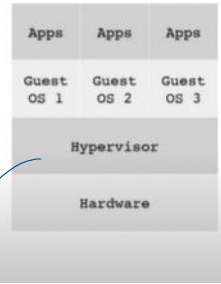
System VM

Hypervisors

- Also called Virtual Machine Monitor (VMM)
- A hypervisor is an operating system for operating systems
  - Provides a virtual execution environment for an entire OS and its applications
  - Controls access to hardware resources
  - When guest OS executes a privileged instruction, Hypervisor intercepts the instruction, checks for correctness and emulates the instruction.



VM tries to stay completely invisible

to do this they intercept instructions & emulates it.

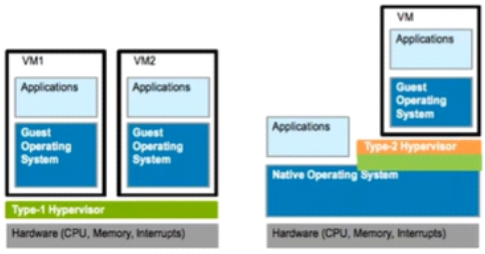
guest OS does not know hypervisor does this.

1st Hypervisor gets booted up

does same thing as OS but for VM's.

Type of Hypervisors

- Type 1 Hypervisor (bare metal, native): supports multiple virtual machines and runs directly on the hardware (e.g., VMware ESX , Xen, Denali)
- Type 2 Hypervisor (hosted) VM - runs under a host operating system (e.g., user-mode Linux)



https://microkerneldude.files.wordpress.com/2012/01/type1-vs-2.png

VM's will initiate & invoke previlleged instructions, But Hypervisior will trap them and emulate them.

⇒ Type-2 Hypervisior gives some flexibility in terms of implementation.

⇒ We're making hypervisor part of OS & user space.

⇒ it must have all drivers that is necessary to access

⇒ we're making Hypervisor part of OS & must
⇒ it must've all drivers that is necessary to access hardware.

⇒ why'll write all drivers from scratch ?

- already present in OS.
- why write which Type-1 Hypervisor doing.

we take advantage of already present drivers.

native/host OS — bare metal
guest OS — in VM running

Type-2 Hypervisors

Put Hypervisor in kernel module in OS to take over Previlleges from host OS & some lib. that are required to run apps.

Para-virtualized VMs

- Modify guest OS for better performance
- Traditional Hypervisors provide full-virtualization
  - They expose to VMs virtual hardware that is functionally identical to the underlying physical hardware.
  - Advantage : allows unmodified guest OS to execute
  - Disadvantage: Sensitive instructions must be trapped and emulated by Hypervisor.
  - E.g. KVM and VMWare ESX provide full virtualization
- Para-virtualized VM
  - Sees a virtual hardware abstraction that is similar, but not identical to the real hardware.
  - Guest OS is modified to replace sensitive instructions with "hypercalls" to the Hypervisor.
  - Advantage: Results in lower performance overhead

- Para-virtualized VM
  - Sees a virtual hardware abstraction that is similar, but not identical to the real hardware.
  - Guest OS is modified to replace sensitive instructions with "hypercalls" to the Hypervisor.
  - Advantage: Results in lower performance overhead
  - Disadvantage: Needs modification to the guest OS.
  - Xen provides both para-virtual as well as full-virtualization

→ if Hypervisor wants to get fully transparent all the instructi. must be trapped & emulated.

