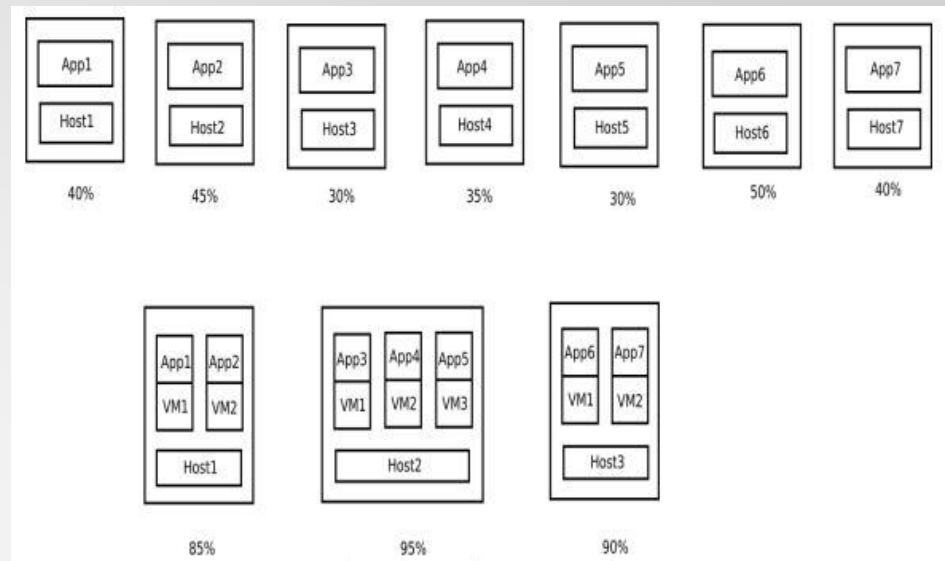
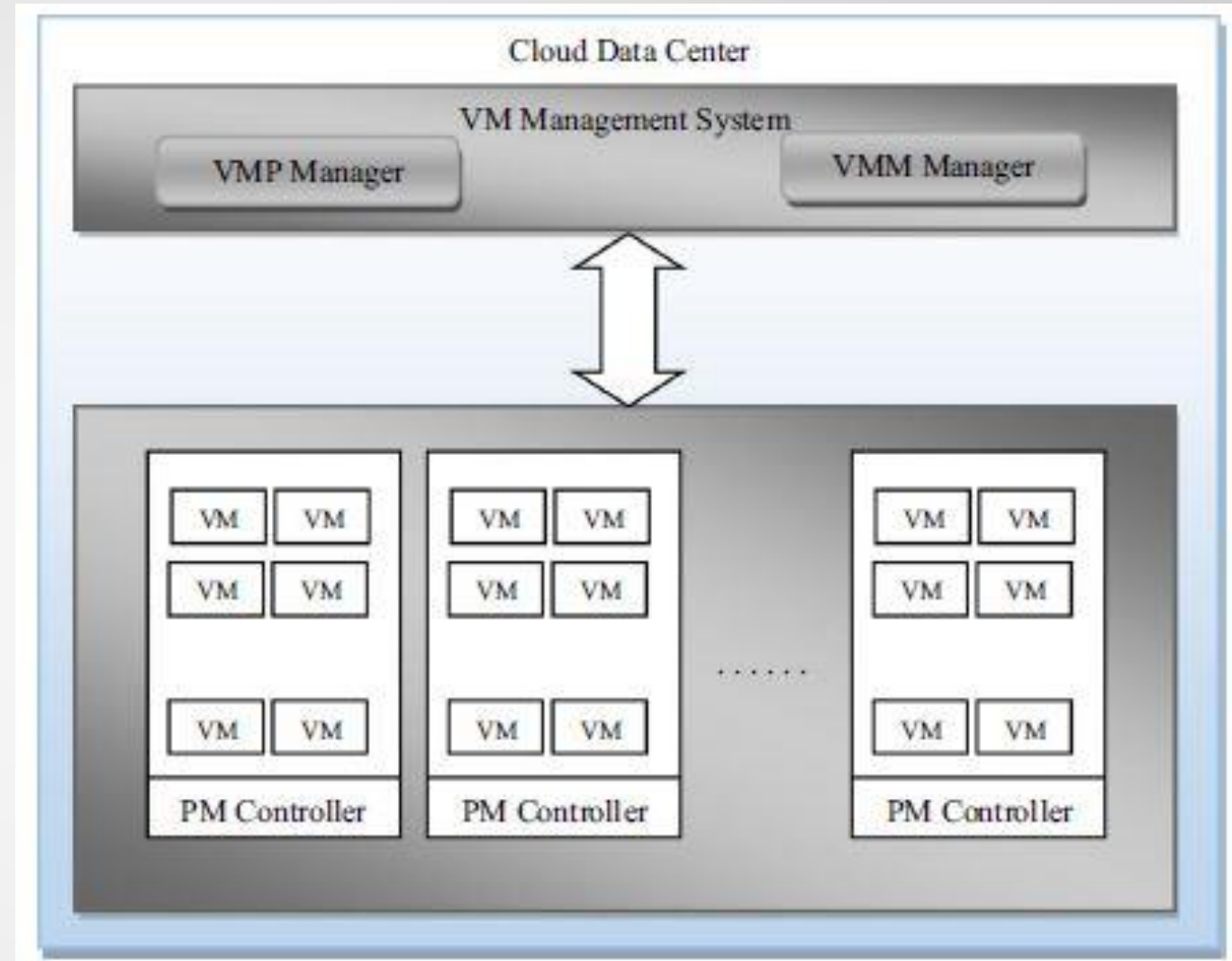
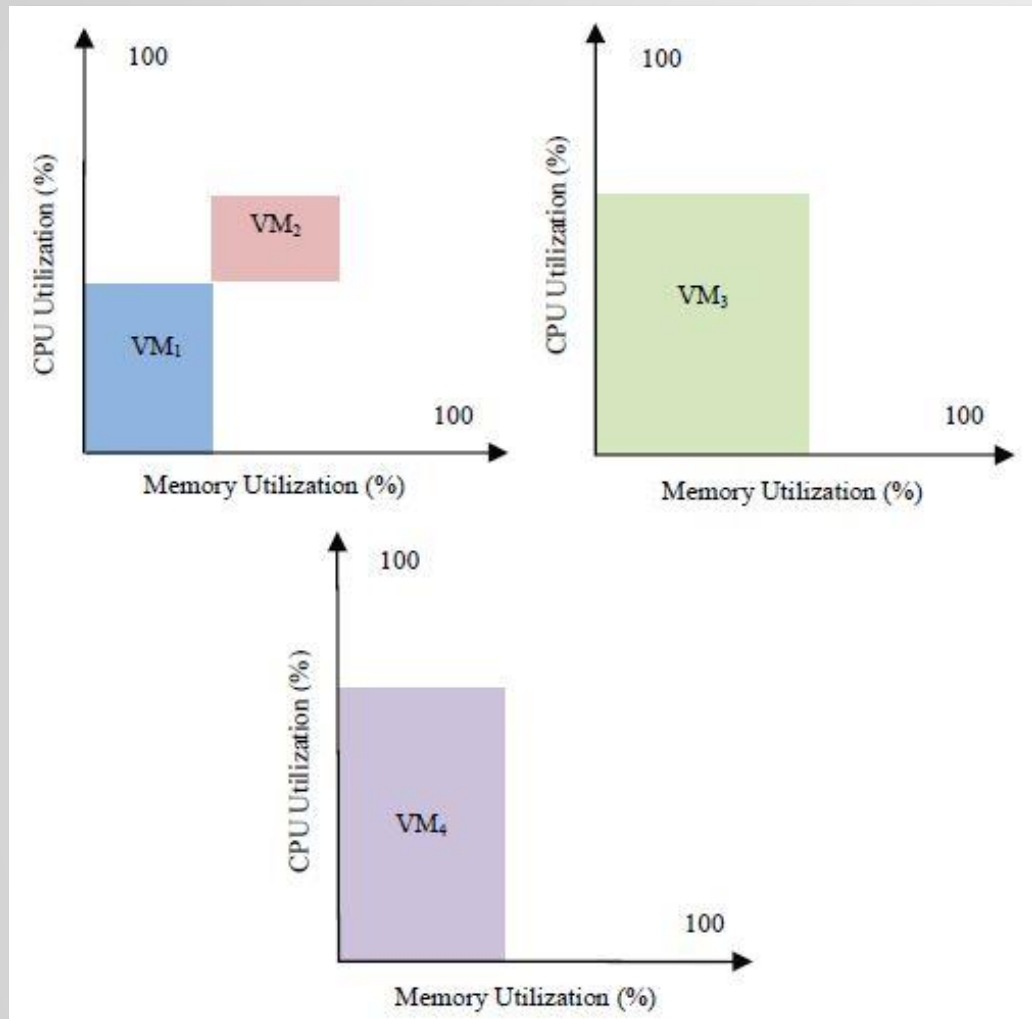


