# Architectural Design and Issues for Ad-Hoc Clouds

Sanjeev Kumar Pippal[1], Shakti Mishra[2], and Dharmender Singh Kushwaha[1]

[1] Computer Science & Engineering Department
MNNIT Allahabad, India
{rcs0955,dsk}@mnnit.ac.in
http://www.mnnit.ac.in
[2] Institute for Development & Research in Banking Technology, Hyderabad, India
{smishra@idrbt.ac.in}

**Abstract.** Effectively using, managing and harnessing the data is the key to the success of organizations in the time to come. We propose a cloud architecture that uses donation based resources in a network & helps multiple organizations to collaborate and yet compete with each other. The resources are utilized non intrusively. Organizations collaborate to create a Data-centre, that doesn't harm their existence or profitability. At the same time, these organizations can compete by spreading to those locations where they carry certain edge over others. This is where an ad-hoc cloud in heterogeneous environment helps to venture into remote areas with. To achieve this, ad-hoc cloud architecture is proposed along with issues and strategies.

**Keywords:** Ad-hoc Cloud, Cloud Computing, multitenancy, heterogeneity.

## 1 Introduction

Cloud computing is a computing paradigm where data and services reside in common space in elastic data centers, and the services are accessible via authentication. It supports "pay as you go" model. The services are composed using highly elastic and configurable resources. Cloud computing [18] services can form a strong infrastructural/service foundation framework to provide any kind of service oriented computing environment. Ad-hoc clouds enables existing infrastructure as cloud compliant, the resources available in the environment are utilized non-intrusively. Education-cloud [2], where a cloud computing framework is harnessed to manage Information system of an Educational institution would be highly efficient in terms of accessibility, manageability, scalability and availability. An ad-hoc cloud would enable us harness services offered by Fixed Education –cloud and services created and composed within ad-hoc cloud.

An e-Education [13] system doesn't fit well in the scenario. As a solution to this problem an ad-hoc cloud architecture is proposed that can rightly fit into the picture to serve the purpose. An ad-hoc cloud created at the remote site could be connected to the fixed cloud using and ad-hoc link. Hence the ad-hoc cloud would benefit in terms of existing service and cloud applications from the fixed cloud. But due to ad-hoc connectivity it needs to create its own data center and service composition environment where it can persist and also process its data.

V.V. Das and J. Stephen (Eds.): CNC 2012, LNICST 108, pp. 291–296, 2012.

The cloud computing paradigm [14] is new and there is a need of standardizing the interfaces and methods of programming the cloud. Presently all giants (Microsoft-Azure [11], IBM Blue-Cloud [9], Amazon-EC-2 [1], salesforce.com [13] etc.) who have ventured into cloud computing [18] paradigm have their own way of implementing the cloud. Without standardization interoperability would be a major problem.

## 2 Existing System

A very close comparison with our system is [12], which considers voluntarily donated resources to be reused as cloud compliant resource. In [12] some of the challenges and some of its solutions are discussed. In [8] a similar concept in which a dispersed under-utilized system is used to implement data-center[19] is considered from implementation perspective. Both of the above mentioned do not mention any application perspective, by the ad hoc cloud could be used and in our approach we have considered some of the challenges and proposed solution to some of them.

## 3 Proposed Architectural Framework

An fixed cum adhoc architecture is proposed which extends the fixed cloud to an ad-hoc cloud through an ad-hoc link. To handle multitenancy, it is proposed to establish a three tier data tables so as to increase sharing and reduce redundancy. Failure transparency is achieved by mirroring at this site itself. Availablity and reliability is increased by replication. A complete replica is first stationed at the ad-hoc site. Future updates are received at this node depending upon the bandwidth and availability. For a standard IDE all giants (Microsoft-Azure [11], IBM Blue-Cloud [9], Amazon-EC-2 [1], salesforce.com [15] etc.) must come together and agree on standard interfaces of programming and composing tools. The various issues under consideration for adhoc clouds are as follows:

### 3.1 Cloud Formation Architecture

Following issues are to be handled during the formation of an ad hoc cloud.

**Instancial Dynamic Heterogeneity**
The ad-hoc cloud might be running on different set of machines at different instances, the heterogeneity in the environment will greatly influence the design of a cloud. The Data-centre must support dynamic heterogeneity of the participating machines. Heterogeneity could be in terms of computing power shared and disk space available, RAM and n/w bandwidth on independent machines. This requires the virtualization to be highly dynamic in nature.

The ad-hoc cloud manages this issue by maintaining a table whose attributes are Node-id, MaxCPUSpeed, %CPU-usage, MAXStorage, %Storage-usage. This information is collected periodically in single phase about the P (Persistent) nodes and the V (Volunteer) nodes. Before entering the dynamic set a node allows its resources to be managed by ad-hoc Data-centre [12], and when a node exits it replicates or persists data to a persistent storage.

