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Resource Mapping Algorithm Between the Layers Based on Reconfigurable Network

[1,2]Bin Zhuge, [1,2]Li Deng, [1,2]Huanhuan Song, [1,2]Guowei Dai, [1,2]Weiming Wang and [1,2]Julong Lan
[1]College of Information and Electronic Engineering, Zhejiang Gongshang University, Hangzhou, 310018, People Republic of China
[2]Institute of Information Engineering, Information Engineering University, Zhengzhou, 450002, People Republic of China

Abstract: With the increasing number and variety of network business, the existing Internet architecture can't be able to meet the ubiquitous, heterogeneous and credible requirements of advanced services at home and abroad. Many new institutions and individuals have begun to research the next generation of network's architecture which is called reconfigurable network. Reconfigurable network can be divided into Atomic Capability layer and Atomic Service layer and Business layer. In order to achieve effective cooperation between the upper and lower layers in the hierarchical model, this study plans to design a "mapping" mechanism to complete the virtual network requests between upper and lower layers. This study proposes a virtual link embedding and virtual node embedding algorithm to complete the service request process. Simulation result shows that: the algorithm plays an important role in improving the utilization of network resources as well as energy saving.

Key words: Reconfigurable network, path splitting, path migration, virtual network

INTRODUCTION

Nowadays, a sharp increase of network traffic due to the continuous expansion of the network size and a variety of large-scale deployment of new network applications, traditional network operator that takes a "best effort" mode has caused a serious obstacle on the future of the Internet technology innovation. Therefore, the future network is a developing trend and direction. The next generation network has become a current research focus, the general view of academia to the next-generation network is the essence of the new network should be maintain the consistency and coherence of the network development. Take full account of information infrastructure that combined with unknown network, capable of supporting various fields comprehensive information on the basis of fully considering a controllable credible information infrastructure (Liu *et al*., 2010).

If the current network is described as the "best effort" service model to carry the network business, it cannot effectively meet the ubiquitous, interconnected, quality, integration, heterogeneous, credible, tube, scalability requirements of advanced services. Ubiquitous information services, diversification and a full range of network services, different businesses may have different QoS requirements, these issues challenge the current network architecture system. Flexible reconfigurable network is proposed to solve these problems (Liu *et al*., 2010; Qi *et al*., 2010). The reconfigurable network model provides an opportunity to resolve the contradiction between supply and demand of the current Internet. Unlike traditional networks, reconfigurable network is business-oriented which has loose relationship between the network services provided by the network users (Wang *et al*., 2012).

The emergence of virtual network makes people see a rudiment of the future network. The increase of the business lead us to create a new network architecture that can provide a variety of different services to support different application requirements and the features of the intrinsic network structure can adaptively adjust the characteristics and requirements of the business. In the recent years, research institutions at home and abroad research and explore the new network architecture, different reconfigurable facets of the technology, architecture of network routing switch and technology of the new information and communication network system actively.

This study mainly research resources embedding algorithm between different layers of the reconfigurable

Corresponding Author: Bin Zhuge, College of Information and Electronic Engineering, Zhejiang Gongshang University, Hangzhou, 310018, People Republic of China

network, the algorithm includes virtual link embedding and virtual node embedding algorithm, the basic idea is the path splitting and path migration. The study's purpose is to improve the resource utilization of the element capacity layer through embedding mechanism between the different layers of configurable network. Finally, the study will use the CloudSim simulation tool to prove that the embedding algorithm can improve the utilization of network resources and it plays an important role in energy efficiency.

HIERARCHICAL MODEL OF RECONFIGURABLE NETWORK

Some research on network virtualization: Network virtualization technology plays a very important role in the study of reconfigurable network. Reconfigurable network which supports network virtualization divides the traditional network service providers into two categories, one is the substrate network provider and the other is the service provider. The substrate network provider is responsible for the operation and maintenance of the underlying substrate network, including network equipment, network topology. The service provider does not have the physical resource, they lease the resources from the substrate network provider and create a virtual network to provide services to the user.

Virtualization technology allows multiple virtual networks to share a physical device. Each virtual network is logically divided into different logical collection resources of the physical device. Virtualization technology achieves a logical abstraction of resources and unified representation which greatly reduces complexity of management, improves resource utilization and operational efficiency so that effectively control the cost.

Currently, virtualization technology has a lot of virtualization concept, in the computer field, virtualization technology has been applied to memory virtualization, storage virtualization and desktop virtualization; in the field of communication, virtualization is related with many technologies, for example, Asynchronous Transfer Mode (ATM), virtual circuit, Multi-protocol Label Switching (MPLS) virtual path, Virtual Private Network (VPN), Virtual Local Area Network (VLAN) and virtual overlay network.

Through theoretical study on the network, network virtualization technology is considered to be an effective means to resolve the current Internet "ossification" (Schaffrath *et al*., 2009; Guo *et al*., 2010). In the innovative experiments on future network research, network virtualization technology and the new reconfigurable routing equipment is an important part of the design to research and testing group (Mckeown *et al*., 2008). In the reconfigurable network, network virtualization is also an important supporting technology.