Placement and Migration of Virtual Machines

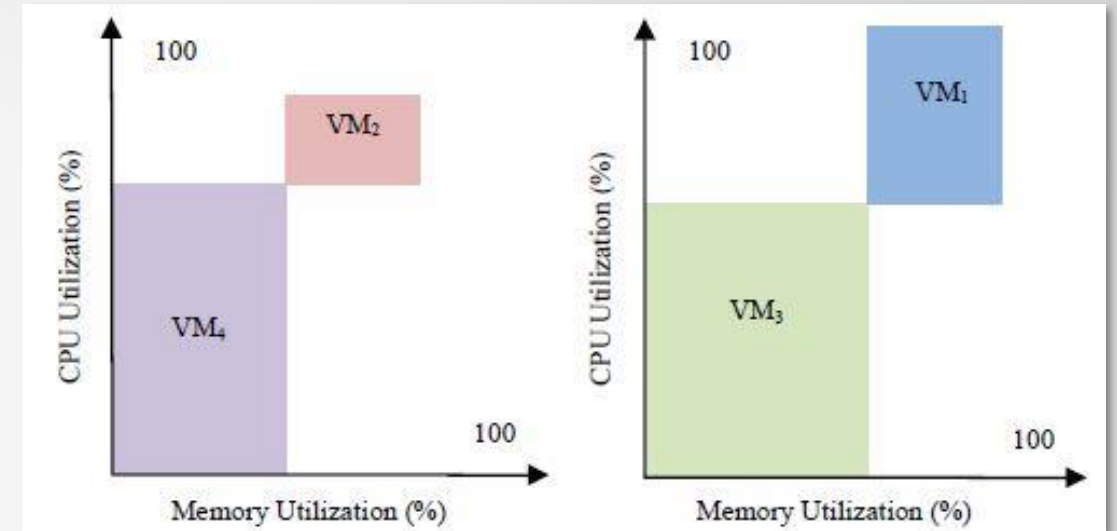


System model for VM Placement



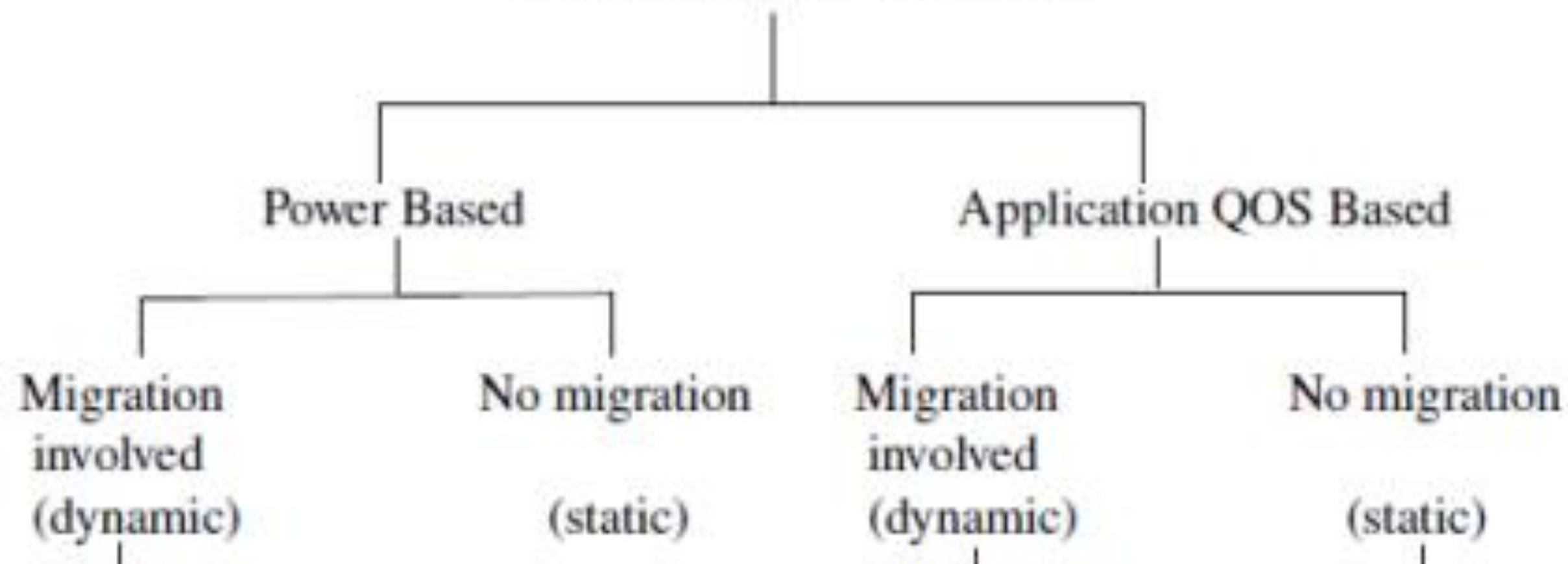


Before placement



After placement

Virtual Machine Placement



VM Placement VS VM Migration

- Placement is the choice of physical resources the VM will use such as host and datastore. It can be manual or automatic.
- Migration is about moving VMs to a different location, typically on a different datacenter.
- Placement would be an initial part of the migration process but placement need not involve migration. i.e. provisioning also includes placement.

Reason of VM Placement in Cloud

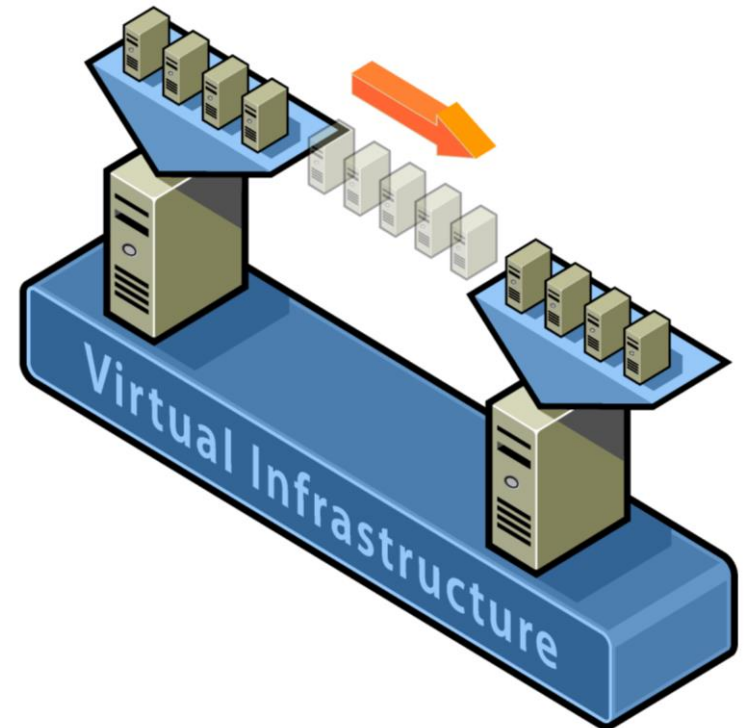
- Maximize the Resource Utilization
- Balancing the Load
- Protection from System Failures (Fault Tolerance)
- Hassle-free Transfer of Data
- Cost-Effective Strategy
- Energy Efficient way



Motivation

What's VM live migration?

- Move VM instances across distinct physical hosts with little or no downtime for running services.
 - Services are unaware of the migration.
 - Maintain network connections of the guest OS.
 - VM is treaded as a black box.



Types of vM Migration

- Basically VM migration are of two type:
- **Cold Migration:** which means as the word says "Cold" in the sense power off the vm and move the vm to another host which is manual work
- **Live Migration:** which means migrating a vm from one host to another while the vm is still running and powered on by using a vmware technology called Vmware vMotion.

Why
complete
understanding

Cold
Migration

VM
Migration

Suspended
Migration

Live
hot
Vmotion
Popular

Physical
to
virtual
P2V

Virtual
to
virtual
V2V

VMware \Rightarrow DC \neq VMware \Rightarrow How many offer. HA

Level of Agreement

8.76 hours \leftarrow 99% \rightarrow 87 hours

99.9% \leftarrow 99.99% \rightarrow 52 minutes

99.999% \rightarrow 5 minutes

Down Time / year

VSphere

↳ ESXi Hypervisor type-1

↳ Vcenter server ✓

↳ VSphere client ✓

↳ VSphere web client ✓

Cold Migration

- Movement of Virtual Machine to another host in powered-off state
- VM must be powered-off during Migration
- Cold Migration are flexible than vmotion
- Cold migrations Can be used to move a Virtual machine between data Centers, as long as both data Centers are on the Same vCenter Server instance
- Chances of failure is less in Cold Migration, in Comparison to hot migration

Suspended Migration

- Migrating a Virtual Machine that is in Suspended state
- Suspended state is like paused state in which you resume from Same point on later stage
- Suspended and vmotion migration are Considered hot because in both Cases the Virtual Machine is running
- The primary reason to suspend a Virtual Machine on an ESXi host is for troubleshooting

vMotion

- Migrating a Virtual Machine that is in 'Powered ON' state. This is very useful as this does not cause any downtime for the VM.
- In VMware vMotion machine is migrated from one ESXi Host to another in powered ON state, whereas in storage vMotion machine is migrated from one Datastore to another datastore in powered-ON state.
- vMotion moves a running virtual Machine to a different ESXi host in the same Cluster.
- It is also known as Live Migration.

