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Research on the Reconfigurable Network System Based on the Task Decomposition

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Abstract: A new network architecture, the network can be flexible scheduling, combinational network resource to provide service. A new generation of reconfigurable network, the network node with programmable, virtualization and other characteristics, therefore the network node resource can provide richer, flexible service. In this study, the research of reconfigurable network resource allocation and management is very important. Through the effective allocation of resources, the network can be a flexible combination of reconfigurable node of network resources, to provide various services to users. In order to cyber source distribution more reasonable, flexible to meet the diverse needs of users, this combination of cloud resource allocation model of reconfigurable network design system of calculation and relates to the task decomposition and resource allocation of the two key technologies in-depth research.

Key words: Reconfigurable network, task decomposition, resource allocation

INTRODUCTION

Computer and network has become the most important part of the global information infrastructure, it has gradually penetrated into all walks of life and constantly into people's daily life. But from the various investigations and studies, in order to meet the people's daily life information service, diversification and a full range of network business, the network architecture has been difficult to support the network application which is so complex, changeable and provide safe and reliable information service. Therefore, for the current network architecture, its defect is more and more obvious, the gap between the architecture and the demand of the network services of social security and the diversification of the network application is more and more obvious, or even seriously affect the national information security and sustainable development issues. In general, from the point of the basis of network system and the mechanism, information network at present cannot meet the demand that such as the interconnection of heterogeneous network, provide various support diverse network applications, high quality communication services, the safe and reliable information interaction, the effective implementation of the network management. Therefore, we need a kind of new network architecture, so that the new future information network from the internal structure to

avoid recurrence of major problems existing in the current network and the network node capacity can be properly combined, scheduling management of cyber source. Through the flexible combination of the cyber source and the nodes ability, reach the universal realization of network on a variety of business.

On the other hand, in recent years, people's requirements for data storage and computation ability are continually increasing, the major IT companies to gradually increase the hardware investment, expanding the size of data center. This not only makes the data center management, configuration and security issues become more and more complex and even against the green theme. Therefore, rely solely on the increase in the server cannot be fundamentally meet Internet demand. With the development of network technology, cloud computing is born. Cloud computing provides various resources(including storage capacity, computing power, bandwidth and so on) to users in the form of services, It can be based on the physical resources to virtualization the dynamically configurable virtual resources according to the needs of users. It is precisely, of course, this is transparent to the user. Because of these characteristics, cloud computing by the major manufacturers and researchers favor. At present, cloud computing is mainly in the study of data center resources management, cloud security and cloud storage. We started by research on

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resource management of cloud computing data center, can be more reasonable, flexible, timely to allocate resources to each task for cloud, cloud users with efficient, convenient and ensure the quality of service. Information security is the link that the state and enterprises pay much attention to, therefore, research on cloud security information can reduce network hackers to individuals, enterprises and the country's loss. Cloud storage is an important part of cloud services, enterprises can not only efficient storage, access to the internal data, can also become a cloud storage service providers to provide storage service.

With the continuous deepening of the future network research, this article in the context of the research group on the new generation of reconfigurable network system combined with cloud computing data center resource allocation. As everyone knows, cloud computing data center has a large number of computing resources and storage resources and can provide a steady stream of computing power and storage capacity for cloud computing, cloud computing service operators took advantage of these rich computing and storage resources to provide users with a colorful service. But judging from the present situation, the node resources of cloud computing data center, its scalability and program ability is still not perfect. Because of its programmable virtualization features, the node resource of reconfigurable network can provide richer service capabilities. Therefore, In this paper, our research is on the cloud computing data center resource allocation and combined with the cloud computing and the study of a new generation reconstruction of network system and under this architecture is proposed for a recursive task decomposition model based on the ability of the library, it not only can meet the diverse needs of the network, but also can be very good for the cyber source distribution in order to achieve customer satisfaction.

RESEARCH STATUS RECONFIGURABLE NETWORKS

Communication network architecture is designed to be simple; it was originally only designed in order to complete the data exchange, through a "best effort" service model to carry all business. Therefore, it is fundamentally not provide flexible, safe and reliable, controllable management information service. In recent years, Home and abroad have been on active research and exploration on the new information and communication network system from the aspects of the new network architecture, reconfigurable technology. From a new generation of network infrastructure, it should have the

packet, multi-service, QoS, broadband, openness, compatibility, mobility, universal, security, management, operation and other characteristics.

