



Virtualization & Cloud Computing

Corso di: Big Data Architectures

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Structure

- | Elements of cloud Computing
 - ♣ Motivation and definitions
- | Virtualization
- | Cloud Computing
- | High Availability
- | vSphere Infrastructure
- | Security on the Cloud
- | Conversions among VM and physical machines
- | vCenter, datacenters and cluster management
- | Comparison among virtual computing solutions
- | How to work with Virtual Machines
- | IaaS solutions
- | PaaS Solutions
- | SaaS Solutions
- | ICARO project
- | Container

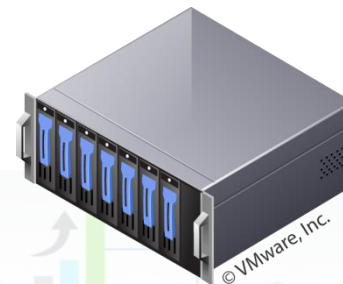




Datacenter, definition

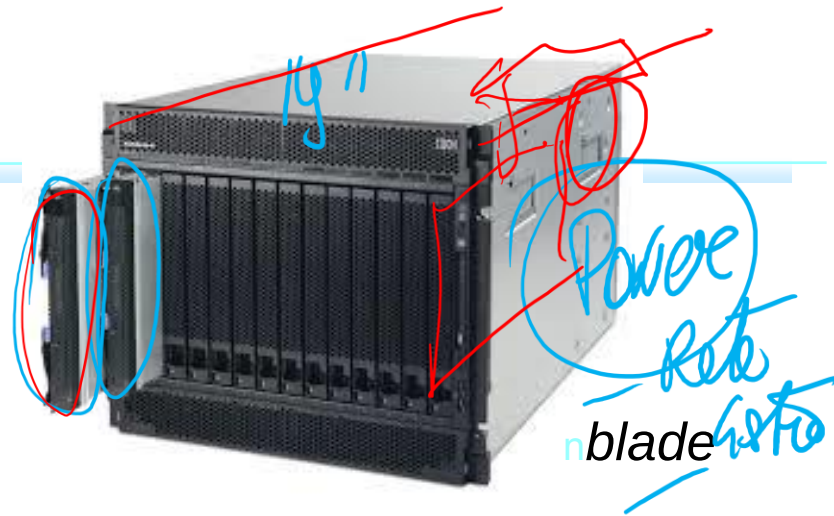
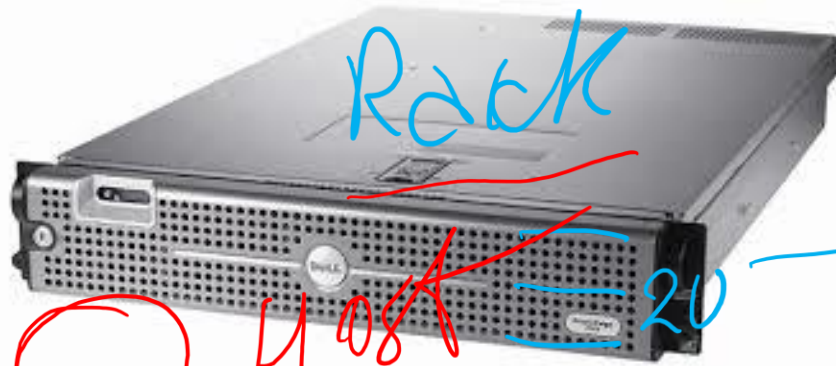
I Datacenter

- ❖ A computer factory/farm in which servers/computers are called HOSTS and are hosted and organized:
 - ➔ power, net maintenance, etc.
 - ➔ As: industrial computers, blades
- ❖ They can be exploited for private purposes, grid, cloud computing, renting/hosting, etc.





Server

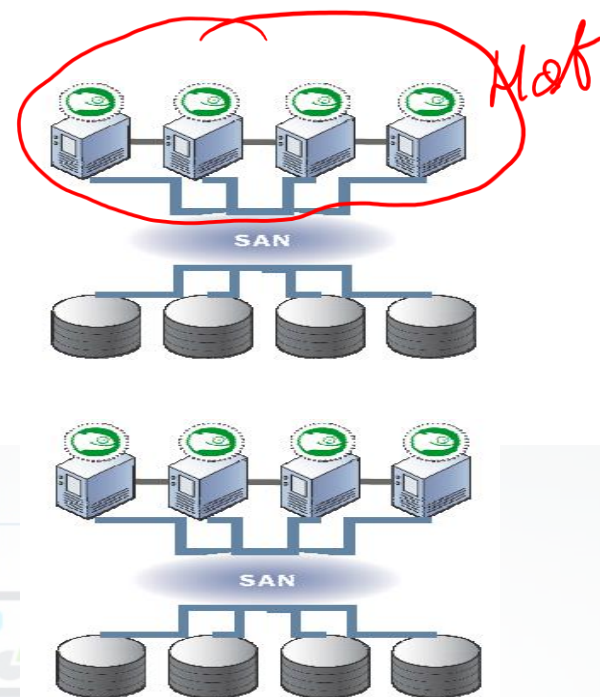




Infrastructure, definition

- | A set of datacenter and clusters
 - ♣ Cluster: group of servers plus storage (if any)
- | A storage as a set of
 - ♣ NAS: Network Area Storage
 - ♣ SAN: Storage Area Network

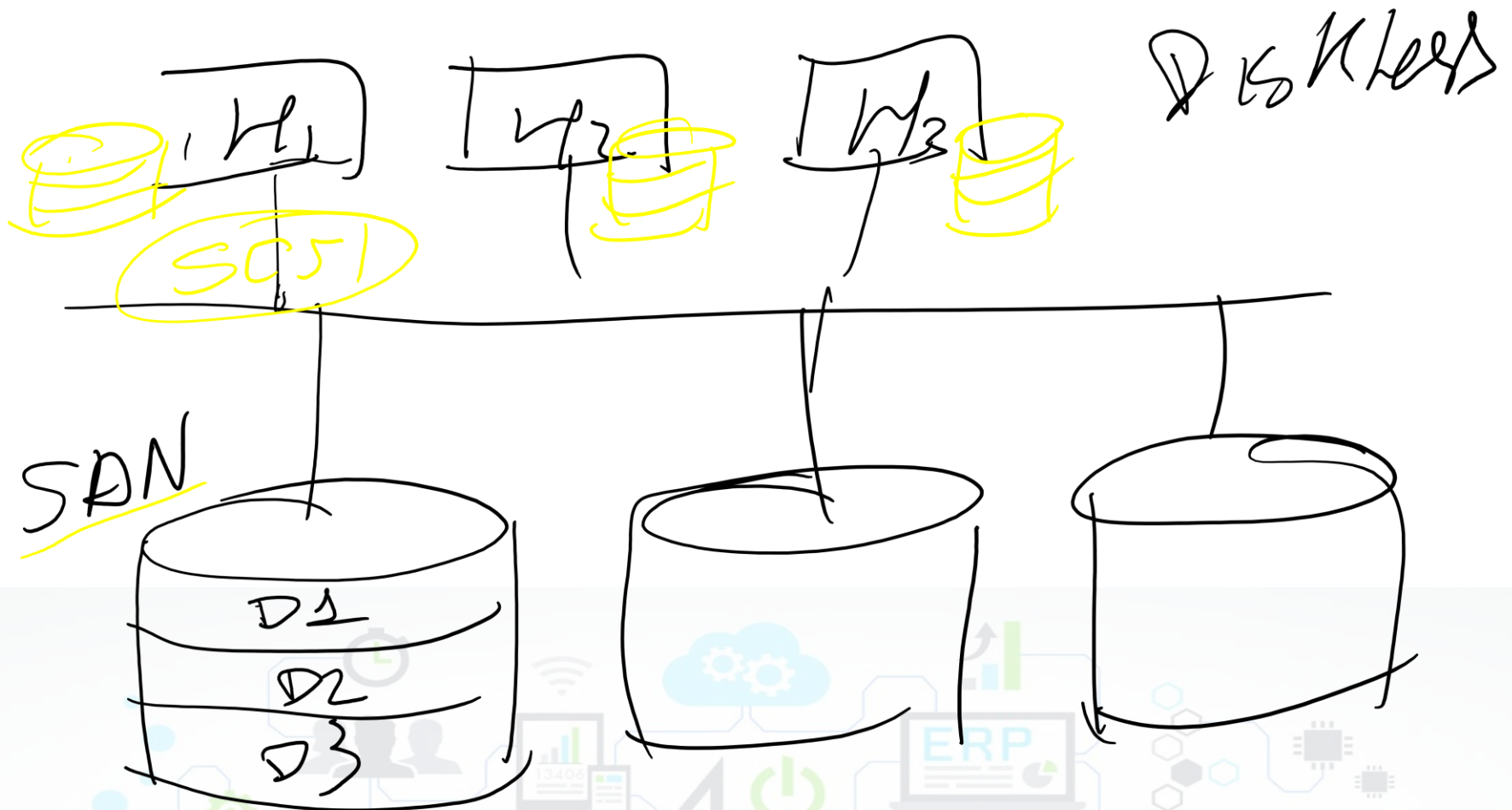
Etc..





SAN vs NAS

- In most cases they are wrongly considered the same staff
 - ✿ It is true that: NAS/SAN typically are HD in Raid connected/shared to/by Servers
- | **NAS: Network Area Storage**
 - ✿ Network HD sharing content at level of File via TCP/IP, HTTP, NFS, CIFS, etc., protocols
 - ✿ Multiple servers may access to them, the HD can be easily mounted, and see on the OS
 - ✿ Reduced performances with respect to SAN
- | **SAN: Storage Area Network**
 - ✿ HD system segmented in LUN, mounted by the Server(host)/VM OS at level of disk block
 - ✿ The OS accessing to them has to format with its own file system
 - ✿ Multiple server may access to them
 - ✿ Possible protocols: low level IP, iSCSI, Fiber, etc.

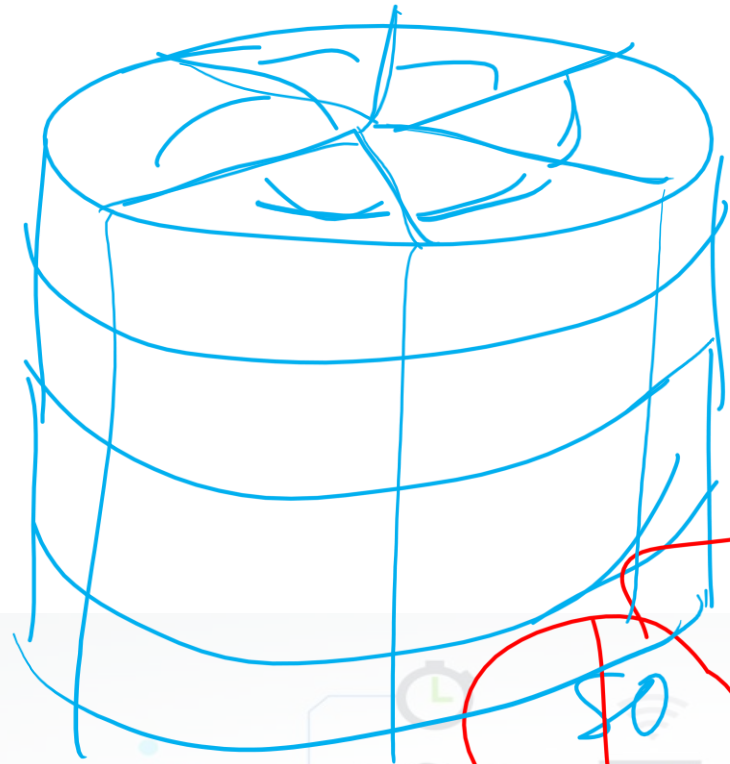




10TB

Sector/Cylinder/Disk
3000/1000/10 $\Rightarrow$ 1000000

$\rightarrow$ Behaviour 8TB



LUN 2 5 TB
LUN 2 6 TB

SO
WU



RAID



Consideration

- | The fact that we have servers and storage is not a key for cloud
- | Cloud is not a synonymous of data center
- | Since 60' **John McCarthy supposed to have a number of servers providing services for all**
- | Servers have been typically used
- | Close to the end of the 90', the first Software as a Service, SaaS, started.

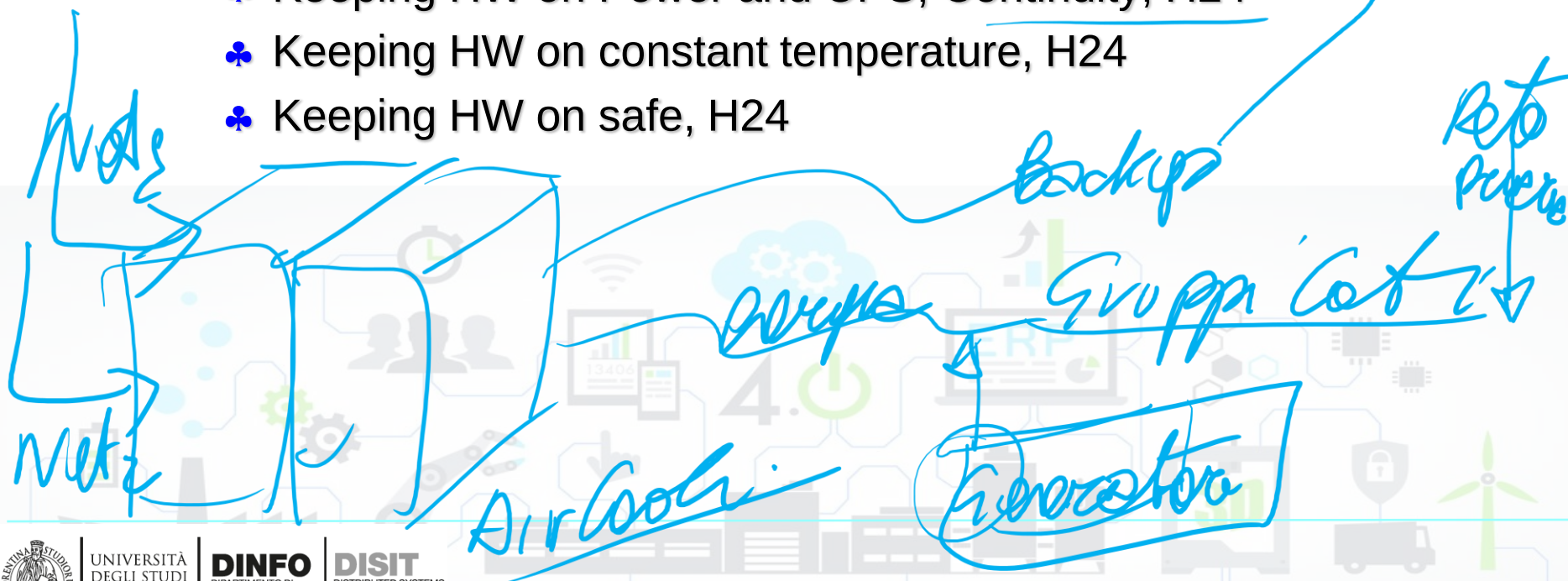
♣ Since.....





Housing

- | Moving HW, Moving servers from local premise to an infrastructure:
- | Buying HW and finding a safe location to placing,
 - ♣ Keeping HW on maintenance, H24
 - ♣ Keeping HW on Power and UPS, Continuity, H24
 - ♣ Keeping HW on constant temperature, H24
 - ♣ Keeping HW on safe, H24





Motivations for Cloud computing and Virtualization

Computer Based Physical Systems (servers) are

♣ not flexible:

➔ The HW/SW has to be dimensioned for the workload worst case and not for the real/typical one

➔ HW/SW can be hardly reused for different purposes since specific allocation is performed

♣ subjected to HW failure, and thus:

➔ Software has to be installed again when changing hardware

➔ OS has to be reinstalled in most cases



Motivations for Cloud computing and Virtualization

Computer Based Physical Systems (servers) are

- ♣ Subjected to high costs of setup, installation and use:

- Power, conditioning, network connection, etc.

- ♣ not scalable, to scale up frequently implies hardware change/re-engineering, (it was the gold period of the Moore's Law, of performance duplication every two years)

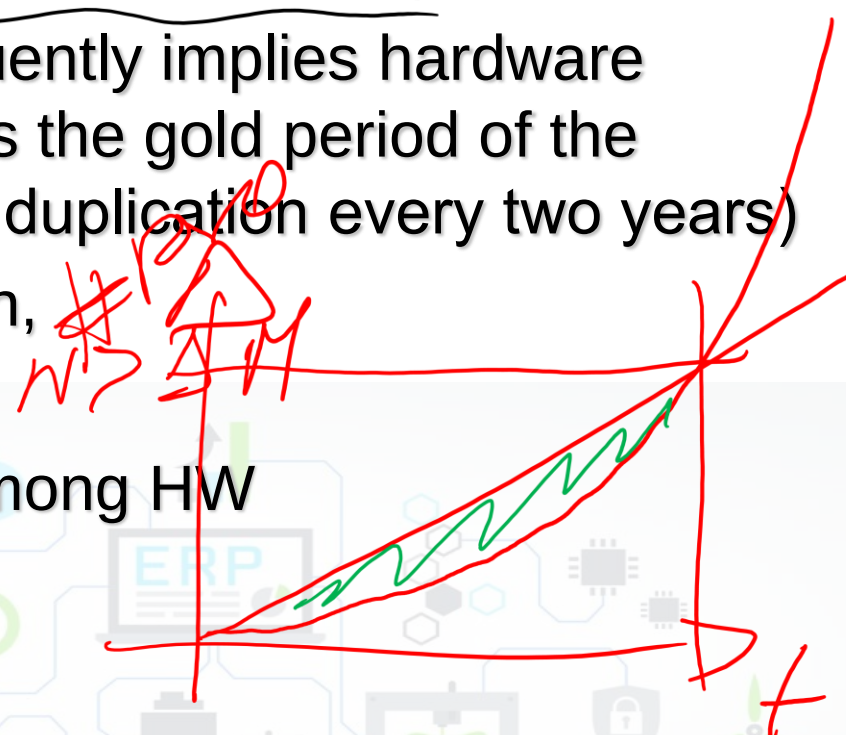
- Data duplication, migration,

- sharing databases, etc.

- Distribution of activities among HW

- Balancing or workload,

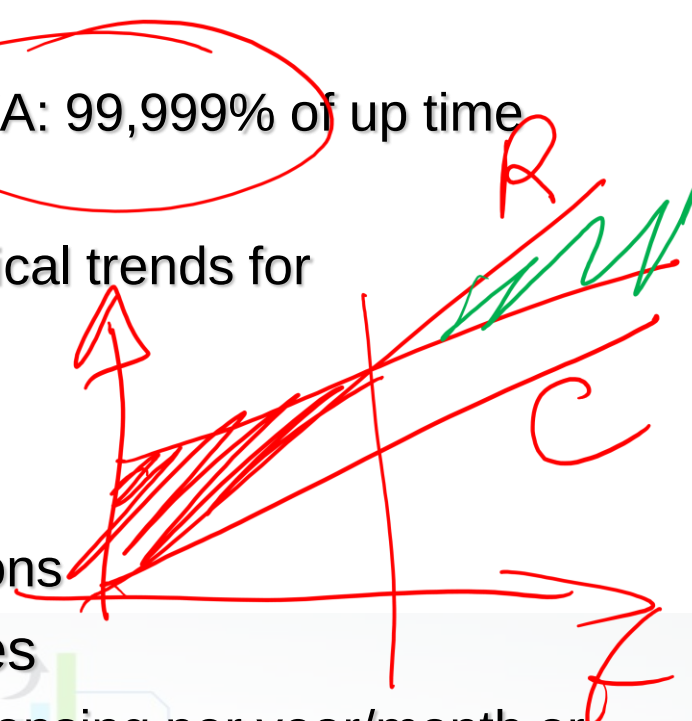
- Add more HW,





Final Motivations

- | Reduction of costs for HW and operating system SW maintenance.
 - ♣ High costs to guarantee high availability, HA: 99,999% of up time
 - ♣ High costs to guarantee high reliability
 - ♣ High costs to follow the HW/SW technological trends for performances, computational needs
 - ♣ Critical mass is needed to justify HW costs
- | Sharing resources
 - ♣ Among for multiple applications and solutions
- | Needs of High flexibility in terms of features
 - ♣ Most of the SW is becoming a services (licensing per year/month or users) and not anymore a product.
 - ♣ Many vendors provide complex SW systems in terms of services, on the basis of their consumption via network connection





Hosting, definition

HPC: high performance computing

- ♣ Solution based on cloud/grid for parallel execution of algorithms and tools.

Hosting web portal into a datacenter/cluster *SLA*

- ♣ Renting a web space via some SLA (service level agreement), contract, monthly rate to publishing web pages: service httpd
- ♣ Additional services: mysql, php, asp, ftp, ssh, https, etc..
- ♣ Features:
 - ➔ Space on disk, networking
 - ➔ Domain space, etc.

Hosting a machine (computer/VM) into a datacenter

- ♣ According to some SLA, contract...
- ♣ Renting a Computer/VM/Cluster into a data center



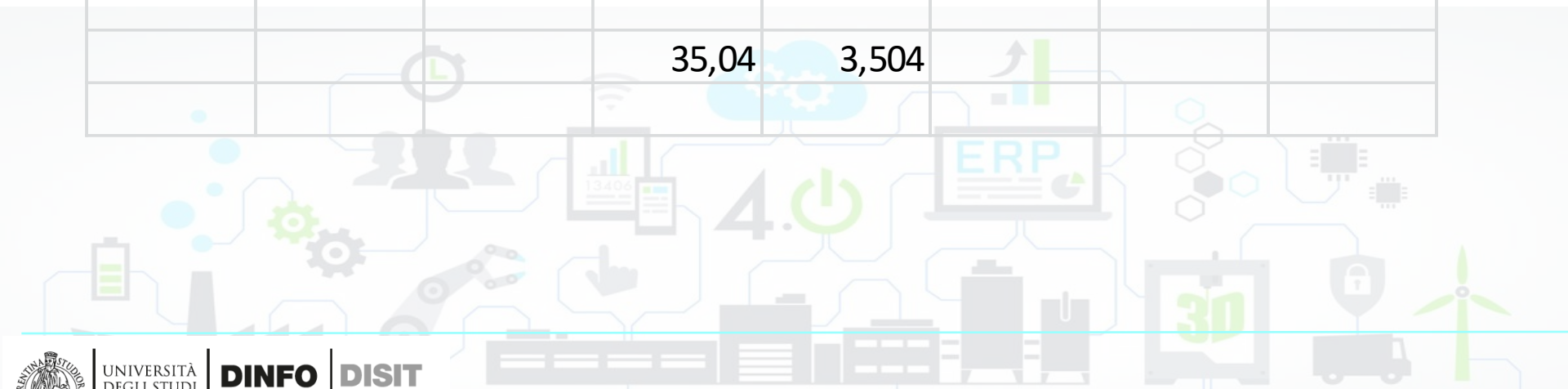


Service Level Agreement

Availability % ▲	Downtime per year ^[2] ◆	Downtime per month ◆	Downtime per week ◆	Downtime per day ◆
55.555555% ("nine fives")	162.33 days	13.53 days	74.92 hours	10.67 hours
90% ("one nine")	36.53 days	73.05 hours	16.80 hours	2.40 hours
95% ("one and a half nines")	18.26 days	36.53 hours	8.40 hours	1.20 hours
97%	10.96 days	21.92 hours	5.04 hours	43.20 minutes
98%	7.31 days	14.61 hours	3.36 hours	28.80 minutes
99% ("two nines")	3.65 days	7.31 hours	1.68 hours	14.40 minutes
99.5% ("two and a half nines")	1.83 days	3.65 hours	50.40 minutes	7.20 minutes
99.8%	17.53 hours	87.66 minutes	20.16 minutes	2.88 minutes
99.9% ("three nines")	8.77 hours	43.83 minutes	10.08 minutes	1.44 minutes
99.95% ("three and a half nines")	4.38 hours	21.92 minutes	5.04 minutes	43.20 seconds
99.99% ("four nines")	52.60 minutes	4.38 minutes	1.01 minutes	8.64 seconds
99.995% ("four and a half nines")	26.30 minutes	2.19 minutes	30.24 seconds	4.32 seconds
99.999% ("five nines") HA	5.26 minutes	26.30 seconds	6.05 seconds	864.00 milliseconds
99.9999% ("six nines")	31.56 seconds	2.63 seconds	604.80 milliseconds	86.40 milliseconds
99.99999% ("seven nines")	3.16 seconds	262.98 milliseconds	60.48 milliseconds	8.64 milliseconds
99.999999% ("eight nines")	315.58 milliseconds	26.30 milliseconds	6.05 milliseconds	864.00 microseconds
99.9999999% ("nine nines")	31.56 milliseconds	2.63 milliseconds	604.80 microseconds	86.40 microseconds



			99,8	99,98	99,998	99,999	
			0,2	0,02	0,002	0,001	
	60						
ore	24		17,52	1,752	0,1752	0,0876	ore anno
	365						
minuti	525600		1051,2	105,12	10,512	5,256	minuti
	100	0,2					
	525600 X						
			35,04	3,504			





Infrastructure as a Service, IaaS

- I the provision of infrastructure with a relevant processing power, storage, network and other basic resources independently of application services of any type.

- ♣ Example: a server in rent, a VM for rent

- I Thus, it is possible to use an infrastructure of a provider to run your application, against a payment based on the renting (consumption) of the infrastructure, leaving the responsibility of the HW, OS, and SW (libraries, middleware, backup, storage, network, etc.) as well as of the application itself to the provider.

- ♣ Amazon EC2 is an example of IaaS service.

\$ HW $\xrightarrow{\text{Service}} \text{CSP}$

100.000 + Mem + Core + RA + Rote

Nec CPU

Yes

App #

Scale
Nec



Motivations for Applications on the Cloud

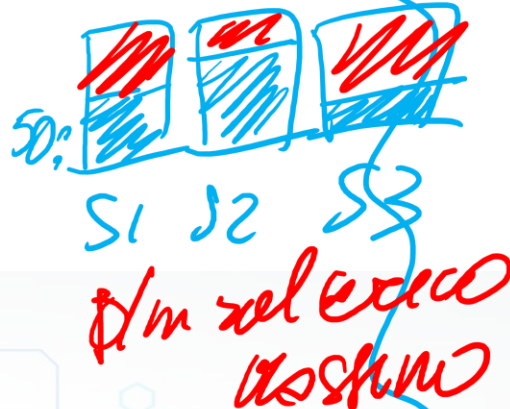
Single-tier applications, such as small web portals, do not demand a complex system, and

- do not justify the acquisition of a host server !!!???

Multi-tier applications have multiple servers, such as:

- High performance web server, high number of users
- SN: Social networks
- CMS: content management systems
- CRM: customer relationship management
- CDN: Content delivering network
- ERP: enterprise resource planning
- P2P torrent tracker: see Piratebay

All typically parallel applications that may need grid, computation, storage, etc. may run on cloud, etc.



Are solo quello che serve !!



Structure

- | Elements of cloud Computing
- | Virtualization 
 - ♣ emulation, para-virtualization
 - ♣ virtual resources
 - ♣ snapshots
- | Cloud Computing
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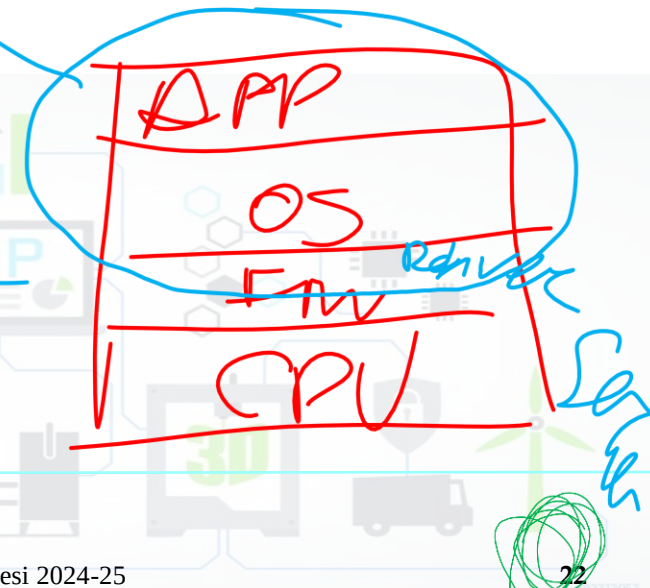
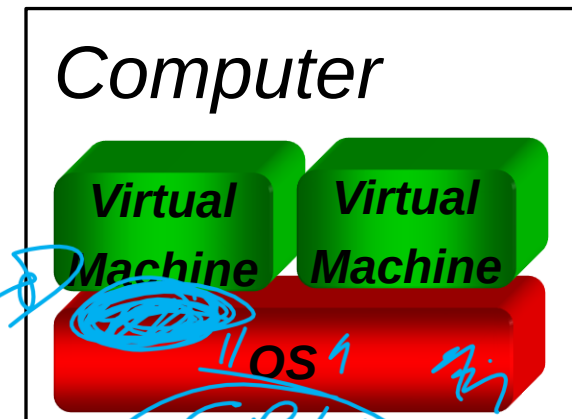
Concept of Virtual Server

I Hyp:

- ♣ you can make the image (in a file) of the HD of a Physical Server (with its Operating System and files) and
- ♣ put in execution the OS from the HD (file) by a program of "emulation"

I Thus we have:

- ♣ a computer with an operating system OS
- ♣ that hosts a program of "emulation",
- ♣ which in turn, it is capable to run in separate processes the images of the corresponding OS VM





Typical Features for renting a Computer or a Virtual Machine into a Datacenter

(1/2)

X

Requesting to have one or more Computers/Hosts and/or VMs

Hardware:

• CPU: 32/64 bit, number of cores/CPU, frequency of work, intel/amd, etc.

• RAM memory: size and frequency of work

~~• Power supply: fault-tolerant or not; with UPS or not, etc..~~

Host frequency

• HD: space, speed (7.2, 15Kgiri), security level/RAID, type SAS/SATA, SCSI

• NAS/SAN, Network area storage/SAN, fiber/internet: size, RAID, etc.

• Network features:

→ Number of connections/cards, NICs

→ number of IP addresses, static/DHCP

→ Transfer rate: minimum guaranteed, maximum possible, down/upload

→ Maximum transferred bytes: per day, per month, etc.

SLA
Mbps



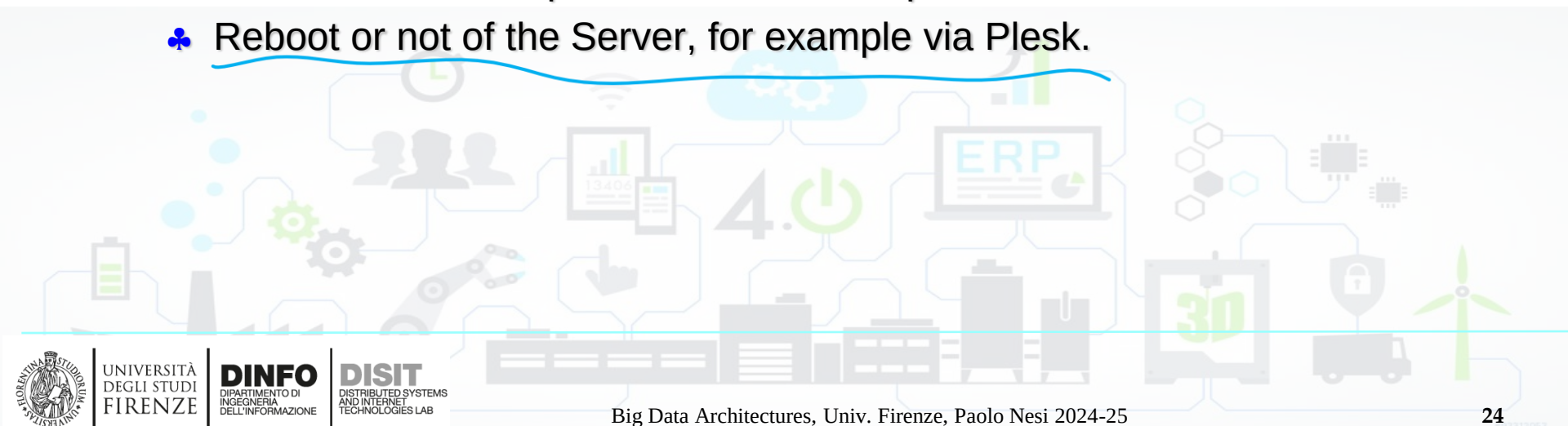
Typical Features for renting a Computer or a Virtual Machine into a Datacenter (2/2)

| Software:

- ♣ Operating systems: versions, with maintenance, etc.
- ♣ Software preinstalled into the Computer/VM, see in the following

| Services:

- ♣ Periodic back up: details on HD space
- ♣ Access to VM/Computer: remote desktop or KVM tool
- ♣ Reboot or not of the Server, for example via Plesk.





Virtual Machine, Virtualization

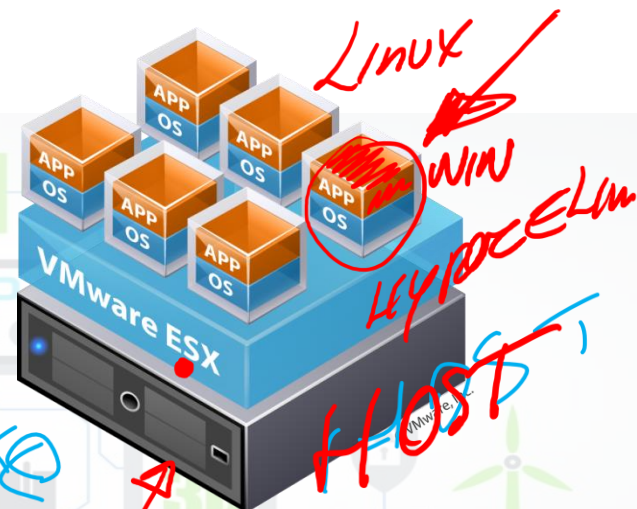
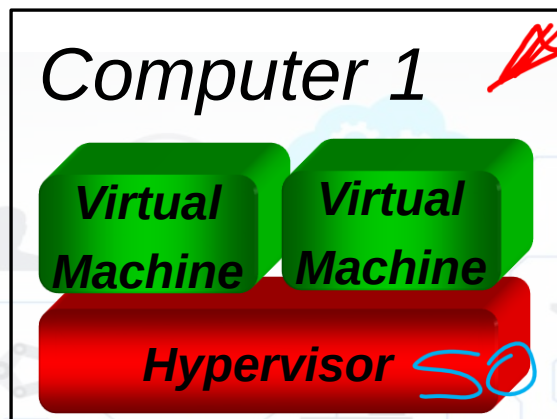
| Virtual Machine:

- ♣ An image of an operating system that can be put in execution into a real host/computer creating a virtual computer that exploits a part of all of the host resources
- | E.g.: Host may be Linux-like while the VM may be Window, Mac, Linux, ...

| Virtualization

- ♣ Transforming a physical computer into a VM, virtual machine, hosted on some Host computer

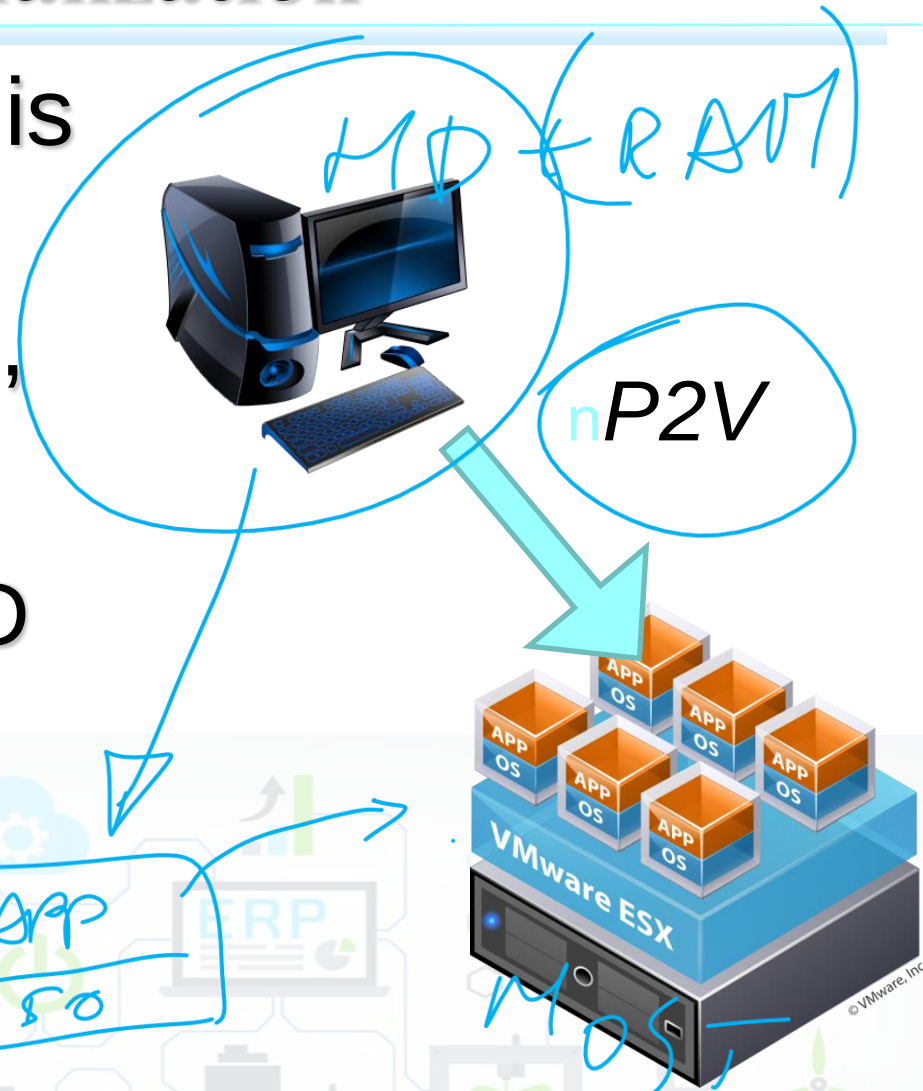
| Hypervisor (VM Monitor) to manage the several VMs on the host





The Virtualization

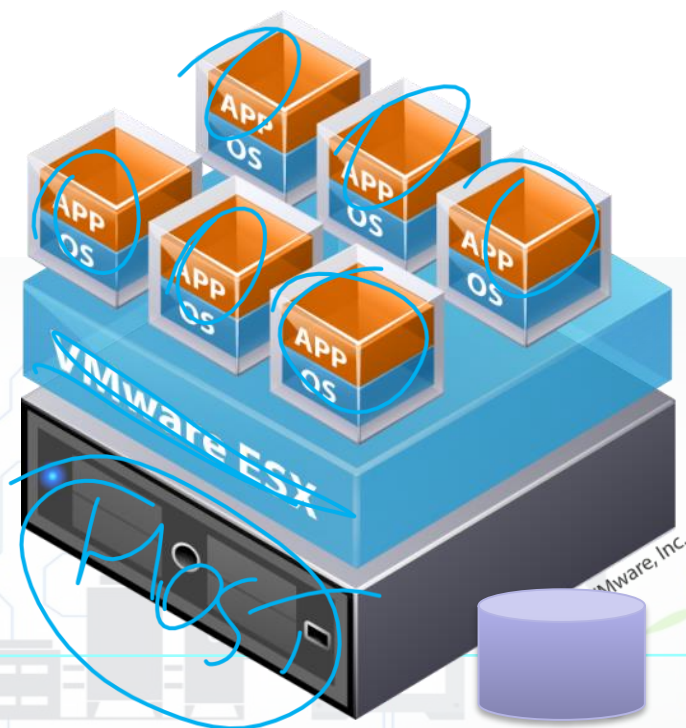
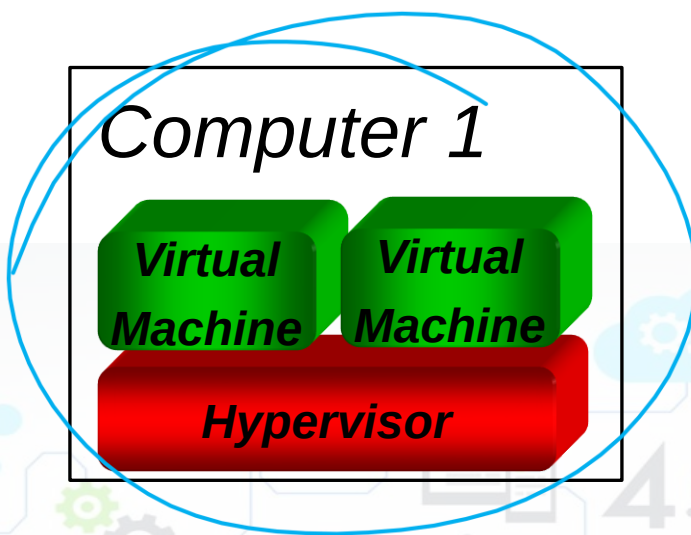
- | Process by which it is possible to create a virtual machine, VM,
- | For example by:
 - ♣ An installation DVD
 - ♣ Cloning a physical machine (P2V)
 - ♣ Clone from VM
 - ♣ Template from..