P2V Migration → Converts a physical Computer to Virtual One

For eg → You have a Webserver Running on physical Hardware. You can run VMware vCenter Converter, target the Webserver, and have a Copy of the Physical Server Created on an ESXi Host.

V2V migrations are exactly like P2V migrations except that the source machine is already a Virtual Machine.

→ For eg → Migrating from Hyper-V and VMware Workstation to ESXi would be considered a V2V migration.

State of VM Migration

Cold migration

Moves a powered-off virtual machine to a new host. Optionally, you can relocate configuration and disk files to new storage locations. Cold migration can be used to migrate virtual machines from one datacenter to another.

Migration of a suspended virtual machine

Moves a suspended virtual machine to a new host. Optionally, you can relocate configuration and disk files to new storage location. You can migrate suspended virtual machines from one datacenter to another.

Migration with VMotion

Moves a powered-on virtual machine to a new host. Migration with VMotion allows you to move a virtual machine to a new host without interruption in the availability of the virtual machine. Migration with VMotion cannot be used to move virtual machines from one datacenter to another.

Migration with Storage VMotion

Moves the virtual disks or configuration file of a powered-on virtual machine to a new datastore. Migration with Storage VMotion allows you to move a virtual machine's storage without interruption in the availability of the virtual machine.

Pre-copy and post copy VM migration

- **Post-copy** sends each page exactly once over the network.
- In contrast, **pre-copy** can **transfer** the same page multiple times if the page is dirtied repeatedly at the source during **migration**.
- If the destination fails during **migration**, **pre-copy** can recover the **VM**, whereas **post-copy** cannot.

Preparation for VM Migration

- A common preparation process for a VM migration in cloud computing might include enabling remote desktop protocol (RDP) on the VM, which allows local systems to connect to the instance once the migration is complete.
- Many preparations are similar when readying a VM for an AWS compute instance, but AWS' recommendations are more granular. For example, AWS recommends that you enable RDP for Windows VMs or Secure Shell (SSH) for Linux VMs -- making sure to allow RDP and SSH access through the firewall.

- VM live migration can be an extremely powerful tool for cluster administrators.
 - Hardware / Software maintenance / upgrades
 - Load balancing / resource management
 - Distributed power management



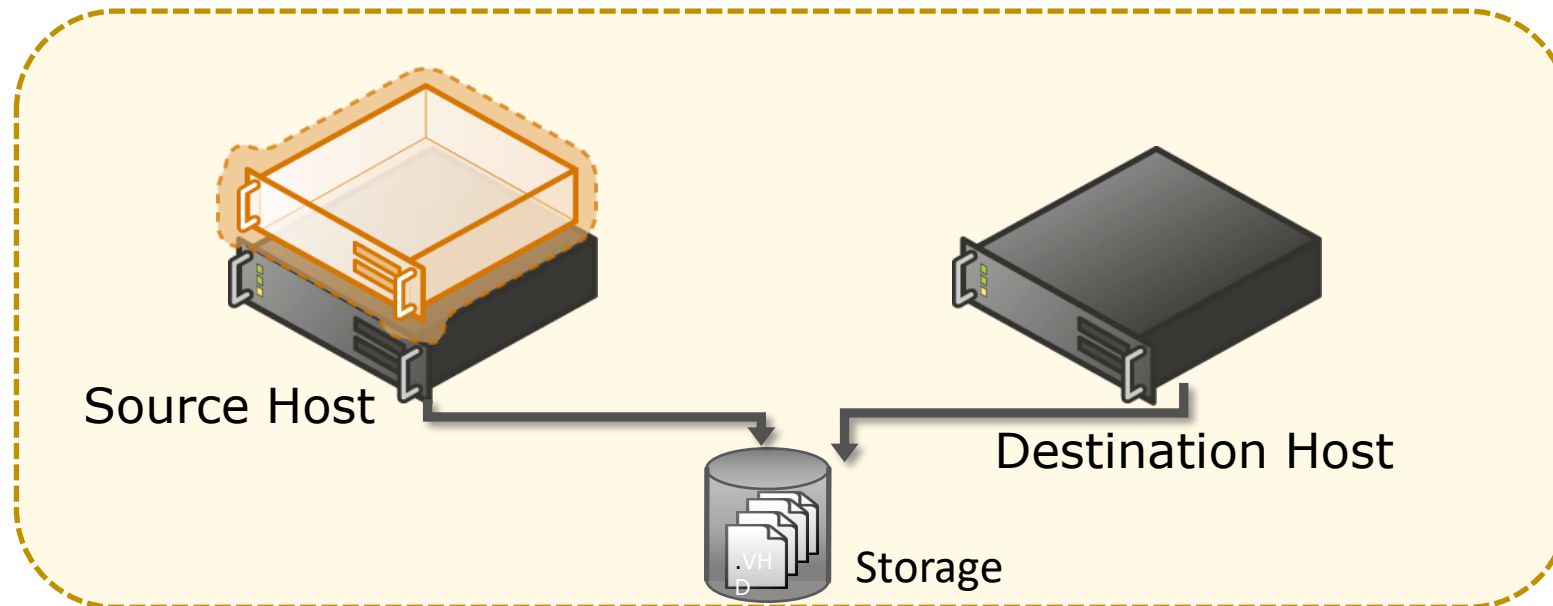
Motivation

Why OS-level migration, instead of process-level?

- Avoid 'residual dependencies'
 - Original host can be power-off / sleep once migration completed.
- Can transfer in-memory state in a consistent and efficient fashion
 - E.g. No reconnection for media streaming application
- Allow a separation of concerns between the users and operator of a cluster
 - Users can fully control of the software and services within their VM.
 - Operators don't care about what's occurring within the VM.

