XFLOW RESEARCH

Hypervisors

hypervisors (April 2024)

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Introduction

- Hypervisors are software or firmware components that enable the virtualization of computing resources.
- They allow multiple operating systems (OS) to run concurrently on a single physical machine, known as a host system.
- Hypervisors facilitate the creation and management of virtual machines (VMs), each running its own OS and applications.

Benefits of Hypervisor

- **Server Consolidation**

  allows for the efficient utilization of hardware resources by running multiple VMs on single physical server.

- **Resource Isolation**

  provides isolation between VMs, ensuring that applications running on one VM do no impact others.

- **Flexibility and Scalability**

  enables rapid deployment, cloning, and migration of VMs to adapt to changing work demands.

- **Cost Savings**

  reduces hardware and energy costs by optimizing resource utilization and consolida infrastructure.

How Does a Hypervisor Work?

- A hypervisor is a software layer that enables multiple operating systems (OS) to run concurrently on a single physical machine.
- It abstracts physical hardware resources and allocates them to virtual machines (VM allowing them to operate independently.

Types of Hypervisors

Type 1 Hypervisor (Bare Metal)

- Installed directly on the physical hardware.
- Manages VMs directly without the need for a host operating system.
- Examples include VMware ESXi, Microsoft Hyper-V, and Xen.

Type 2 Hypervisor (Hosted)

- Installed on top of a host operating system.
- Requires the host OS to manage hardware resources.
- Examples include VMware Workstation, Oracle VirtualBox, and Parallels Desktop.

Virtualization

Virtualization in hypervisors involves creating virtual instances of computer hardware, suc
CPUs, memory, storage, and networking resources, allowing multiple virtual machines (VM
run concurrently on a single physical machine. This abstraction layer enables efficient res
utilization, isolation, and flexibility, as each VM operates as if it were running on its own dedicated hardware, independent of others sharing the same physical infrastructure.

Virtualization Techniques

1. Full Virtualization

- Each VM runs a complete copy of the guest OS.
- Hypervisor intercepts and translates privileged instructions from guest OS to host O
- Suitable for running different OS types concurrently.

2. Para-virtualization

- Guest OS is modified to be aware of the virtualization layer.
- Offers better performance by allowing direct communication between guest OS and hypervisor.
- Requires OS modification, limiting compatibility.

3. Hardware-Assisted Virtualization

- Relies on hardware extensions (e.g., Intel VT-x, AMD-V) to improve virtualization performance.
- Allows hypervisor to offload some tasks directly to the processor.
- Enhances efficiency and performance of virtual machines.

Resource Management

1. CPU Allocation

- Hypervisor schedules CPU time among VMs based on priority and resource demands
- Utilizes techniques like time slicing and CPU affinity.

2. Memory Management

- Allocates physical memory to VMs.
- Implements techniques such as memory ballooning and page sharing to optimize m usage.

3. I/O Device Management

- Mediates access to physical I/O devices among VMs.
- Provides mechanisms like device emulation and passthrough for efficient device acc

Security Features

Isolation

- Hypervisor ensures strict isolation between VMs to prevent unauthorized access and data breaches.
- Each VM operates in its own isolated environment.

Secure Boot

- Ensures that only authorized and trusted OSes are loaded within VMs.
- Prevents malware and unauthorized OS modifications.

Snapshotting and Rollback

- Allows users to take snapshots of VM states for backup and recovery purposes.
- Enables quick rollback to a previous state in case of system failures or errors.

Live Migration

Process of moving a running VM from one physical host to another with minimal disruptio service.

Benefit

- Enables load balancing and resource optimization across physical hosts.
- Facilitates hardware maintenance and upgrades without downtime.

Implementation

- Involves transferring memory, storage, and network state of the VM between hosts it remains operational.
- Requires coordination between source and destination hosts to ensure seamless migration.

Why do we need Hypervisors

1. Efficient resource utilization

Hypervisors enable multiple virtual machines (VMs) to share physical hardware resources, maximizing resource utilization and reducing costs.

