Enabling Hypervisor Environment for Increasing Efficiency and Effectiveness of Training Programmes - A Case Study at NAARM

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SUMMARY

The National Academy of Agricultural Research Management (NAARM) was established by the Indian Council of Agricultural Research (ICAR) at Hyderabad, in 1976, to address issues related to agricultural research and education management. The Academy also renders services for building IP portfolios like patents and geographical indications to various stakeholders including farmers and scientists. Keeping in view the increasing national and global need to integrate agriculture with agribusiness for raising rural incomes, and the increased emphasis on the creation, dissemination, application and exchange of knowledge in this vital area, the Academy has recently initiated post graduate education programmes and set up an Agribusiness Knowledge Centre.

In the above mentioned scenario, NAARM also conducting many training programmes/courses over the year and there is lot of time and money being invested into purchasing physical machines and software. There is a need of maintaining specific set of software required for each training. The Coordinators of the training programmes has to ensure beforehand that all the machines are working fine and all the software required for that training got installed in all machines and working without any issues. This requirement of preparedness for training programmes has been avoided completely by establishing a private cloud which can provide Infrastructure as a Service (IaaS) at our organization. At the end of programmes may it be a regular or refresher course, coordinators has supposed to be evaluate the participants by tools like quizzes and exams. NAARM is using SynchronEyes Student-Teacher software for evaluation purpose. Many issues were there in this examinations system because of network, virus and power problems. This also has been completely avoided by establishing a hybrid cloud.

Keywords: Hypervisor computing, Virtualization, Education, Computers in education, Cloud campus.

1. INTRODUCTION

Cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software and information are provided to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet). (Wikipedia.org 2011).

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.   (National Institute of Standards and Technology website - www.nist.gov 2011)

While there are many definitions of Cloud Computing, the simplest one defines Cloud Computing as obtaining computer services/resources from the Internet rather than from local individual platforms. Cloud is a known metaphor for describing the Internet. (The Economist 2009) Cloud can be deployed using hypervisor / Virtualization technology as:

* Software-as-a-Service (SaaS) - software application services obtained from the Internet.

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- Platform-as-a-Service (PaaS) - the user utilizes the Internet as a computing platform, rather than having his own individual, localized platform.

- Infrastructure-as-a-Service (IaaS) - a computing infrastructure based on the Internet rather than local servers.

The philosophy behind any education system is learning and experimentation. It is only natural that schools would want to experiment with different kinds of applications and platforms. Under the traditional software system, this is expensive and difficult to implement. Cloud computing offers greater flexibility to experiment with newer apps and platforms (Batson 2011, Harrison 2011). The low cost of Cloud computing associated with ubiquitous availability makes it a suitable candidate to level the playing field in education across many organizations of NARS. With cloud computing it is possible to implement an universal curriculum for all the agricultural universities [AUs] of NARS.

2. VIRTUALIZATION AT NAARM

The National Academy of Agricultural Research Management (NAARM) was established by the Indian Council of Agricultural Research (ICAR) at Hyderabad, in 1976, to address issues related to agricultural research and education management. The Academy also renders services for building IP portfolios like patents and geographical indications to various stakeholders including farmers and scientists. Keeping in view the increasing national and global need to integrate agriculture with agribusiness for raising rural incomes, and the increased emphasis on the creation, dissemination, application and exchange of knowledge in this vital area, the Academy has recently initiated post graduate education programmes and set up an Agribusiness Knowledge Centre.

In the above mentioned scenario, NAARM is conducting many training programs/courses over the year. The period of training programme usually ranges from 5 days to 21 days. The officials of various organizations of ICAR and Agricultural Universities (AU) come here to attend the training programme and will be back to their organization after completing the programme. Apart from this, there are some regular courses also offered by NAARM like

