Intensive Traffic Resource Scheduling based on Map/Reduce in Multi-domain Optical Networks

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Abstract. In the intelligent optical networks, there are two key problems in the long-distance and high-speed intensive service transmission. First one, the sharing scheduling problem of the optical networks resources, namely the privacy problem. Second problem, users of network services require high-quality, real-time protection. Based on these two key issues, we focus on the resource scheduling of intensive services under the premise of ensuring the privacy of each domain. Firstly, the physical resources of optical network is virtualized, and the architecture of optical network resource management is improved, namely IRMON, addresses privacy issues. On this basis, Map/Reduce is introduced into resource scheduling. The simulation results show that the scheduling of optical network's intensive traffic resource based on Map/Reduce can greatly shorten the scheduling time.

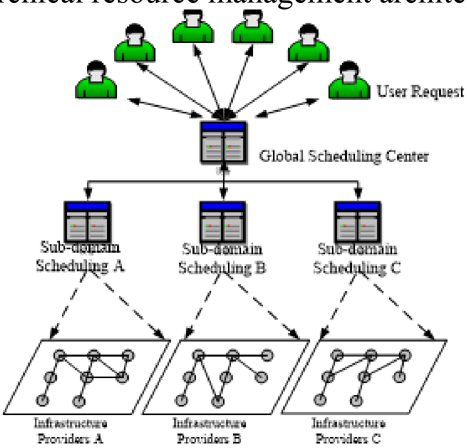
Introduction

The existing intelligent optical networks resource management architecture can be divided into two kinds of mechanism: centralized management and distributed management. The processing efficiency of centralized management is relatively low, the applicable network is small, and poor scalability [1]. Distributed management is characterized by good scalability, but the complexity of implementation is very large, the network overhead is heavy, it is difficult to realize the mapping and scheduling of the cross-autonomous domain scale [2]. The existing resource scheduling algorithm can be divided into traditional scheduling algorithm and heuristic intelligent scheduling algorithm. The traditional scheduling algorithm has the round robin scheduling algorithm, tabu search, these algorithms are simple, easy to implement features, but poor performance when dealing with complex problems [3]. The heuristic intelligent scheduling algorithm can find the optimal solution better and introduce it into the resource scheduling application, which can improve the performance of scheduling efficiently. But the algorithm is relatively complex in searching the optimal solution [4].

In this paper, a IRMON architecture is proposed, and a virtual resource module is added to the global dispatch center to store the physical resources of the optical network. On this basis, combining Map/Reduce and scheduling algorithm to improve the resource scheduling method.

IRMON

This article uses the hierarchical domain resource management strategy, establishing a centralized management and distributed control management model, as shown in Fig.1. The architecture consists of a global scheduling center and a sub-domain scheduling center. The main function of the global scheduling center is responsible for the overall resource scheduling management, network users access control, authentication management, network partitioning and other functions. The main function of the sub-domain scheduling center is responsible for the resource allocation in the area, including the functions of resource discovery, resource status monitoring, fault management, and mobility management. Infrastructure providers, which stand for intelligent optical networks, deploy and manage the underlying physical network resources, and responsible for the operation and maintenance of the physical infrastructure. The global scheduling center is composed of a global scheduling module, a location information database, a registration module and a virtual resource module. The sub-domain scheduling center is composed of a resource discovery module, a resource scheduling module, a resource monitoring module and a resource information database. The structure of the global scheduling center and the sub-domain scheduling center in the hierarchical resource management architecture are shown in Fig.2.



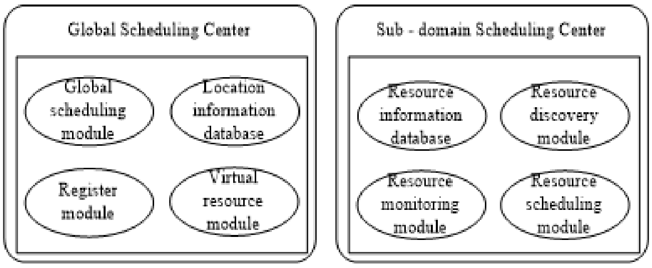


Fig.1.Resource scheduling framework

Fig.2.Scheduling center module

The improved optical network resource scheduling process is shown in Fig.3.