HIERARCHICAL MODEL OF RECONFIGURABLE NETWORK

With the problem of network changes, the U.S. National Science Foundation (NSF) began to support the Global Environment Network Innovation (GENI) platform. The NSF has officially announced GENI program on August 22, 2005 (Hu and An, 2007). This plan is to explore new Internet architecture so as to promote scientific development and stimulate innovation and economic growth. On the one hand, GENI is committed to building a global programmable laboratory facility that provide support for the study of future network technology, on the other hand, NSF has funded projects as funding for its research programs.

The main research of this study is a new Internet architecture, which is called reconfigurable network. Reconfigurable network system is composed of business layer, Atomic Capability layer and Atomic Service layer. The three-functional model is based on virtualization technology. The model is shown in Fig. 1.

In the model that is showed in Figure 1 bearer services provided for adaptive business is achieved through building a logical bearer network. The so-called logic bearer network (hereinafter referred to as the logical network) refers to the network provide the ability according to the service. In accordance with the entry node, exit node, bandwidth requirements and the type of business specified users appointed, it can built private network on top of the substrate network in order to meet user's business needs, the nature of it is to build a private transmission network information flow channel for user's services. The logical bearing layer provides users network services generated by logical bearer network; the edge of the layer can be

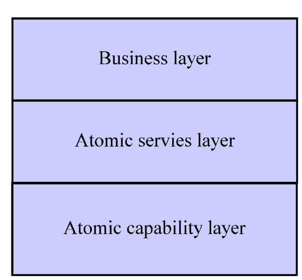

Fig. 1: Hierarchical model of reconfigurable network

reconstructed according to the needs of logical bearer layer, the use of resource sharing layer provides the physical resources to construct a logical bearer network (Wang *et al*., 2009). The lower in the model is to provide support for the upper, it provides network elements required to build the network and services. It can also provide the necessary services to the reached business and improve resource utilization.

The basic idea of the reconfigurable network is structure determines function, the network reconstructed different structure to meet the diverse and changing business needs. In reconfigurable networks, the relationship between each layer is the layer below provides the resources to the top layer, while the top layer manages the following layer in order to achieve network reconfiguration. The virtual network of the upper layer is a subset of the substrate network resources. The same underlying infrastructure network can provide support for different user services which reduces the network innovative greatly.

The business layer is located in the uppermost layer of hierarchical model of the reconfigurable network, if the service is divide in accordance with the business order in the network, then business layer is the first layer that service for arrived business requests.

Specifically, when the user sends a service request, he does not know the structure of network resources which is not yet formed virtual network. When diverse service requests are sent to the business layer to process, business layer will extract the elements of the basic network services required by the business. As is shown in Fig. 2, the business layer gets network service elements through the cognitive mechanisms of abstracting, clustering and refining characteristics and requirements of different types of business, so that the business layer can give the information to the layer below it. A network business may eventually be clustered a number of different business attributes, these properties are handed over to the underlying Atomic Service layer as logic unit to process.

The atomic service layer locates under the business layer and above Atomic Capability layer. The Atomic Service layer can carry various types of network services that reach from the business layer.

Figure 3 shows the morphology of business layer and the Atomic Service layer. In the network, arrived

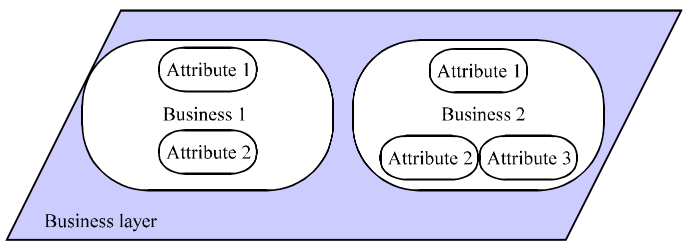

Fig. 2: Morphology of the business layer

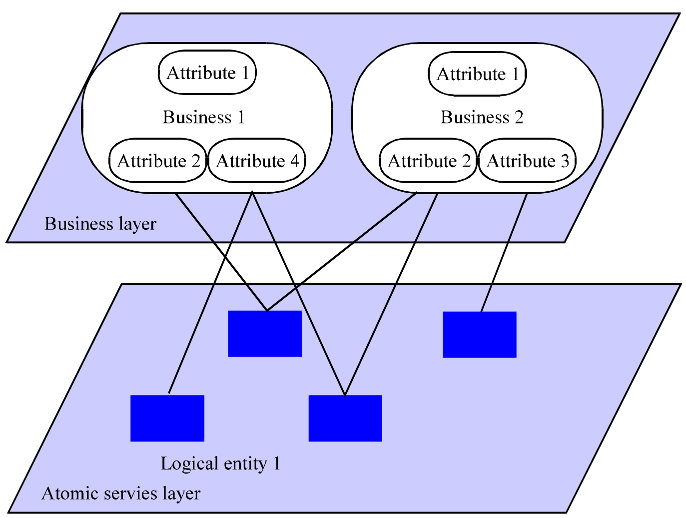

Fig. 3: Reconstructed morphology of business layer and atomic service layer

business is formed to various attributes flag business through the business layer's extraction, clustering and then divided into various properties given to service layer to process. Atomic Service layer diversified business cluster and abstract through the characteristics and requirements of public which can reduce the coupling between the network resources and business to the maximum extent.

