TOWARDS DEVELOPMENT OF CLOUD OPERATING SYSTEMS

Priyesh Kanungo
SCSIT, Devi Ahilya University, Indore, India
e-mail: priyeshkanungo@hotmail.com

Abstract— Cloud operating system provides the abstraction of complex physical datacenter infrastructure by providing different interfaces for local and remote users. It manages the interaction between aplications and their interfaces so that they are well managed and protected. The paper describes various functions, characteristics and components of Cloud Operating System.

Keywords- Virtualization, Virtual Machine, Hypervisor, Server Consolidation, Storage Manager, Cloud Scheduling, Federation Manager, Load balancing.

I. INTRODUCTION

Exponential increase in processor power, development of man-machine interfaces together with the rise of the high-speed Internet has turned a computers initially meant for batch-mode calculations into information superhighway that has become an integral aspect of our life. The manner in which people interact with smaller and increasingly pervasive pieces of connected hardware changed life in unexpected ways. Users of cloud services have experienced drastic improvements in output as a result of having uninterrupted access to the right combination of technology to solve their complex business problems. Further, the evolution of Clouds is a major step towards unimaginable effects of Information Technology that we have yet to foresee [4].

The operating system for cloud provides an interface for the management of cloud resources. As we know that the conventional Operating System (OS) is set of modules that manages the computer's hardware. Cloud OS consists of a set of distributed processes whose purpose is the management of Cloud resources. Cloud operating system provides a way of supporting the complex arrangement of cloud computing resources. As in case of centralized and distributed operating systems, a cloud OS is necessary to unlock the hidden potential of the cloud infrastructure consisting of central processing units, memories, high volume storage and network infrastructure. The aim of cloud operating systems is to provide easy to use abstraction to the cloud resources isolation among the processes and integration of networked resources while hiding the intricacies required in supporting applications in a complex federated environments. Moreover, it should also provide fault tolerance, autonomous management of the cloud and elasticity.

II. FUNCTIONS OF CLOUD OPERATING SYSTEMS

Primary functions of cloud operating systems are [1]:

- Well designed interface to hide the underlying complexities: Cloud OS provides application programming interfaces (APIs) to application developers enabling data and services interoperability among various distributed environments. These APIs may allow virtual machine monitoring, scheduling, security, power management and memory management.
- Virtualization: Virtualization is the key concept in cloud environment. The traditional link between the application and physical servers is broken using virtualization. Virtualized environment is managed by the hypervisor which can be assumed to be an operating system on physical hardware. It provides the abstraction and I/O instructions in the cloud environment. Cloud OS arranges various system components using virtualization, provisioning and automated workflow so that the cloud components may be aligned in line with user needs [6].
- Scheduling for management of workload to provide quality of service and performance: In a federated environment, management of the workload is based on Quality of Service (QoS) requirements defined in the Service Level Agreement (SLA). Therefore, simple as well as complex workload should be supported in a similar manner. The scheduler has to balance and optimize these workloads based on QoS requirements.
- Security services, user authentication, and accounting: Security is an important issue to ensure protection for assets in a highly distributed cloud environment that involves dynamically connecting and disconnecting from a huge variety of internal and external systems and assets. OS has to ensure the right connection between IT applications and the resources, particularly in hybrid cloud environments [5, 6].
- Capabilities of a cloud federation to enable the sharing of remote clouds' resources: Cloud federation is the interconnected system of clouds from various cloud service providers to meet the busty load situations. Main component of any IaaS Cloud is the operating system that is responsible for managing the virtual cloud infrastructure and satisfy the user requirement by virtual resource provisioning. However, functionality provided to the remote users may not be as powerful as in case of local users [7].

