Laboratory Manual

Cloud Computing Lab
(CS-804)

For

Final Year Students CSE
Departmeny: Computer Science & Engineering

INSTITUTE OF TECHNOLOGY & MANAGEMENT
GWALIOR • MP • INDIA

Department of Computer Science and Engineering

Vision of CSE Department:

The department envisions to nurture students to become technologically proficient,research competent and socially accountable for the welfare of the society.

Mission of the CSE Department:

I. To provide high quality education through effective teaching-learning processemphasizing active participation of students.

II. To build scientifically strong engineers to cater to the needs of industry, higherstudies, research and startups.

III. To awaken young minds ingrained with ethical values and professional behaviorsfor the betterment of the society.

Program Educational Objectives:

Graduates will be able to

I. Our engineers will demonstrate application of comprehensive technical knowledge forinnovation and entrepreneurship.

II. Our graduates will employ capabilities of solving complex engineering problemsto succeed in research and/or higher studies.

III. Our graduates will exhibit team-work and leadership qualities to meet stakeholderbusiness objectives in their careers.

IV. Our graduates will evolve in ethical and professional practices and enhancesocioeconomic contributions to the society.

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Program Outcomes (POs):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Course Outcomes

Cloud Computing(CS-804)

CO1:	To understand the cloud computing architecture.
CO2 :	To illustrate and demonstrate virtual machines through hypervisor.
CO3 :	To illustrate the storage as a Service on cloud through google drive.
CO4 :	To understand and evaluate the different cloud services like google app engine, Microsoft Azure.
CO5 :	To describe the performance evaluation of Services in Cloud Computing.

Course	Course Outcomes	CO Attainment	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	To understand the cloud computing architecture.		3				1								2		
CO2	To illustrate and demonstrate virtual machines through hypervisor.		2				2								1	2	
CO3	To illustrate the storage as a Service on cloud through google drive.										1					1	2
CO4	To understand and evaluate the different cloud services like google app engine, Microsoft Azure.				1		1					1			2		1
CO5	To describe the performance evaluation of Services in Cloud Computing.											1		1	1		1

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LIST OF PROGRAMS

Program-1

Architecture Design for Bank Industry

ABSTRACT

Technology makes life easy. People contact banks in their day to day life activity. And also the banks are committed to serve their customers with the help of currently advanced technology. The aim of a bank is to give consistent and satisfactory banking services for the customers. The use of advanced technology in banking requires sophisticated knowledge of the technology andexpertise and a large number of employees are required for implementation and management of that system. Cloud computing makes easy the management of IT infrastructure and the bank sector systems. Cloud service providers provide three basic types of services: infrastructure as a service, software as a service and platform as a service. In a cloud environment, there are concerns in the security and confidentiality of the data placed at the cloud.

The main purpose of the study is design the cloud computing architecture for Dashen bank, which will reduce the labour need for managing IT infrastructure and system and enhance theuse of technology with the required security verification.

The study focused on designing aspects of cloud computing. The study used interview, observation and document analysis to gather the data. The interview was conducted on the selected department and employee of the bank. All the required data was collected from the head quarter of Dashen bank. The study revealed the management of the bank recognized the potential benefit of cloud computing and has started dealing with companies like Microsoft andIBM to adopt the technology. Future researcher needs to focus on assessing and developing an appropriate security system for bank sector.

INTRODUCTION

In the evolution of computing technology, information processing has moved from mainframes to personal computers to server-centric computing to then to the Web-based system. Cloud computingis a newly emerging and vastly growing technology. Innovation in banking is a concept in continuous change. Cloud computing technology allows banks to use their resources more efficiently by a betterbudget management and resource allocation. There were released many definitions in order to explain Cloud Computing concept.

The most common types of cloud computing deployment models are four, those are:

- **Private cloud:** The cloud infrastructure is operated solely for an individual organization and managed by the organization or a third party; it can exist on or off the organization's premises.
- **Community cloud:** The cloud infrastructure is shared by several organizations and supports a specific community that has common interests (e.g., mission, industry collaboration, or compliance requirements). It might be managed by the community organizations or a third party and could existon or off the premises.

- **Public cloud**: The cloud infrastructure is available to the general public or a large industry group and is owned by an organization selling cloud services.

- **Hybrid cloud:** The cloud infrastructure is composed of two or more clouds (private, community, orpublic) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability. Banks are adopting cloud services , with SaaS (Software as a service) being the most-widely deployedform, mainly in peripheral, non-core solution areas, such as collaboration, customer relationship management and human resources department, but exceptions do exist. Adoption varies by bankingsegment, with more small-tier and large-tier banks adopting SaaS than banks in the mid-tier segment. The adoption of Cloud Computing model imposes a list of capabilities involved in the comprehension of the model strategy. The Cloud Maturity model implies concepts such as: capabilities, domains, maturity and adoption.

LITERATURE REVIEW

Cloud computing makes the business scalable and upgradeable in the bank industry. Using cloud computing banks can create a flexible and agile banking environment that can quickly respond to new business needs Cloud technology offers secure deployment options that can help banks developnew customer experiences, enable effective collaboration and improve speed to market all while increasing IT efficiency.

Cloud computing provides an option for the user to use advanced technology and being beneficial toits features. The use of cloud computing that the most advanced technology in the field of IT infrastructure, is a dynamic of its own capabilities, the most common way to share and manage IT resources in developed countries world, developing its infrastructure and cloud-based services with the speed, is growing. Cloud computing provides the full scalability, reliability, high performance andrelatively low cost feasible solution as compared to dedicated infrastructures.

STATEMENT OF THE PROBLEM

In any financial services institutions, IT infrastructure and support are constantly facing cost pressures, while computing needs and amount of data are ever increasing. The critical thing that weneed to see in infrastructure architecture is the ability to scale, the “traditional” non-cloud infrastructure; systems are typically architected to sustain potential future growth and resource demand.

Business sectors can benefited from the fact that cloud computing helps to create a more flexible, agile business model to meet the growing business needs in a dynamic and competitive landscape. Cloud computing helps banks to transform their business processes and enhance their ability to grow in new sectors or regions without the time and cost burdens involved with establishing a physical presence. The bank main objective is to facilitate financial business transaction based systemusing the advantage of existing technology. So cloud computing is an ideal solution to get rid of these issues.

Banks have a huge number of IT infrastructure and deploy an appropriate system that allows the banks to do their business transaction process. The type of system and technology the bank uses tomake the bank being the first choice by the customer. Deployment and management of the system and IT infrastructure requires big financial fund and strong management skill. Because of cloud computing providing easy management option for the cloud customer passing out of the servicethrough cloud provider is the best way.