Atomic Service layer is formed by a lot of logical entities, these logical entities are created based on its lower layer which is called Atomic Capability layer to abstract and reconstruct heterogeneous resources. Various attributes of the business unit in the business layer is handed over to these logical entity to deal with, one logical entity can only deal with a kind of attribute but the types of attribute can come from different business. For example, as shown in Fig. 3, logical entity 1 in service layer can handle attribute 1 which includes attribute 1 of business 1 and business 2. They are all processed by the logical entity 1. Atomic Service layer adapts to the business through the reconstruction of each logical entity and achieve the universality of diversified business through the mutual cooperation between the various logical entity and flexible combination of internal resources. Meanwhile, different from other single business that is handled by proprietary virtual network, business of reconfigurable network hierarchical mode can be a complex business service flow combined with a variety of business service. For example, video file business contains images, voice business which can be correspond to the element in the service layer to be dealt with separately, the relationship between the business and service layer is no longer just a one-to-one relationship but may be one-to-many or many-to-one relationship.

Atomic capability layer is located below the atomic service layer which provides basic network carrying capacity within the scope of the whole network. Compared with Atomic Service layer that services for business in internet more directly, the more important thing Atomic Capability layer to do is to provide the support for the entire network.

As is shown in Fig. 4, Atomic Capability layer consists of many Logic Function Blocks (LB), these

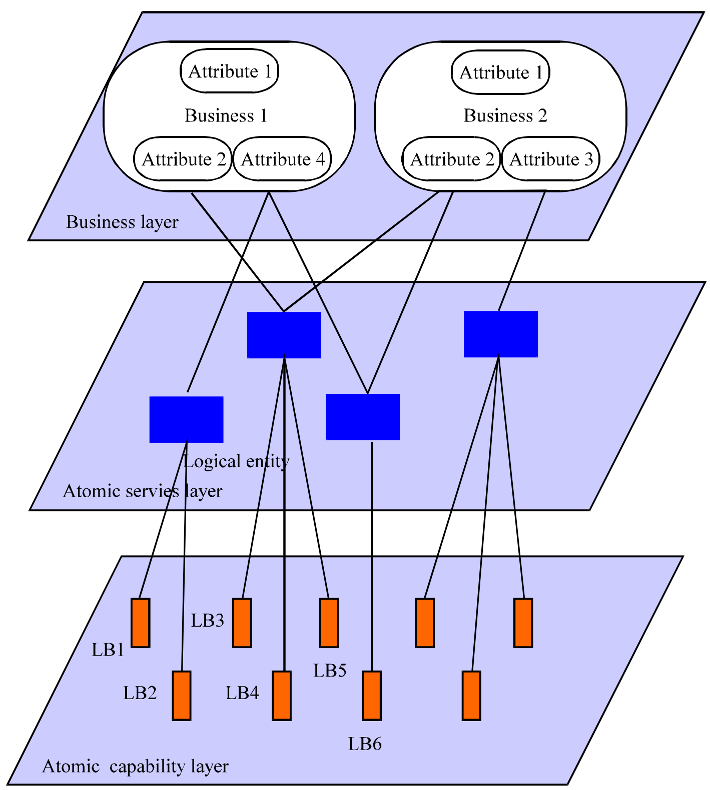

Fig. 4: Reconstructed morphology of business layer, atomic capability layer and atomic service layer

logical function blocks are generated through reconstructing and abstracting heterogeneous resources of the substrate network node and they can be logical entities. Atomic Capability layer shows network's element capacity and can be divided into the point Atomic Capability and surface Atomic Capability that clusters and groups basic transmission capacity provided by internet through dynamic perceiving dynamic behavior characteristics of business, node resources and network resources. It can coordinate, cognitive and dynamic adjust to capacity and resources within the global network, so that to provide a variety of basic carrying capacity within the scope of the whole network for Atomic Service layer.

Specifically, the point element capacity is a logical entity that reconstructs and abstracts from heterogeneous resources in the network's nodes. Point element ability provides a basis for the reconstruction of the whole network's bearer, the logical entity formed by the virtualization of the underlying physical resources has optimal schedule and plan for the network resources of the node. The point element capacity can be seen as the concept of the virtual subnet.

