Operating Systems Virtualization mechanisms

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Outline

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Objectives

Knowledge

- What is virtualization
- Which uses has virtualization
- Which uses does **NOT** have virtualization
- Virtualization solutions

Abilities

- Create/delete virtual machines
- Management capabilities for virtual machines
- Virtual Machine Administration
What is virtualization...

An abstraction mechanism to manage (by partitioning, by merging,...) physical resources

- Virtualization is based on the creation of one (or more) virtual representations of a particular resource
- Examples
  - Local Area Network (VLAN)
  - Web Virtual Hosts
  - Storage Virtualization (e.g., LVM, Cloud storage)
  - Data Virtualization (e.g., seamless access to information)
  - **Hardware Virtualization**
Hardware Virtualization

- The virtualization affects the whole machine where new “virtual” instance is/are created.
- The original OS is called *host OS*.
- The other “virtual” OS(s) is/are named *guest OSs*.
- The new instances work autonomously and use the host OS as proxy with the hardware.

**Types of Hardware Virtualization**
- Full Virtualization
- Paravirtualization
- Partial virtualization
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   - Full Virtualization
   - Paravirtualization
   - OS virtualization

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Full Virtualization – Overview

- Complete emulation of hardware components
  - Using the legacy OS as proxy to the hardware
- Transparent for guest OS
Full Virtualization – Functionalities and Examples

**Functionalities**

- Memory reservation
- CPU virtualization
- Virtual Network Interfaces

**Examples**

- Multiplatform
  - VMWare
  - VirtualBox
- Linux
  - QEmu/KVM
- Windows
  - Microsoft® Hyper-V Server 2008
- MacOS
  - Parallels
Paravirtualization

- Concurrent execution of different OS
  - Management Domain controls the rest of OS
- Requires support of the hardware and the OS
Paravirtualization – Functionalities and Examples

**Functionalities**
- Memory partitioning
- CPU partitioning
- Network card separation
- Controlled bus access

**Examples**
- Xen
- UML
OS Virtualization

- Collaboration between host and guests
  - Direct access to the hardware form the guests
  - Can run in userspace
- Requires support of the OS
  - Host and guests use the same OS

![Diagram of OS Virtualization](image-url)
OS virtualization – Functionalities and Examples

### Functionalities

- Concurrent execution of various instances of the operating system

### Examples

- OpenVZ
- Solaris Containers
- BSD Jails
- Linux Containers
  - LXC
  - Docker.io
Applications

Useful for:
- Energy saving
- Space saving
- Lightweight processes
- Service aggregation
Applications

Useful for....

- Energy saving
- Space saving
- Lightweight processes
- Service aggregation

Should not be used for...

- Heavyweight processes
- Computational power
Main Functionalities

- Machine level backup/restoration
  - Snapshots
  - Regular backups
- Machine Pause/Suspend
- Service Isolation
- Resource limitation (CPU, Memory, I/O, Networking)
- Machine teleporting
  - Memory teleporting
  - Full machine teleporting
- Cloning
- Centralized management
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   - Rationale
   - Delivered Services

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Rationale under Cloud Computing

- Offer computation, storage, and services
- Outsourcing of IT local resources through well defined APIs
- Easy adoption for customers
  - Masking operational details
  - Less management overhead
  - Increase in resources
  - Increase in performance
  - Low cost
Delivered services

Software as a Service

- Software licensed on a subscription-based fee model
  - Through periodic fees
  - Through advertisement

- Mostly web-based

- Examples
  - GMail
  - Facebook
  - Whatsapp
Delivered services

Platform as a Service

- Computing platform
- Customer deploys application using service provider features into the provider’s premises
- Provider offers storage, computation, memory, networks, and other necessary facilities
- Examples
  - Amazon Web Services (AWS)
  - Rackspace
Delivered services

Infrastructure as a Service

- Lowest level
- Providing hypervisor, networking, storage
- The customer is in charge of configuring and administering everything
- Examples
  - Amazon Web Services (AWS)
  - Rackspace
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   - VM Creation and Deletion
   - Integrated Management Solutions
   - Backups
6. Practical Tips
VM Creation

Required steps to create a VM

- Create system hard drive
  - Dynamically allocated – Less space / Slower
  - Statically allocated – More space / Faster
- Create hardware
  - CPU(s)
  - Memory
  - Disk(s)
  - ...
- Install the operating system
- Configure services
VM Deletion

Required steps to delete a VM

- Backup user/shared data
- Disable/ban users
- Stop all the services
- Unregister virtual machine
- Remove the hard drive
VM Resources Management

Resource enhancements

- More CPU(s)
- Memory increase
- Hard disk resizing
  - Different from Filesystem resizing

System administration
- Use passwordless remote administration (ssh, pssh)
- Create management scripts
- Send command to all
- Install to all
### VM Resources Management

#### Resource enhancements
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OS Virtualization

Integrated Management Solutions

- **libvirt**: `virsh`, `virt-manager` [http://www.libvirt.org]
- **VMWare vSphere** [http://www.vmware.com/products/vsphere]
- **OpenNebula**: [http://www.opennebula.org/]
- **OpenStack**: [http://www.openstack.org/]

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Backup mechanisms

**Full Hardware backup**

- Use available facilities within the Virtualization Software
- Use a master copy of the system
Backup mechanisms

Full Hardware backup
- Use available facilities within the Virtualization Software
- Use a master copy of the system

Regular backup
- Similar to the legacy case
- Backup shared storage area
Practical Tips

- GUI are evil
  - Use headless setups
- Monitor resource usage
- Use shared storage for user data
- Clone the VMs
- Use different servers
  - Resilience
  - Load balancing
Management Interface – virt-manager

- Aggregated management and monitoring
- Create/Delete/Modify VMs
- Connect/Disconnect removable media
Management Interface – VirtualBox

- Aggregated management and monitoring
- Create/Delete/Modify VMs
- Connect/Disconnect removable media