For the reconfigurable network software technology, Xbind (Guojie, 2010) in the early developed a set of distributed software components, we can use the set of distributed components in an ATM-based multimedia network to services create, deploy and manage. In addition, the Massachusetts Institute of Technology designed a modular and scalable network device structure in the Click software router project (Guojie, 2010). This idea that being modular extensible structure in the network equipment has been reflected in Intel IXA software architecture, Juniper's T4000, Cisco's CRS-3, Stanford University 100Tb/s routers and many other projects. For reconfigurable entire network structure, the literature (Tutsch and Hommel, 2002) raised the scalability of routing method used in Reconfigurable Multistage Interconnection Network (MIN).The literature (Fan and Ammar, 2006)studied a reconfigurable overlay network, node or link change, reconfigurable network structure can be used to ensure the quality and performance of the network. Currently, the business network reconfiguration is still rare, in literature (Attig and Lockwood, 2005) for analyzing some characteristics of the reconfigurable network and literature (Demestichas *et al.*, 2006) around the reconstructed purpose beyond sort protocols family of the 3G wireless communications network.

In China, on the reconfigurable network research, the PLA Information Engineering University study on the open architecture reconfigurable routing and switching platforms based on the "component-components-platform" (Binqiang and Jiangxing, 2009); Tsinghua University has proposed a scalable, service-oriented network model (Ke, 2010); National University of Defense Technology has proposed a virtualization technology based on reconfigurable router control software model, through the operating system kernel virtualization technology, reconfigurable network can provide the same operating environment to different components, improve the entire reconfigurable router control software system openness and security (Zexin and Xiaozhe, 2009), Zhejiang University has designed concept based on the green reconfigurable router, through a dormant member to reduce the energy consumption of equipment (Hu *et al.*, 2011); Zhejiang Gongshang University researches on the reconfigurable service mapping, providing a routing node contains a generic roles, protocols, quality and control of the service model of the four types of elements (Fengmin *et al.*, 2010).

RESEARCH ON RECONFIGURABLE NETWORK SYSTEM

With the evolution and development of the Internet, network services and configuration management has become diverse and complex, so we need a new network reconfiguration model to solve the problem of the match between the basis capacity of the network and user business requirements. The traditional load balancing schemes typically need at the entrance of the server cluster, through a gateway or router to monitor and count server workloads and user requests are dynamically allocated to a relatively light load on the server accordingly. However, in a reconfigurable network system, since the network devices through the network controller for centralized control and management and the same time, the application server load can be timely feedback to the network controller, so reconfigurable networks should be very suitable to do load balancing. On the other hand, the traditional network nodes are fixed function and closed structure; it is difficult to meet the scalability, configurability, manageability and even higher demands on the programmability of network nodes. The virtualization technology and flexible programmable mechanism for the introduction of network nodes, network nodes evolved into the open programmable virtual structure to support the implantation and reorganization of the business-oriented features and to support new technologies and applications quickly and easily deploy. When the business needs of the user submits come, we can build a virtual and the network node capacity can be properly combined, scheduling management of cyber source network or a virtual

channel and the abstract network nodes by the completion of the business and in the form of virtual link comprise the virtual channel.

RECONFIGURABLE NETWORK MODEL

The defined Atomic Capability (ATC, Atomic Capability) is an abstract logic function module for programmable network node and to do standardized modeling research on the nodes based on the Atomic Capability. Standardized Atomic Capability modeling abstract a set of logical entities based on node function clustering.

As Fig. 1 shown, according to different processing operations of data packets, Atomic Capability can be classification, typical Atomic Capability includes port Atomic Capability, forwarding Atomic Capability, classification Atomic Capability, the scheduling Atomic Capability.

Typically, the characteristics and needs of the business is diverse and varied, relatively speaking, the service capacity of the network is limited and a model abstracted from the needs of the operational characteristics and network bearer service is determined to effectively bridge the differences in a feasible way. It is divided into a top-down: business layer, Atomic-services layer and Atomic Capability layer, is proposed to meet any business need network reconfiguration model, shown in Fig. 2. Then we can be directly hosted a business networking service broken down into a set of fine-grained elements of basic network services, a basic network service element called "Atomic-services", each business service provided by a set of Atomic-services. The sums
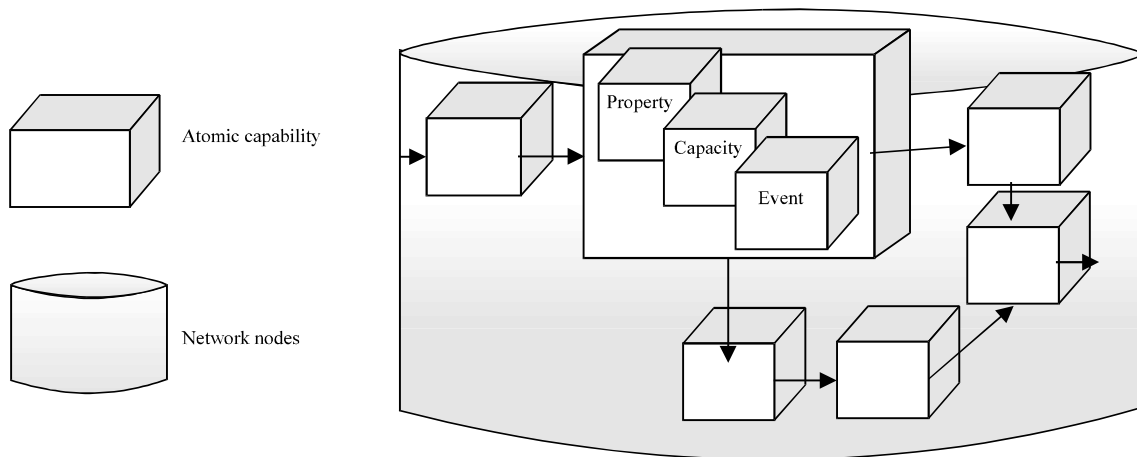

