INDIAN INSTITUTE OF TECHNOLOGY BHUBANESWAR

Cloud Computing

M.Tech CSE (2021 -2023)

Assignment - 2

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Content :

1. Write a comparative study of pre-copy and post-copy based virtual machine migration.

2. Write a report on Google Cloud Platform and discuss application development, usability and performance challenges.

3. Write a report on Amazon Web services.

4. Write an experimental report on Xen Virtual Machine Migration service and related performance and security challenges.

1. Write a comparative study of pre-copy and post-copy based virtual machine migration.

Virtual Machine Migration

Virtual machine migration is the migration of virtual machine from one physical host to another without disrupting the users.

It is categorized as:

(a) Non-live or Off-line Virtual Machine Migration: In it, Virtual machine at the source host is paused and then transfer all states of source host to the target or destination host and then finally resume the working of virtual machine at the target host. The major drawback of it is that it results in larger down time.

(b)Live Virtual Machine Migration: In it, Virtual machine is transferred from one host to another with minimum possible disruption of services. It has following performance metrics [3][4][6][10]:

(i) Preparation Time: Time between the migration process start and virtual machine's processor state is sent to the destination node, during which the virtual machine run continuously and creates page faults is called preparation time.

(ii) Resume Time: Time between the resuming of the virtual machine's running and migration end is called resume time. Note that, all dependencies are removed on the source host.

(iii) Pages transferred: The total amount of pages transferred including the copies of pages.

(iv) Down Time : Time during which the running of virtual machine is stopped. It contains sending of state of the processor.

(v) Total Migration Time: Time taken by the migration process; from the initiating of the migration process until end of the migration process. This time is important as it affects the resource releasing on both the source node and the destination node.

(vi) Application Degradation: When migration of virtual machine take place from on host to the other, the performance of the application is degraded which is executing at that virtual machine.

Live Virtual Machine migration Techniques:

(i) Pre-Copy memory migration

(a) Warm-up phase: In it, the hypervisor create duplicates of all memory pages from the source node and copies to the destination node but virtual machine is not halted at the source node. If some changes are there in the pages of source node during the process copying the duplicates, then data will be re-duplicated until the rate of reduplicating the data is less than the rate of copied page which does not contain the recent value i.e. the page being corrupted(dirty page) .

(b) Stop-and-Copy phase: In it, once the warm-up phase is over; the virtual machine is halted at the source host, the changed data left will be copied to the destination node and virtual machine start processing at the destination host.

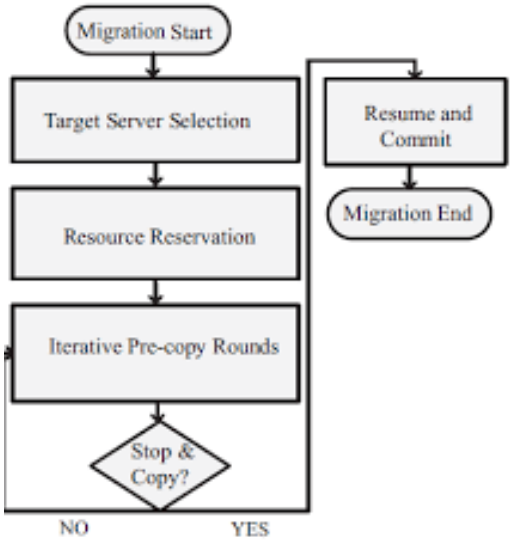
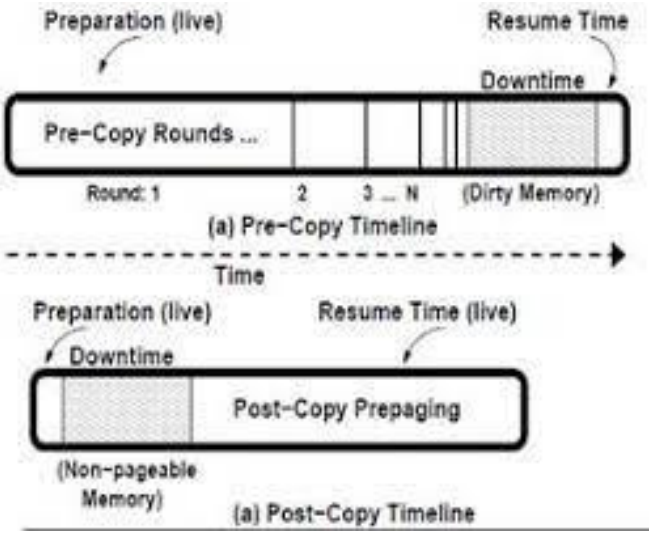