PGDMA(Post Graduate Diploma in Management of Agriculture) & PGD-TMA(Post Graduate Diploma in Technology Management of Agriculture). PGDMA course is fully residential and students have to stay at NAARM campus for 2 years. There is lot of time and money being invested into the maintenance of physical machines and software for providing the same to students of regular courses like PGDMA and trainees of various training programmes. There is a need of maintaining specific set of software required for each training and for each course of PGDMA. The coordinators of the training programmes has to ensure beforehand that all the machines are working fine and all the software required for that training programme got installed in all the machines and working without any issues. NAARM has to provide one machine per user for the entire training period/ course. This requirement of preparedness for each training programme has been avoided completely by establishing a small hybrid cloud at our organization which has provided Infrastructure as a Service (IaaS). We have designed various templates, where a template meets the needs of a specific training programme. A template is a master image of a virtual machine that one can use to create and provision new virtual machines. Using these templates can save the time of configuring a new virtual machine and installing a operating system & required software upon that. Based on the number of participants of a training programme, we create the same number of virtual machines [VMs], where a single VM is assigned to a single participant. We create logins required for a each user, so that un-authorised access can be avoided completely. Training Participant has to browse the web URL of control node
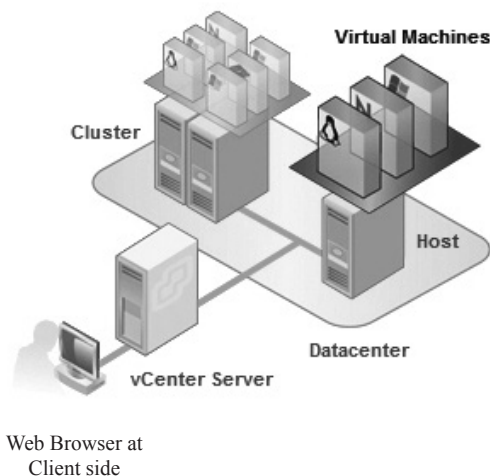

Fig 1: Typical Model of Cloud Computing (Source: www.vmware.com)

of the NAARM cloud and has to provide the username & password provided to him. After logging in, he/she gets access to all the resources provided to him/her. Trainee can start and shutdown the machines[VMs] assigned to him as his personal computer. The policy is to allocate a single machine to each user with all the required software.

Whenever a new training programme starts, we start creating machines [VMs] from the concerned TEMPLATE which are already designed and hosted in our Datacenter. The only input required for cloud is the name of the template and the number of machines need to be created out of that. Typically NAARM Cloud takes a 15 minutes time for creating 20 machines, which is less than a minute per machine. The scenario without cloud is few dedicated staff has to install operating system and all the required software in all the systems of the lab. This activity has been completely avoided by enabling cloud computing. More over the VMs are created from proven template and is devoid of any manual mistakes during installation and configuration of the software. Also from end user

point, the hardware failures are very rare in cloud environment. According to Gartner's Survey, Cloud gives users close to the full functionality of their desktop operating system and applications with less hardware failure. Specifically, a 2006 Gartner study found that the annual failure rates (AFRs) of desktop computers is about 5 percent in a computer's first year and 12 percent in its fourth. Notebooks have higher AFRs; 15 percent in the first year and 22 percent by the fourth year. Apart from this the utilization of server capacity will be optimum (Pettey 2011). A McKinsey survey cited by The Economist (2008) suggests that, without virtualization, on average only 6% of the server capacity is used (Powell 2011). So for optimum utilization of bare metal for more than 90%, implementation of virtualization on large scale is very much essential.

After completion of training programme, NAARM will have a proper shake hand with the participant and remove the virtual machine[VM], there by the computing resources will go back to the cloud for further utilization in other forthcoming programmes of the academy.

3. METHODOLOGY AND ARCHITECTURE

Our aim is to demonstrate the viability of virtualization for organizations especially for educational establishments and its huge potential benefits by using our recent experience on NAARM Hypervisor environment as a case study.