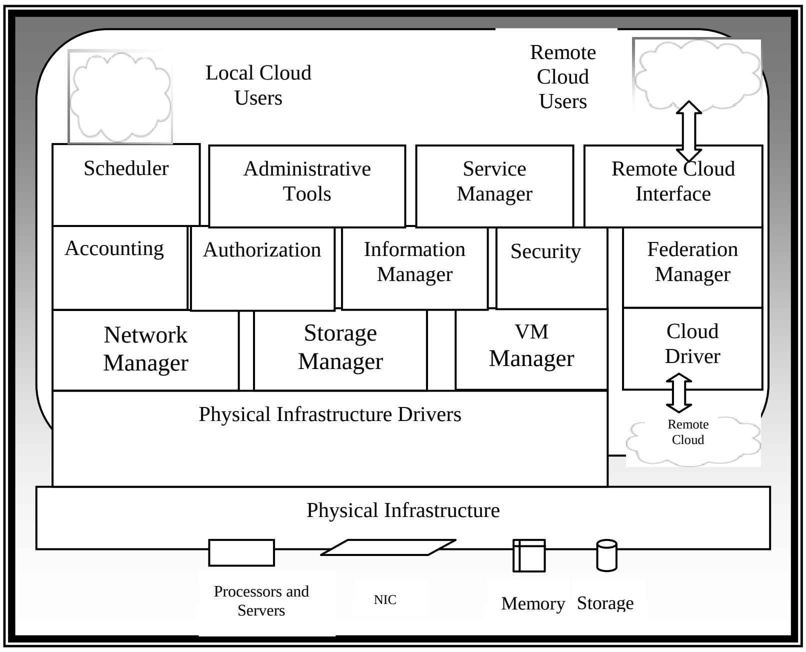
III. COMPONENTS OF CLOUD OPERATING SYSTEMS

A cloud operating has various components that include [9]:

Virtual Machine (VM) Manager: *VM manger manages the life cycle of a VM as per the scheduling criteria and the user instructions using hypervisor drivers viz.:*

- Deployment of a VM
- Migrating a VM,
- Suspending a VM,
- Resuming a VM,
- Shut down of a VM

Hypervisor driver avoids the restriction on operating system to limit to a specific virtualization technology. The VM also preserves service level agreement (SLA) expressed as guarantee of VM availability in the cloud infrastructure. Therefore, the VM manager has to detect the VM failure and automatically restart the VM [3].



B. Storage manager: Storage manager provides the virtual storage system so that the system can grow dynamically as per the users' needs. The storage systems need to have following properties:

- Performance: The system should be able to support data intensive workloads.
- Reliability: Data access should not be disrupted due to failure.
- Scalable: System should be able to grow as per the users' needs.
- Transparent: User need not have the knowledge of underlying complexity.
- The storage system allows data to move among the pool of storage devices. This pool must appear to user as a single storage system. To enable the storage, drivers are used which form a layer of abstraction between services and physical storage.

C. Information Manager: The function of information manager is to collect the information regarding VMs state, servers, and other parts of the cloud's virtual infrastructure e.g. storage system and networking devices. The information Manager has to monitor performance on the infrastructural components. Information drivers collect information about physical and virtual resources using specialized tools. As the VMs are monitored using the information provided by the hypervisors, information may differ from hypervisor to hypervisor.

D. Network Manager: To interact with various virtualization techniques, OS uses drivers or adaptors. These drivers are called hypervisor, storage, information and network drivers. Service deployment requires communication network to interconnect service components. Thus, the network manager manages a private network to interconnect the internal components, public pools of IP addresses and the front end service components to the internet. Network drivers are used to abstract the virtual network over physical network.

E. Resource Usage Accounting: Resource usage information of deployed services is required for billing users with the help information manager. With the help of resource usage auditing, information is collected regarding various activities in cloud resources, i.e. users accessing cloud resources, timing of accesses, and operations performed. This information helps in cloud security and protection from unauthorized access and other threats of intrusion.

F. Cloud Scheduling: Within a cloud, the scheduling may be at physical host level and at the cloud level. The hypervisor scheduler manages the scheduling at host level to decide when the virtual machines will get resources like memory, or Central Processing Unit (CPU) and which cpu is assigned to VM etc. Cloud O.S. Scheduler decides the placement of each VM using specific criteria and decides particular physical servers where each VM is deployed. In a federated cloud, VM can be deployed on remote cloud if sufficient resources are not available in the local platform [6, 8].

In a cloud environment, scheduler provides dynamic optimization enabling dynamic relocation of the virtual machines. A number of scheduling policies can be used for initial placement as well as dynamic relocation. Constraints are specified by the users for hardware requirement e.g. CPU and Memory required, platform, hypervisor location or SLA etc [8].

Various scheduling criteria may be for scheduling of processes:

(i) Workload Balancing: The scheduler interacts with VM manager to allocate new VM to lightly loaded server or dynamically distributing processing workload is among available servers. Dynamic load balancing improves the utilization of computing resource and provides better response to the processes. The scheduler may also interact with federation manager to deploy VMs to remote cloud environment in case the whole cloud is in overloaded state [2].

(ii) Thermal Balancing: To reduce the cooling requirement due to servers overheating, temperature of the servers is balanced by allocating and relocating the VMs to the serves based on their temperatures. This enables to achieve the objective of environmental friendly green computing.