Figure i : Pre copy migration

(ii) **Post copy memory migration**

In it, virtual machine is firstly retired for some time at the source host; when it is suspended a small set of running state of virtual machine (CPU Registers) is sent to the destination host and virtual machine start its working at the destination node even though most of the memory state is yet residing on the destination host. At the destination host when virtual machine tries to fetch the pages which are not being sent; it will create page faults. The two said faults are trapped at the destination host and sent back to the source host over the network which will create network faults. The source host responds to these network faults by sending faulted pages. In this case, it can degrade the performance of the application running inside the virtual machine.



Performance metrics	Pre-copy technique	Post-copy technique
Preparation time	It includes all the modified pages in iterative memory copying phases	Negligible
Downtime	It includes transferring any remaining dirty pages	It includes transferring another minimal execution state
Resume time	Re-schedule the target VM at the destination server and remove the memory pages at the source server	Majority of post-copy approach transfer the VM state and most of the memory pages in this period
Pages transferred	Transfer number of pages during preparation time period	Transfer number of pages during resume time period
Total migration time	More	Less
Performance degradation	High due to the tracking of dirtied pages for write-intensive workloads	High due to servicing of faulty pages

2. Write a report on Google Cloud Platform and discuss application development, usability and performance challenges.

Google Cloud Platform

Google Cloud Platform (GCP) is a suite of cloud computing services provided by Google. It is a public cloud computing platform consisting of a variety of services like compute, storage, networking, application development, Big Data, and more, which run on the same cloud infrastructure that Google uses internally for its end-user products, such as Google Search, Photos, Gmail and YouTube, etc.

The services of GCP can be accessed by software developers, cloud administrators and IT professionals over the Internet or through a dedicated network connection.

Why Google Cloud Platform?

Google Cloud Platform is known as one of the leading cloud providers in the IT field. The services and features can be easily accessed and used by the software developers and users with little technical knowledge. Google has been on top amongst its competitors, offering the highly scalable and most reliable platform for building, testing and deploying the applications in the real-time environment.

Most companies use data centers because of the availability of cost forecasting, hardware certainty, and advanced control. However, they lack the necessary features to run and maintain resources in the data center. GCP, on the other side, is a fully-featured cloud platform that includes:

- **Capacity**: Sufficient resources for easy scaling whenever required. Also, effective management of those resources for optimum performance.

- **Security**: Multi-level security options to protect resources, such as assets, network and OS -components.
- **Network Infrastructure**: Number of physical, logistical, and human-resource-related components, such as wiring, routers, switches, firewalls, load balancers, etc.
- **Support**: Skilled professionals for installation, maintenance, and support.
- **Bandwidth**: Suitable amount of bandwidth for peak load.
- **Facilities**: Other infrastructure components, including physical equipment and power resources.

Therefore, Google Cloud Platform is a viable option for businesses, especially when the businesses require an extensive catalog of services with global recognition.

Benefits of Google Cloud Platform

Some of the main benefits of Google Cloud Platform are explained below:

Best Pricing: Google enables users to get Google Cloud hosting at the cheapest rates.

Work from Anywhere: Once the account is configured on GCP, it can be accessed from anywhere. That means that the user can use GCP across different devices from different places.

Private Network: Google has its own network that enables users to have more control over GCP functions. Due to this, users achieve smooth performance and increased efficiency over the network.

Scalable: Users are getting a more scalable platform over the private network. Because Google uses fiber-optic cables to extend its network range, it is likely to have more scalability.

Security: There is a high number of security professionals working at Google. They always keep trying to secure the network and protect the data stored on servers.