Surface capability is from the point of view of the whole network course, the network is also based on the logical network virtualization technology, it can percepts business, clusters and groups with the behavioral characteristics and network resources on the data plane so that can adapt to Atomic Service to achieve the universality of a variety of business in the network. The Atomic Capability layer builds or reuses these resources by sensing the characteristics and the dynamic characteristics of the nodes in the whole network resources and network resources which provides basic network carrying capacity within the scope of the whole network for Atomic Service layer.

The logical entity in service layer is reconstructed by the Atomic Capability layer's LB but the specific function of these logical entities is decided by the Atomic Capability layer's LB's remodeling mechanism. For example, in Fig. 4, the logical entity 1 is reconstructed by the logic function blocks of LB 1 and LB 2 and the logical entity 2 is reconstructed by LB 3, LB 4 and LB 5, while the logical entity 3 is corresponded directly to LB 6.As mentioned above, logic function blocks in the Atomic Capability layer are the essentially same as the logic entities in Atomic Service layer, they are all logical entity with specific functions generated by the heterogeneous resources through reconfigurable mechanism, or it can also be called logical function blocks.

RESEARCH ON RESOURCE MAPPING ALGORITHM IN RECONFIGURABLE NETWORK HIERARCHICAL MODEL

Currently, in academic research, many people agree that virtualization method in reconfigurable network is an effective means to solve the "ossification" problems now, in terms of innovation and experiment, network virtualization and new reconfigurable routing equipment are important parts of the network design about the future of network research and test.

From the above, the intrinsic features of the reconfigurable network structure could change according to the characteristics and needs of the business and effectively adapt to diverse business. However, a "mapping" mechanism is needed to achieve effective cooperation between the upper and lower layers in the reconfigurable network structure and to complete the services process of virtual network users' request. The reconfigurable network can learn from the traditional mapping relationship between virtual and substrate network and get resource allocation process through researching on traditional node mapping and link mapping.

TRADITIONAL VIRTUAL NETWORK NODE MAPPING AND LINK MAPPING

The first thing virtual network mapping should involve is describing the problem, regardless of the underlying network resources or the upper virtual network request, they all should have a mathematical language to describe when they are discussed in mapping algorithm.

Firstly, the study uses a non-directed graph G^s to represent the underlying network resources which G represents a non-directed graph and s represents underlying network resources. Secondly, N^s and L^s in the study represent the collection of nodes and links in the underlying network, respectively. The nodes and links in the underlying network are associated with their attributes, so the study uses A^s_N and A^s_L to represent their attributes, A^s_N only considers the CPU processing power and position attributes in node resources and A^s_L only considers bandwidth capacity of the link attribute. P^s is used to describe all acyclic paths in the substrate network.

Then, the study denotes a virtual network request by an undirected graph $G^s = (N^v, L^v, R^v_N, R^s_L)$. A virtual network request usually has link and node constraints that exist in substrate network. The study uses R^v_N and

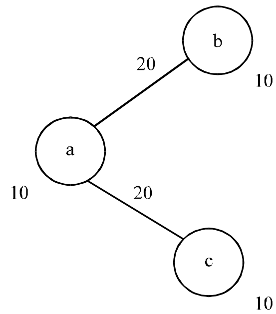

Fig. 5: Virtual network requests 1

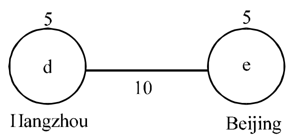

Fig. 6: Virtual network requests 2

R^v_L to denote link and node constraints, respectively. Fig. 5 and 6 depicts two VN requests: the VN request 1 requires the bandwidth 20 over the links (a, b) and (a, c) and the CPU resource 10 at all nodes a, b and c; the VN request 2 is connecting two nodes d, e and d, $e \in N^v$, the constraints is that node d should be in Hang Zhou (where substrate nodes D and G are located) and node e should be in Beijing (where substrate nodes E and I are located), there are ten units of bandwidth on the virtual link between them.

At last, the study should consider Specific virtual network mapping problem. A virtual network embedding for a VN request is defined as a mapping M from G^v to a subset of G^s, such that the constraints in G^v are satisfied, i.e.,:

$$M: G^v \to (N', P', S_N, S_L) \quad (1)$$

where, $N' \in N^S$ and $P' \in P^s$ and S_N and S_L are the node and link resources allocated for the VN requests. In fact, the VN network embedding can be divided into node and link mapping as follows:

Node mapping: $M^N: (N^v, R^v_N) \to (N', S_N)$

Link mapping: $M^L: (L^v, R^v_L) \to (P', S_L)$

The following Fig. 7 shows the VN embedding solutions for the two VN requests. In VN request 1, the nodes are mapped to the substrate nodes A, E and F and the virtual links (a, b) and (a, c) are mapped to the substrate paths (A, D, E) and (A, D, F) when the bandwidth and CPU constraints are all satisfied. In VN request 2, besides node and link constraints, the study should also consider the substrate constraints of virtual node d and e, so they are mapped to (G, H).

