

CS528

virtualization

A Sahu

Dept of CSE, IIT Guwahati

Outline

- What is Cloud Computing?
- (HPC, Data Center, Grid) Vs Cloud
- Virtualization : Driving factors

Cloud computing takes virtualization to the next step

- You don't have to own the hardware
- You “rent” it as needed from a cloud
- There are public clouds
 - e.g. Amazon EC2, and now many others (Microsoft, IBM, Sun, and others ...)
- A company can create a private one
 - With more control over security, etc.

Virtualization

- Abstraction of computer resources.
- Virtualization hides the physical characteristics of computing resources
 - From their users, be they applications, or end users.
- **Virtualization: Abstraction for “Compatibility and Portability”**

Virtualization

- Virtualization includes making a **single** physical resource
 - such as a server, an operating system, an application, or storage device
 - appear to function as **multiple** virtual resources
- Also include making **multiple** physical resources
 - such as storage devices or servers
 - appear as a **single** virtual resource










Truck on Train: Compatible for Speedy Transportation



Mobile Multi Charger: Portability



EV charger: Portability

	N. America	Japan	EU <i>and the rest of markets</i>	China	All Markets <i>except EU</i>
AC	 J1772 (Type 1)	 J1772 (Type 1)	 Mennekes (Type 2)	 GB/T	
DC	 CCS1	 CHAdeMO	 CCS2	 GB/T	Tesla

Virtualization Basic

- In OS, Classic example **FILE** as abstract virtual object
- File read/write:
 - fwrite: write data to File
 - fread: read data from File
- Underlying target **File** may be in HDD, Buffer, SSD, Network File, CDROM
- Internal may be diff but externally the same call

Virtualization Basic

- Example: **Virtual BOX** , QEMU, Wine, Dalvik, JVM
- **QEMU** : ARM emulation on X86
- **JVM and Dalvik** : Java byte code and in Andriod
- **Oracle Virtual BOX**
 - Running MS Window OS on Linux Host
 - Running Linux on MS Window Host
- **Cygwin**: Running Linux App on Window
 - Assume running shell script and GIMP in Window
- **Wine**
 - Running MS Window app on Linux, Running your favorite MS-Office in Linux

Virtualization Basic

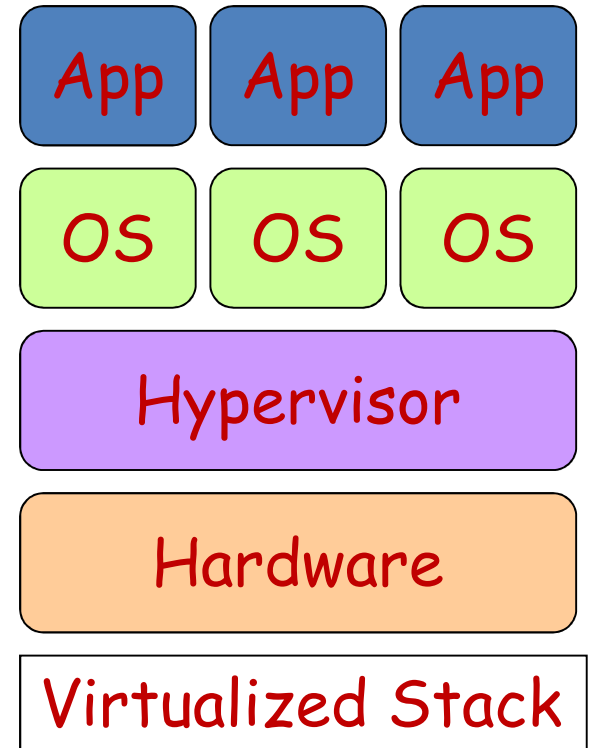
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Virtualization

- Virtual workspaces
 - An abstraction of an execution environment that can be made dynamically available to authorized clients by using well-defined protocols,
 - Resource quota (e.g. CPU, memory share),
 - Software configuration (e.g. O/S, provided services).

