Ayman Najmuddin
100830359

Virtualization and Cloud Computing

Introduction

Virtualization plays a crucial role in cloud computing. To begin with, cloud computing is a model that provides on-demand network access to a shared pool of computing resources. Examples of cloud computing include networks, servers, storage, applications, and services. This paper discusses the fundamental service types of cloud computing, the concept of virtualization, security threats associated with virtualization, the benefits of virtualization, real-world examples of virtualization in cloud computing, and recent advancements in cloud computing.

Literature Review

Virtualization Security in Cloud Computing

Chen et al. (2020) examine the security issues in cloud computing, especially focusing on virtualization. They explain that virtualization can be vulnerable to attacks like data breaches and unauthorized access. The study emphasizes the need for strong security measures to protect virtual environments and keep data safe.

Challenges and Issues with Virtualization in Cloud Computing

Goel et al. (2021) discuss various problems that arise when using virtualization in cloud computing. These issues include performance slowdowns, inefficient resource use, and security weaknesses. The authors suggest ways to address these challenges and highlight the importance of improving virtualization technology for better cloud services.

Virtualization in Mobile Cloud Computing for Augmented Reality Challenges

Khadhim et al. (2021) explore how virtualization can help mobile cloud computing, especially for augmented reality (AR) applications. They point out that mobile devices have limited battery life and storage, which makes running powerful AR apps difficult. The authors propose using virtualization to offload heavy tasks to the cloud, making AR apps run better on mobile devices.

Virtualization Layer Security Challenges and Intrusion Detection/Prevention Systems in Cloud Computing

Modi and Acha (2017) review the security challenges at the virtualization layer in cloud computing. They talk about the vulnerabilities that can be exploited by attackers and discuss various systems designed to detect and prevent these attacks. The study highlights the need for strong security measures to protect the virtualization layer from sophisticated threats.

Ayman Najmuddin
100830359

Developments and Trends in Virtualization in Cloud Computing

Odun-Ayo et al. (2017) look at the latest developments and trends in virtualization technology within cloud computing. They describe how virtualization has evolved and its impact on cloud services. The authors discuss new trends like containerization and hypervisor-based virtualization, and how these advancements can make cloud computing more efficient, scalable, and flexible.

These references collectively provide a clear understanding of virtualization in cloud computing, covering security issues, performance challenges, technological advancements, and practical applications. They highlight the critical role virtualization plays in making cloud computing more effective and reliable, offering valuable insights for both researchers and practitioners.

Analysis :

To begin with, it's important to understand what cloud computing is. Cloud computing is a model that provides on-demand network access to a shared pool of computing resources. Some well-known examples of cloud computing include Google Drive, Netflix, Google Cloud, AWS, and Microsoft. Cloud computing advances technological developments by improving how IT activities are performed. Key features of cloud computing include elasticity, scalability, multi-tenancy, and resource pooling.

There are three main types of cloud computing services: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS).

- **SaaS**: The cloud provider offers applications to users over the internet for a set fee.
- **PaaS**: The cloud provides an environment for creating and deploying applications through provided interfaces. Users have full control over the deployed applications, while the provider manages the infrastructure.
- **IaaS**: The cloud provides computing and storage infrastructure to users. Resources are available on demand and at cost. Users control the operating system and applications, while the provider manages the underlying resources.

Other terminology to remember on Cloud Computing are the four deployment types. They are the private cloud, public cloud, community cloud, and hybrid cloud. The private cloud is owned by an organization and is only available for the employees of the organization and is not available for public use. The public cloud is owned by major cloud service providers and is open

for public use. The community cloud is formed by several organizations that have a common interest. The hybrid cloud is a mix of private, public or hybrid cloud.

Virtualization plays a vital role in cloud computing. Some things to note are that visualization is where the computer is virtualized into multiple logical computers and each logical computer can run different OS's. The applications can also run in different areas without impacting each other which increases the efficiency of the computer. A term that is important is the VMM, it stands for the virtual machine manager. It is the core software for virtualization and middle layer software between physical and the OS. It can access all the physical devices on the server, for example, CPU, memory disk, and the network card. Along with accessing the physical devices, it also provides security between multiple virtual machines. The minute the server is booted, the VMM is executed. It would load all of the virtual machine client operating systems and allocate a proper amount of memory, CPU, network, and disk to each virtual machine.