The Hypervisor

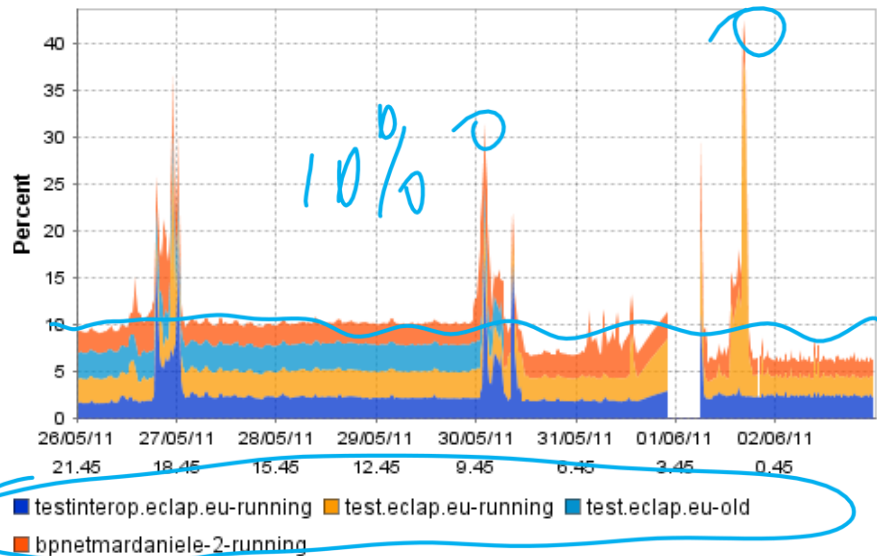
- | It is the essential OS, that can be installed in a Host and can put in execution and manage one or more VM
- | The Host is a server HW that host the Hypervisor
- | ESX of VMware is an Hypervisor.



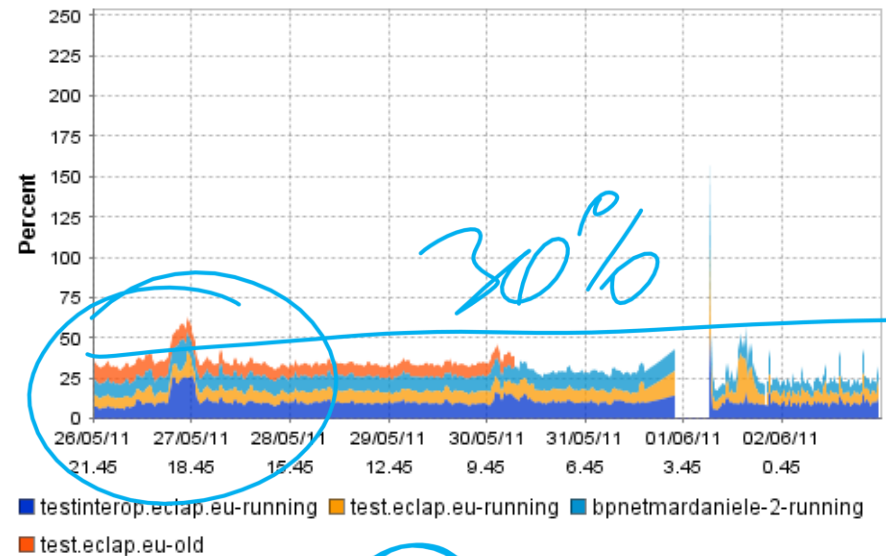


Performance Analysis of VM on the Host

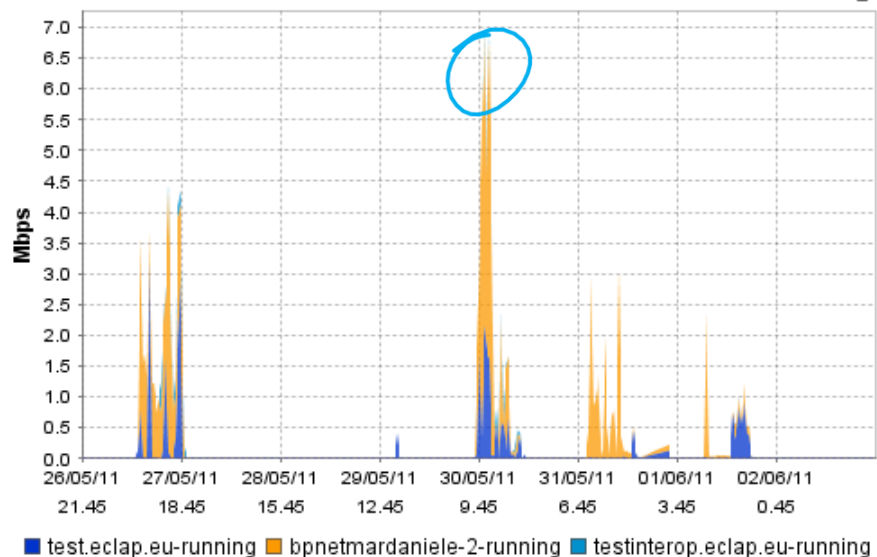
CPU Usage (Top 10)



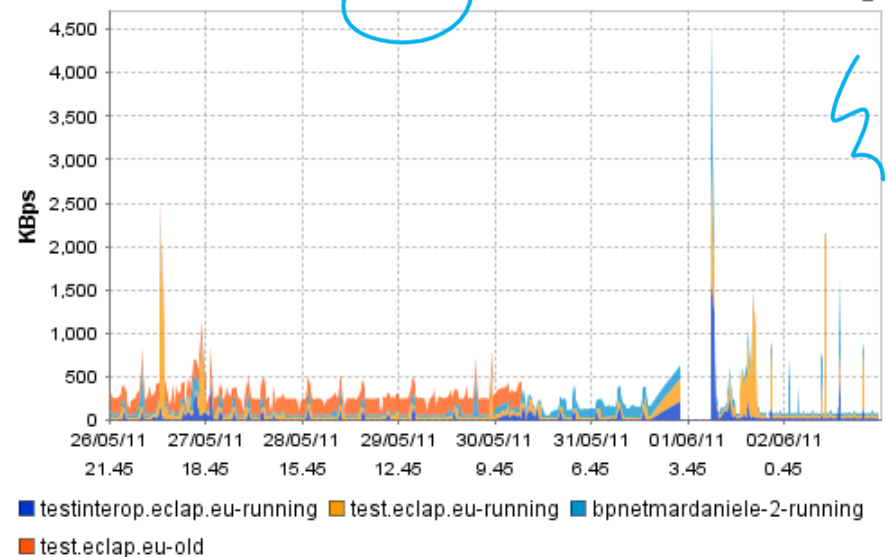
Memory Usage (Top 10)



Network (Mbps) (Top 10)



Disk (KBps) (Top 10)





Motivations for Cloud computing and Virtualization

- | **Most of the Host/datacenter capabilities** are not exploited at 100% in every time instant
 - ♣ They are typically present in large industries/institutions or in large services: google, amazon, tiscali, Dada, ibm, cnr, etc
 - ♣ Their size is typically defined on the basis of the workload worst case
- | ***If they are big***: the exploitation of the remaining resources for cloud/hosting is a solution to recover money, since a non working machine (like a caw) is a costs without any return.
- | ***If they are small***: it could be a solution to host machines on a professional infrastructure to reduce annual costs for HW/SW
 - ♣ Delegating to cluster owners the costs for *maintenance, renovating hardware, renovating software, network costs, back up costs, power supply, etc.*



Benefits of Virtual Machine

Main benefits:

- ♣ Separation of OS+SW with respect to the needed HW
- ♣ Exploiting legacy solutions which can be wrapped into a VM and protected with a physical firewall without reinstalling and recompiling old applications.
- ♣ The simple upgrade can be obtained by giving more CPU instead of changing HW and reinstalling all SW elements.

For example:

- ♣ An old Linux Server hosting several web portals with a old versions of: MySQL, PHP, etc.. and many configuration aspects: users, mailing lists, etc. very time consuming to port on a new server
- ♣ An old Cobol application running only on an old Windows 2000 Server, which cannot be recompiled into a new Windows Server 2008 at 64 bits without spending months of work.
- ♣ A Cobol application running on machine based on an IBM system 36....
- ♣ Etc.



VM on PC workstations

- | On a single Computer it is possible to put in execution a VM by using a standalone Hypervisor
- | **VMware Workstation** can play on Windows:
 - ♣ VMware Virtual Machines with: MS Win, Linux, Mac, ChromeOS, etc.
- | **VMware Player** can play on Windows or Linux
 - ♣ Free of charge
 - ♣ VMware Virtual Machines with: MS Win, Linux, Mac, ChromeOS, etc
- | **VMware Fusion** can play on MAC:
 - ♣ VMware Virtual Machines with: MS Win, Win 7, ChromeOS, etc.
- | **Microsoft Virtual PC** on Windows 7:
 - ♣ Free of charge
 - ♣ Create VM with Win XP, Linux Ubuntu,



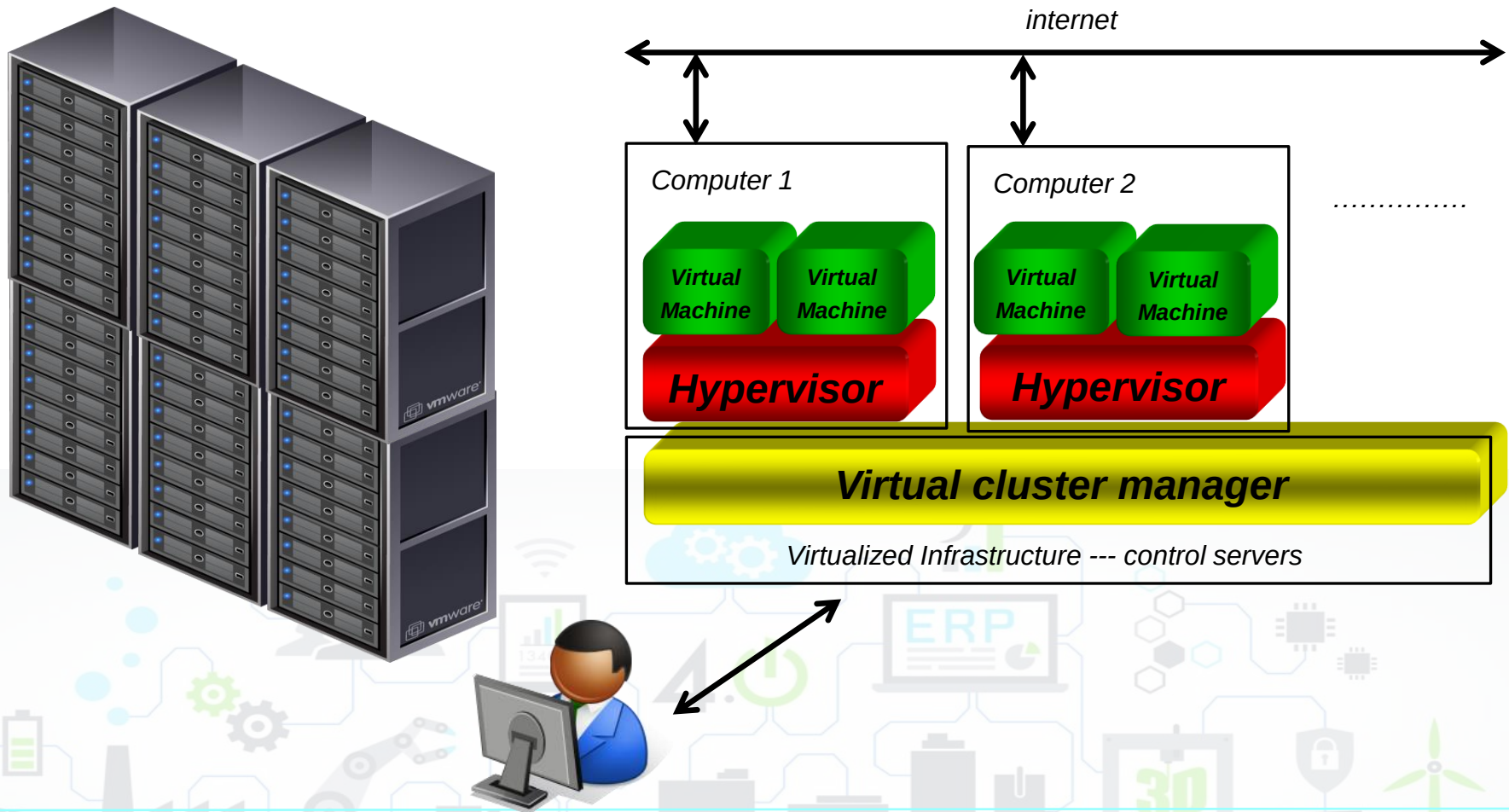
Software/Components preinstalled into rented Computers/VMs

- | **Several kinds of software components/tools** that can be accessible on rented VM and/or Computers.
- | **Availability of HW/SW:** for example at 98% or 99.999%
- | **Typical components** that could be requested:
 - ♣ DB: MySQL
 - ♣ FTP: server and client
 - ♣ Web Server: Apache, IIS
 - ➔ Add-on: PHP, Perl, Python, cache tools on several levels
 - ♣ SMTP address, antispam
 - ♣ Web Application Server: TomCat,
 - ♣ And: Antivirus, backup, email, Drupal, Joomla, etc...
- | **A full server can be customized, so that any other tool can be installed as well from the user**



Cloud Computing with VMs

Several Hypervisors on a Clusters

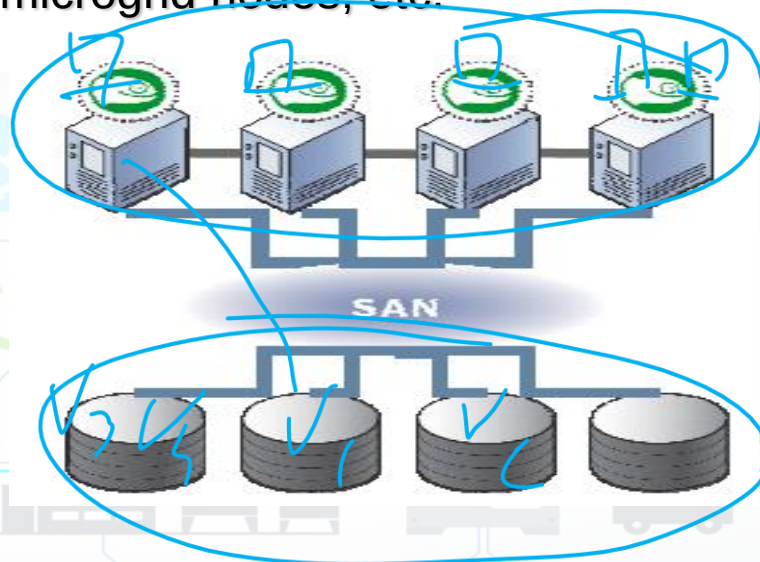




Clusters, generic definition

For Cluster, it is typically intended:

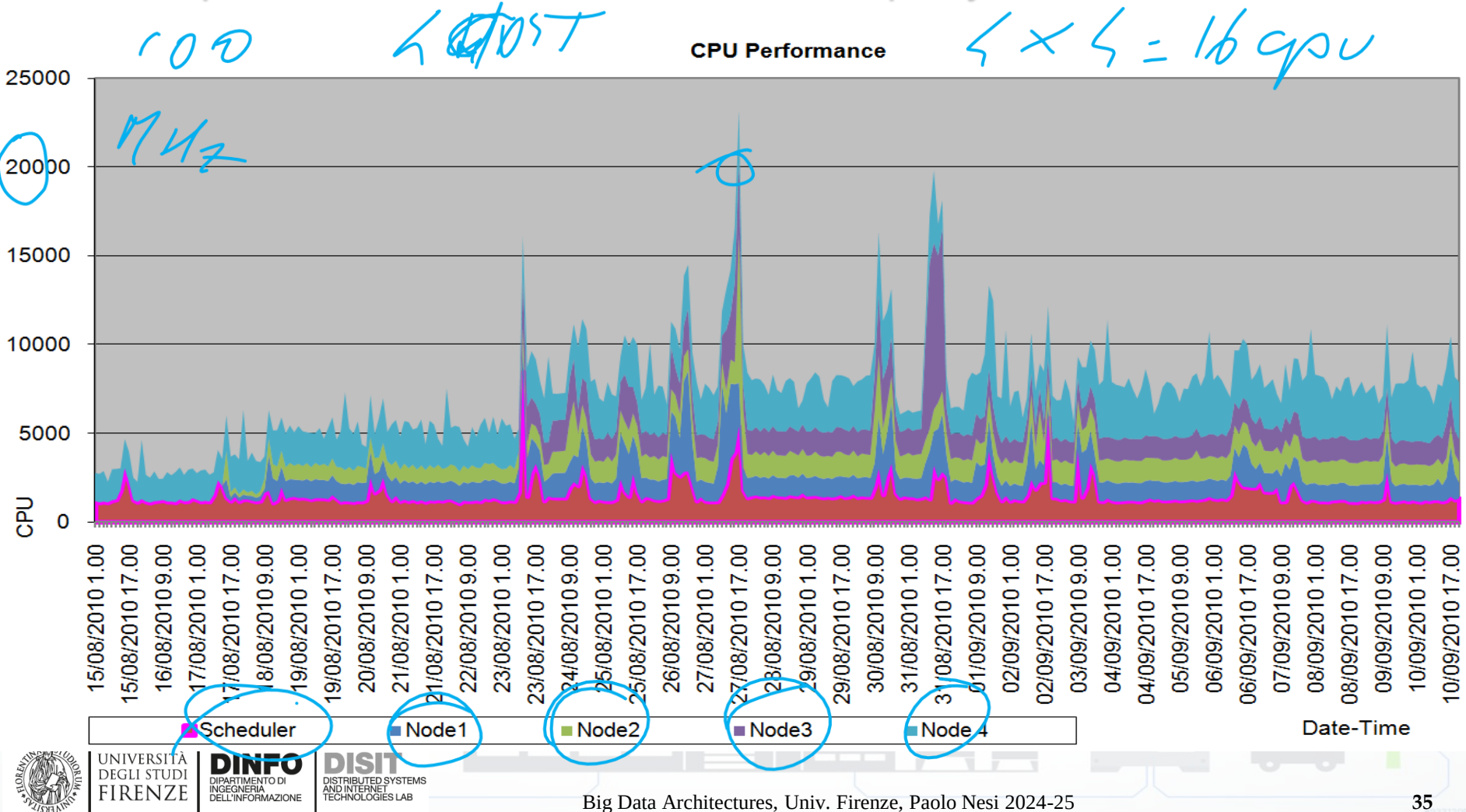
- Several kinds of computers and/or VMs used to compose a group of resources, that can be managed together, and may be sharing the same domain or not.
- a set of computers/VMs into a datacenter which are dedicated to a unique problem, for example:
 - ➔ A microgrid, an Hadoop cluster,
 - ➔ A social network.....
 - ➔ A web portal with its multi-tier servers: front-end portals, balancer, database computers, backoffice microgrid nodes, etc.





From Clustering VM to Cloud

- The first step has been the exploitation of unused resources to provide them as a service to third party.





Approaches for Virtualization

I Hardware Emulation

- ❖ Full emulation of Hardware devices and features
- ❖ It is possible to use an original OS without changes, may be with some drivers installed, but **not kernel** changes
- ❖ Higher isolation among VMs, strong robustness, limited efficiency.
- ❖ **Used by** Vmware core
- ❖ Typically 10% of overhead

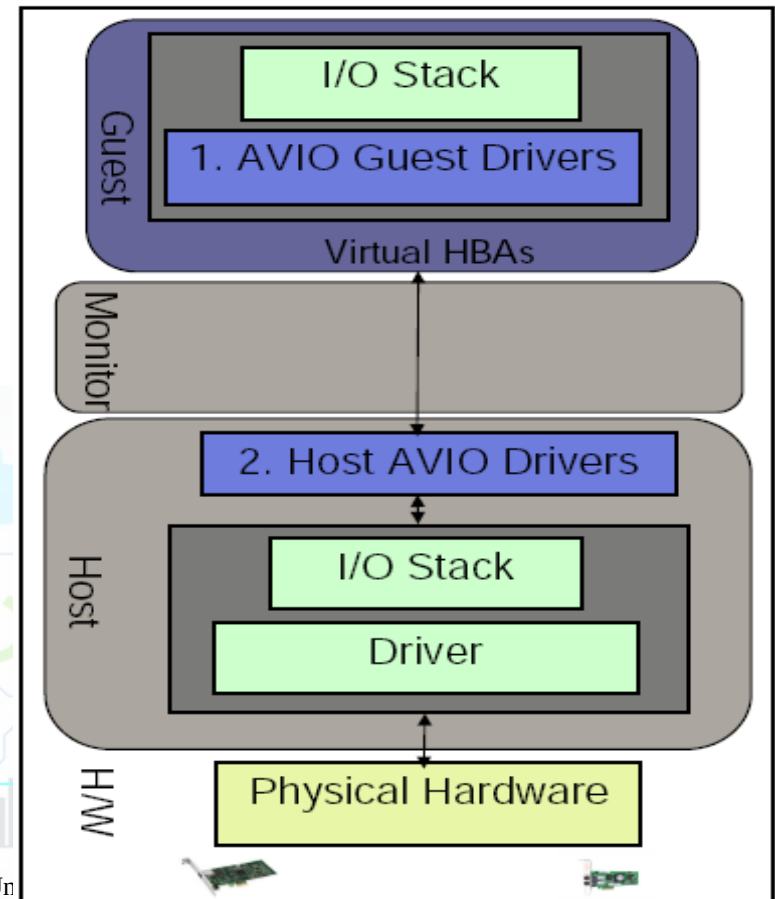
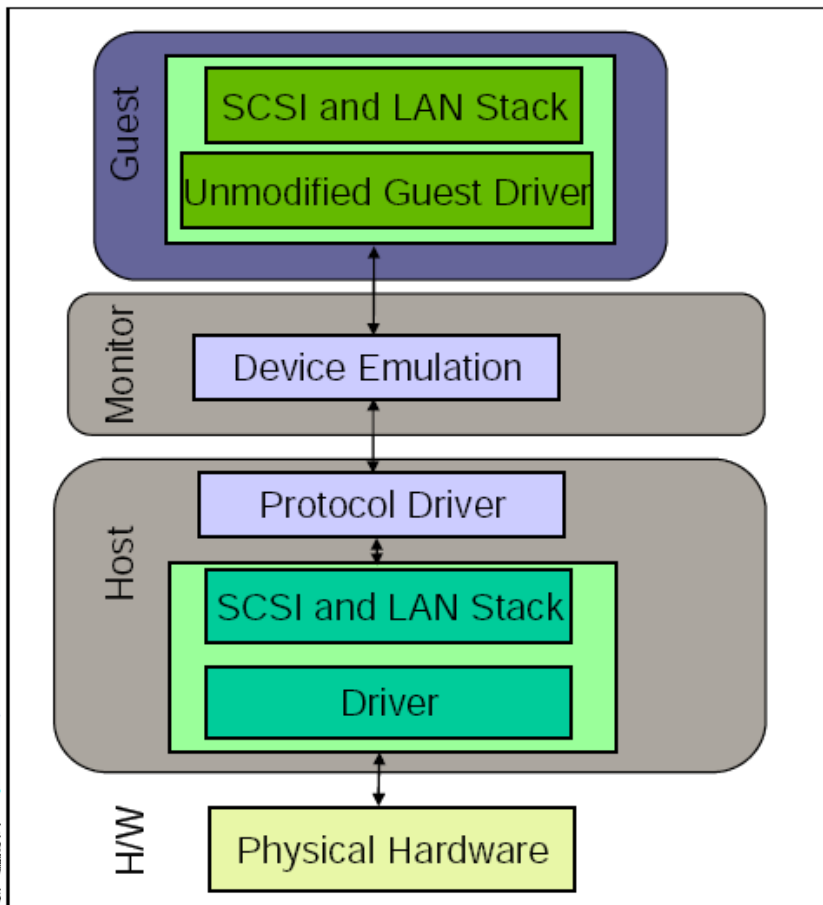
I Paravirtualization (total or only on some devices)

- ❖ The execution is performed via specific API and the hosted OS has to be modified to use them instead of the original HW
- ❖ Lower isolation, higher efficiency
- ❖ Lower robustness: VM crashes may crash the whole system
- ❖ **Used by:** HP-VM, Xen (both of them which can also go in emulation mode)
- ❖ **Used by VMware:** VMXNET (100 Gbps net), PVSCSI in vSphere4
- ❖ Typically 2% of overhead



Para-virtualization

- It is intended as a solution to cut out a part of the I/O stack, for example for the HD access or network.
- The following example is related to HP VM v. 3.5

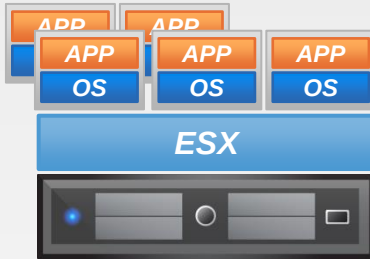




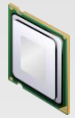
“Speeds and Feeds”

Optimization for the Highest Consolidation Ratios

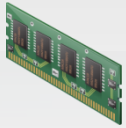
Virtual Machines



CPU



Memory



Networking



Storage



■ VM Scale Up

- 8-way vSMP and 255 GB of RAM per VM

■ Hardware Scale Up

- 64 cores and 512GB of physical RAM

■ Hardware Assist

- Lowest CPU overhead

■ Purpose Built Scheduler

■ Hardware Assist

- Maximum memory efficiency

■ Page Sharing

■ Ballooning

■ VMXNET3

- Wirespeed network access

■ VMDirectPath I/O

■ Storage stack optimization

- Greater than 360k iops per second
Lower than 20 microsecond latency

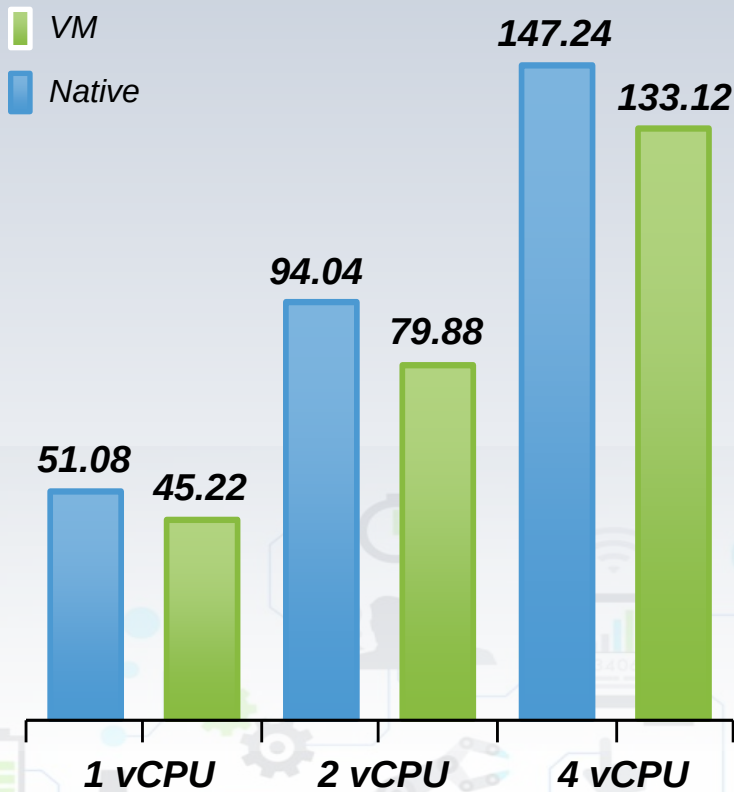
■ VMDirectPath I/O

■ Current ■ NEW



ESX 4.0 Performance with SQL Server 2008

Relative Scaling Ratio



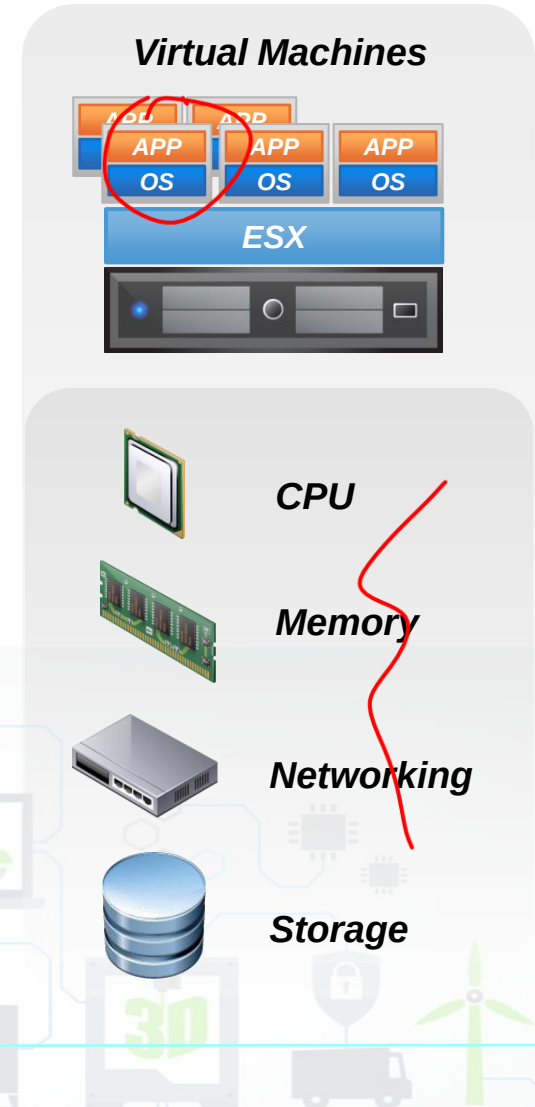
- | ESX achieves 90% of native performance on 4.0 vCPU VM
- | Workload transaction latency unchanged between ESX 4.0 and Native



Host: risorse primarie

Host Profile

- ♣ Memory Reservation
- ♣ Storage
- ♣ Networking
- ♣ Date and Time
- ♣ Firewall
- ♣ Security
- ♣ Services
- ♣ Users and User Groups
- ♣ Security





Limiting VM Resources

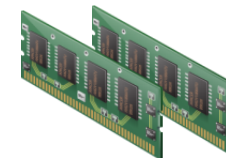
- | **VM Resources** (CPU, Mem, HD, net.) consists also in providing support for:



- ❖ Dynamically providing resources over the reserved values that can be negotiation into the SLA/ contract.

- | **Controlling and limiting** access/cost and the exploitation of HW resources:

- ❖ A limit on the number of CPUs
 - ➔ A limit on the number of Clocks, over of a reserved number of clocks
- ❖ A limit on the maximum size of the RAM, over of the reserved number of Mbytes
- ❖ A limit on the size of the HD, SAN/NAS access
- ❖ A limit on the number of network cards, number of Mbps, etc.