Fig. 1: The atomic capability modeling diagram

of corresponding to the entire business network service elements constitute the network Atomic service layer. Each service need a set of basic network functional elements to be supported and each basic network functional elements is called a "Atomic Capability", all Atomic Capability supporting one Atomic service is called a collection. Sums of the basic network functional elements that all Atomic service corresponding to constitute the network Atomic Capability layer.
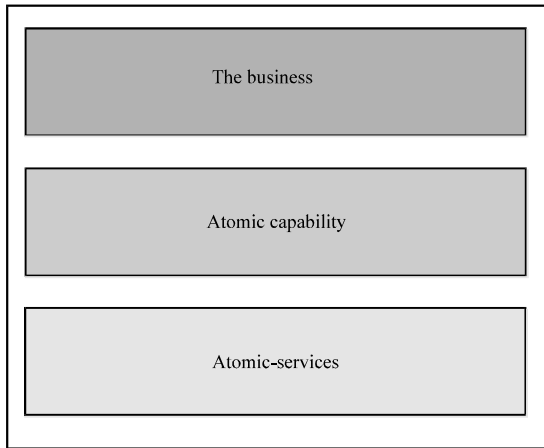
In Fig. 3, from the node supporting whole network reconstruction, we further divided Atomic Capability into points Atomic Capability and plane Atomic Capability. Points Atomic Capability is refactoring abstract logical entity in heterogeneous resources of network nodes, node network with resources to optimize scheduling and planning, points Atomic Capability to provide a basis for the reconstruction of the whole network bearer. The plane Atomic Capability starts from the point of view of the whole network, apperceiving business and clustering and group with the behavioral characteristics of the data plane network resources, suitable for network so as to realize the universal business with Atomic service.

The model performs specific user service request process shown in Fig. 4.

As is shown in Fig. 4, firstly, users submit service requests, through the analysis of the business and issued to each layer of model. Secondly, parameter collector is to collect the memory and CPU resources, storage and other performance parameters on physical node and then delivered to the upper, that is network Atomic Capability layer. Thirdly, network Atomic Capability layer will evaluate based on the principle of optimization, select the most appropriate physical nodes, logical nodes, construct the transfer matrix T. Finally, model layers will be
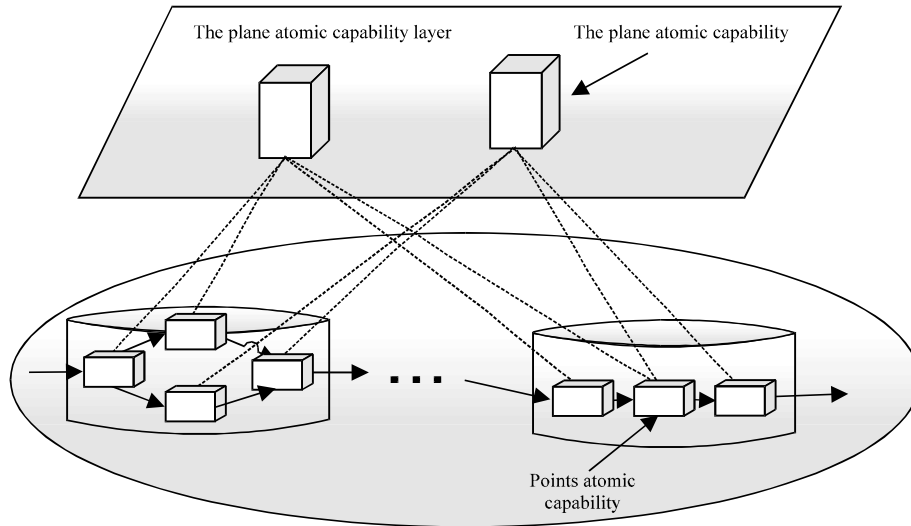

Fig. 2: Reconfigurable network mode

Fig. 3: Atomic capability model

Fig. 4: Business refactoring process

calculated and load configuration information. Once configured, the model layers will execute the business.

