A Study of Dragon-lab Federal Experiment Cloud and Network Contest

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***Abstract*—Through the research and analysis on the contests of the IT organization management mode, operation platform and the trend of Network Contests (NC) development , the paper explores the issue about Dragon-lab federal experiment cloud and network contest environment construction, furthermore, it proposes a comprehensive solution for network contests layered management model based on the cloud computing. The solution has the following novel features: (i) a hierarchical level of contest management model based on cloud computing resources; (ii) design for network framework based on the Dragon-lab federal experimental cloud; (iii) service operation mode in Dragon-lab experiment cloud; (iv) scheduling strategy for the contest management platform. The advantages of scheme lie in: (i) eliminating the limitations of contestants, physical location, match point location and hardware/software resource space in the maximum; (ii) promoting the scheduling and sharing of device resource among the different NC areas; (iii) reducing the NC cost and improving the efficient utilization of the tournament game equipment. Finally, the solution had been verified, in Dragon-lab experiment cloud, by successfully hosting network skills competition in four NC regional sites.**

Keywords- cloud computing; dragon-lab federal; Network Contest; experiment cloud; contest management model

I. INTRODUCTION

The contest based on computer use and development started from 1970. Since the Texas A&M university held the first games, this new discovery and the way of developing top students majoring in computer science, responded positively by some U.S. and Canadian universities immediately[1]. In 1977, the international collegiate programming contest (ACM/ICPC) organized by ACM has become a classic event-an annual session of multinational international computer programs.

With the booming of Internet technology and rapid development, contests about network equipment use skills have appeared in recent ten years. Among those the most famous are: ICTF UCSB Contest[2], Collegiate Cyber Defense Competition[3], NTU Network Security Competition[4], and China university NOC description activity network security competition, network skills contest sponsored by education ministry[5], etc. Competition contents of Network Contests mainly focused on the design and implementation of network security solution in LAN of the enterprises, campus and government which emphasizes network attack and defense technology. The purpose of NC is to test contestants'capabilities in understanding and manipulating Internet infrastructure and business information system security. This kind of competition demands large amount of network equipment, meanwhile, the management of the contest is a little complex.

The competition management of computer program mostly use the following systems: Programming Contest Control (PC2) and Mooshak system[6]. Both are based on C/S structure of competition system which only support single regional sites competition, while do not support division online competitive[7][8]. This system cannot directly support network tournament organization management.

In recent years, with the increasing number of participants in Network Contests, the competition modes are also developing toward the trend of multi participant areas and multi participant spots. Obviously, the existing local contest organization management cannot meet the requirement of the of network tournament's development. Therefore, how to eliminate the limitations of physical location of the traditional tournament mode, how to take the advantage of network environment in maximum in order to satisfy the demands of the network contests which includes depending largely on network equipment, large quantities, variety types, complex requirements and high requirement of hardware and software environment, becomes the major problem of our study. In the process of research, we propose the Dragon-lab federal experimental environment and construct experimental cloud network to solve the problem of effective use of network equipment; Using cloud computing technology in order to develop contests management system based on cloud service environment, promoting the scheduling and sharing of device resource among different NC areas, and verifying the effective of this idea by holding a four areas of the joint tournament. The value of this study lies in expanding the application field of cloud computing.

The use of cloud computing in contests has not been reported yet[9~13]. The construction of contests is developing rapidly, therefore, the unity resource platform and regulation rules will be benefit to network contests. For some contest sponsors, the cost of building contests computing center is too high which does not match with the fast development of contests and diversification of services. The cloud computing mode supply contests sponsor with

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appropriate schemes, using cloud computing can coordinate the network infrastructure, network equipment and the tasks of date center based on contests. This mode can effectively reduce the cost and the work of maintain, upgrade and update equipment can be done less.

Maximize the resources sharing. Using the stronger management mechanism, automation deployment and high level of virtuality function of cloud computing techniques, to realize the maximization of network virtual environment resource sharing and co-work.

II. THE BASIS OF CLOUD COMPUTING

This section illustrates the key technologies currently used in cloud computing which lay a foundation of contest organization management based on cloud computing that proposed in the next section.

A. The types of cloud computing service

The types of cloud computing service have three mainstream types according to the types of classification approach[10]: infrastructure as a service (IaaS), platform as a service (PaaS), software as a service (SaaS).

Infrastructure as a service (IaaS) is the basic facilitate. Service providers offer servers, storage and other hardware, so users' application system and software can be managed by the Service providers.