Step 1: Initialize the resource information database of each sub-domain scheduling center to virtualize the physical resources into virtual resources in an abstract way, and submit the corresponding attribute information of the virtual resources to the intra-domain scheduling center, then perform the resource registration. The virtual resource module in the intra-domain scheduling center upload the virtual resource information to the global scheduling center and open to the whole network.

Step 2: The user describes the resource request based on the request description language firstly, which includes requirements for nodes and links. The requirements for the node resource include the node type, the network protocol stack type, the connected virtual link type, and so on. The requirements for link resources include bandwidth, delay, and delay jitter. After generating the request description, the user submits the request to the global scheduling center. After receiving the request, the global scheduling center checks the validity of the user first. If the user passes the authentication, the corresponding request is placed in the service waiting queue.

Step 3: For the request of the cross-domain resource scheduling, the global scheduling center divides the request according to the geographical location information of the node and the geographic information of the infrastructure provider. The global scheduling center executes the resource scheduling.

Step 4: The global scheduling center accesses the global shared virtual information in the virtual resource module according to the request of the cross-domain resource scheduling proposed by the user, and uses the resource discovery algorithm to query a set of available virtual resource candidate sets from the global virtual resource set.

Step 5: The global scheduling center allocates resources according to different resource allocation objectives, such as improving the mapping revenue, improving load balancing, reducing the node link pressure and other resource constraints such as node requirements, node location information, link bandwidth requirements. and responsible for selecting the optimal resource from the candidate resource set. This process is called resource selection.

Step 6: After the resources are selected, the infrastructure provider allocates and reserves virtual resources for the users according to the instructions of the intra-domain scheduling center, gives the users the right to use the resources within the time of life and implements the services that necessary for guaranteeing the user's operation of the network service.

Step 7: Contrary to the resource reservation process, resource reclamation refers to the process in which the intra-area scheduling center reclaims the network resources after the network lifetime.

After resource reservation and resource reclamation are successful, it is necessary to update the information such as the number of nodes available in the resource information database and the available bandwidth of the link.