Para-virtualized VMs →

guest os modified
not all the instruction
trapped. & imulate

#only sensitive info.] one set

which -ll ve executed through hyp

& rest instr. -ll be system c

hypervisor not fully transp

→ often additional hyp

are partially Pa

device drivers in g

Para-virtualized

CPU & memory ma

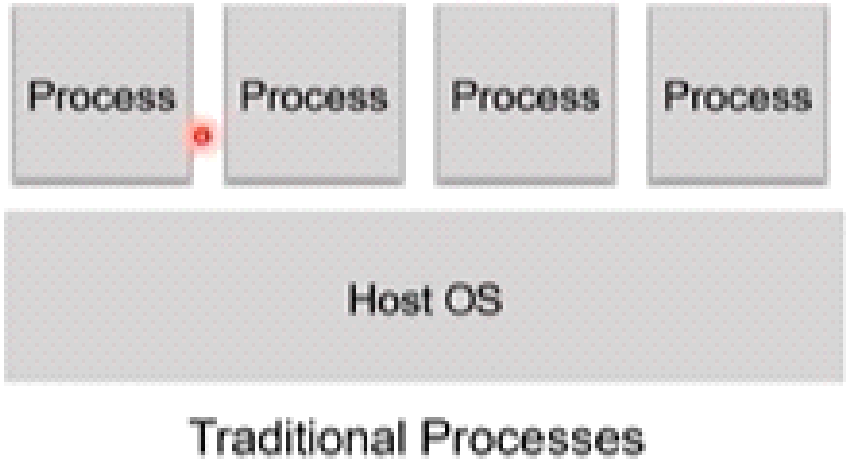
ra - virtualized

est OS may be

. whereas

y be fully virtualized

Traditional Process vs traditiona

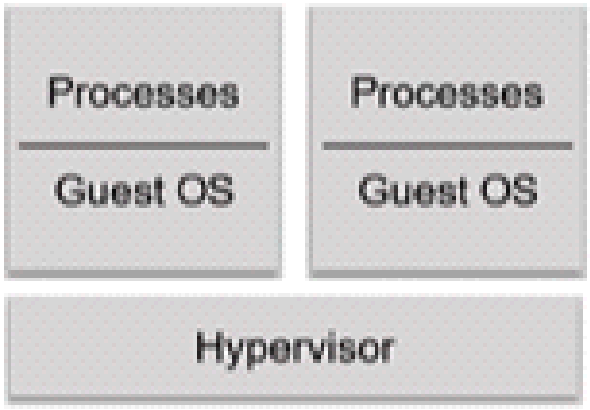


Traditional Processes

Resources shared among Processes.

→ some virtualization / multi

l VMs



Traditional VMs

isolation blw Process that are running on top of these two guest os is completely

plexing

→ Some Virtualization / multi
done by OS in this lev

→ Loosely isolated

→ Processes will talk thr
System calls & Eg.
Sys calls. in Linux.

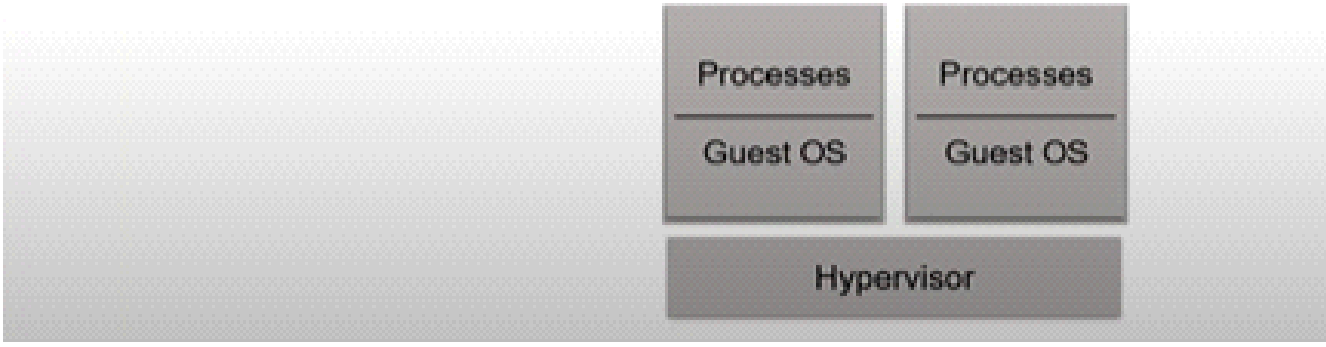
→ all sys. calls available
resources.

Completely rigid.

