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Cloud Computing

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IT381

Lecture 10

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Chapter 10

Introduction to Virtualization Features & Cloud Computing Trends

- Virtualization
- Paravirtualization
- Characteristics of Virtualization in Cloud Computing
- Cloud Computing Trends

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Virtualization

Virtualization is a fundamental technology that plays a pivotal role in the field of cloud computing. It forms the cornerstone upon which the flexibility, scalability, and efficiency of cloud services are built. In this article, we will dive into the characteristics of virtualization in cloud computing, exploring how it empowers businesses to optimize their IT resources, streamline operations, and deliver enhanced user experiences.

Virtualization

Different types of hardware virtualization include:

- **Full virtualization** – Almost complete virtualization of the actual hardware to allow software environments, including a guest operating system and its apps, to run unmodified.
- **Paravirtualization** – The guest apps are executed in their own isolated domains, as if they are running on a separate system, but a hardware environment is not simulated. Guest programs need to be specifically modified to run in this environment.

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Full virtualization

Full virtualization requires that every salient feature of the hardware be reflected into one of several virtual machines – including the full instruction set, input/output operations, interrupts, memory access, and whatever other elements are used by the software that runs on the bare machine, and that is intended to run in a virtual machine.

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Paravirtualization

Paravirtualization is a type of virtualization where guest operating systems (OSs) — those installed on a virtual machine (VM) — are modified to enable the guest OS and the hypervisor to communicate and manage resources, creating a collaboration environment. This collaboration between the guest OS and the hypervisor can improve performance and efficiency.

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Paravirtualization

VMs in paravirtualization are therefore not fully isolated, because they share resources and can modify their usage according to their needs. Contrary to full virtualization where resources assigned to a VM by a hypervisor are fixed and simulate a real physical device, in paravirtualization the allocated resources are not fixed but flexible.

Paravirtualization hypervisors are more advanced versions of full virtualization hypervisors because they do not just assign resources and manage them, but can also perform certain services on behalf of the guest OS.

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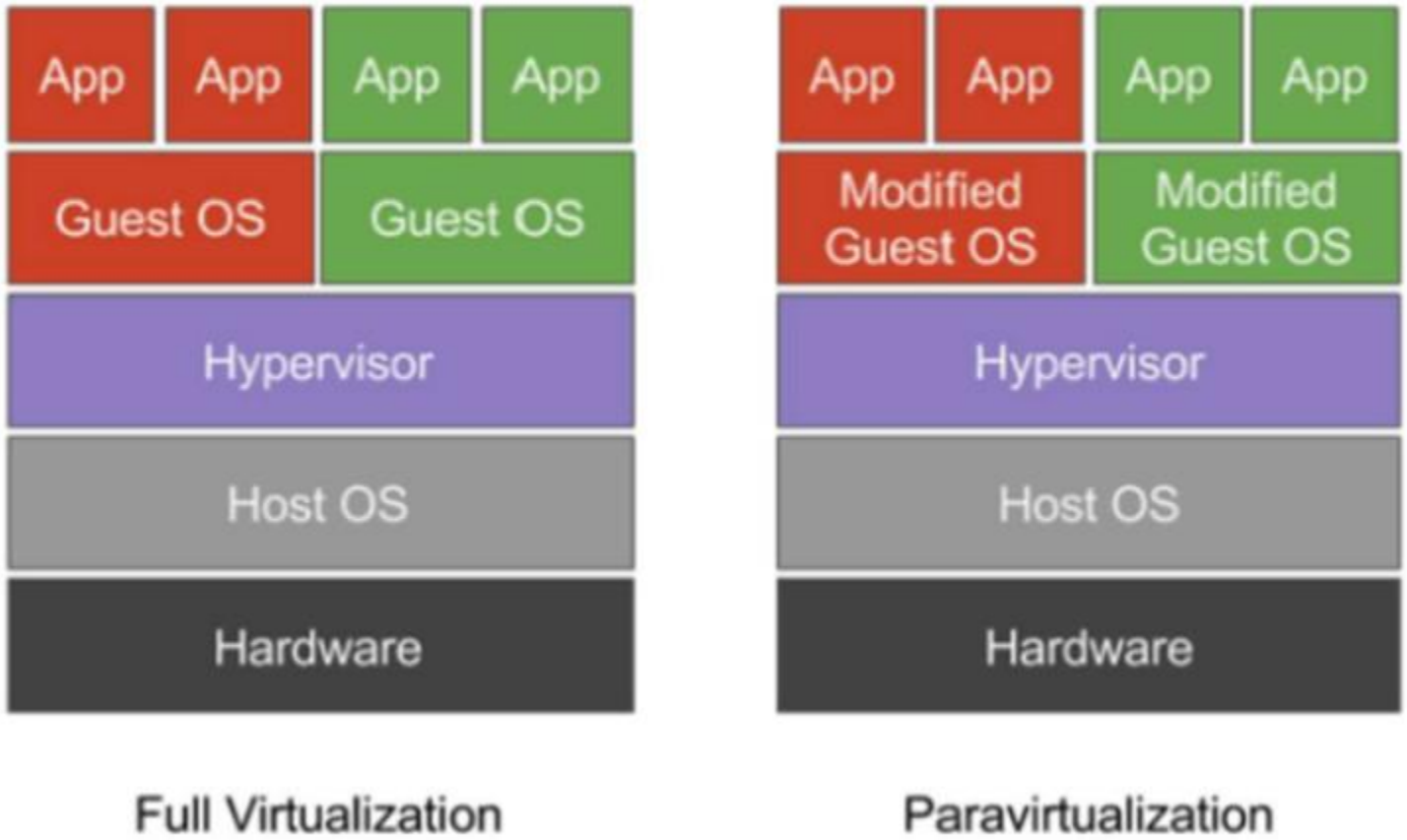
Paravirtualization