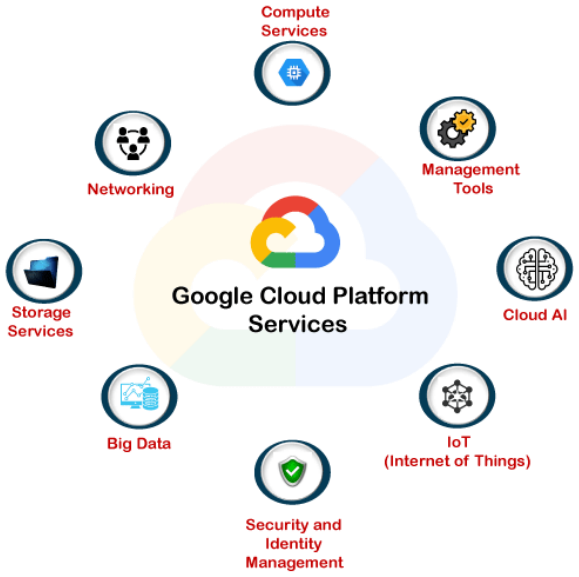
Redundant Backup: Google always keeps backup of user's data with built-in redundant backup integration.

Key Features of Google Cloud Platform

The following are some key features of Google Cloud Platform:

- **On-demand services**: Automated environment with web-based tools. Therefore, no human intervention is required to access the resources.
- **Broad network access**: The resources and the information can be accessed from anywhere.
- **Resource pooling**: On-demand availability of a shared pool of computing resources to the users.
- **Rapid elasticity**: The availability of more resources whenever required.
- **Measured service**: Easy-to-pay feature enables users to pay only for consumed services.

Google provides a considerable number of services with several unique features. That is the reason why Google Cloud Platform is continually expanding across the globe. Some of the significant services of GCP are:



3. Write a report on Amazon Web services.

Cloud computing has become an important tool not only in the business world but also in our day-to-day activities. Most businesses have opted to cloud computing as it is considered safer and more reliable especially in inventory tracking. Cloud computing is the on-demand provision of services that includes data and projects can be put away and gotten to easily. Amazon is at the forefront in providing cloud-computing services globally using a service called Amazon Web Services (AWS). It allows customers to store data on the platform. However, AWS has a major shortcoming, which is denial of service, which may be risky especially for businesses that heavily rely on the platform to conduct their businesses. Cloud computing, is important in helping SMEs (Small and Medium size Enterprises) utilize emerging opportunities, thus giving an advantage to compete evenly in business. Most SMEs are seen to prefer AWS over other service providers as AWS is efficient and more affordable. As a result new and upcoming companies are more likely to use AWS as their service provider for cloud computing. Despite the advantage cloud computing offers, there are worries as to the safety of stored data and ease of use.

The Technological component of cloud

a. **Equivalence** The longing to get a specialized assistance, which is at any rate same (as far as security, inertness and accessibility) to that, accomplished when utilizing a locally running conventional IT frameworks.

b. **Variety** The craving to get a help which furnishes assortment comparing with the utilization for which the administration will be put.

c. **Abstraction** The longing to get specialized administrations which theoretical away superfluous unpredictability for the administration they give.

d. **Scalability** The craving to get an assistance which is versatile to satisfy need..

The administration measurement of cloud

e. **Efficiency** The craving to get an assistance that assists clients with being more productive financially.

f. **Creativity** The longing to get a help which helps advancement and innovativeness.

g. **Simplicity** The longing to get an assistance, which is easy to comprehend and utilize

- AWS stands for **Amazon Web Services**.
- The AWS service is provided by the Amazon that uses distributed IT infrastructure to provide different IT resources available on demand. It provides different services such as infrastructure as a service (IaaS), platform as a service (PaaS) and packaged software as a service (SaaS).
- Amazon launched AWS, a cloud computing platform to allow the different organizations to take advantage of reliable IT infrastructure.

Uses of AWS

- A small manufacturing organization uses their expertise to expand their business by leaving their IT management to the AWS.
- A large enterprise spread across the globe can utilize the AWS to deliver the training to the distributed workforce.
- An architecture consulting company can use AWS to get the high-compute rendering of construction prototype.
- A media company can use the AWS to provide different types of content such as ebox or audio files to the worldwide files.

Based on the concept of Pay-As-You-Go, AWS provides the services to the customers.

AWS provides services to customers when required without any prior commitment or upfront investment. Pay-As-You-Go enables the customers to procure services from AWS.

- Computing
- Programming models
- Database storage
- Networking

Advantages of AWS

1) Flexibility

- We can get more time for core business tasks due to the instant availability of new features and services in AWS.
- It provides effortless hosting of legacy applications. AWS does not require learning new technologies and migration of applications to the AWS provides the advanced computing and efficient storage.
- AWS also offers a choice that whether we want to run the applications and services together or not. We can also choose to run a part of the IT infrastructure in AWS and the remaining part in data centres.