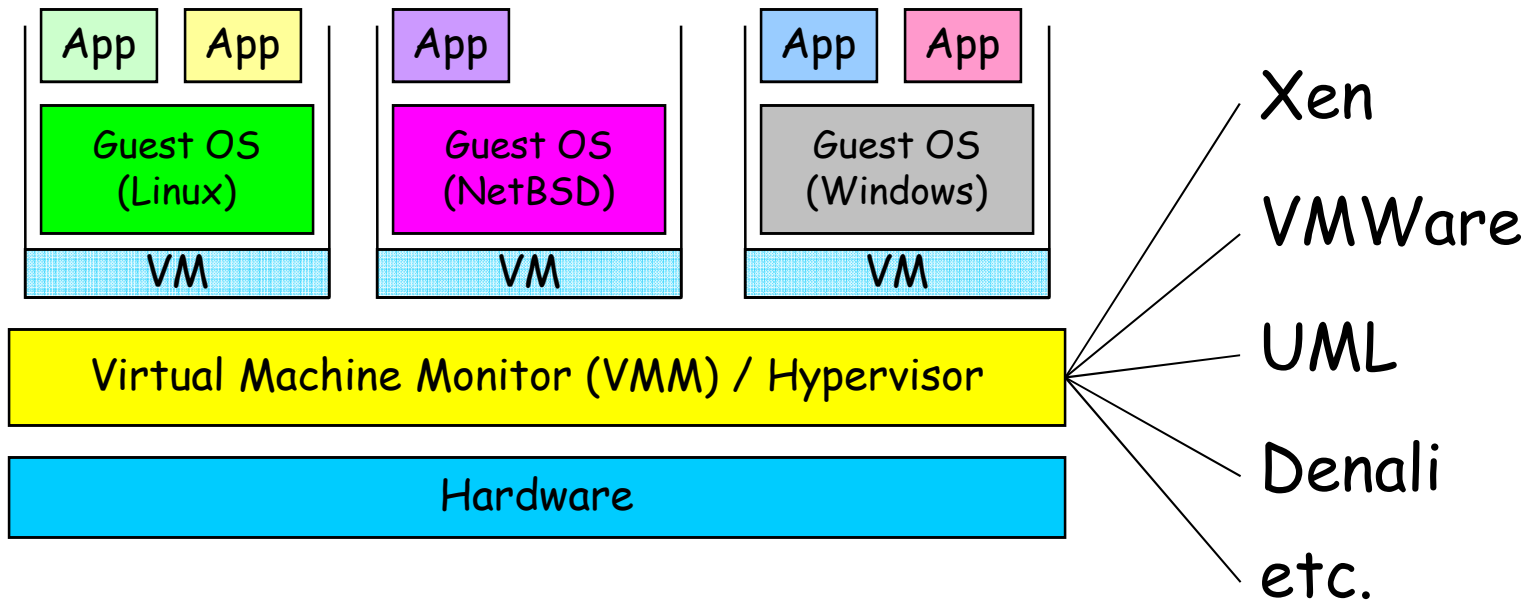
Virtualization

- Virtual WS Implement on Virtual Machines (VMs):
 - Abstraction of a physical host machine,
 - Hypervisor intercepts and emulates instructions from VMs, and allows management of VMs,
 - VMWare, Xen, etc.
- Provide infrastructure API:
 - Plug-ins to hardware/support structures



Virtual Machines

- VM technology allows multiple virtual machines to run on a single physical machine.

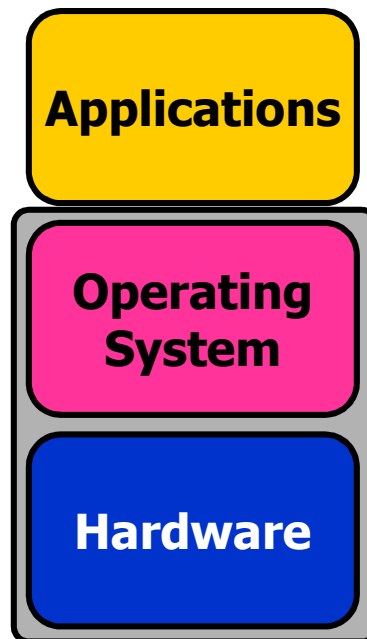


Performance: Para-virtualization (e.g. Xen) is very close to raw physical performance!

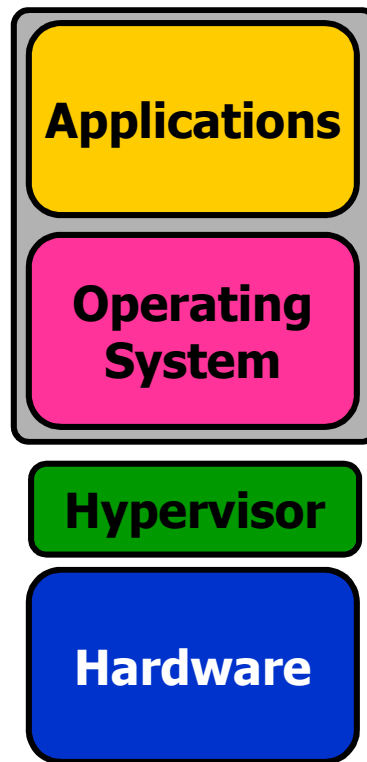
Virtual Machine

- What is Virtual Machine (VM)?
 - **VM** is a software implementation of a machine (i.e. a computer) that executes programs like a real machine.
- Terminology :
 - Host (Target) : The primary environment where will be the target of virtualization.
 - Guest (Source) : The virtualized environment where will be the source of virtualization.

