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Cloud Virtual Machines: State-of-the-Art and Future Directions - A Survey

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Abstract. Cloud computing has revolutionized the way IT resources are provisioned, and at the heart of this transformation are virtual machines (VMs). Cloud virtual machines, often referred to as VMs, have become fundamental building blocks in delivering scalable and flexible computing services to organizations and individuals. This survey paper, titled "Cloud Virtual Machines: State-of-the-Art and Future Directions," offers a comprehensive examination of the current landscape of cloud VM technologies and explores the emerging trends that will shape their future. The paper begins by providing a detailed overview of virtualization technology, delving into hypervisors, containerization, and the orchestration of VMs in cloud environments.

Keywords: Cloud Computing, Virtual Machine, VM Technology.

1. Introduction

Cloud computing has redefined the way organizations and individuals access and manage computing resources. At the core of this transformative technology are virtual machines (VMs), which play a pivotal role in delivering scalable and flexible computing services through the cloud. The ability to run multiple virtual instances on a single physical server, facilitated by virtualization technology, has ushered in a new era of efficiency, cost-effectiveness, and agility in the IT landscape.

This survey paper, titled "Cloud Virtual Machines: State-of-the-Art and Future Directions," embarks on a comprehensive exploration of the present and future of cloud VM technology. It is no exaggeration to state that virtual machines have become the bedrock of cloud computing, providing the means to isolate workloads, allocate resources dynamically, and simplify infrastructure management. As organizations increasingly migrate their IT operations to the cloud, understanding the capabilities, trends, and challenges associated with cloud VMs becomes essential.

2. Literature survey

In the article "An Analysis of Virtualization Technologies for Cloud Computing" by Kavisankar and Kavitha, various virtualization technologies and their relevance to cloud computing are explored. This article serves as a primer on the technological underpinnings of cloud virtual machines (VMs), providing a foundational understanding of their role in cloud environments.

The paper titled "A Survey of Virtual Machine Sizing Techniques in Cloud Computing Environments" by Aneka and Buyya delves into the optimization of VM sizes in cloud environments. It reviews techniques that help strike a balance between resource capacity and utilization, a crucial aspect for efficient resource allocation and cost management.

In "Emerging Trends in Cloud Computing: A Survey" by Priyadharshini and Rajaram, a broader perspective on emerging trends in cloud computing is offered. This comprehensive

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review sheds light on areas that may influence the state-of-the-art and future directions of cloud VMs, providing a panoramic view of the dynamic cloud landscape.

The article "Serverless Computing: Current Trends and Open Problems" by McSherry and Isard discusses serverless computing, a disruptive technology in cloud computing. It explores its potential impact on VM deployment and management, as serverless architecture reshapes the way applications are built and executed in the cloud.

"Artificial Intelligence and Machine Learning for Cloud Security: A Review" by Samy, Mohamed, and Sathik explores the integration of AI and ML in cloud security. This integration is expected to have implications for VM security and management, as AI and ML technologies enhance threat detection and response.

The concise survey titled "Quantum Computing: A Short Survey" by Harrold and Wich introduces the concept of quantum computing and its potential to disrupt classical computing paradigms. While not VM-specific, it hints at broader technological shifts that could influence virtualization.

The review article "Green Cloud Computing: A Review" by Garg and Buyya delves into green cloud computing practices, emphasizing the importance of energy efficiency and sustainability in VM management within cloud environments. It highlights the growing concern for environmentally responsible computing.

In "Edge Computing: Vision and Challenges" by Shi, Cao, Zhang, Li, and Xu, edge computing and its relevance to cloud VMs are discussed, especially in scenarios where low-latency processing is crucial. Edge computing enables responsive applications and real-time data processing, influencing VM deployment strategies in latency-sensitive environments