Model for Memory

I Memory

- 
- Total host memory

- For each VM

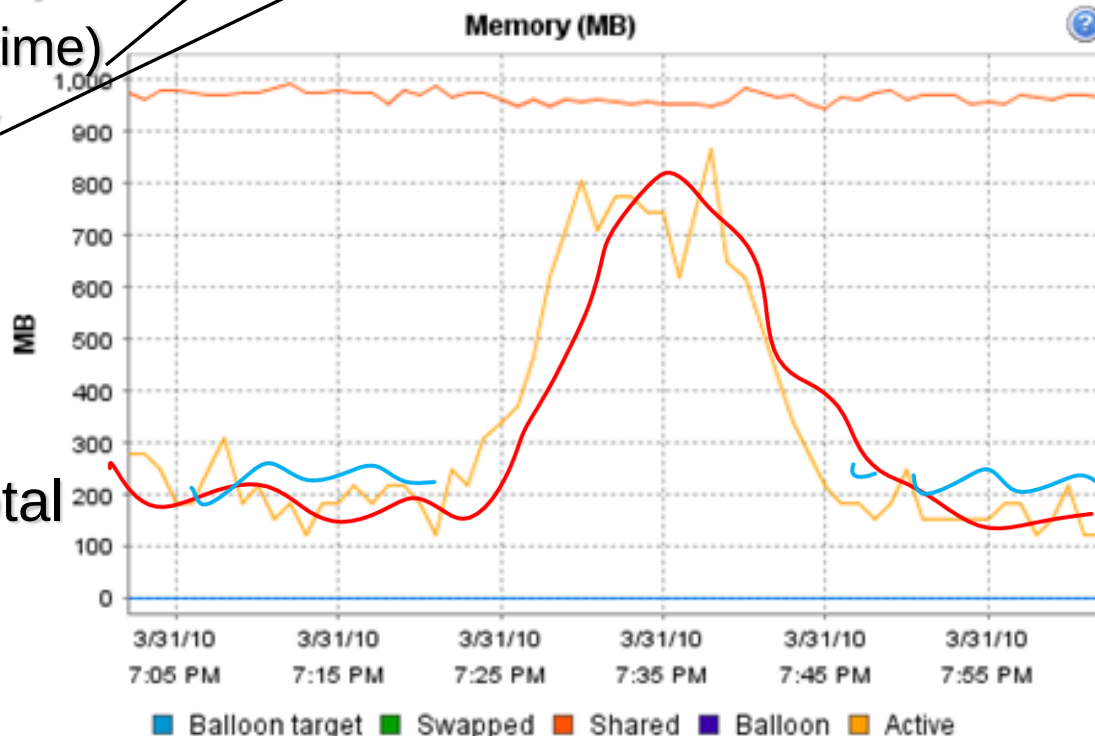
- Max memory for the OS

- ## → Reserved Memory

- Used Memory (time)

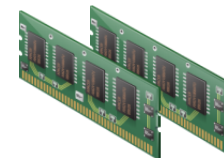
- Limited memory:

Be careful to overcommitted resources on the Host respect to the total CPU and Mem of the hosted VMs





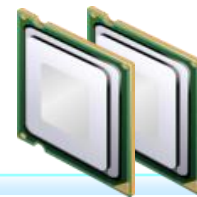
VM: Memory Definitions



- | **Reserved:** not available for the other VM on the same host!!
- | **Active:** memory actually used
- | **Ballon:** Memory requested by the VM to the host
 - ♣ This memory is shared among several hosts
- | **Shared:** memory available for sharing
- | **Swapped:** amount of memory that has been swapped into the HD by the VMKernel of the host
 - ♣ This parameter has to be low as much as possible
 - ♣ Increase the reserved to make it low or reduce the number of VM on the host



Model for CPU



Memory

♣ Total host Clock

♣ For each VM

➔ Max #cks/s host

➔ Reserved #cks/s

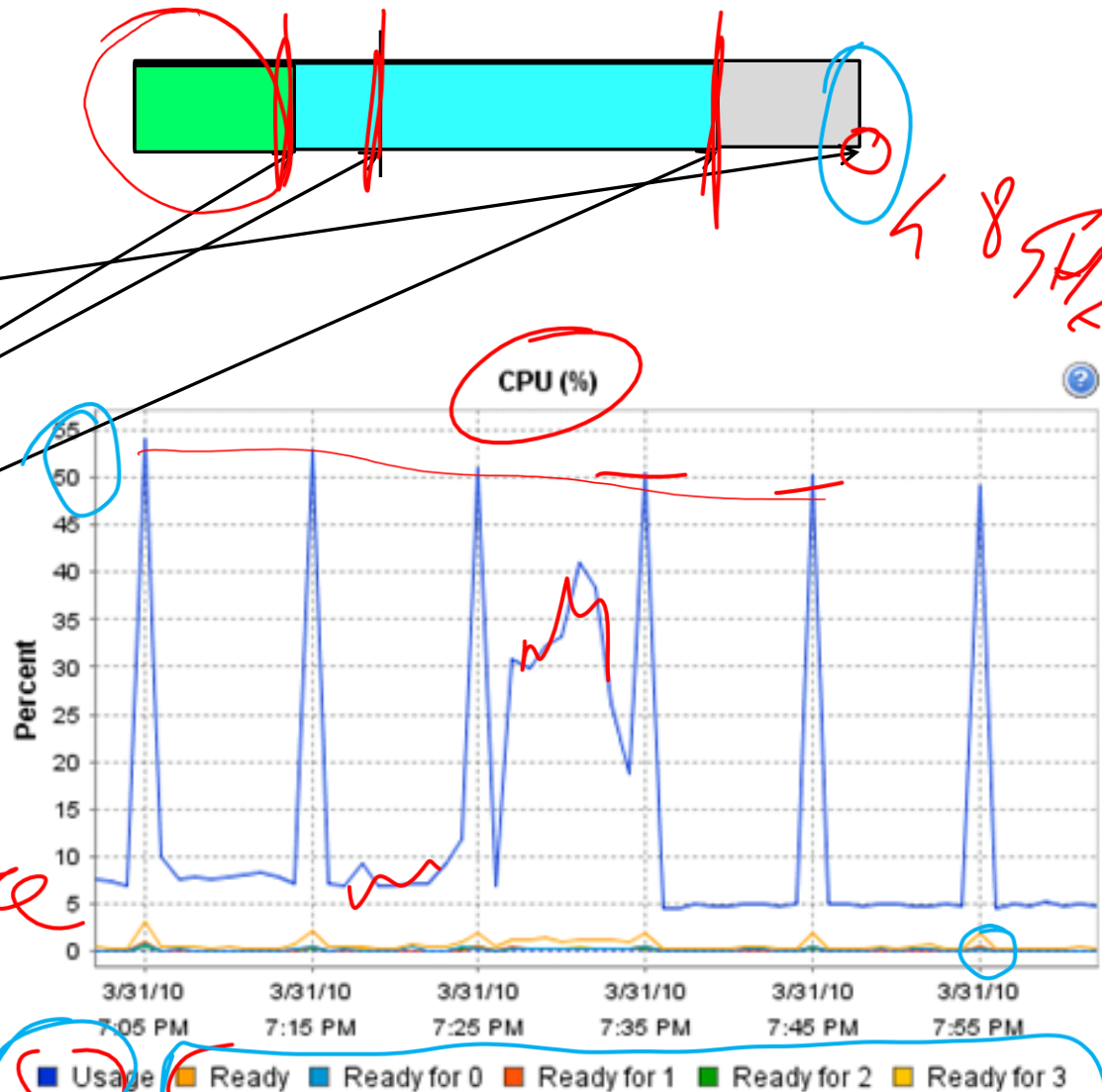
➔ Used #cks/s

➔ Limited #cks/s

Ck/s $\rightarrow$ Hz

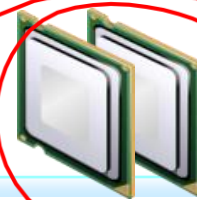
1 GHz $\rightarrow$ 1000 MHz

Handwritten: Xoon #1 CPU core
75 GHz

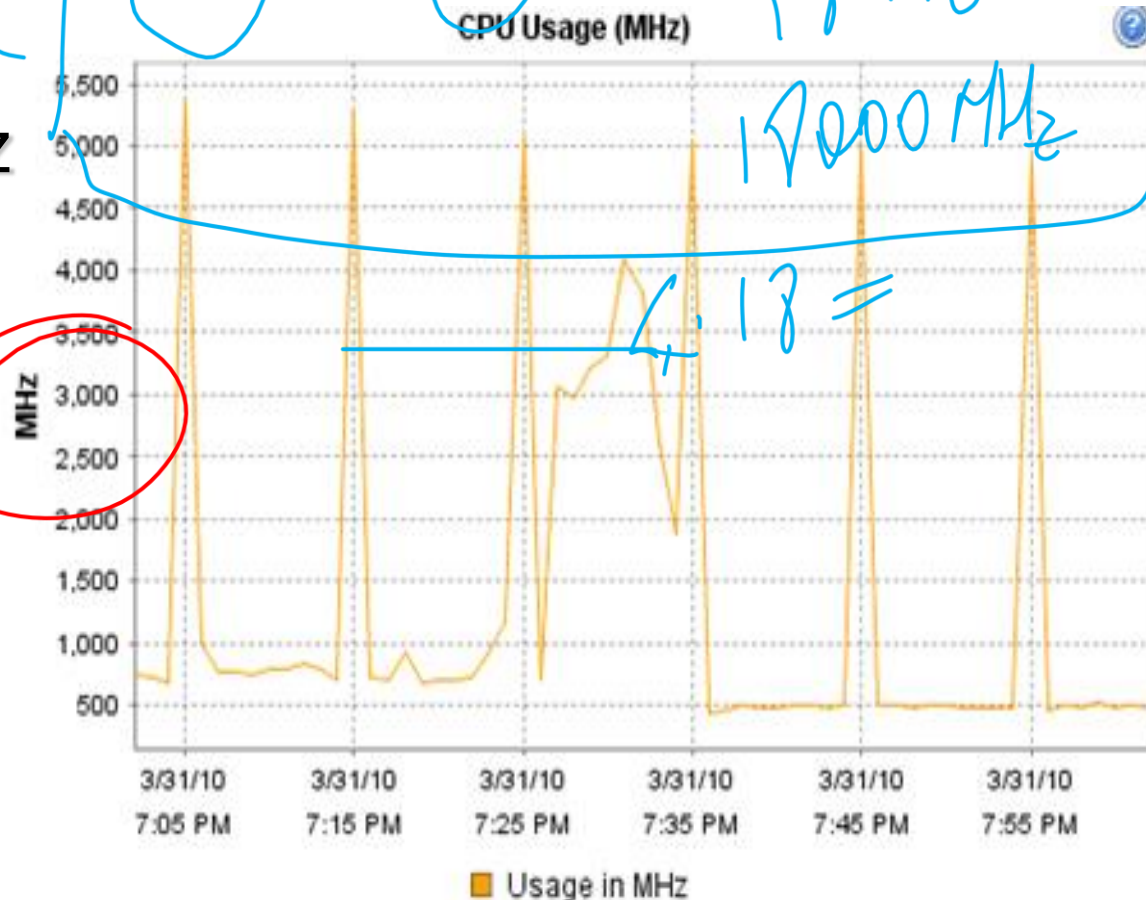




Model for CPU



- An host may have multiple CPU with multiple Core
- An host with 4 CPU at 3Ghz and 6 core each has
 - 24 cores at 3Ghz
 - 72.000 MHz
- VMs share this amount





Virtual Resources, 1/2

- The idea of Virtual Resources (CPU, Mem, HD, net.) consists in providing a number of resources larger than those that physically available and manage them virtually and/or dynamically

- For example, one Host may have 2 VM and HW resources:

- ♣ 2 cores at 1300 Mhz

- ♣ 1.8 Gbyte RAM

- ♣ 2 network cards

- ♣ Best case:

- CPU=400+800 Mhz

- RAM=400+400 Mbyte

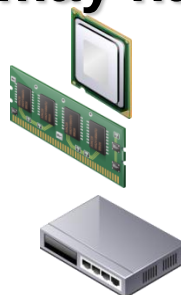
- 2 Network cards shared

- ♣ Worst case → no resources enough:

- CPU=3 cores at 1300 Mhz

- RAM=2 Gbyte

- 2 Network cards shared



VM1:

- n 1 CPU 1300 Mhz, 400 Mhz reserved

- n 1 Gbyte RAM max, 400 Mbyte reserved

- n 2 network cards, 2 IPs

VM2:

- n 2 CPU 1300 Mhz, 800 Mhz reserved

- n 1 Gbyte RAM max, 400 Mbyte reserved

- n 2 network cards, 2 IPs



Virtual Resources, 1/2

- | The idea of Virtual Resources (CPU, Mem, HD, net.) consists in providing a number of resources larger than those that physically available and manage them virtually and/or dynamically

- | **For example, one Host may have 2 VM and HW resources:**

- ♣ **2 cores at 1300 Mhz**

- ♣ **1.8 Gbyte RAM**

- ♣ **2 network cards**

- ♣ **Best case:**

- ➔ CPU=400+800 Mhz

- ➔ RAM=400+400 Mbyte

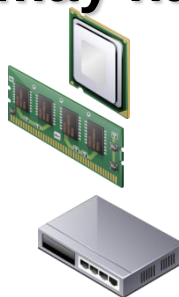
- ➔ 2 Network cards shared

- ♣ **Worst case → no resources enough:**

- ➔ CPU=3 cores at 1300 Mhz

- ➔ RAM=2 Gbyte

- ➔ 2 Network cards shared



VM1:

- n 1 CPU 1300 Mhz, 400 Mhz reserved

- n 1 Gbyte RAM max, 400 Mbyte reserved

- n 2 network cards, 2 IPs

VM2:

- n 2 CPU 1300 Mhz, 800 Mhz reserved

- n 1 Gbyte RAM max, 400 Mbyte reserved

- n 2 network cards, 2 IPs



Virtual Resources, 2/2

I The server hosting the VMs

♣ Min Mhz:

➔ 400Mhz + 800Mhz

♣ Max Mhz:

➔ 1300Mhz + 2*1300Mhz

♣ Min RAM:

➔ 400Mbyte + 400Mbyte

♣ Max RAM:

➔ 1000Mbyte + 1000Mbyte

♣ Network:

➔ No limits on the number of virtual IP addresses/cards

VM1:

n 1 CPU 1300 Mhz, 400 Mhz reserved

n 1 Gbyte RAM max, 400 Mbyte reserved

n 2 network cards, 2 IPs

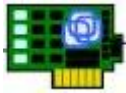
VM2:

n 2 CPU 1300 Mhz, 800 Mhz reserved

n 1 Gbyte RAM max, 400 Mbyte reserved

n 2 network cards, 2 IPs





Model for network



- | An host may have multiple network cards with one physical IP each or some of them bridged
- | Each single VM may have:
 - ♣ access to a number of networks (physical or virtual)
 - ♣ Installed multiple network cards
 - ➔ Each card can have one IP and may be connected to a network
- | This means that an host may be connected to multiple networks with multiple IP
- | Network cards may be connected to:
 - ♣ Physical switch
 - ♣ Virtual switch





Example of Cloud Networking

Example of allocation of a three tiers solution

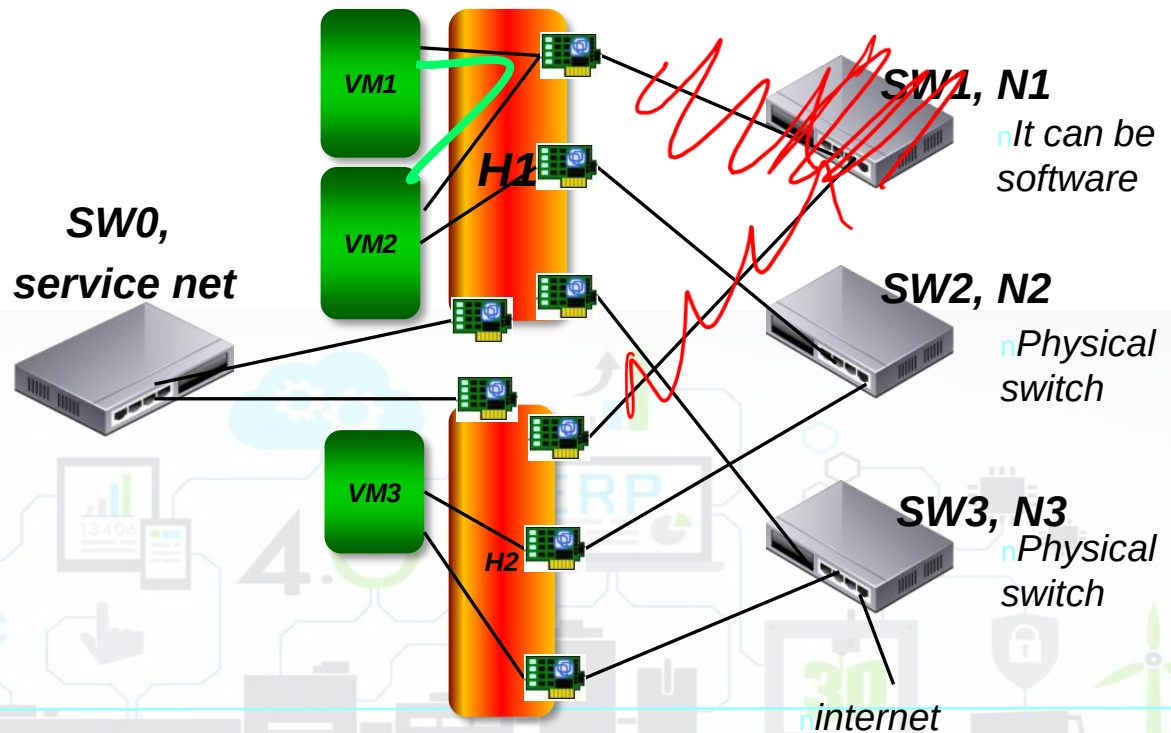
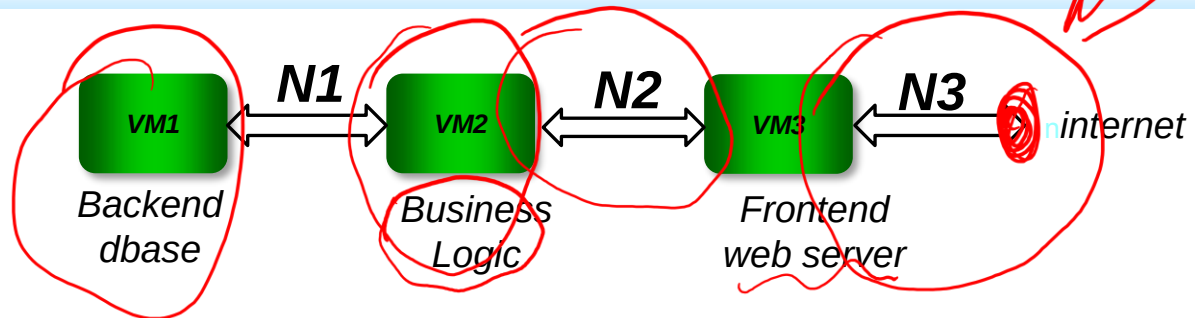
3 different networks (N1, N2, N3)

2 Host: H1, H2

3 VM: VM1, VM2, VM3

→ SW1 is convenient to be software (full virtual). If it is HW, the VM1 can be moved from H1 to H2, dynamically

→ SW2 could be fully virtual if VM3 is moved on H1





Example of Cloud Networking

Example of allocation of a three tiers solution

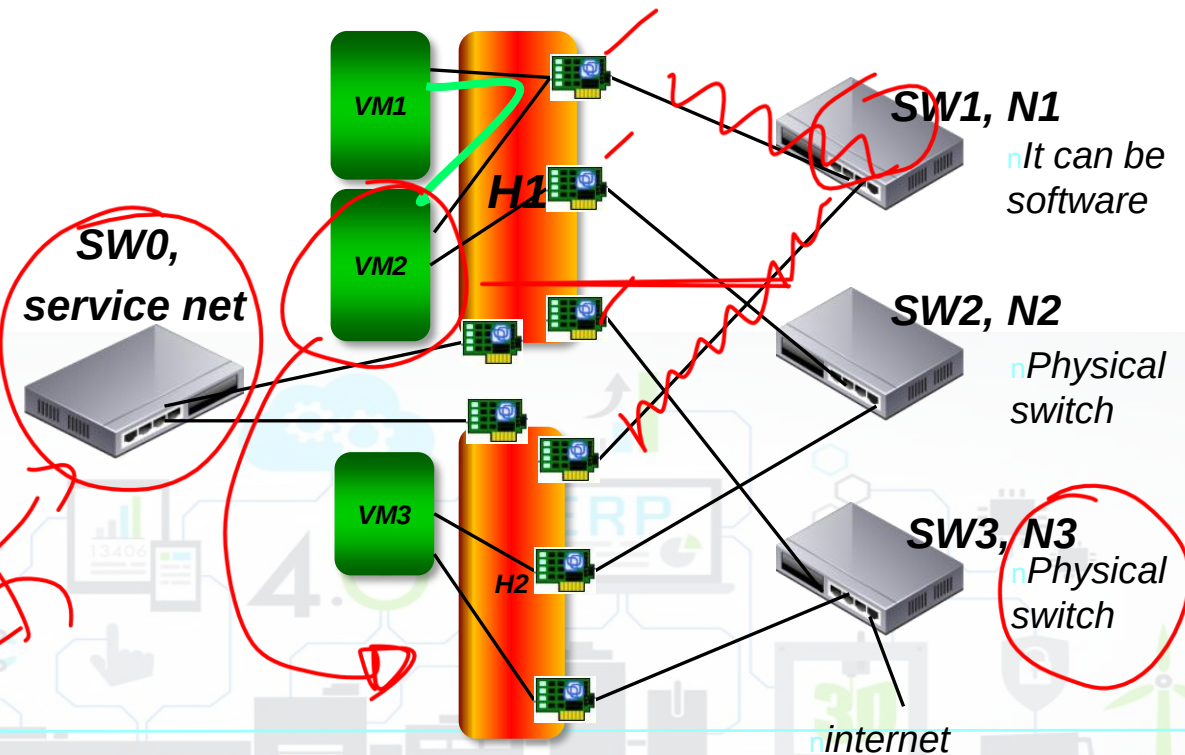
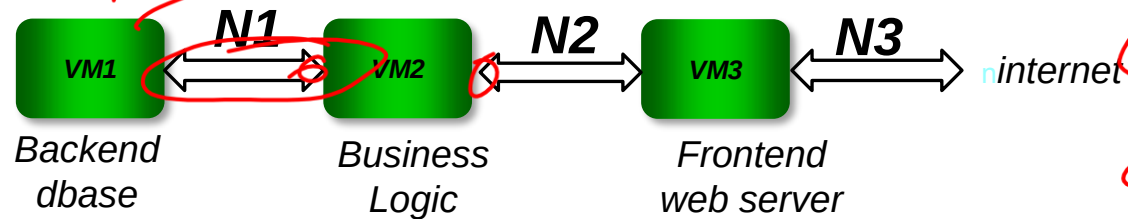
3 different networks (N1, N2, N3)

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Example of Cloud Networking

Example of allocation of a three tiers solution

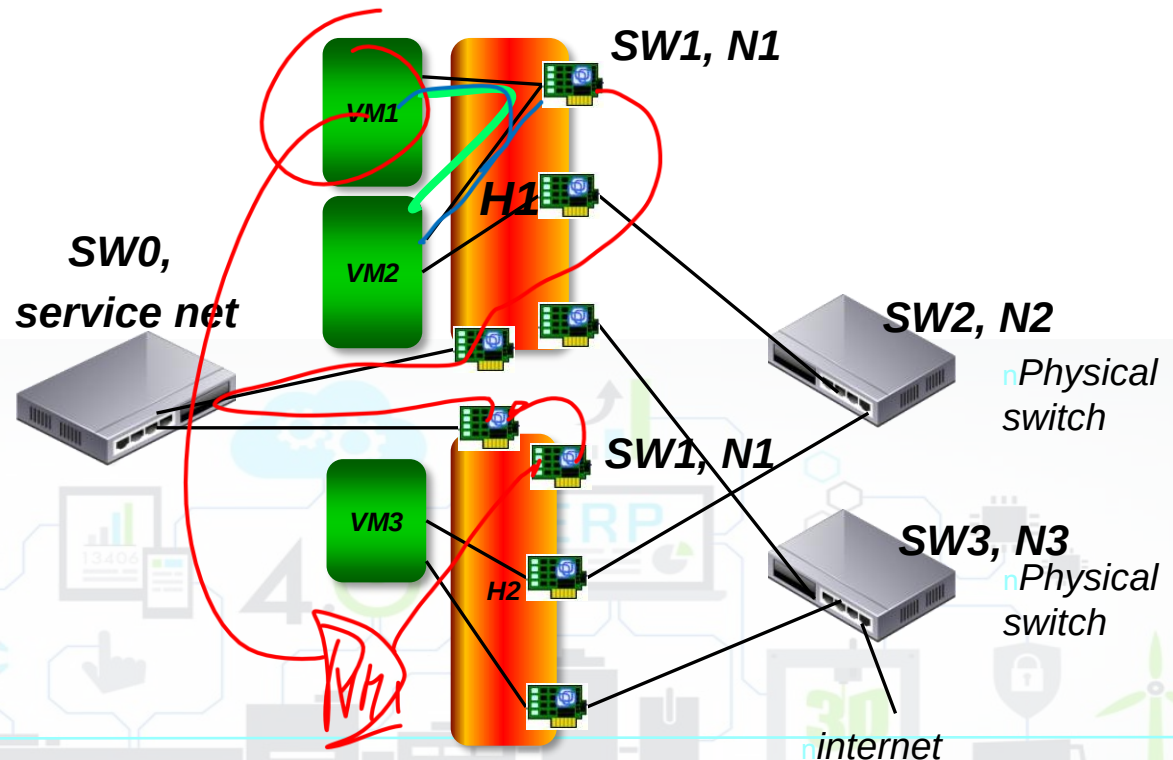
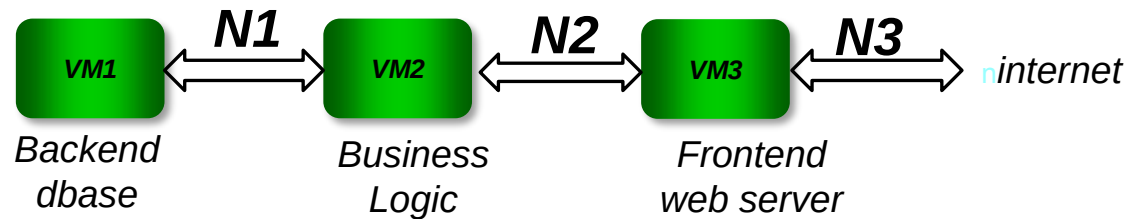
3 different networks (N1, N2, N3)

2 Host: H1, H2

3 VM: VM1, VM2, VM3

→ SW1 is convenient to be software (full virtual). If it is HW, the VM1 can be moved from H1 to H2, dynamically

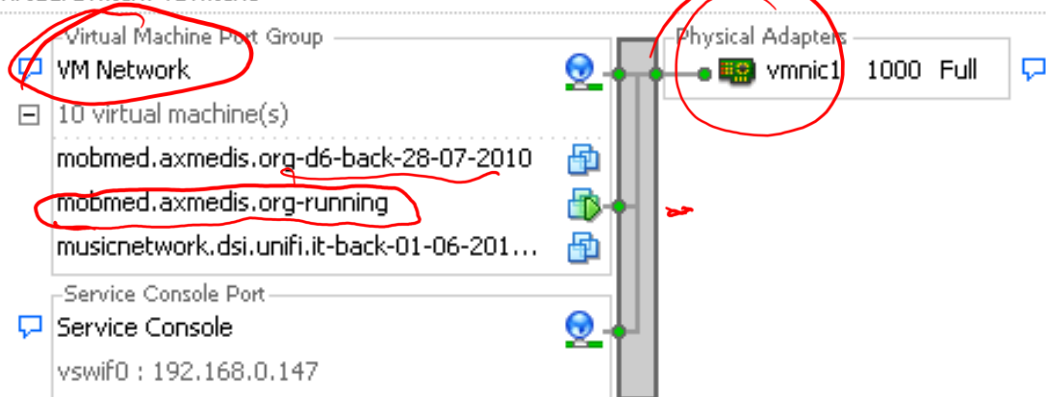
→ SW2 could be fully virtual if VM3 is moved on H1





Network and Virtual Networks

Virtual Switch: vSwitch0



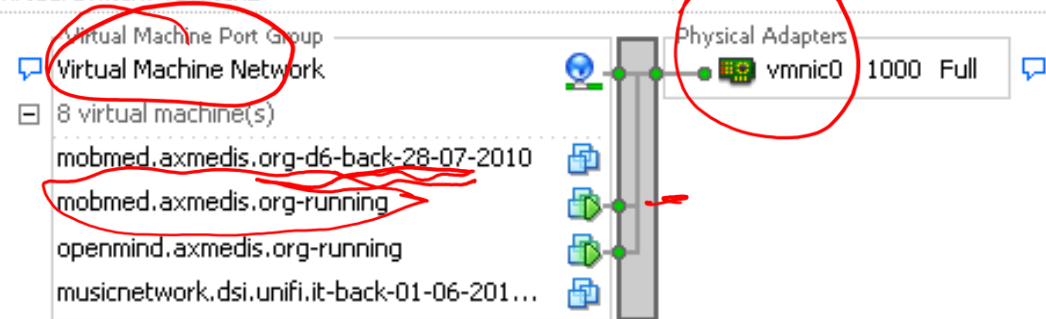
| The same VM with access to 2 different network via real network adapters

Virtual Switch: vSwitch1



| A virtual network

Virtual Switch: vSwitch2





Model for HD, Storage



| Storage:

- ♣ HD contained into VM
- ♣ SAN: External to VM and mounted for their usage
- ♣ In any case connected with some Operating Systems (may be dedicated)

NAS host

| HD with fault tolerant solution:

- ♣ Redundancy: replications into the Storage
- ♣ Distributed/federate/replicated: replications into multiple storage





Model for HD, Storage



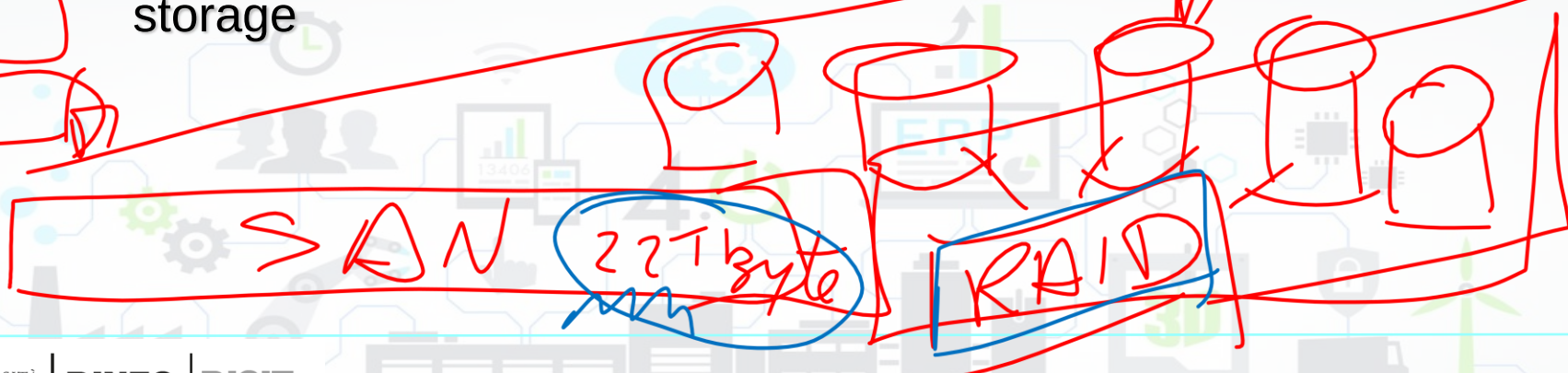
Storage:

- ♣ HD contained into VM
- ♣ SAN: External to VM and mounted for their usage
- ♣ In any case connected with some Operating Systems (may be dedicated)

HD with fault tolerant solution:

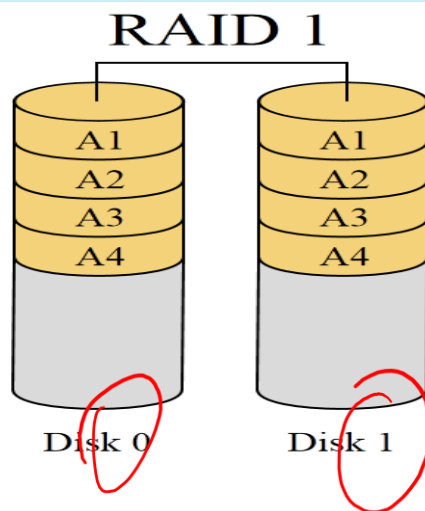
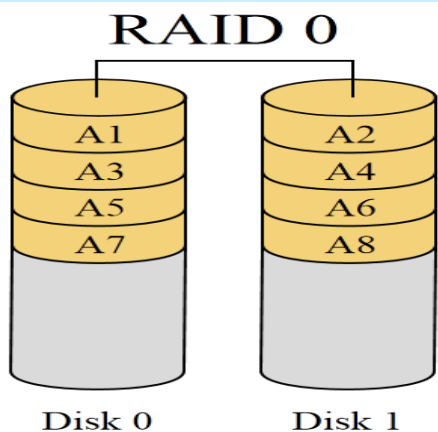
- ♣ Redundancy: replications into the Storage
- ♣ Distributed/federate/replicated: replications into multiple storage

LUK
15
11V



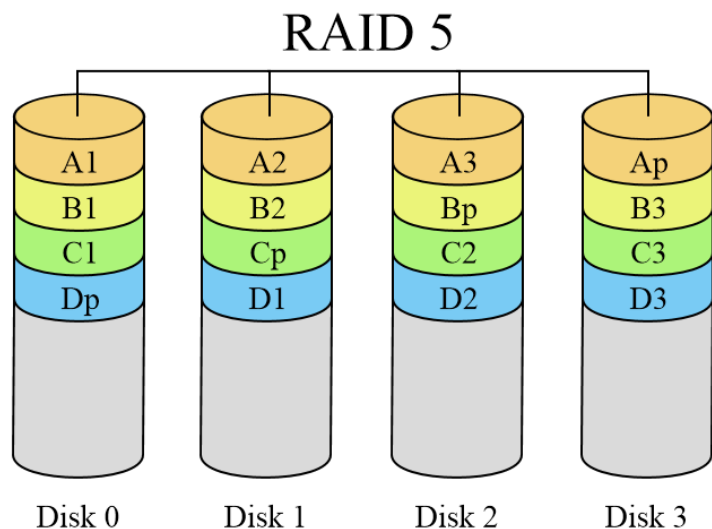


Internal replications: HD RAID



nRAID 0: HD0+HD1

nRAID 1: HD0 cloned on HD1



nRAID 5: gestione del guasto di un disco

n valido fino a 14

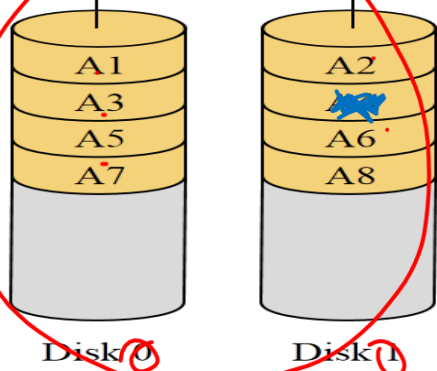
*n per la doppia parità
→ RAID 6*



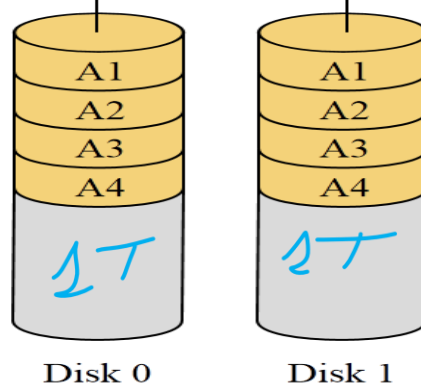
Internal replications: HD RAID



RAID 0



RAID 1

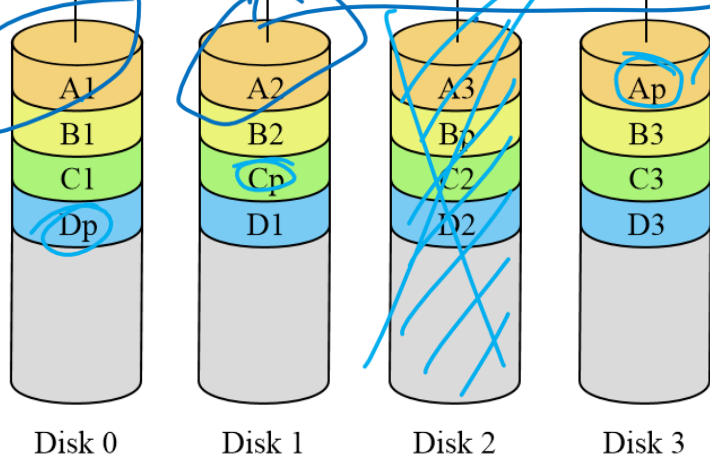


RAID 0: HD0+HD1

2T
1T + 1T = 2T

RAID 1: HD0 cloned on HD1

RAID 5



RAID 5: gestione del guasto di un disco

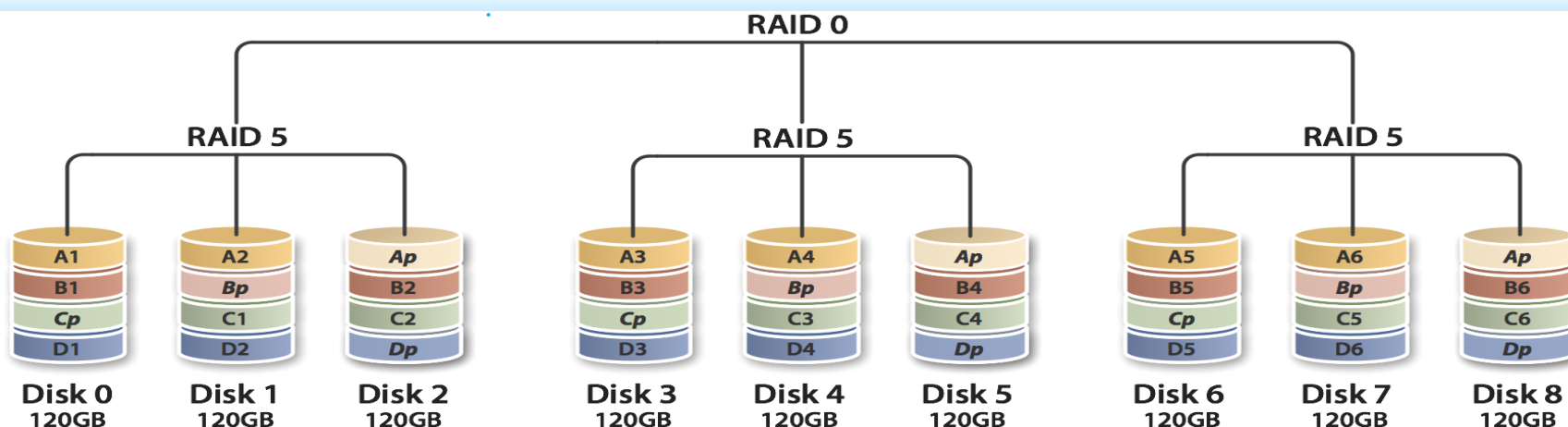
valido fino a 14

per la doppia parità
→ RAID 6





Internal replications: RAID 50



RAID 50: A1,A2,A3,A4,A5,A6 and three Parities

- ♣ Min 9HD, can support failures of three HDs
- ♣ improves upon the performance of RAID 5

In this case:

- ♣ Size: 6 over 9 HD, you lose a HD per R5
- ♣ Read/Write speed up: $n(m - 1) \times \text{HD}$

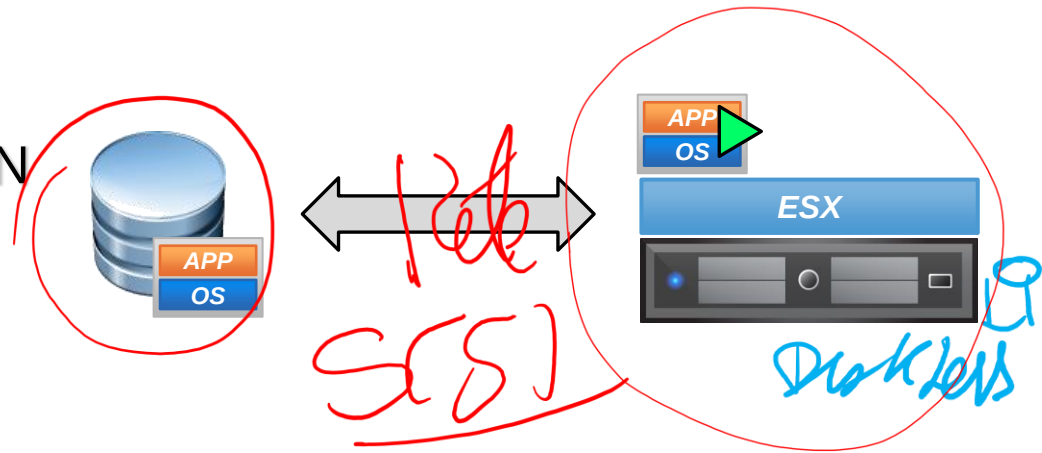
→ $n=3, m=3 \rightarrow 6x$ in this case