DISCUSSION

- The discussion of the collected data focuses on the interview question, observed place and reviewed documents generalized and presented as a follows.
- Existence of Problem: - The bank uses a different system to serve the customer, and that system also supported a number of information related to customers profile and other vital records. As the employee and management of the bank respond there are system failures at working time and loss of data occasionally.
- Awareness Of Cloud Computing: - As cloud computing is a new discipline, investigating the awareness of the employee and higher management about cloud computing was compulsory and done. Based on the information gained from the interviewee, almost all interviewee from the IT infrastructure department are well aware of cloud computing and its basic function plus deployment model.
- Interest and Plan to Work by Cloud Based System: - The bank is fully interested to work using cloud-based system. In addition to the interest, the bank also started to work with some cloud providers, for example, Microsoft. From the benefit, the most and common are make the bank to focus on core banking activity, reduce the time taken for information management, data centre and IT infrastructure management, reduce unnecessary expenditure and cost expense on-demand capacity utilization, easy disaster recovery, easy scalability and upgradeability feature of the system.
- Trust of The Service Provider: - Customers do not directly engage with the new services offers unless they know the benefit or crisis of the system. Cloud computing was not implemented in Ethiopia; this makes the customer of the bank have a negative image on their system. Because of the employee and management bank knows the benefit and risk cloud system, the bank trust the word class cloud services providers like Microsoft, IBM, and Oracle.
- Financial Expenditure and Resource Usage: - In order to know the benefit of cloud computing in the sake of financial investment observation the data centre and some infrastructure and document analysis was necessary because of these observed and document seen.

RESULT

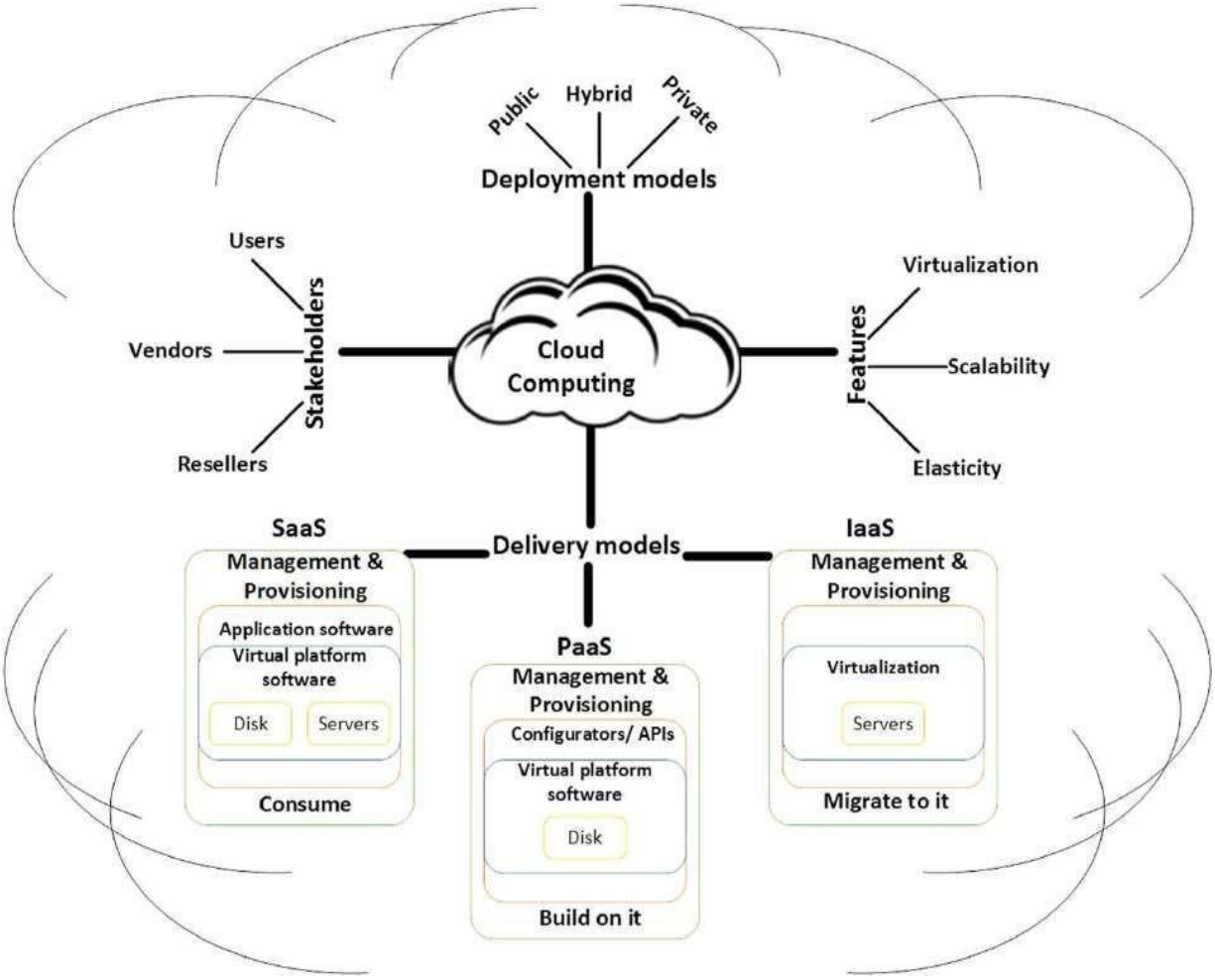
As a result of collected and analyzed data, the researcher concludes that as into two ways.

- Interest and Wish Of The Bank
- Tackle and Fear of Cloud

1. **Security:** the bank data is very sensitive and need strong care but cloud computing will implement via the internet and the internet-based system is near for hacker and cracker so this one will as the drawback of cloud computing.
2. **Customer perception and trust:** because of the service is not as such familiar for Ethiopian people the customer will not have trust in the system and the bank too.
3. **Procedure:** in Ethiopian no ground rule that governs cloud and even there is some negativity for not outsourcing bank data for international origination.
4. **Internet:** since Ethiopia has only internet service provider there is internet connection interruption.

The design of the PROPOSING CLOUD ARCHITECTURE

Architecture consists of the layer which indicated in the detail component of each layer and the description for each attribute.



- **SaaS Layer :-** The software as a service layer of this architecture contains the software package that allow to implement the cloud at the bank plus the software that Dashen bank use to make transaction, process an activity that will use for decision making and compatibleand authorized browser that added on the directory of the bank for the use of security.

- **Management Layer :-** The layer in which that manages the activity between the cloudprovider and the user of it include service request, software usage approval and authentication, privilege deliverance and like of functions.

- **Data Security and Privacy Layer: -** The major challenge of the cloud computing system is the security system, in this proposed architecture the security layer has a step to identify the authorized user on not at the provider end using browser authentication and at the bank end using username and password to access the client computer.

- **Functionality Layer:-** Functionality layer is the overall integration of the cloud system and the actual implementation of the cloud system at Dashen bank, including accessing of the system and device, controlling and monitoring of the system and device, transaction and information processing of the bank.

Advantages of cloud computing

- Back-up and restore data
- Improved collaboration
- Mobility
- Excellent accessibility
- Low maintenance cost

Disadvantages of cloud computing

- Internet Connectivity
- Limited Control
- Security
- Vendor lock-in

Conclusions :- Focused on designing cloud computing architecture for the bank industry in particular for Dash bank operated at Ethiopia. While designing the main issue to be addressed is to make the system more secure from third party intruder. This helps the customer on the bank to develop confidence in their transaction and avoid the fear of potential information loss.