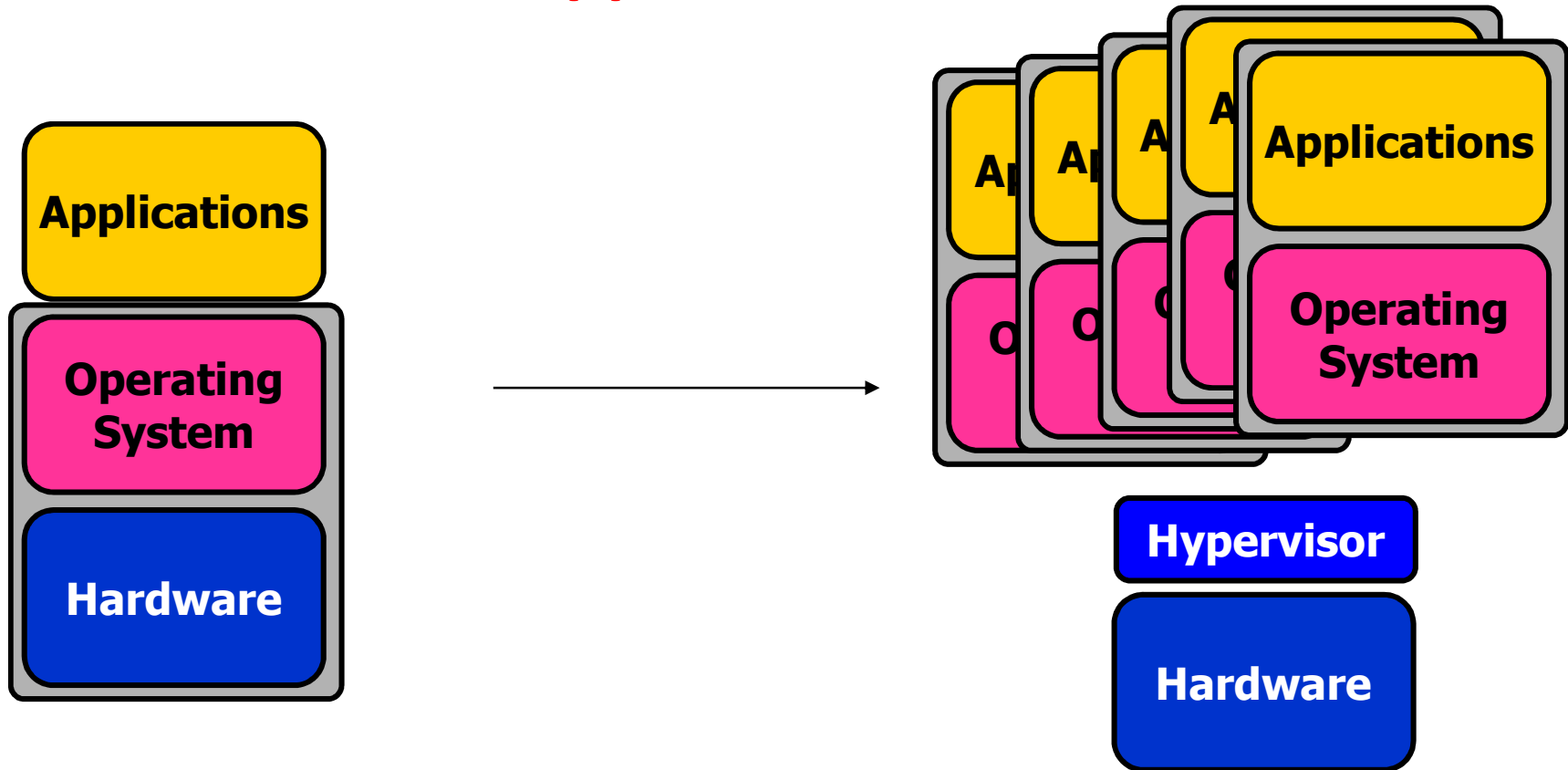
The Use of Computers



Virtualization



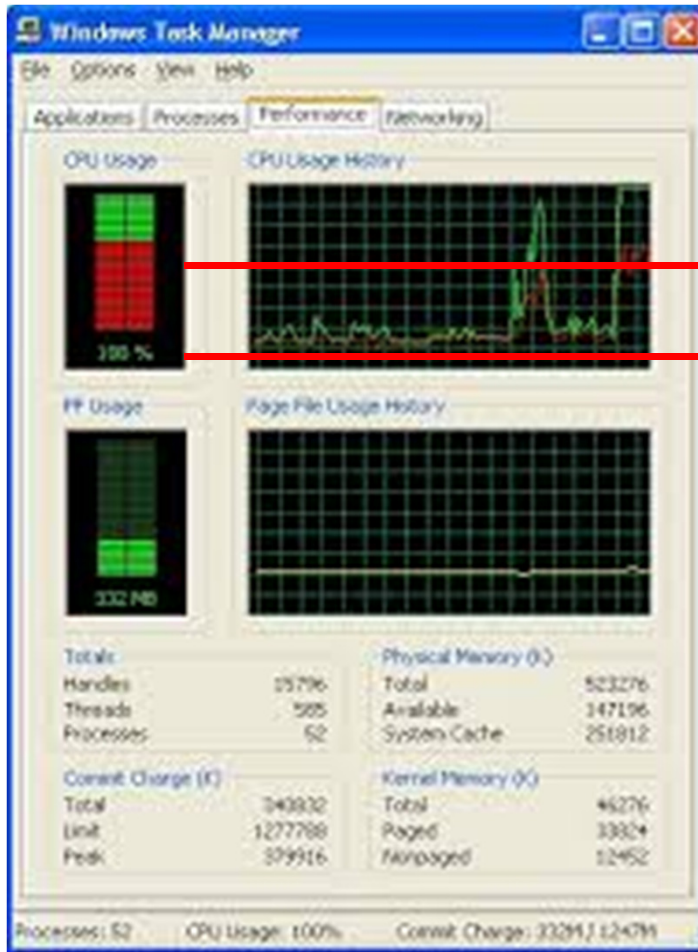
Virtualization -- a Server for Multiple Applications/OS



Virtualization -- a Server for Multiple Applications/OS

- **Hypervisor** is a software program
 - that manages multiple operating systems (or multiple instances of the same operating system)
 - on a single computer system.
- The hypervisor manages the system's
 - processor, memory, and other resources to allocate what each operating system requires.
- Hypervisors are designed for a particular processor architecture
 - and may also be called **virtualization managers**.