2. Isolation

Hypervisors provide strong isolation between VMs, preventing interference and ensuring security and stability.

3. Flexibility

Hypervisors allow for the easy creation, deployment, and management of VMs, facilitating scalability and adaptability to changing workload demands.

4. Disaster recovery and high availability

Hypervisors support features like snapshots, live migration, and replication, enabling quic recovery from failures and ensuring continuous availability of services.

Table of Comparison between Type 1 and Ty 2 Hypervisor

Feature	**Type 1 Hypervisor**	**Type 2 Hypervisor**
Installation	Installed directly on the physical hardware	Installed on top of a host operating system
Performance	Generally higher performance	Generally lower performance
Hardware Access	Has direct access to hardware resources	Relies on host OS for hardware access
Security	Typically more secure due to reduced attack surface	Less secure due to reliance on host OS
Resource Overhead	Minimal resource overhead	Higher resource overhead
Use Cases	Ideal for server virtualization in data centres	Suitable for desktop virtualization or testing environments
Management Tools	Often comes with sophisticated management tools	May have limited management capabilities
Scalability	Suitable for large-scale virtualization deployments	Suitable for small-scale virtualization or personal use
Examples	VMware ESXi, Microsoft Hyper-V, KVM	Oracle VirtualBox, VMware Workstation

How To Use Hypervisors

1. Choose a Hypervisor

- Select a hypervisor based on your requirements and compatibility with your hardwa and software environment.
- Popular choices include VMware ESXi, Microsoft Hyper-V, and KVM.

2. Install the Hypervisor

- Install the chosen hypervisor software on your physical server or workstation.
- Follow the installation instructions provided by the hypervisor vendor.

3. Create Virtual Machines (VMs)

- Launch the hypervisor management interface.
- Use the interface to create virtual machines, specifying settings such as CPU, memo storage, and networking.

4. Install Guest Operating Systems

- Install operating systems (OS) on the virtual machines as you would on physical hardware.
- Use ISO images or network-based installations to install guest OSes.

5. Configure Networking

- Set up networking for your virtual machines, including configuring network adapters addresses, and network connectivity options.
- Choose between bridged, NAT, or host-only networking modes, depending on your requirements.

6. Allocate Resources

- Allocate CPU, memory, and storage resources to each virtual machine based on its workload and performance requirements.
- Monitor resource usage and adjust allocations as needed.

7. Manage Virtual Machines

- Start, stop, pause, and restart virtual machines as necessary.
- Use management tools provided by the hypervisor to manage VMs remotely.

8. Backup and Disaster Recovery

- Implement backup strategies to protect your virtual machines and data.
- Use features such as snapshots, replication, and backup agents provided by the hypervisor for disaster recovery purposes.

9. Monitor Performance

- Monitor the performance of your virtual infrastructure, including CPU usage, memor usage, storage I/O, and network throughput.
- Use built-in monitoring tools or third-party solutions to track performance metrics ar identify bottlenecks.