The limitation is done by the devices used for end users, for example, in the banking sector, some reports, even if it are ran over the cloud infrastructure, the visualization and interpretation suffer due to the inadequate device used. Cloud Computing will remain a reliable solution in order to modernize the company activity, due to its virtualized flavour, more or less, is the feasible solution, which can go in parallel with intranet zero or thin client architectures, in fact the differential in choosing the right solution is related to the company activity flavour.

Cloud computing is the ideal point to facilitate the bank financial transaction process and develop the bank by managing and deploying of the IT infrastructure and system.Bank sector need to focus on the business and transaction process with the help of the current technology, the technology deployment requires much amount of money and human labor.The designed architecture for Dashen bank is a logical design that will show to the bank there is another way to make the business possible in an easy manner with better efficiency. As one barrier to doing not fully deploy cloud at the bank is no local service provider in Ethiopia.

Program-2

Explain the Study and Implementation of virtualization through any Hypervisor

What is Hypervisor?

- A hypervisor is computer software or hardware that enables you to host multiple virtual machines. Each virtual machine is able to run its own programs. A hypervisor allows you to access several virtual machines that are all working optimally on a single piece of computer hardware.

- For the most part, cloud computing entails you being able to access a virtual machine for you to be able to do what you need to do anywhere. A hypervisor manages these virtual machines.

- With a hypervisor, each virtual machine or operating system you have will be able to run itsown programs, as it will appear that the system has the host hardware's processor, memory and resources. In reality, however, it is actually the hypervisor that is allocating thoseresources to the virtual machines.

  You may think that the hypervisor is a fairly recent phenomenon. The first hypervisors were introduced in the 1960s to allow for different operating systems on a single mainframe computer. However, its current popularity is largely due to Linux and Unix. Around 2005, Linux and Unix systems started using virtualization technology to expand hardware capabilities, control costs, and improved reliability and security that hypervisors provided tothese systems.

  Now, hypervisors are fundamental components of any virtualization effort. You can think ofit as the operating system for virtualized systems. It can access all physical devices residing on a server. It can also access the memory and disk. It can control all aspects and parts of a virtual machine. How does it work?

  The servers would need to execute the hypervisor. The hypervisor, in turn, loads the client operating systems of the virtual machines. The hypervisor allocates the correct CPU resources, memory, bandwidth and disk storage space for each virtual machine.

  A virtual machine can create requests to the hypervisor through a variety of methods,including API calls.

  There are two types of hypervisors:

1. Embedded or hosted hypervisors, and
2. Bare metal or native hypervisors
3. Bare metal, native or type I hypervisors

  This is when the hypervisors are run on the host's hardware to control it as well as managethe virtual machines on it.
  If you are currently using Microsoft Hyper-V hypervisor, VMware ESX/ESXi, Oracle VM Server for x86, KVM, or Citrix XenServer, then this is the type of hypervisor with which youare working.

Embedded, hosted or type II hypervisors
These hypervisors are run as a software using an operating system such as Windows, Linuxor FreeBSD. This is what the Virtage hypervisor, VirtualBox and VMWare Workstation areclassified as.

So, native hypervisors run directly on the hardware while a hosted hypervisor needs anoperating system to do its work. Which one is better? It depends on what you're after.

Bare metal hypervisors are faster and more efficient as they do not need to go through theoperating system and other layers that usually make hosted hypervisors slower. Type I hypervisors are also more secure than type II hypervisors.

Hosted hypervisors, on the other hand, are much easier to set up than bare metal hypervisors because you have an OS to work with. These are also compatible with a broad range of hardware.

Hypervisors for Data Replication

What are the uses of hypervisors and where are they applied?
Hypervisors may be used in data services for easy cloning and replication. Hypervisor-based replication is also more costeffective and less complex than current replication methods, especially those involving virtual machines.

Traditionally, it is very difficult to replicate virtual machines. For one, you would need to know how to manage and do data replication. If you use a storage system-based replication method, you will need to replicate the entire volume of the virtual machine. If you have a lotof virtual machines running on a particular hardware, you will have to get a significant amount of storage in order to be able to store the entire volume. With hypervisor-based replication, you can choose which VMs and what parts are to be replicated, so that you couldsave up on storage space.

Hypervisor-based replication is also hardware neutral, meaning you could store any dataduplicates to any storage device.

If you are currently using VMWare, you can get hypervisor-based replication in vSphere. Microsoft has also included this feature in any Windows package that has Hyper-V.

Hypervisors for consolidating servers
Hypervisors have a graphical dashboard you could work with. They are also plug-able whereyou can download enhancements. This capability lets you easily consolidate your servers even if they do not have the same operating systems.

Hypervisors for desktop virtualization
You can use a hypervisor to easily host a virtual desktop on a server. This virtual desktop willbe the exact replica of a user's physical desktop. This will allow your employees to be able to work remotely, no matter where they are since they can access their PCs over the Internet, or through a slim client.

Type 2 Vendors
As is the case with bare-metal hypervisors, you can choose between numerous vendors and products. Conveniently, many type 2 hypervisors are free in their basic versions and provide sufficient functionalities.

Some even provide advanced features and performance boosts when you install add-onpackages, free of charge. We will mention a few of the most used hosted hypervisors:

Oracle VM VirtualBox
A free but stable product with enough features for personal use and most use cases for smaller businesses. VirtualBox is not resource demanding, and it has proven to be a good solution for both desktop and server virtualization. It provides support for guest multiprocessing with up to 32 vCPUs per virtual machine, PXE Network boot, snapshot trees,and much more.

VMware Workstation Pro/VMware Fusion
VMware Workstation Pro is a type 2 hypervisor for Windows OS. It is full of advancedfeatures and has seamless integration with vSphere. This allows you to move your appsbetween desktop and cloud environments.

It does come with a price tag, as there is no free version. If you want to take a glimpse into VMware hosted hypervisors free of charge, you can try VMware Workstation Player. This isthe basic version of the hypervisor suitable for small sandbox environments.

For MacOS users, VMware has developed Fusion that is similar to their Workstation product.It comes with somewhat fewer features, but also carries a smaller price tag.

Windows Virtual PC
It only supports Windows 7 as a host machine and Windows OS on guest machines. Thisincludes multiple versions of Windows 7 and Vista, as well as XP SP3. Virtual PC is completely free.

Parallels Desktop
A competitor to VMware Fusion. It is primarily intended for MacOS users and offers plentyof features depending on the version you purchase. Some of the features are network conditioning, integration with Chef/Ohai/Docker/Vagrant, support for up to 128GB per VM,etc.