⇒ resources shared b/w guest OS're completely managed by Hypervisor

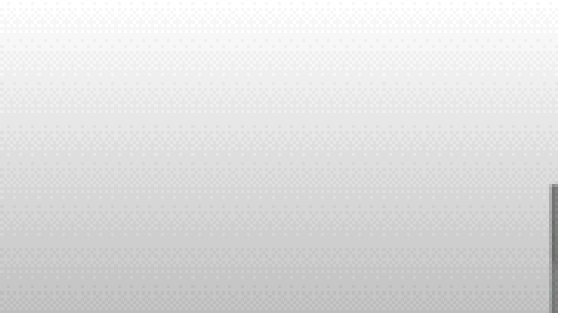
System VMs

- Each VM has its own
  - Guest OS
  - Guest physical memory ("virtualized" view of m
  - One or more virtual CPUs
  - Virtual I/O devices: virtual disk, virtual network
- Ideally: Co-located VMs don't see/share ANYTHING



emory seen by guest OS

S



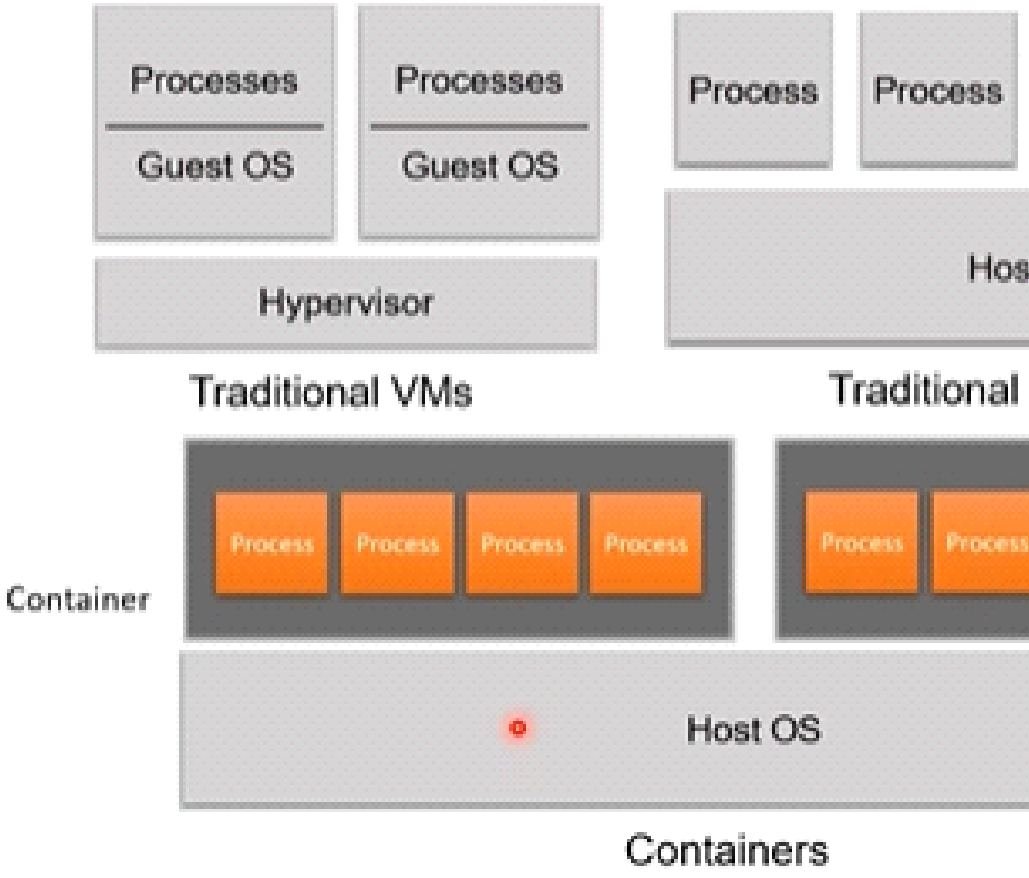
Isolation is important

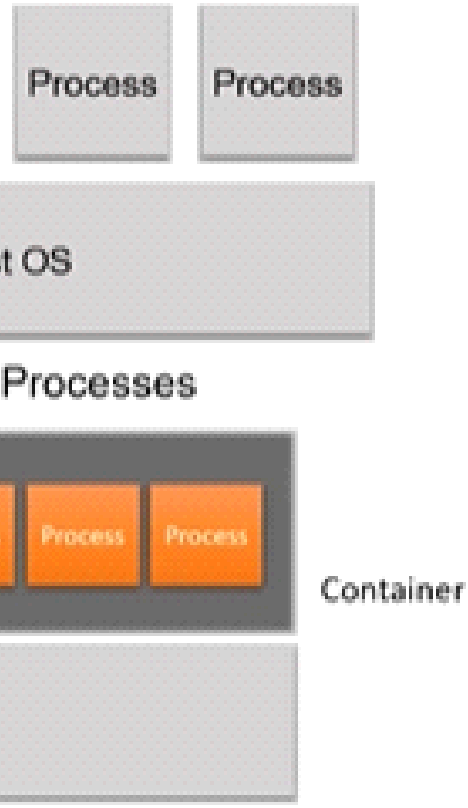
- Limiting what/who a process/application can see.
- Limiting who can see a process/application

- Processes share too much
  - Great performance but not isolated enough
  - System VMs are too heavy
- Great Isolation but too heavy due to separate gues system-level virtualization
  - Multiple isolated user-spaces
  - Share one kernel
  - Native performance

t OS per VM Operating-