RECURSIVE TASK DECOMPOSITION MODEL BASED ON THE ABILITY OF THE LIBRARY

Reconfigurable network system can be well adapted to the diversity of the business, but the complexity of the business may make a single Atomic service can not complete the business needs. As for the task of the large amount of data, we can complete through the idea of distributed computing. Therefore, we consider the decomposition of a complex business and make it corresponds our services; it is a good efficiency to the completion of the entire business.

Map Reduce (Dean and Ghemawat, 2008) is a distributed programming model developed by Google for massive data processing. In simple terms, Map is a divided process, it is to give to certain units of the processor to handle massive data is divided into several pieces; Reduce is an amalgamated process, it is mainly to summarize these results of processors execution.

Shown in Fig. 5, Map Reduce model divides the entire system into three roles that is User, Master and Worker (Sun *et al.*, 2007). User is mainly responsible for submitting the user program to the Master; Master is the master node, is primarily responsible for data partitioning, task scheduling, load balancing, fault-tolerant and so on and processing idle in the cluster will be selected

according to the load of each Worker and will be assigned Map, Reduce task; Worker is a work node, is responsible for receiving the task as well as data processing and calculation from Master. The Worker is divided into Map Worker and Reduce Worker. In MapReduce framework, the task appears in the form of key-value pairs, Map Worker through parsing the key tasks and then perform a Map operation, then the intermediate results are cached on the local disk and save the address of the results returned to the Master; Reduce Worker obtains the intermediate results of the key address from the Master, then read the data and sort key value, perform Reduce operating. Finally, the results are returned to the user program.

This paper proposes a recursive task decomposition model based on the ability of the library on the request of the user task decomposition. It is divided into four main modules: task decomposition module, ability library and task execution policy repository and pipeline library, as shown in Fig. 6.

Task decomposition module for recursive decomposition tasks until the corresponding executing ability can be found in the ability of the library and then allocate it to the implementation of the resource.

Ability libraries are constituted by artificial capabilities and procedures. In reality, we can through artificial or programmed to perform certain tasks. Therefore, regardless of the artificial capacity or the program capacity and any resources to complete the task
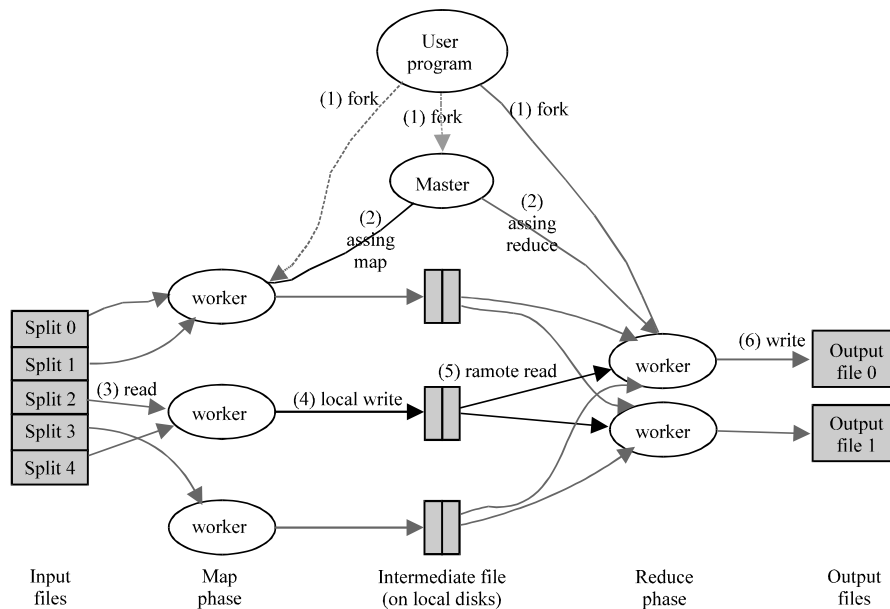