Simple configuration

VM stored on a storage and executed on a remote hypervisor host

- At the start is uploaded on ESX memory and RUN
- Each write is passed back to the storage, SAN
- All via network



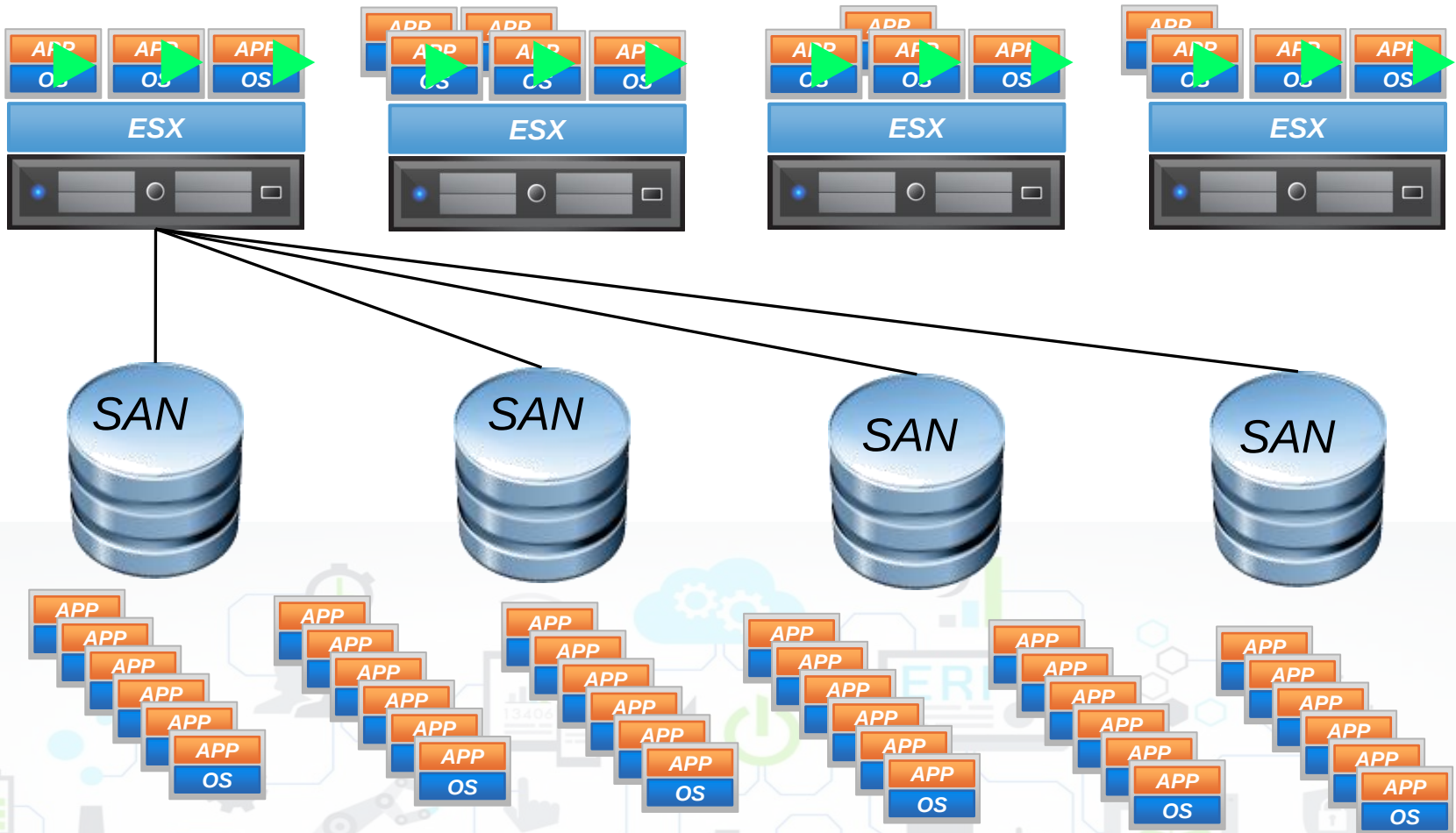
VM stored and executed on the same hypervisor host

- At the start is uploaded on ESX memory and RUN
- Each write is passed back to the storage
- All via internal communication
- higher performances
- lower flexibility





Cluster of Hosts in DRS







Model for storage consumption



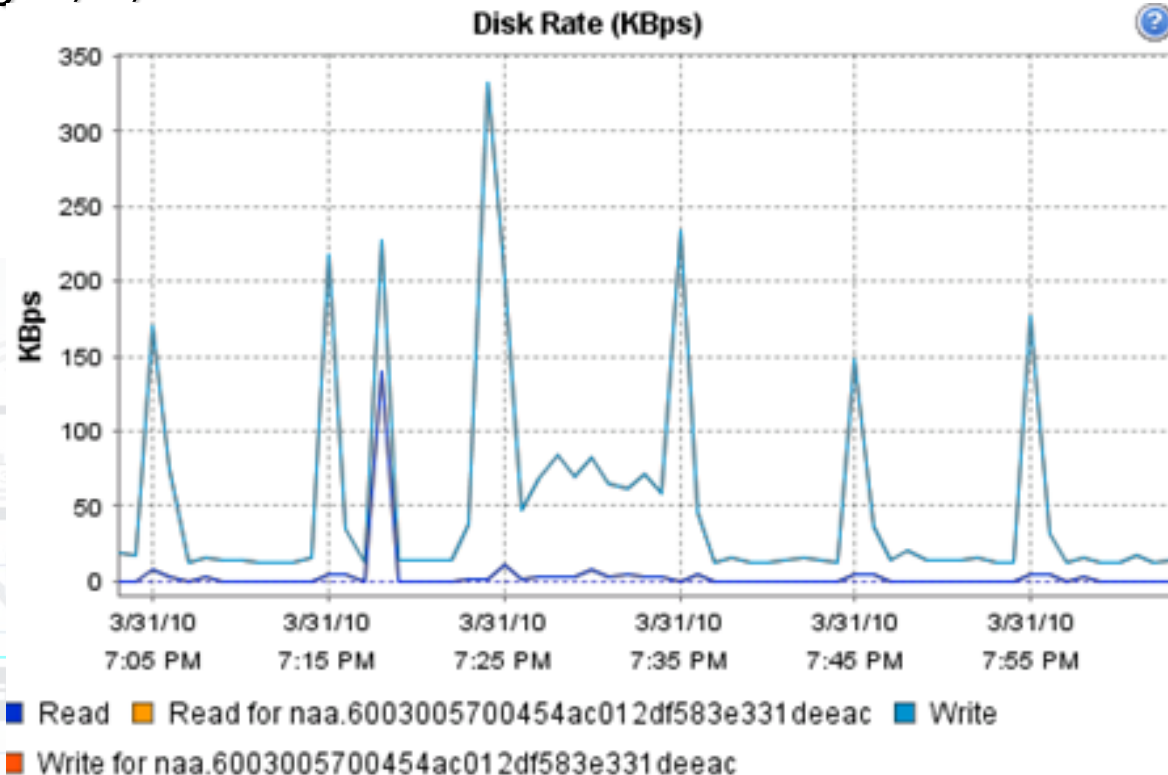
HDD Typical:

- ♣ 100 Mbyte per sec. (high/max value) *DMA*
- ♣ Seek time 5-7 Msec.
- ♣ 5000-7500-10000-15000 rpm (revolution per minute), spindle
- ♣ Thus latency: (5.56, 4.17, 3.00, 2.00) respectively *ms*
- ♣ Format Block size: 2Mbyte, 4, ..8

Cache, no cache;
different kind:

SSD:

- ♣ 30% faster

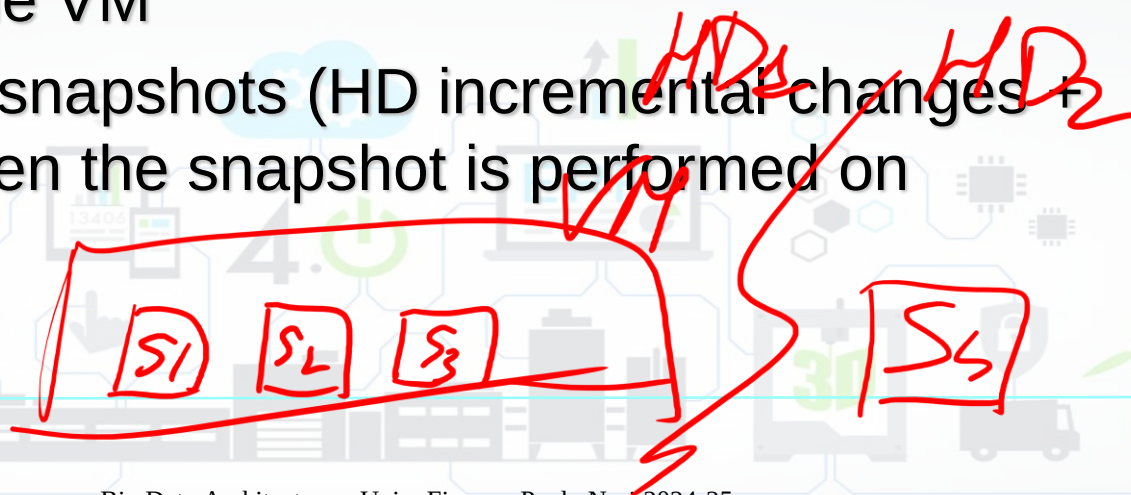




Storage Consumption



- | Each host may have
 - ♣ internal Storage one or more HD
 - ♣ External storage may be mounted (SAN or NAS)
- | External storage may be shared or reserved for a specific Host
- | Each VM has its permanent memory consumption:
 - ♣ Image for the VM
 - ♣ + space for snapshots (HD incremental changes + memory when the snapshot is performed on running)





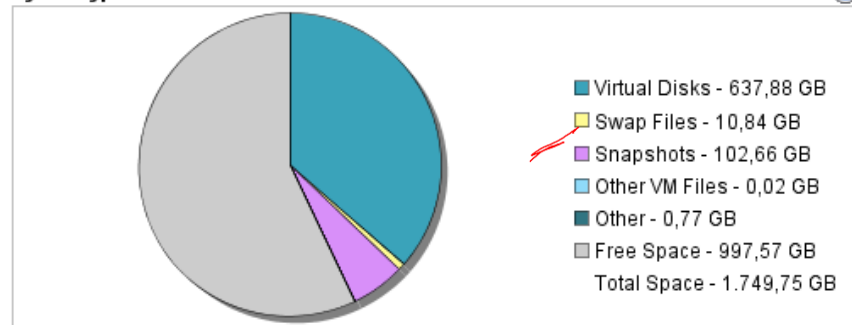
Examples



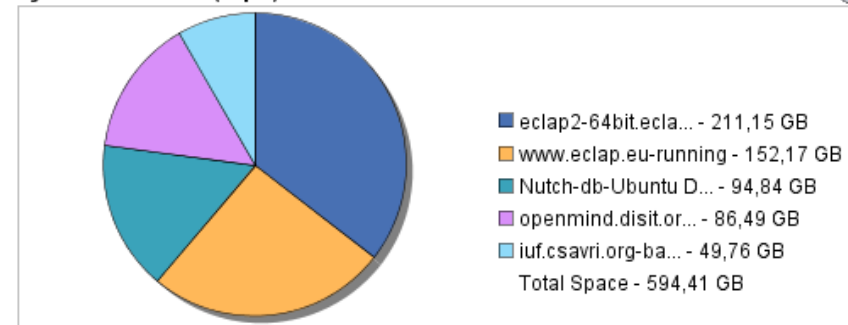
nHost

Space Utilization for 145-Storage-A-4

By File Type

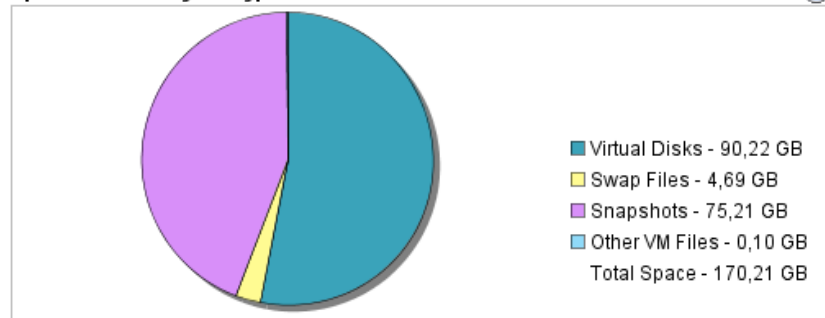


By Virtual Machines (Top 5)

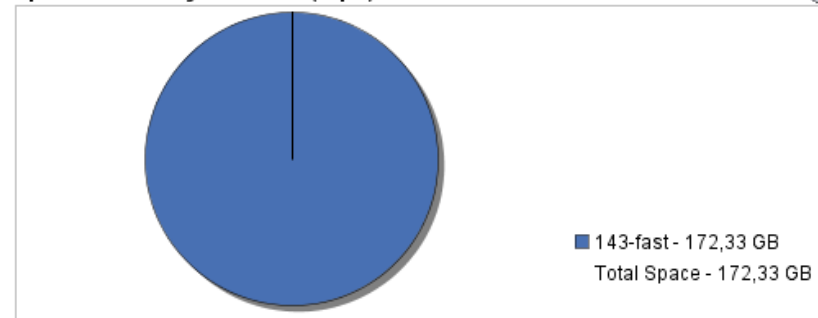


nVirtual Machine

Space Utilization By File Type



Space Utilization By Datastores (Top 5)





Virtual Machine: Snapshots

Working on VM Snapshots

♣ Creating a Snapshot:

- ➔ A point from which it is possible to ~~reboot~~, restart
- ➔ Consuming HD space
- ➔ Making back up since the core image of the VM is not changed, changes are confined in the files representing the last status “you are here” and not the previous conditions

♣ Restarting from a past snapshot

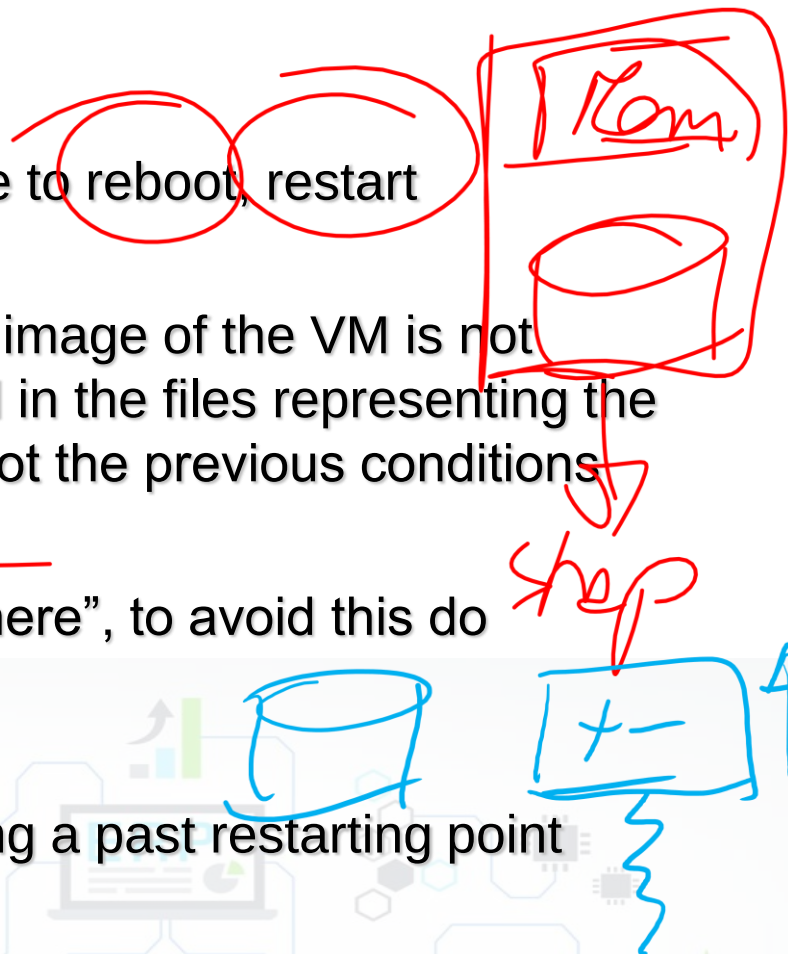
- ➔ Losing current point: “you are here”, to avoid this do another snapshot!!

♣ Deleting a past snapshot

- ➔ Recovering HD space, removing a past restarting point

♣ Removing all snapshots

Defragmenting images of the HDs into the VM





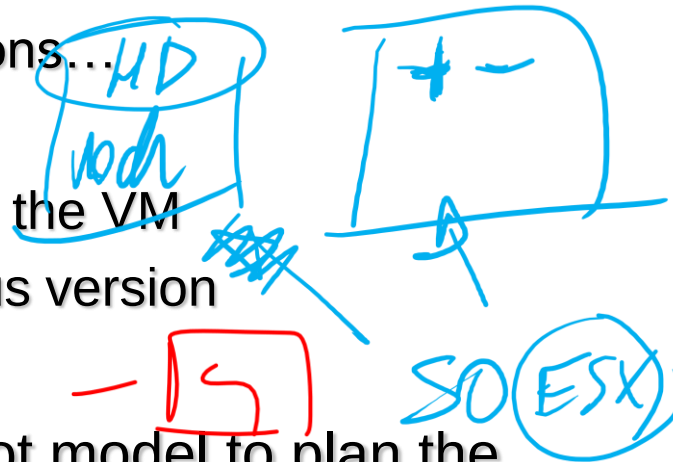
VM Snapshots

VM Snapshots can be at VM Off or ON

- ♣ Snapshots of running VM have implications...

Removing Snapshots

- ♣ Defragmenting images of the HDs into the VM
- ♣ Consolidating the changes in the previous version



VMware WS has an automated Snapshot model to plan the periodic snapshotting of the VM, for example:

- ♣ every hour, day, week, ...

A way to make back up

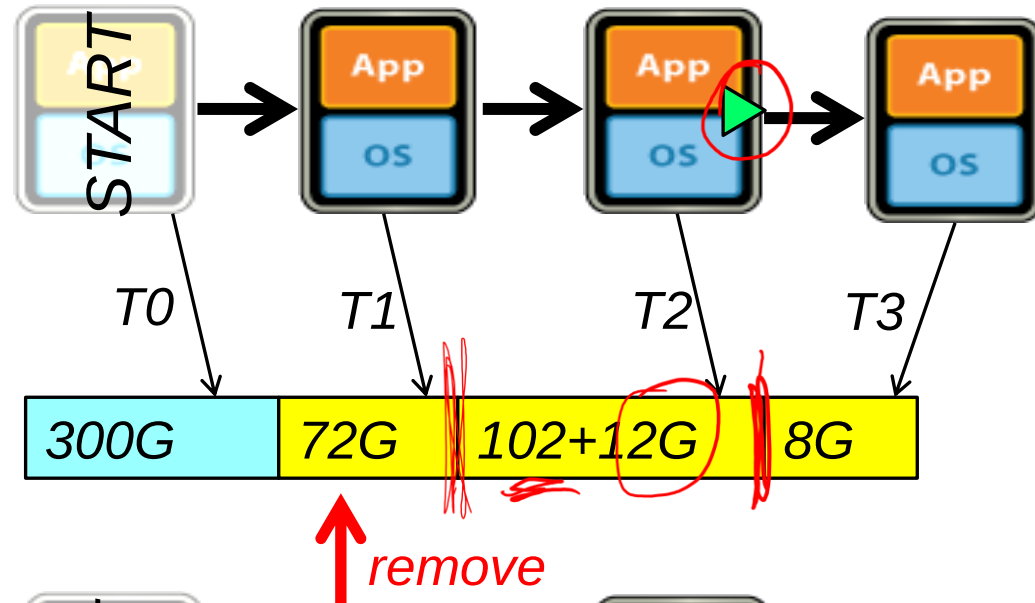
- ♣ A different way can be to clone the VM on different host or NAS. In most cases, the cloning implies the loss of performed snapshots



Snapshot process

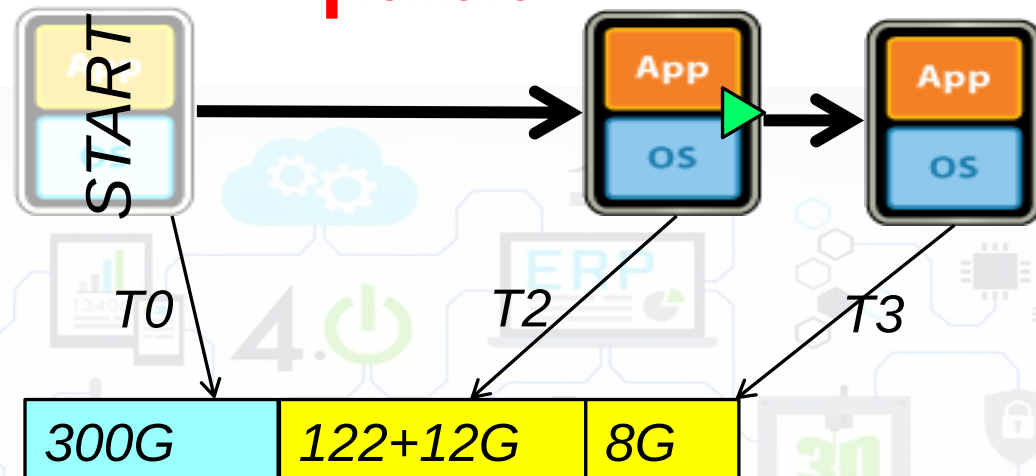
Original version

- 1 VM
- 12 Gb ram
- 300Gbyte hd
- 72+102+12+8 Gbyte snapshots



After T1 Rimoval

- 1 VM
- 12 Gb ram
- 300Gbyte hd
- 72+122+12+8 Gbyte snapshots

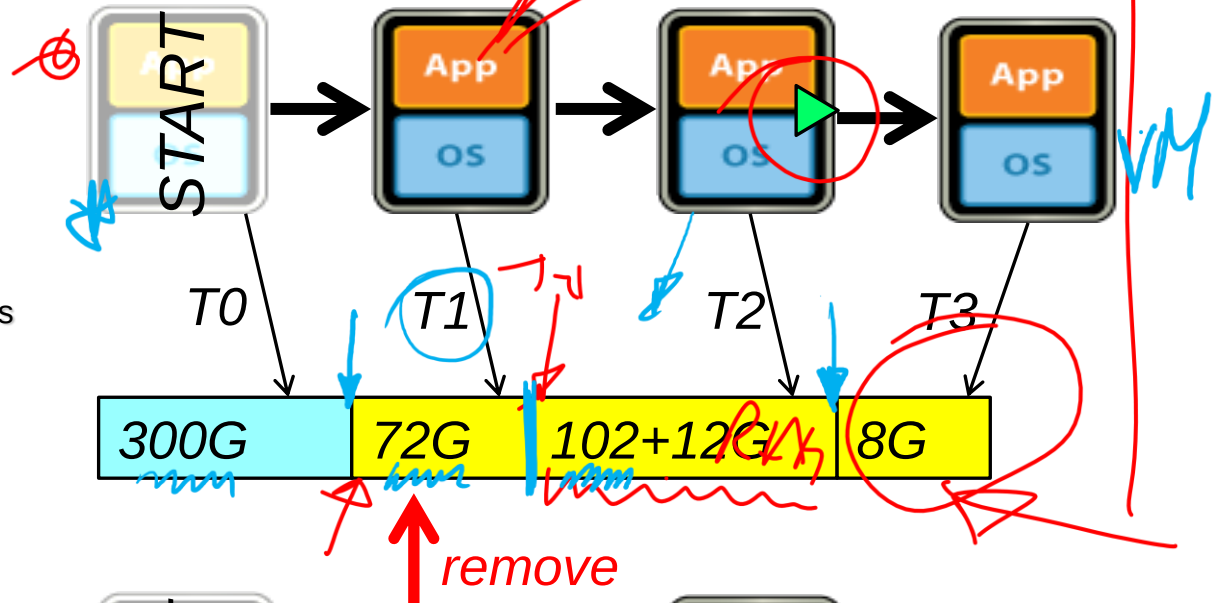




Snapshot process

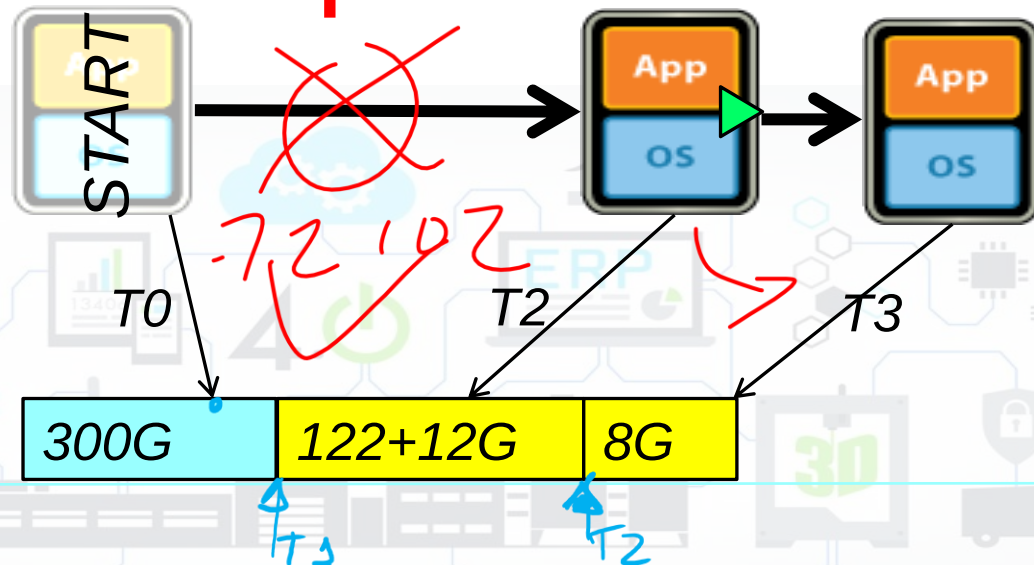
Original version

- 1 VM
- 12 Gb ram
- 300Gbyte hd
- 72+102+12+8 Gbyte snapshots



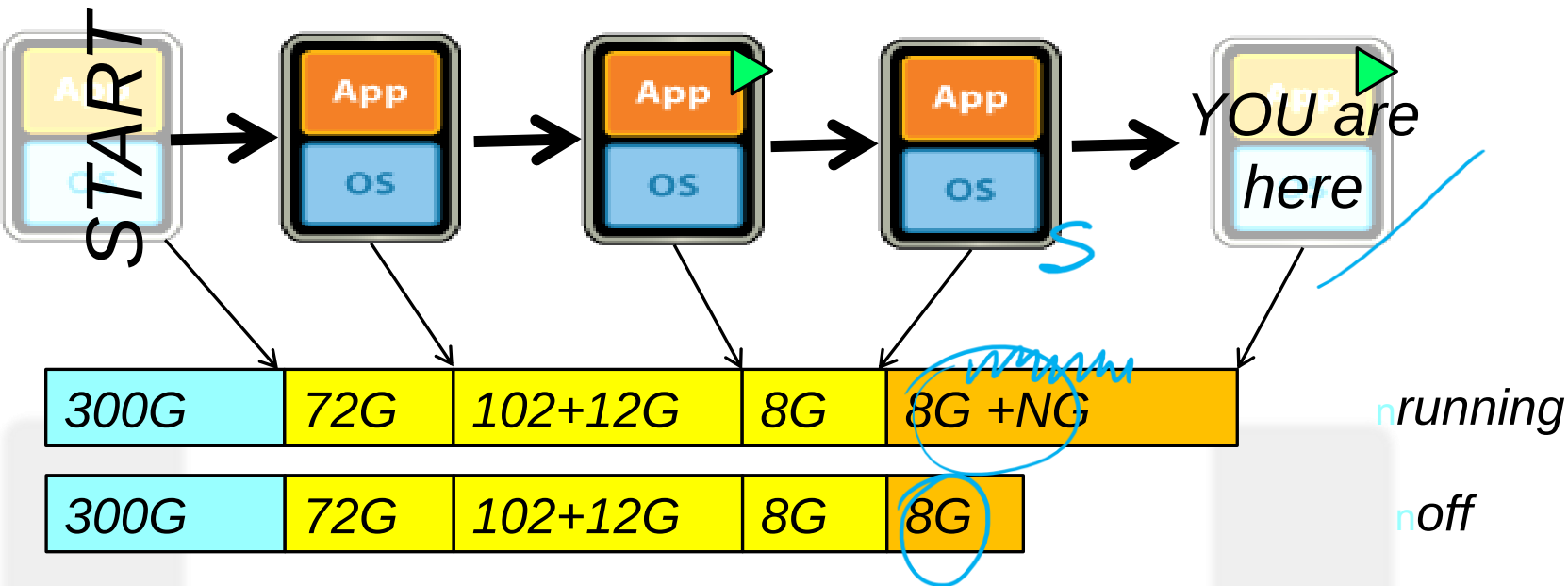
After T1 Rimoval

- 1 VM
- 12 Gb ram
- 300Gbyte hd
- 72+122+12+8 Gbyte snapshots





Virtual Machine: Snapshots, 1/3

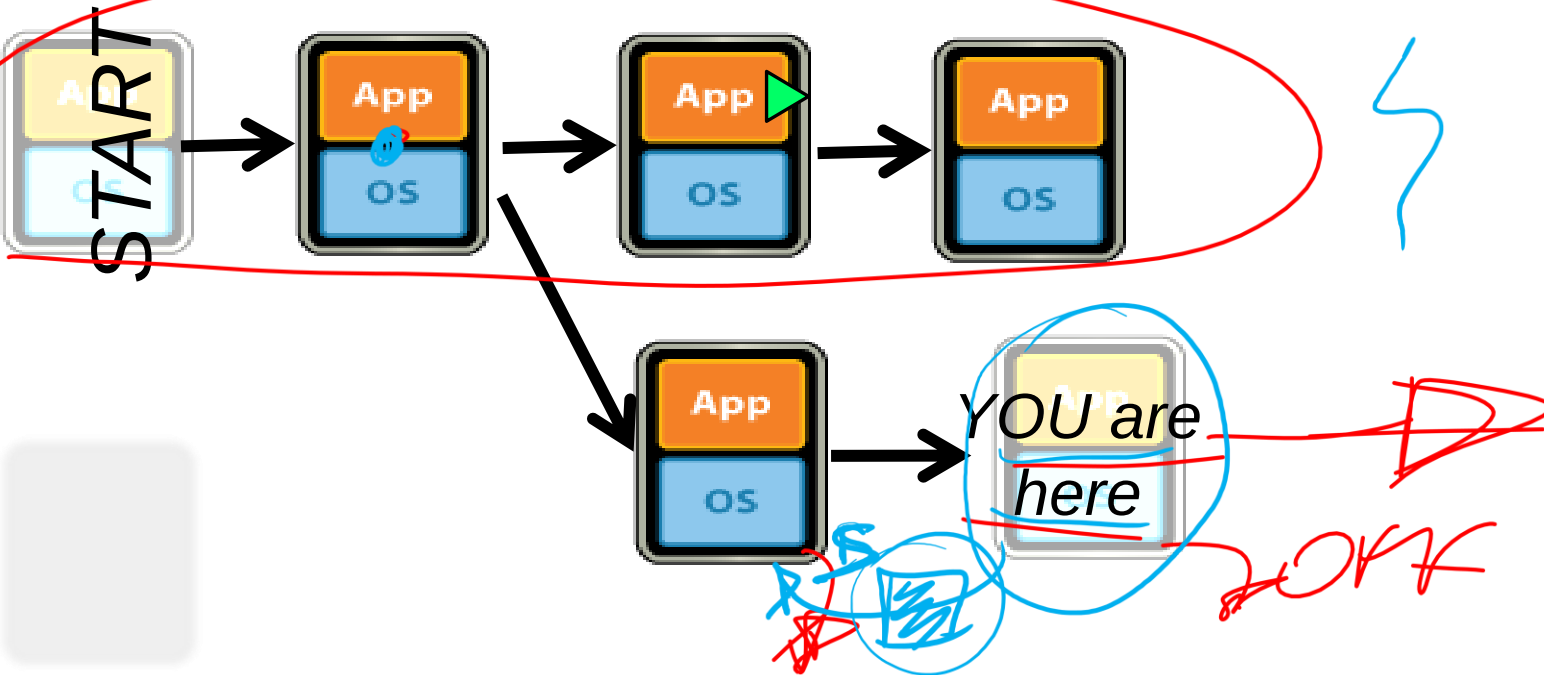


When a number of snapshots are in place:

the access to HD is deteriorating since the data are not contiguous, the data access implies multiple seek for multiple accesses at different segments of the same data in different file representing the different progressive snapshots!