B. The application of cloud computing

Cloud computing, based on virtualization and web, providing services such as basic architecture, platform, and software, integrating the large-scale extensible computation, storage, data, and application of distributed computing resources to carry on the work together. As a brand new Internet application mode, this paper mainly discusses the following points.

(1) Virtualization technology

Virtualization technology provides an effective solution to resource management in cloud computing. By sealing the service in virtual machine and rejecting to each physical server, virtualization technology can remap the virtual and physical resource according to the change of loading, as a result, the balance load of the whole system can be realized.

(2) Security technology

It includes the following six areas: (i) The security about access control of cloud. (ii) Data security and privacy protection. (iii) Audit Security. (iv) Storage security. (v) Defense security. (vi) Safety laws and regulations.

(3) Storage technology

The data storage layer of cloud connects the different types of storage devices to achieve the goal of unified management of massive data and centralized management of storage devices, status monitoring, and dynamic capacity expansion. In essence, it is a service-oriented distributed storage systems to meet the need of performance and storage capacity requirements under the conditions of multi-user.

(4) Scheduling and allocating technology

The scheduling and allocating in cloud computing supports three levels management: (i) It specifies how much processing power per core in a host should be assigned for each virtual machine. (ii) The virtual machine allocates an available amount of processing power to independent unit of the task. (iii) It must decide to choose which data center for the user and use the strategies of resources management and model of cost about access in the data center for cloud services.

III. NETWORK CONTEST ORGANIZATIONAL MANAGEMENT MODE

The whole contest is generally managed by three institutions. Its management system adopts B/S structure, and running on the Dragon-lab federal experiment cloud network platform which based on CERNET, supporting fast, efficient communication command and control, so it can avoid congestion caused by all the participants access to a site simultaneously.

The three levels of management institutions are: organizing committee, executive committee and sub-regional contests. (i) The organizing committee is responsible for managing the affairs of information center about contest. (ii) The executive committee is responsible for the management of the business center in sub-regional contests. (iii) The sub-regional contest is only responsible for the competition in the LAN and monitoring the competition, checking the eligibility and marking the features for contestants online. The number and the position of the centers for information and business management can be dynamically arranged based on the actual demand.

The service target of the contest management system are contestants, judges in review committee, staff of the centers for business in executive committee, staff of the centers for information management in contest organizing committee and visitors who have not registered. The jury, the organizing committee and the executive committee are related to the management of organizations, in the management system for contest, they are called the judges, staff of the centers for information management, staff of the centers for business separately.

The management system of the network contest is divided into two corresponding subsystems which are the management systems of the business and information. The management system of business manage sub-regional contest and be responsible for competition device resource scheduling and judging sub-regional contest. The management system of information includes events proposition and event information openness. By using the strategy of cloud computing, the contest management platform can resolve the problem of space limitation in the contest user, location, hardware and software resources. The model of hierarchical architecture about contest was shown as Fig. 1.

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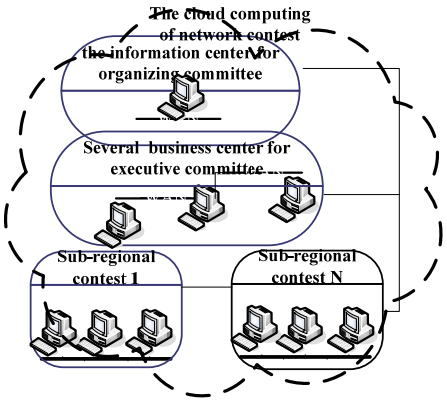

Figure 1. Example of a model of hierarchical architecture about contes

IV. CONTESTS MANAGEMENT BASED ON DRAGON-LAB FEDERAL EXPERIMENT CLOUD

A. *Contests management based on Dragon-lab federal experiment cloud*

Federal is a unique form of cooperation. It mainly consists of two meanings: autonomy and cooperation. Autonomy means that the resources of the federal are invested, maintained and cooperated by members autonomously and voluntarily. The federal of network infrastructure is a loose coupling form, resources invested by members may not be stable, but with a certain level, the effects of random will gradually decrease, while the advantage is obvious, that is, low operating costs and strong sustainable development.

Dragon-lab[14] is the research platform of CNGI-CERNET2 which is a large-scale IPv6 Internet's backbone network belongs to China Education and Research Network.

It is the only large-scale next-generation Internet technology cooperative research platform that based on federal structure.