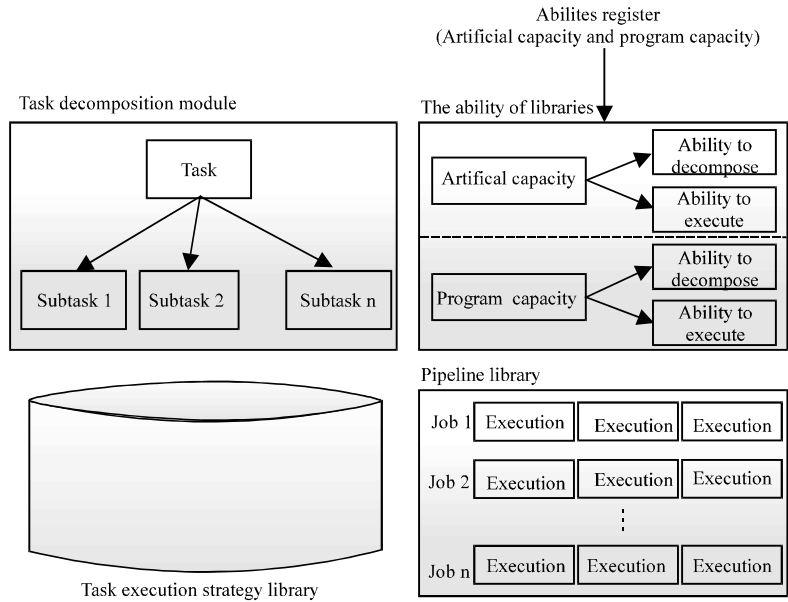Fig. 5: Map reduce framework map

Fig. 6: Recursive task decomposition model based on the ability of thlibrary

can be registered to the ability of the library. Capacity library is responsible for the ability to record each registered resource properties, so that we can statistics system has all the resource capacity, so that we will have the task of resource allocation.

Pipeline base is mainly responsible for the execution of each task according to the matching combination of instruction system of the ability to perform task decomposition was made.

Task execution strategy library is mainly responsible for the implementation strategies of the storage tasks. System is based on the task execution strategy library to determine whether the business that user submits is a new task. In addition, the task execution strategy library also contains a set of key features abstract from known business and a list of rules corresponding to the key element of the service and its parameters set, the policy library can effectively guide the business in accordance with the distribution of its collection of business execution strategy to pipelined execution, to improve the effectiveness and overall performance of the business fit. That is, if it is known to the task, direct scheduling to match task pipelining library implementation; and the request for a new type of task decomposition, performing the task, the system will analyze, collect the key features of the task and the strategy will be added to the task execution strategy library, task execution strategy library with their own ability to learn.

RECONFIGURABLE NETWORK RESOURCE SCHEDULING SYSTEM

Based reconfigurable network resource scheduling system is shown in Fig. 7. The programmability, management and flexibility of reconfigurable resource pool node resources are better and Atomic service is corresponding task decomposition module library's ability to execute and task execution is more efficient.

Shown in Fig. 8, a reconfigurable network-based resource scheduling model is mainly divided into four modules: business module, task decomposition module, resource allocation module and reconfigurable resources module.

BASED RECONFIGURABLE NETWORK BUSINESS MODULES

Reconfigurable network-based business layer is mainly used for user interaction. The layer is to show users a web page and user interaction; the user can through the page to submit the business. Business layer through cognitive mechanisms to cluster and abstract the characteristics and requirements of the network business, extracting basic network service elements of various types of business needs from business layer, that is the business property. System is based on business property description to allocate resources.
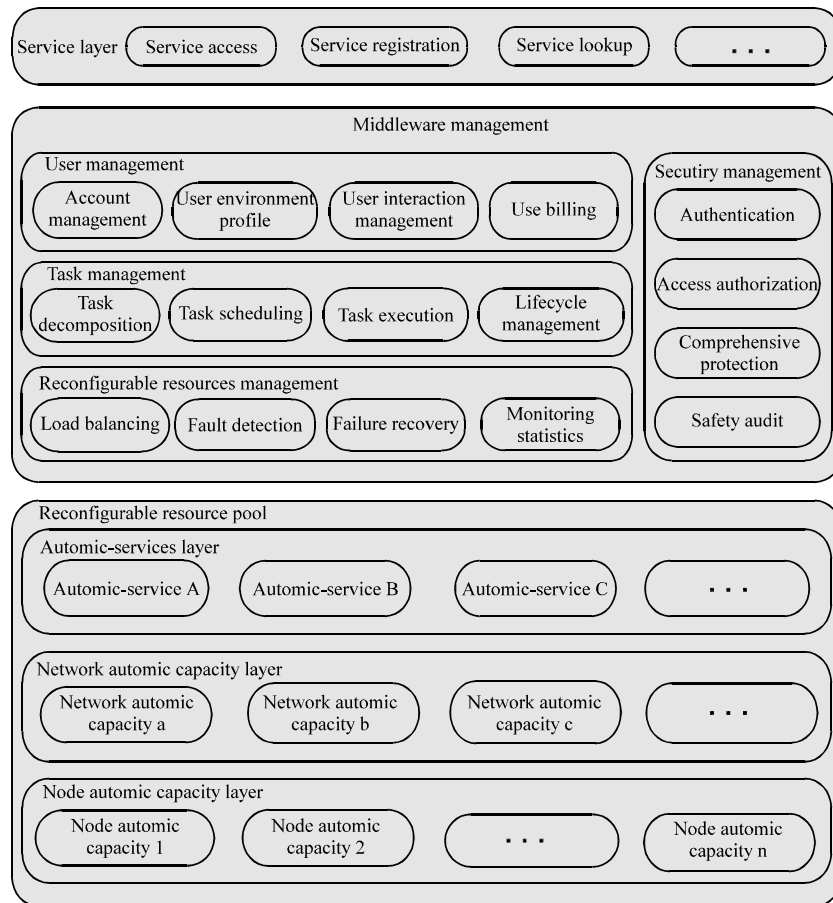
Fig. 7: A reconfigurable network-based resource scheduling system