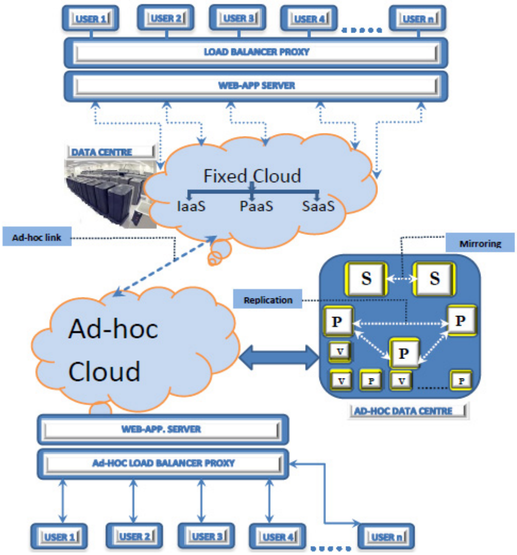


**Fig. 1.** Proposed ad-hoc cloud architecture

### 3.2 Issues for Data Storage and Dissemination of Information

**Data Persistency**

An ad-hoc Data-centre is proposed having some Super(S) nodes, some Persistent (P) nodes and other Volunteer (V) nodes. S nodes are permanent, P nodes are persistent store data on ad-hoc basis and V nodes voluntarily participate in Data-centre. Mirroring is performed between S nodes, replication is performed between P nodes and V nodes acts as data sources fig. 2.

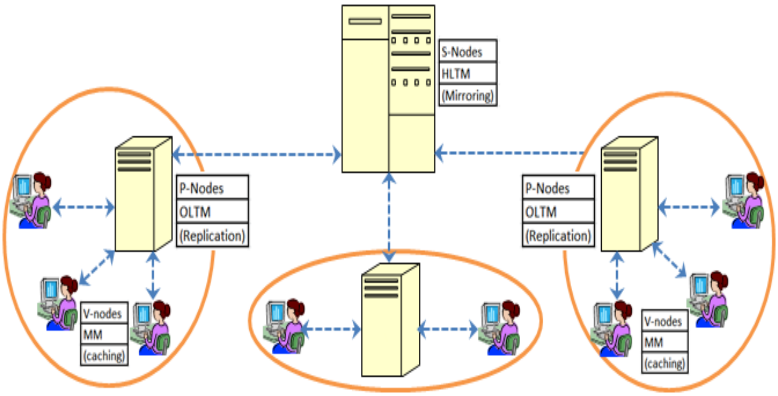


**Fig. 2.** Ad-Hoc and dispersed Data Centre in a heterogeneous environment

### 3.3 Scalability and Data Management Service

Many approaches for scalability and data management services have been proposed like big table [5] and dynamo [6], but lack in providing transactional level guaranty. We use the concept of Elastras [16] which is a light weight data store capable of providing transactional level guaranty. Our data store would have Organizational level transaction manager (OLTM) and Higher level transaction manager HLTM. The transactions within an organization would be handled by OLTM and between organizations would be handled by HLTM. Elasticity at data store level is important as it would not limit upper layer for scalability. Elasticity is provided by decoupling the data base manager (DM) with the transaction manager. Application servers access the data store through load balancer for data store. For a transaction request the OLTM checks his capacity to guarantee ACID properties for a transaction, if it cannot then it forwards the request to immediate HTLM. Finally a single or collection of ODM (Organizations Database Manager) owing the database (data storage layer) commits the transaction.

The Metadata Manager (MM) implementation provides decoupling of database and transaction manager and it also provides mapping of distributed database partitions into OLTM. Synchronous replication of MM is required for fault tolerance. Storage layer takes care of replication of data and fault tolerance. Slower nodes can use metadata caching for improved performance. Since HTLM are stateless therefore to improve performance during scalability spawning a new HTLM is easy. Further data base migration between data-store or in cloud can be done as discussed in Albatross [17].

## 4 Benefits Offered by Education Cloud

Cloud Computing for Education [13] is good idea for many reasons.

### 4.1 Infrastructure as Service

If a Cloud is provided to each education institute, it removes the biggest hurdle of deploying expensive enterprise hardware servers for Database and other resource consuming applications. Imagine Amazon like setup for Education institute to Rent and Use rather than Buy and Deploy mode.

### 4.2 Software as Services

Cloud support SaaS well with presently prevailing like Saleforce.com [15] and Google [7] will also help an academic participant to harness his skills. Education applications like LMS (Learning management system) can be first logical target and next can be back office applications.