B. *Key characteristics of Dragon-lab experimental cloud network*

The network is run in multi space-time environment. Dragon-lab will integrate all kinds of network application environments including the center of internet exchanges, international backbone networks, national backbone network, campus network, satellite, wireless, etc, which can record and playback IPv4/IPv6 network flow at any time, and import OSPF, ISIS and BGP routing information from running network. Therefore, through Dragon-lab long time and large space span, real network behavior research and running can be carried out.

Unified and efficient management of network equipment[15].By using Dragon-lab special configuration system, it can manage the existing laboratory equipment unified, and break the original laboratory situation of isolated and inapplicable. By creating a unified experiment platform, and making full use of the original equipment, the local comprehensive designed network experiment become possible.

Remote visualization experimental configuration. Dragon-lab is a remote laboratory, which can customize the lab environment remotely by using a dedicated client program by means of visualization.

Programmable experiments. Dragon-lab presents an innovative idea about programmable experiments. The experimental repeatability is improved by translating the lab environment definition into an executable test script.

C. *Dragon-lab Network Contests management*

Network contests management system, running in Dragon-lab federation experiment network cloud platform, contains three parts: the organizing committee contests information center, executive committee business management centers and area sites. Network infrastructure which is used by contests also has three-layer in figure 2. Cloud computing mainly supply the following services: (i) infrastructure service, namely multi-area management which is in charge of the executive committee, supply hardware resource, distribute and adjust those network equipment resource through virtualization technology. (ii) software service, dynamically using resources such as software tool, application system. (iii) data service , cloud computing data supply data sharing, date storage and data recovery.

In the Fig. 2, Dragon-lab federal runs in the China education online, and the core main node is in Beijing in Tsinghua university. The nodes of the first level are provincial node, which is the center of the contests information, called CCI (including data center, contests information management platform, the backbone network equipment, etc.). Secondary nodes are division business center (division data center), administrating the business of the contests and the next level of resources, such as servers, host, switches, routers, network security equipment, and the equipment of agreements and flow analysis, equipped with division competition business management platform. The nodes of the third level are tournament competition points which connected with many kinds of network equipment. Through the above level nodes, scheduling, sharing equipment resources can be realized.

Through login the spots management systems of the business, the user can use the resources of each division management center to take part in the contest. Area business management center is responsible for the division review and management. The contact between the contests spots and the area management center are randomly composed and expanding easily. Business management systems of the contests spots which use cloud computing can improve the expansibility, maintainability and resources utilization of the system, etc.

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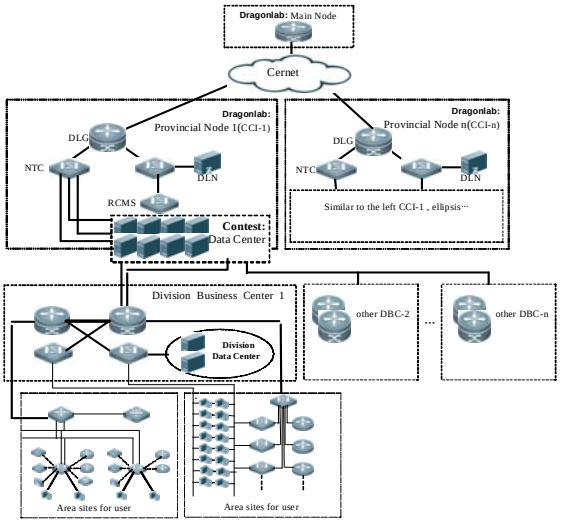

Figure 2. Dragon-lab federal experiment cloud Network infrastructure.

V. SHARING CONTESTS RESOURCE IN ENVIRONMENT CLOUD

The contests resource service running in cloud computing complete are achieving through running in contests/areas data center. This service divide into 5 classes: data discovery, resource allocation, resource storage, resource scheduling and monitoring.

A. network resource running Ways in Dragon-lab experiment cloud

•Cloud computing service agents assign the competition task which is submitted by area users to appropriate area data center. Area data center agent will receive request of all kinds of contests application examples, and then change these requests into cloud task of contests data center, schedule Dragon-lab experiment cloud software/hardware infrastructure resource through virtual machine, complete tasks of real time monitoring, scheduling and resource allocation. The detail flow is shown in Fig. 3.

