which implements the ServiceDataProvider interface of GT3 and outputs a valid XML document. By means of the provider mechanism, the information suppliers capture the information from the local system to form their service data. XMLDataProvider extends the SimpleDataProvider interface for XML service data and is capable of emitting an org.w3c.dom.Document object at runtime.

The implementation of the aggregator and provider service is shown in Figure 7 (a) and Figure 7 (b).

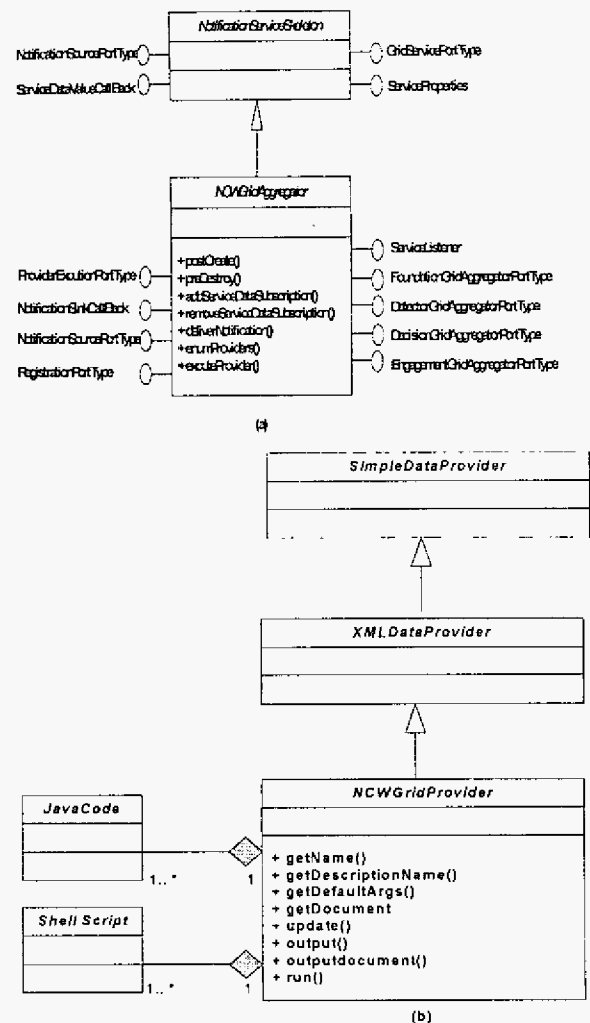


Figure 7 Implementations of Aggregator and Provider

V. CONCLUSIONS AND FUTURE WORK

OGSA is a grid architecture brought forward by the Global Grid Forum based on web service. NCW is a new type of Information Warfare brought forward by American navy. In this paper, we put forward and simulate a Logic grid architecture model of NCW according to the two hotspots.

Today, many work concerns about NCW, and Grid Computing is rapidly developing. American DOD puts forward the concept of GIG (Global Information Grid) in

sep. 1999, and then introduces the framework of Joint Vision 2010 and Joint Vision 2020, our future work will focus on the architecture of NCW, framework of OGSA grid service, security of grid computing ,and how to apply grid computing to NCW.

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