Type 1 Vendors
There are many different hypervisor vendors available. Most provide trial periods to test outtheir services before you buy them.
The licensing costs can be high if you want all the bells and whistles they have on offer.These are the most common **type 1 hypervisors**:

VMware vSphere with ESX/ESXi
VMware is an industry-leading vendor of virtualization technology, and many large data centers run on their products. It may not be the most cost-effective solution for smaller IT environments. If you do not need all the advanced features VMware vSphere offers, there is afree version of this hypervisor and multiple commercial editions.

KVM (Kernel-Based Virtual Machine)

KVM is built into Linux as an added functionality. It lets you convert the Linux kernel into a hypervisor. It is sometimes confused with a type 2 hypervisor (see definition below). It has direct access to hardware along with virtual machines it hosts. KVM is an open-source hypervisor that contains all the features of Linux with the addition of many other functionalities. This makes it one of the top choices for enterprise environments. Some of thehighlights include live migration, scheduling and resource control, alongside higher prioritization.

To learn more about working with KVM, visit our tutorials How To Install KVM OnUbuntu and How To Install KVM On CentOS.

Microsoft Hyper-V

Despite VMware's hypervisor being higher on the ladder with its numerous advanced features, Microsoft's Hyper-V has become a worthy opponent. Microsoft also offers a freeedition of their hypervisor, but if you want a GUI and additional functionalities, you will have to go for one of the commercial versions. Hyper-V may not offer as many features asVMware vSphere package, but you still get live migration, replication of virtual machines,dynamic memory and many other features.

Oracle VM

This hypervisor has open-source Xen at its core and is free. Advanced features are only available in paid versions. Even though Oracle VM is essentially a stable product, it is not asrobust as vSphere, KVM or Hyper-V.

Citrix Hypervisor (formerly known as Xen Server)

This Server virtualization platform by Citrix is best suited for enterprise environments. It can handle all types of workloads and provides features for the most demanding tasks. Citrix is proud of its proprietary features, such as Intel and NVIDIA enhanced virtualized graphics andworkload security with Direct Inspect APIs.

Advantages

1. Facilities to be simplified, space-saving, time and cost-saving.
2. Centralized management and Full compatibility with applications.
3. Greater availability and easier recovery in case of disaster.
4. The ability for running backups and can use multiple operating system environmentson the same computer.
5. Controlled access to sensitive data and intellectual property by keeping them safeinside the data center.
6. Best use of space: the fewer physical devices installed, the greater the availability ofspace in racks.
7. Migrating servers to new hardware transparently.
8. Reliability and Availability – the failure of software does not affect the other services.
9. The cost reduction is possible using small virtual servers on a more powerful singleserver.
10. Adapting to different workloads, which can be treated simply. Typically, virtualization software reallocates hardware resources dynamically between a virtualmachine and another.
11. Load balancing: the whole virtual machine is encapsulated. Thus, it becomes easy tochange the virtual machine platform and increase its performance.

12. Support for legacy applications: when a company decides to migrate to a newoperating system, you can keep your old operating system running in a virtualmachine, which reduces the cost of migration.
13. Reduction of personnel costs, power, and cooling by using less physical equipment.
14. Better utilization of hardware – the hardware sharing by virtual machines is reducedto idle equipment.
15. Creates independent user environments. Keeping everything separate is especially useful for purposes like software testing.
16. Reduced downtime.
17. Ease of migration environments – prevents reinstallation and reconfiguration ofsystems to be migrated.

Disadvantages

1. The biggest disadvantage of virtual servers is that if or when the server goes offline,all the websites hosted by it will also go down. Hence, to solve this, the company could set up a cluster of servers.
2. **Management** – virtual environments need to be instantiated (create instances onvirtual machines), monitored, configured and saved.
3. Difficulty indirect access to hardware, for example, specific cards or USB devices.
4. **Performance** – currently, there are no consolidated methods to measure the performance of virtualized environments.
5. When several virtual machines are running on the same host, performance maybehindered if the computer it's running on lacks sufficient power.
6. Huge RAM consumption since each virtual machine will occupy a separate area ofthe same.
7. It requires multiple links in a chain that must work together cohesively.
8. Great use of disk space, since it takes all the files for each operating system installedon each virtual machine.

Program-3

Google App Engine

INTRODUCTION

Google App Engine (often referred to as **GAE** or simply **App Engine**) is a cloud computing platform as a service for developing and hosting web applications in Google- managed data centers. Applications are sandboxed and run across multiple servers.[1] App Engine offers automatic scaling for web applications—as the number of requests increases for an application, App Engine automatically allocates more resources for the web application to handle the additional demand.
Google App Engine primarily supports Go, PHP, Java, Python, Node.js, .NET, and Ruby applications, although it can also support other languages via "custom runtimes".The service is free up to a certain level of consumed resources and only in standard environment but not in flexible environment. Fees are charged for additional storage, bandwidth, or instance hours required by the application. It was first released as apreview version in April 2008 and came out of preview in September 2011.

Runtimes and framework

Google App Engine primarily supports Go, PHP, Java, Python, Node.js, .NET, and Ruby applications, although it can also support other languages via "custom runtimes". Python web frameworks that run on Google App Engine include Django, CherryPy, Pyramid, Flask, web2py and webapp2, as well as a custom Google-written webapp framework and several others designed specifically for the platform that emerged since the release. Any Python framework that supports the WSGI using the CGIadapter can be used to create an application; the framework can be uploaded with the developed application. Third-party libraries written in pure Python may also be uploaded. Google App Engine supports many Java standards and frameworks. Core to this is the servlet 2.5 technology using the open-source Jetty Web Server, along with accompanying technologies such as JSP. JavaServer Faces operates with some workarounds. A newerrelease of App Engine Standard Java in Beta supports Java8, Servlet 3.1 and Jetty9. Though the integrated database, Google Cloud Datastore, may be unfamiliar to programmers,it is accessed and supported with JPA, JDO, and by the simple low-level API. There are several alternative libraries and frameworks you can use to model and map the data to the database such as Objectify, Slim3 and Jello framework. The Spring Framework works with GAE. However, the Spring Security module (if used)requires workarounds. Apache Struts 1 is supported, and Struts 2 runs with workarounds.

The Django web framework and applications running on it can be used on App Engine with modification. Django-nonrel aims to allow Django to work with non-relational databases andthe project includes support for App Engine.
All billed App Engine applications have a 99.95% uptime SLA.
App Engine is designed in such a way that it can sustain multiple data centre outages withoutany downtime. This resilience to downtime is shown by the statistic that the High ReplicationDatastore saw 0% downtime over a period of a year.

Free support is offered in the App Engine Groups, Stack Overflow, Server Fault, and GitHub. However, assistance by a Google staff member is not guaranteed. Paid support from Google engineers is offered as part of Premier Accounts.