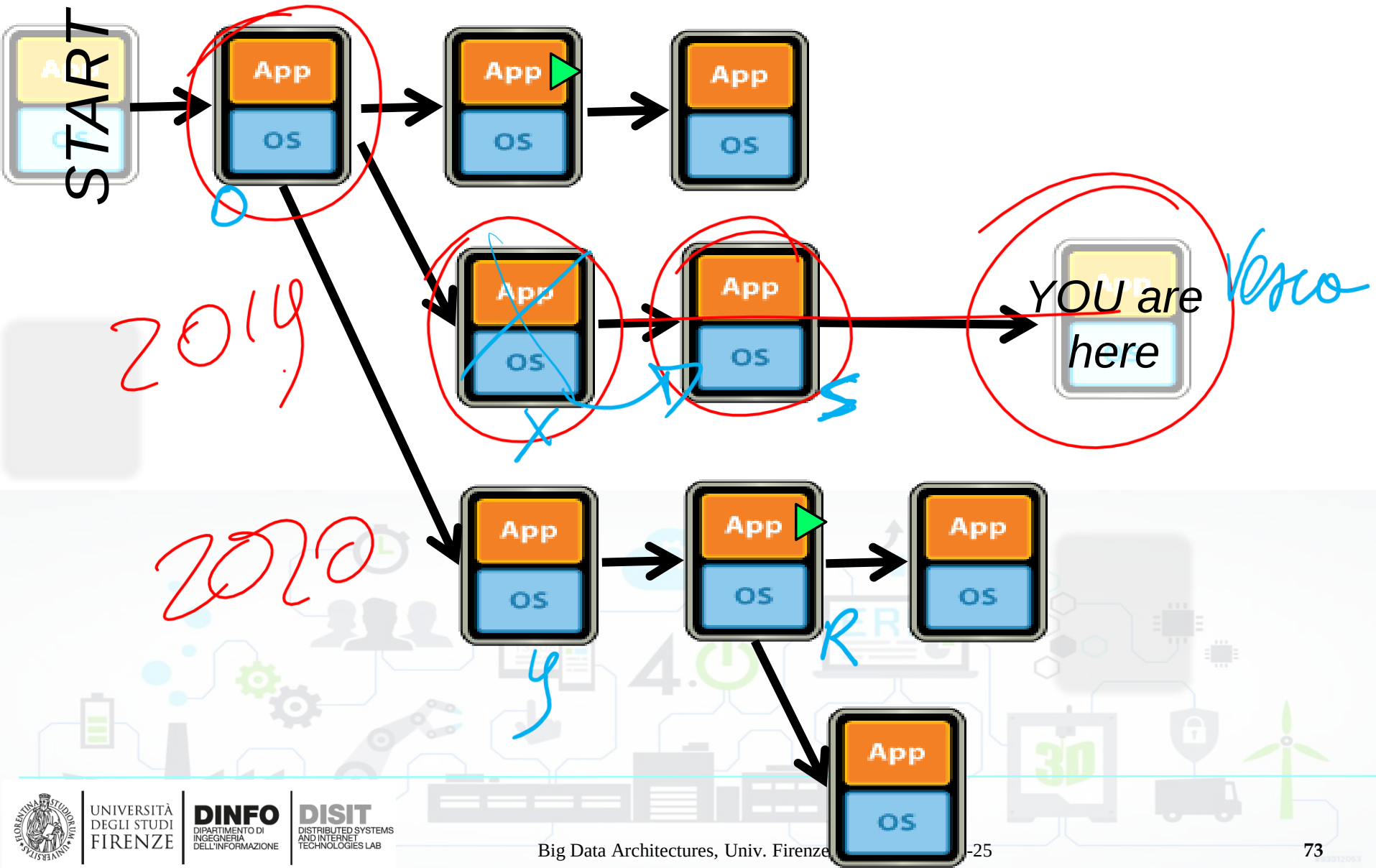


Virtual Machine: Snapshots, 2/3





Virtual Machine: Snapshots, 3/3





Structure

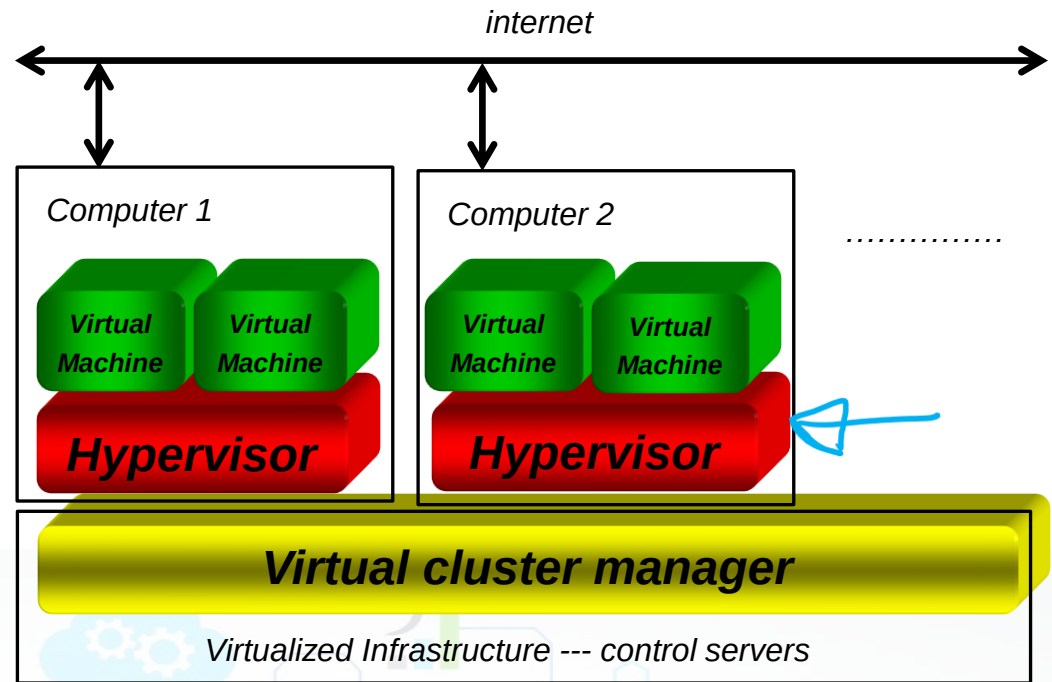
- | Elements of cloud Computing
- | Virtualization
- | Cloud Computing 
 - ♣ cloud vs grid
 - ♣ goals of cloud computing
 - ♣ Solutions as a Service
- | High Availability
- | vSphere Infrastructure
- | Security on the Cloud
- | Conversions among VM and physical machines
- | vCenter, datacenters and cluster management
- | Comparison among virtual computing solutions
- | How to work with Virtual Machines
- | IaaS solutions, SaaS Solutions, PaaS Solutions
- | Progetto ICARO





Cloud Computing with VMs

Several Hypervisors on a Clusters



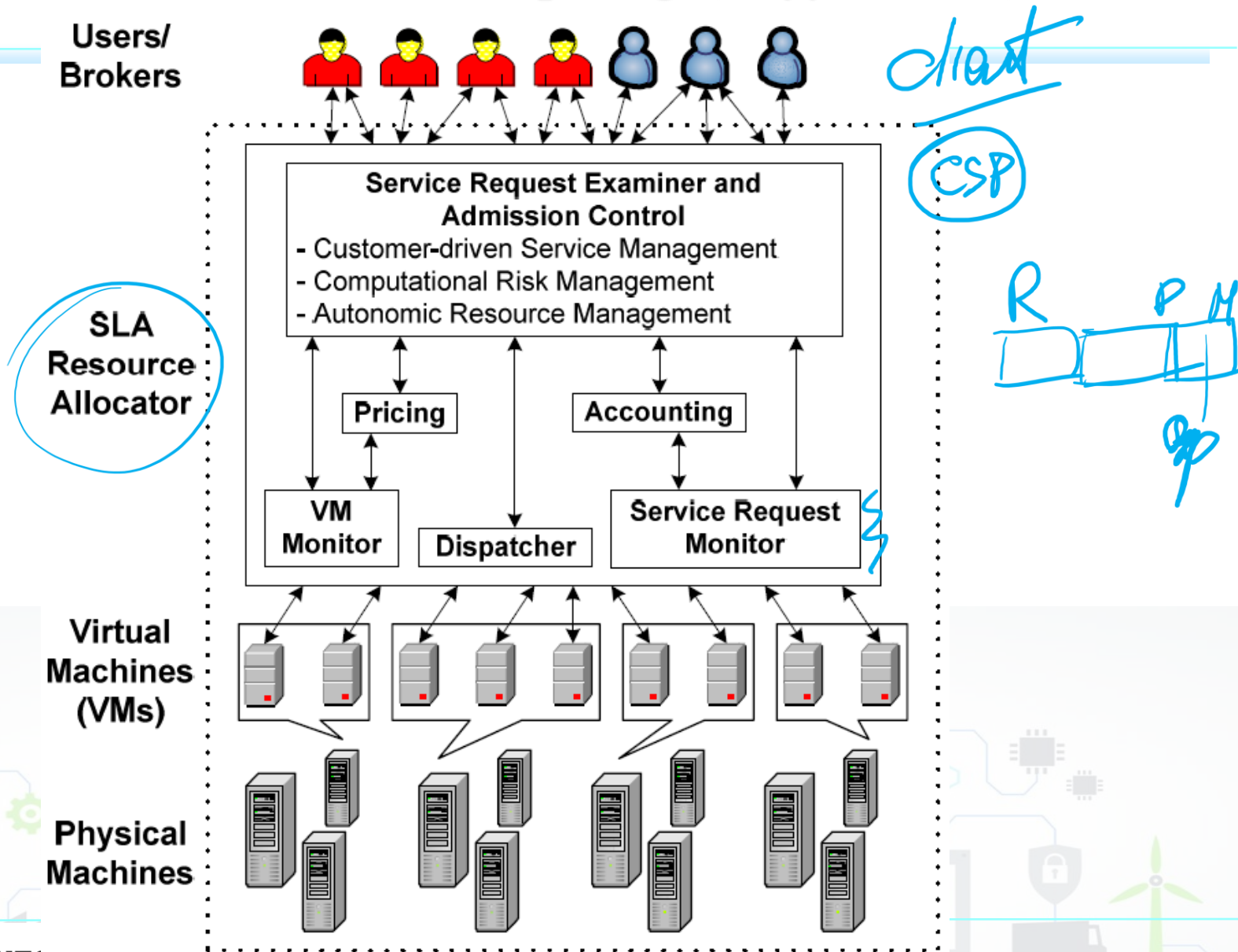


Cloud Computing

- | **A Cloud:** a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers, VMs
 - ♣ They are dynamically provisioned and presented as one or more unified computing resources
 - ♣ based on service-level agreements, SLA, established through negotiation between the service provider and consumers
- | Subset of grid computing where the allocated process are virtual computers
- | **Implies**
 - ♣ An alternative way to have local servers or GRIDs
 - ♣ Outsourcing: HW and SW tools, they may be grid elements
 - ♣ Outsourcing: network, CPU, memory, HD, etc.
 - ♣ Definition of some service agreement, monthly rate, minimum network capability, kind of HW, mem space, minimum level of CPU/mem, etc.



Abstraction of Cloud Computing, (Buyya & Yeo)



High-level market-oriented cloud architecture.



Cloud vs GRID computing, HPCN

- | **Cloud computing** is an evolution of GRID computing
- | **Renting a GRID** service means:
 - ♣ Parallelize the algorithm, demand the execution, wait for the results, etc.
 - ♣ To do not know where the processes are executed. In most cases batch processing such as on Globus
- | **Renting a VM/Computer** into a Cloud means:
 - ♣ Simple contracts, remote access to servers
 - ➔ Get access to virtual or physical resources at 100%
 - ♣ Privacy of the allocated processes in your VM/Host
 - ♣ Processes running on your preferred OS and do not have to be recompiled as in most Grid solutions.
 - ♣ Scalability in terms of number of CPU, Mem, network performance, computers, etc. OR you have to change your OWN architecture
 - ➔ Simple creation and reconfiguration of multitier solutions
 - Creating fault tolerant solutions
 - Balancing load of CPU, Memory, network, etc.



Cloud vs SuperComputers

Cloud Computing is based on a set of Hosts for hosting VM or providing access to single/multiple Servers fully at disposal of the customers accessing to the cloud via remote access (see later).

- ♣ They are MIMD computers
- ♣ Hosts may contains hypervisors to host VM of diff. OSs.
- ♣ Hosts may be single computers with Linux, Windows,...

Super Computers, such as Blue Gene/P:

- ♣ Processor PowerPC 450 with 4 cores, 850 Mhz
- ♣ Each board: 32 CPU processors
- ♣ Each Rack: 32 boards
- ♣ Jülich Research Centre in Germania has a Blue Gene with 65536 processors → 167 teraFlops, the strongest computer in the world!





Comparing Computing Services

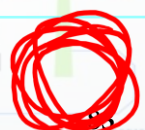
System Property	<u>Amazon</u> Elastic Compute Cloud (EC2)	<u>Google</u> App Engine	<u>Microsoft</u> Live Mesh	<u>Sun</u> Network.com (Sun Grid)	<u>GRIS Lab</u> Aneka
Focus	Infrastructure	Platform	Infrastructure	Infrastructure	Software Platform for enterprise Clouds
Service Type	Compute, Storage (Amazon S3)	Web application	Storage	Compute	Compute
Virtualisation	OS Level running on a Xen hypervisor	Application container	OS level	Job management system (Sun Grid Engine)	Resource Manager and Scheduler
Dynamic Negotiation of QoS Parameters	None	None	None	None	SLA-based Resource Reservation on Aneka side.
User Access Interface	Amazon EC2 Command-line Tools	Web-based Administration Console	Web-based Live Desktop and any devices with Live Mesh installed	Job submission scripts, Sun Grid Web portal	Workbench, Web-based portal
Web APIs	Yes	Yes	Unknown	Yes	Yes
Value-added Service Providers	Yes	No	No	Yes	No
Programming Framework	Customizable Linux-based Amazon Machine Image (AMI)	Python	Not applicable	Solaris OS, Java, C, C++, FORTRAN	APIs supporting different programming models in C# and other .Net supported languages





Comparing Computing Services

- | In the previous table, different solution for computing services in the network are compared.
- | They are mainly: cloud computing, grid services, application services,
- | The solutions taken have been selected as representative of their category
 - ♣ Please see the slides on GRID for more details and a wider comparison on the grid solutions
 - ♣ Please see the slides regarding the general distributed systems for multitier applications





Advantages of Cloud Computing

I Grids are difficult to use and to maintain:

- ♣ GRID customers have too many different needs that make the creation of fully open grid very difficult.

I Cloud computing

- ♣ HW/SW is hosting virtual computers that can be moved to other solutions with low costs
- ♣ Lower costs since the HW/SW is seen as a service
 - ➔ No maintenance, centralized services such as back up, scaling, etc.
- ♣ Lower costs for Small Business:
 - ➔ Reduction of costs since the admortment can be performed by who is exploiting the computer
- ♣ Scalability similar to grid:
 - ➔ Horizontal scaling
 - ➔ Parallelization as MIMD





Goals of Cloud Computing

| **Scalability.**

- ♣ scaling with workload demands so that performance and compliance with service levels remain on target

| **Availability.**

- ♣ users of Internet applications expect them to be up and running every minute of every day, i.e.: h24, 24/7

| **Reliability**

- ♣ physical system components rarely fail, but it happen. So that, they can be replaced without disruption.
- ♣ Today, reliability means that applications do not fail and most importantly they do not lose data, and the service is not stopped.

| **Security.** *Privacy*

- ♣ Applications need to provide access only to authorized, authenticated users, that need to be able to trust that their data is secure.



Goals of Cloud Computing

Flexibility and agility:

- ❖ Adapt rapidly to changes of business conditions by increasing the velocity at which applications are delivered into customer hands. E.g.: more CPU, more clock, more memory, more network cards, etc.

Serviceability:

- ❖ In the past this meant using servers that could be repaired without, or with minimal, downtime.
- ❖ Today it means that an application's underlying infrastructure components can be updated or even replaced without disrupting its characteristics including availability and security.

Efficiency:

- ❖ differentiates the cloud computing. The process allocation and costs have to be very effective with respect to the investment.



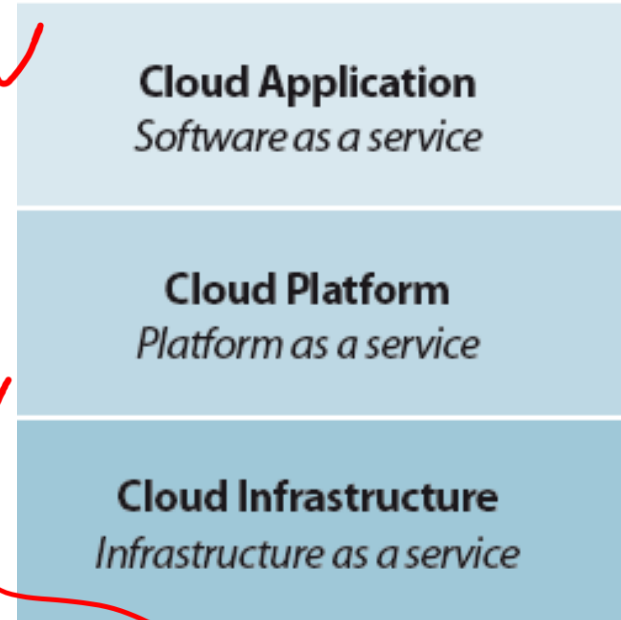
Definizioni

XaaS

Classificazione NIST

- ♣ Software as a Service (SaaS)
- ♣ Platform as a Service (PaaS)
- ♣ Infrastructure as a Service (IaaS)

SW
ITW



Business Process as a Service (BPaaS)

- ♣ Aggiunto in seguito

Everything as a Service (XaaS)

MaaS

- ♣ Middleware as a Service !!!!



Infrastructure as a Service (IaaS)

CSP

- | erogazione di servizi infrastrutturali relativi a capacità elaborativa, storage, rete e altri elementi di base assolutamente indipendenti da servizi applicativi di qualunque tipo.
- | Si utilizza quindi l'infrastruttura messa a disposizione dal provider per eseguire la propria applicazione,
 - ♣ pagamento in base al consumo dell'infrastruttura
 - ♣ lasciando sotto la responsabilità dell'utente la gestione del sistema operativo, dell'eventuale middleware e della parte di runtime, oltre che dell'applicazione stessa.

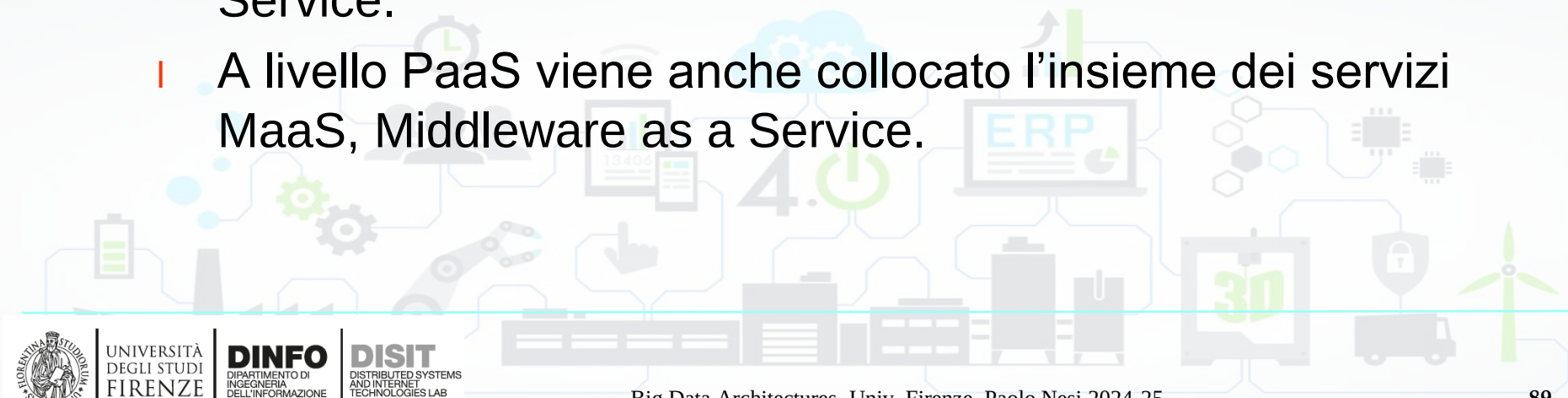
Host
Host up
VM

- | Amazon EC2 è un esempio di servizio IaaS.



Platform as a Service (PaaS)

- | erogazione di servizi applicativi di base come sistemi operativi, middleware, linguaggi, tecnologie di base dati e l'ambiente runtime necessari per eseguire l'applicazione,
- | L'applicazione rimane l'unica cosa sotto la responsabilità dell'utente, oltre alla definizione del modello (e.g., numero e dimensione dei server, datacenter, caratteristiche del networking) da utilizzare per l'esecuzione dell'applicazione.
- | Google AppEngine è un esempio di Platform as a Service.
- | A livello PaaS viene anche collocato l'insieme dei servizi MaaS, Middleware as a Service.





Software as a Service (SaaS)

- | erogazione di servizi applicativi di qualunque tipo, accessibili indipendentemente dalla collocazione e dal tipo di device utilizzato.
- | Non è eseguita un'applicazione proprietaria del cliente, ma il cliente stesso paga il diritto (mediante licenza o canone di affitto) di utilizzo di un'applicazione messa a disposizione dal provider, senza preoccuparsi di come essa venga realizzata e gestita nel cloud.
- | L'unica preoccupazione del cliente in questo caso, oltre ovviamente alla scelta della corretta applicazione che soddisfi le sue necessità, è gestire il numero di licenze richieste in funzione del numero di utenti.
- | Salesforce.com Customer Relationship Management (CRM) è un esempio di soluzione in cui il software è venduto in modalità as a service.



Business Process as a Service (BPaaS):

- | erogazione di servizi non esclusivamente riferiti ad ambiti applicativi ma direttamente alle funzionalità di business o di processo, potenzialmente trasversali rispetto alle piattaforme applicative.
- | un processo di business mappato interamente nel cloud (composto da servizi, applicazioni web, applicazioni legacy, servizi di integrazione, etc.).
- | Il processo di business è un pattern di servizi ed include problemi di sicurezza, costi, scalabilità connessione fra local e cloud bidirezionale, il cloud può essere un burst per l'azienda, e può sgravare i costi nel momento del bisogno.





Modello Generale

Caratteristiche
Essenziali

Measured Service

Rapid Elasticity

On-demand self
service

Broad Network
Access

Resource Pooling

Modelli di
Servizio

Software as a
Service (SaaS)

Platform as a
Service (PaaS)

Infrastructure as a
Service (IaaS)

Modelli di
Deployment

Public

Private

Hybrid

Community

CSO



Definizioni

- | **Private Cloud.** abilitata per operare soltanto per un'organizzazione. può essere gestita dalla stessa organizzazione o da parte di terzi.
- | **Community Cloud.** condivisa da più organizzazioni a supporto di una singola community che ha interessi e obiettivi comuni. Questa può essere gestita dalle stesse organizzazioni o da terzi in modalità on-premise e off-premise.
- | **Public Cloud.** resa disponibile in maniera pubblica ed è di proprietà di un'organizzazione che vi gestisce la vendita di servizi cloud.
- | **Hybrid Cloud.** Infrastruttura composizione di due o più cloud (siano essi private, community o pubblici), rimangono entità separate, ma comunque accomunate da standard o tecnologie proprietarie che abilitano un certo livello di portabilità di dati e/o applicazioni di migrazione e/o bursting.



Structure

- | Elements of cloud Computing
- | Virtualization
- | Cloud Computing
- | High Availability 
 - ♣ Workload Balancing
 - ♣ RAID on HD
 - ♣ SAN/NAS
- | vSphere Infrastructure
- | Security on the Cloud
- | Conversions among VM and physical machines
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High Availability

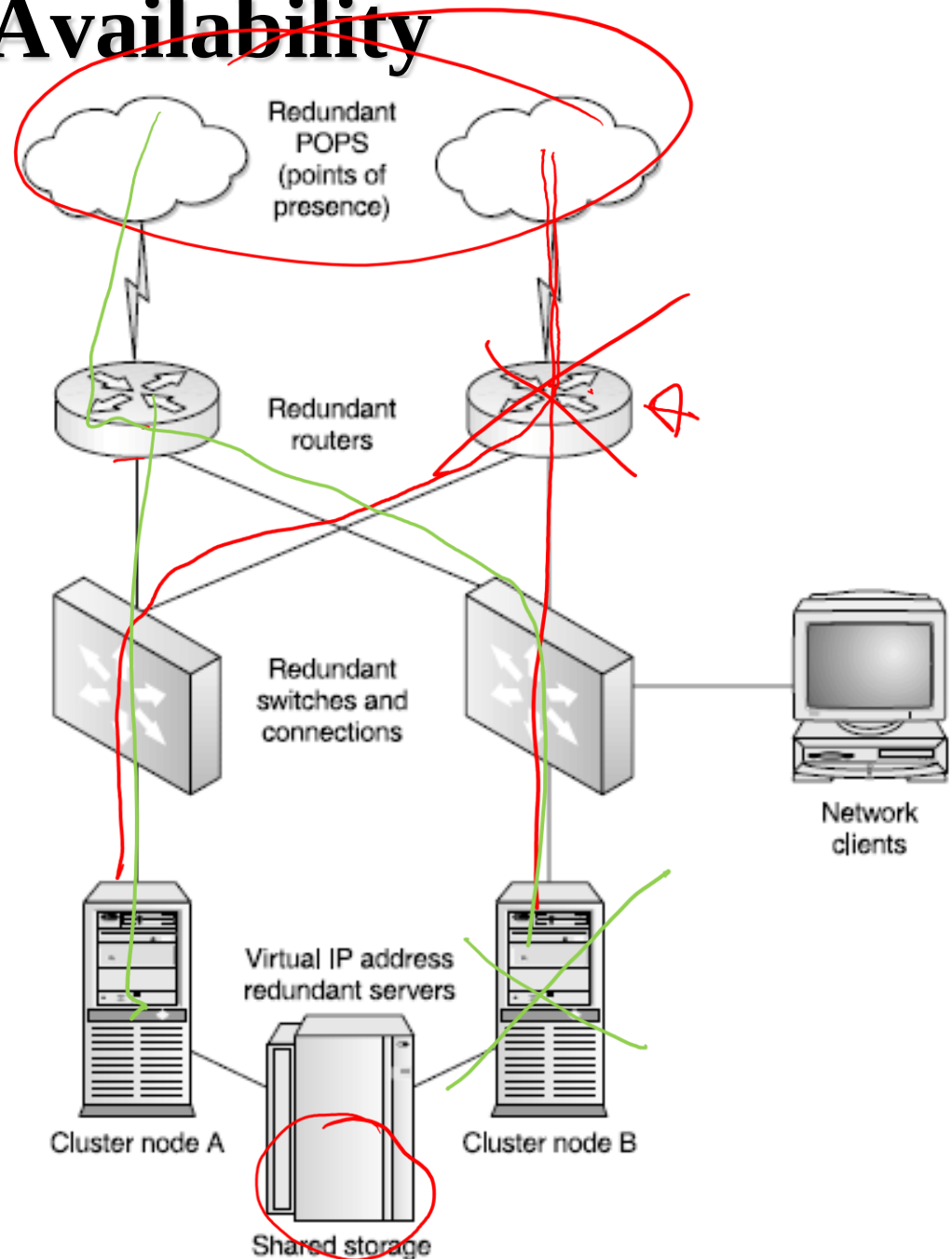
- | The high availability has to be guaranteed only by the integration of features of:
 - ♣ ***High Reliability***
 - ♣ ***High Serviceability***
 - ♣ ***Fault tolerance***
 - ♣ ***Migration of VM to different HW***
 - ♣ ***Disaster recovering***





High Availability

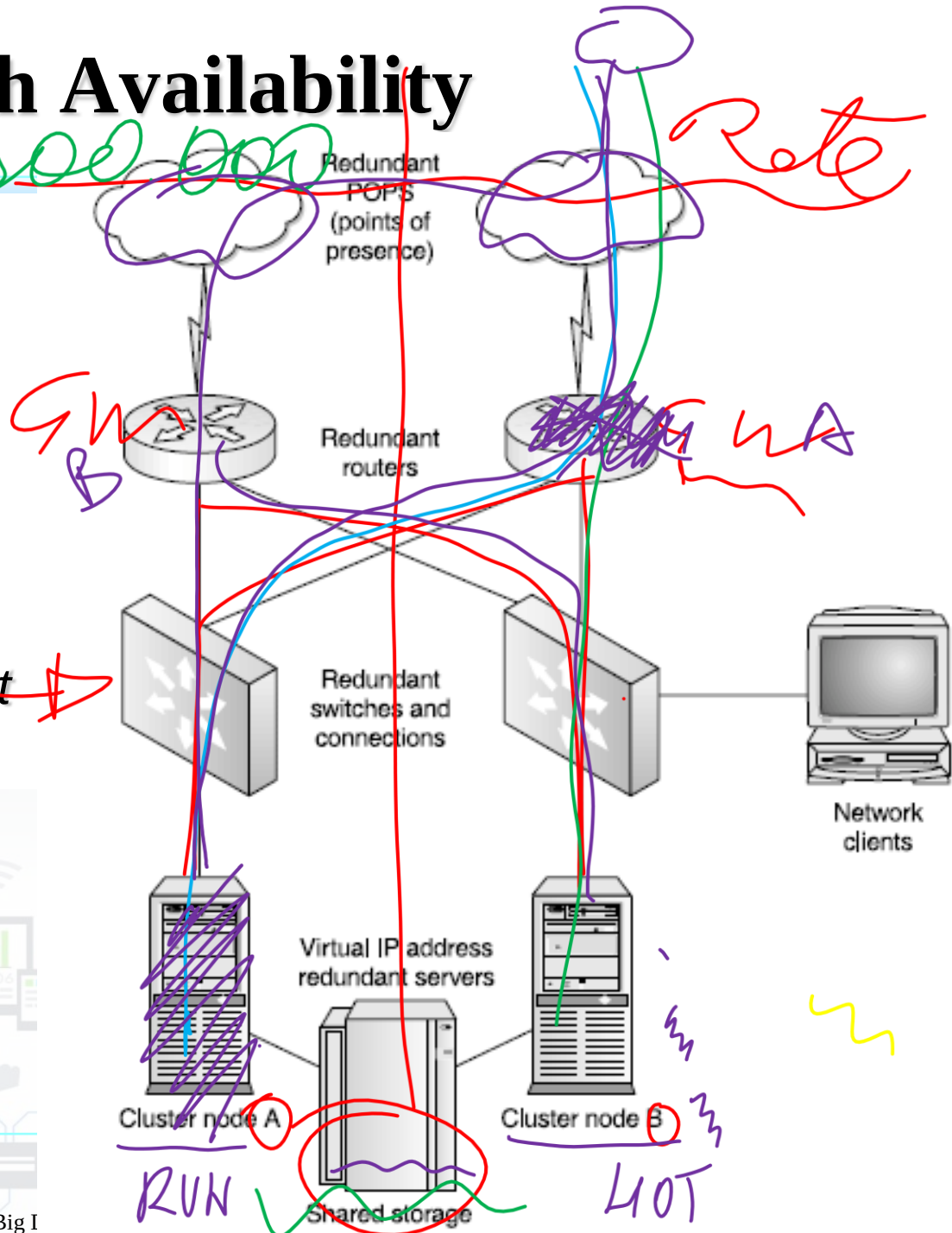
- | **High Availability**, available 99.999 % (called "Five Nines") percent of the time.
- | **Five Nines** is the term for saying a service or system will be up almost 100 percent of the time.
- | In case of failure:
 - ♣ the path changes to guarantee the service





High Availability

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- | **Five Nines** is the term for saying a service or system will be up almost 100 percent of the time.
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 - the path changes to guarantee the service





High Availability

I May be achieved by redundancy of :

- Servers and Services in hot spare or balancing
 - VM based architectures
- HW/SW: power supply, network connections, etc.

♣ **Load Balancing/Balancer** according to server traffic/requests

- Server Clustering, multitier solution

♣ **Hot Spare:**

- Server: cloned server to be used when the main is not functioning: heartbeat to detect the server availability and thus failover. (heartbeat signal to communicate the correct running of a process/CPU)
- HD: Raid based on SAN/NAS, LUN, in host

♣ **Mixed: balancing and hot spare**



High Availability: Load Balancing

Service distributed/cloned on more servers

- According to different policies

 - Round robin

 - Network traffic

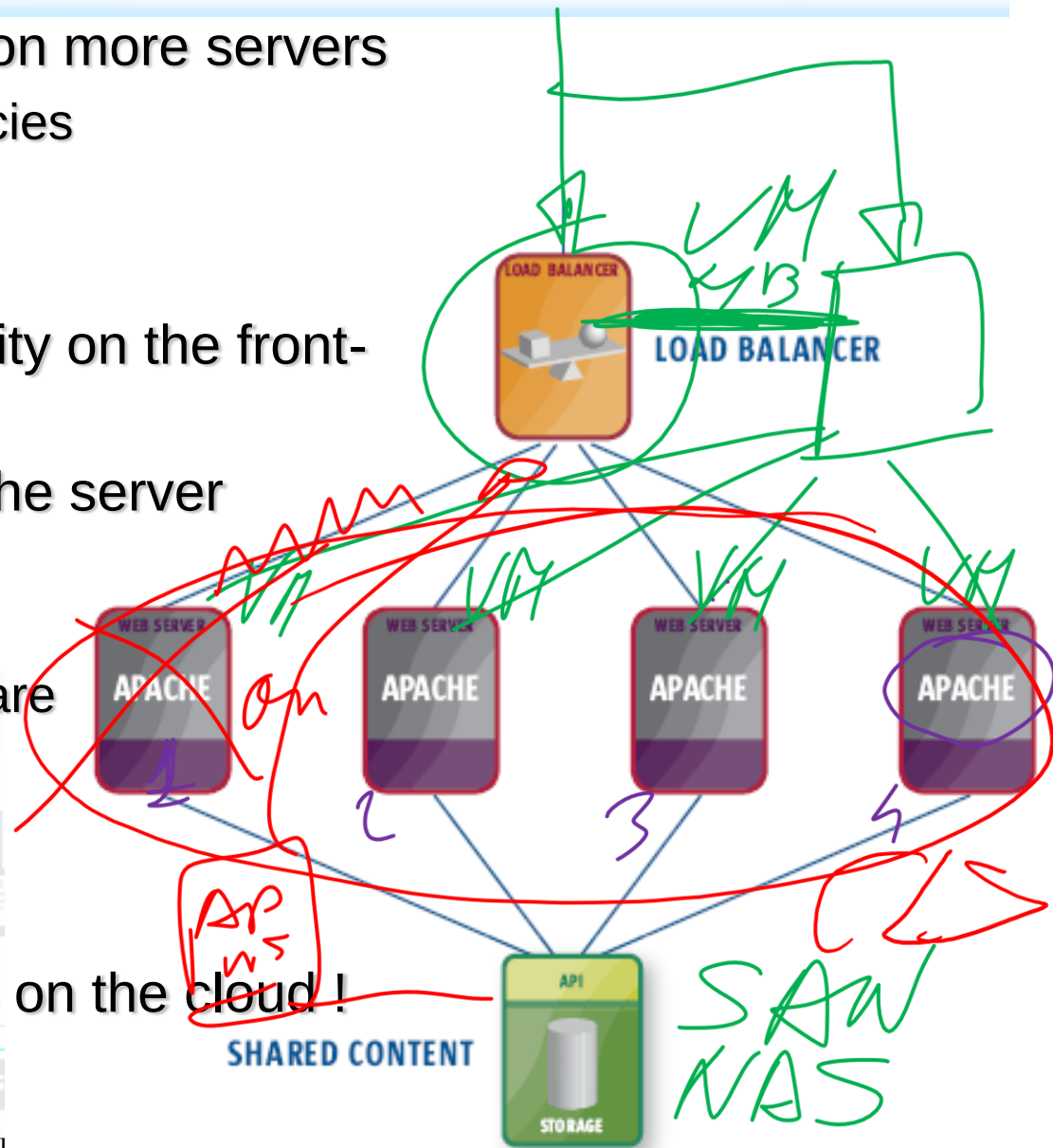
Single transfer rate capability on the front-end of the load balancer

Sensing the availability of the server on balancer +

- heartbeat solutions to understand if the servers are alive or not

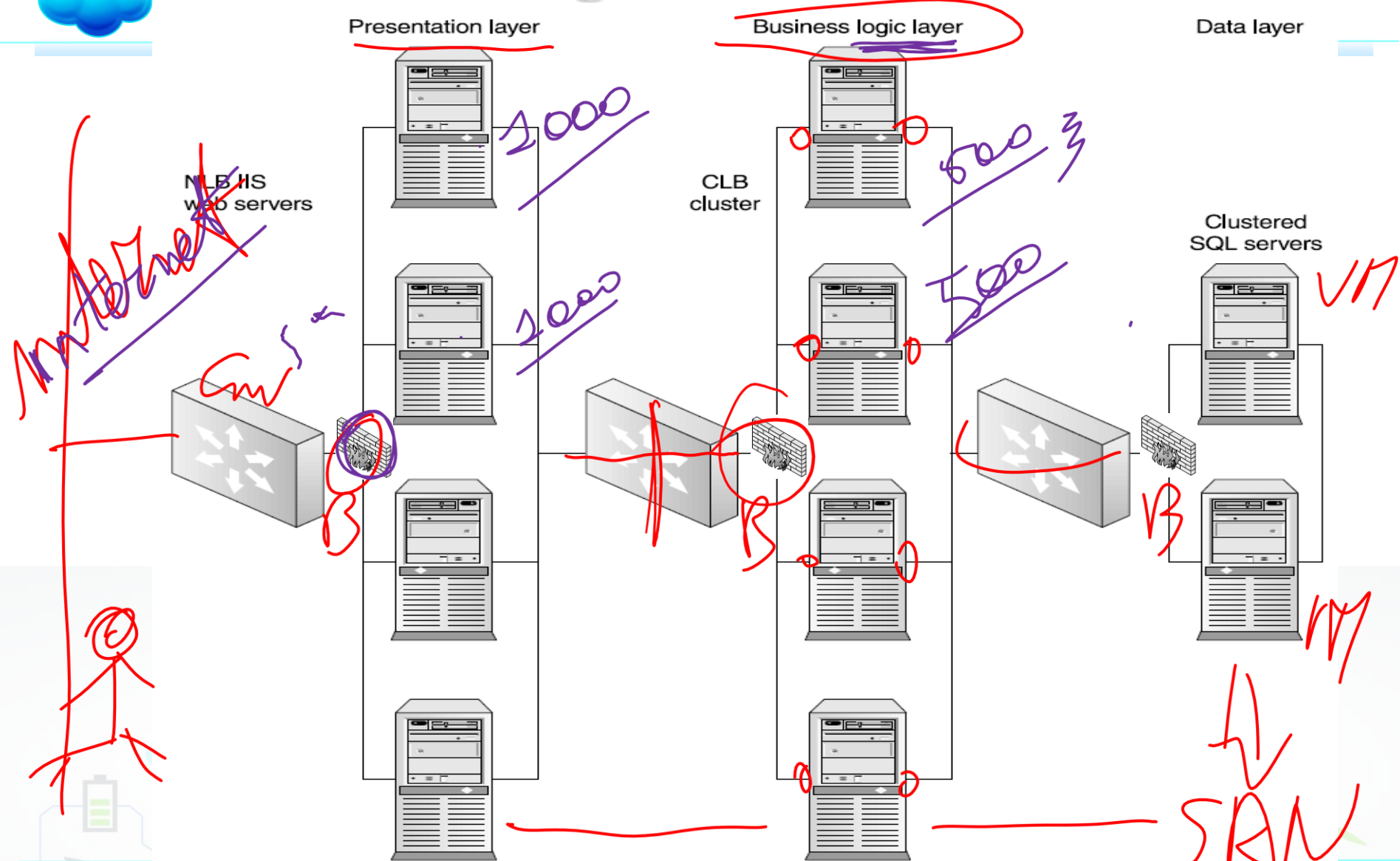
Common NAS/SAN

That is a Cluster of servers on the cloud !