Capacity Utilization



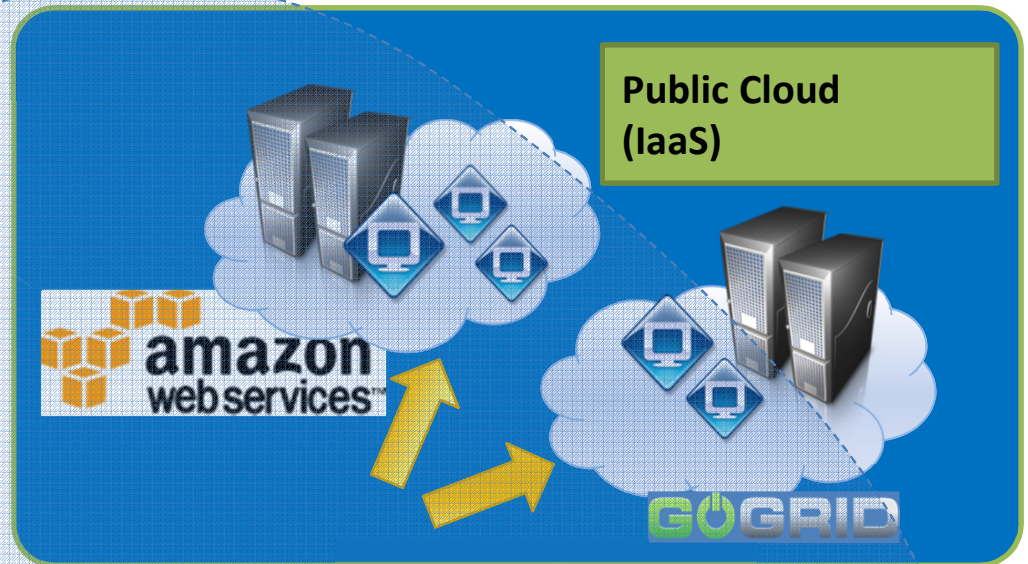
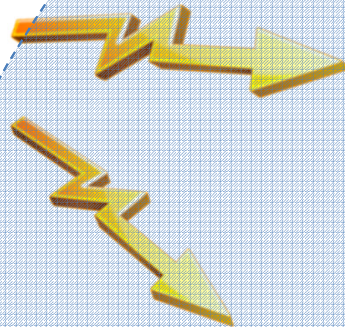
Virtualized system (high)
High utilized*
Low utilized
Stand alone system (low)

* But not overloaded...

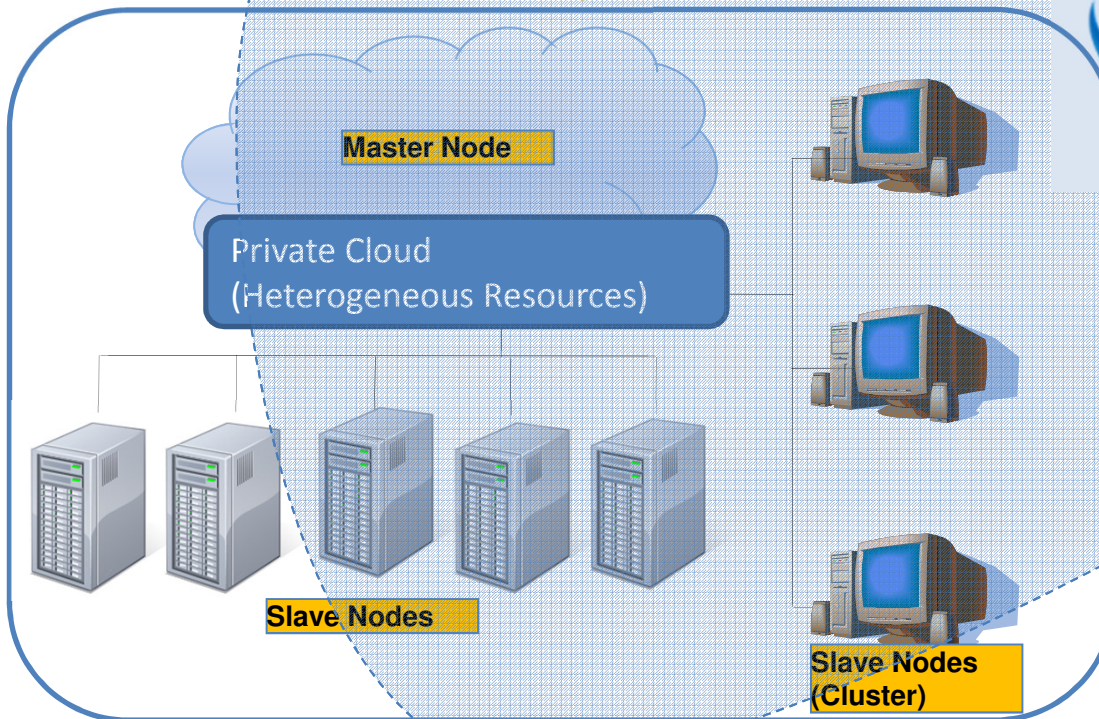


User

User
Middleware



Public Cloud
(IaaS)

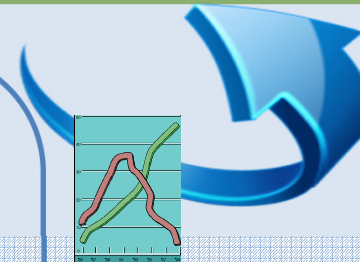


Master Node

Private Cloud
(Heterogeneous Resources)