There are nine types of virtualization that are full virtualization, hardware assisted virtualization, partial virtualization, paravirtualization-OS assisted virtualization, operating system level virtualization, multi-server cluster virtualization, hypervisor-based virtualization, application level virtualization, and network virtualization

Type of Virtual Technology	Description
Xen	● Fastest growing ● Stable ● Least resource intensive ● Open source virtualization on X86 architecture
KVM	● Open source ● Full virtualization uses QEMU (an open source system emulator) in order to provide device virtualization ● Belongs to the hypervisor model ● Supports several hardware platforms
VMware	● Global leader in virtualization and cloud computing infrastructure ● Provides customer-proven solutions that improve IT efficiency by reducing complexity and delivering services that are both flexible and nimble
Hyper-v	● Hypervisor virtualization technology that is made by Microsoft

	● Achieve desktop virtualization
Docker container	● More portable than traditional virtual machines ● Each container contains its own file system ● Processes between containers do not affect each other and can distinguish computing word resources

(Table 1)

The challenges of virtualization consist of several security threats in cloud computing. The following table contains the types of security threats and the descriptions of each security threat. (Refer to table 2)

Security threats	**Description**
Virtual machine migration	When the virtual machine is not shut down, the virtual machine is migrated to another physical machine. Reasons for migration include maintaining fault tolerance or load balancing. Security threat: loss of data privacy and integrity as it is exposed to the network
Virtual machine escape	On virtual machines, users can share resources of the host and achieve mutual isolation. Normally a program that is running on a virtual machine shouldn't affect other virtual machines. Security threat: Loopholes and technical limitations allow the program to bypass those isolation restrictions and run on the host machine directly. There is a threat to the hypervisor and the host.
Rootkit attack	Malware hides itself and certain files, processes, and network connections on the infected system.

Ayman Najmuddin
100830359

	It often works with other malicious programs such as trojans and backdoors. It conceals information by using special drivers and alternating the system's core (kernel).
Denial of Service Attack	If an attacker uses a virtual machine to drain resources from the host machine, it can cause other virtual machines on the same host to slow down or crash due to lack of resources.
Virtual machine monitor problem	If a virtual machine monitor (VMM) is compromised, an attacker can control all virtual machines managed by that VMM and access any data on it.
Decoupling attacks on virtualization platforms	A single vulnerability in a virtualization platform can allow an attacker to target the physical machine. On cloud platforms, multiple users can share system information, enabling an attacker to compromise the entire virtual platform through one virtual machine.

Despite there being security threats to virtualization in cloud computing, there are many benefits of virtualization in cloud computing. The first one is functional execution isolation which is where a hypervisor protects virtual machines (VMs) and their applications from each other. Users can have privileges within their own virtual machine without affecting the isolation or security of the host. Another benefit is a customized environment. Virtualization allows for creating customized environments with specific operating systems, libraries and runtime setups. It also provides different views of the same physical hardware by isolating functions. Virtualization also provides easier management as its customized run-time environments can be easily started, moved, or shut down based on the hardware provider. Legacy applications can run alongside new ones. Virtual machines (VMs) ensure that these older applications remain compatible in the current environment. Testing and debugging parallel apps is another benefit. This is where virtualized environments can be used to test parallel applications. This allows a full distributed system to be simulated on a single host. Virtualization enhances reliability as hypervisors and live migration improve the reliability of virtualized applications. The applications would still remain reliable even if the underlying hardware has issues.

Ayman Najmuddin
100830359

Application:

In the world of Mobile Cloud Computing, there are still plenty of advancements to be made in the process of mobile devices. An example of this being that with the CPU, they are unable to run applications that use lots of power in their local physical resources because of battery and storage limitations. However it has also benefited the customers and the cloud service providers. As mentioned earlier, the unique features of cloud computing include elasticity and scalability, the same also applies for Mobile Cloud Computing. Whenever there are insufficient resources, the cloud service provider has to meet and satisfy all of the mobile user's needs. An issue that is consistent is the service interruptions due to lack of resource availability. Due to lack of resources, important tasks are put on hold and held back from being completed delaying user experience which impacts the service quality.

