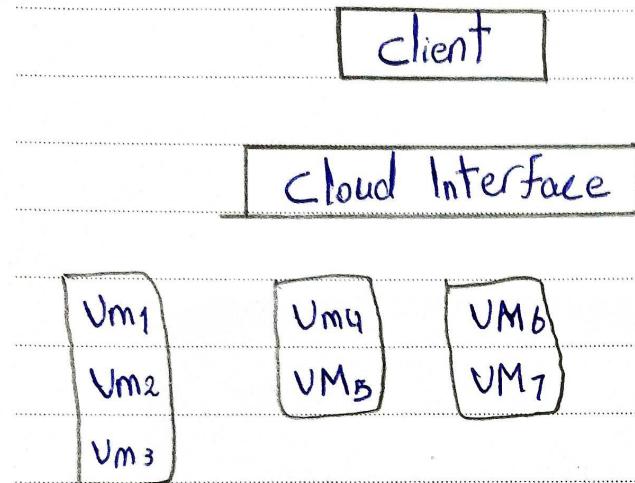


{ chapter 4 = Migration }

Migration Services:



⇒ Help to:

1 Utilize resources

Scull migration هي عملية انتقال VM من physical server 1 إلى physical server 2، حيث يتم إلزام physical server 1 بـ VMs 1, 2, 3، بينما physical server 2 يحصل على VMs 4, 5, 6.

2 Load Balance

online real migration (أجنبانياً) فعل migration على physical server (idle balance) على physical server (busy) (heavy load) على physical server (lazy) (light load).

Scull migration هي عملية انتقال VM من physical server 1 إلى physical server 2، حيث يتم إلزام physical server 1 بـ VMs 1, 2, 3، بينما physical server 2 يحصل على VMs 4, 5, 6.

3 Save Power (Green ICT)

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Virtual Machine Migration Services

⇒ Migration Service in the context of Virtual machines, is the process of real moving a Virtual machine from:

- 1 one host server to another (at the same data center)
- 2 Storage location to another
- 3 one data center to another

Migration Services

⇒ All keys of Virtual Machine's components such as CPU, storage disks networking and memory completely Virtualized.

this facilitates the entire state of the virtual machine to be captured and moved by a set of easily moved data files

Various Techniques:

live → حيا
hot → حار

- live (hot or real time) migration : VM is Powered on

- Warm migration : VM is Suspend

live pausing

- Regular (cold) migration : VM is Powered off

- live Storage migration (laas)

VMs Migration, Why?

- [1] Load Balancing move VMs to a less busy host, make use of a newly-added capacity
- [2] Maintenance move VMs off a host before it is shut down
- [3] Recovery from host failure Restart VM on a different host

Example:

PM capacity	1 physical machine os is		
	Network Bandwidth 10Gbps	Memory 16GB	CPU 8 cores
Resource Allocation	VM1 $N = 5 \text{ Gbps}$	VM2 $N = 5 \text{ Gbps}$	Leisure extra available migration possible
	$M = 8 \text{ GB}$	$M = 8 \text{ GB}$	migration possible
	$C = 4 \text{ cores}$	$C = 4 \text{ cores}$	

⇒ An increase in Workload can be handled by allocating more resources to VM

Main Issues If PM does not have (enough or no) idle resources to satisfy VM's requirement that will lead to:

- 1. Performance of the app degrades
- 2. SLA Violation occurs

Key Ideas

1. Replication VM
2. Migration VM

ISSUES in long distance migration (across data centers)

- ⇒ VM migration can be used to **reduce** Power consumption in cloud data centers
- ⇒ **Support Green ICT**

أولاً VM lots PM uses of
power 2nd more resources one PM
PM idle time و sleep الـ 2nd
reduce power consumption

* VM consolidation is a process that utilizes live migration of (VMs) to transfer a VM among Physical Servers in order to improve the utilization of resources and energy efficiency in cloud data centers

When we need to migrate?