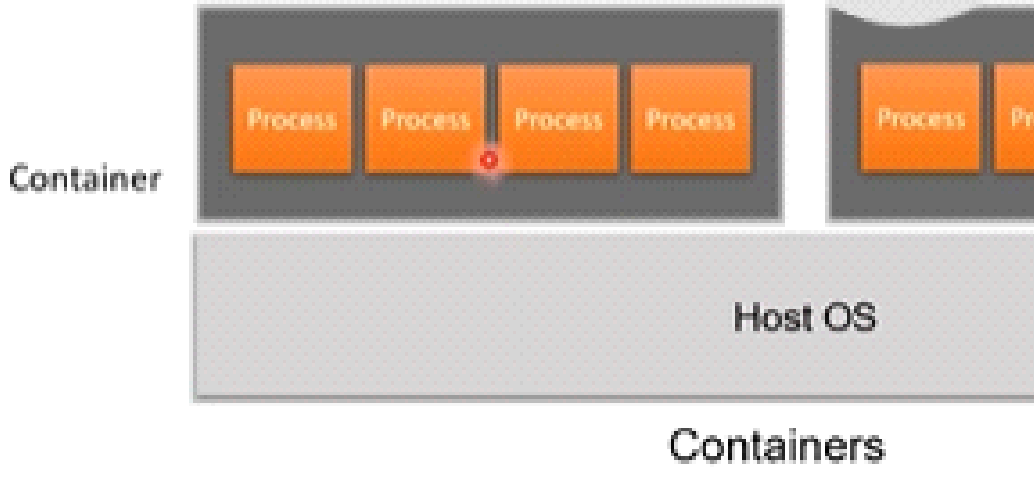
Process VMs and Containers




Process
Process
t OS
Processes
Process
Process
Container

Containers

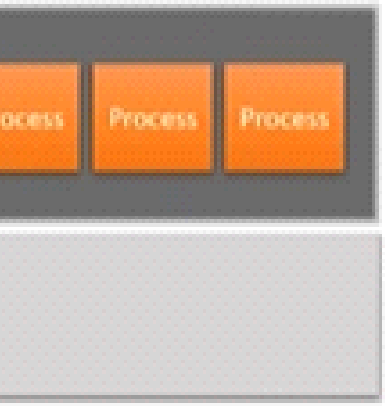
- Containers
  - group traditional processes together and
  - restrict what resources they can see/access
- In Linux, containers consist of
  - Namespaces
  - Control Groups (cgroups)



Containers

Processes share names
create one seperate
group of processes.

.



spaces - So if you
namespace & control

⇒ diff. containers will inv
to resource OS.

⇒ in terms of sys level v
one cannot get full
But with containers, u
approach, where we c
for these Processes & b/w these containers.

oke host sys. calls

Ms or fully virtualized VMs

isolation of Processes.

e can get Big resource

an've namespace seperated

isolated resource sharing

Cloud Computing

- Virtualized distributed processing, storage
  service.