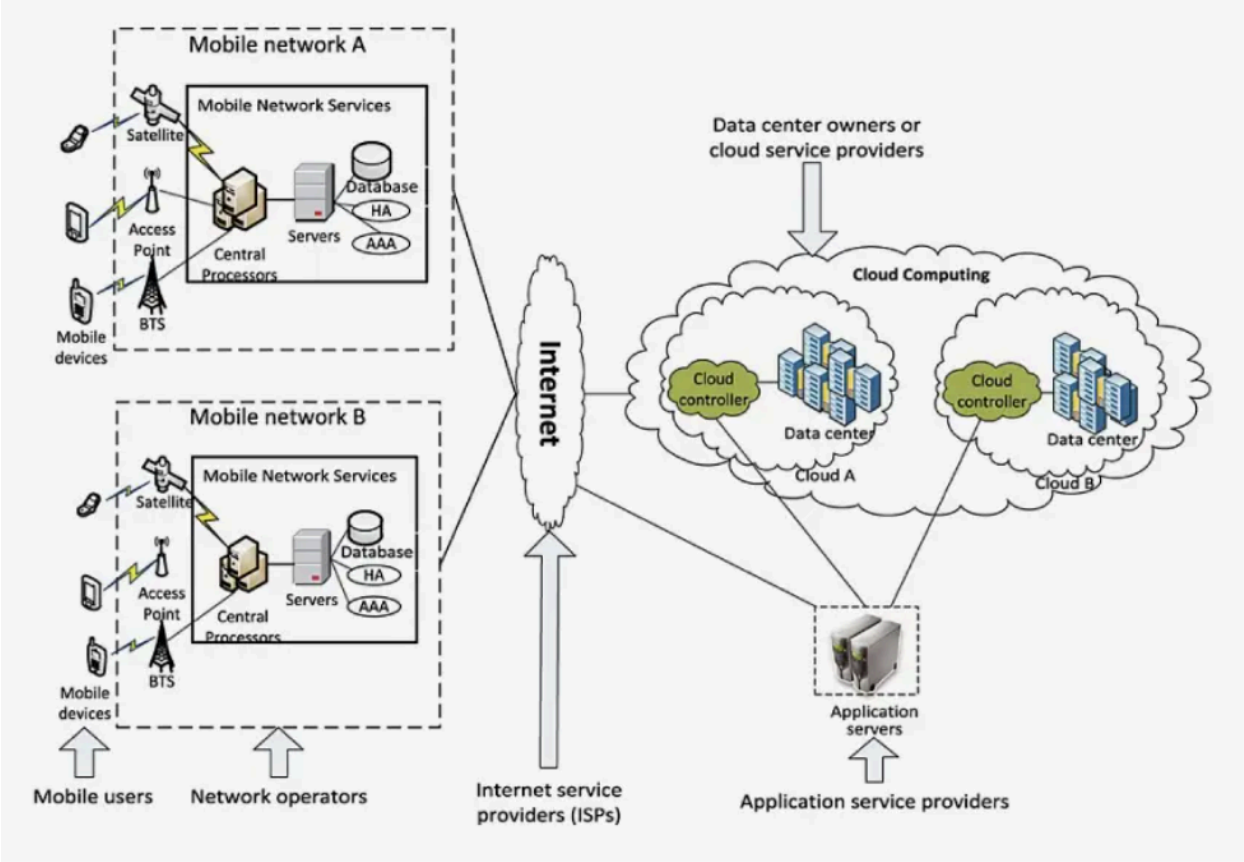

Figure 1.

In Figure 1, you see the right side of the image where the virtualizing computing core (VC) is located. It shows the cloud service providers that host various cloud services that would be run on the mobile. You can also see the left side of Figure 1 that represents the client's side. The

mobile cloud computing applications are run on the host device. When applications need to be executed, the client's side would be using a cloud execution service.

1. **Conclusion:**

Virtualization is essential in cloud computing, enhancing resource efficiency, scalability, and flexibility. It allows multiple systems to run on a single physical machine, maximizing hardware use and isolating applications for stability and security. Despite security threats like virtual machine escape and rootkit attacks, the benefits—such as functional isolation, customized environments, easier management, legacy support, and reliability—are significant.

Technologies like Xen, KVM, VMware, and Docker containers offer unique advantages, addressing various needs and improving cloud performance. In mobile cloud computing, virtualization helps overcome device limitations, ensuring seamless service and optimal resource use.

Overall, virtualization transforms IT infrastructure, making cloud computing more efficient and reliable. As technology advances, its role will only become more crucial for both providers and users.

Ayman Najmuddin
100830359

References

Chen, L., Xian, M., Liu, J., & Wang, H. (2020). Research on Virtualization Security in Cloud Computing. *IOP Conference Series. Materials Science and Engineering*, *806*(1), 12027-. https://doi.org/10.1088/1757-899X/806/1/012027

Goel, G., Tanwar, P., Bansal, V., & Sharma, S. (2021). The Challenges and Issues with Virtualization in Cloud Computing. *2021 5th International Conference on Trends in Electronics and Informatics (ICOEI)*, 1334–1338. https://doi.org/10.1109/ICOEI51242.2021.9452848

Khadhim, B. J., Kadhim, Q. K., Khudhair, W. M., & Ghaidan, M. H. (2021). Virtualization in Mobile Cloud Computing for Augmented Reality Challenges. *2021 2nd Information Technology To Enhance E-Learning and Other Application (IT-ELA)*, 113–118. https://doi.org/10.1109/IT-ELA52201.2021.9773680

Modi, C. N., & Acha, K. (2017). Virtualization layer security challenges and intrusion detection/prevention systems in cloud computing: a comprehensive review. *The Journal of Supercomputing*, *73*(3), 1192–1234. https://doi.org/10.1007/s11227-016-1805-9

Odun-Ayo, I., Ajayi, O., & Okereke, C. (2017). Virtualization in Cloud Computing: Developments and Trends. *2017 International Conference on Next Generation Computing and Information Systems (ICNGCIS)*, 24–28. https://doi.org/10.1109/ICNGCIS.2017.10

Figure 1: *Mobile Cloud Computing Architecture explained*. KnowledgeHut. (2023, September 15).https://www.knowledgehut.com/blog/cloud-computing/mobile-cloud-computing-architecture#mobile-cloud-computing-architecture%C2%A0