Balancing multi-tier, 3-tier





High Availability: Hot spare

Fully cloned servers to be alternatively used when the running one fails

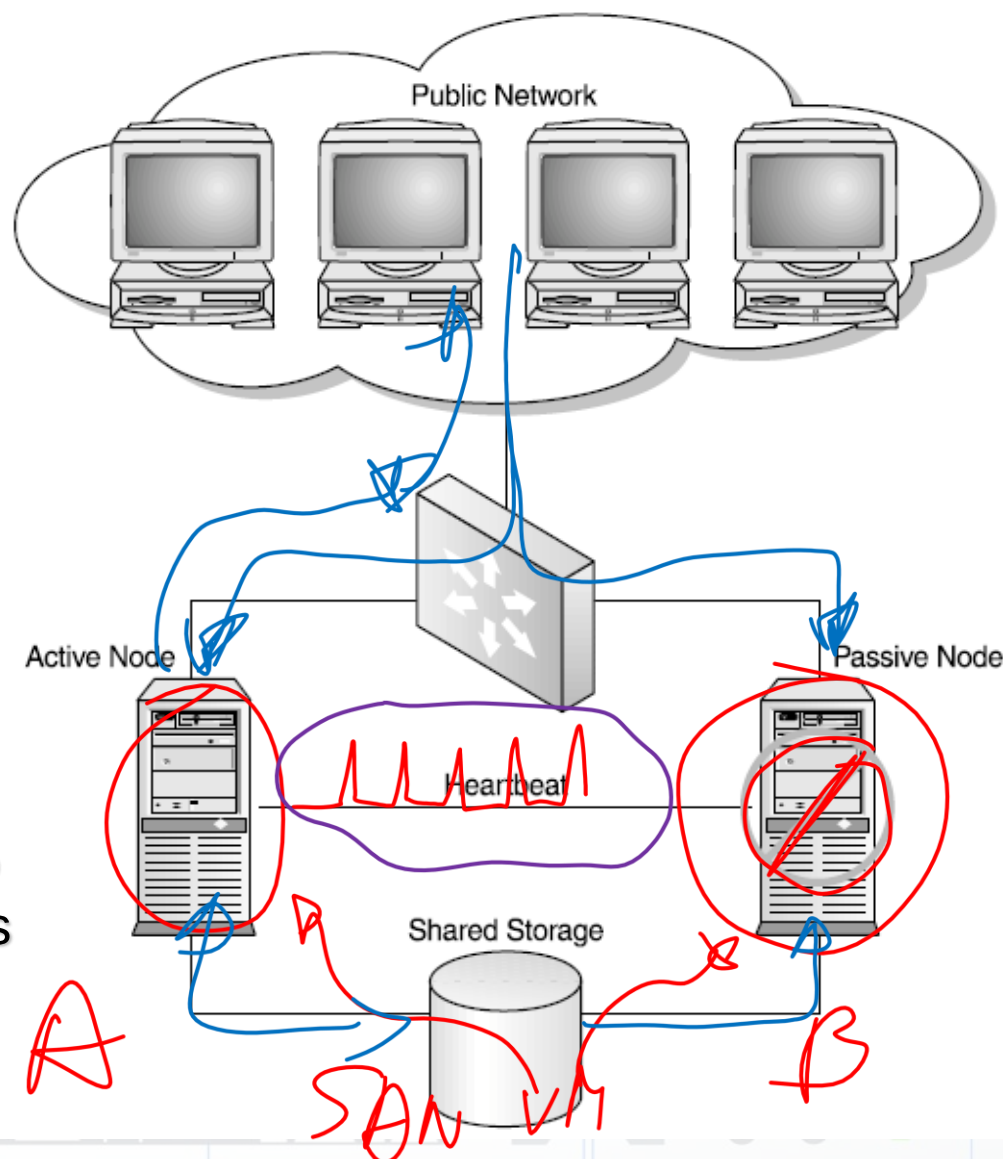
Internal Network

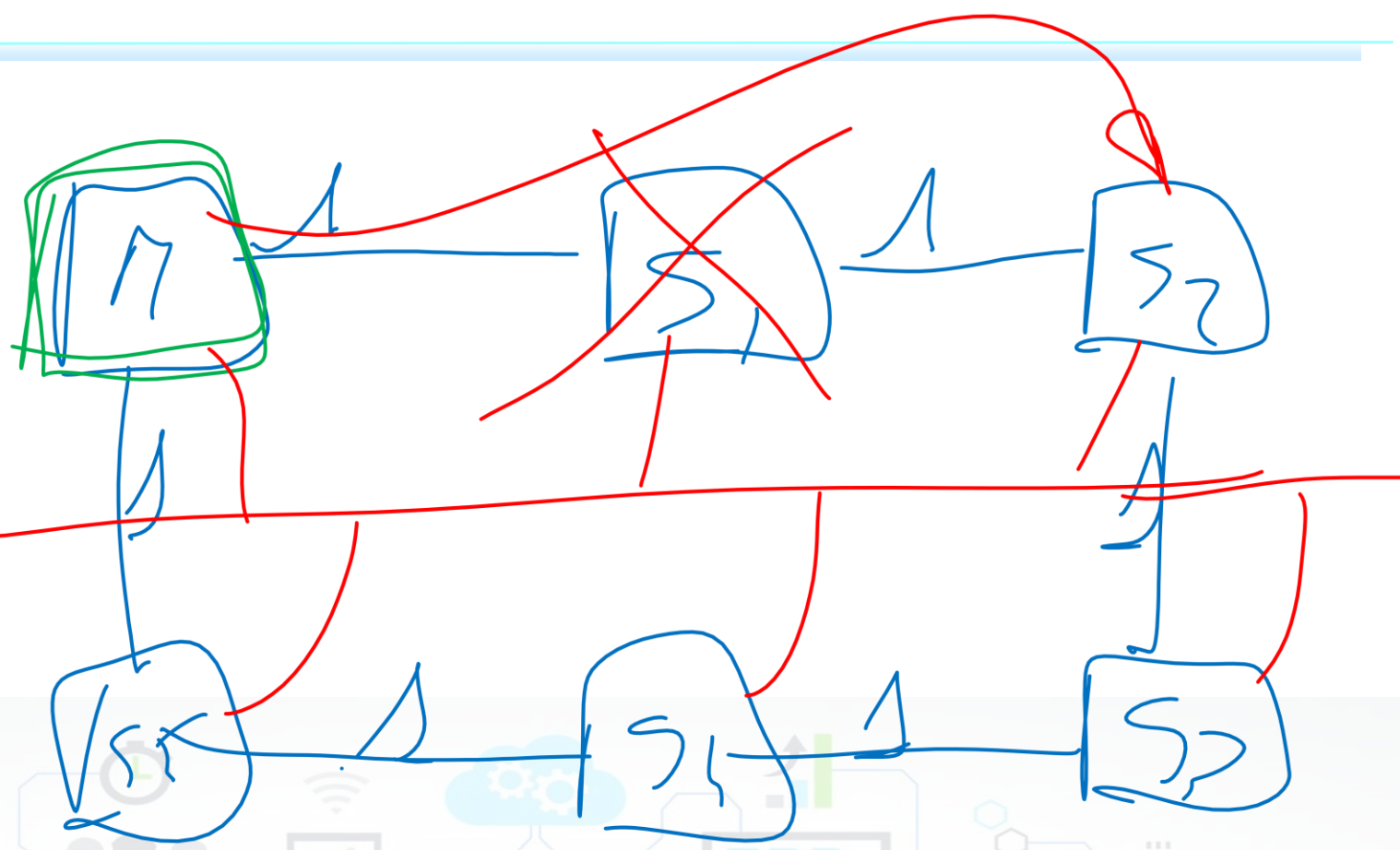
- ♣ *Heartbeat* to detect the server availability and thus failover.

- ♣ *[To keep servers aligned on context and data]*

Shared data storage is a simplification and optional.

- ♣ A different solution may be to have a cloned storage to keep aligned among the two servers







Three separate network cards

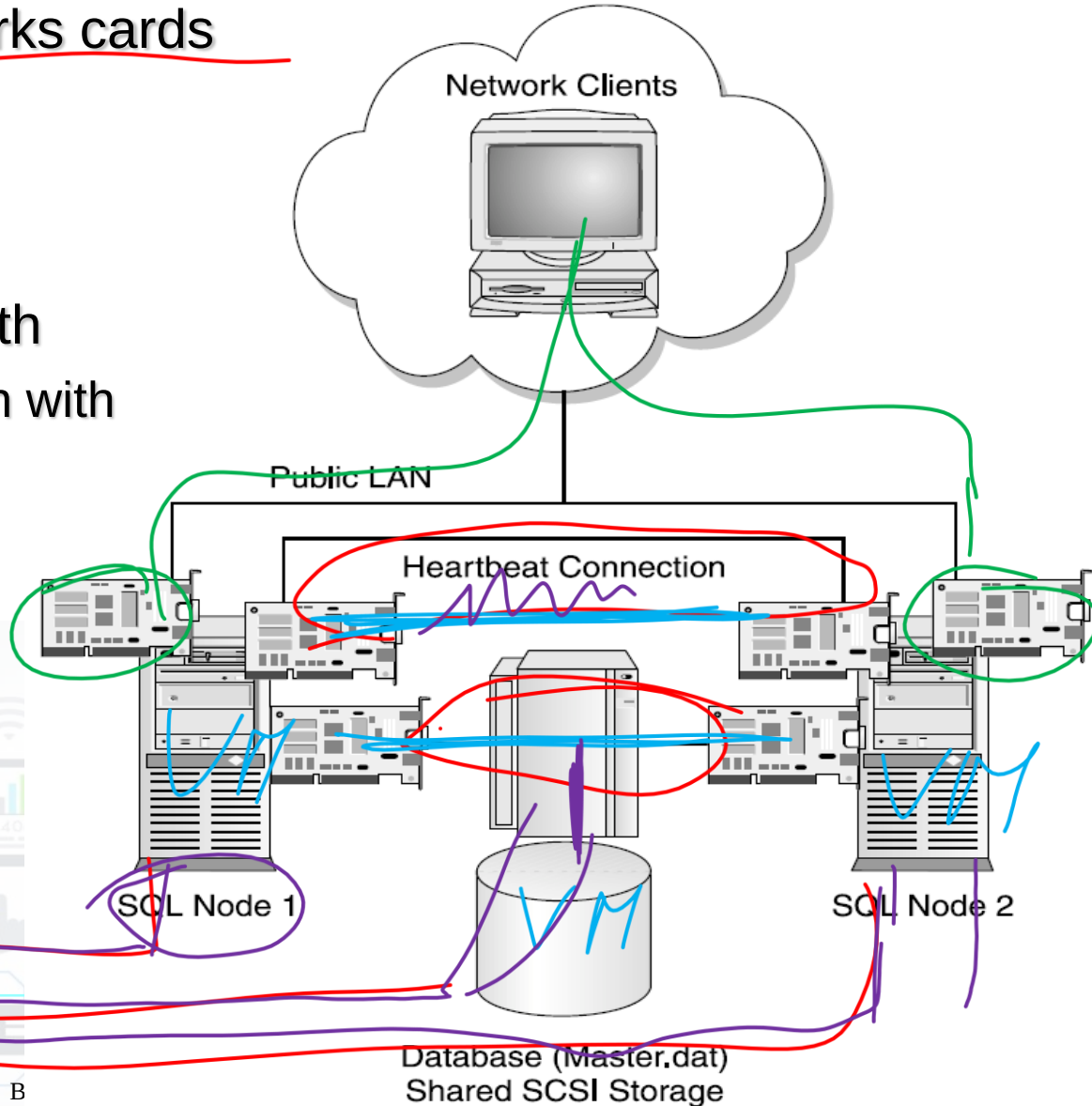
- ♣ Front end
- ♣ Heartbeat
- ♣ Database NAS/SAN

UPS/APC solutions with

- ♣ 2 UPS, each of which with network card

NAS/SAN

- ♣ Raid 5 or 6, 60
- ♣ Fiber connection

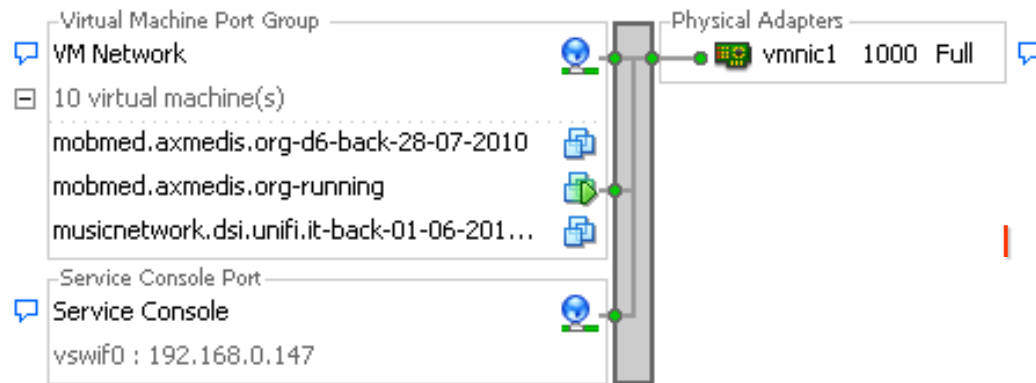




Network and Virtual Networks

Virtual Switch: vSwitch0

[Remove...](#) [Properties...](#)



| The same VM with access to 2 different network via real network adapters

Virtual Switch: vSwitch1

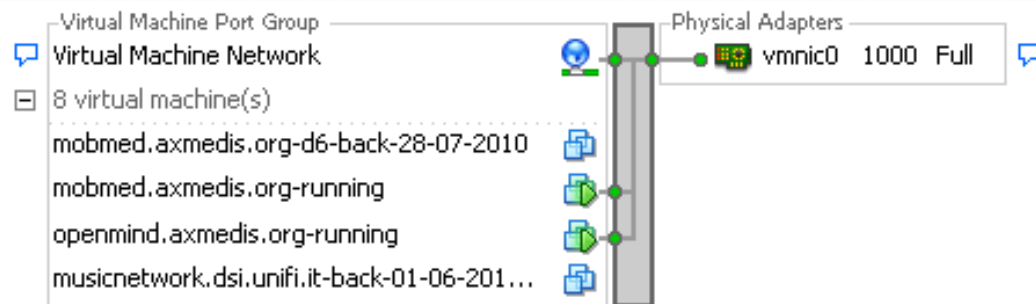
[Remove...](#) [Properties...](#)



| A virtual network

Virtual Switch: vSwitch2

[Remove...](#) [Properties...](#)



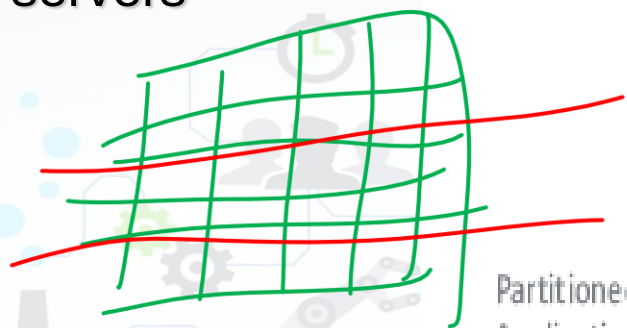


Partitioning the database

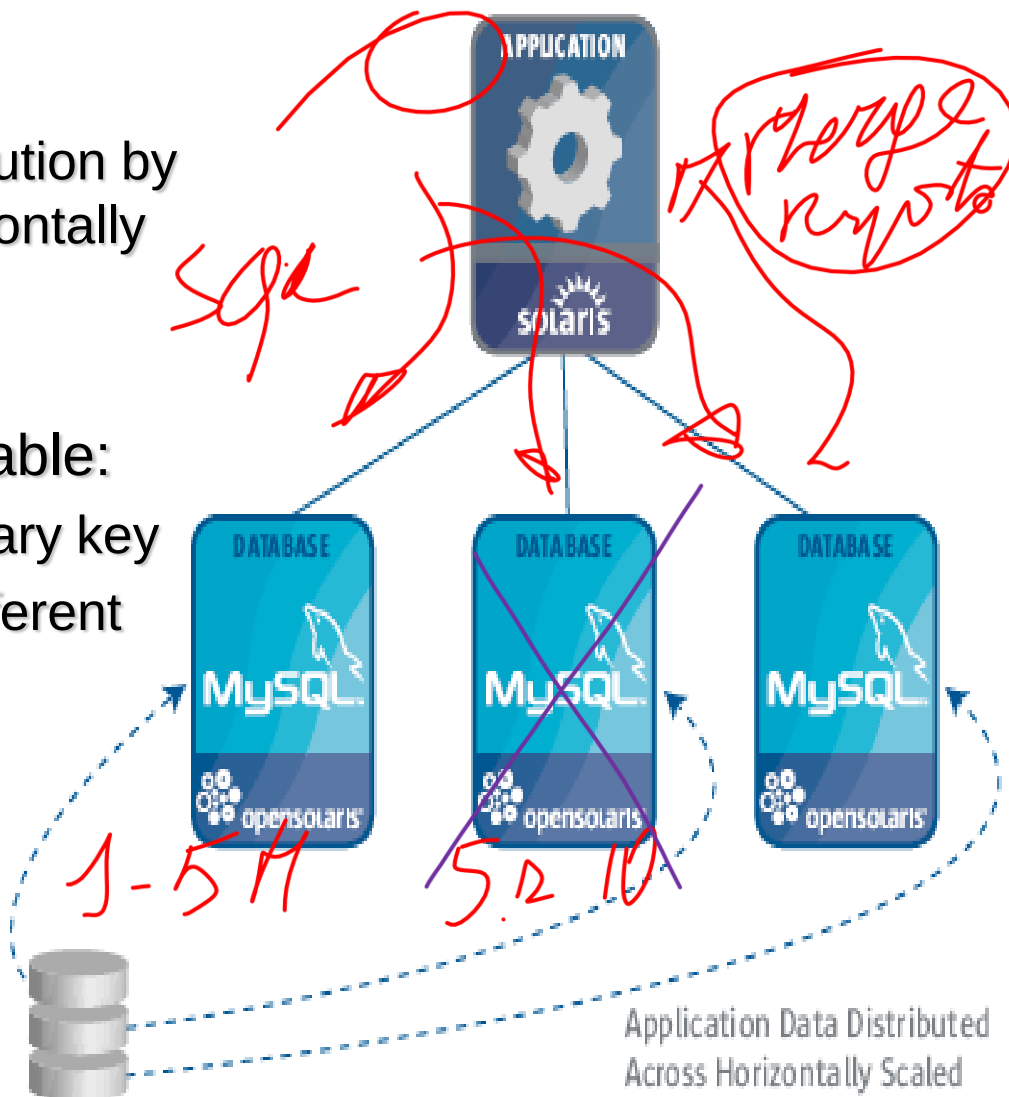
- | The database may be
 - ♣ stored in a single NAS
 - ♣ stored into a distributed solution by partitioning the tables horizontally or vertically

- | **Horizontal** partitioning of a table:

- ♣ According to a certain primary key
- ♣ Distributing the table on different servers



Partitioned
Application
Data



Application Data Distributed
Across Horizontally Scaled
Database Instances



Structure

- | Elements of cloud Computing
- | Virtualization
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- | High Availability
- | vSphere Infrastructure 
 - ♣ Vmotion
 - ♣ Power Management
 - ♣ Resource Scheduling
 - ♣ Fault Tolerance
- | Security on the Cloud
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vSphere 4 infrastructure of VMware

V6.5

I High level features:

- ♣ HA: high availability
- ♣ DRS: Distributed Resource Scheduling
- ♣ Creating Fault Tolerance architectures
- ♣ DPM: datacenter power management, based on VMotion
- ♣ Converting VM into VM for infrastructure, from physical to VM
- ♣ vApp: are Virtual Application Services
- ♣ Cloning and Moving VM
- ♣ Making Templates for VM
- ♣ Backup VM and thus virtual servers

I Low level features:

- ♣ VMotion: VM moving among Hosts
- ♣ Dynamic increment of: CPU ck, MEM, net...



Existing Applications



Future Applications



Summary of VMware vSphere 4.0

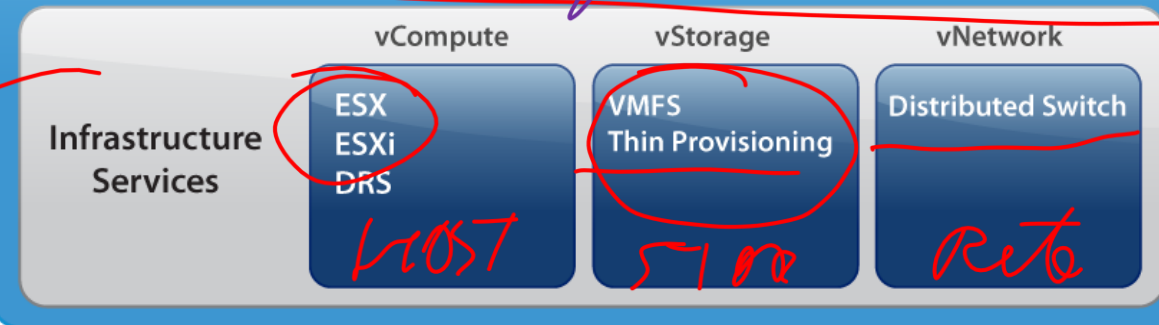
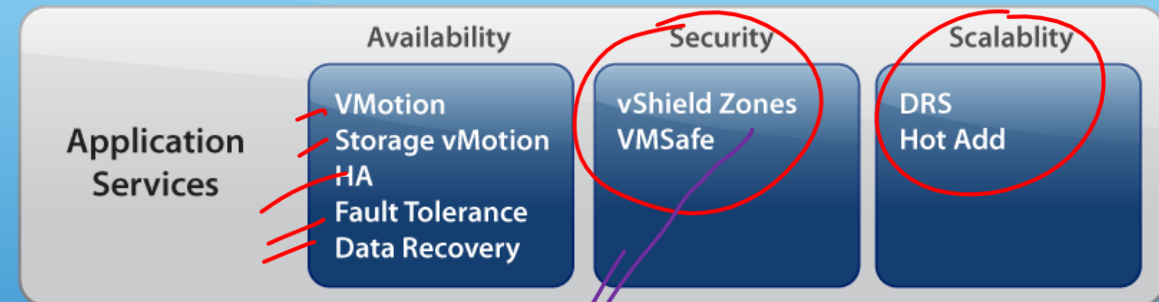
Vsphere

Host

© VMware, Inc.

VMware vCenter Suite

VMware vSphere 4





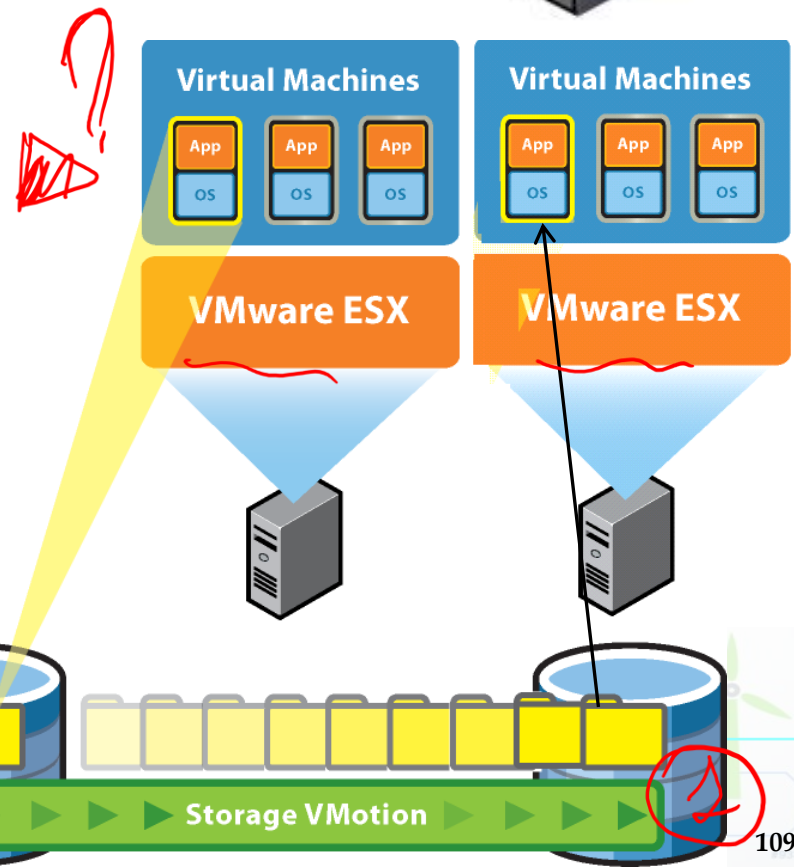
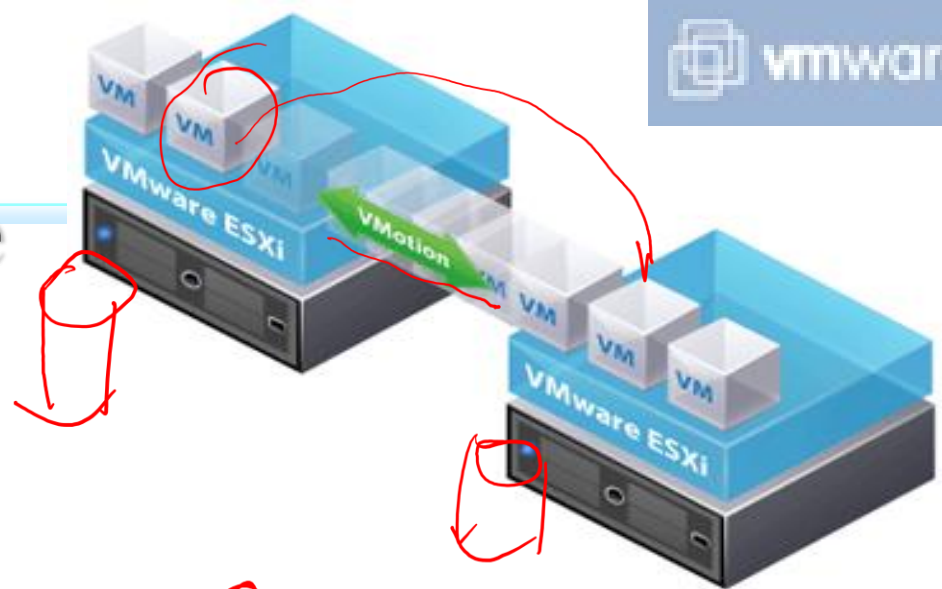
VMotion of VMware vSphere

I you need:

- ❖ VM without snapshots
- ❖ VM must be powered off to simultaneously migrate both host and datastore
- ❖ Compatibility among host CPU and VMs
- ❖ Dedicated virtual network
- ❖ **The VMs can be ON**

I Steps:

1. moving HD images
2. aligning OS and CPU status
3. off-the old and then on-new





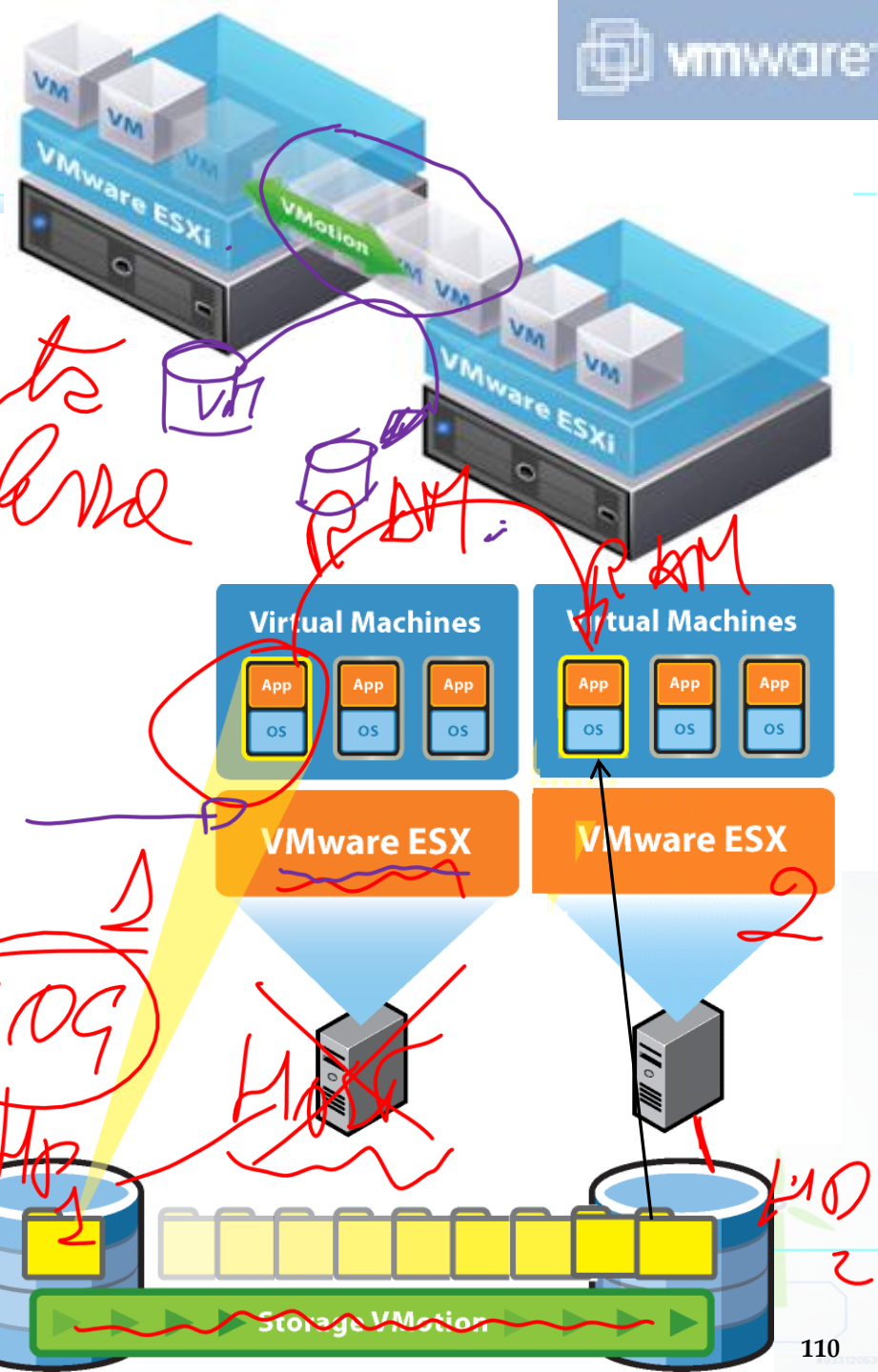
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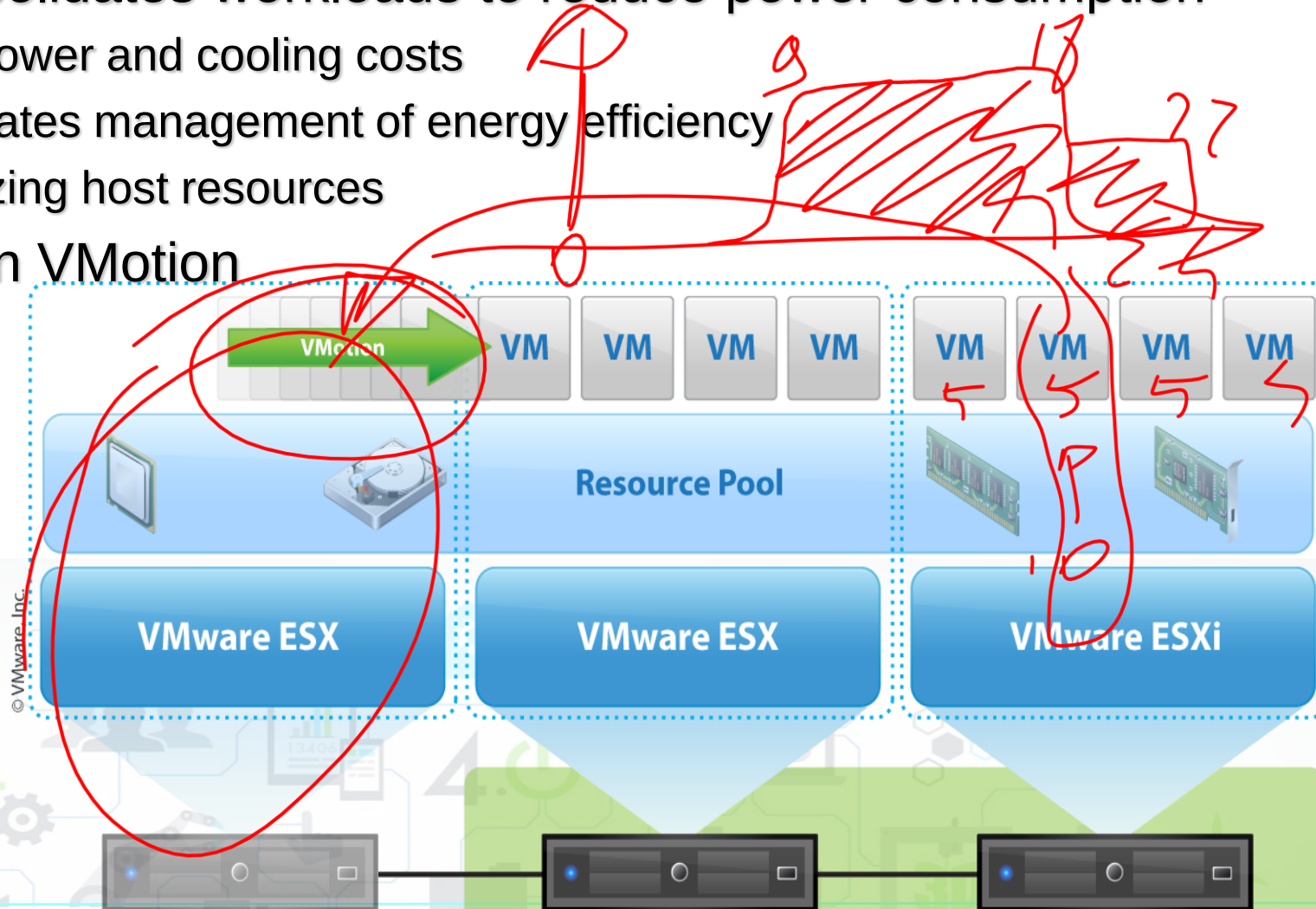
VMware DPM, Power Management

I DPM consolidates workloads to reduce power consumption

- ♣ Cuts power and cooling costs
- ♣ Automates management of energy efficiency
- ♣ optimizing host resources

I Based on VMotion

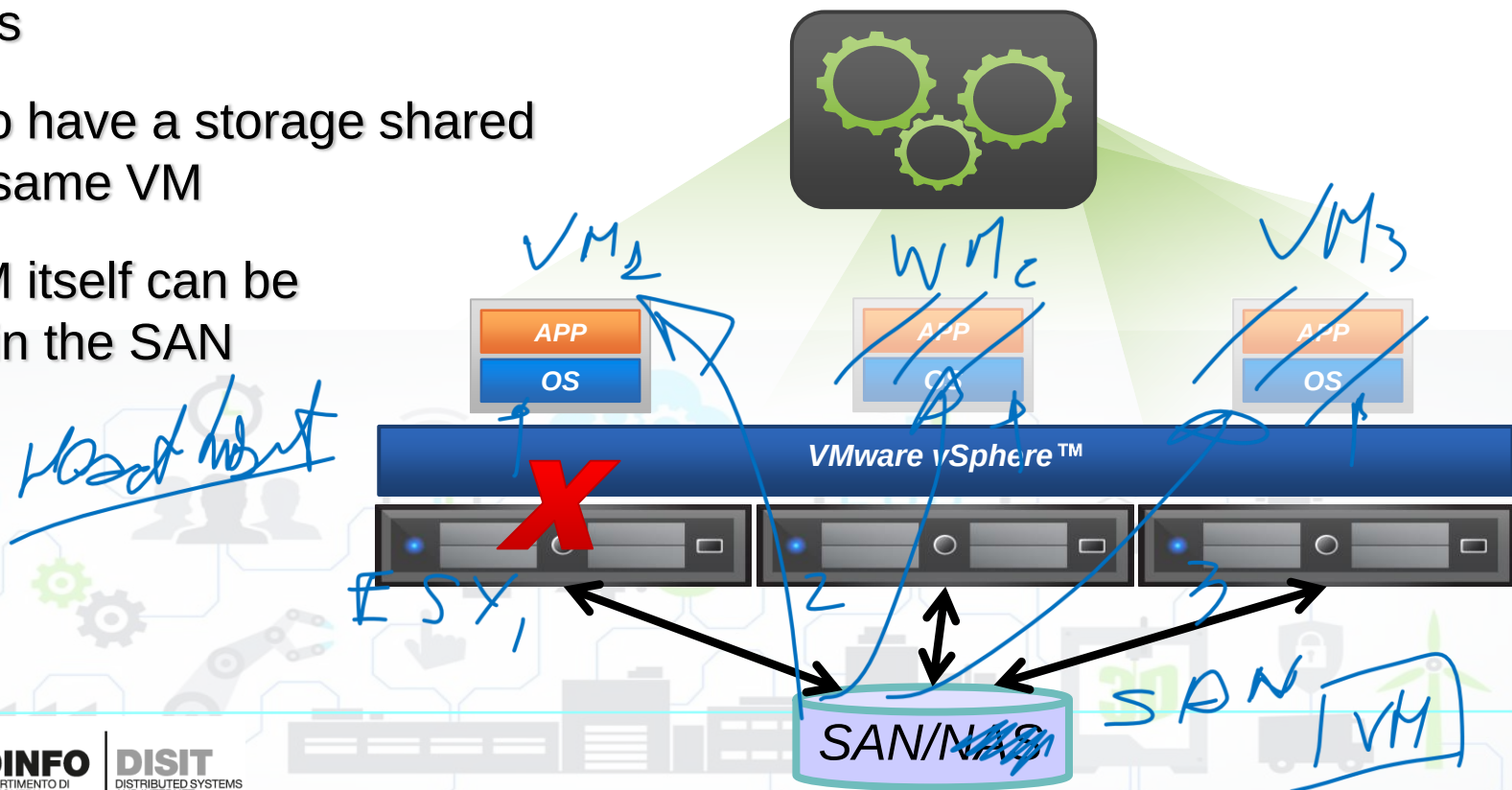
PAM





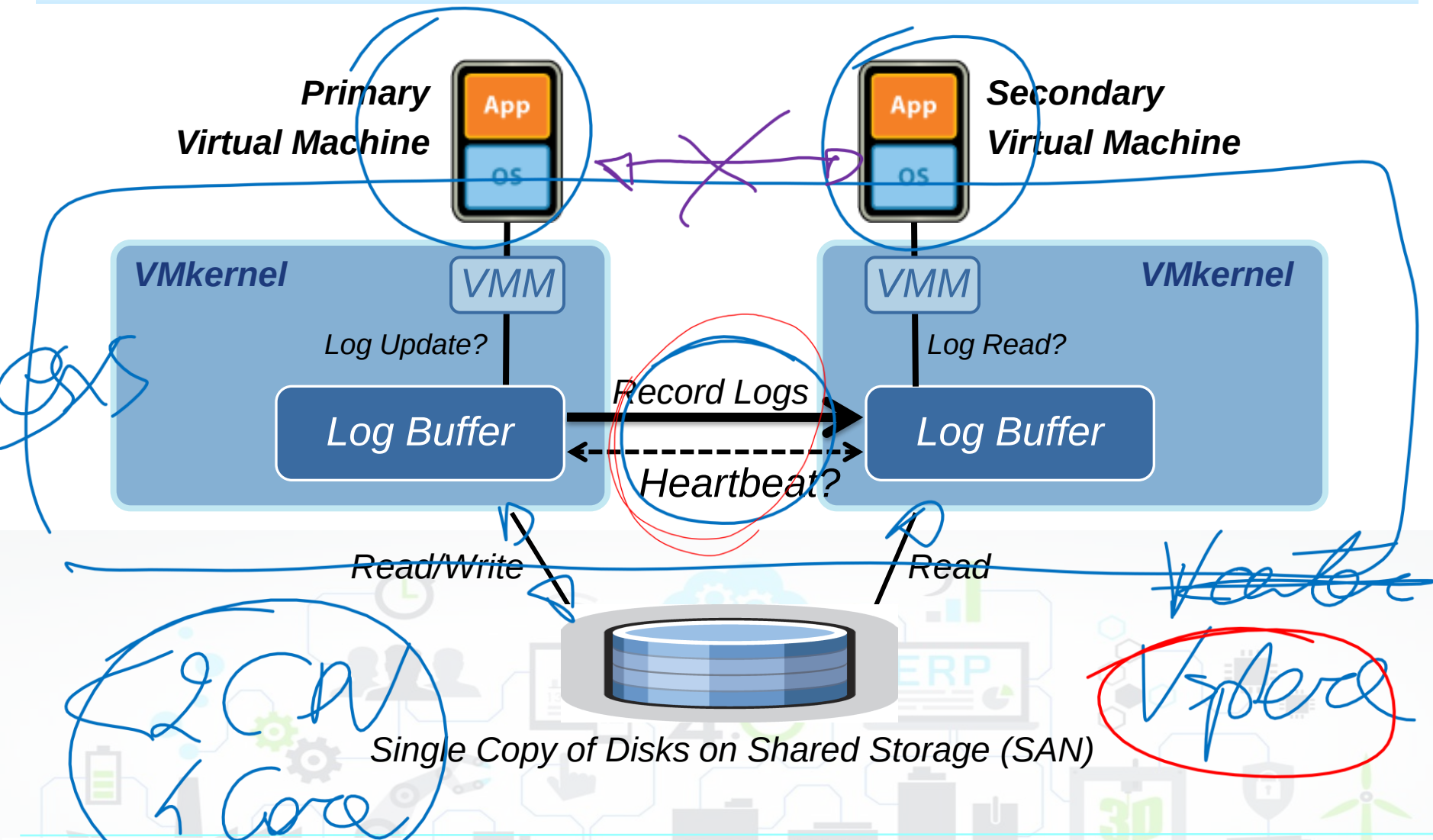
VMware Fault Tolerance, FT

- Single identical VMs running in lockstep on separate hosts
- Zero downtime, zero data loss failover for all virtual machines in case of hardware failures
- Single common mechanism for all applications and Operating systems
- Need to have a storage shared by the same VM
- The VM itself can be stored in the SAN