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Characteristics of Virtualization in Cloud Computing

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1. Resource Abstraction

Virtualization enables the abstraction of physical resources such as processors, memory, storage, and network components. This abstraction allows multiple virtual instances to run on a single physical machine, optimizing resource utilization and maximizing efficiency. For instance, a single physical server can be virtualized into multiple virtual machines (VMs), each operating independently of its operating system.

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2. Isolation and Security

Virtualization provides a layer of isolation between different virtual instances. This isolation ensures that resources allocated to one virtual instance do not interfere with others. This characteristic is crucial for ensuring security and preventing unauthorized access. Cloud providers leverage virtualization to ensure that customer workloads are isolated from each other, enhancing data security and confidentiality.

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3. Hardware Independence

One of the defining characteristics of virtualization is its ability to decouple virtual instances from the underlying physical hardware. This hardware independence allows IT teams to migrate virtual instances across different physical hosts without incurring downtime. Businesses can upgrade or replace hardware components without affecting the functioning of virtualized workloads.

Characteristics of Virtualization in Cloud Computing

4. Scalability

Cloud computing's scalability is greatly amplified by virtualization. Through the creation of VM templates, cloud providers can rapidly provision new virtual instances to meet varying demands. This elasticity enables businesses to scale their resources up or down dynamically, ensuring optimal performance without over-provisioning.

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5. Management and Orchestration

Virtualization empowers cloud administrators to manage and orchestrate resources efficiently. Virtualization management tools allow for VM creation, deployment, monitoring, and scaling tasks. Orchestration frameworks enable the automation of complex workflows, making it possible to manage entire environments with minimal manual intervention.

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6. Workload Isolation and Sandboxing

The concept of virtualization also lends itself to the isolation and sandboxing of applications and workloads. Developers can create isolated environments for testing and development without affecting the underlying infrastructure. This is particularly beneficial for ensuring application compatibility, debugging, and experimenting with new configurations.

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7. Legacy System Migration

Virtualization facilitates the migration of legacy systems to modern environments. By encapsulating legacy applications within virtual instances, organizations can extend the lifespan of crucial software without being tied to outdated hardware. This characteristic simplifies the process of transitioning to cloud-based infrastructure.

Characteristics of Virtualization in Cloud Computing

8. Disaster Recovery and Backup

Virtualization enhances disaster recovery and backup strategies. Virtual machine snapshots can be taken at various points in time, providing the ability to restore systems to a specific state. In case of hardware failures or data corruption, organizations can quickly restore virtual instances from these snapshots, minimizing downtime and data loss.

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9. Cost Efficiency

Virtualization contributes to cost efficiency by optimizing resource usage. Organizations can reduce hardware and energy costs by consolidating workloads on fewer physical machines. Additionally, the scalability and flexibility of virtualized environments allow businesses to align their resource expenditure with actual demand.

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10. DevOps and Continuous Integration/Continuous Deployment (CI/CD)

Virtualization aligns seamlessly with DevOps practices and CI/CD pipelines. Developers can create reproducible development and testing environments using virtualization, leading to consistent and reliable software deployments. The ability to create and destroy virtual instances rapidly aids in the automated testing and deployment of applications.

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Characteristics of Virtualization in Cloud Computing

In the cloud computing landscape, virtualization's characteristics stand as pillars of innovation and efficiency.

Virtualization enables the abstraction of physical resources such as processors, memory, storage, and network components.

Virtualization management tools allow for VM creation, deployment, monitoring, and scaling tasks.

Virtualization facilitates the migration of legacy systems to modern environments.

