Federation of Cloud Computing Infrastructure

Riddhi Solani
B. Tech. Student
Department of Information Technology
Institute Of Technology, Nirma University

Kavita Singh Rathore
B. Tech. Student
Department of Information Technology
Institute Of Technology, Nirma University

Prachi Gaur
B. Tech. Student
Department of Information Technology
Institute Of Technology, Nirma University

Sharnil Pandya
Assistant Professor
Department of Computer Science and Engineering
Institute Of Technology, Nirma University

Abstract

This paper proposes federation of cloud computing environments, thereby supporting scaling of applications across various vendor clouds. As the users are geographically distributed, the burden on cloud providers can be reduced by automatic load coordination. Later, we discussed some threats posed by federation and some solutions for the same. Also we discussed a general model for implementing inter-cloud federation.
Keywords: Cloud Computing, Federation, Cloud Architecture.

I. INTRODUCTION

NOWADAYS cloud computing is emerging as a new paradigm and is paving way for the IT operators with good business opportunities. Future is demanding business operators to go forward towards interoperable federation of cross cloud platform. Researchers have claimed in [1] that cloud computing market can be categorized into three phases: 1) 'Monolithic': where cloud providers are based on isolated proprietary architectures; 2) Vertical Supply Chain: where cloud providers are able to leverage both Cloud-based services and virtualized resources from other providers in a distributed environment 3) Horizontal Federation: smaller, medium, and large providers will federate horizontally themselves to gain: economies of scale, an efficient use of their assets, and an enlargement of their capabilities.

II. WHY TO GO FOR FEDERATION OF CLOUD

Cloud computing provide the users on-demand services and they are charged for the services as per the usage. It becomes very important for cloud service provider to provide QoS-assured services and customizable computing environment. It is impossible for single-provider cloud to meet these requirements every-time and everywhere. Federation of clouds allows the cloud providers to maximize the usage of available resources and it offers flexibility to customers to switch to different Cloud providers for quality resources and greater satisfaction. Creation of federated Cloud computing environment facilitates on-time, efficient and flexible provisioning of services, helps the CSP to achieve QoS parameters even if number of users and their demand for services are changing dynamically. The Federated cloud computing supports dynamic expansion and contraction of resources like VMs, services, storage, database, etc for managing sudden variations in services demands. infrastructure and applications can scale elastically according to the business needs at a reasonable price Another reason for why federated clouds should be adopted is that no single cloud infrastructure provider can establish their data centers at all possible locations throughout the world. As a result Cloud provider will face difficulty in meeting the QoS expectations of clients. Therefore they need to leverage the services of other cloud service providers. This kind of requirements often arises in enterprises with global operations and applications such as Internet service, media hosting and Web 2.0 applications. This makes the technologies and algorithms for federated clouds indispensable.

III. CHALLENGES IN FEDERATION OF CLOUD

A. *Precise prediction of the demands of application service:*

Critical decisions are required in a federated cloud for dynamic demands or de-scaling of resources. A model needs to be designed to predict or forecast the behavior of requirements of the service, be it compute, storage or networking requirements. [2] The real challenge in devising such models is accurately learning and fitting statistical functions to the observed distributions of service behaviors such as request arrival pattern, service time distributions, I/O system behaviors, and network usage.

B. Economic models:

The market-driven decision making problem [3] is a combinatorial optimization problem that searches the optimal combinations of services and their deployment plans. Unlike many existing multi-objective optimization solutions, the optimization models that ultimately aim to optimize both resource-centric (utilization, availability, reliability, incentive) and user-centric (response time, budget spent, fair-ness) QoS targets need to be developed

C. Flexible mapping of resources to the services:

The process of mapping resources to the services is a complex task as we are dealing with composite system which requires maximizing maximize energy efficiency, cost-effectiveness, and utilization. [3] It requires the system to compute the best software and hardware configuration (system size and mix of re-sources) to ensure that QoS targets of services are achieved, while maximizing system efficiency and utilization. This process is further complicated by the un-certain behavior of resources and services.