- Delivering computing as a on-demand, pay

- "A model for enabling convenient, on-dem
  pool of configurable computing resources
  applications, and services) that can be rapi
  minimal management effort or service pro
  definition

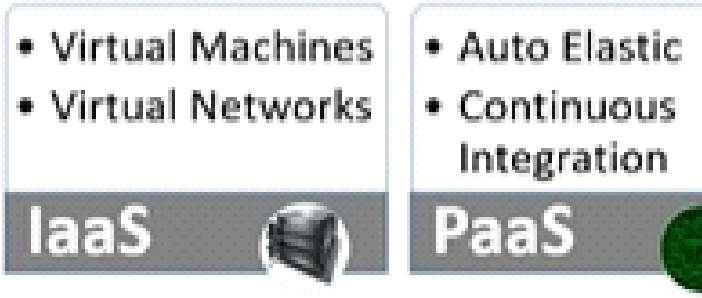
, and software resources and a

y-as-you-go service.

and network access to a shared
(e.g., networks, servers, storage,
idly provisioned and released with
vider interaction" – NIST

Service models

- IaaS: Infrastructure as a Service
  - Consumer can provision computing resourc
    upon which they can deploy and run arbitra
    applications
- PaaS: Platform as a Service
  - Consumer can create custom applications
    by the provider and deploy them onto the
- SaaS: Software as a Service
  - Consumer uses provider's applications runn
    infrastructure



ces within provider's infrastructure
ary software, including OS and

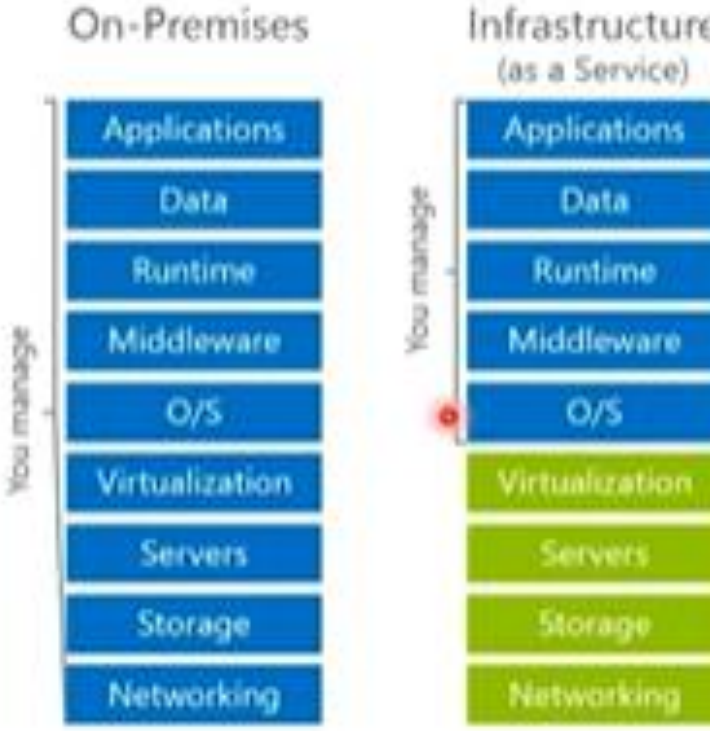
using programming tools supported
provider's cloud infrastructure