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Characteristics of Virtualization in Cloud Computing

By abstracting physical resources, ensuring security, enabling scalability, and streamlining management, virtualization transforms the way businesses deploy, manage, and utilize IT resources.

Whether it's achieving hardware independence, enhancing security, or facilitating seamless legacy application migration, virtualization remains a cornerstone technology that shapes the modern cloud computing landscape.

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Cloud Computing Trends

The future of cloud computing 2025 promises extraordinary shifts as a result of technical breakthroughs and changing business demands. As organizations increasingly rely on cloud technologies to improve efficiency and scalability, staying up to date on developing cloud technology trends is critical.

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Cloud Computing Trends

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Increased adoption of multi-cloud strategies

This approach involves using services from multiple cloud providers, allowing businesses to blend resources from private clouds (cloud infrastructure dedicated to a single organization) and public clouds (cloud services provided over the internet). By leveraging a mix of these environments, companies can tailor their infrastructure to better fit their specific needs.

Multi-cloud setups help you manage workloads more flexibly, enabling you to optimize costs and avoid being locked into one vendor. This flexibility allows you to choose the best services from various providers, ensuring you have access to the latest technologies while enhancing overall operational efficiency.

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Cloud Computing Trends

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Growth of serverless computing

Serverless computing is gaining popularity because it removes the need for developers to handle server infrastructure. With this model, cloud providers handle server provisioning, maintenance, and scaling.

This allows you to focus solely on writing and deploying your code. As a result, you can significantly reduce the time to market for your applications and lower development costs. Serverless computing is especially appealing for businesses looking to innovate quickly, as it allows for faster deployments and greater scalability without the burden of managing underlying infrastructure.

Cloud Computing Trends

Expansion of edge computing

Edge computing is developing as a major topic in the technology industry. It refers to processing data closer to its source, such as local servers or Internet of Things (IoT) devices, rather than depending only on centralized data centers.

This approach brings data processing capabilities nearer to users and devices, which leads to faster insights and improved application performance. By reducing the distance data must travel, you can lower latency (delay) and decrease bandwidth usage, which enhances the overall user experience.

These cloud computing trends are especially helpful for applications that demand real-time computing, such as those found in smart cities or self-driving cars.

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Cloud Computing Trends

Advancements in cloud security

Cloud security is evolving rapidly, with significant advancements driven by technology. One of the most significant advancements is the use of Artificial Intelligence (AI) and Machine Learning (ML) in security measures. These technologies enable systems to analyse large volumes of data to detect potential threats in real time. By recognising unusual patterns, AI can alert your security team to possible breaches, allowing for faster responses.

Additionally, the zero-trust security model is gaining traction.

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Advancements in cloud security

Unlike traditional security methods that trust users inside the network, zero trust requires verification for every user, device, and application before granting access.

This means no one is assumed to be safe until proven otherwise. Implementing this model helps reduce risks from insider threats and external attacks, enhancing overall security for cloud environments.

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Cloud Computing Trends

Rise of AI and Machine Learning in the cloud

With advances in AI and ML, you may expect cloud trends like self-automation (where computers complete tasks automatically), personalised cloud experiences, and improved data security. Major cloud service providers such as Google and Amazon are significantly investing in AI and machine learning technology.For instance, Amazon's AWS DeepLens camera and Google Lens are products that showcase their commitment to these innovations.

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Enhanced cloud-native development

Cloud-native development is a significant trend that focuses on building and running applications specifically designed for cloud environments.

This approach utilizes modern technologies and practices, such as:

- Containers (packaging applications and their dependencies together)
- Microservices (breaking applications into smaller, independent services)
- Dynamic orchestration (automating the management and coordination of these services).

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Enhanced cloud-native development

By adopting cloud-native practices, you can develop applications that are scalable, flexible, and resilient. This means that your applications can efficiently handle increased loads, adapt to changes, and recover quickly from failures.

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Greater focus on compliance and data privacy

Governments worldwide are enforcing strict data governance and privacy regulations, such as the California Consumer Privacy Act (CCPA), Health Insurance Portability and Accountability Act (HIPAA), and General Data Protection Regulation (GDPR).These laws dictate how businesses should handle user data and ensure the protection of customer privacy. Adhering to these regulations not only helps you meet compliance requirements but also builds trust with your customers, reinforcing the importance of data security in cloud services.

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Evolution of cloud cost management toolsAs the number of users adopting cloud services increases, managing costs has become a crucial concern for businesses. To address this, cloud providers are developing advanced cost management tools that help you monitor and optimise spending.These tools typically include features such as:

- **Cost monitoring**: Keep track of your cloud expenditures in real time.
- **Budgeting tools**: Set financial limits to help you stay within your budget.

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- **Instance sizing recommendations**: Get advice on the right size of resources needed for your applications, preventing overprovisioning (paying for more resources than you use).
- **Reserved instance options**: Secure discounts for long-term resource commitments.