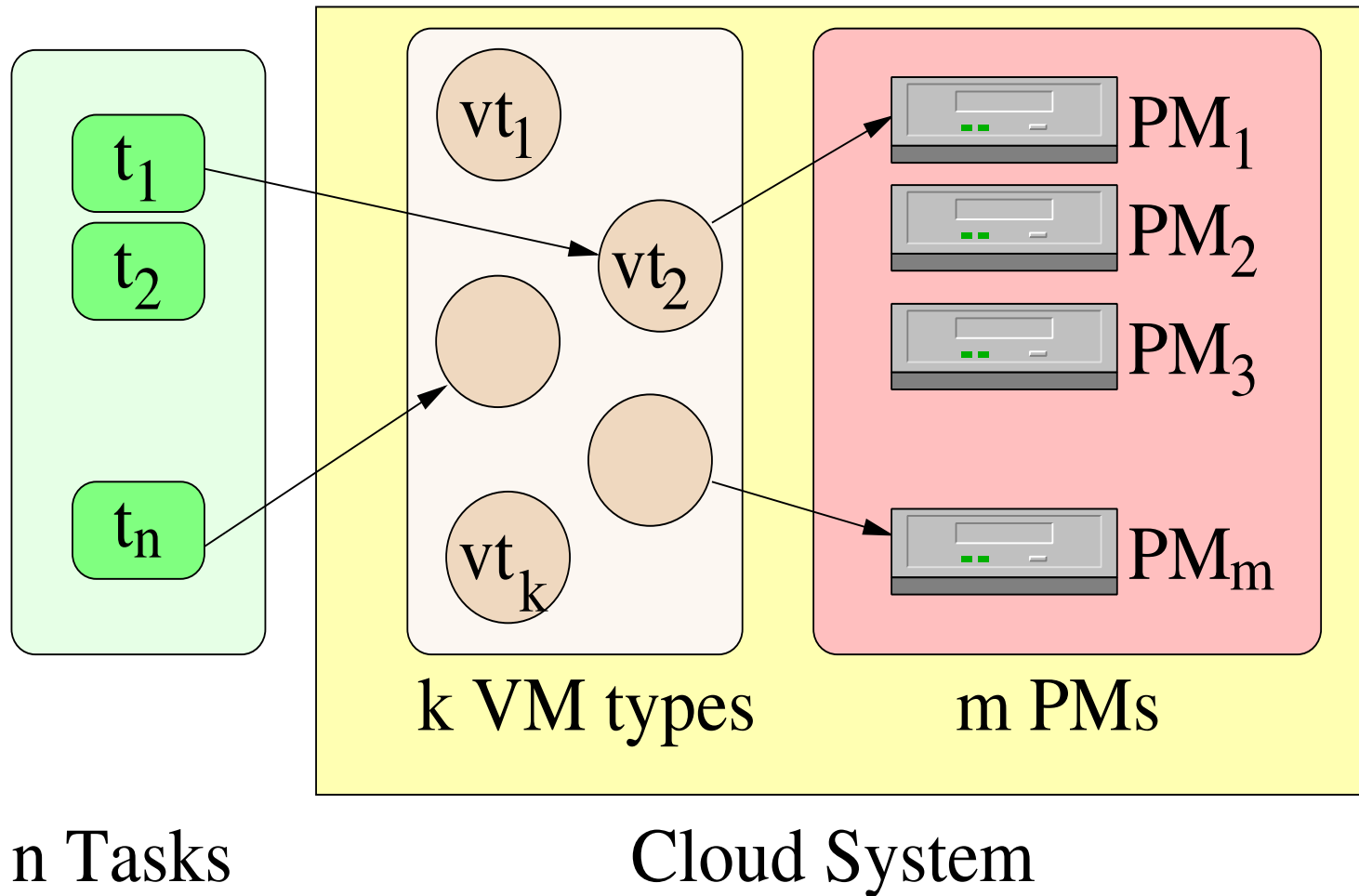
Slave Nodes

Slave Nodes
(Cluster)



Hybrid Cloud

Logical view of Cloud System



Why now?

- 1960—1999
 - IBM, CP-40, CP/CMS, S/360-370, VM370, Virtual PC, VMware
- 2000—2005
 - IBM z/VM, Xen
- 2006
 - Intel VT-x
 - AMD's AMD-V
- 2008—

Hardware evolution

- Faster CPU clock than ever
 - Though almost hit its top
- More CPU cores in a single chip
 - 32/64-core CPUs already in the market
- Multi-core architectures make parallel processing more realizable
- Virtualization support on chip from CPU manufacturers (e.g., Intel, AMD)

Virtualization

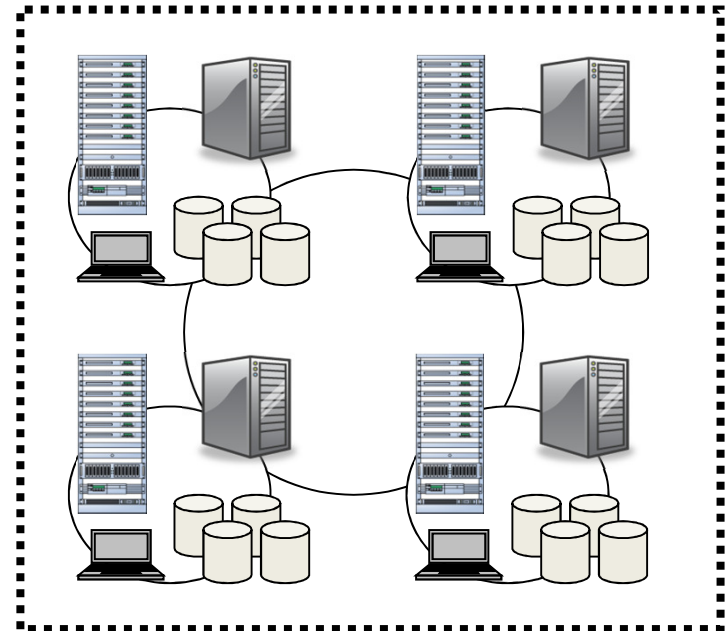
- Binary translation is the most established technology for full virtualization
- Hardware assist is the future of virtualization, but it still has a long way to go
- Para-virtualization delivers performance benefits with maintenance costs
 - Xen
 - VMWare, VBox
- OS level Virtualization: Container/Kubernetes