Design-challenges

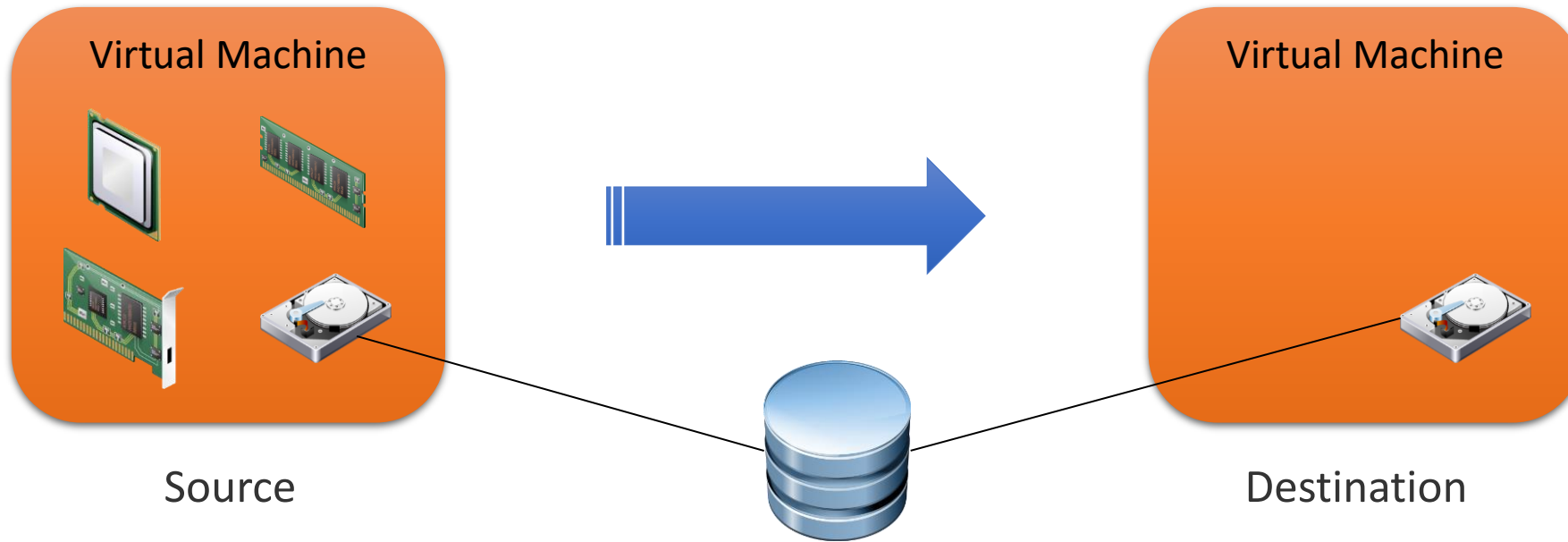
- Minimize service downtime
- Minimize migration duration
- Avoid disrupting running service