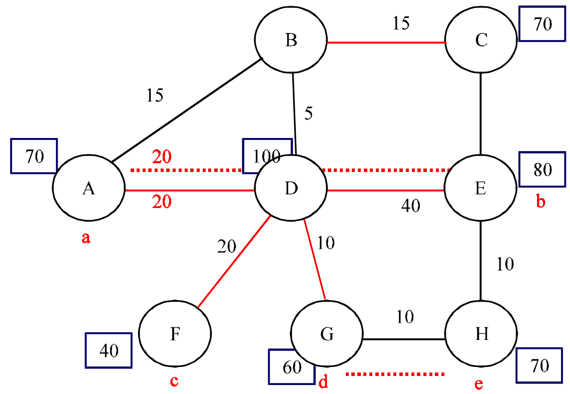

Fig. 7: Traditional resource embedding

The first thing virtual network should consider is target problem what aspects of the requirements satisfy. Such as revenue problem, the more VN requests a virtual network can meet, the better quality of a service, the higher the underlying resource utilization and the higher gains may get. So the study should put forward an efficient embedding algorithm for the online problem, where VN requests arrive and depart over time. From the substrate network provider's point of view, an online embedding algorithm that satisfied VN request would be to maximize the revenue.

The study is denoted by P (G^v (t)) the revenue of serving the VN requests at time t. The purpose is to maximize the long-term average revenue, given by the following:

$$\lim_{T\to\infty} \frac{\sum_{t=0}^{T} P(G^v(t))}{T} \quad (2)$$

The revenue can be defined in various forms according to economic models. The study mainly focuses on bandwidth and CPU as the main substrate network resources above. A basic computing virtual network request service revenue is weighting sum revenues for bandwidth and CPU, each of which is proportional to the amount of the requested resources in order the substrate provider can strike a balance between the relative costs of the two classes of resources. So the study introduces a tunable weight α. In a VN request $G^v(t)$, the study defines P (G^v (t)) as its revenue at any particular time t. Then the formula is as following:

$$P(G^v(t)) = \sum_{l^v \in L^v} bw(l^v) + a \sum_{n^v \in N^v} CPU(n^v) \quad (3)$$

where, bw (l^v) and CPU (n^v) are the bandwidth and CPU requirements for the virtual link l^v and the virtual node n^v, respectively. It can be seen from the forum that the bandwidth revenue is not affected by the substrate paths that the virtual links are mapped to, especially physical distance and the mapped paths. This seems to be reasonable because VN requests only care about whether their constraints in the substrate network can be satisfied or not. They will not pay for longer distance. In order to get long-term revenue maximization, it is crucial to use efficient embed scheme when VN requests arrives, such as occupying substrate resource minimally. Because an inefficient embedding of a virtual network may limit the substrate's ability to accept future requests.

PATH SPLITTING AND PATH MIGRATION IN RECONFIGURABLE NETWORK

Each virtual link embedding restricted to a single physical link embedding make the embedding problem difficult to calculate and generates the inefficient embedding results. Based on this problem, the virtual network request only needs to satisfy its own constraints and here is no impact on the distance and position of the embedded physical path, the study proposes a hypothesis: a virtual link is no longer solely embedded to a single physical path on the substrate network that is substrate network should support flexible splitting of virtual links over multiple substrate paths and suggest a new link-embedding algorithm which the characteristic is very flexibility. And how to regularly re-optimize virtual link-embedding that already exists so that the underlying substrate network can accept more requests. Of course, it is an important problem that how to support substrate path splitting and migration is in the actual network.

PATH SPLITTING IN RECONFIGURABLE NETWORK

In order to know the problem of path splitting, the study considers the following figures. Figure 8 is each line's requirement of virtual request. In this virtual network, there is three virtual nodes and two virtual lines, each virtual line needs 20 units of bandwidth, three virtual nodes are mapped to physical nodes A, E and F and two virtual lines are mapped to substrate path (A, D, E) and (A, D, F), as is shown in Fig. 9.