Virtualization at NAARM is implemented by implementing vSphere RC5 environment for optimal utilization of existing resources. VMWare Inc is generous enough to provide vSphere software on trail basis for 60 days for the purpose of evaluation. VMWare vSphere is a system for managing virtual infrastructure. vCenter Server is a tool that manages multiple host servers that run multiple machines and it acts as a control node of the cloud. With control node, we can quickly provision new server virtual machines and create a library of standardized virtual machine templates so the newly provisioned systems always conform to the NAARM datacenter requirements. A control node has been established to provide a convenient single point of control to the data center. Control node unifies the resources from individual hosts to be shared among virtual machines [VMs] in the entire data center. vCenter Server allows the use
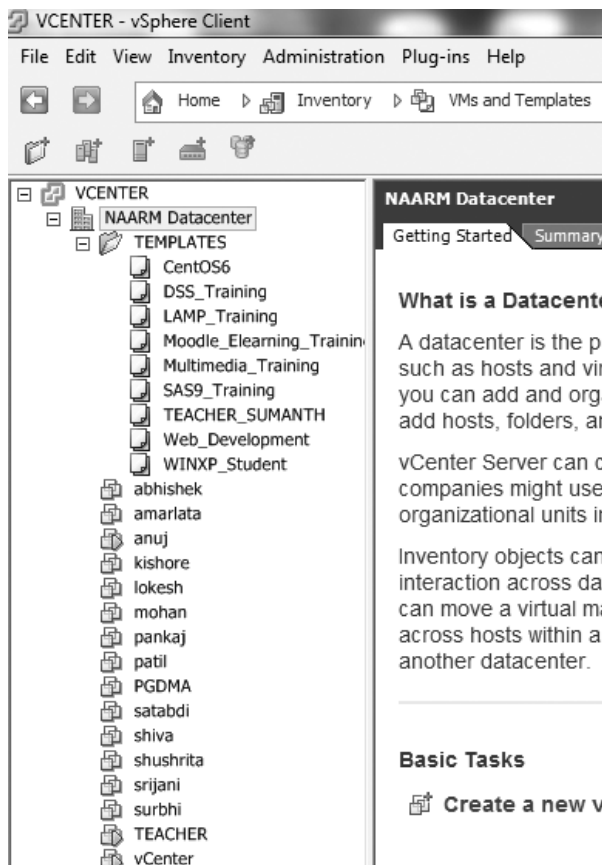

Fig 2: Templates & VMs hosted at NAARM Hybrid Cloud.

of advanced vSphere features such as vSphere DRS, vSphere HA and vMotion (2011).

The vCenter Server allows to migrate running virtual machines between host servers so that one can perform hardware maintenance with minimal downtime. It also features allow us to balance machine workloads across hosts and manage virtual machines for high availability and disaster recovery.

Software Used

Host Operating system:
     VMware ESXi 5.0 (Free ware)

Server management Node:
     Windows 2003 R2 Enterprise edition

Cloud Management node Software:
     VMware vCenter server 5

Cloud infrastructure :
     VMware vSphere 5
     vCloud Director 1.5
     Vmware vShield 5
     VMware vCenter Site Recovery manager
     VMware vShield App with Data security

Hardware Used

We have used our existing infrastructure of two blade servers for implementing the cloud. The design of Virtualization setup at NAARM is given in Fig. 3.
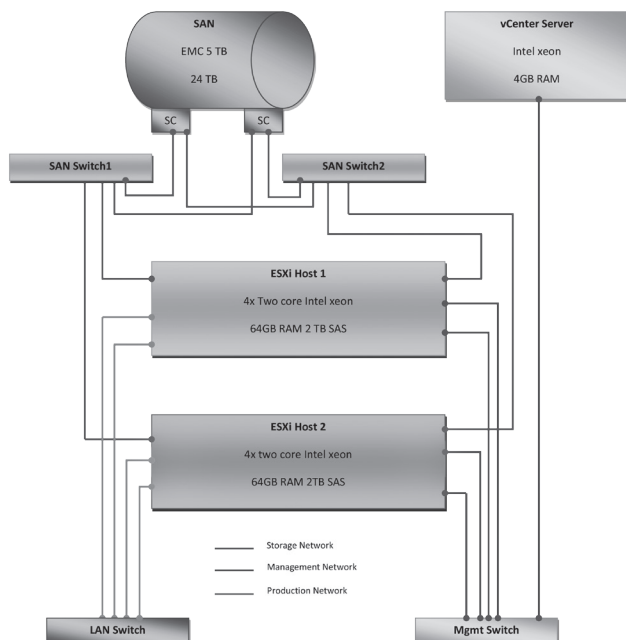

Fig 3: Architecture of the System

We used two blade servers on which two ESXi servers are installed, out of which one is dedicated for PGDMA Students and the other one is for various training programmes of NAARM. NAARM Cloud can be accessed from anywhere at anytime, and can be easily shared with others over network. At client side all that user need is a browser and a internet connection by which one can have seamless access to the cloud resources.