### 4.3 Platform as Services

Platform [13] as service provides great flexibility to the developers to use specific platforms for specific applications, providing improved performance. Education institutes can look forward towards developing their own application in fields of various subjects right from Elementry Math's, Science, Physics, and chemistry to advance subjects like Mechanics and Industrial engineering etc.

## 5 Need and Benefit of Ad-Hoc Cloud

Ad-hoc clouds provides necessary infrastructure and services. Due to unavailablity of the fixed educational cloud at remote locations, setting up an educational organization would pose a major problem specifically in terms of the resource requirements of an educational organization. An adhoc cloud further enhances the benefits of an fixed education cloud to remote areas via an ad-hoc link.Thus provision of an ad-hoc cloud connected to the fixed cloud provides globally competitive framework, which can be harnessed by venturist with decreased cost and delay.

## 6 Conclusion and Future Work

In this paper, the architecture of ad-hoc cloud was presented as an extended option to create cloud services for remote educational institutions. The ad-hoc cloud service running on volunteer hardware may not fit the current well-managed, pay-as-you-go cloud model, but it could open plenty of options for those who dare to enter remote locations for providing educational services. The requirements and challenges for providing scalability and performance in an heterogeneous environment were also discussed with possible solutions to overcome some of these challenges. It is believed that ad-hoc clouds can exist as complementary infrastructures to clouds, and can even serve as a fixed cloud for many services. Further the proposed architecture can be implemented for performance and QoS evaluation with private cloud framework like Eucalyptus [3], Blue Cloud [9], Azure [11], Nebula [12] etc.

## References

1. Amazon Web Services, `http://aws.amazon.com`
2. Dong, B., Zheng, Q., Qiao, M., Shu, J., Yang, J.: BlueSky Cloud Framework: An E-Learning Framework Embracing Cloud Computing. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 577–582. Springer, Heidelberg (2009)
3. Eucalyptus, `http://open.eucalyptus.com`
4. Berman, F., Fox, G., Hey, T.: Education and the Enterprise With the Grid. In: Grid Computing (May 30, 2003), doi:10.1002/0470867167.ch43
5. Chang, F., Dean, J., Ghemawat, S., Hsieh, W.C., Wallach, D.A., Burrows, M., Chandra, T., Fikes, A., Gruber, R.E.: Bigtable: A Distributed Storage System for Structured Data. In: OSDI, pp. 205–218 (2006)
6. DeCandia, G., Hastorun, D., Jampani, M., Kakulapati, G., Lakshman, A., Pilchin, A., Sivasubramanian, S., Vosshall, P., Vogels, W.: Dynamo: Amazon's highly available key-value store. In: SOSP, pp. 205–220 (2007)
7. Google App Engine, `http://appengine.google.com`

8. Kirby, G., Dearle, A., Acdonald, A., Fernandes, A.: An Approach to Ad hoc Cloud Computing. In: DBLP: CoRR Volume abs 1002.4738 (June 2010)
9. IBM Cloud Computing, http://ibm.com/ibm/cloud
10. Mell, P., Grance, T.: The NIST definition of cloud computing (v15). Tech. rep., National Institute of Standards and Technology (2009)
11. Microsoft Azure, http://www.microsoft.com/windowsazure
12. OpenNebula Project, http://www.opennebula.org
13. Pasatcha, P., Sunat, K.: A Distributed e-Education System Based on the Service Oriented Architecture. In: 2008 IEEE International Conference on Web Services (2008)
14. Qian, L., Luo, Z., Du, Y., Guo, L.: Cloud Computing: An Overview. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudComp 2009. LNCS, vol. 5931, pp. 626–631. Springer, Heidelberg (2009)
15. Salesforce.com, http://salesforce.com
16. Das, S., Agarwal, S., Agrawal, D., El Abbadi, A.: ElasTraS: An Elastic, Scalable, and Self Managing Transactional Database for the Cloud. Technical Report 2010-04, CS, UCSB (2010)
17. Das, S., Nishimura, S., Agrawal, D., Ei Abbadi, A.: Albatross: Lightweight Elasticity in Shared Storage Databases for the Cloud using Live Data Migration. In: the 37th International Conference on Very Large Data Bases, VLDB (2011)
18. Xia, T., Li, Z., Yu, N.: Research on Cloud Computing Based on Deep Analysis to Typical Platforms. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 601–608. Springer, Heidelberg (2009)
19. Zimory GmbH: Building the flexible data centre, http://zimory.com
20. Zhang, Q., Cheng, L., Boutaba, R.: Cloud computing: state-of-the-art and research challenges. Journal of Internet Services and Applications 1, 7–18 (2010)