2) Cost-effectiveness

AWS requires no upfront investment, long-term commitment, and minimum expense when compared to traditional IT infrastructure that requires a huge investment.

3) Scalability/Elasticity

Through AWS, autoscaling and elastic load balancing techniques are automatically scaled up or down, when demand increases or decreases respectively. AWS techniques are ideal for handling

unpredictable or very high loads. Due to this reason, organizations enjoy the benefits of reduced cost and increased user satisfaction.

4) Security

- AWS provides end-to-end security and privacy to customers.
- AWS has a virtual infrastructure that offers optimum availability while managing full privacy and isolation of their operations.
- Customers can expect high-level of physical security because of Amazon's several years of experience in designing, developing and maintaining large-scale IT operation centers.
- AWS ensures the three aspects of security, i.e., Confidentiality, integrity, and availability of user's data.

Cloud computing has enabled ease in conducting businesses and delivering services. It has also promoted the growth of Small and Medium Enterprises in great proportions. AWS proves to be the best in offering cloud-computing services for individuals, organizations and many business entities. It is very efficient and cost effective as compared to its competitors. Provision of these services affordably makes Amazon Web Services more popular and leads in the service globally. Provision of cloud computing services is not only limited to the business sector alone. The biomedical industry greatly benefits from these services. A service more popular with researchers, is the IaaS as they are able to carry out projects with large computational requirements at an affordable cost. Security is a major concern for all customers especially due to data vulnerability. Customers are particularly sensitive about their data being accessed without their consent. However, Small and Medium Enterprises observe a greater sense of security with Amazon Web Services in addition to its affordability. As a result, AWS is a preferable option for all new and upcoming companies.

4.Write a report on Xen Virtual Machine Migration service and related performance and security challenges.

Xen is an open source hypervisor based on paravirtualization. It is the most popular application of paravirtualization. Xen has been extended to compatible with full virtualization using hardware-assisted virtualization. It enables high performance to execute guest operating system. This is probably done by removing the performance loss while executing the instructions requiring significant handling and by modifying portion of the guest operating system executed by Xen, with reference to the execution of such instructions. Hence this especially support x86, which is the most used architecture on commodity machines and servers.