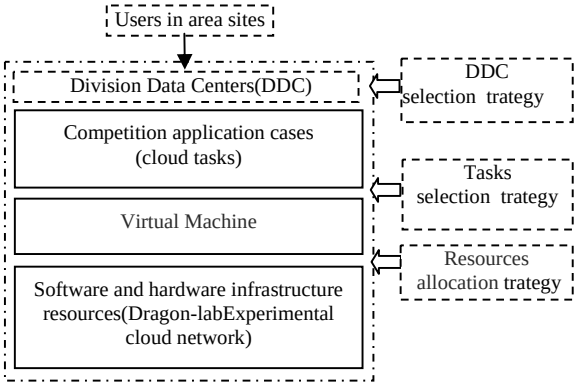

Figure 3. Example of resources scheduling and management in Dragon-lab Experimental cloud

Balance loading of dragon-lab experiment cloud network infrastructure resource is completed through scheduling strategy in Fig. 4. The scheduling strategy mainly includes creating, using, destroying and so on.

New contests data center register service information into cloud service agent. When cloud service agent receive request of area user, it chooses appropriate area data center, schedules and arrange cloud resource task based on user service quality demand, and then take charge of real time coordinate task between user and service.

The monitor center is located at the data center agent of division, in each terminal of network shared device of the division data center, there are configuration of monitor nodes. The monitor nodes are responsible for monitoring the status of computing power resources and usage of the network device, the main information is the property of equipment resources, IP address, the size and usage of CPU and memory, etc real-time information; These information is passed to the monitoring center. The monitoring agent uses the polling monitor strategies, according to the information of the terminal of the monitoring nodes, records the real-time situation of each node periodically and dynamically. Each division data center adopting disaster recovery technology, achieves storage of the important data of network events.

Fulfill distribute computing resource on demand by creating visual machine in the area of data center. Each visual machine is correspond to the resource of network device. Visual technology can make the visual machine remap to physical resource according to the change of load, through packaging services in the visual machine and mapping to the specific network device. The software of visual platform can cut proper size of visual computer pieces (including the kind of device, the number of CPU, the memory size .etc) according to the demand of the contest. The task is running on the visual machine, and data center assign visual resource. By creating, destroying and transferring visual machine periodically, the load balance of cloud network infrastructure resources of Dragon-lab experiment can be reached.

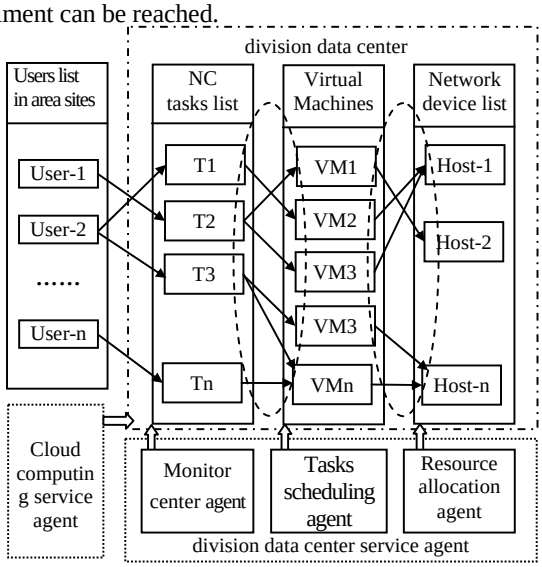

Figure 4. Example of Load balance in Dragon-lab resources

B. The scheduling strategy of test management platform

The strategy execute by contest/area data center service agent include: monitor strategy, resource distribution and task schedule. It can cluster and divide resource according to K-means algorithm. The resource in the data center can be divided into several clusters according to Qos in order to find the proper resource which matches the task quickly when schedule and distribute resource to data center, by this way fulfill the common Qos reputation of users, then complete this task.

Work scheduling strategy and resource allocation strategy use the way of first come first service, and join the general expectation constraint of the user service quality QoS, and budget limit and time limit, matching the service tasks of the user and the resources of the virtual machine with network equipment. The specific methods are: normalizing the data of the tasks, making the normalized task data and general expectation constraint data as equipment quality, CPU, memory, bandwidth, expenses, at last calculating the minimum distance of equipment resources according to the Euclidean distance equation "(1)" namely the host resources which is the most conformed to the user QoS general expect, and then making the virtual machine resources of executing the tasks and the network equipment resources matched. The scheduling algorithm involves 5 aspects.

$$D(x, y) = \| x - y \| \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \quad (1)$$

- The selection function of date center: sequence the data registered in the cloud service agent by priority, according to user's Qos demand.
- Resource Clustering: cluster and device the source in data center and sequence it by computing power through K-means algorithm.
- Function of task parameters and classification: set general expectation vector of task QoS, and assign parameters of classification when submit task by user. Creating visual machine for task execution.
- VM resources parameterized algorithm function: calculating standardized resources parameters on VM host.
- Matching task with resources: In accordance with the classification of task, the task of each category correspond to the general expectations and parameters of the resource vector is matching, computing the Euclidean distance algorithm to achieve the task with the host VM resource binding.