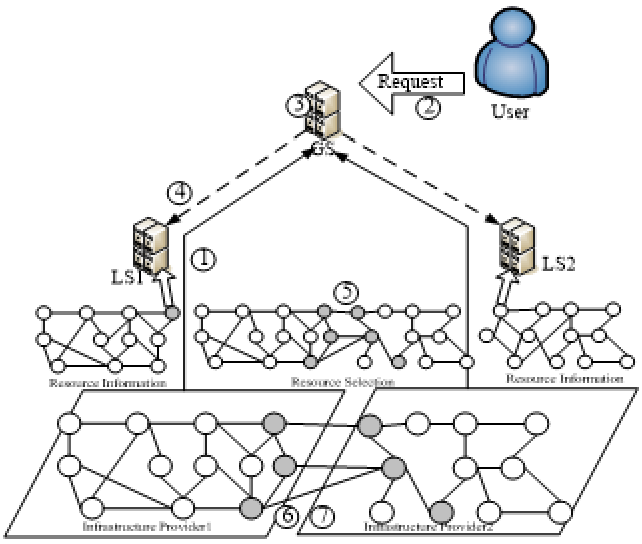


Fig.3.Scheduling center module

Intensive traffic Resource Scheduling Based on Map/Reduce

The idea of Map/Reduce [5] is distributed parallel processing, traffic decomposition and reduction of computing results. In order to deal with large-scale intensive traffic transmission, this paper introduces the idea of Map/Reduce mode creatively. On IRMON architecture, when the intensive service arrives at a node of the optical network, it is assumed that the node is an agent node. First, the input split function is used to divide the traffic data into N blocks. The agent node starts the Map task, and lists the nearest 2N nodes as the candidate nodes. The nodes design the scheduling algorithm according to the traffic request. Calculated from the algorithm's key-value pairs from the Mapper, which are automatically sorted by the essential attributes of the key, and the calculated intermediate results are stored in the buffer of each node. Agent nodes perform Reduce tasks, according to the scheduling algorithm and the value of the sort to find out the best N nodes (leaving N nodes as candidate nodes). In the different scheduling time, the block traffic are scheduled to the domain to meet the traffic needs of the best nodes for parallel transmission processing resources. If a best node can not perform the task, it returns a failure message to the agent node, and the agent node re-selects the best node assignment task from the candidate nodes which are not selected. When a service flow is processed, the resource reclaims and updates the network resources. The scheduling based on Map/Reduce is shown in Fig.4.

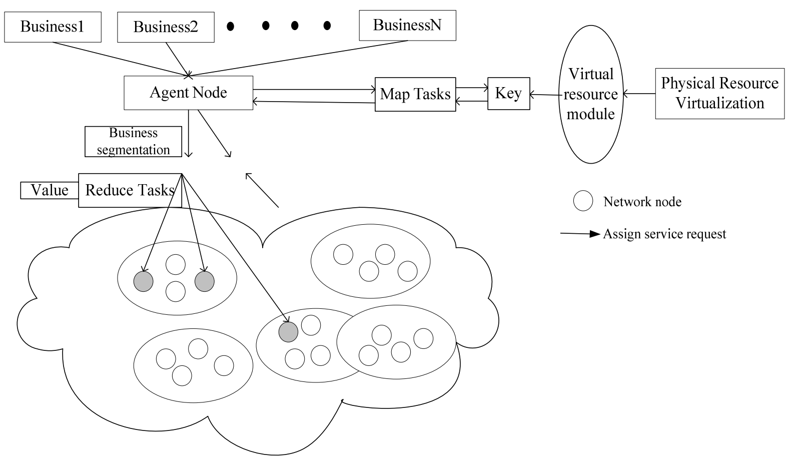


Fig.4.Scheduling based on Map/Reduce

Test results

In this section, The open source software, CloudSim, is extended to the resource virtualization tool that uses the Vm Java classes provided by it to inheritance and extension of Java classes to virtualize network resources. First, it needs to modify the parameter class, the virtual machine corresponds to the optical network physical node, the virtual machine parameter corresponds to each domain node parameter index .There are 10 virtual nodes in the simulation. The performance parameters of the node include tasktrackerid, jobtrackerId, mips, pesNumber, ram, bw, ur, lr, er, size, wavelength, transceiver, tasktrackerm, newCloudletSchedulerTimeShared(). The intensive services in this experiment are all on the order of T bits per second. The comparison time between scheduling algorithms and their Map/Reduce scheduling are shown in Fig.5.

Fig.5.Comparison time between scheduling algorithms

It can be seen from the comparison of the above four algorithms with their Map/Reduce scheduling algorithms. In the case of 20 intensive services, The time needed for scheduling based on Map/Reduce is 14.06% less than that based on sequential scheduling; The time needed for scheduling based on Map/Reduce is 22.13% less than that based on greedy scheduling; The time needed for scheduling based on Map/Reduce is 20.37% less than that based on delay cost scheduling; The time needed for scheduling based on Map/Reduce is 19.60% less than that based on distinguish traffic scheduling.

In optical network, when the number of services increases from 20 to 40 and 80 in the same network resource allocation, the corresponding services are 100, 200, 400, and the comparison is based on four types of Map/Reduce scheduling. The result are shown in Fig.6.

Fig.6.Comparison time between scheduling algorithms

It can be seen from the above comparison chart, the four scheduling algorithms based on Map/Reduce compare the four scheduling algorithms in the intensive traffic volume of 20,40,80 of scheduling time is significantly reduced, that is based on Map/Reduce scheduling is more suitable for Intensive traffic transmission.

Conclusions

In this paper, Firstly, the physical resources of optical network is virtualized, then to the IRMON architecture, addresses privacy issues. On this basis, Map/Reduce is introduced into resource scheduling. The scheduling of intensive traffic resource scheduling based on Map/Reduce can greatly shorten the scheduling time.

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