* Hotspots can cause SLA Violations

⇒ Burden some VMs or PMs are called Hotspots

Hotspot → any resource exceeds a threshold or SLA violations for a sustain period

resources || Provisioning rules which lots less than PM lots causing over threshold is hotspot or not consider a re

* Hotspot Detection (SandPiPer)

1. Black_box monitoring:

- CPU / Processes
- Network (Processes / network / devices)
- Memory (Swap)

Framework (SandPiPer) lies detect hotspots quickly by monitoring

② Gray box Monitoring

- gather OS level statistics and application logs



1 Nucleus → gathering resource usage statistics on that server

2 Monitoring engine → gathers Processor, network and memory swap statistics for each VM

3 VM1 → implements a daemon to gather OS-level statistics and application logs

History of data for each server integrated with all the 3 components || OS

④ Profiling engine → construct resource usage profiles for each virtual server (Predict PM Workload)

↳ Using analysis flow

↳ Identifying hotspots (hot)

⑤ Hotspot detector → monitors usage profiles to detect hotspots

⑥ Migration manager → Determine:

1. What Virtual Servers should migrate
2. Where to move them
3. How much of a resource to allocate the Virtual Servers after migration

When We need to migrate why?

① SLA Violation detection

↳ SLA Violation detection

- a. Mapping low-level resource metrics to high-level SLAs
- b. crude data maps to user requirements such as
 - CPU Speed maps to response time
 - Occupied memory size maps to number of concurrent clients

c. Predictive strategy for detection of Possible SLA Violations

② Detection interval

↳ Short intervals

a. Short measurement intervals may degrade Performance

b. Long measurement intervals may cause ignorance of heavy SLA Violations

How migration is done?

→ Transferring a VM refers to the transfer of its state include: (its memory, internal state of the virtual CPU, network and storage disk) among these, the most Time-consuming one is the memory Transfer

⇒ Memory Migration

1 Pre-copy approach

- a. Warm-up
- b. Stop-and-copy

Algorithm (two approach) goes with directions
algorithm 1 is copy direction is approach 2
algorithm 1 is copy direction is approach 2

2 Post-copy approach

memory | copy | dev | Pre copy ||
Post copy || (VM || dev) | lock
copy | dev | Post | lock | VM || dev

⇒ File System migration

- In case of distributed File System, there is no need to copy
- Alternatively, copy only changed local files to the destination using VM Manager's API

⇒ Network migration

- If both source and destination are on same LAN switch

↳ an Address Resolution Protocol (ARP)

Reply from the migrating host is provided

Configuring interface
(ARP) || LAN ||
Networking || Dev
global Task ||

- if both source and destination are on a switched network
→ the migrating OS can keep its original Ethernet Mac address,
relying on the network switch to detect its move to a new port

Migration across data centers:

- Need for VM mobility across data centers. Why?

- a. Data center maintenance Without downtime
- b. Disaster avoidance
- c. Data center migration/expansion
- d. Workload balancing across multiple sites

↗ Time during which the VM on source host is suspended (not available)

- Issues should be considered for VM mobility across data centers:

1 Trust to remote execution environment

ابراج اقلي لازم اقلي data center
authorized area

2 Interoperability at the level of Web services, Java etc.

لازم اقلي اقلي اقلي، وينقل هناك
من يخلي VM على كل المقيضات
لجلب كل resources

3 Migration across multiple domains are vulnerable to security exploits

Migration Process Goals

1 Migration Time

- Minimize total end-to-end migration time
- Predictability of migration time
- Keep the total migration time manageable
 - a) do not crash during migration

2 Guest Penalty

Minimize Performance loss

Minimize downtime (maximize availability)

3 Atomicity

Avoid dependence on multiple Volumes (For replication Fault domain)

⇒ Guarantee that We Want migrations to

- 1 complete successfully
- 2 Limit the impact of migration on both the Guest and the local network

Migration and Storage:

The VM disk image has to be accessible from the new host after the migration

لارم اقرا وصول لى image على الثاني host

يتيح المدفه هنا ازايه اعرفه اعمل image access

Sol: Copy the disk image across?