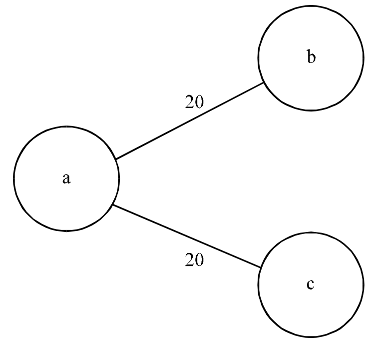

Fig. 8: Virtual network request 1

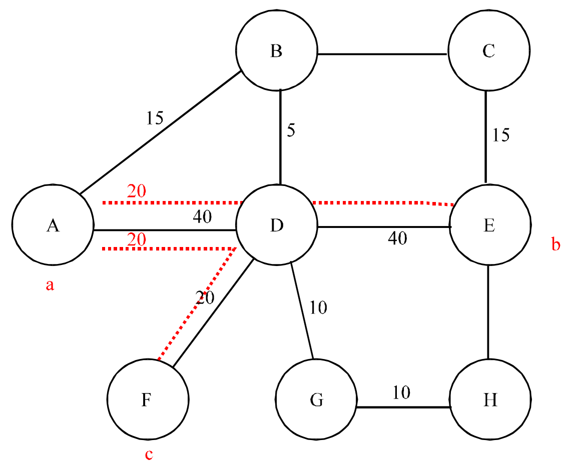

Fig. 9: The original graph of virtual network request 1

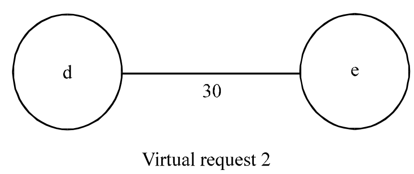

Fig. 10: Line requirement in virtual request 2

Now, assuming that there is a new VN request arrives which is a single virtual link that requires 30 units of bandwidth as shown in Fig. 10. However, there is no path suitable for this new VN requests in substrate network. If the substrate network can give 20 units of bandwidth on the path (D, E) and 10 units of bandwidth on the path (D, G, H, E), then the new virtual network can be mapped to nodes D and E. That is to say, directing two-thirds of the traffic on the path (D, E) and one-third on the path (D, G, H, I, E), so that the substrate network can accept the second request. As is shown in Fig. 11.

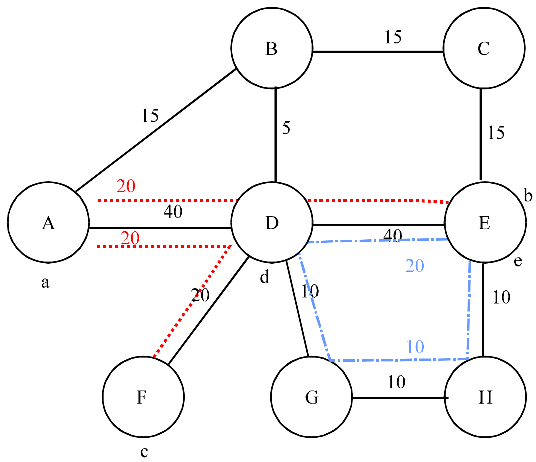

Fig. 11: Path splitting in virtual request 2

Path splitting gets better resource utilization through using small pieces of available link bandwidth and accepts more virtual network requests in substrate network. In addition, the flexible path splitting makes it easier to calculate link-embedding problem. Multi-flow problem can be solved in polynomial time. Multi-path has many advantages, such as load balancing and reliability which are better than a single flow path.

PATH MIGRATION IN RECONFIGURABLE NETWORK

The main ideal of path migration is changing the route and ratio of a virtual link, so the network can better handle online reached VN requests. This is proved to be another advantage of allowing multi-path in the substrate network.

Since VN requests in the network arrive and depart over time, the substrate network may easily fall into an inefficient configuration where resources are increasingly dispersed, forcing the substrate network to reject future requests or guide new virtual links to more expensive paths. Theoretically, the network could deal with these problems with predictive models of future requests and mathematical techniques like dynamic programming. However the practice is that the arrival and departure of requests is unpredictable and the underlying search space is too large which leads to the infeasibility of dynamic programming. Instead, the substrate network should be able to readjust virtual network's embedding to make more efficient use of the substrate resources and to maximize the chances of acceptance of the future requests. If the virtual links can be migrated to different substrate paths

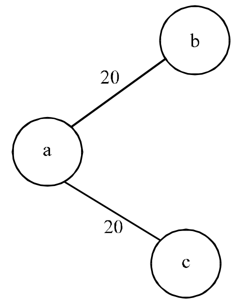

Fig. 12: Link request of virtual request 3

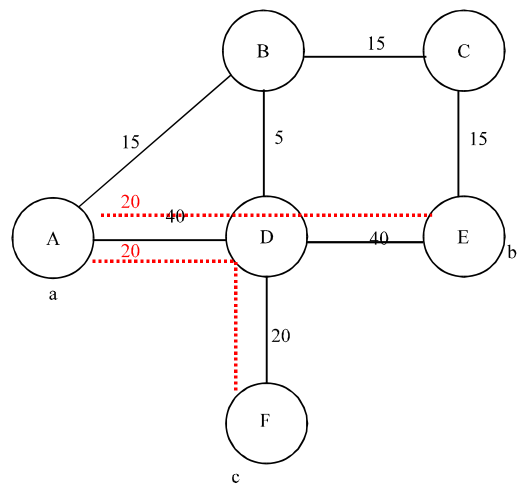

Fig. 13: Mapping path of virtual request 3

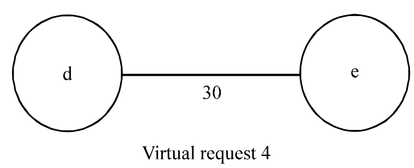

Fig. 14: Link request of virtual request 4

while maintaining the virtual node mapping unchanged, it can improve the substrate's ability to accept virtual request.