Issues in Virtualization for Cloud-Computing

- Aspects and expectation from
 - End-user
 - Operator/Manager

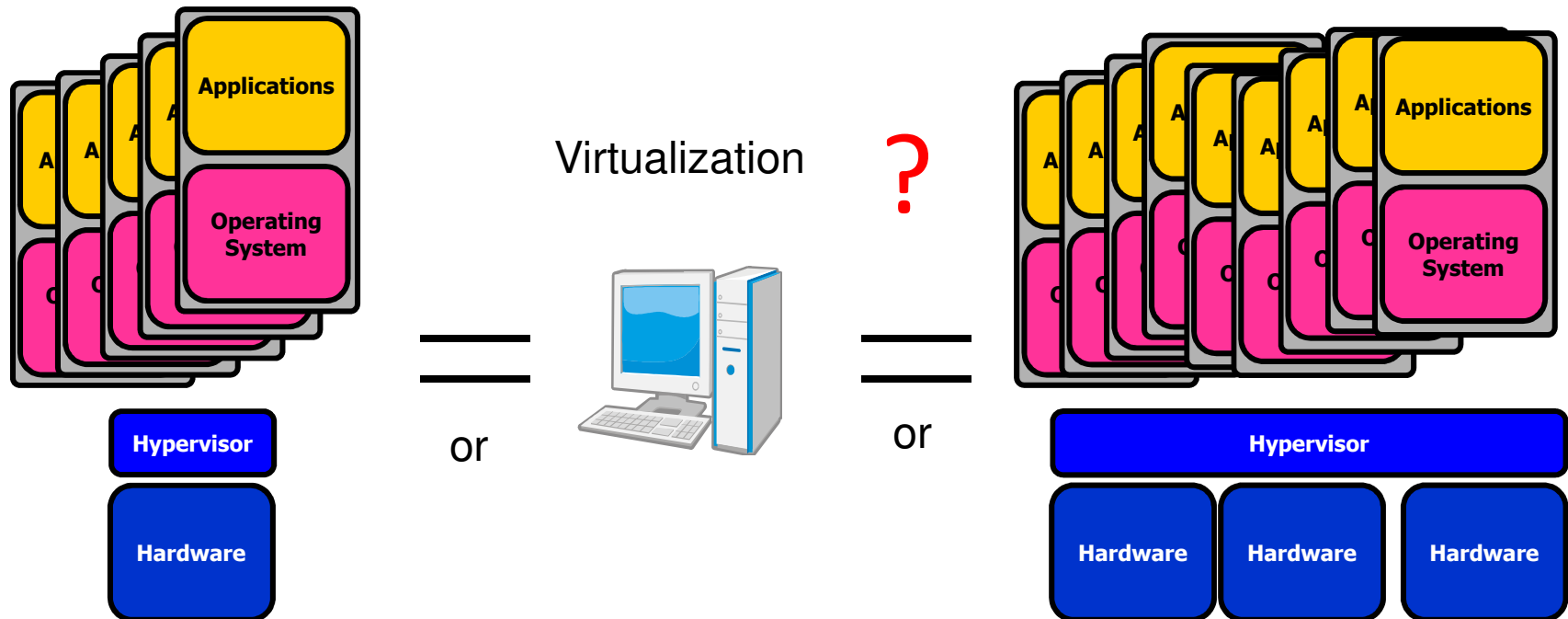


Virtualization
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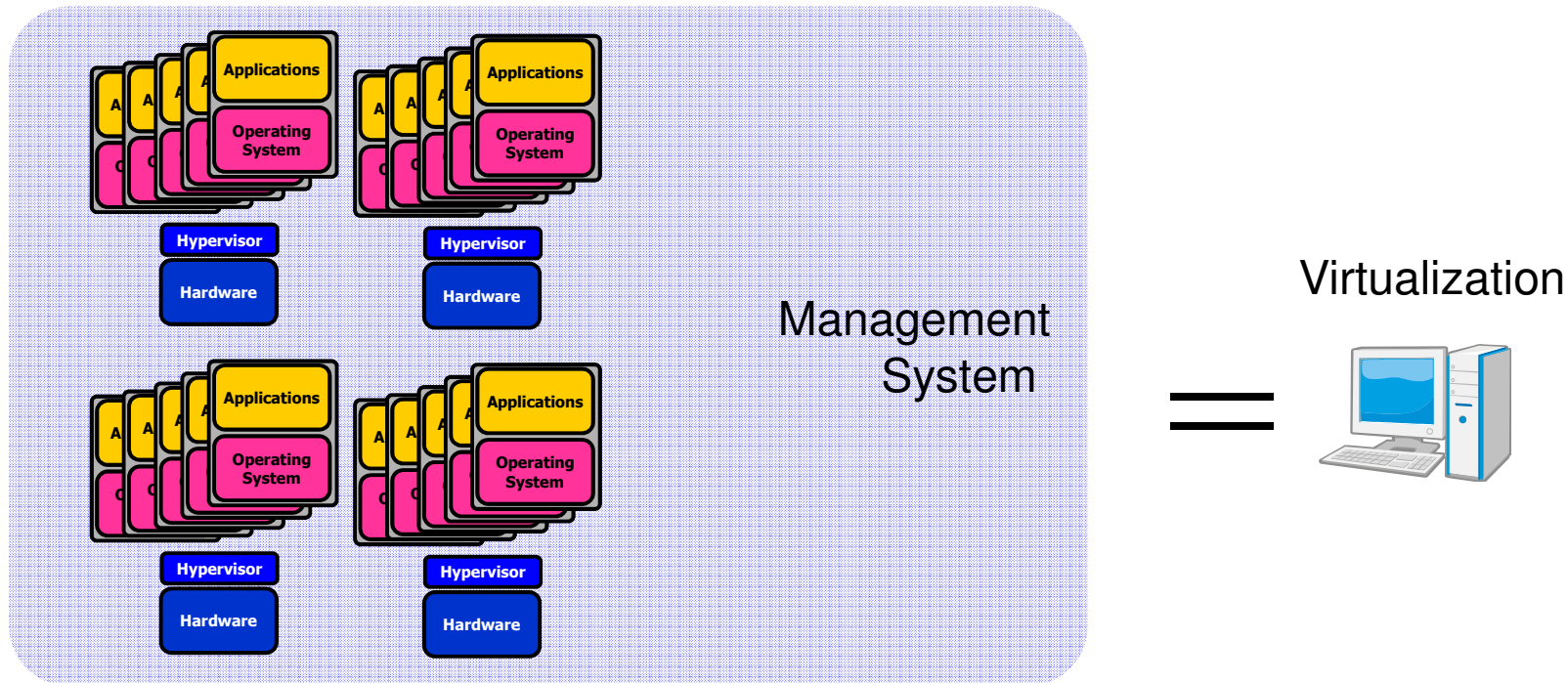
Issues in Virtualization for Cloud-Computing