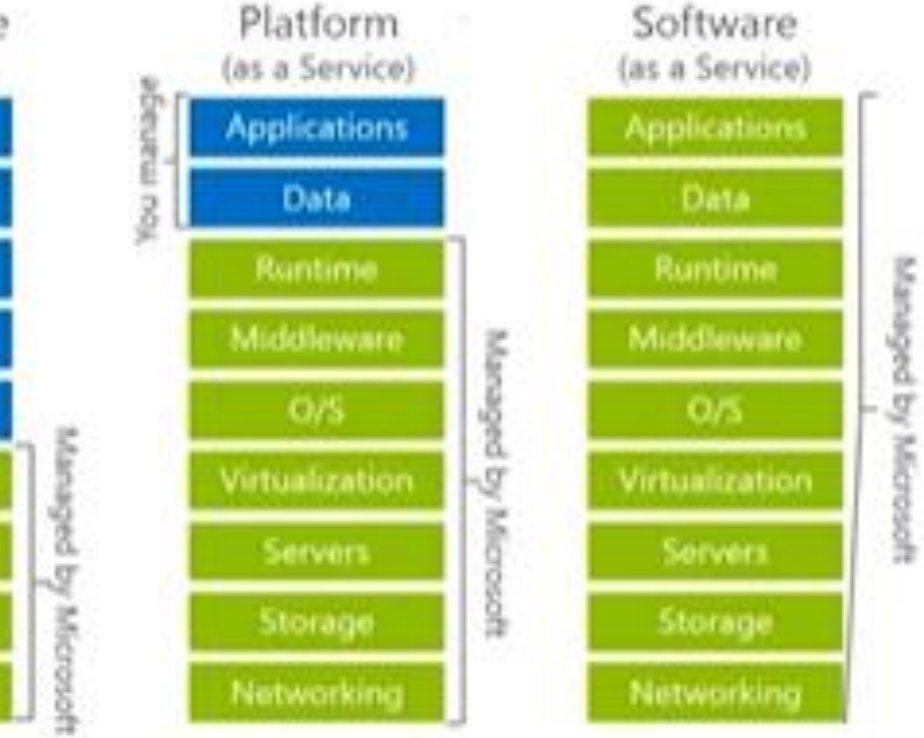
ning on provider's cloud

- Built for Cloud
- Uses PaaS

SaaS

Service models




Platform
(as a Service)
Applications
Data
Runtime
Middleware
O/S
Virtualization
Servers
Storage
Networking
You manage
Managed by Microsoft
Software
(as a Service)
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Data
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Middleware
O/S
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Servers
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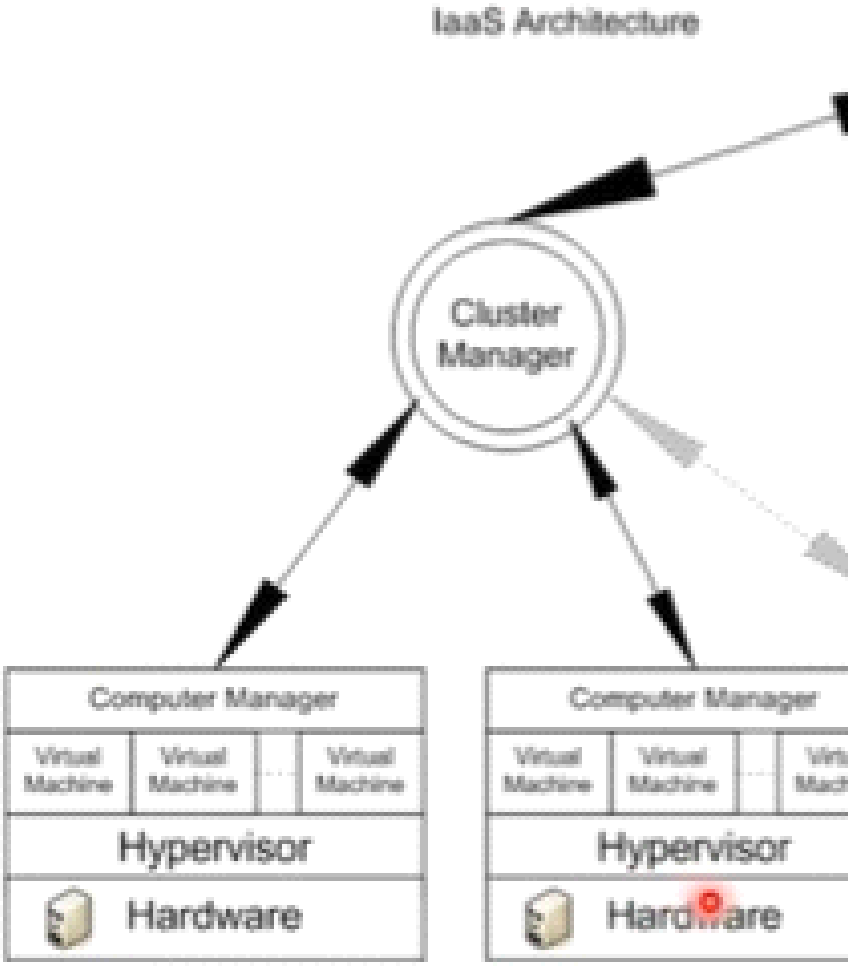
Managed by Microsoft