Very slow, fine for cold migration

الخطوه بطيءه جداً ولكنها ممكنه

وتحصل مع ال cold migration

حيث انها Warm أو hot migration

تحصل بسرعة ولكنها user level

another Sol: Can we do live migration of storage?

yes (KVM), but risky and doesn't help recover from node failure

(KVM) → Kernel-Based Virtual Machine, it is virtualization module in the linux kernel that allows the kernel to function as a hypervisor

disk image | copy | live migration

live migration

Traditional Solution:

use shared storage

فيها VMs التي تأخذ data images

او كل جهاز يأخذ image

Advantages of Shared Storage

1 Complete mobility of VMs with live migration

لـlive migration لـ VMs

2 easy to shared storage access

3 VM destination and source

VM لـ storage

4 can scale the compute nodes and the storage nodes independently

component اـ local storage

component اـ own storage

4 اـ local storage for compute

5 اـ local storage for storage

6 اـ local storage for VMs

7 اـ shared storage for VMs

3 simpler compute nodes (little or no local storage required)

4 central point of volume management

5 central point of backup / Data Recovery

Disadvantages of Shared Storage

1 storage becomes single point failure once to one storage goes down

Traffic جـ معـ خـ لـ الـ

2 Network traffic increases

3 bandwidth can be bottleneck

VM لـ storage لـ access

④ Network latency can impact Performance

⑤ Network security

⑥ Risk of accidentally starting 2 VMs using the same disk image

* VM Burst migration Benefits: load balancing, Disaster recovery
Hardware maintenance and Fault take over

VM Migration Techniques

① Cold (Regular) Migration (offline migration)

- In this, VM is completely power off before its migration to remote end
- Shutdown VM on Host 1, restart on Host 2
- You have options to move associated disks from one data store to another
- The Virtual machines are not required to be on a shared storage

Steps of cold migration Process:

- 1] Shut down VM
- 2] The configuration files (NVRAM, log files) as well as the disks of the VM, are moved from the source host to the destination host's associated storage area. (IS configuration) (IS g.)
VM status
Host host values
- 3] the VM is registered with the new host
- 4] After it is completed, the old version of the VM is deleted from the source host.

[2] Warm (Suspended/Paused) Migration

Transfer the VM from one physical server to another without shutting down it.

Steps of Warm migration Process:

- 1] State of VM saved in hard disk or RAM for short time
- 2] Suspend VM on Host 1, copy across RAM and CPU registers. (RAM) (جهاز جديد)
CPU (جهاز قديم)
Shared hard disk
- 3] Continue on Host 2

3) Hot (Live/Real Time) Migration

- Transfer VM from physical host to another while being Powered on
- Requires Shared memory between VMs لتحقيق ذلك
- The goal is to find quick and efficient way to transfer services between physical servers
- 2 Parameters are considered while performing

1. Down Time : Time during which the service of the VM is not available أيام لا يحصل على الخدمة

zero مقداره صفر

2. Migration Time : Total time required to transfer a VM from source to destination node without affecting its availability

* Used For : load balancing and optimization of VM deployment in data centers

- In this process, the state of a VM to migrate is transferred (its memory contents and local file system)

memory الذاكرة, disks disks
لها تأثير على الوقت والأداء

- classified into 2 steps:

- 1 Control is switched to the destination control يتجه إلى الوجهة
- 2 Data Transferring (memory / disk) to the destination البيانات تُنقل إلى الوجهة

Live memory migration (only Shared Storage)/Live block migration

→ It is used to **minimize** the downtime of VM **cross nodes**
migration between servers **between shared storage**

Steps of hot migration

- 1 VM is Powered on
- 2 Copy state of VM across RAM While VM continues to run on Host 1 **lossless CPU allocation** **lossless Task migration**
- 3 Mark "dirty" (changed) RAM Pages and re-copy **in case of failure lossless** **changes dirty andبقاء VM ما هو الآخر بعد ما**
- 4 Brief suspension VM For final copy (<1 sec)