- Virtualization implemented on
 - a single machine (with multi-core CPUs)
 - a cluster of machines (with multi-core CPUs)
- The state-of-the-art
 - Running a Xen or a cluster of Xens



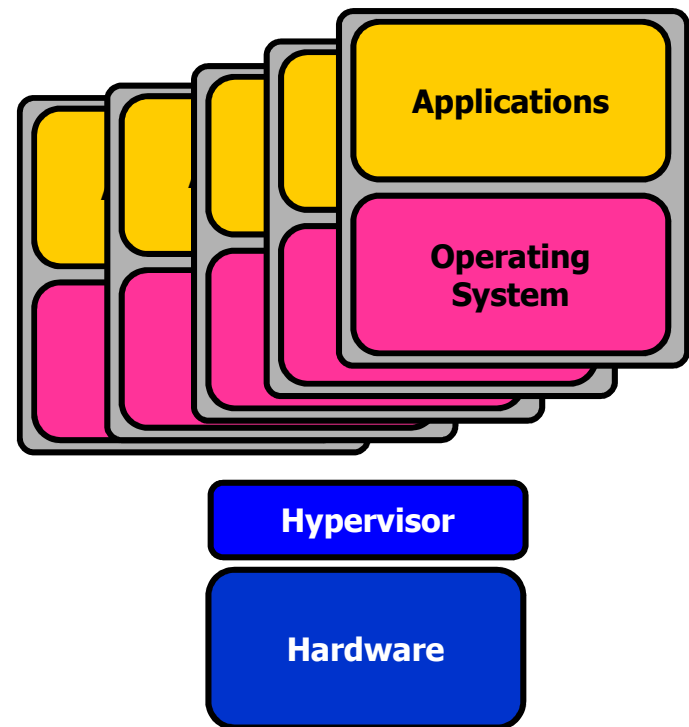
Issues in Virtualization for Cloud-Computing