D. Integration and Interoperability:

For many SMEs, there is a large amount of IT assets in house, in the form of line of business applications that are unlikely to ever be migrated to the cloud. Further, there is huge amount of sensitive data in an enterprise, which is unlikely to migrate to the cloud due to privacy and security issues. As a result, there is a need to look into issues related to integration and interoperability between the software on premises and the services in the cloud. In particular [4]: (i) Identity management: authentication and authorization of service users; provisioning user access; federated security model; (ii) Data Management: not all data will be stored in a relational database in the cloud, eventual consistency (BASE) is taking over from the traditional ACID transaction guarantees, in order to ensure sharable data structures that achieve high scalability. (iii) Business process orchestration: how does integration at a business process level happen across the software on premises and service in the Cloud boundary? Where do we store business rules that govern the business process orchestration?

E. Scalable Monitoring of System Components:

Although the components that contribute to a federated system may be distributed, existing techniques usually employ centralized approaches to overall system monitoring and management. We claim that centralized approaches are not an appropriate solution for this purpose, due to concerns of scalability, performance, and reliability arising from the management of multiple service queues and the expected large volume of service requests. Monitoring of system components is required for effecting on-line control through a collection of system performance characteristics. Therefore, we advocate architecting service monitoring and management services based on decentralized messaging and indexing models [5].

IV. FEDERATED CLOUD ARCHITECTURE AND ITS COMPONENTS

The three basic components of federated cloud architecture are 1) Cloud Exchange 2) Cloud Coordinator 3) Cloud broker. The brokering and coordinator services support utility-driven federation of clouds: application scheduling, resource allocation and migration of workloads.

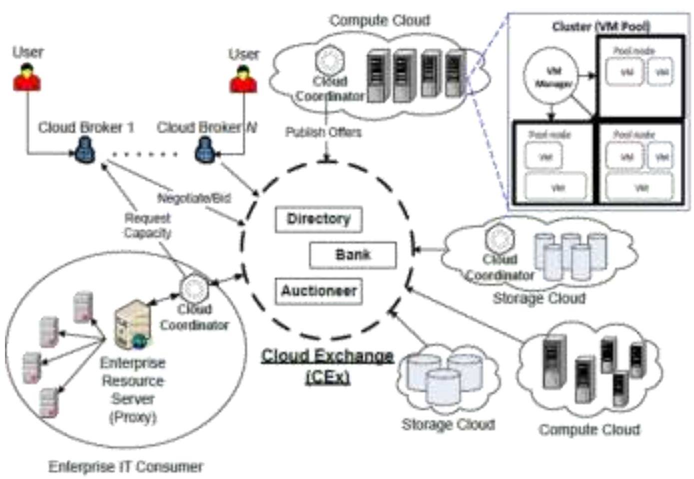

Fig. 1: Federated network of clouds mediated by a Cloud exchange

The Cloud Exchange acts as a mediator between Cloud Coordinators and Cloud Brokers. It aggregates the services demands from the brokers and maps them against the available supply provided by Cloud Coordinator. It supports trading of Cloud services based on competitive economic models [3] such as commodity markets and auctions. The services are provided to clients based on SLAs.

An SLA describes the type of services to be provided to clients in terms of various parameters agreed upon by the client, CSP and the intermediate Clouds, incentives for meeting the expectations and penalties for violating the requirements. Every client in the federated platform needs to create a interface with a Cloud Broker which will can dynamically establish service contracts with Cloud Coordinators via the functions offered by the Cloud Exchange.

A. Cloud Exchange

As an intermediate between Cloud coordinator and Cloud Broker, the Cloud Exchange acts as the database that stores the Cloud's current usage costs, demand patterns and available Cloud service providers. Cloud Coordinators periodically update their availability, pricing, and SLA policies with the Cloud Exchange. Cloud Brokers query the Cloud Exchange to get information about existing SLA offers and resource availability of member Clouds in the federation. It also provides mapping services that map user requests to suitable service providers. Mapping functions will be implemented by leveraging various economic models such as Continuous Double Auction (CDA) as proposed in earlier works [3].