FEATURES

- **Popular language:-** Build your application in Node.js, Java, Ruby, C#, Go, Python, or PHP—or bring your own language runtime.
- **Open and flexible:-** Custom runtimes allow you to bring any library and framework to App Engine by supplying a Docker container.
- **Fully managed :-** A fully managed environment lets you focus on code while App Engine manages infrastructure concerns.
- **Powerful application diagnostics:-** Use Cloud Monitoring and Cloud Logging to monitor the health and performance of your app and Cloud Debugger and Error Reporting to diagnose and fix bugs quickly.
- **Application versioning:-** Easily host different versions of your app, and easily create development, test, staging, and production environments.
- **Traffic splitting:-** Route incoming requests to different app versions, A/B test, and do incremental feature rollouts.
- **Application security:-** Help safeguard your application by defining access rules with App Engine firewall and leverage managed SSL/TLS certificates by default on your custom domain at no additional cost.
- **Services ecosystem:-** Tap a growing ecosystem of Google Cloud services from your app including an excellent suite of cloud developer tools

BENIFITS

Open and familiar languages and tools

Build and deploy apps quickly using popular languages or bring your own language runtimes and frameworks. You can also manage resources from the command line, debugsource code, and run API back ends easily.

Just add code

Focus on writing code without having to manage underlying infrastructure. Protect your apps from security threats using firewall capabilities, IAM rules, and managed SSL/ TLScertificates.

Pay only for what you use

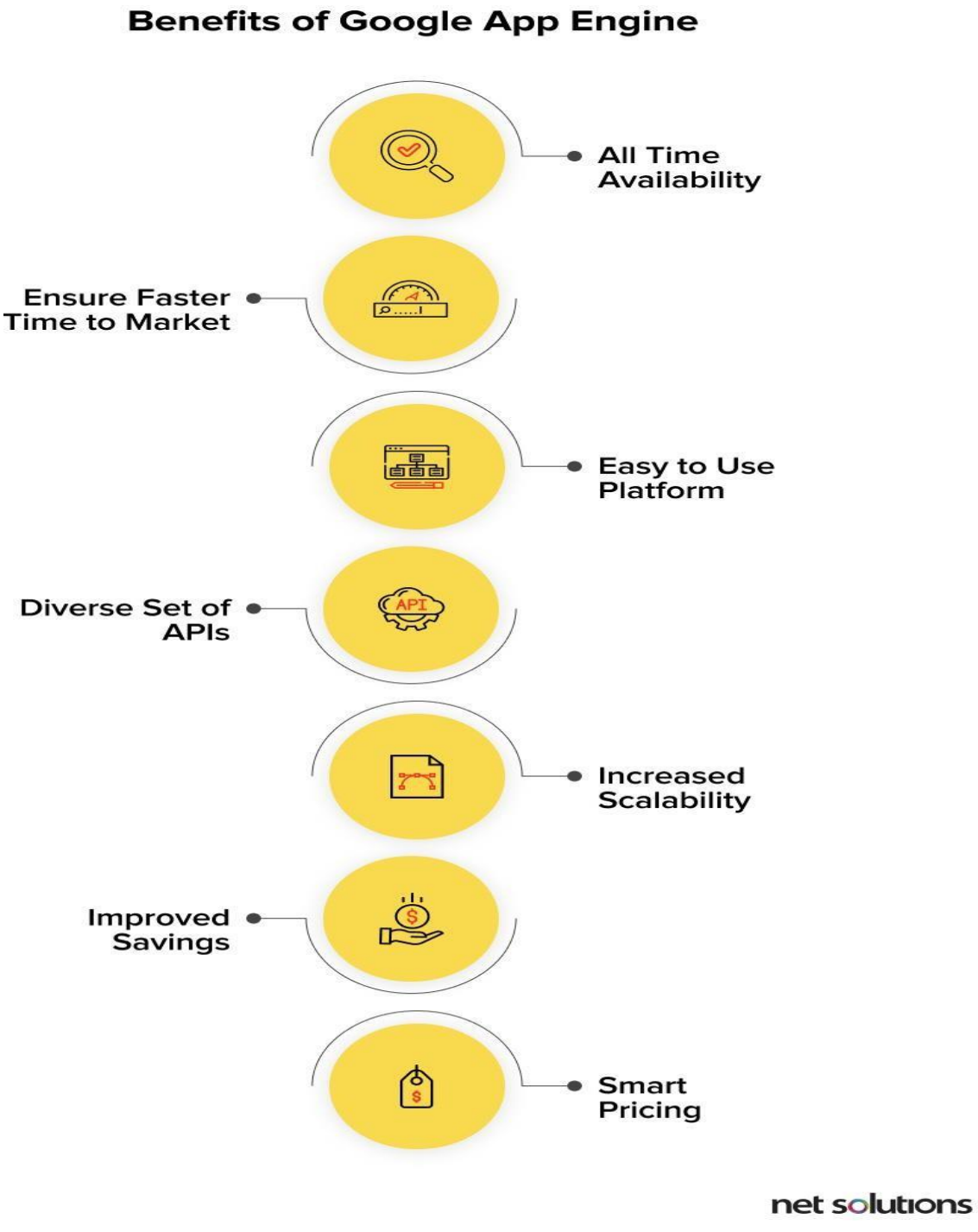
Operate in a server less environment without worrying about over or under provisioning.App Engine automatically scales depending on your app traffic and consumes resources only when your code is running.

Ensure Faster Time to Market

For your web applications to succeed, ensuring faster time to market is imperative as the requirements are likely to change if the launch time is extended. Using Google App Engine isas easy as it can get for developers. The diverse tool repository and other functionalities ensure that the development and testing time gets reduced, which, in turn, ensures faster launch time for MVP and consecutive launches.

Improved Savings

With Google App Engine, you do not have to spend extra on server management of the app.The Google Cloud service is good at handling the backend process.Also, Google App Engine pricing is flexible as the resources can scale up/down based on theapp's usage. The resources automatically scale up/down based on how the app performs in the market, thus ensuring honest pricing in the end.



DISADVANTAGES

- Developers have read-only access to the filesystem on App Engine. Applications can use only virtual filesystems, like gae-filestore.
- App Engine can only execute code called from an HTTP request (scheduled background tasks allow for self-calling HTTP requests).
- Users may upload arbitrary Python modules, but only if they are pure-Python; C and Pyrex modules are not supported.
- Java applications may only use a subset (The JRE Class White List) of the classes from the JRE standard edition. This restriction does not exist with the App Engine Standard Java8 runtime.
- A process started on the server to answer a request can't last more than 60 seconds (with the 1.4.0 release, this restriction does not apply to background jobs anymore).
- Does not support sticky sessions (a.k.a. session affinity), only replicated sessions are supported including limitation of the amount of data being serialized and time for session serialization.

Conclusion

Google App Engine offers a PaaS standard environment to build and deploy web applications on Google's infrastructure.

The Google service is a preferable choice for organizations as they do not have to worryabout hosting and managing the application infrastructure. It helps ensure faster time to market, lets you focus on core business capabilities, and lets you efficiently manage the consecutive release cycle.To start with — Build your cloud strategy, create a GAE account, set up app engine SDK,write the application source code, test the application, and finally deploy it on the cloud.

Program-4

Implementation of storage as a Service on cloudthrough google drive.