How VMware FT Works





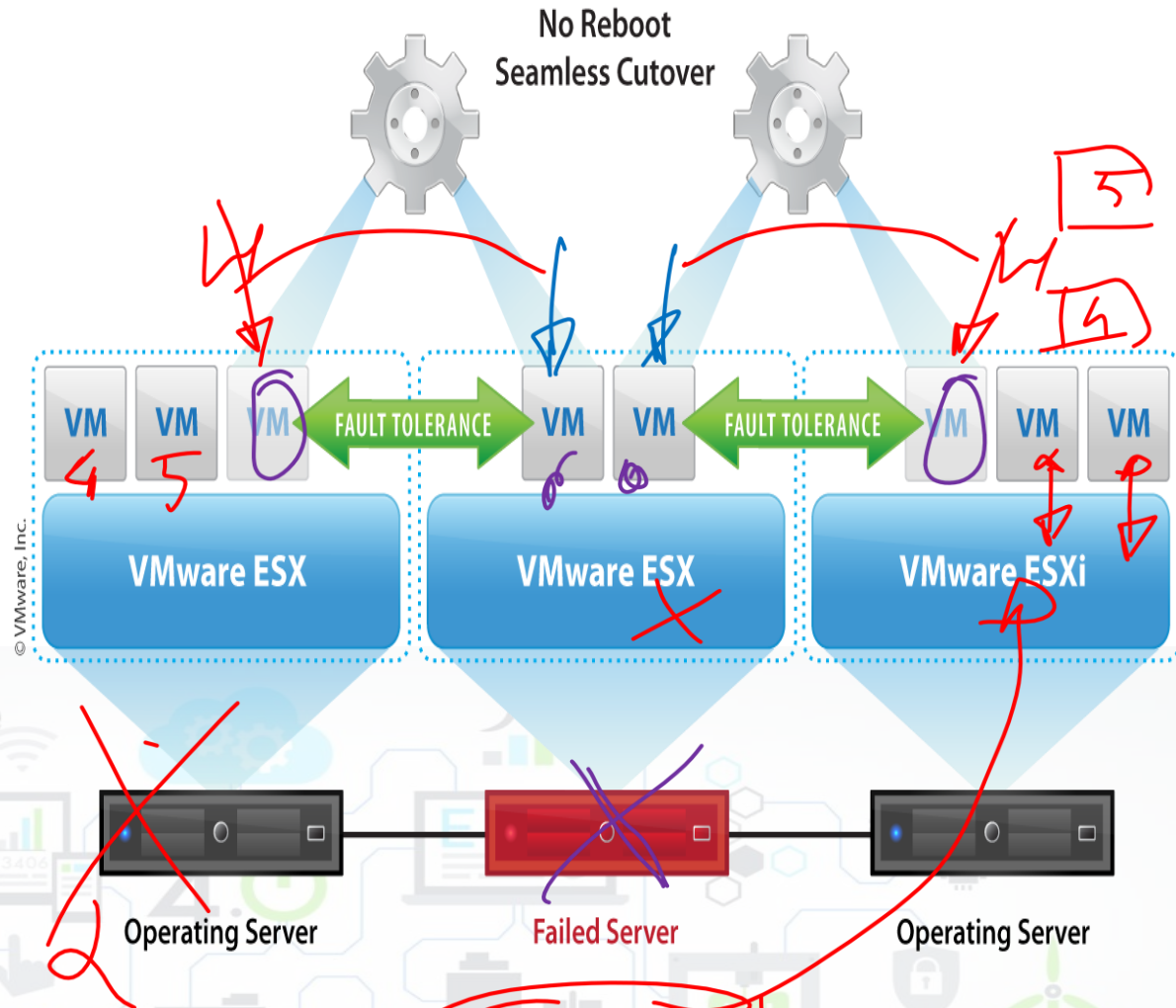
HA: High Availability of vSphere

When a host fails, the running VM on the host may be turned ON on another hosts

- Just the time to turn on again the host

HOT Spare solution:

- It is also possible to keep aligned 2 distinct hosts to make a faster switch OFF→ON of the VM on the faulty host
- implies to have duplicated resources: Host, CPU etc.





VM w auto Reboot

- VM che può lavorare in DRS
- Riavvio 
- SO abboz. data. con i processi in autoreboot
- SO della VM deve avere installato e monitorato i VM TOOLS



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Security on the cloud

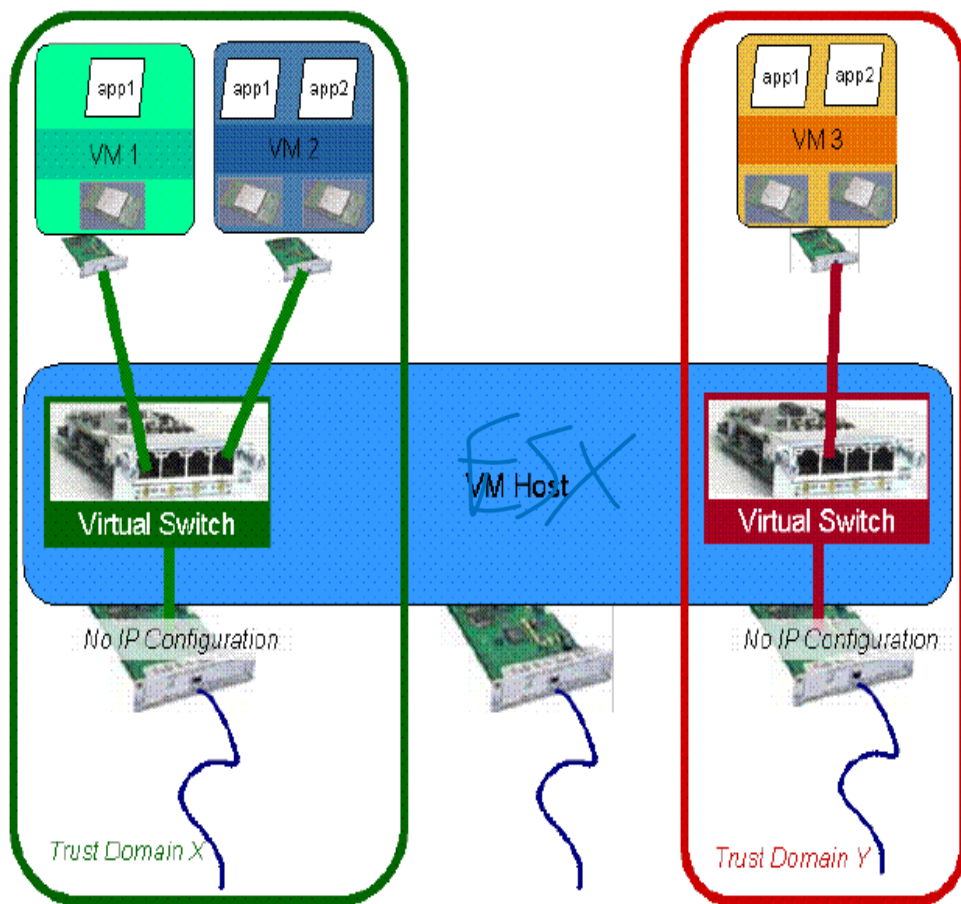
- | Protecting VMs from external access
- | Protecting VMs each other in the cloud
- | Technologies:
 - ♣ Accessing to other VM via dedicated virtual networks, using Virtual Networking, Virtual Switch
 - ♣ Avoiding shared disk, at least using authenticated connections
 - ♣ Using Firewall
 - ♣ Communicating with other VMs via protected connections: protected WS, HTTPs, SSL, SFTP, etc.



Virtual Networking

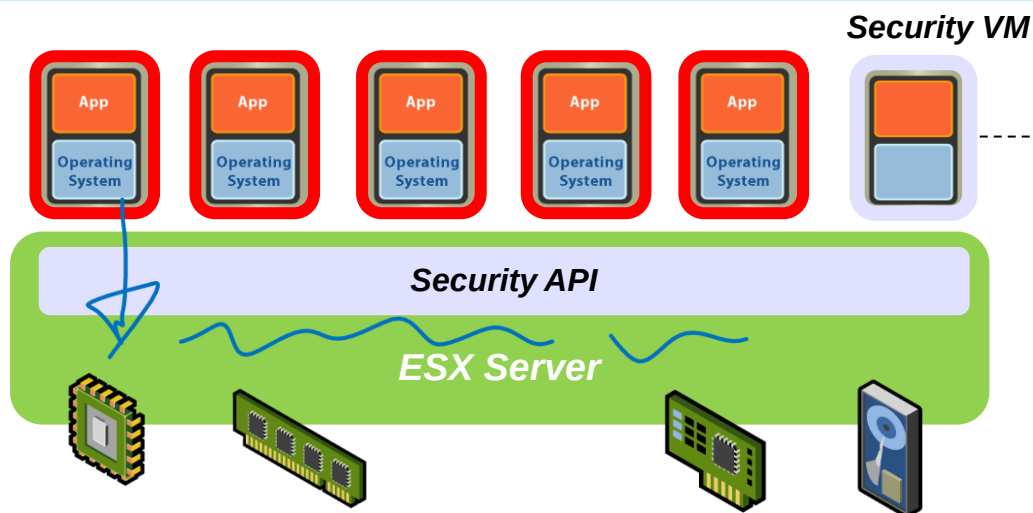
- Per isolare meglio dei guest OS da altri che non sono nello stesso trust domain
- isolare i virtual switch dei singoli trust domain.
- Solo i guest che condividono lo stesso domain hanno schede di rete virtuali sullo stesso virtual switch.
- virtual switch su porte logiche del sistema host che non hanno indirizzo ip configurato.

Figure 1 - Isolating virtual machines to separate network trust domains





Vmware Vsphere VMsafe



- **HIPS**
- **Firewall**
- **IPS/IDS**
- **Anti-Virus**

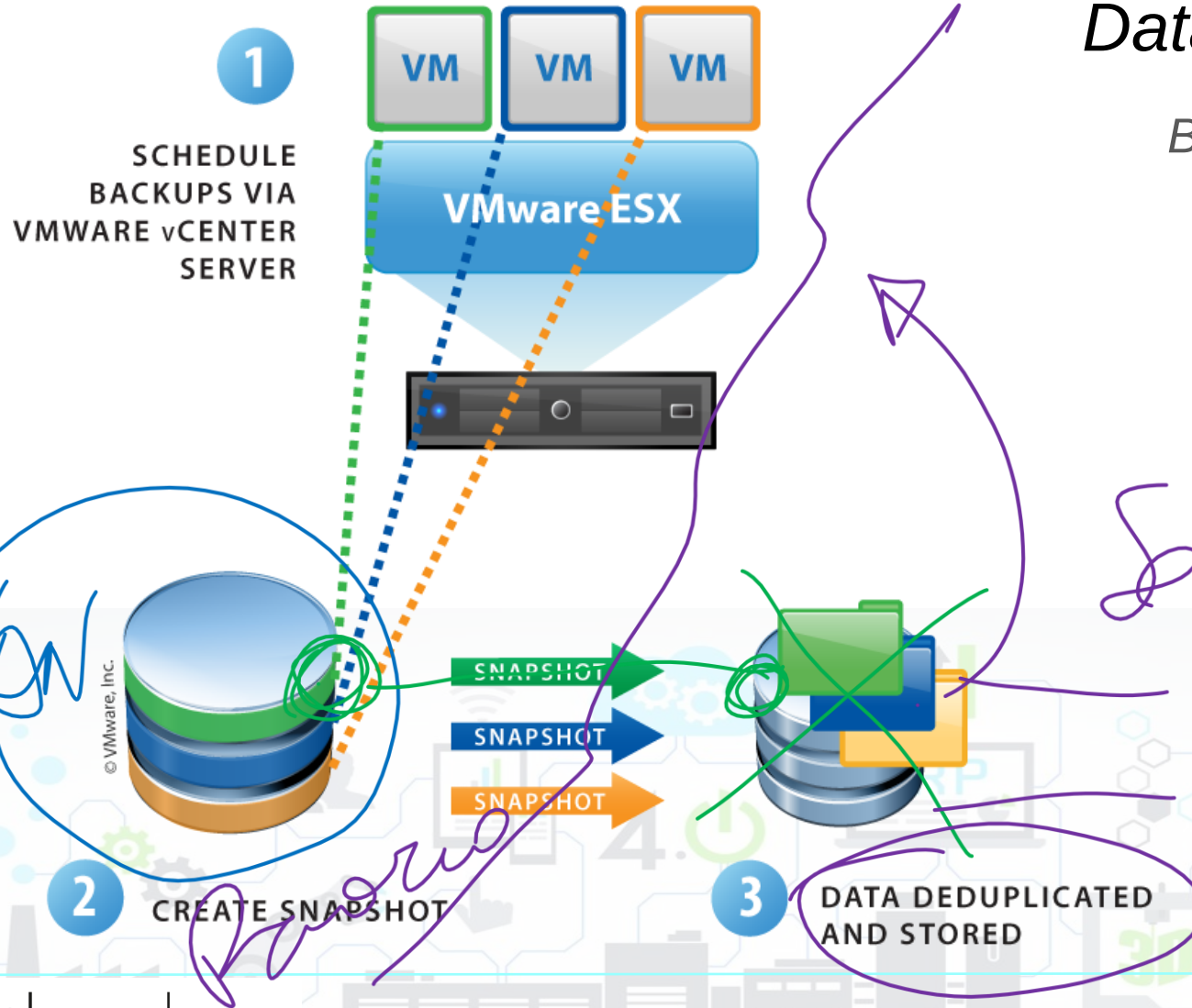
- Creates a new, stronger layer of defense – fundamentally changes protection profile for VMs running on VMware Infrastructure
- Protect the VM by inspection of virtual components (CPU, Memory, Network and Storage)
- Complete integration and awareness of VMotion, Storage VMotion, HA, etc.
- Provides an unprecedented level of security for the application and the data inside the VM

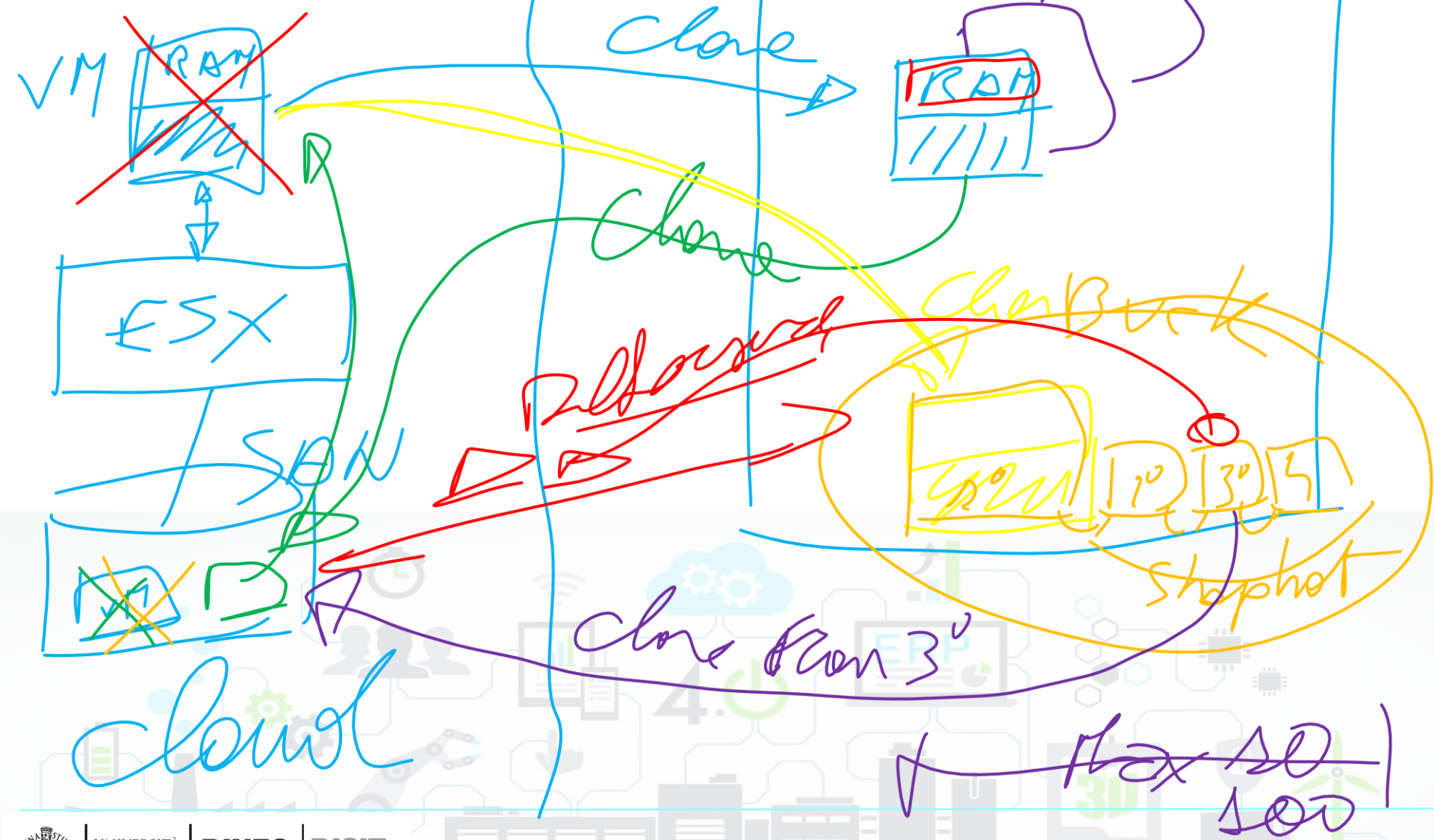


VMware vSphere

Data Recovery

Backup Only

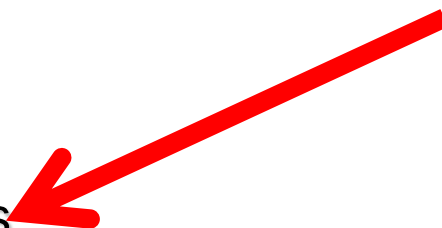






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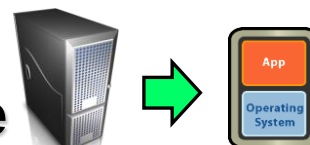




VM Converter, the migration

Conversion possibilities, migration possibilities

P2V, from Physical → Virtual machine



- Reusing legacy servers into stronger and new HW machines
- From ISO CD of an OS → VM

V2V, from Virtual → to Virtual

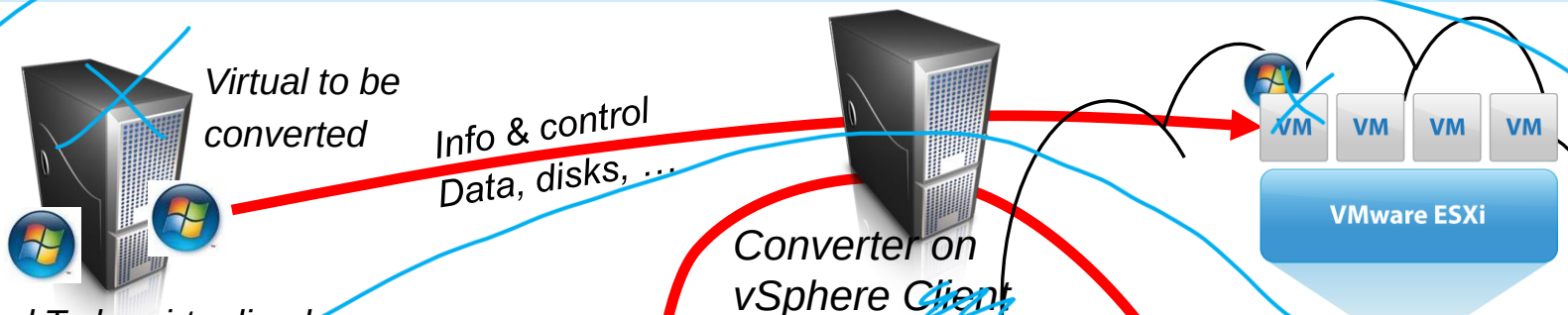


- Import/export a VM from/to different standards
- From VM Workstation → Infrastructure VM
- From Infrastructure VM → template for VM with some parameters
- From Infrastructure VM → VM Workstation
- From Infrastructure VM → Infrastructure VM changing parameters
-

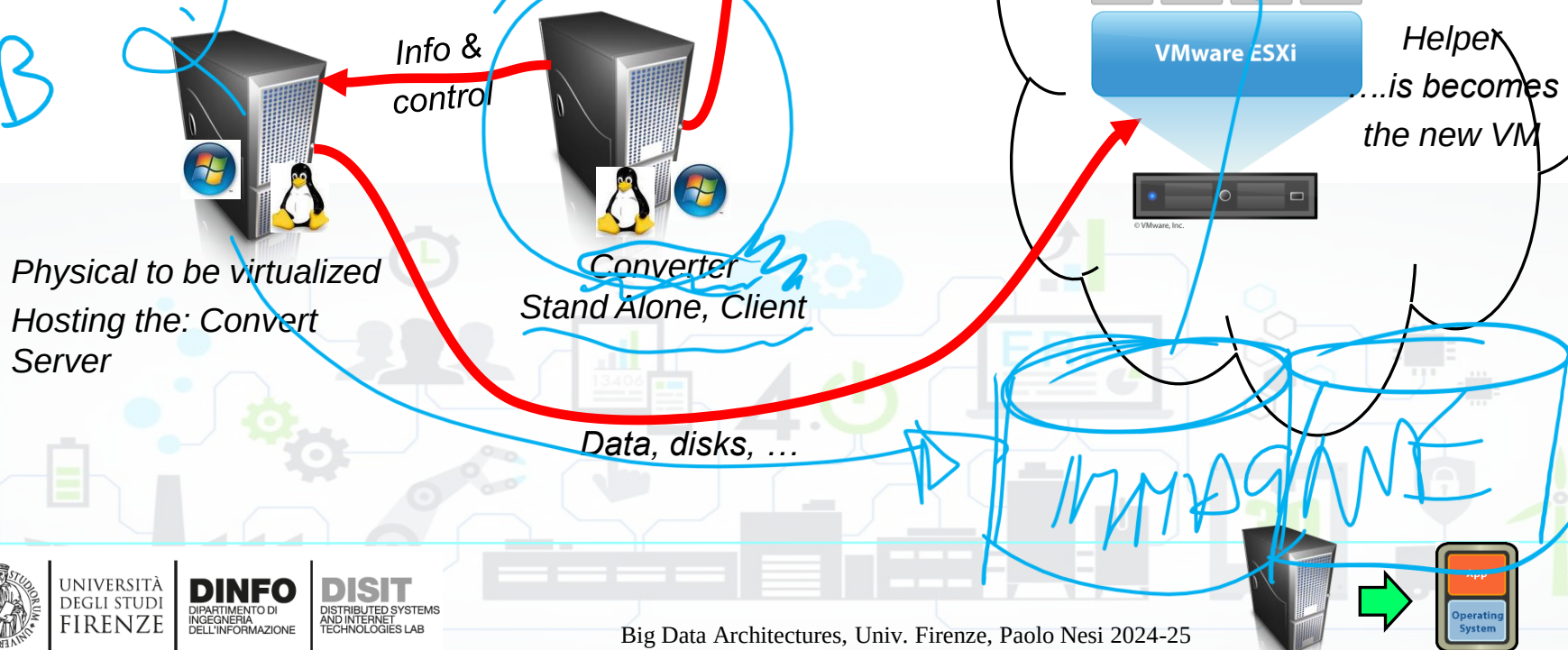


P2V, vConverter vSphere

A

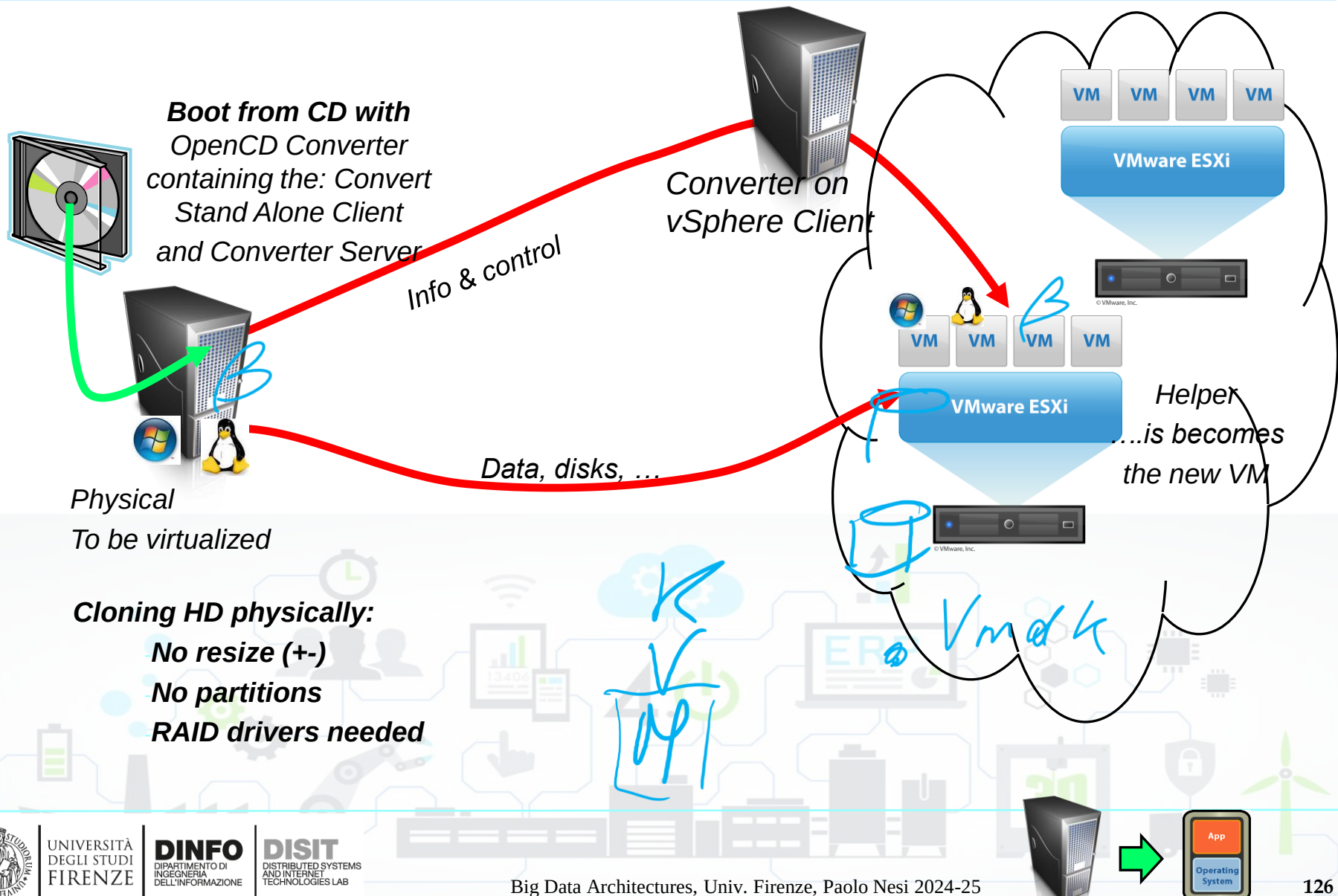


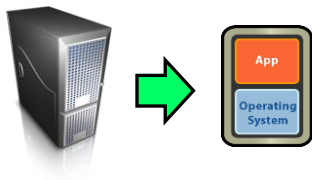
B





P2V, OpenCD vConverter vSphere





P2V conversion

How to convert, typically:

- ♣ From **VM Converter Stand Alone** on Windows or Linux
 - ➔ it includes a Server side and a client consol,
 - server side has to be installed on the P machine to be converted.
 - Client side is a consol
 - ➔ From Linux to VM on ESX Host
 - ➔ From Windows to CM on ESX Host
- ♣ From **VM converter as plugin of vCenter**, via vCenter Client
 - ➔ From Windows to VM on ESX Host
- ♣ From **OpenCD**, with included VM Converter and alone
 - ➔ From Windows to CM on ESX Host
- ♣ From **VMware Workstation**
 - ➔ From Windows to CM on ESX Host



P2V conversion

I Hypothesis:

- ♣ Converter server installed on Physical machine
- ♣ Converter in third machine or on the physical (windows)
- ♣ All snapshots are removed and the disks re-compacted.

I First step:

- ♣ The Converter Client is launched
- ♣ The Converter Client creates an Helper VM on the vCenter Host

I Second step:

- ♣ The Helper VM works independently to transfer the data from VM Converter Server to the new VM via the Helper VM, under the control of Client.
- ♣ The Converter Client provides commands to close and destroy the Helper VM and put in execution the new VM with the final shape



P2V conversion



I Third step:

- ♣ Reboot the new machine as Virtual machine

- ➔ Then install the VMware tools on the VM from the vCenter or from the VMware Workstation hypervisor.
- ➔ Revise the general config, network, etc.
- ➔ See if it possible to use paravirtualized drivers instead of physical drivers.

- ♣ If the converted VM is not booting

- ➔ Verify the VM setting: disk, operating system, disk drivers, etc.
- ➔ Regenerate the VM tools on the VM and try again





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vCenter vSphere

- | The so called Inventory
- | Datacenter

♣ Cluster00

➔ Host....

➔ Host....

➔ Application:

- VM1
- VM2

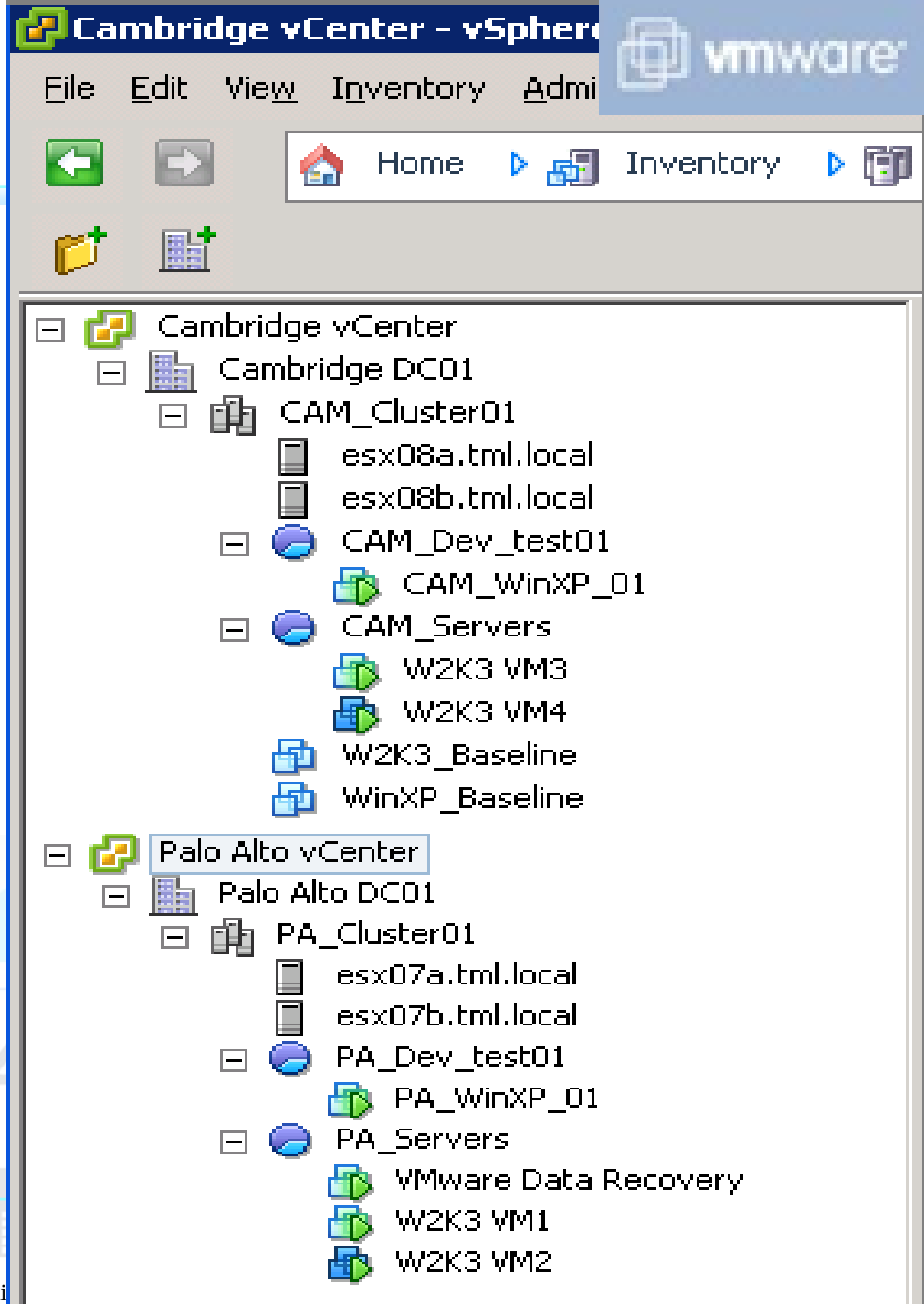
➔ VM3

➔ VM4

♣ Cluster01

➔ H2..

➔ ...





- Cluster00
 - Host....
 - Host....
 - Application:
 - VM1
 - VM2
 - VM3
 - VM4

- H2...



EOLO - vSphere Client

File Edit View Inventory Administration Plug-ins Help

Home Inventory Hosts and Clusters Search Inventory

EOLO

- Regione Toscana
 - PrometeoBIETL
 - PrometeoCluster
 - Regione Toscana DMZ
 - AuroraCluster

Regione Toscana

Summary Virtual Machines Hosts IP Pools Performance Tasks & Events Alarms Permissions Maps Storage Views

General

Hosts: 7

Virtual Machines and Templates: 75

Clusters: 2

Networks: 9

Datastores: 25

Some Snapshots of vSphere

EOLO - vSphere Client

File Edit View Inventory Administration Plug-ins Help

Home Inventory Hosts and Clusters Search Inventory

EOLO

- Regione Toscana
 - PrometeoBIETL
 - prometeo201.regione.toscana.it
 - prometeo202.regione.toscana.it
 - Produzione
 - ercole3
 - ercole4
 - Test
 - ercole3test
 - ercole4test
 - vulcano-restore
 - vulcanotest2
 - PrometeoCluster
 - prometeo1.regione.toscana.it
 - prometeo2.regione.toscana.it
 - prometeo3.regione.toscana.it
 - prometeo4.regione.toscana.it
 - prometeo5.regione.toscana.it
 - Produzione
 - Test
 - crioxtest-proto
 - Microsoft Windows 2008

Recent Tasks

Name Download

prometeo201.regione.toscana.it VMware ESX, 4.0.0, 208167

Summary Virtual Machines Performance Configuration Tasks & Events Alarms Permissions Maps Storage Views Hardware Status

Name, State or Guest OS contains: Clear

Name	Status	VM...	VM Ver...	State	Provisioned Sp...	Used Space	Host CPU - MHz	Host Mem - MB	Guest Mem - %	
ercole4test	✓	Normal	OK	7	Powered On	302,91 GB	302,91 GB	1847	4129	2
ercole3test	✓	Normal	OK	7	Powered On	88,00 GB	88,00 GB	74	3720	13
ercole3	✓	Normal	OK	7	Powered On	88,00 GB	88,00 GB	37	3686	0
ercole4	✓	Normal	OK	7	Powered On	302,91 GB	302,91 GB	37	1700	0

C: 20 core
96 GB

Prod 60 core
70 GB

Test 30 core
26 GB



Storage View



Getting Started | Summary | Virtual Machines | Performance | Configuration | Tasks & Events | Alarms | Permissions | Maps | **Storage Views** | Hardware St...