The cloud exchange service provides following services to cloud broker and cloud coordinator:

1) Database repository:

The cloud exchanger allows the cloud providers to announce their available supply of resources and services and their offered prices. Clients can then search for most appropriate providers based cost or quality of service and can submit their request for required resources. Standard interfaces need to be provided so that both providers and consumers can access resource information from one another readily and seamlessly.

2) Dealer:

Dealer or auctioneer regularly clears and updates the policies of Cloud exchanger and its participants. They are third party controllers that do not represent any providers or consumers

3) Bank:

The banking system within the cloud exchanger facilitates the financial transactions regarding to agreements between cloud exchanger participants. The banks are also independent and not controlled by any providers and consumers, thus building trust among cloud vendors and its clients. Smooth banking is achieved by incorporating the online payment management services such as PayPal.

B. Cloud Broker

The cloud broker acts on behalf of the clients. Each cloud broker negotiates a deal with cloud coordinator by analyzing the SLAs and resource list of various cloud providers in cloud exchange. The cloud broker selects the most appropriate set of services for its client. The various components of cloud broker are:

1) User Interface:

This provides the access linkage between user application interface and the broker. This translates the user requirements of a user application to what is to be executed, the description of tasks, the information about task outputs and the desired QoS. The Service Interpreter understands the service requirements needed for the execution which comprise service location and service type. The Credential Interpreter reads the credentials for accessing necessary services.

2) Core Services:

They constitute the main functionality of the broker. The service negotiator asks for services from Cloud Exchange. The scheduler schedules the user application on most appropriate cloud. The Service Monitor maintains the status of Cloud services by periodically checking the availability of chosen Cloud services and discovering new services that are available. The matching procedure considers two main system performance metrics: first, the user specified QoS targets must be satisfied within acceptable bounds and, second, the allocation should not lead to overloading (in terms of utilization, power consumption) of the nodes.

3) Execution Interface:

In this, the job dispatcher creates the user request which encapsulates the user application and dispatches that application to some remote cloud for its completion.

C. Cloud Controller

The cloud coordinator maintains and manages the domain specific enterprise clouds and their membership. The Cloud Coordinator performs basic functionalities as discussed below:

1) Scheduling and Allocation:

This component of Cloud Coordinator allocates the virtual machine to remote user nodes based on user's QoS requirements and their credits in the cloud banks. If satisfied above two criterions, a sensor component sends back feedback to the remote node. Once the application is hosted successfully, it is periodically monitored until it finishes execution.

2) Market and Policy Engine:

The SLA storing module, stores the service terms, conditions, incentives on meeting QoS parameters successfully and punishments in case of violation of agreement. Based on these SLA's the pricing model is developed. The Accounting module stores the actual usage information of resources by requests so that the total usage cost of each user can be calculated. The Billing module then charges the usage costs to users accordingly.

3) Application Composition engine:

This component of the Cloud Coordinator encompasses a set of features intended to help application developers create and deploy [6] applications, including the ability for on demand interaction with a database backend such as SQL Data services provided by Microsoft Azure, an application server such as Internet Information Server (IIS) enabled with secure ASP.Net scripting engine to host web applications, and a SOAP driven Web ser-vices API for programmatic access along with combination and integration with other applications and data.

4) Sensor:

The sensor infrastructure monitors the power consumption, heat dissipation and utilization of resources by remote clients. The Cloud Coordinator service makes use of Sensor Web services for dynamic sensing of Cloud nodes and surrounding temperature. The output data reported by sensors are feedback to the Coordinator's Virtualization and Scheduling components, to optimize the placement, migration, and allocation of VMs in the Cloud. Such sensor-based real time monitoring of the Cloud operating environment aids in avoiding server breakdown and achieving optimal throughput out of the available computing and storage nodes.