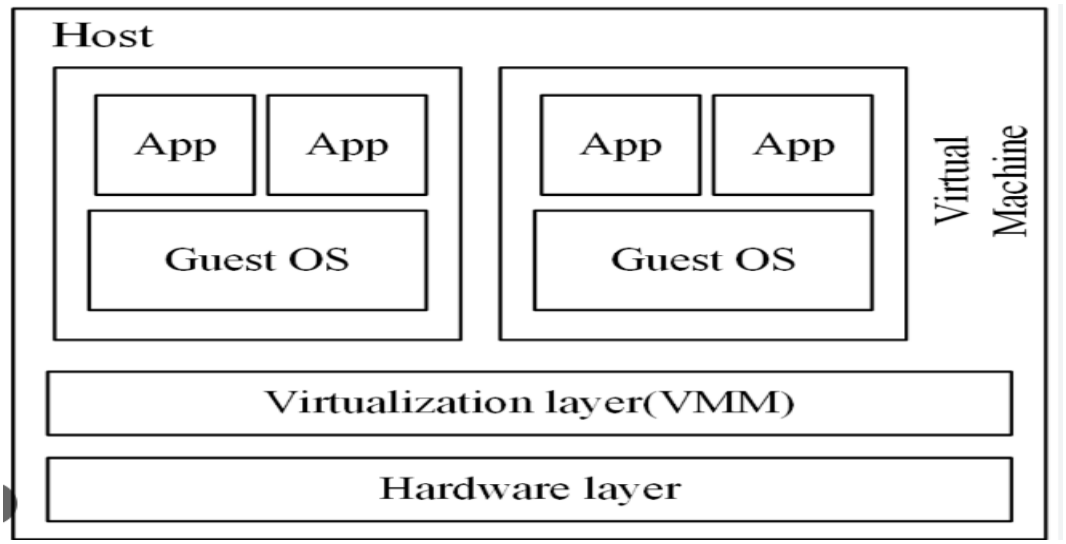

Figure 1 Virtual machines architecture in cloud

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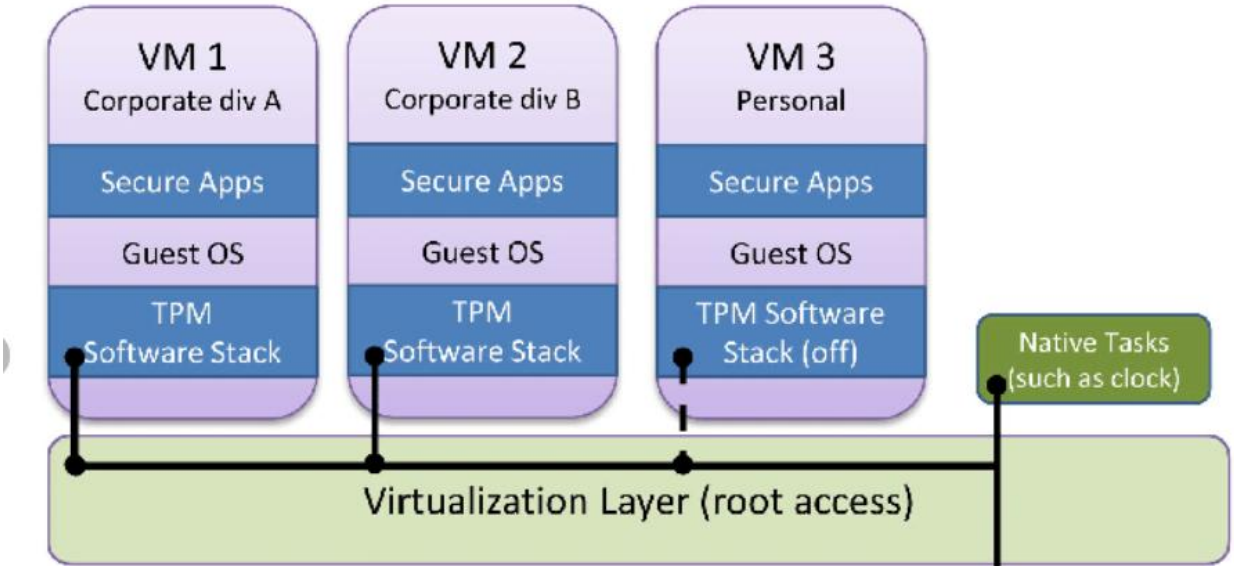

Figure 2 Different Virtual machines configured to a Server

3. Factors effecting Cloud Virtual Machines

Several factors influence the performance, management, and security of cloud virtual machines (VMs). Understanding these factors is crucial for effectively deploying and maintaining cloud VMs. Here are key factors that impact cloud VMs:

Resource Allocation:

Properly allocating resources such as CPU, memory, and storage is essential for VM performance. Overallocation or underallocation can lead to inefficiency or performance issues.
Hypervisor Selection:

The choice of hypervisor technology can affect VM performance, security, and management capabilities. Popular hypervisors include VMware, KVM, and Hyper-V.
Networking Infrastructure:

The quality and design of the network infrastructure impact VM communication, latency, and bandwidth. Network configurations affect data transfer and application performance.
Security and Compliance:

Ensuring VM security through firewalls, access controls, and encryption is crucial. Compliance with industry-specific regulations, such as HIPAA or GDPR, is a factor for certain workloads.
Data Backup and Recovery:

VM backup and disaster recovery plans are necessary to prevent data loss and minimize downtime in case of hardware failures or data corruption.
Licensing Costs:

Licensing costs for the operating system, hypervisor, and any additional software can impact the total cost of ownership for VMs.

Scaling and Elasticity:

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The ability to scale VM resources up or down based on demand is a key factor for efficiency and cost-effectiveness in cloud environments.
Performance Monitoring:

Continuous monitoring of VM performance and resource usage is vital to detect and address issues proactively, optimizing performance and resource allocation.
VM Image Management:

Proper management of VM images, including updates, snapshots, and version control, is essential for consistency and reliability.
Compliance with Cloud Provider Policies:

Cloud providers have specific policies and requirements regarding VM deployment, usage, and compliance, which must be followed.
Data Transfer and Bandwidth Costs:

Data transfer costs and bandwidth limitations can affect the economics of VMs, particularly for workloads with high data transfer requirements.
Service-Level Agreements (SLAs):

SLAs offered by cloud providers define the guaranteed performance, availability, and support for VMs. Understanding and meeting SLA requirements is important for service reliability.
Geographical Location:

The physical location of VMs can impact latency, data sovereignty, and compliance with regional data regulations. Choosing the right data center is critical.
Vendor Lock-In:

The choice of a specific cloud provider can lead to vendor lock-in, making it challenging to migrate VMs and workloads to other providers.
Application Architecture:

The architecture and design of the application running on VMs can significantly impact performance and resource utilization.
These factors, in combination, determine the effectiveness, cost-efficiency, and security of cloud VMs. Successful VM management involves optimizing and addressing these factors based on the specific requirements and goals of the organization or workload.

4. Conclusions

In conclusion, the effective deployment and management of cloud virtual machines (VMs) are influenced by a myriad of factors that span performance, security, cost, and compliance considerations. These factors, individually and collectively, shape the success and efficiency of VM utilization in cloud environments. As organizations increasingly rely on cloud computing for their IT infrastructure, understanding and addressing these factors is paramount. Efficient resource allocation, choice of hypervisor, and network infrastructure design are fundamental to VM performance. Security and compliance considerations are crucial, as the protection of sensitive data and adherence to industry regulations are non-negotiable. Data backup, recovery plans, and licensing costs are essential components of VM management, ensuring data integrity and cost-effectiveness.

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