4. AVAILABILITY OF RESOURCES OVER INTERNET

The most common feedback that we get from trainees at NAARM is, that they did not get time for practicing the technology that was learnt. There are instances where trainees wants to practice on the given software platform even after going back to the parent organizations. In this scenario it would benefit the learning community as NAARM can provide Infrastructure even after the training programme is over.

Whenever a Virtual Machine starts the DHCP server [9] allocates a dynamic IP address to it and VM behaves as any other normal machine present in Local Area Network (LAN) (Mendicino). As the control node has been NATted (Biggalike *et al.* 2005) into the firewall with a public IP Address, all the cloud resources can be accessed over Internet. We have plans to allocate a DNS (Castro 2010) to the control node so that, trainees can access resources using domain name instead of IP Address through the web browser.
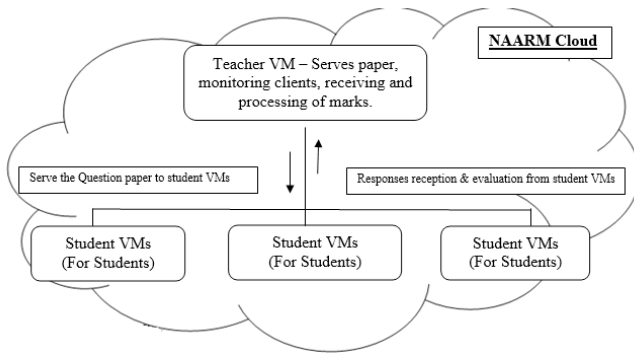
Basically the cloud was designed for the purpose of NAARM Internal usage under the firewall. But whenever valid requests come for cloud resources from other organizations of NARS, NAARM can provide the resources over the internet, so the reason It can be called as Hybrid Cloud (Linthicum 2011).

Fig.: Virtual machines created for PGDMA students of NAARM

5. HYPERVISOR ENABLED CBT [COMPUTER BASED TEST]

At the end of each training programme, may it be a regular or refresher course, co-ordinators are supposed to evaluate the participants by tools like quizzes and exams. NAARM is using SynchronEyes Student-Teacher software for conducting a CBT. Many issues were there in this setup because of network, virus and power problems. In case the CBT of any student got aborted because of any issue, student has to re-start the exam afresh. This creates a lot of pressure on student as well as teacher. This also has been completely avoided by enabling cloud based CBT.

Advantages of Hypervisor Enabled CBT

1. No viruses would be present which may hamper the process, as the machine gets created on fly.

2. No other software like Antivirus/Firewall are present which may interfere.

3. No need to install the student version of evaluation software as it would be bundled with VM Template itself.

4. No Issues with Network as all the machines are carved out of single server.

5. Even though the student logged off accidentally (Because of Network & Other Issues), he/she can login to the VM [Virtual Machine] from some other place and continue the exam where he left. Absolutely there is no need to start the exam afresh.

6. RESULTS AND DISCUSSION

The study of acceptance of cloud based online evaluation is conducted with PGDMA students of NAARM and some of the salient results are discussed below.

6.1 User Perception Study

In this regard, a questionnaire is prepared which touches various aspects of hypervisor enabled online evaluation were taken on 1-5 scale for different statements. The feedback has been collected from 16 PGDM students of the academy. There is highly positive feedback of above 4 points on four out of six aspects of cloud computing infrastructure. This strongly suggests that the new cloud computing infrastructure has been well accepted and implemented.

6.2 Perception of Hypervisor based Online Evaluation by the Users

A questionnaire is prepared which touches various aspects of hypervisor based online evaluation were taken on 1-5 scale for different statements. There is highly positive feedback of above 4 points on all aspects of online evaluation. This strongly suggests that the new method of cloud enabled evaluation has been well accepted and implemented.