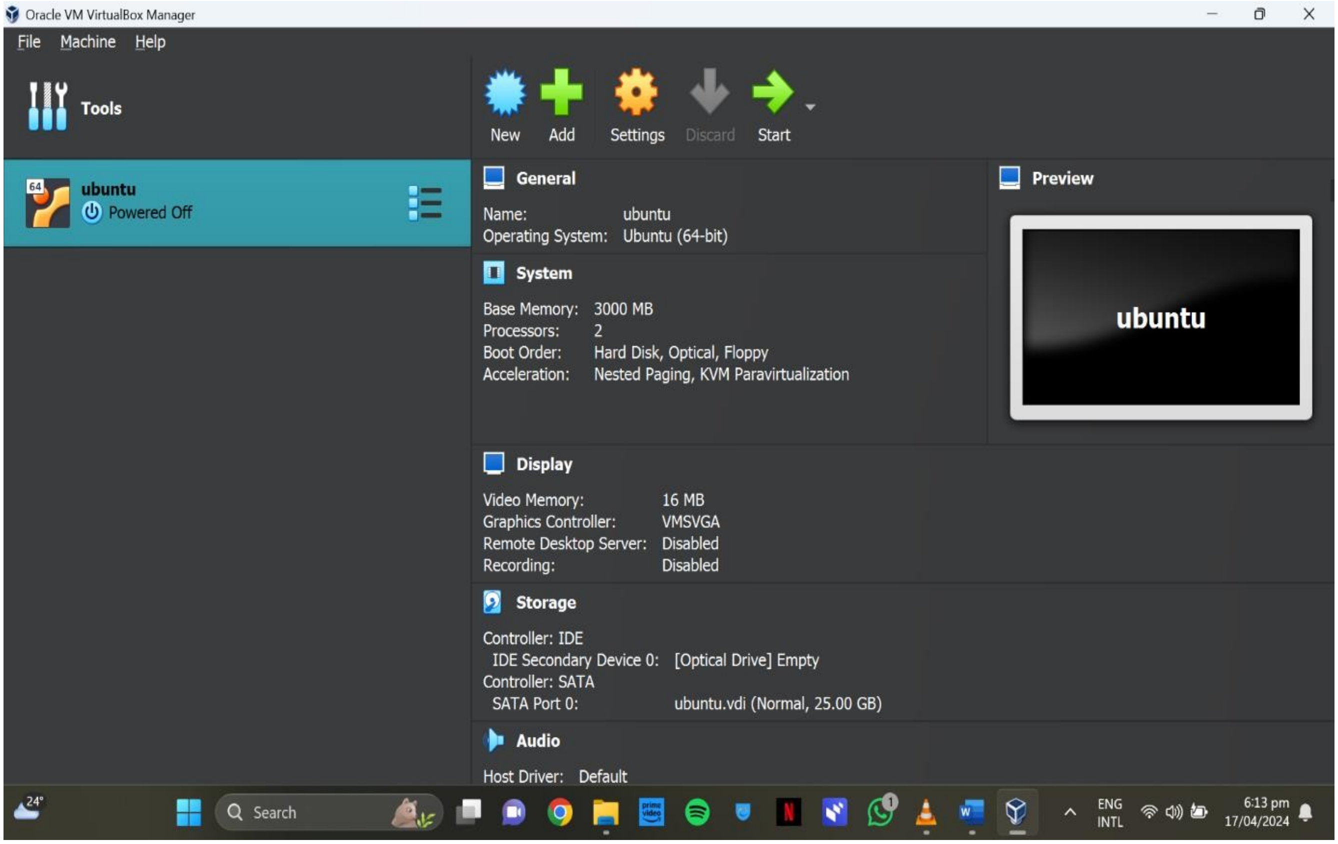
10. Implement Security Measures

- Apply security best practices to protect your virtual environment from threats.
- Implement features such as secure boot, encryption, access controls, and network segmentation to enhance security.

11. Update and Maintain

- Keep your hypervisor software up to date with the latest patches and security updat
- Regularly maintain and optimize your virtual infrastructure for performance and reliability.

ScreenShots of VM



General

Name: ubuntu
Operating System: Ubuntu (64-bit)

System

Base Memory: 3000 MB
Processors: 2
Boot Order: Hard Disk, Optical, Floppy
Acceleration: Nested Paging, KVM Paravirtualization