Cloud storage is a model of computer data storage in which the digital data is stored inlogical pools, said to be on "the cloud". The physical storage spans multiple servers (sometimes in multiple locations), and the physical environment is typically owned and managed by a hosting company. These cloud storage providers are responsible forkeeping the data available and accessible, and the physical environment secured, protected, and running. People and organizations buy or lease storage capacity from the providers to store user, organization, or application data.

Cloud storage services may be accessed through a colocated cloud computing service, a web service application programming interface (API) or by applications that utilize the API, suchas cloud desktop storage, a cloud storage gateway or Web-based content management systems.

Architecture

Cloud storage is based on highly virtualized infrastructure and is like broader cloud computing in terms of interfaces, near-instant elasticity and scalability, multi-tenancy, and metered resources. Cloud storage services can be utilized from an off-premises service(Amazon S3) or deployed on-premises (ViON Capacity Services).

Cloud storage typically refers to a hosted object storage service, but the term has broadenedto include other types of data storage that are now available as a service, like block storage.

Object storage services like Amazon S3, Oracle Cloud Storage and Microsoft Azure Storage,object storage software like Openstack Swift, object storage systems like EMC Atmos, EMCECS and Hitachi Content Platform, and distributed storage research projects like OceanStoreand VISION Cloud are all examples of storage that can be hosted and deployed with cloud storage characteristics.

Cloud storage is:

- Made up of many distributed resources, but still acts as one, either in a federated ora cooperative storage cloud architecture
- Highly fault tolerant through redundancy and distribution of data
- Highly durable through the creation of versioned copies
- Typically eventually consistent with regard to data replicas.

Advantages

- Companies need only pay for the storage they actually use, typically an average of consumption during a month. This does not mean that cloud storage is less expensive,only that it incurs operating expenses rather than capital expenses.
- Businesses using cloud storage can cut their energy consumption by up to 70% makingthem a more green business.
- Organizations can choose between off-premises and on-premises cloud storage options, or a mixture of the two options, depending on relevant decision criteria that is complementary to initial direct cost savings potential; for instance, continuity of operations (COOP), disaster recovery (DR), security (PII, HIPAA, SARBOX, IA/CND), and records retention laws, regulations, and policies.

- Storage availability and data protection is intrinsic to object storage architecture, so depending on the application, the additional technology, effort and cost to add availabilityand protection can be eliminated.
- Storage maintenance tasks, such as purchasing additional storage capacity, are offloadedto the responsibility of a service provider.
- Cloud storage provides users with immediate access to a broad range of resources and applications hosted in the infrastructure of another organization via a web service interface.
- Cloud storage can be used for copying virtual machine images from the cloud to on- premises locations or to import a virtual machine image from an on-premises location tothe cloud image library. In addition, cloud storage can be used to move virtual machine images between user accounts or between data centers.
- Cloud storage can be used as natural disaster proof backup, as normally there are 2 or 3different backup servers located in different places around the globe.
- Cloud storage can be mapped as a local drive with the WebDAV protocol. It can functionas a central file server for organizations with multiple office locations

Cloud storage is available in private, public and hybrid clouds.

- **Public storage clouds**: In this model, you connect over the internet to a storage cloud that's maintained by a cloud provider and used by other companies. Providerstypically make services accessible from just about any device, including smartphones and desktops and let you scale up and down as needed.
- **Private cloud storage:** Private cloud storage setups typically replicate the cloud model, but they reside within your network, leveraging a physical server to create instances of virtual servers to increase capacity. You can choose to take full control of an on-premise private cloud or engage a cloud storage provider to build a dedicated private cloud that you can access with a private connection. Organizationsthat might prefer private cloud storage include banks or retail companies due to the private nature of the data they process and store.
- **Hybrid cloud storage**: This model combines elements of private and public clouds,giving organizations a choice of which data to store in which cloud. For instance, highly regulated data subject to strict archiving and replication requirements is usually more suited to a private cloud environment, whereas less sensitive data (such as email that doesn't contain business secrets) can be stored in the public cloud. Some organizations use hybrid clouds to supplement their internal storage networks with public cloud storage.

Types of Cloud Storage

There are three types of cloud data storage: object storage, file storage, and block storage.Each offers their own advantages and have their own use cases:

1. **Object Storage -** Applications developed in the cloud often take advantage of objectstorage's vast scalability and metadata characteristics. Object storage solutions like Amazon Simple Storage Service (S3) are ideal for building modern applications fromscratch that require scale and flexibility, and can also be used to import existing data stores for analytics, backup, or archive.

2. **File Storage -** Some applications need to access shared files and require a file system. This type of storage is often supported with a Network Attached Storage (NAS) server. File storage solutions like Amazon Elastic File System (EFS) are ideal for use cases like large content repositories, development environments, media stores, or user home directories.

3. **Block Storage** - Other enterprise applications like databases or ERP systems often require dedicated, low latency storage for each host. This is analagous to direct-attached storage (DAS) or a Storage Area Network (SAN). Block-based cloud storage solutions like Amazon Elastic Block Store (EBS) are provisioned with each virtual server and offerthe ultra low latency required for high performance workloads.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files in the cloud (on Google's servers), synchronize files across devices, and share files. In addition to a web interface, Google Driveoffers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google Sheets, and Google Slides, which are a part of the Google Docs Editors office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the Google Docs suite are saved in GoogleDrive.

Google Drive offers users 15 GB of free storage through Google One. Google One also offers100 GB, 200 GB, 2 TB, 10 TB, 20 TB, and 30 TB, offered through optional paid plans. Files uploaded can be up to 5 terabytes in size. Users can change privacy settings for individual files and folders, including enabling sharing with other users or making content public. On the website, users can search for an image by describing its visuals, and use natural language to find specific files, such as "find my budget spreadsheet from last December".

Before the introduction of Google Drive, Google Docs initially provided 15 GB of storage free of charge. On April 24, 2012, Google Drive was introduced with free storage of 5 GB.Storage plans were revised, with 25 GB costing $2.49/month, 100 GB costing $4.99/monthand 1 TB costing $49.99/month.

Originally, Gmail, Google Docs, and Picasa had separate allowances for free storage and a shared allowance for purchased storage. Between April 2012 and May 2013, Google Drive and Google+ Photos had a shared allowance for both free and purchased storage, whereas Gmail had a separate 10 GB storage limit, which increased to 25 GB on the purchase of anystorage plan.

In September 2012, Google announced that a paid plan would now cover total storage, ratherthan the paid allocation being added to the free; e.g. a 100 GB plan allowed a total of 100 GBrather than 115 GB as previously.

In May 2013, Google announced the overall merge of storage across Gmail, Google Driveand Google+ Photos, giving users 15 GB of unified free storage between the services.

In March 2014, the storage plans were revised again and prices were reduced by 80% to $1.99/month for 100 GB, $9.99/month for 1 TB, and $99.99/month for 10 TB. This wasmuch cheaper than competitors Dropbox and OneDrive offered at the time.