6.3 The shift to hypervisor-based services using existing hardware and trail based software, allowed NAARM to provide improved collaboration and research capabilities, opportunities to lower IT costs and at the same time to provide better levels of computing services. With the help of hypervisor computing, students, trainees and faculty can take advantage of the ability to work and communicate from anywhere and on any device using cloud-based applications (McLear 2009, Buyya 2010) Applications like virtual office, spreadsheets, databases and social software can provide students and teachers with free or low-cost alternatives to expensive, proprietary productivity tools. Browser-based applications are accessible with a variety of computer and even mobile platforms (tablets & android based mobiles) (Sultan 2010), making these tools available anywhere the Internet can be accessed.
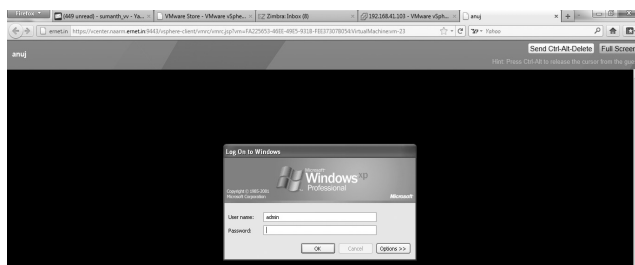
NAARM Hypervisor environment is hosting many open source templates where licensing is not a problem and all the relevant open source software can bundled into templates. These software can be shared with other NARS institutes by implementing Software as a Service (SaaS) at NAARM. For Example, If a user wants to work on GIS, he/she can create a VM

Table 1. Perception of User access to Hypervisor Infrastructure

Sl No.	Statement	Proportion of Rating, %					Mean Rating
		1	2	3	4	5	
1.	Login process is easy to reach my terminal.	0.0	0.0	12.5	25.0	62.5	4.50
2.	There are no connectivity issues in connecting hypervisor.	0.0	12.5	12.5	25.0	50.0	4.125
3.	My System had not become 'slow' after connecting to hypervisor.	0.0	0.0	12.5	6.25	81.25	4.6875
4.	Accessing regular applications like MS Office, Internet Explorer etc., is quick on the virtual machines.	0.0	6.25	37.5	31.25	25.0	3.75
5.	Logging out process from virtual machine is simple.	0.0	0.0	6.25	12.5	81.25	4.75
6.	Having multiple log-ins is not confusing.	0.0	18.75	18.75	12.5	50.0	3.94

Table 2. Perception of Hypervisor enabled Online Evaluation

Sl No.	Statement	Proportion of Rating, %					Mean Rating
		1	2	3	4	5	
1.	User Interface of screen for online examination is simple.	0.0	0.0	0.0	12.5	87.5	4.875
2.	Scrolling from one question to another is comfortable	0.0	0.0	0.0	18.75	81.25	4.812
3.	Going back to un answered question is easy	0.0	0.0	0.0	12.5	87.5	4.87
4.	Scrolling of screen is flexible	0.0	0.0	12.5	18.75	68.75	4.56
5.	Screen Resolution and font size is good	0.0	0.0	0.0	18.75	81.25	4.81
6.	Answering options (radio buttons) are clear	0.0	0.0	6.25	12.5	81.25	4.75
7.	Reviewing the answers before submitting the exam is easy	6.25	0.0	12.5	6.25	75.0	4.44
8.	Submitting the exam on completion is easy to understand	0.0	6.25	0.0	18.75	75.0	4.625
9.	Online is better than Offline mode	0.0	0.0	31.25	6.25	62.5	4.31

Fig 5: User logging into the machine by using Web Browser.

out of a "Open GIS Template" which contains the Post GIS & Postgresql Database server bundled together. User can create a machine out of naarm cloud, login to the VM, get the work done, logoff and dissolve the VM, so that resources can go back to the cloud for further utilization. We understood that cloud is a powerful platform that can enhance engagement among educators to understand and improve practice, and thus, increase productivity.

7.   CONCLUSION

This work is done to test the effectiveness of hypervisor/virtualization on our training programmes and the results are enormous. With the initiation of NAARM virtualization, It has become very easy to share the content created, both in terms of collaborating on its creation and distributing the completed work. We believe that the cloud computing will be the model of the future for information technology delivery and utilization in educational organizations. Across higher education, the cloud computing landscape should be quite active over the next few years, some of the most exciting uses and best practices for cloud computing could come from the world of higher education (Yanosky 2009).