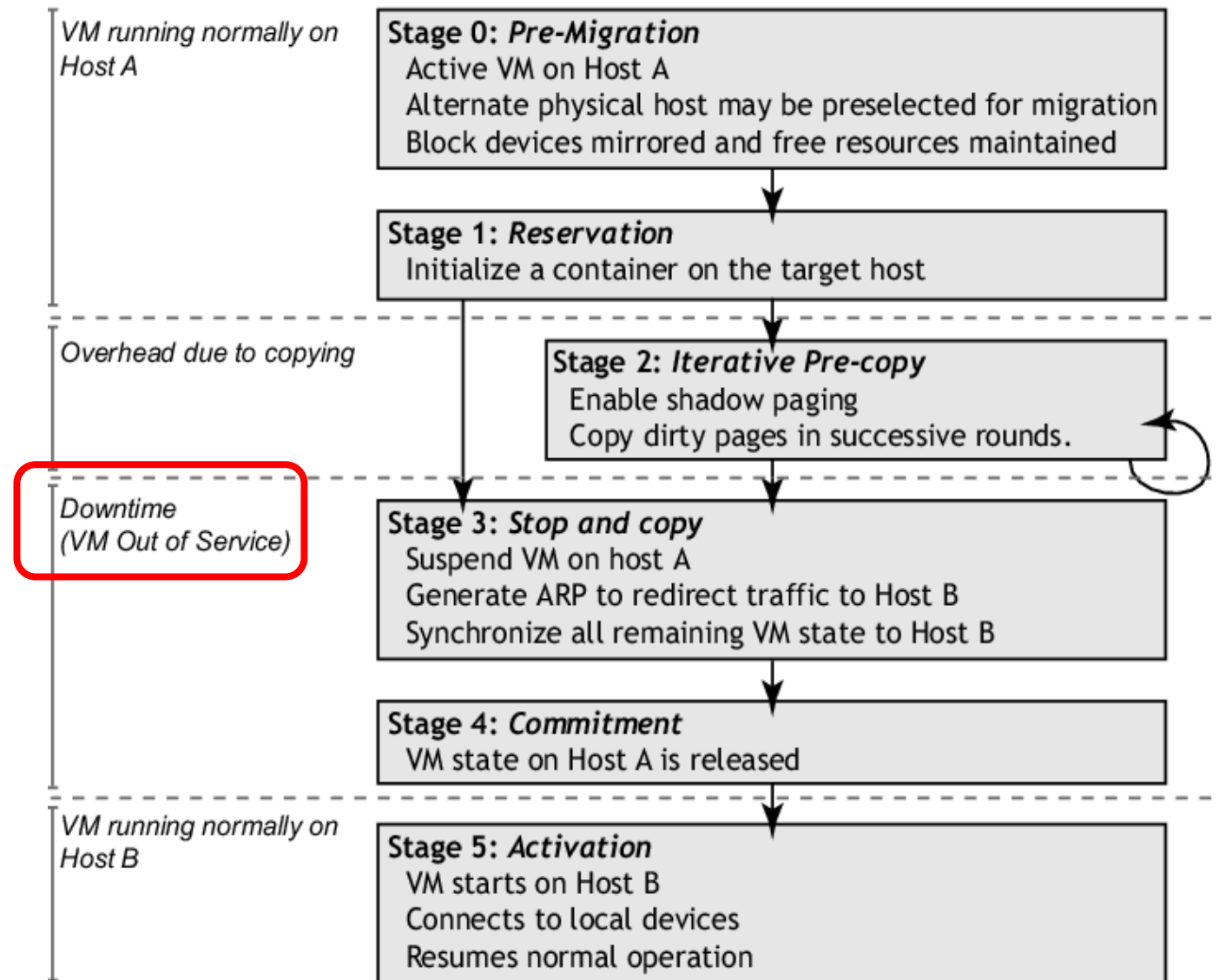
Design-local resources

- **Open network connections**
 - Migrating VM can keep IP and MAC address.
 - Broadcasts ARP new routing information
 - Some routers might ignore to prevent spoofing
 - A guest OS aware of migration can avoid this problem
- **Local storage**
 - Network Attached Storage

Design-local resources



Design-overview

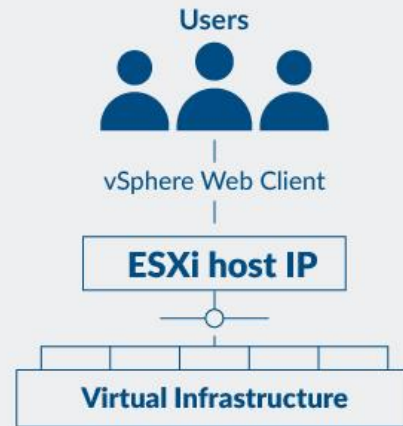




vSphere Client

VMware vSphere

