Research on Hybrid Scheduling Mechanism based on SOA and Cloud Computing

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***Abstract*—In this paper, we review the features and applications in scheduling the service and flow for using SOA and cloud computing, combine the advantage of service orchestration of SOA and the dynamic scheduling technology of cloud computing. We propose a hybrid scheduling mechanism based on SOA and cloud computing, design three application models of hybrid scheduling, and have a comparison analysis of them, through the examples of using domestic mapping satellite data to verify the practicability and validity of the hybrid scheduling mechanism. Finally we give the conclusion.**

Keywords- hybrid; scheduling; cloud computing; SOA; flow

I. INTRODUCTION

The development of information technology (IT), especially the rapid growth of using Service-Oriented Architecture (SOA) and cloud computing technology in different domains in recent years, promotes the process of the information technology, and improves the production efficiency in different domains.

SOA is a software design and software architecture design pattern based on structured collections of discrete software modules, known as services, that collectively provide the complete functionality of a large software application [1]. The purpose of SOA is to allow easy cooperation of a large number of computers that are connected over a network. Every computer can run an arbitrary number of programs - called services in this context - that are built in a way that they can exchange information with any other service within the reach of the network without human interaction and without the need to make changes to the underlying program itself.

Cloud computing is a combined IT technology. Google CEO Eric Schmidt first mentioned "Cloud computing" in a speech on the Search Engine Strategies conference in August 9, 2006. Google, Amazon, IBM and Microsoft, and other Internet and IT giants put cloud computing as a core strategy in the future. At present, there is no uniform definition for Cloud computing, and people have different understanding of cloud computing, for example cloud computing is Internet-based computing; cloud computing is the integration of a number of new technologies includes virtualization, cloud computing computing, distributed computing, public computing, WEB2.0, SAAS an so on; cloud computing is a information system which can provide the IT resources to the users based on actual usage of resources[2][3].

II. NORMAL SCHEDULING MECHANISM

A. SOA Scheduling

SOA is a kind of modular information system, which encapsulates business function as a service. The SOA scheduling is through the construction of the business services set that meet the requirement of business, than orchestrate these services in different ways, so as to achieve a new or better business process.

SOA scheduling is centralized scheduling. The service requestor's requests are forwarded by the routing function of the service bus, and link the service to the corresponding technology. SOA scheduling has the hierarchical structure of multi layers in logical, which is easy to clear the functions and responsibilities of each layer, and can achieve the separation of the functions to achieve business and the technology, business and technology decoupling at the same time. Meanwhile, it has the characteristics of location and protocol transparency.

B. Cloud Computing Scheduling

Cloud Computing scheduling refers to multiple job mapping to multiple administrative domains on resources. A cloud computing work can be divided into many small tasks. The task scheduling is based on the execution time or throughput and resource utilization cost, considers the needs of users and applications, and then chooses the resources and scheduling. Usually the Cloud Computing scheduling consists of 4 main stages: resource discovery, resource selection, scheduling and task execution[4][5].

Cloud computing has many scheduling strategies. They are widely used both at home and abroad, and the common scheduling strategy is first in first out (FCFS), priority based scheduling (Priority), FirstFit and BestFit, Reservation, Bickfilling etc[6][7].

C. Comparison of SOA Scheduling and Cloud computing Scheduling

SOA scheduling and cloud computing scheduling both have the advantages and disadvantages. The differences between them mainly refer to the following aspects.

SOA scheduling is based on the standard service and flow, in charge of registration, management, maintenance the service and flow, and communicates through the service bus, scheduling through the BPEL engine. SOA scheduling is focused on the logical level scheduling, and is a large size, task level scheduling. We usually call the SOA scheduling

static scheduling, because SOA scheduling does't have the resource selection function.

Cloud computing Scheduling can also achieve the business process management and control, but it does not require service and flow in standard format. It is a kind of dynamic scheduling, which focuses on the dynamic selection of resources. It is a small granularity, lower level, resource level scheduler. It can flexibly choose different scheduling methods, shorter the overall execution time, and improve work efficiency. It has the disadvantage that the scheduling has not had a unified format, which is difficult to control the flow in logic layer.

III. HYBRID SCHEDULING MECHANISM

Because SOA Scheduling and Cloud computing Scheduling have different advantages and disadvantages, they can complement each other. SOA Scheduling is suitable for static schedule the service and flow of in the logic layer, while Cloud computing Scheduling is good at dynamic schedule the service on resource level. So we combine the advantages of SOA Scheduling and Cloud computing Scheduling, giving the structure of Hybrid Scheduling and three application models.

A. The Structure of Hybrid Scheduling

Hybrid Scheduling is based on hierarchical scheduling, and SOA Scheduling focuses on the control of business services and flows. Cloud computing Scheduling focuses on dynamic selection and scheduling of resources. We give the Structure of Hybrid Scheduling as shown in Figure 1.