In 2018, the paid plans were re-branded as "Google One" to emphasize their applicationbeyond Google Drive, along with the addition of a $2.99/month plan for 200 GB, and increasing the $9.99 plan to 2 TB at no additional charge.

In most cases during these changes, users could continue with their existing plans as long as they kept their accounts active and did not make any adjustments to the plan. However, if theaccount lapsed for any reason, users had to choose from current plans.

On November 11, 2020, Google announced charging Google Photos' storage once the usersexceed the limit of 15 GB on their account. The update was announced to come into effect from June 1, 2021. Before June 1, all photos and documents uploaded on Google’s online storage will not be counted under the 15 GB cap.

Program – 5

Discuss the Cloud Computing Security Issue.

Introduction

Cloud computing is flexible and cost-effective, allowing employees to access data remotely from anywhere around the world. Cloud computing benefits are well documented, however, security issues and challenges are probably more difficult to identify. Undoubtedly migration your sensitive information to third party infrastructure will have security implications.

What are the security issues in cloud computing?

- **Misconfiguration**
  Misconfigurations of cloud security settings are a leading cause of cloud data breaches. Many organizations' cloud security posture management strategies are inadequate for protecting their cloud-based infrastructure

- **Unauthorized Access**
  Unlike an organization's on-premises infrastructure, their cloud-based deployments are outside the network perimeter and directly accessible from the public Internet. While this is an asset for the accessibility of this infrastructure to employees and customers, it also makesit easier for an attacker to gain unauthorized access to an organization's cloud-based resources. Improperly-configured security or compromised credentials can enable an attacker to gain direct access, potentially without an organization's knowledge.

- **Cyberattacks**
  Cybercrime is a business, and cybercriminals select their targets based upon the expected profitability of their attacks. Cloud-based infrastructure is directly accessible from the public Internet, is often improperly secured, and contains a great deal of sensitive and valuable data. Additionally, the cloud is used by many different companies, meaning that a successful attackcan likely be repeated many times with a high probability of success. As a result, organizations' cloud deployments are a common target of cyberattacks.

Denial of Service Attacks

The cloud is essential to many organizations' ability to do business. They use the cloud to store business-critical data and to run important internal and customer-facing applications. This means that a successful Denial of Service (DoS) attack against cloud infrastructure is likely to have a major impact on a number of different companies. As a result, DoS attacks where the attacker demands a ransom to stop the attack pose a significant threat to an organization's cloud-based resources.

Conclusion

Since Cloud computing is flexible and cost-effective, allowing employees to access data remotely from anywhere around the world. Cloud computing benefits are well documented, however, security issues and challenges are probably more difficult to identify. There are everyday new types of issues that come across us.

Program – 6

Study of Performance Evaluation of Services inCloud Computing.

Introduction

Cloud Computing is a new service area in Information Technology environment with huge requirements on the shared information, infrastructure, software, resources, devices and services. Performance Evaluation is an important aspect of Cloud Computing environment. Efficient Performance evaluation technique is used to evaluate the all Performance activities, because Cloud users on demand basis in pay-as-you-go model. In this paper, we analyze and evaluate the cloud performance in different environment based on quality attributes, features, services, support specifications and access.

Cloud Computing Performance Evaluation

Cloud computing resources must be compatible, high performance and powerful. High performance is one of the cloud advantages which must be satisfactory for each service.
Higher performance of services and anything related to cloud have influence on users and service providers. Hence, performance evaluation for cloud providers and users is important. There are many methods for performance prediction and evaluation; we use the following methods in our evaluation:

- Evaluation based on criteria and characteristics
- Evaluation based on simulation

Factors affective on performance

Nowadays , the term “performance” is more than a classic concept and includes moreextensive concepts such as reliability, energy efficiency, scalability and soon. Due to the extent of cloud computing environments and the large number of enterprises and normal users who are using cloud environment, many factors can affect the performance of cloud computing and its resources. Some of the important factors considered in this paper are as follows:

- Security, the impact of security on cloud performance may seem lightly strange, but the impact of security on network infrastructure has been proven. For example, DDoS attacks have wide impact on networks performance and if happen, it will greatly reduce networks performance and also be effective on response time too. Therefore, if this risk and any same risks threaten cloud environment, it will be a big concern for users and providers.
- Recovery, when data in cloud face errors and failures or data are lost for any reason, the time required for data retrieval and volumes of data which are recoverable, will be effective on cloud performance. For example, if the data recovery takes a long time will be effective on cloud Performance and customer satisfaction, because most organizations are cloud users and have quick access to their data and their services are very important for them.
- Availability, with easy access to cloud services and the services are always available, performance will be increase.
- Number of users, if a data center has a lot of users and this number is greater than that of the rated capacity, this will reduce performance of services.

- Location, data centers and their distance from a user's location are also an important factor that can be effective on performance from the users' view.

Other factors that can affect performance which are as follows:

- Usability
- Scalability
- Workload
- Repetition or redundancy
- Processor Power
- Latency