Arguably the best-known product by VMware is vSphere. vSphere includes many products, most notably the ESXi hypervisor and the vCenter suite of applications.

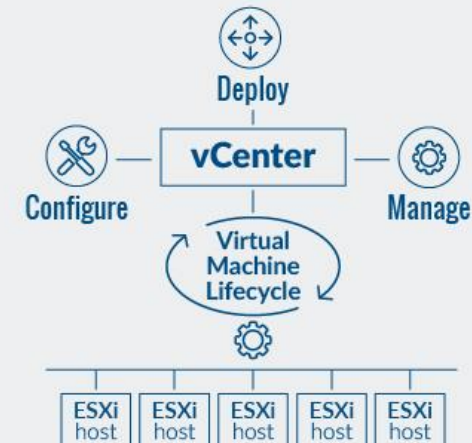


ESXi is an operating system installed on a compatible enterprise-class server.

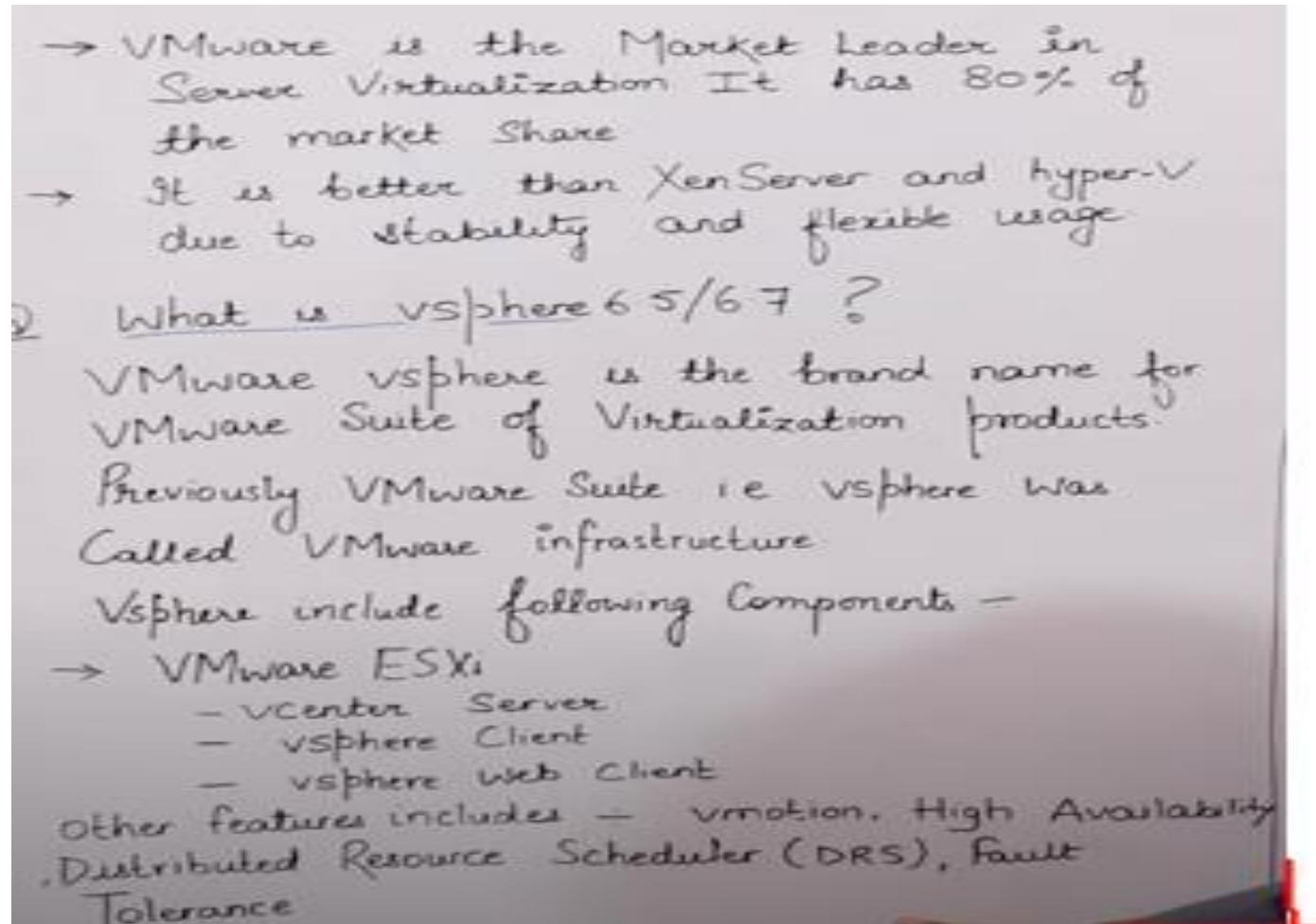
Users can connect directly to an ESXi host IP using the vSphere Web Client and start deploying virtual infrastructure.