(iii) Server Consolidation: To optimize the consumption electricity, the VMs are allocated to minimum number of servers and also relocated at runtime to reduce the number of servers being used.

G. Federation Manager: As we have seen above, a cloud federation is the federation of cloud service providers for the situation of sudden change in the processing load. Various types of cloud federation are [9]:

- **Brokering cloud architecture** allows service delivery capabilities e.g. deployment of virtual resources in the cloud, makes scheduling decisions based on various criteria (cost, performance, or energy consumption), to automatically deploy virtual user service in the most suitable cloud, or distribute the service components across multiple clouds.
- **Bursting cloud** to meet peak demand load.
- **Aggregated cloud architecture** consists of partner clouds to aggregate their resources and provide users with a larger virtual infrastructure.
- **Multitier Architecture** follows a hierarchical arrangement where clouds are managed by third cloud OS instance that usually belongs to same organization.

Further, a cloud federation may be loosely coupled, tightly coupled or partially coupled. In loosely coupled architecture, the cloud instances are autonomous and have little or no control over the remote resources. In tightly coupled federations, the clouds are managed by the same OS possibly as they belong to the same organization. Partially coupled federation consists of the partner clouds governed by some agreement for resource sharing. The service providers may be similar entity or a public service provider. Federation manager provides mechanism managing virtual resources in the remote clouds by performing following functions:

- Authenticating the users of remote cloud
- Access control for remote resource
- Deployment of virtual resources
- Dynamic management of resources
- Termination of virtual resources

A federation manager may be of various types. Design of a federation manager depends on the cloud federation type and the level of interoperability. It is implemented as part of cloud operating system and supports architectures at the infrastructure level.

IV. CONCLUSION

Cloud computing has inevitably change the way in which IT services are delivered across an organization's, customers and suppliers. A Cloud Operating System should provide set of standardized and well defined abstractions of computing resources across the data center and federated cloud structures. This not only provides convenience to the users but also improves overall response time and resource utilization.

REFERENCES

[1] A. Makwe and P. Kanungo, Scheduling in Cloud Computing Environment Using Analytic Hierarchy Process Model IEEE International Conference, Medicaps Institute of Technology and Science, Indore 10-12 Sept 2015(Paper Available on IEEE Explore).

[2] A. Tiwari and P. Kanungo, “Dynamic Load Balancing Algorithm for Scalable Heterogeneous Web Server Cluster with Content Awareness,” 2nd International Conference on Trendz in Information Sciences & Computing, (TISC) 2010, Satyabhama University, Chennai, India, pp. 143-148.

[3] D. Wentzlaff, Charles Gruenwald III, Nathan Beckmann et al. “An Operating System for Multicore and Clouds:Mechanisms and Implementation” SoCC’10, June 10–11, 2010, Indianapolis, Indiana, USA.Copyright 2010 ACM

[4] H. Mehta, M. Chandwani, P. Kanungo, "Towards development of a distributed e-Learning ecosystem", T4E, 2010, 2012 IEEE Fourth International Conference on Technology for Education, 2012 IEEE Fourth International Conference on Technology for Education 2010, pp. 68-71.

[5] H. Mehta, P. Kanungo and M. Chandwani “On Trust Management and Reliability Issues in Distributed Scheduling Algorithms,” International Conference on Advance Computing and Utility and Cloud Computing (ICoAC), 14-16 December, Anna University, Chennai in Association with IEEE Chennai section 2010.

[6] J. Hurwitz, M. Kaufman,The Role of the Operating System in Cloud Environments, A Hurwitz White Paper.

[7] R. Moreno-Vozmediano, , R., Montero, and I. Llorente, , "IaaS Cloud Architecture: From Virtualized Data Centers to Federated Cloud Infrastructures", IEEE Computer Vol. 45 (12), Dec. 2012, pp. 65-72.

[8] R. K. Sharma, P. Kanungo Performance Evaluation of MPI and Hybrid MPI+OpenMP Programming paradigms on Multi-core Processor Cluster, IEEE International Conference on Recent Trends in Information Systems, Kolkata, 21-23 Dec, 2011, 137-140. Print ISBN. 978-1-4577-0790-2.

[9] S. P. Ahuja, 2010-14 FIS Distinguished Professor of Computer Science, School of Computing, UNF. Lecture Notes on “IaaS Cloud Architectures: Virtualized Data Centers to Federated Cloud Infrastructures”.