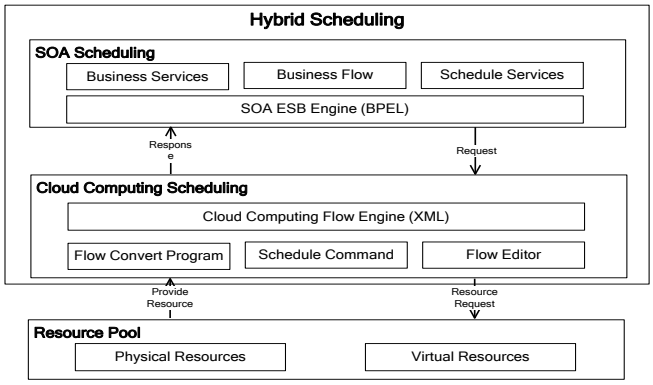

Figure 1. The Stucture of Hybrid Scheduling.

Hybrid Scheduling combines SOA Scheduling with Cloud computing Scheduling, and uses the static scheduling and dynamic scheduling flexible, when it is necessary. The Hybrid Scheduling can convert static scheduling to dynamic scheduling through flow converter, use the characteristic of friendly flow editor interface and the standard services in efficiency of SOA, and at the same time, make full use of the characteristics of cloud dynamic scheduling.

Hybrid Scheduling is composed of three layer, which are SOA scheduling layer, cloud computing scheduling and resource pool. In SOA scheduling layer, the business services and business flow are managed by the SOA Enterprise Services Bus (ESB), and the schedule services is used to realize dynamic scheduling which is packaged for the schedule command of cloud computing schedule. The SOA scheduling layer sends resource or schedule request to the cloud computing scheduling layer and receives the available resources which are provided by the cloud computing scheduling layer.

The cloud computing scheduling layer, which receives the resource or schedule requests from the SOA scheduling layer and converts the SOA flow format to cloud computing flow format, can also use the flow editor to make the flow, then use the schedule command to cloud computing platform for selecting the suitable resource and do the job. The resources are provided by the resource pool, and finally give the response to the SOA scheduling layer.

The resource pool layer receives the resource requests which are from the cloud computing scheduling layer, and then provides the physical or virtual resources to the cloud computing layer.

B. Application model 1:SOA flow converst to cloud computing flow (dynamic scheduling totally)

In application model 1, we use SOA flow editor to customize the business flow quickly. The flow format is according to the format of Business Process Execution Language (BPEL). BPEL format flow cannot be accepted by cloud computing platform directly, so we should use the flow format convert program that is custom developed to change the BPEL format flow to the unique cloud computing flow format which is XML format. Then the cloud computing schedule engine receives the converted flow document, called the schedule command to select the appropriate resources for executing the job and flow, and finally sends the state and result of the job and flow to SOA. In this model, the whole process is dynamic scheduling totally. We give the Structure of Application model 1 as shown in Figure 2.

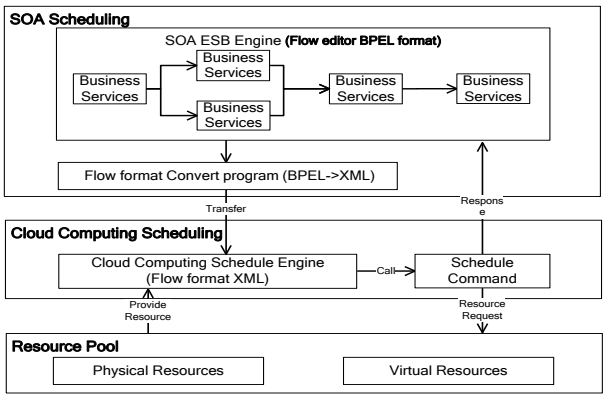

Figure 2. The Stucture of Application Model 1.

C. Application model 2:SOA flow calls scheduling command service of cloud computing totally (dynamic scheduling totally)

In application model 2, we use SOA flow editor to customize the business flow quickly, and the flow format is

according to the format of Business Process Execution Language (BPEL). Each business service in the flow isn't called by SOA engine directly, and instead we use schedule service to call the business function which is accepted by the cloud computing platform such as exe, bat and etc. In this way, we should not convert the SOA flow to cloud computing flow format, but we also have the dynamic scheduling capability for using the schedule service which packages the schedule command of cloud computing. Then the cloud computing schedule engine calls the schedule command to select the appropriate resources for executing the job and flow, and finally sends the state and result of the job and flow to SOA. In this model, the whole process is dynamic scheduling totally. We give the Structure of Application model 2 as shown in Figure 3.

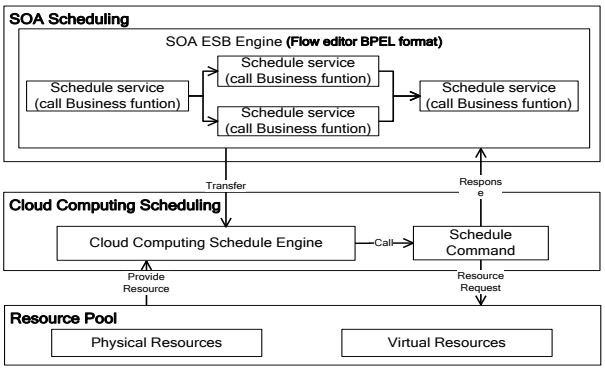

Figure 3. The Stucture of Application Model 2.