The **vCenter** Server (VC) is a licensed product that allows you to configure, deploy, and manage the entire virtual machine lifecycle from a centralized location.

It is used to manage multiple ESXi hosts. vCenter itself is a virtual machine, deployed during the installation of vSphere. It is available as an appliance (vCSA) or as an installer for a Windows Server instance.



Introduction to VMware and vSphere



→ VMware is the Market Leader in Server Virtualization It has 80% of the market share

→ It is better than XenServer and hyper-V due to stability and flexible usage

2. What is vSphere 6.5/6.7?

VMware vSphere is the brand name for VMware Suite of Virtualization products.

Previously VMware Suite i.e vSphere was called VMware infrastructure

Vsphere include following Components -

- VMware ESXi
 - vcenter Server
 - vSphere Client
 - vSphere web Client

Other features includes - vMotion, High Availability, Distributed Resource Scheduler (DRS), Fault Tolerance

Difference between vcenter Server and Vsphere Client.

Vsphere client is an interface (GUI) used to connect remotely to an ESX/ESXi host from Windows PC.

This Client can be used to access and manage Virtual Machines on the ESXi Host and also perform other Management and Configuration Tasks.

→ If we want to have all the ESXi hosts in a single console then we need vcenter Server.

- VCenter Server is Similar to vsphere Client but it Comes with rich features and more powers. It is the Centralised management tool
- Multiple ESXi host & VM Can be Managed from Single Console, whereas using vsphere Client we were accessing only a Single host.
- For using Features like DRS, HA, vMotion and Fault Tolerance we need vcenter Server
- VCenter 6.7 includes a flash and a HTML5 Based Interface

→ VMware Availability & Machine Migration

- Availability or High availability in vmware deals with ESXi host failure and what happens to the VMs running on those host. Availability is to make sure that downtime is very less in the event of failure and Machines are always up.

Level of Agreement	Downtime per year
99%	87 hours
99.9%	876 Hours
99.99%	52 minutes
99.999%	5 minutes

Above is the agreement done with Client in terms of / availability.

High Availability

For H.A, Also we need following things -

- ① Cluster
- ② Shared Storage
- ③ Vcenter Server Configured for the Environment



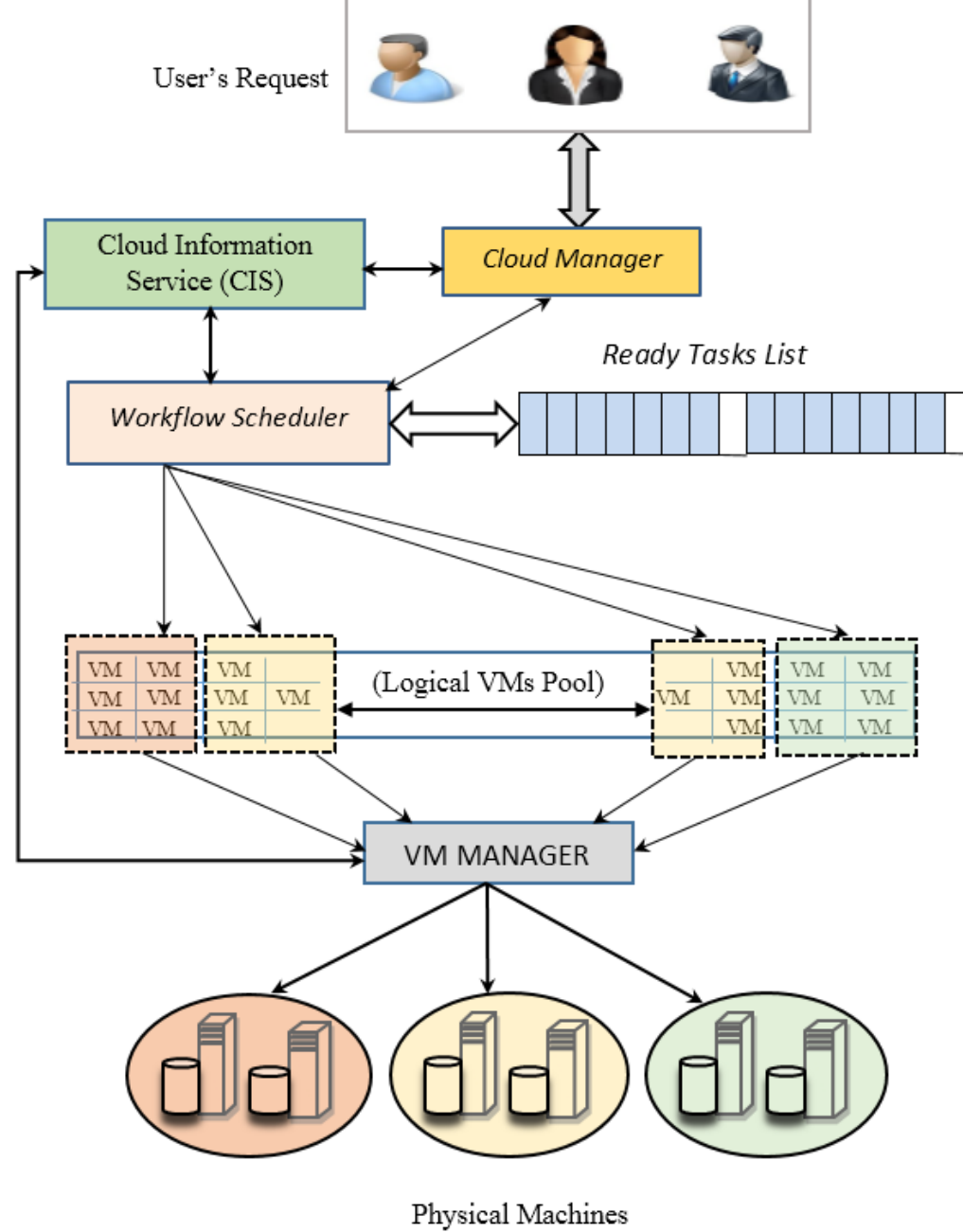
Before HA was available, the failure of a Single ESXi Host meant that a large no. of Virtual Machines that were running on it would be down. This was referred to as the "all of your eggs in one basket" issue and caused some companies not to deploy Virtual Servers.

