Horizontal Dynamic Cloud Collaboration Platform: Research Opportunities and Challenges

Mohammad Mehedi Hassan, Biao Song, and Eui-Nam Huh
Internet Computing and Network Security Lab
Department of Computer Engineering, Kyung Hee University
1 Seocheon-dong, Giheung-gu, Yongin-si, Gyeonggi-do 446-701, South Korea
{hassan, bsong, johnhuh}@khu.ac.kr

1. Introduction

Currently, collaboration or federation among cloud providers [1] is gaining popularity in the research community. However, current research efforts [2] in this context mainly focus on vertical supply chain collaboration model in which cloud providers will leverage homogeneous cloud services from other cloud providers for seamless provisioning. Nevertheless, in the near future, we can expect that hundreds of cloud providers will compete to offer services and thousands of users also compete to receive the services to run their complex heterogeneous applications on cloud computing environment. In this scenario, the existing collaboration models are not applicable. In fact, while clouds are typically heterogeneous and dynamic, the existing federation models are designed for static environments with homogeneous service requirements where a priori agreements among the parties are needed to establish the federation.

To move beyond these shortcomings, this paper establishes the basis for developing advanced and efficient horizontal collaborative cloud service approach called "Dynamic Cloud Collaboration (DCC)" in which cloud providers (smaller, medium, and large) of complementary service requirements will collaborate themselves to gain economies of scale and an enlargement of their capabilities to meet QoS targets of heterogeneous cloud service requirements. In this context, this paper addresses architectural framework and principles for the development of DCC platform. It describes the components, architectural features, use cases, and formation of dynamic collaborating arrangements. In addition, we present the utility of DCC to measure its content-serving ability as compare to the existing static cloud collaboration. The challenges and core technical issues to implement dynamic cloud collaboration are also discussed,

This research was supported by Future-based Technology Development Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0020725)

2. Proposed Architecture

Formation of a DCC is initiated by a CP, which realizes a good business opportunity which is to be addressed by forming DC with other CPs for providing a set of services to various consumers. The initiator is called a primary CP (pCP), while other CPs who share their resources/services in DCC are called collaborating CPs. Each CP in DCC platform must agree with the resources/services contributed by other providers against a set of its own policies.

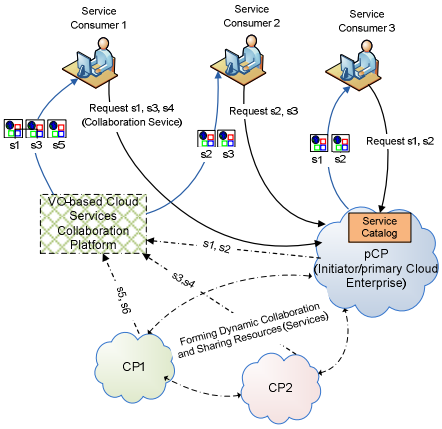

Fig. 1: A Formed VO based Cloud Services Collaboration Platform

Users interact transparently with the VO-based DC platform by requesting services through a service catalog of the pCP as shown in Fig.1. The CPs offer capabilities/services to consumers with a full consumption spec, formalized as a standard SLA. The requested service requirements (single, multiple or collaborative cloud services) are served either directly by the pCP or by any collaborating CPs within a DC. Fig. 2 presents the cooperative architecture of a system for DCC. The steps of a DCC platform formation are as follows:

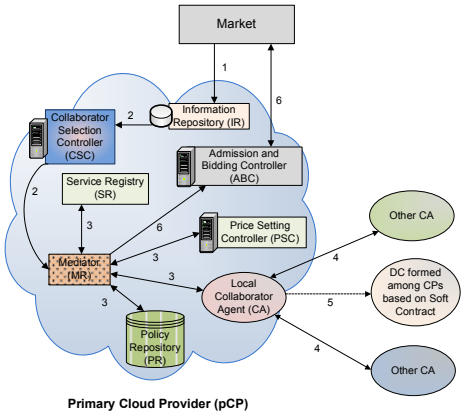

Fig. 2: Architecture of a system to assist the creation of DCC

Step 1: A pCP finds a business opportunity in the market from information repository (IR) and then it finds suitable partners by using collaborator selection controller (CSC) which provides many combination of probable partners list.