Program-7

Study on Hadoop

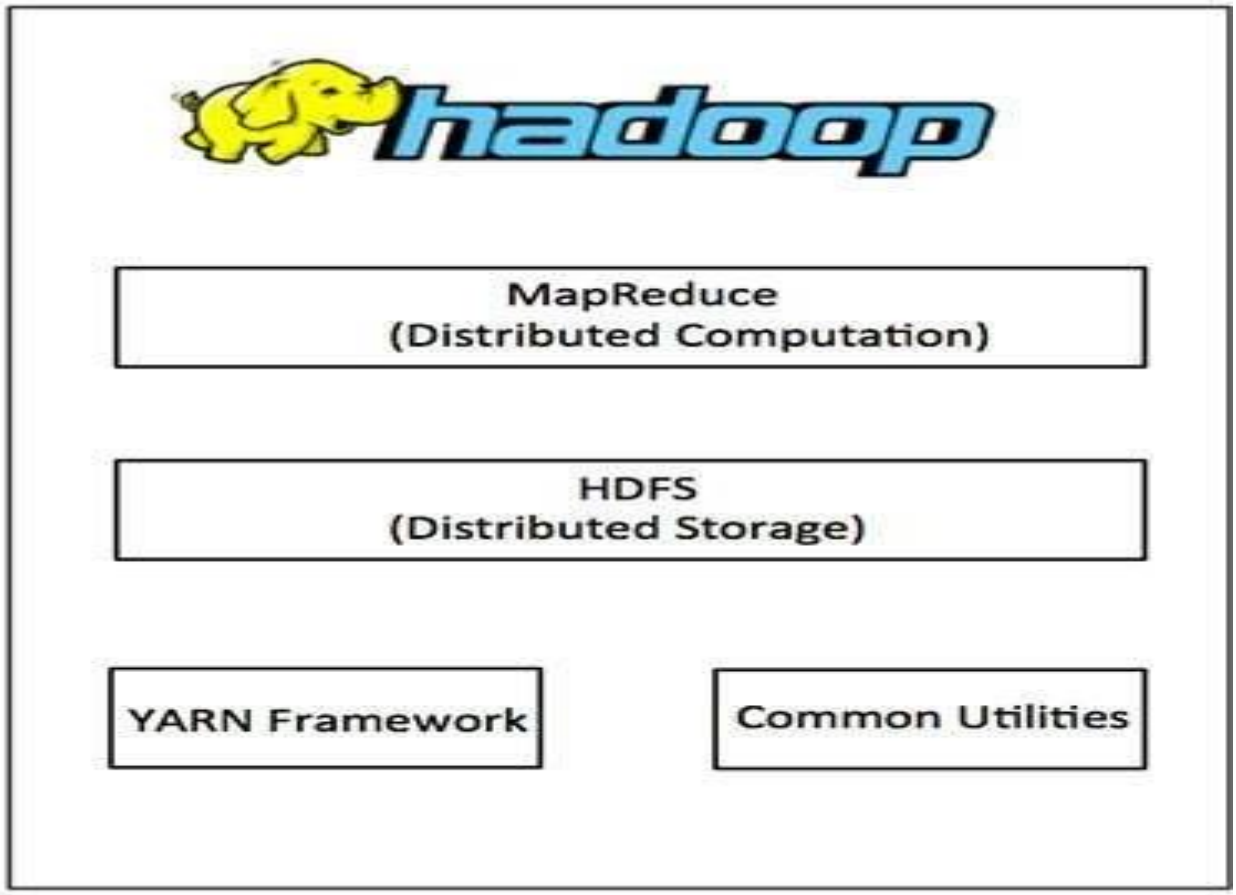
Introduction

Hadoop is an Apache open source framework written in java that allows distributed processing of large datasets across clusters of computers using simple programming models. The Hadoop framework application works in an environment that provides distributed storage and computation across clusters of computers. Hadoop is designed to scaleup from single server to thousands of machines, each offering local computation and storage.

Hadoop Architecture

At its core, Hadoop has two major layers namely −

- Processing/Computation layer (MapReduce), and
- Storage layer (Hadoop Distributed File System).



MapReduce

MapReduce is a parallel programming model for writing distributed applications devised atGoogle for efficient processing of large amounts of data (multi-terabyte data-sets), on large clusters (thousands of nodes) of commodity hardware in a reliable, fault-tolerant manner.The MapReduce program runs on Hadoop which is an Apache open-source framework.

How Does Hadoop Work?

It is quite expensive to build bigger servers with heavy configurations that handle large scale processing, but as an alternative, you can tie together many commodity computers with single-CPU, as a single functional distributed system and practically, the clustered machines can read the dataset in parallel and provide a much higher throughput. Moreover, it is cheaper than one high-end server. So this is the first motivational factor behind usingHadoop that it runs across clustered and low-cost machines.

Hadoop runs code across a cluster of computers. This process includes the following core tasks that Hadoop performs −

- Data is initially divided into directories and files. Files are divided into uniform sized blocks of 128M and 64M (preferably 128M).
- These files are then distributed across various cluster nodes for further processing.
- HDFS, being on top of the local file system, supervises the processing.
- Blocks are replicated for handling hardware failure.
- Checking that the code was executed successfully.
- Performing the sort that takes place between the map and reduce stages.
- Sending the sorted data to a certain computer.
- Writing the debugging logs for each job.

Advantages of Hadoop

- Hadoop framework allows the user to quickly write and test distributed systems. It is efficient, and it automatic distributes the data and work across the machines and in turn, utilizes the underlying parallelism of the CPU cores.
- Hadoop does not rely on hardware to provide fault-tolerance and high availability (FTHA), rather Hadoop library itself has been designed to detect and handle failures at the application layer.
- Servers can be added or removed from the cluster dynamically and Hadoop continuesto operate without interruption.
- Another big advantage of Hadoop is that apart from being open source, it is compatible on all the platforms since it is Java based.

Conclusion

Hadoop has been very effective solution for companies dealing with the data in perabytes. Ithas solved many problems in industry related to huge data management and distributed system. As it is open source, so it is adopted by companies widely.

Program – 8

Management of Cloud Resources

Introduction

Cloud computing is currently an established industrial standard, growing extremely fast, andit utilizes large-scale virtualized data centers to provide rapid and cost-effective computing services. To efficiently manage such large volume of resources, cloud computing heavily utilizes automation and dynamic resource management. Also, with a wide variety of private, hybrid, and public cloud-based systems and infrastructure already in use, companies surely need to consider resource management in their cloud computing strategy. However, resource management for such a complex system as cloud computing requires different ways ofmeasuring and allocating resources.

The resource management strategy

Resource management is a core function required for any cloud system, and inefficient resource management has a direct negative effect on performance and cost, while it can also indirectly affect system functionality, becoming too expensive or ineffective due to poor performance.

The strategies for cloud resource management associated with the three cloud delivery models – Iaas, PaaS, SaaS – differ from one another. In some cases, when cloud service providers can predict a spike, they can provision resources in advance (ex. the case of seasonal web services).

However, for an unplanned spike, the situation can get more complicated. You can use Auto Scaling for unplanned spike loads, but in order to do that you need a pool of resources youcan release or allocate on demand, and a monitoring system that lets you decide in real timeto reallocate resources. Keep in mind that Auto Scaling is supported by PaaS services, but is more difficult for IaaS due to the lack of standards.
Technically speaking, a cloud is a portion of cluster resources capable of growing andshrinking to accommodate the load changes. Also, cloud resources are controlled on three independent levels:

- **Cluster level** – The cluster level of power management is represented by cluster resource manager, a software complex that manages resources and tasks in a cluster in order to maintain its efficiency. Basically, a CRM is responsible for creation and deletion of clouds.

- **Node level** – The node-level power management is done by an operating system (OS), so an OS controls the high-level state of equipment. For instance, to save energy the OS can put a processor (CPU) into the sleep state or spin-down disks.

- **Hardware level** – Modern CPUs consist of many modules, which may not be permanently involved in an operation. Therefore, unused modules can be switched off. This is done by a special circuit responsible for internal power management of the CPU. So, all management is done on a hardware level without involving any OS.

- **Controlling the cloud**-Allocation techniques in computer clouds must be based on a disciplined approach, rather than ad hoc methods. So, here are the four basic mechanisms for implementing resource management policies in cloud computing:

- **Control theory** – Control theory uses feedback to guarantee system stability and predict transient behavior, but it can only predict local behavior.

- **Machine learning** – A major advantage of machine-learning techniques is that they don't need a performance model of the system. You could apply this technique to coordinating several autonomic system managers.

- **Utility-based** – Utility-based approaches require a performance model and a mechanism to correlate user-level performance with cost.

- **Market-oriented** – Such mechanisms don't require a system model, such as combining auctions for bundles of resources.

Conclusion

A cloud computing infrastructure is a complex system with a large number of shared resources. These are subject to unpredictable requests and can be affected by external events beyond your control. Cloud resource management requires complex policies and decisions for multi-objective optimization. This is why planning ahead for how you are going to manage these resources will help ensure a