VI. PROVING CASES

The second College Network Skill Contest for Hebei Province in China was hold under Dragon-lab federal experiment Cloud Network environment. Contest resources were distributed in four colleges, which are Tsinghua University in Beijing, Shijiazhuang Railway University in Shijiazhuang, Hebei Polytechnic University in Tangshan, and North China Institute of Aerospace in Langfang. Shared network device resources compose of switches, routers and servers supporting Ipv6,etc.Using cloud computing service mechanisms for this network contest works, it was very effective to realize the share of the various types of network experiment resource ,and it can also reduce concentrated calls of network devices for contests, the players can join contests nearby, which greatly reduced the cost of contests.

The typical applications in this case, which using test bed for Next Generation Network--Dragon-lab federal experiment platform, had proved a number of network services for Ipv6.The content IPv6 address configuration and planning of covers routers, switches and servers, such as:(i)Router configuration: address translation between IPv4 and IPv6, configurations of static routers and OSPFv3 router protocols, ISATAP tunnel configurations, etc. (ii)Switch configuration: switches' IPv6 address configurations, divided VLAN and no-state configuration for subnet getting IP address. (iii)Parts of system application: configuring the ISATAP tunnel on PCs; configuring IIS services on servers which using IPv6 address of servers for access, etc.

VII. CONCLUSION

With the development of cloud computing technology, it will expand a new development space for the contests field. The management and information processing of the contests will gradually migrate to the cloud, which will have a significant and far-reaching impact on the areas of competition. Contest participants can make better use of the information resources and services with the cloud computing services. Contest management agencies can manage the contests resources, organize and operate the contest process much better.

Cloud computing obtained four achievements in the application of network contests:

A. Integrate the resource and improve the service functions of the competition

Through the integration of contests resources, the contests cannot be effected by the geographical location, data processing ability of server etc. The construction of the contests resources need to emphasize the introduction of new technology and the construction of contests contents, meanwhile, emphasize the utilization, retrieval and sustainable development of resources, improving the service consciousness of resource construction, satisfying the effective sharing and utilization of information and resources. Tournament organizers and contests spot who using clouds large-scale server groups, have powerful computation ability and high bandwidth, can rapidly respond to the request of user.

B. Reducing the cost of hardware, providing economical software service

Using cloud computing, most tasks of computing is carried out by cloud end, the computer is just connected to internet. By cloud computing, purchasing cost of hardware and software will be reduced greatly. The demand of terminal equipment is low by using cloud computing. Therefore, cloud computing will be popular in contest field for it can reduce purchasing and maintaining cost for the contest host. Some commonly used software such as online document editing tools, contest software tools can adopt

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cloud computing. If the contest areas connect to the service of cloud computing, the cost of software construction and the expense of maintain and update will be reduced. What the users do is just open the explorer, use the cloud computing, perform the contest management, contest staff management and take part in the contest.

C. *Building contest Platform of network competition , convenient for contest and study*

With the gradual development and popularization of Cloud Computing pattern, processing varieties of information about competition will be gradually transplanted to Cloud, which will take a positive influence on network competition. Cloud Computing will have an active influence on building environment of colonial competition and individual autonomy learning and implementing change and sharing information. Users can freely choose related methods, among those the service, resource and platform are provided by Cloud Computing, which provides network competitor and learner abundant resource of network competition and a favorable platform for competing and studying. That will help to launch network competition.

D. *Providing more secure and reliable data center to avoid illegal attack and destruction*

With the virus and hacker prevailing, the security and reliability of data are becoming more and more important. Cloud Computing service is severing for competition which uses the most advanced data center in the world to store data. There is a powerful technological management team managing the committed data, which provides the competition reliable and secure data storage center. There is no need to worry about the data loss problem caused by intrusion of virus and hacker and destruction of hardware by using Cloud Computing platform.

In the Internet era, the virus and hackers are rampant, data security and reliability is becoming more and more important. Contests which use cloud computing service, can store the data by the advanced data center in the world, have the strong technical management team to manage the submitted data, and provide reliable and safe data storage centers for the tournament. By using the cloud computing platforms, there is no need to worry about data loss problems resulting from viruses and attacks of hackers and hardware damage in the future contest areas

There are many issues that we have to explore because of the opening of cloud computing, high efficiency of equipment, extendibility, deployment flexibility of the business and so on.

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