Display

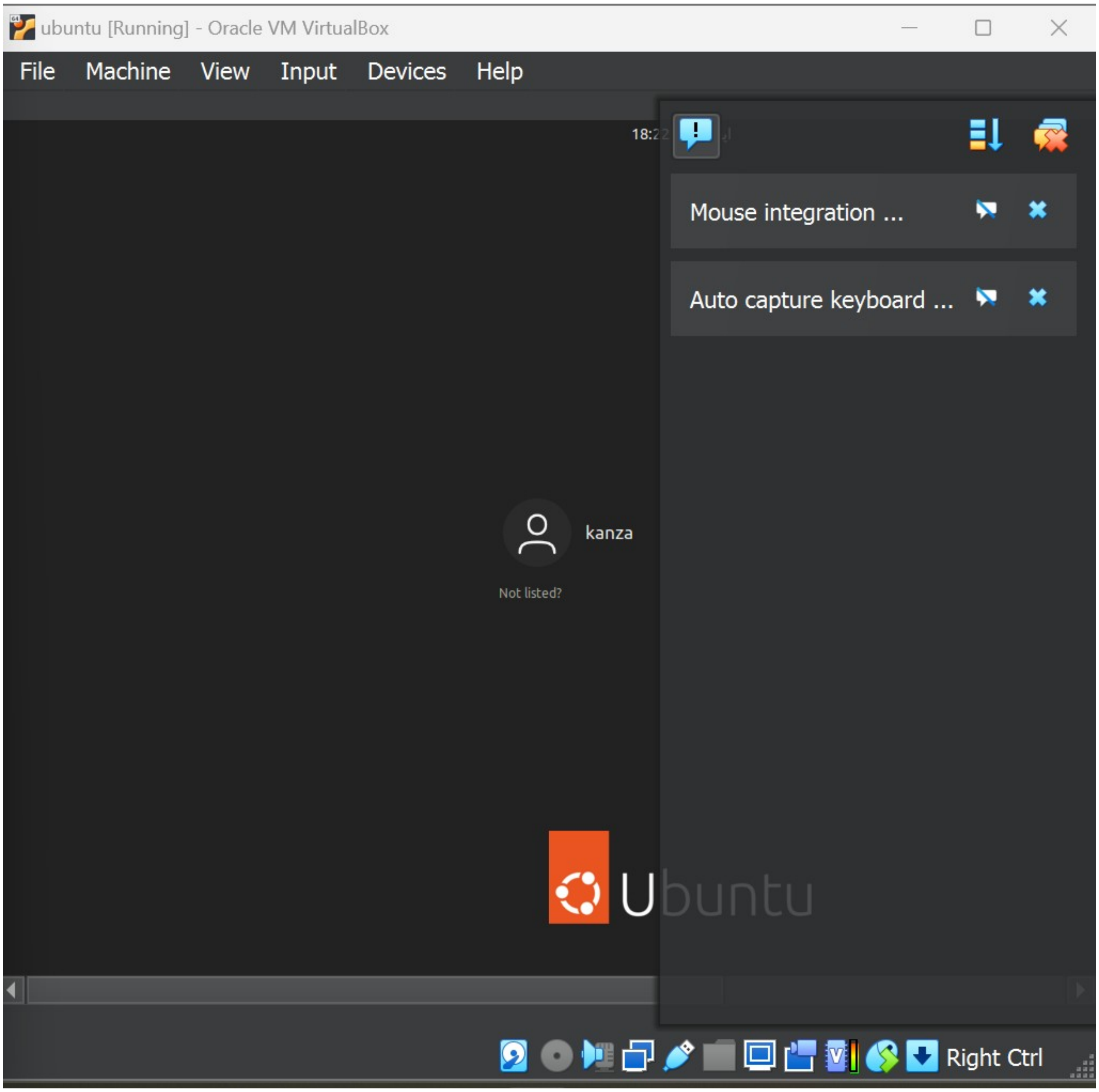
Video Memory: 16 MB
Graphics Controller: VMSVGA
Remote Desktop Server: Disabled
Recording: Disabled

Storage

Controller: IDE
  IDE Secondary Device 0: [Optical Drive] Empty
Controller: SATA
  SATA Port 0: ubuntu.vdi (Normal, 25.00 GB)