By utilizing these tools, you can better manage your cloud costs and ensure that you are getting the best value from your cloud investments.

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Integration of blockchain technology

Blockchain technology is making its way into cloud computing, enabling new applications and services. It works as a distributed ledger, which means it records transactions across many computers, making it secure and tamper-resistant.

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Integration of blockchain technology

Cloud providers are now offering Blockchain-as-a-Service (BaaS) solutions. This enables organizations to create and deploy blockchain apps without having to handle the underlying infrastructure. BaaS solutions simplify the process of developing blockchain applications, making them accessible to more organizations.

By integrating blockchain with cloud services, you can enhance transparency, improve security, and streamline processes in various sectors, including finance, supply chain, and healthcare

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Development of quantum computing in the cloud

Quantum computing is an emerging technology that promises to change the way we process information. Though still in the early stages, it is expected to provide immense processing power compared to traditional computers.

Cloud platforms are starting to integrate quantum processors into their infrastructure, allowing businesses to access quantum computing capabilities via the cloud. This development could significantly boost areas like cryptography (the practice of securing information) and complex data analysis.

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Development of quantum computing in the cloud

By leveraging quantum computing, you can solve problems much faster than with conventional methods, paving the way for innovations in various fields such as drug discovery, financial modelling, and large-scale optimisation.

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More emphasis on sustainability

As concerns about environmental impact grow, sustainability in cloud computing future is becoming a top priority for many organisations. This move, known as green cloud computing, aims to reduce energy usage and the carbon footprint associated with cloud services. Future cloud platforms will likely adopt more energy-efficient practices and technologies to support sustainability efforts.

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More emphasis on sustainability

Key aspects of this trend include:

- **Energy efficiency**: Cloud providers are investing in technologies that consume less energy. This can involve using renewable energy sources, optimizing data centers for lower power usage, and implementing better cooling techniques.
- **Cost savings**: By improving energy efficiency, cloud providers can reduce operational costs, which can translate into savings for end-users. This makes sustainable practices not only good for the environment but also beneficial for your budget.

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More emphasis on sustainability

Key aspects of this trend include:

- **Compliance with regulations**: Many governments are implementing stricter environmental regulations. Cloud providers that focus on sustainability can help your business comply with these regulations, ensuring you meet necessary legal requirements.
- **Corporate responsibility**: More businesses are recognizing their role in promoting sustainability. This change, known as green cloud computing, aims to reduce energy usage and carbon footprints connected with cloud services.

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Advances in cloud networking and connectivity

Cloud networking is essential for delivering computing services like storage, databases, and applications over the internet. Recent advancements in this area are transforming how organizations connect to cloud resources and manage their networks.

Key components of cloud network technology include:

Cloud networking services: These services provide the infrastructure needed for seamless connectivity between cloud resources and users. They enable you to access resources without worrying about the physical hardware.

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Advances in cloud networking and connectivity

Virtual Private Networks (VPNs): VPNs enhance security by creating encrypted connections between your device and the cloud, protecting sensitive data from unauthorized access.

Software-Defined Networking (SDN): SDN separates the network management from the physical hardware, allowing for more flexible and efficient network management. This technology enables you to configure and manage networks dynamically, adapting to changing needs.

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The most recent advancements in cloud computing include:

AI and Machine Learning (AI/ML): AI and ML are being integrated into cloud computing for automation, enhanced data privacy, and personalized cloud experiences. Cloud platforms provide access to AI tools without requiring investment in expensive infrastructure. AI-driven cloud solutions are projected to boost enterprise productivity.

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The most recent advancements in cloud computing include:

Multi-Cloud and Hybrid Cloud Deployments: Organizations are adopting multi-cloud strategies to avoid vendor lock-in and increase flexibility. Hybrid cloud solutions are also growing due to the demand for secure and scalable infrastructure. AWS and Google are linking up to ease multi-cloud deployments, with Microsoft Azure joining in 2026.

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The most recent advancements in cloud computing include:

Serverless Computing: This allows developers to build and run applications without managing server infrastructure. Cloud providers handle infrastructure management, reducing operational costs and increasing scalability.

Edge Computing: Edge computing processes data closer to the source, reducing latency and improving response times. It is crucial for applications requiring real-time processing, such as IoT devices and autonomous vehicles.

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Conclusion

As we look ahead, the evolution of cloud computing presents exciting opportunities and challenges. Plus, embracing multi-cloud trends like sustainability, advanced networking, and innovative development practices will empower organizations to maximize their cloud investments.

By staying updated on these cloud computing trends and adapting to the changing cloud market trends, you can ensure your organization remains competitive and responsive to future demands.

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Thank You