Shown in Fig. 9, the reconfigurable network business layer is composed more than one business and a description of each business can have multiple attributes, where each attribute of the business to treat it as a job. So, each business can be seen as constituted by a plurality of jobs and for a description of these operations may include:

- The type of operation, such as the priority consideration of task completion time or the task of being completed to cost
- Job ID, job length, job creation
- Completion of the job deadline time (Deadline), the operating budget (Budget)

RECONFIGURABLE NETWORK-BASED TASK DECOMPOSITION MODULE

Based reconfigurable network task decomposition is mainly responsible for the decomposition processing various jobs in the business layer. Some cannot find a

suitable ability to match in the library because some of these operating constraints, so we need to decompose them, until you find the right execution capabilities. Based reconfigurable network capacity is provided by reconfigurable network resources. Reconfigurable network-based task decomposition model has been described in detail, the decomposition process shown in Fig. 10:

- Users to submit certain types of service request
- The system will determine whether it is a new type of task according to the task strategy library
- If the request for a known task, directly to the task of matching the pipelined execution, wait until the execution is completed after the end
- If the request for a new task, according to the ability of libraries to match and decomposed into multiple sub-tasks, continuous cycle until each sub-task can correspond to the execution capabilities of the ability library, wait until the execution is completed after the end
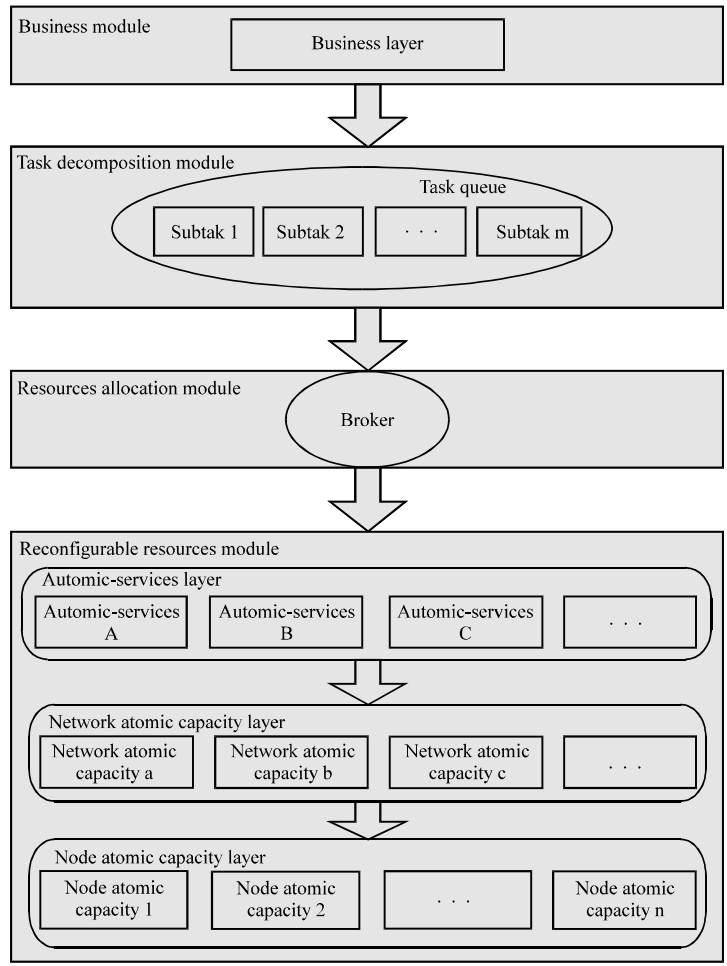
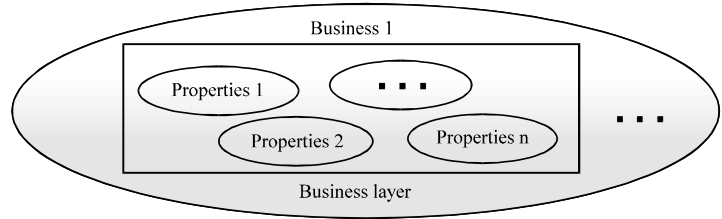Fig. 8: A reconfigurable network-based resource scheduling model