D. *Application model 3: SOA flow calls scheduling command service of cloud computing partly (dynamic scheduling plus static scheduling)*

In application model 3, we use SOA flow editor to customize the business flow quickly. The flow format is according to the format of Business Process Execution Language (BPEL), and some business services are called by SOA engine directly, but others are not.I Instead we use schedule service to call the business function which is accepted by the cloud computing platform such as exe, bat and etc. In this way, we should not convert the SOA flow to cloud computing flow format, but we also have the dynamic scheduling capability for using the schedule service which packages the schedule command of cloud computing. Then the cloud computing schedule engine calls the schedule command to select the appropriate resources for executing the job and flow, and finally sends the state and result of the job and flow to SOA. In this model, the whole process has the function of static scheduling and dynamic scheduling. We can flexibly choose which jobs need dynamic scheduling, and on the other hand, which jobs need static scheduling. We give the Structure of Application model 3 as shown in Figure 4.

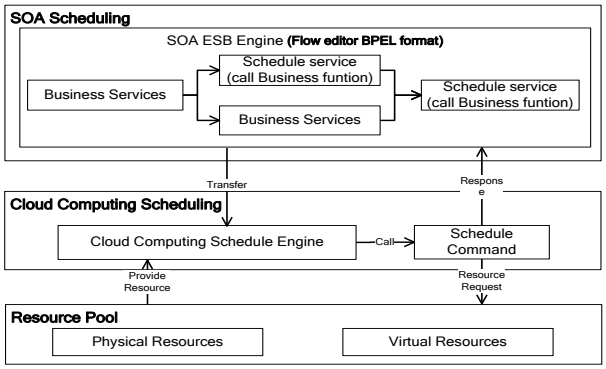

Figure 4. The Stucture of Application Model 3.

E. *Comparison of three application models*

As mentioned above, we introduced three kinds of application models of hybrid scheduling, and the differences among the three application models are as follows: dynamic scheduling, static scheduling, manage services, flow format convert, SOA flow editor, schedule service, schedule command, using virtual resources. We give the comparison of three application models as shown in TABLE I.

TABLE I. COMPARISON OF THREE APPLICATION MODELS

Item	**Hybrid Scheduling Application Models**		
	Application model 1:SOA flow converts to cloud computing flow	***Application model 2:SOA flow calls scheduling command service of cloud computing totally***	***Application model 3: SOA flow calls scheduling command service of cloud computing partly***
Dynamic scheduling	Totally	Totally	Partial
Static scheduling	Not support	Not support	Support
Manage services	Essential	Essential	Essential
Flow format convert	Essential	Non-essential	Non-essential
SOA flow editor	Essential	Essential	Essential
Schedule service	Non-essential	Essential	Essential
Schedule command	Essential	Essential	Essential
Using virtual resources	Support	Support	Support

IV. EXAMPLES AND ANALYSIS

The experiment is based on the cloud computing platform in National Disaster Reduction Center of China (NDRCC). The hardware and software environment are shown as follows.

A. *Hardware environment*

10 CB60-G2:Intel Xeon E5620, 2.4G frequency, dual CPU, 8 core, 16 threads; 24G memory, 600G hard SAS; high performance Gigabit Ethernet.

1 TC3600 blade server (5 blades), of which, 1 blades for the management node, 4 for the compute nodes.

17 virtual server, 2 master node server, 15 computing node server.

B. Software environment

SOA engine ODE, J2EE, IBM Platform 8.0, VMware vSphere, VMware vCenter, ENVI/IDL, C/C++/Java.

C. Computing flows for Disaster Reduction work

We apply the three application models to calculate these flows as follow of using domestic mapping satellite data: NDVI-VCI Index computing flow, remote sensing data pre-processing flow, flood scope validity test flow, loss pre-assessment process. In the three models, the calculations are completed successfully; the execution efficiency is 2-5 times.

D. Analysis

Using the three application models of hybrid scheduling improves the computational efficiency because of using dynamic schedule of cloud computing, and meanwhile, using the SOA flow editor to edit the business flow is very convenient. Although the implementation mechanism of three application models is slightly different, the results prove that hybrid scheduling is very useful.

V. CONCLUSION

In this paper, we review the traditional scheduling mechanisms, which include the SOA scheduling and the cloud computing scheduling. In order to make full use of the advantages of both SOA scheduling and the cloud computing scheduling, we design the hybrid scheduling, and give three application models. Through running the flows for disaster reduction work, we prove that hybrid scheduling is reasonable and feasible. The scheduling mechanism combines the ability of managing and editing service, flow of SOA and the dynamic scheduling of cloud computing perfectly.

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