- Abiquo/abcloud may provide partial solutions

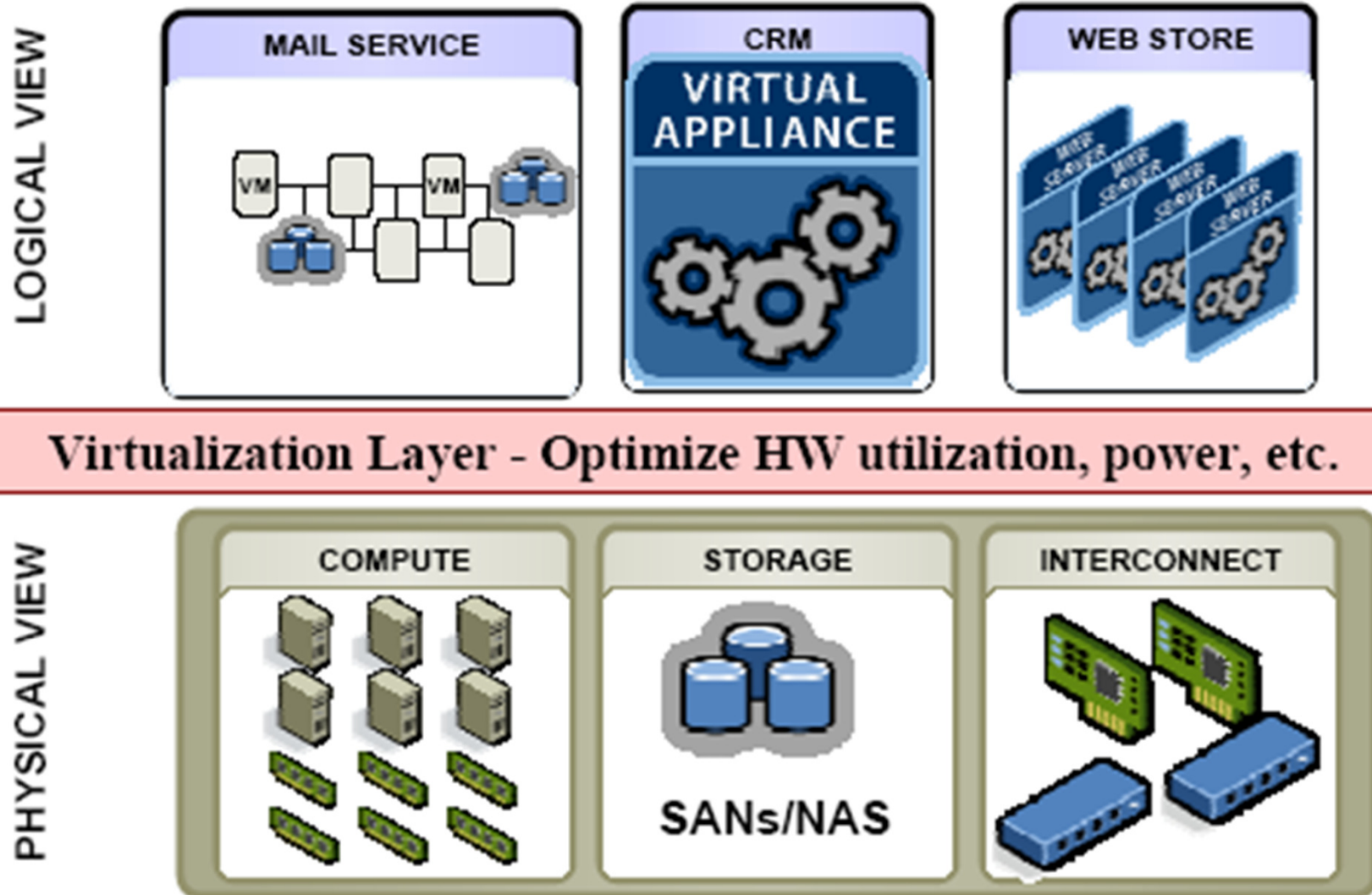


Running multiple OS and applications

- Virtualization: One physical hardware can run multiple OS and applications through a hypervisor.
- A hypervisor is the virtualization manager on a physical hardware.

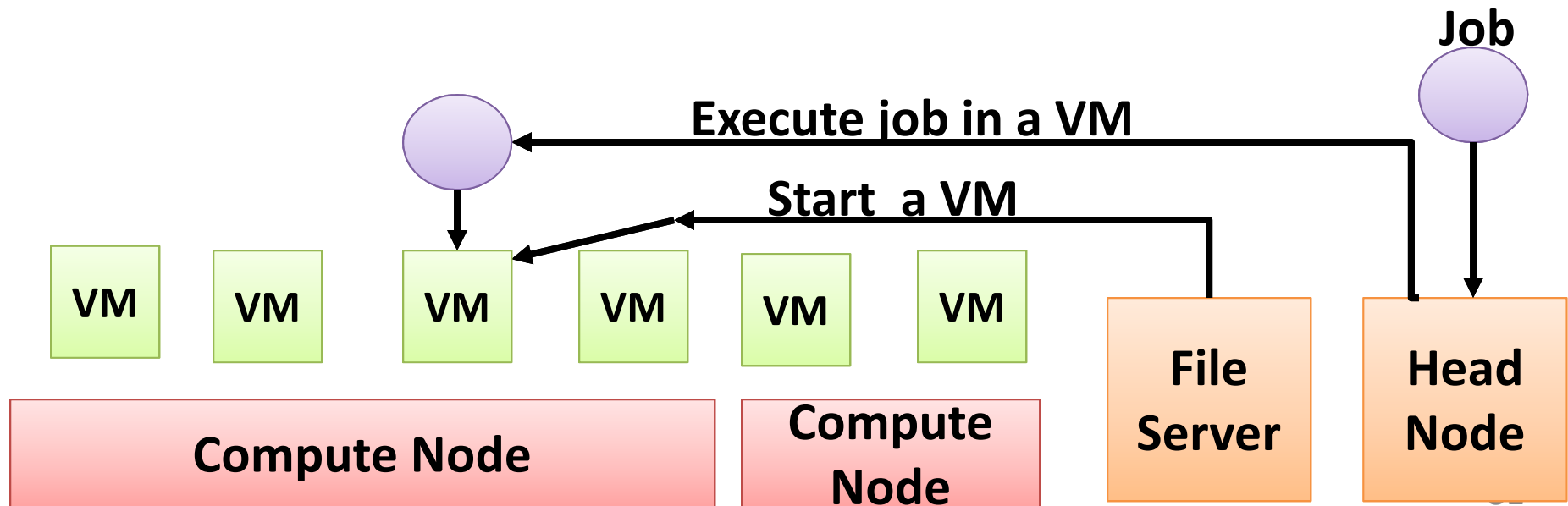


User View of Virtualization



Cloud Computing

- Features of Clouds
 - Scalable, Enhanced Quality of Service (QoS)
 - Specialized and Customized, Cost Effective
 - Simplified User Interface



Task to VM and VM to PM

- Task VM Mapping
 - Optimization for Speed, Portability,...
- VM to PM Mapping
 - Optimization for Energy, Cost, Reliability

Virtualization in Five Abstraction Levels

**Application
Level**

JVM/.NET CLR/Panot

**Library/API
Level**

WINE/LXRun/vCuda

OS Level

Jail/Virtual Environment
/FVM/Docker/Container

**H/W Abst Layer
(HAL) Level**

Vmware/Xen/L4/Virtual PC/Virtual Box

ISA Level

Vovhs/QEMU/BIRD/Dynamo