Step 2: After choosing a combination of partners, the mediator (MR) obtains the resource/service and access information from the service registry (SR), whilst SLAs and other policies from the policy repository (PR). It generates a eContract [4] that encapsulates its service requirements on the pCP's behalf based on the current circumstance, its own contribution policies, prices of services generated by price setting controller (PSC) and SLA requirements of its customers and passes this eContract to the local Collaborating Agent (CA).

Step 3: The local CA of pCP carries out negotiations with the CAs of other identified partner CPs using the eContract. If all CPs (including the pCP) agree with each other, they make initial agreement between them. When pCP acquires all services/resources from its collaborator to meet SLA with the consumer, a new DC becomes operational. If no CP is interested in such arrangements, DC creation is resumed from Step 1 with new combination partners.

The major research challenges in DCC area include - when to collaborate (triggering circumstances), whom to collaborate with (suitable partner selection algorithm), how to collaborate (cooperative negotiation), how to allocate collaborative tasks (scheduling algorithm) and how to demonstrate collaboration applicability (measurement and simulation study). We will discuss these issues in the poster session and provide candidate solutions.

3. Simulation Results

For the experiment of measuring the utility of a DCC platform, the workloads have been generated using Lublin99 model [3]. To show the usage benefits of DCC, we compare its performance with non-collaborated approach and existing static collaboration approach, we use two metrics to measure its utility - percentage of service rejection and overall resource utilization. Simulation results are shown in Fig. 3. Here, the parameter *umed* represent varying size and heterogeneity of workloads. The smaller values of *umed* result in higher workloads. We can see form Fig. 3 that under heavy and light workload, both cases DCC outperforms the static collaboration and non-collaborated approaches. The reason is that in a DCC platform, based on

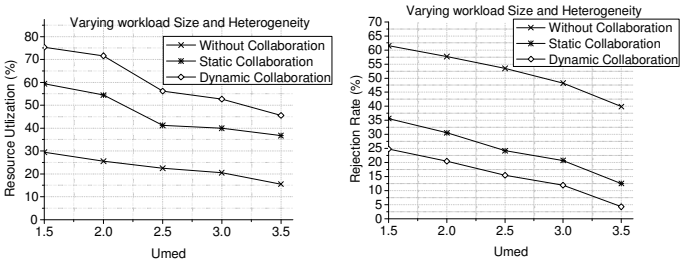

Fig. 3: Performance of DCC in terms service rejection and resource utilization

service request suitable partners can be selected who can fulfill the service request while in case of static approaches, fixed or pre-existing partners can only fulfill the service requests. Thus rejection rate becomes very high. Also service heterogeneity makes static collaboration to reject many jobs since it cannot always predict the incoming service behavior and requirements of consumers.

4. Conclusions

In this paper, we present architectural framework and principles for the development of horizontal dynamic cloud collaboration model where clouds can cooperate together accomplishing trust contexts and providing new business opportunities such as cost-effective assets optimization, power saving, and on-demand resources provisioning. Simulation results reveal that the DCC platform is a viable business model allowing providers to revel on increased scale and reach than that is achievable individually. We also discussed the research challenges to realize the DCC platform in practical context.

References

[1] R. Buyya, R. Ranjan, and R. N. Calheiros, Intercloud: Utility-oriented federation of cloud computing environments for scaling of application services. LNCS, vol. 6081, pp. 13-31, 2010.

[2] A. Celesti, F. Tusa, M. Villari, and A. Puliafito, How to enhance cloud architectures to enable cross-federation, IEEE Int. Conf. on Cloud Computing, pp. 337–345, 2010.

[3] U. Lublin, D. G. Feitelson. The workload on parallel supercomputers: Modeling the characteristics of rigid jobs. J. *Parallel Distrib. Comput.* Vol. 63(11), pp. 1105–1122, 2003.

[4] P. Radha Krishna, Kamalakar Karlapalem and A. R. Dani, From Contracts to E-Contracts: Modeling and Enactment, *Information Technology and Management*, vol. 6, pp. 363-387, 2005.