IAAS cloud acrhitectur



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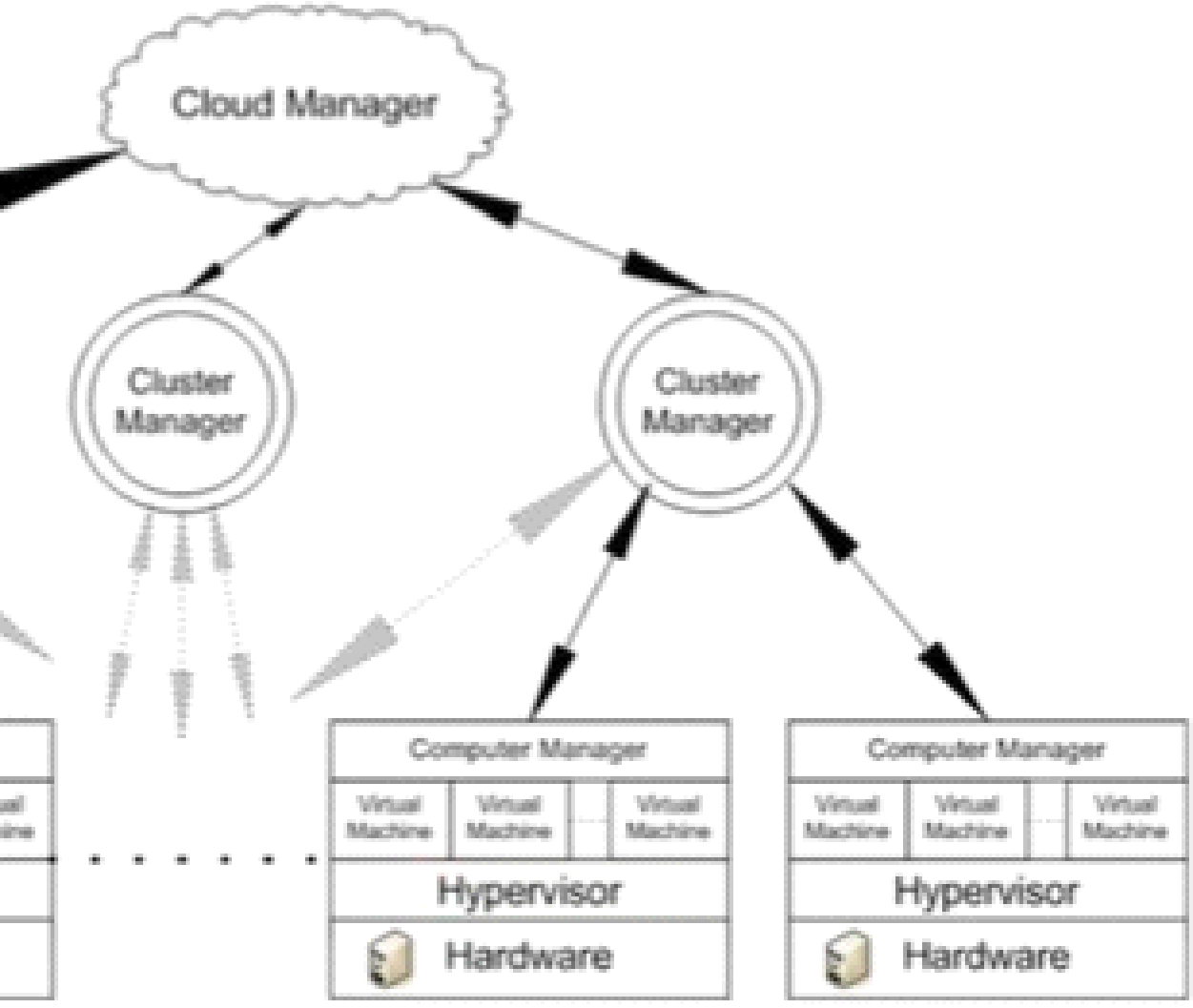
Cloud Manager
Cluster Manager
Cluster Manager
Computer Manager
Virtual Machine
Virtual Machine
Virtual Machine
Hypervisor
Hardware
Computer Manager
Virtual Machine
Virtual Machine
Virtual Machine
Hypervisor
Hardware