5) Discovering and Monitoring:

The Discovery and Monitoring component performs the following activities: (i) updates the resource status metrics including utilization, heat dissipation, power consumption based on feedback given by the Sensor component; (ii) facilitates the Market and Policy Engine in periodically publishing the pricing policies, SLA rules to the Cloud Exchange; (iii) aids the Scheduling and Allocation component in dynamically discovering the Clouds that offer better optimization for SLA constraints such as deadline and budget limits; and (iv) helps the Virtualization component in determining load and power consumption.

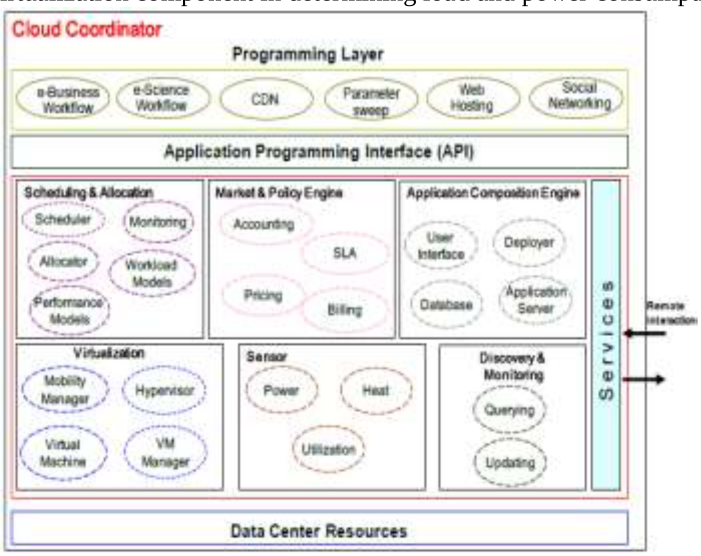

Fig. 2: Cloud Coordinator Software Architecture

V. Conclusion

Cloud computing has the potential of changing the way business operations are being performed. Just as in the early days of the power grid, nobody could have imagined fully automated production plants, or the high-definition TVs in our houses or even the smartphones, today we can't really predict what will happen once the computing utility dream becomes a reality. With this evolutionary change in the computing techniques, one can leverage many exciting opportunities: Cloud computing providers will probably achieve levels of efficiency and utilization that seem imaginary just a few years ago, while consumers of cloud computing services will be able to free resources and focuses on their business. However, along the way there are many difficulties that the business operators needs to tackle with. First interoperability between cloud providers and standardization are a fundamental need. Second, cloud providers will need to build mechanisms to ensure the service levels; without proper warranties on the levels of reliability, serviceability, and availability, companies are going to be reluctant to move any of the more critical operations to the cloud. Last, but not least, the need to build trust is essential and probably the hardest because it is not a technical issue only.

References

[1] T. Bittman, "The evolution of the cloud computing market," Gartner Blog Network,http://blogs.gartner.com/Thomas_bittman/2008/11/03/theevolution-of-the-cloud-computing-market/, November 2008.

[2] D. G. Feitelson, Workload Modelling for Computer Systems Performance Evaluation, in preparation, www.cs.huji.ac.il/~feit/wlmod/. (Accessed on March 19, 2010).

[3] R. Buyya, D. Abramson, J. Giddy, and H. Stockinger. Economic Models for Resource Management and Scheduling in Grid Computing. Concurrency and Computation: Practice and Experience, 14(13-15): 1507-1542, Wiley Press, New York, USA, Nov.-Dec. 2002.
[4] R. Ranjan and Anna Liu. *Autonomic Cloud Services Aggregation*. CRC Smart Services Re-port, July 15, 2009.
[5] R. Buyya, "CLOUD COMPUTING: principles and paradigms", "http://www.chinacloud.cn/upload/2011-07/11073107539898.pdf"
[6] Spring.NET, http://www.springframework.net [17 March 2010].