→ Resource Check → Ensure that Capacity is always available in Order to Restart all Virtual Machines affected by Server failure. HA Continuously monitors Capacity Utilization and Reserves Spare Capacity to be able to Restart Virtual Machine.

→ In (H.A) When the host Crashes or fails, the VM gets Restarted on another Host. So there is a Very Small Downtime which is only related to the time taken for VM to Restart.

- No passive standby ESX host is required
neither any extra VM. The VM for which
its parent host is crashing it can restart
on any of the other running host.

→ HA does not use vMotion
→ Enable HA on the Cluster Setting,
in order to use H.A.



Pre-requisite for VMware Vsphere HA

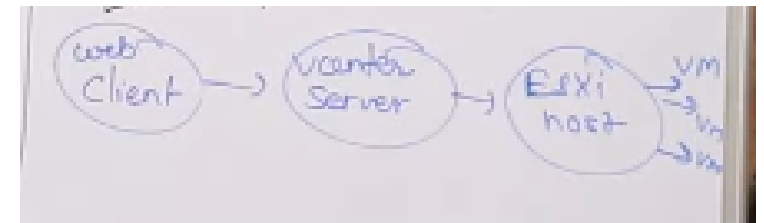
- All host must be licensed for VMware HA
- You need at least two host in the Cluster
- All host need a unique host name
- All host need to be Configured with Static IP address. If you are using DHCP, you must ensure that the address for each host persist across reboots
- Virtual Machine must be located on Shared, not local storage, otherwise they cannot be failed Over in case of a host failure

- All host in a VMware HA Cluster must have DNS Configured
- HA Works on the master and Slave Architecture. When you enable HA on the Cluster then election process occurs between all the host in the Cluster & one host which has large number of datastore mounted has an chance to become a master server. Once the election process complete, there will be one master server and other ESXi are considered as the slave server. If the master server goes down or crashes then the new election process will occur.

HA failover Time

We measured the time from the point Vcenter Server VM Stopped responding to the point vsphere web Client started responding to user activity again. With the 64 host/6000 VM inventory, the total time is around 460 Seconds (approx 7 min) with about 30-40 Sec for HA to get into action.

HA Works on the ESXi host level, where if any of the ESXi host gets failed, HA will restart those VM onto another ESXi Host.



Fault Tolerance

- AIM of Fault Tolerance is Similar to HA, but in terms of availability it provides 0% downtime and full availability as Machine does not go down or restarts
- This is meant for mission critical applications/servers. Eg → Robotic Surgery, ARM, Auto-pilot System, Spacecraft mission

- VMware lockstep technology is used in F.T.

- With FT a secondary VM is Created on another host using distributed resource Scheduler. This VM is exact replica of the primary VM.

- A Fault-Tolerant Virtual Machine and its Secondary Copy are not allowed to run on the Same Host. This Restriction ensures that a host failure Cannot result in the loss of both VM.

Primary and Secondary work in lockstep i.e the lockstep technology Captures the Current state and events of primary VM and sends them to Secondary VM. If primary goes down, instantly Secondary VM takes over and Continue Operation

→ It Requires extra standby VM, therefore it is a Costlier Solution



- Fault Tolerance avoid 'Split Brain' Situation Which Can leads to two active Copies of a VM after Recovery from a failure
- F.T works on V.M Level Therefore you Can enable or disable FT on VM
- The primary and Secondary VM Continuously exchange Heartbeat This exchange allows the VM pair to monitor the status of one another to ensure that FT is Continually maintained

Virtual Machine Template

You Can Convert a fully Configured Virtual machine into a Virtual Machine Template

- This Can be used to rapidly deploy large numbers of new VM that are Configured like the Original VM

Distributed Resource Scheduler

- DRS is a feature of Cluster which is managed by vcenter Server. It Balances load of VM across ESXi Host.
- A DRS enabled Cluster has following resource management Capabilities -
 - 1) Initial VM Placement
 - 2) Load Balancing
 - 3) Power Management
- Depending on how end-users are using applications on virtual machines, VMs constantly expands & Contracts throughout the day, week or Month. The physical hosts becomes over utilized or under utilized based on VM utilization and no of VM running over it.

→ Vmotion is a primary Req of DRS

Main goal of DRS is to:-

- Keep all ESXi Servers in the Cluster healthy and Well Utilized by dynamically / automatically moving VMs across the ESXi Host
- Provide VMs with enough Resources all the time to keep them Running in Most efficient Ways.
- Conduct Zero-downtime server Maintenance
- By default, DRS checks in every 5 minutes to see if the Cluster Workload is Balanced or Not.



DRS Types

There are Three Selections Regarding the automation level of the DRS Cluster:-

- 1) Manual - When a DRS Cluster is set to Manual, every time you power on a VM, the Cluster Prompts you to Select the ESXi Host where that VM Should be hosted

2) Partially Automated - If you Select the Partially Automated Settings in the DRS Automation Settings, DRS will make an automatic decision about which host a VM should run on when it is initially Powered ON (without prompting the User who is performing the power-on task) but will still prompt for all migrations on the DRS tab

Thus, initial VM placement is automated, but migrations are still manual

Fully Automated - The third Setting for DRS is fully automated. This setting makes decision for initial placement without prompting and also makes automatic vmotion decisions based on the Selected automation level.