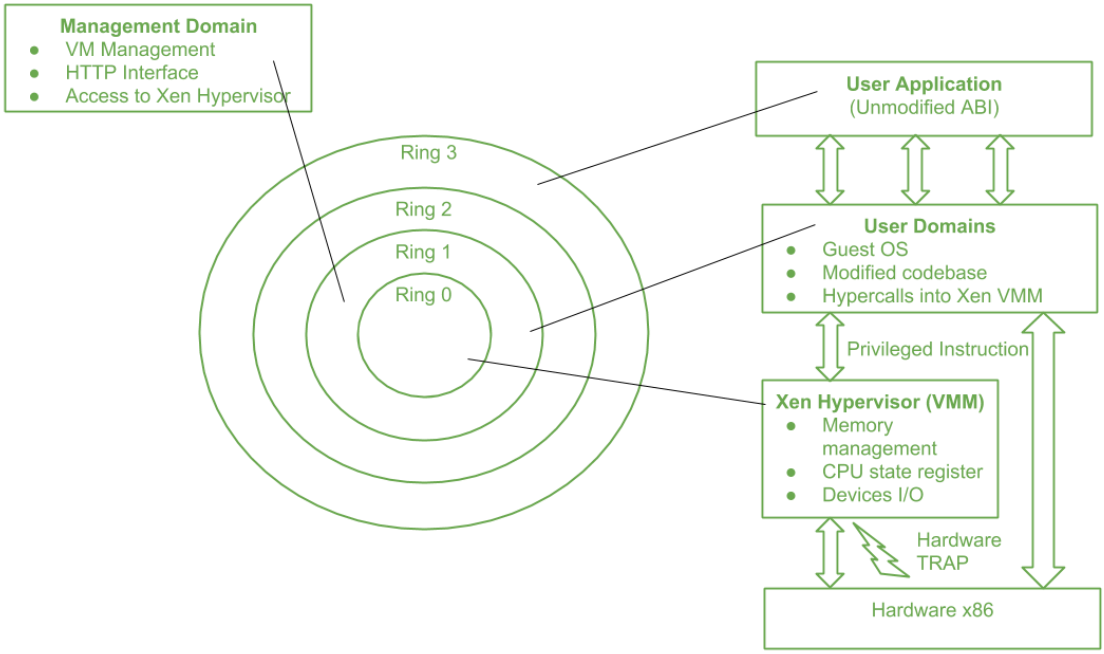


Figure ii Xen Architecture and Guest OS Management

Above figure describes the Xen Architecture and its mapping onto a classic x86 privilege model. A Xen based system is handled by Xen hypervisor, which is executed in the most privileged mode and maintains the access of guest operating system to the basic hardware. Guest operating system are run between domains, which represents virtual machine instances.

In addition, particular control software, which has privileged access to the host and handles all other guest OS, runs in a special domain called Domain 0. This the only one loaded once the virtual machine manager has fully booted, and hosts an HTTP server that delivers requests for virtual machine creation, configuration, and termination. This component establishes the primary version of a shared virtual machine manager (VMM), which is a necessary part of Cloud computing system delivering Infrastructure-as-a-Service (IaaS) solution.

Various x86 implementation support four distinct security levels, termed as rings, i.e.,

Ring 0 represents the level having most privilege and **Ring 3** represents the level having least privilege. Almost all the frequently used Operating system, except for OS/2, uses only two levels i.e. Ring 0 for the Kernel code and Ring 3 for user application and non-privilege OS program. This provides a chance to the Xen to implement paravirtualization. This enables Xen to control unchanged the Application Binary Interface (ABI) thus allowing a simple shift to Xen-virtualized solutions, from an application perspective.

Due to the structure of x86 instruction set, some instructions allow code execution in Ring 3 to switch to Ring 0 (Kernel mode). Such an operation is done at hardware level, and hence between a virtualized environment, it will lead to a TRAP or a silent fault, thus preventing the general operation of the guest OS as it is now running in Ring 1.

This condition is basically occurred by a subset of system calls. To eliminate this situation, implementation in operating system requires a modification and all the sensitive system calls needs re-implementation with hypercalls. Here, hypercalls are the particular calls revealed by the virtual machine (VM) interface of Xen and by use of it, Xen hypervisor tends to catch the execution of all the sensitive instructions, manage them, and return the control to the guest OS with the help of a supplied handler.

Paravirtualization demands the OS codebase be changed, and hence all operating systems can not be referred to as guest OS in a Xen-based environment. This condition holds where hardware-assisted virtualization can not be free, which enables to run the hypervisor in Ring 1 and the guest OS in Ring 0. Hence, Xen shows some limitations in terms of legacy hardware and in terms of legacy OS.

In fact, these are not possible to modify to be run in Ring 1 safely as their codebase is not reachable, and concurrently, the primary hardware hasn't any support to execute them in a more privileged mode than Ring 0. Open source OS like Linux can be simply modified as its code is openly available, and Xen delivers full support to virtualization, while components of Windows are basically not compatible with Xen, unless hardware-assisted virtualization is available. As new releases of OS are designed to be virtualized, the problem is getting resolved and new hardware supports x86 virtualization.

Pros:

a) Xen server is developed over open-source Xen hypervisor and it uses a combination of hardware-based virtualization and paravirtualization. This tightly coupled collaboration between the operating system and virtualized platform enables the system to develop lighter and flexible hypervisor that delivers their functionalities in an optimized manner.

b) Xen supports balancing of large workload efficiently that capture CPU, Memory, disk input-output and network input-output of data. It offers two modes to handle this workload: Performance enhancement, and For handling data density.

c) It also comes equipped with a special storage feature that we call Citrix storage link. Which allows a system administrator to uses the features of arrays from Giant companies- Hp, Netapp, Dell Equal logic etc.

d) It also supports multiple processor, live migration one machine to another, physical server to virtual machine or virtual server to virtual machine conversion tools, centralized multiserver management, real time performance monitoring over window and linux.

Cons:

a) Xen is more reliable over linux rather than on window.

b) Xen relies on 3rd-party component to manage the resources like drivers, storage, backup, recovery & fault tolerance.

c) Xen deployment could be a burden some on your Linux kernel system as time passes.

d) Xen sometimes may cause increase in load on your resources by high input-output rate and and may cause starvation of other Vm's.