Audio

Host Driver: Default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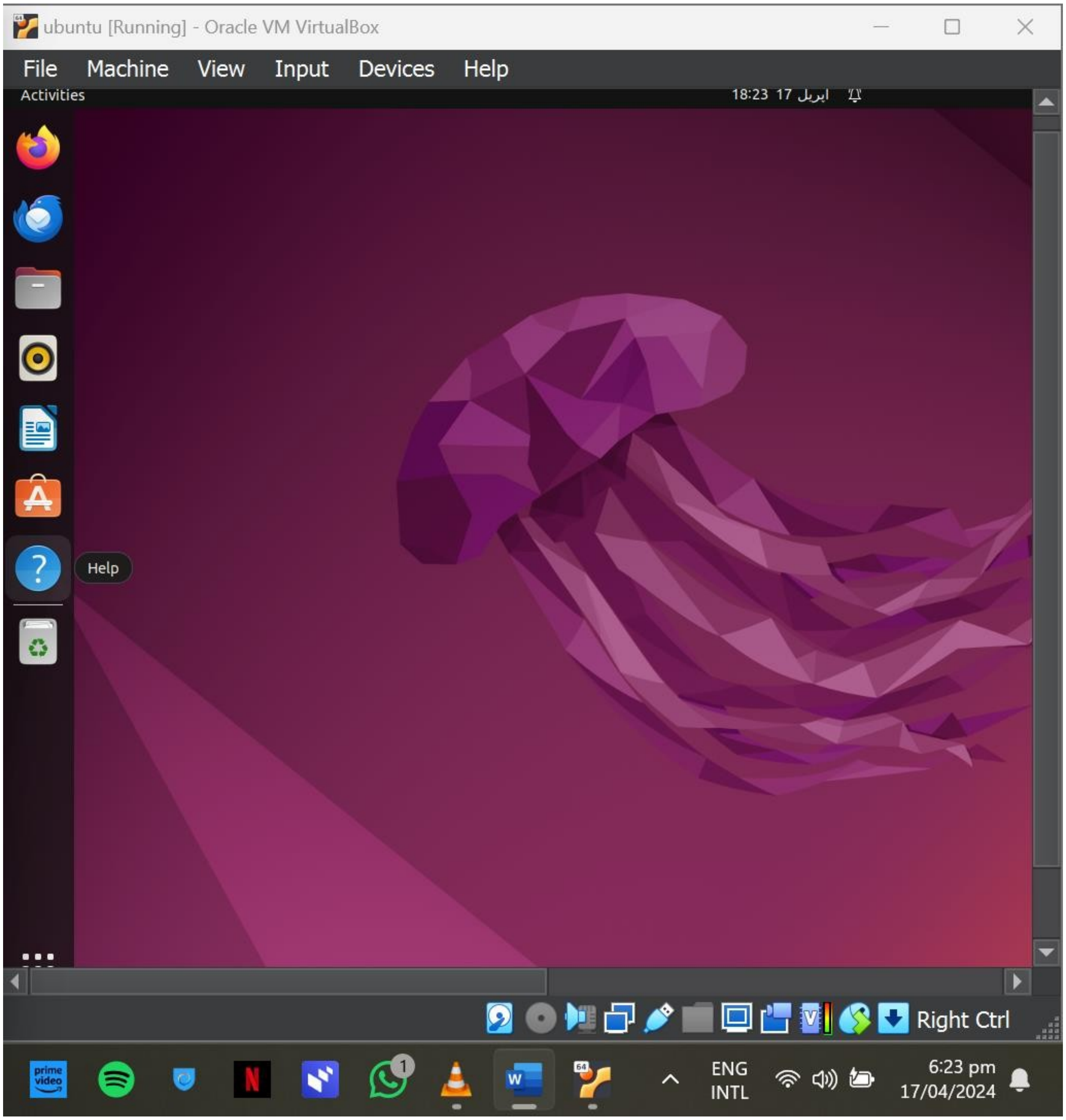
File
Machine
View
Input
Devices
Help
18:2
Mouse integration ...
Auto capture keyboard ...
kanza
Not listed?
Ubuntu
Right Ctrl


ubuntu [Running] - Oracle VM VirtualBox
File
Machine
View
Input
Devices
Help
Activities
18:23 17 ابريل
Help
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