Fig. 9: Based reconfigurable network business layer model

After the end of the task decomposition, task execution strategy libraries would be to learn the implementation strategy of the new task, its key features and implementation of strategies will be added to the library of task execution strategy for the next encounter this k ind of tasks, then it can be directly matched to the pipeline for processing.

RECONFIGURABLE NETWORK-BASED RESOURCE ALLOCATION MODULE

The reconfigurable network resource allocation module is mainly responsible for the allocation of resources according to the description of the tasks and resources, then we can be more rational use of resources, it is equivalent to a resource broker and is mainly responsible for the following tasks:
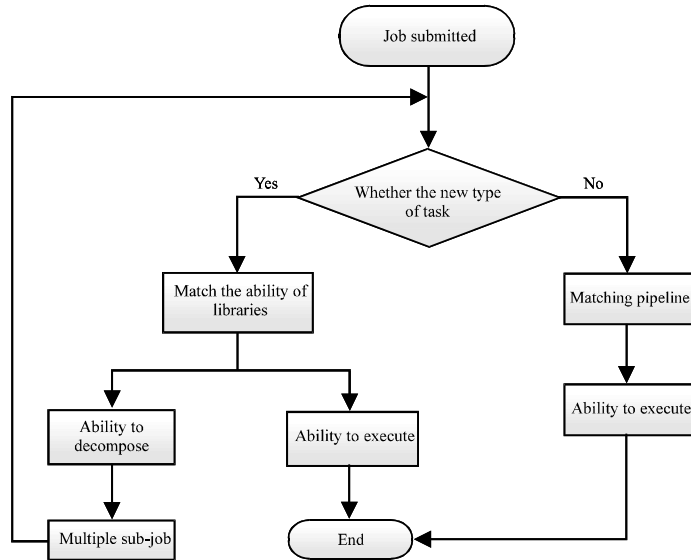
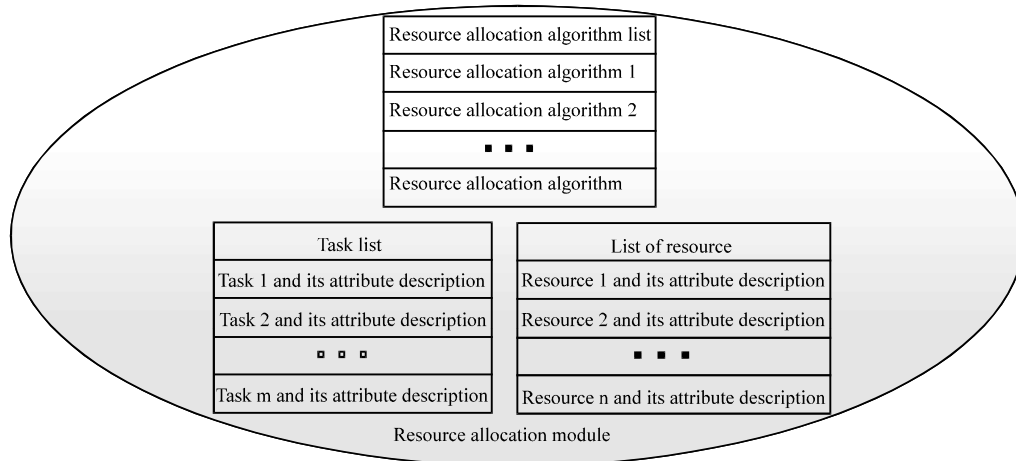Fig. 10: Reconfigurable network-based task decomposition process

Fig. 11: Reconfigurable network-based resource allocation module

- After reconfigurable network task decomposition module decomposition task will be submitted to the Resource Broker
- Reconfigurable resource pools will regularly report to the Resource Broker about current use of resources, including resources in real-time load, new registration of resources, destruction of damaged resources
- The agent is based on tasks, resources and the development of resource to allocation strategies to allocate resources

Shown in Fig. 11, based reconfigurable network resource allocation module consists of three tables: task list, a list of resources and a list of resource allocation algorithm. The task list is used to store main attributes of the task queue, a list of resources is mainly used store all resources and their attributes of the reconfigurable resource pool and a list of resource allocation algorithm for storage resource allocation algorithm, agent according to the preferences of task and the actual situation of resources to select the appropriate resource allocation algorithm for matching the tasks and resources.