In order to show path migration's ideal clearly, the study considers the following example. At the first, the substrate network only has one virtual network mapping on which three nodes, a, b and c which are showed in Fig. 12 are mapped to the physical nodes A, E and F which are showed in Fig. 13 and two virtual link (a, b) and (a, c) are mapped to the physical link (A, D, E) and (A, D, F) where each virtual link needs 20 units of bandwidth in Fig. 12.

Now, suppose there is a new virtual request arrives which is showed in Fig. 14. The virtual request needs 30 units of bandwidth. Unfortunately, even if allowing

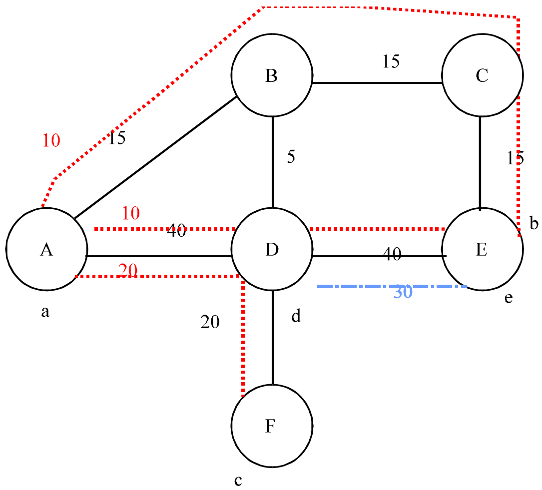

Fig. 15: Virtual link migration mapping process

path splitting, there is no pair of nodes in the substrate network to accommodate the new virtual request. As is shown in Fig. 13, there is a path (D, E) with 20 units of bandwidth, a path (D, B, C, E) with 5 units of bandwidth and a path (D, A, B, C, E) with 0 units of bandwidth between the nodes D and E, however, these are not enough to support a virtual link that requires 30 units of bandwidth. If the first virtual network's traffic can be migrated to a different physical path, then the substrate network could accept the new request. The underlying substrate network should transfer half of the traffic of path (a, b) (originally mapped to the physical path (A, D, E)) to a new path (A, B, C, E) to make substrate link (D, E) has more bandwidth. Then, the second virtual network can make link (d, e) mapped to substrate path (D, E). It can be shown in Fig. 15.

As is shown above, keeping the node mapping of the virtual network that already running on the substrate unchanged. The study performs path migration by rerunning link mapping algorithm. Virtual path request 3's splitting ratio is changed and has new path, the bandwidth distribution changes from 20:20-20:10:10.

If only allowing adjustment of the splitting ratio without creating any new paths, that is to maintain the original (A, D, E) and (A, D, F) but each link's bandwidth adjust accordingly. For example, the splitting flow ratio replaced by 30:10. Linear constraints as follows:

$$f(c_i, l^s) = 0, \;\; l^s \subset L^s \tag{4}$$

Of course, if it allows to create a new mapping path, there is no problem described above. Path migration allows us to constantly correct virtual network's mapping problem and handle a large number of virtual requests to improve the utilization of substrate resource (Yu *et al*., 2008).

However, in fact, path migration will introduce indirect overhead to establish new paths through creating new paths and shutting down the old path. Therefore, considering the benefits of path migration, the study should also weigh against its cost. To illustrate this point, the study expects the VN request can be quite diverse in their duration and their duration is the running time ranging from several hours to several months in the substrate network. Here is an example, a content distribution network like Akamai (Zhang *et al*., 2005) can run infinitely, while an impromptu conference or video game may only last for a few hours. The study hopes that the algorithm does not migrate very short-lived virtual network, for example, the network exits quickly after completing the migration. Therefore, the study's algorithm only considers the duration of the VN requests which is larger than a certain threshold. Fortunately, in practice, migrating long-running virtual networks are able to provide adequate benefits, because many short-lived virtual networks will come and go while they are running. VN request should indicate their likely duration, or the virtual network which has been running for a long period of time will continue to run for a long time, similar to previous studies on migration in the context of job scheduling.

From the above analysis, it can be known that the resource embedding problem is actually the resources allocation of virtual request. Because the VN requests can divide into online VN request and offline VN request, so the requests allocation of resources can be divided into online resource allocation and offline resource allocation. Compared to request of offline resource allocation, request of online resource allocation problem is much simpler, because constraints information of the request of offline resource allocation has been clearly known before making resource allocation, so they only need to allocate resources in accordance with the appropriate requirements (Lu and Turner, 2006; Shamsi and Brockmeyer, 2007).