The cloud-based educational model is a relatively new idea in terms of adoption. Educational institutions can take advantage of cloud applications to provide students and lecturers with free or low-cost alternatives to expensive, proprietary productivity tools. Before full adoption, education institutes must consider key issues, which may include lack of reliability and availability, privacy and security, loss of control over operations and data and other problems. It is expected the cloud education to undergo many changes regarding issues, risks, best practices and standards.

The Cloud is here to stay. Whatever view we take of the changes in IT, there is no doubt that the future is cloudy.

REFERENCES

Batson, T. (2011). The Cloud Opens the Floodgates for Faculty Innovation. http://campustechnology.com - accessed September 2011.

Biggadike, A., Ferullo, D., Wilson, G., and Perrig, A. (2005) NATBLASTER: Establishing TCP connections between hosts behind NATs. In Proceedings of ACM SIGCOMM ASIA Workshop (Beijing, China, Apr. 2005).

Buyya, Rajkumar; Chee Shin Yeo, Srikumar, Venugopal (2010). Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities. Department of Computer Science and Software Engineering, University of Melbourne, Australia. p. 9. Retrieved 2010-07-31.

Castro, Sebastian Zhang, Min John, Wolfgang Wessels and Duane claffy. (2010). Understanding and preparing for DNS evolution, Traffic Monitoring and Analysis Workshop (TMA) in April 2010.

Christy Pettey. (2011). Annual Failure Rates of PCs Are Improving, but Manufacturers Can Do Better, http://www.gartner.com/it/page.jsp?id=493841 Accessed in October 2011.

Cloud Computing: Clash of the clouds. *The Economist*. 2009-10-15. Retrieved 2011-11-03.

Harrison, D. (2011). Is Cloud Computing a Credible Solution for Education?, IT Trends, http://campustechnology.com; accessed August 2011.

Linthicum, David (2011). Why the hybrid cloud model is the best approach., http://www.infoworld.com/d/cloud-computing/why-the-hybrid-cloud-model-the-best-approach-477 Accessed in December 2011.

Lofstrand, Erik (2011). DHCP in a Cloud Enabled World, http://blogs.technet.com/b/privatecloud/archive/2012/03/22/dhcp-in-a-cloud-enabled-world-by-eric-lofstrand.aspx Accessed in October 2011.

McLear, J. (2009). Heading into the cloud: cloud computing and education, Blogs:educationau, http://blogs.educationau.edu.au/jmillea/2009/06/23/; accessed August 2011.

Mendicino, Samuel F. OCTOPUS: THE LAWRENCE RADIATION LABORATORY NETWORK, COMPUTER NETWORKS, pp 95-100.

Powell, John (2011). Cloud computing – what is it and what does it mean for education?, http://erevolution.jiscinvolve.org/wp/files/2009/07/clouds-johnpowell.pdf Accessed in October 2011.

Sultan, N. (2010). Cloud computing for education: A new dawn? International Journal of Information Management. Kidlington: Apr 2010. Vol. 30, Iss. 2; pg. 109.

vSphere and vCenter Server, vSphere 5 Documentation, http://pubs.vmware.com/vsphere-50/index.jsp?topic=%2Fcom.vmware.vsphere.solutions.doc_50%2FGUID-4DB6A316-4A70-49A1-926A-851C5F160378.html Accessed in October 2011.

Yanosky, R (2009), From Users to choosers: The cloud and the changing shape of enterprise authority, in Katz, R (ed) (2009), The Tower and the Cloud: Higher Education in the Age of Cloud Computing, Educause.

http://en.wikipedia.org/wiki/Cloud_computing;   accessed   August 2011.

http://csrc.nist.gov/publications/drafts/800-145/Draft-SP-800-145_cloud-definition.pdf; NIST of US Department of Commerce, accessed August 2011.

Further information about Cloud Computing services:

- Microsoft Cloud services - http://www.microsoft.com/cloud/
- Google Cloud services - http://www.google.com/apps/intl/en/business/index.html
- Amazon (EC2) Cloud services - http://aws.amazon.com/ec2/
- CA Cloud services - http://www.ca.com/us/cloud-solutions.aspx
- IBM Cloud Services - http://www.ibm.com/ibm/cloud