**RECONFIGURABLE NETWORK
RESOURCE POOL**

Resources of reconfigurable resource pool mainly consist of three parts: Atomic-services layer, network Atomic Capability layer and node Atomic Capability
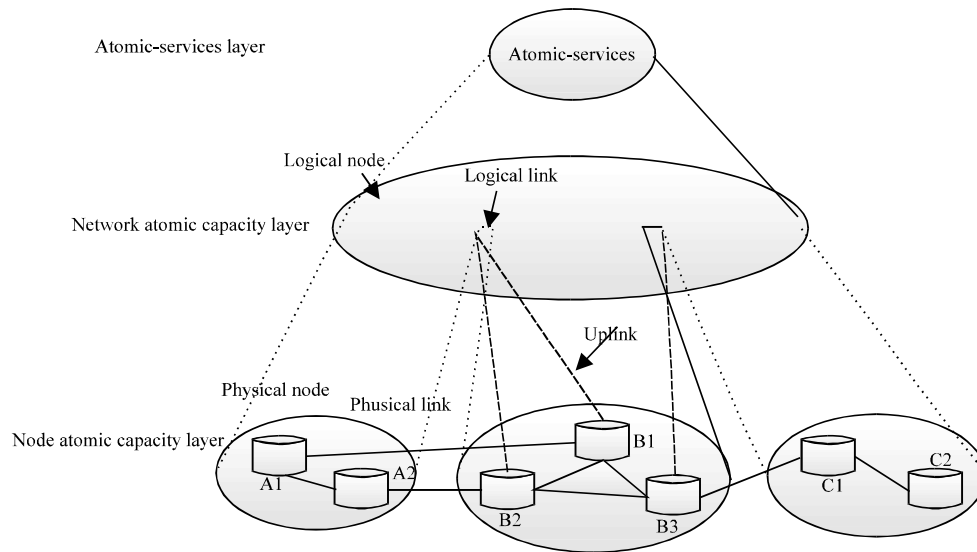
Fig. 12: Reconfigurable network resources

layer. Shown in Fig. 12, reconfigurable network is interconnected network composed by reconfigurable network equipment.

In the reconfigurable resource pool, reconfigurable network equipment correspond node Atomic Capability and many reconfigurable network devices connected through the physical link to form node Atomic Capability layer. Therefore, the resources in the node Atomic Capability layer have virtualization programmable features, which greatly improve the reconfigurable properties, combined properties and other properties of the resources. Because each physical node of node Atomic Capability layer has virtualization features, so we can through the network virtualization technology to reconstruct the function that multiple nodes element can complete, then form network Atomic Capability, so network Atomic Capability is logical node. Atomic Capability layer is by this network Atomic Capability network through the virtual link to form. While the Atomic service is some network Atomic Capability through logical link connection reconfiguration services. So, the more Atomic services constitute Atomic-services layer to support the business layer, it provides support to the completion of the business needs of the user submits. Task decomposition based reconfigurable network module, the implementation of the ability of the library is realized through Atomic service. Specifically, Atomic service using one or more network element capacity logical link connections to form a virtual private network, the network is designed to handle certain types of tasks, which is the ability of library about this kind of task execution.

Some scholars have proposed some reconfigurable network systems, such as the reconfigurable network based on components (Liu *et al.*, 2010), the reconfigurable network based on Crossbar (Bo *et al.*, 2012), the reconfigurable network based on P2P traffic planning (Ma *et al.*, 2012) and the reconfigurable network based on network centrality and topology potential (Wang *et al.*, 2012), compared to those, reconfigurable network based on task decomposition proposed on the paper is a combination of the above advantages, combined with the programmable technology and automation and it is better to do load balancing, to meet the user in the network node scalability, configurability, manageability and even higher demands on programmability.

CONCLUSION

At present, more and more tasks in data network capacity, in order to improve the system of task request acceptance rate, we combine MapReduce decomposition model to design task decomposition model based on the ability of libraries. It is divided into four main modules: task decomposition module, ability library and task execution policy repository and pipeline library. Task decomposition module for recursive decomposition tasks; ability library is used to store system decomposition and implementation capacity; task execution strategy library is mainly responsible for the implementation strategies of the storage tasks. The pipelined library used to combine a variety of executive ability to complete tasks.

At the same time, we design a resource scheduling model based on reconfigurable system and introduce each module of the model.

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