EXPERIMENTAL SIMULATION

In this experiment, the study uses CloudSim tool to simulate energy consumption with new scheduling algorithm and data center agent. The advantages of CloudSim are supporting large-scale cloud computing modeling and simulation and a platform that supports

Table 1: Information of simulation equipment

	5 physical machine's configuration	20 virtual machine's configuration
CPU	3000 MIPS	Dynamic
Memory	10 GB	256 MB
Bandwidth	1000 (Mb sec^{-1})	100 (Mb sec^{-1})
Peak power consumption	250W	

self-contained data center, service agent, scheduling and allocation strategy. CloudSim adds Data center Broker in it. The basic process is as follows: Firstly, the initialization of Cloudsim package which each simulation needs; Secondly, creating a data center; Thirdly, creating host and adding it to the list of hosts in which the parameters of the host are ID, memory bandwidth and so on; Fourthly, creating feature object of data center which includes architecture, operating system and a list of machines; Fifth, creating a data center object and its parameters include baud rate, peak load and so on, then creating a data center agent to coordinate the relationship between users and service providers according to service quality requirement of users and deploy service work; At last, the study should create virtual machines, they are the nodes of a virtual network, these virtual machines also have a range of parameters, including the ID, allocated memory, bandwidth, CPU number; creating a task and set the number and the length of the task, then, the simulation can start and statistical results can be achieved.

In this simulation experiments, the data center includes 5 hosts and each host is configured a processor with 3000 MIPS and peak power is 250W, the study allocates 10 GB memory for each host and the bandwidth is 1000 Mb/s. The data center has a total of 20 virtual machines, these virtual machines will spread all over the hosts. The virtual machine's configuration memory is 256M, allocated bandwidth is 100 Mb sec^{-1}. Configuration information list are showed in Table 1.

When virtual machine migrates, it arranges in descending list based on the utilization of each host, that is the virtual machine which more than the maximum threshold most is the first to move out and migrated destination host based on the utilization of small to large order, the minimum utilization of the host will be the first to accept the migrated virtual machine.

The 25 sec is the virtual machine's state before migration, while the 35 sec is the state after the virtual machine migrates. Between the 25 and 35 sec of the system time, the output of the information, the utilization and power consumption changes of the host 1, 2, 3, 4 and 5 are shown in Fig. 16 and Fig. 17.

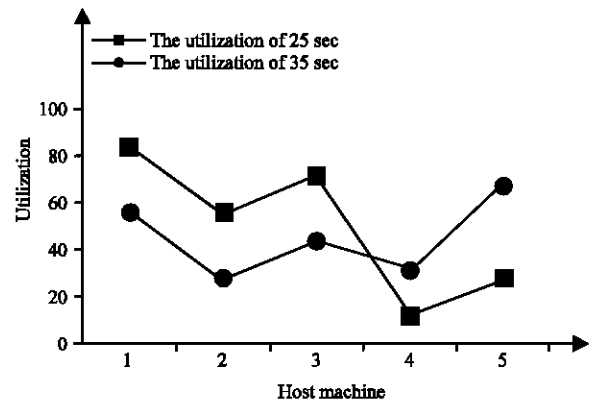

Fig. 16: Utilization of each host before and after virtual machines migrate

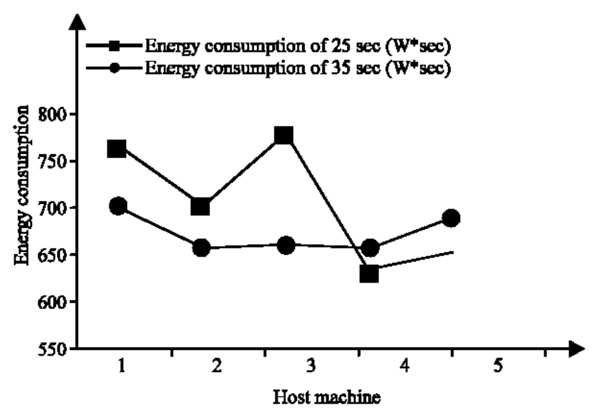

Fig. 17: Comparison chart of energy consumption of each host before and after virtual machine migrates

From the above two figures, it can be seen that: the utilization of each host in the 25 sec is quite different. The utilization of host 1, 2, 3 is higher than it is in 35 sec but host 4 and 5 are lower than the utilization in 35 sec. And power consumption differences in 25 sec is also large. While in 35s, virtual machine migration make load balance so that each host's utilization is similar and the average energy consumption is small. Therefore, the result can be concluded that: the difference of the energy consumption of each host in the 25 and 35 sec is mainly due to the change of utilization of the host which lead to changes in energy consumption. Therefore, the research resources mapping algorithm has some advantages in energy saving and resource utilization.

CONCLUSION

This study mainly describes the reconfigurable network and a resources embedding algorithm in reconfigurable network. The algorithm is divided into virtual node embedding and virtual link embedding, its main idea is path migration and path splitting. Finally, the study can show the importance of this algorithm in improving resource utilization through the experimental simulation data. Above all, it can be seen from the study that resource utilization has been significantly improved with this algorithm in the reconfigurable network and the timeliness of the information is better, this overcomes the bottlenecks of insufficient resources in modern network. The emergence of reconfigurable networks will have a significant role in promoting the information society.

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