View: Reports | Maps | Last Update Time: 2/23/2009 11:56:25 PM [Update...](#)

Controls

Show

- ☐ Datacenter
- ☐ Cluster
- ☐ Host
- ☒ Virtual Machine
- ☒ **Datastore**
- ☒ SCSI Volume (LUN)
- ☒ NAS Mount
- ☒ SCSI Adapter
- ☒ SCSI Target (Array Port)

[Update View](#)

Zoom

Virtual Machines | Performance | Configuration | Tasks & Events | Alarms | Permissions | Maps | **Storage Views**

View: Reports | Maps | Last Update Time: 2/23/2009 11:16:05 PM

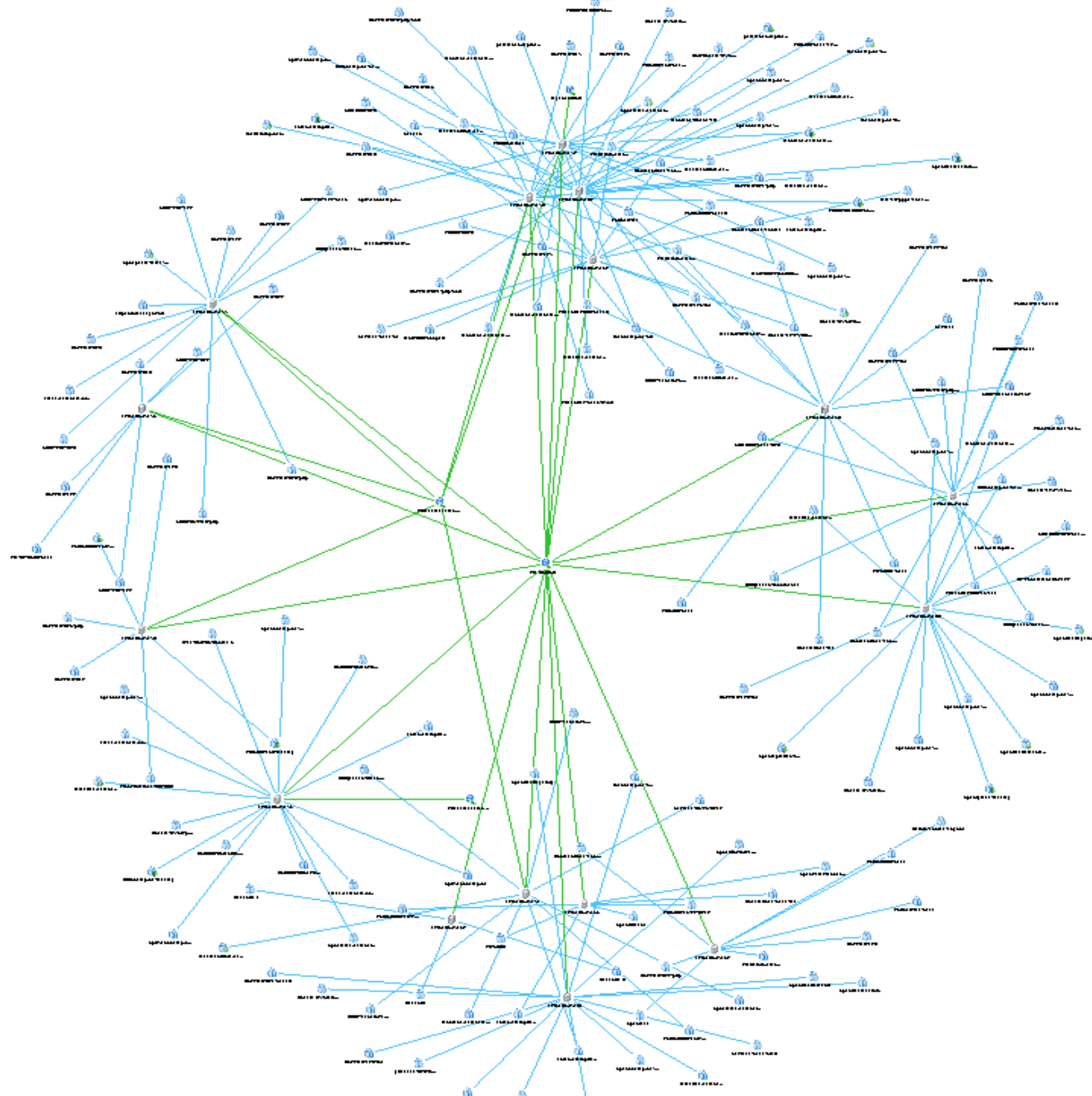
Show all Virtual Machines ▾ VM or Multipathing Status contains: ▾

VM	Multipathing Status	Space Used	Snapshot Space
Train01_WindowsXP_01	Partial/No Redundancy	1.94 GB	0.00 B
VM2-XP	Partial/No Redundancy	3.38 GB	0.00 B
VM4-RHEL5	Partial/No Redundancy	8.10 MB	0.00 B
VM2-W2K3	Partial/No Redundancy	4.50 GB	256.07 MB
W2K3 Template	Partial/No Redundancy	4.00 GB	0.00 B
XP Template	Partial/No Redundancy	3.00 GB	0.00 B

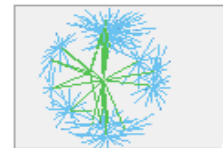


A Larger Datacenter

Time since last data update: 01:02 [Refresh](#)



Overview



Map Relationships:

Custom Map

Host Options

- ☒ Host to VM
- ☒ Host to Network
- ☐ Host to Datastore

VM Options

- ☐ Fault Tolerance relationships
- ☐ VM to Network
- ☐ VM to Datastore
- ☐ Show only powered on VMs

[Apply Relationships](#)



Partially Collapsed with Separate Physical Trust Zones

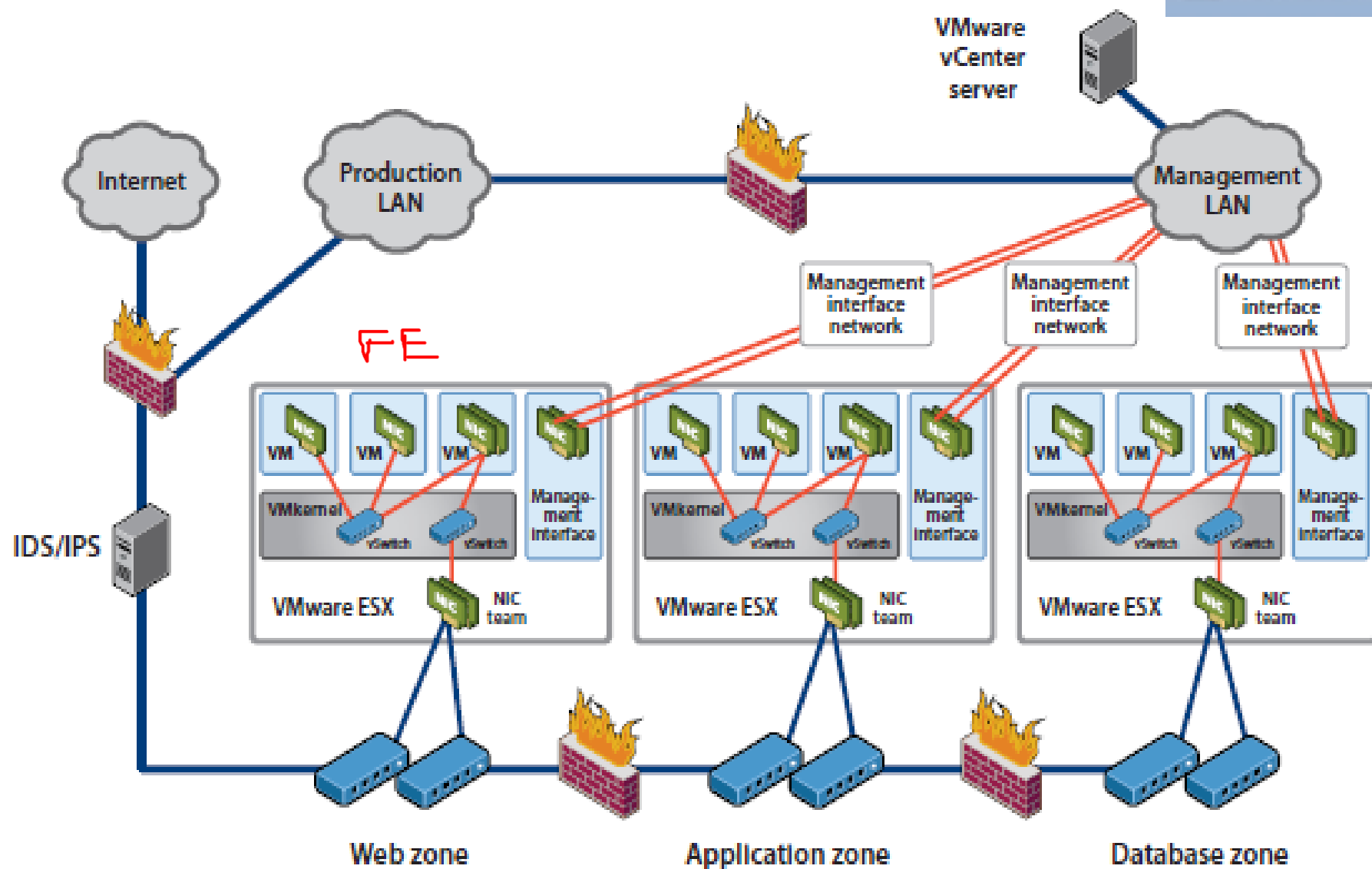


Figure 2 — Partially collapsed with separate physical trust zones



Partially Collapsed with Separate Physical Trust Zones

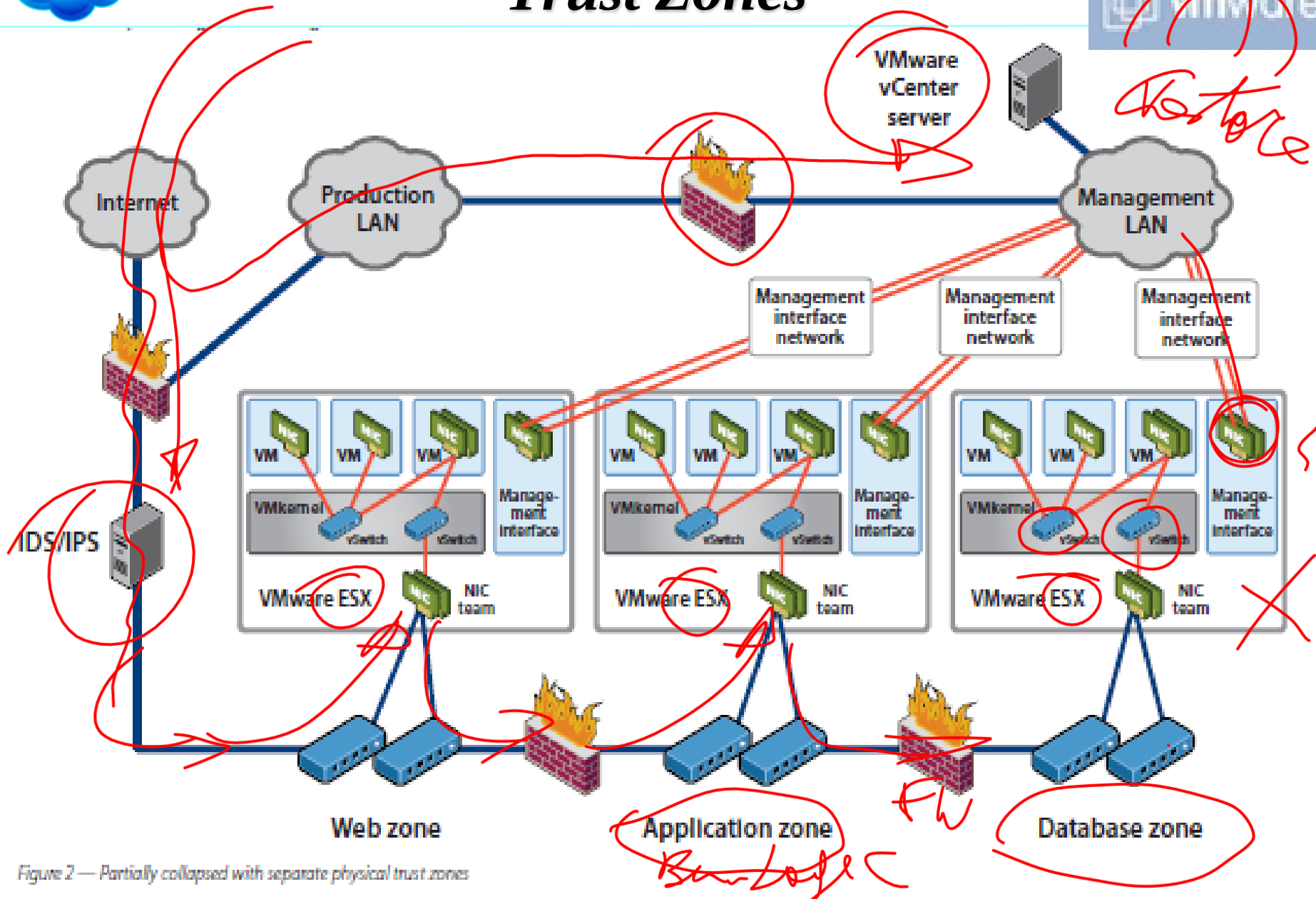


Figure 2 — Partially collapsed with separate physical trust zones



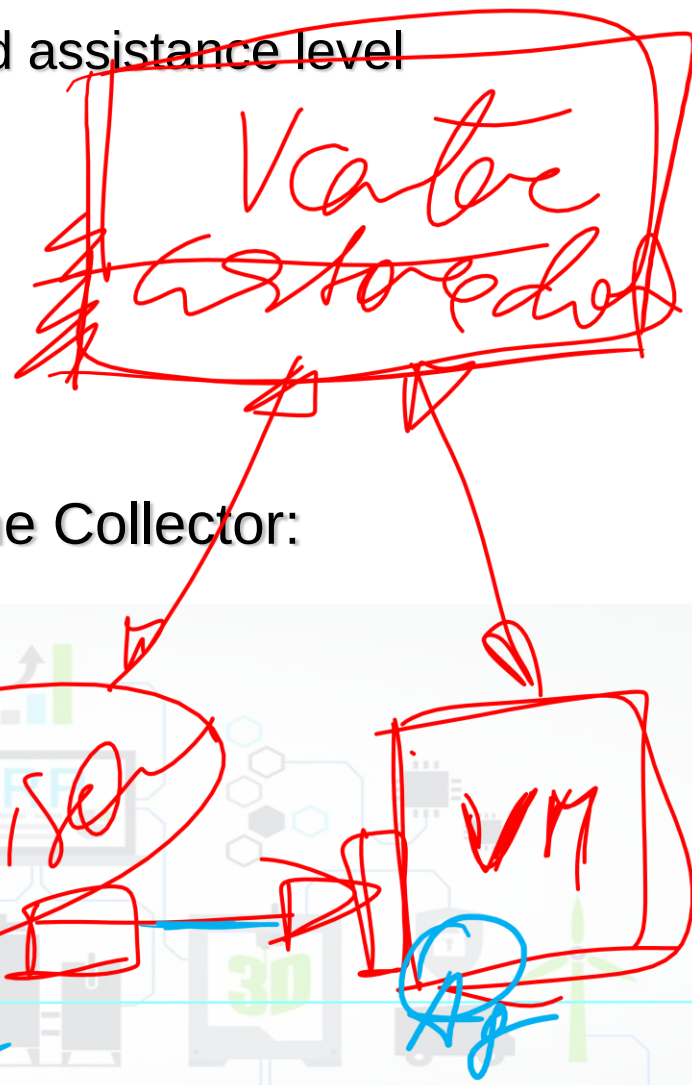
Monitoring the Solution

- | Monitoring and assessing performance at level of:
 - ♣ Datacenter, Cluster, Host
 - ♣ Virtual Machine from outside
 - ♣ Virtual Machine inside:
 - ➔ this has to be performed by using tools inside the VM operating system
 - ➔ Windows:
 - System monitoring hosts, detailed performances
 - ➔ Linux:
 - Top or other tools



Main Monitoring methods

- | Agent and Agentless
 - ♣ Problems to maintain the certification and assistance level
- | Protocols:
 - ♣ SSH
 - ♣ API of hosts hypervisors
 - ♣ Storage protocols
 - ♣ Network monitoring protocols
- | Call from applications and services to the Collector:
 - ♣ Call REST
 - ♣ Call to WebService
 - ♣ Write on database





Performance Analysis, Cluster/DC

EOLO - vSphere Client

File Edit View Inventory Administration Plug-ins Help

Home Inventory Hosts and Clusters

Search Inventory

prometeo1.region.toscana.it VMware ESX, 4.0.0, 208167

Summary Virtual Machines Performance Configuration Tasks & Events Alarms Permissions Maps Storage Views Hardware Status

Name, State or Guest OS contains: Clear

Name	Status	VMware Tools Status	VM Version	State	Provisioned Sp...	Used Space	Host CPU - MHz	Host Mem - MB
crio8	✓ Normal	OK	7	Powered On	75,00 GB	75,00 GB	198	7458
saturnotest	✓ Normal	OK	7	Powered On	35,15 GB	35,15 GB	0	869
crio2	✓ Normal	OK	7	Powered On	79,00 GB	79,00 GB	1127	10966
carontex	✓ Normal	OK	7	Powered On	12,00 GB	12,00 GB	265	1131
azan	✓ Normal	OK	7	Powered On	15,50 GB	15,50 GB	88	483
crio4test	✓ Normal	OK	7	Powered On	48,00 GB	48,00 GB	884	7747
elio6test	✓ Normal	OK	7	Powered On	43,00 GB	43,00 GB	176	1971
elio6	✓ Normal	OK	7	Powered On	43,00 GB	43,00 GB	154	508
crio7	✓ Normal	OK	7	Powered On	48,00 GB	48,00 GB	66	6196
ganimede	✓ Normal	Out of date	4	Powered On	99,66 GB	99,66 GB	22	1883
giapeto	✓ Normal	Out of date	4	Powered On	53,02 GB	53,02 GB	44	2688

vmware

Recent Tasks

Name	Target	Status	Initiated by	vCenter Server	Requested Start Ti...
------	--------	--------	--------------	----------------	-----------------------



Performance Analysis, Cluster/DC

EOLO - Client per terminal server

EOLO - vSphere Client

File Edit View Inventory Administration Plug-ins Help

Home Inventory Hosts and Clusters Search Inventory

ercole3
ercole4
Test
ercole3test
ercole4test
vulcano-restore
vulcanotest2
PrometeoCluster
prometeo1.regione.tos
prometeo2.regione.tos
prometeo3.regione.tos
prometeo4.regione.tos
prometeo5.regione.tos
Produzione
Test
criotest-proto
Microsoft Windows 200
Microsoft Windows 200
nereide2test
ubuntu-dsk
Regione Toscana DMZ
AuroraCluster
aurora.regione.toscane
aurora1.regione.toscar
Produzione
Test
baccotest_bk
cassiopea3test
cassiopeatest
carhern?

prometeo1.regione.toscana.it VMware ESX, 4.0.0, 208167

Summary Virtual Machines Performance Configuration Tasks & Events Alarms Permissions Maps Storage Views Hardware Status

Name, State or Guest OS contains: Clear

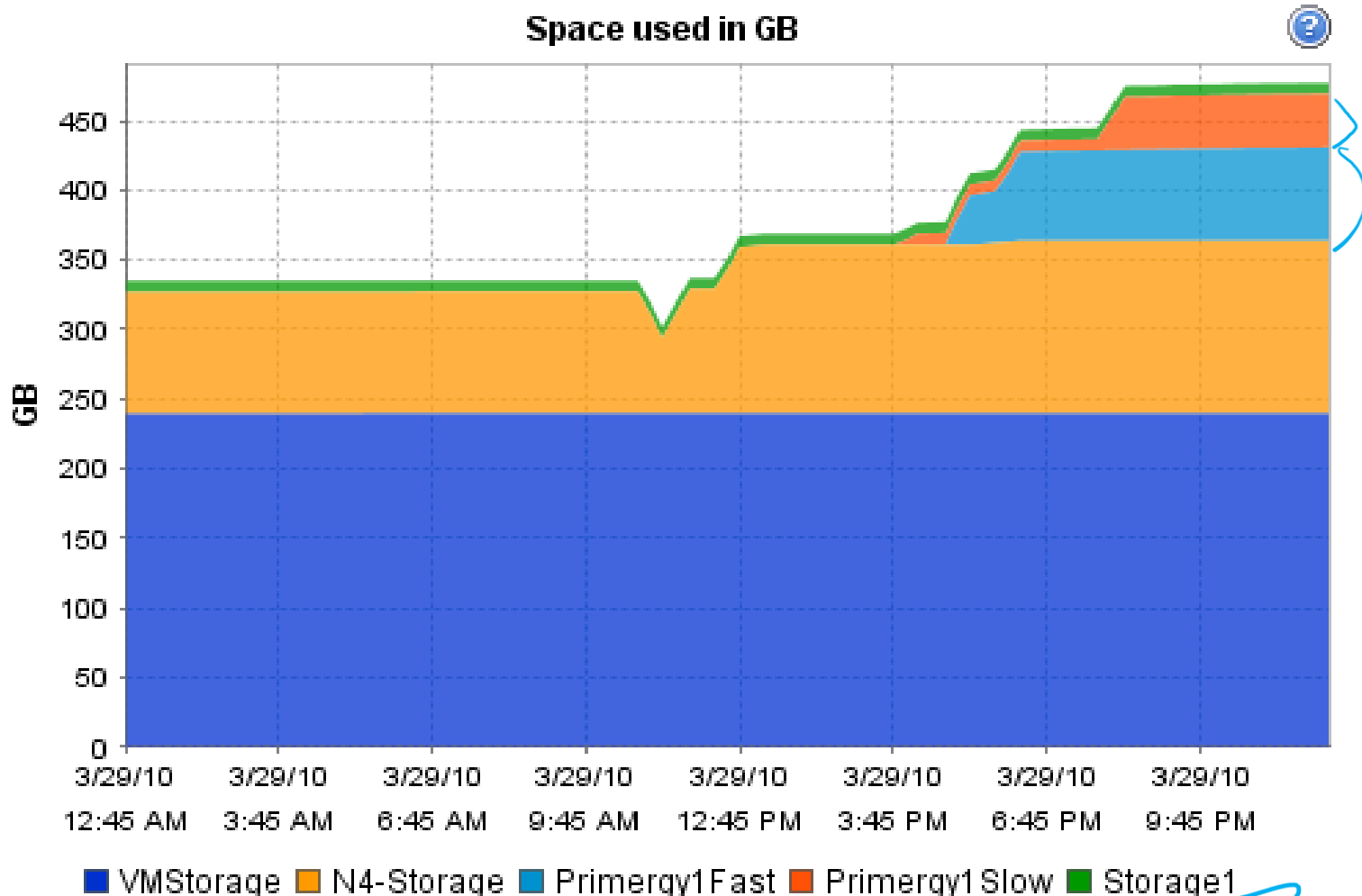
Name	Status	VMware Tools Status	VM Version	State	Provisioned Sp...	Used Space	Host CPU - MHz	Host Mem - MB
crio8	✓ Normal	OK	7	Powered On	75,00 GB	75,00 GB	106	7458
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ganimede	✓ Normal	Out of date	4	Powered On	99,66 GB	99,66 GB	22	1883
giapeto	✓ Normal	Out of date	4	Powered On	53,02 GB	53,02 GB	44	2688

Recent Tasks

Name	Target	Status	Initiated by	vCenter Server	Requested Start Ti...
------	--------	--------	--------------	----------------	-----------------------



Datacenter space consumed again time





Performance Analysis, Single VM

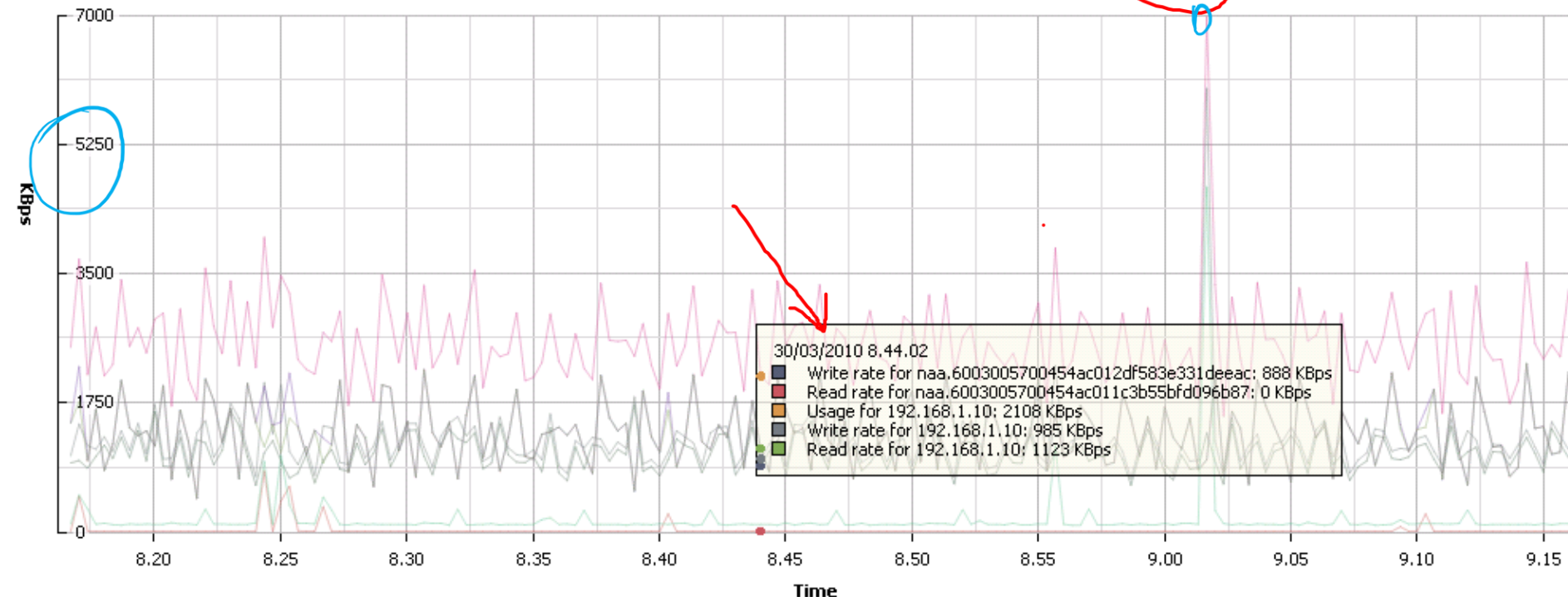
Getting Started Summary Virtual Machines Resource Allocation Performance Configuration Tasks & Events Alarms Permissions Maps Storage Views Hardware Status

Overview Advanced

Disk/Real-time, 30/03/2010 8.16.12 - 30/03/2010 9.16.12 Chart Options...

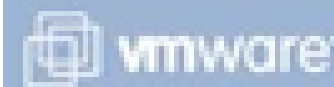
Graph refreshes every 20 seconds

Switch to: Disk



Performance Chart Legend

Key	Object	Measurement	Rollup	Units	Latest	Maximum	Minimum	Average
	naa.600300570...	Write rate	Average	Kbps	1001	1727	626	1058,693
	naa.600300570...	Read rate	Average	Kbps	0	820	0	18,045
	192.168.1.10	Usage	Average	Kbps	3281	6992	1564	2594,006
	192.168.1.10	Write rate	Average	Kbps	1110	6019	716	1218,615
	192.168.1.10	Read rate	Average	Kbps	2170	2279	446	1374,872
	naa.600300570...	Read rate	Average	Kbps	2170	2279	446	1356,693
	naa.600300570...	Write rate	Average	Kbps	1001	1727	626	1058,693





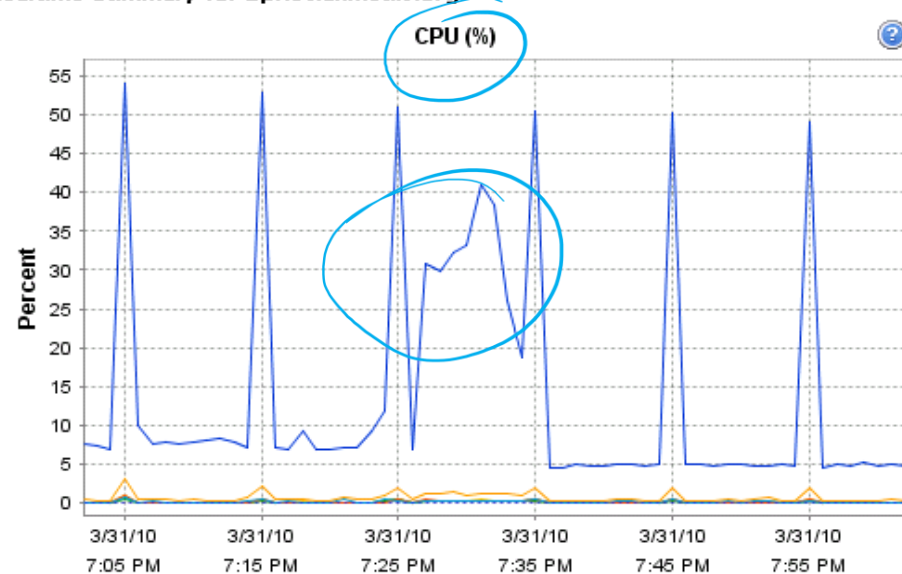
Performance Analysis, Single VM

Getting Started Summary Resource Allocation Performance Tasks & Events Alarms Console Permissions Maps Storage Views

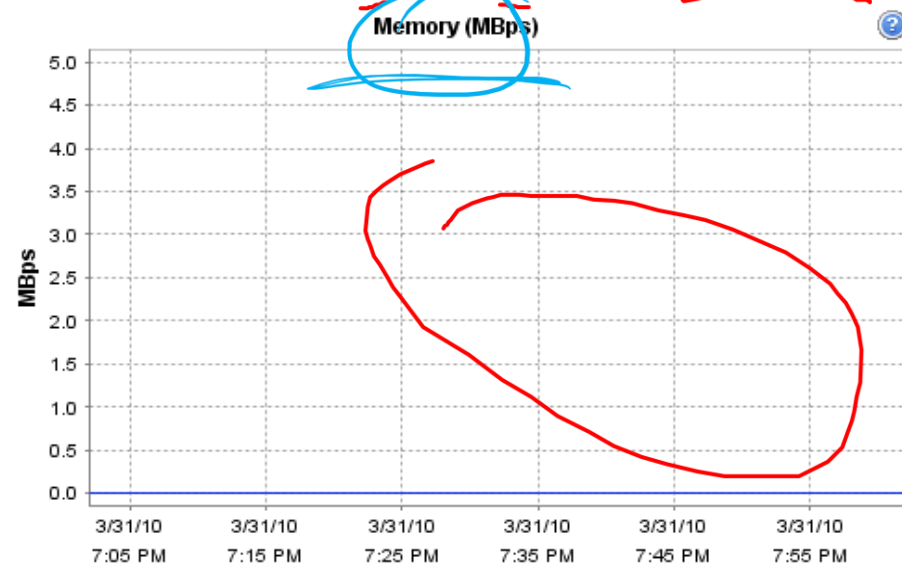


Overview Advanced

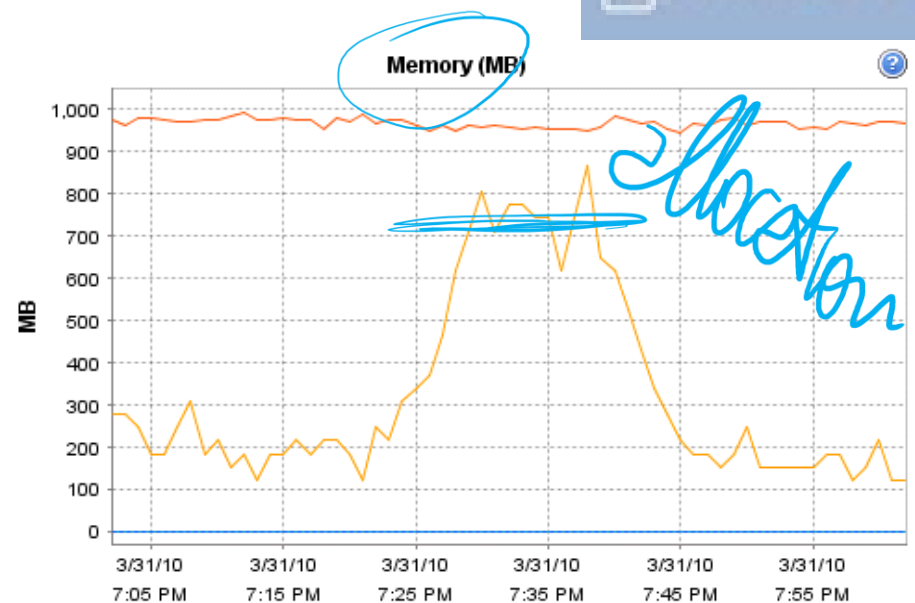
Realtime Summary for bpnet.axmedis.org



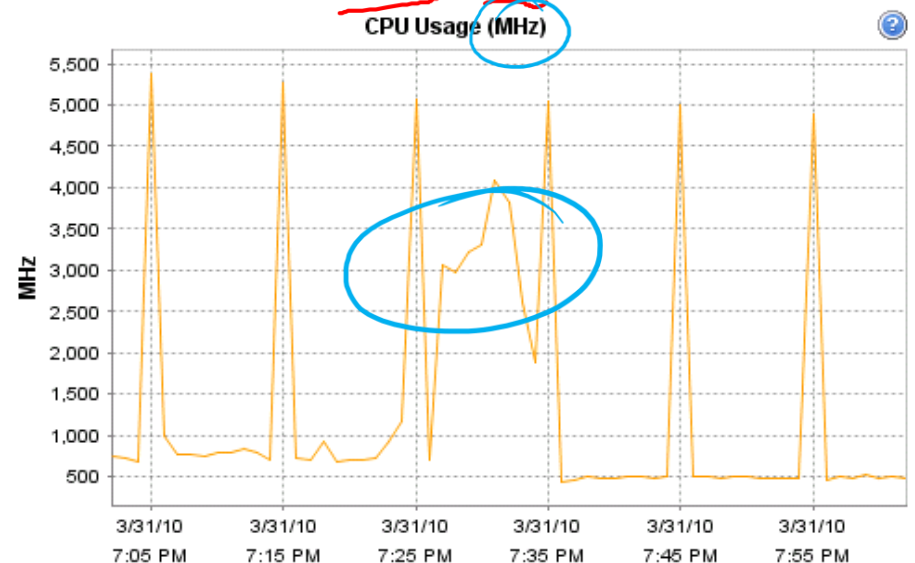
■ Usage ■ Ready ■ Ready for 0 ■ Ready for 1 ■ Ready for 2 ■ Ready for 3



■ Swap in rate ■ Swap out rate



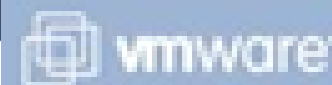
■ Balloon target ■ Swapped ■ Shared ■ Balloon ■ Active



■ Usage in MHz



Performance Analysis, Single VM

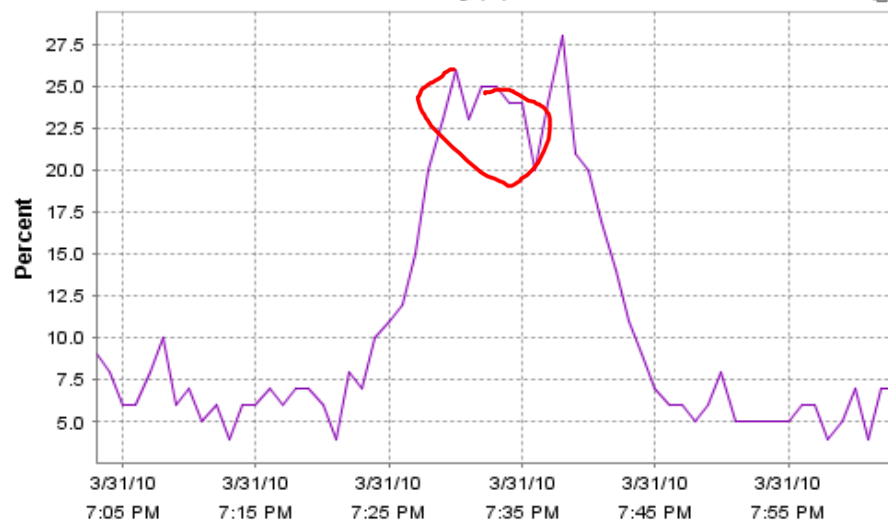


Getting Started Summary Resource Allocation Performance Tasks & Events Alarms Console Permissions Maps Storage Views

Overview Advanced

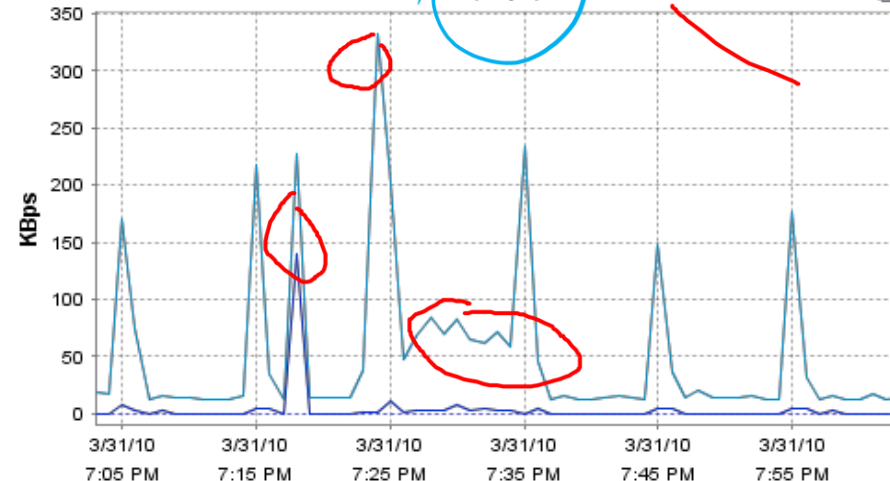
■ Swap in rate ■ Swap out rate

Memory (%)

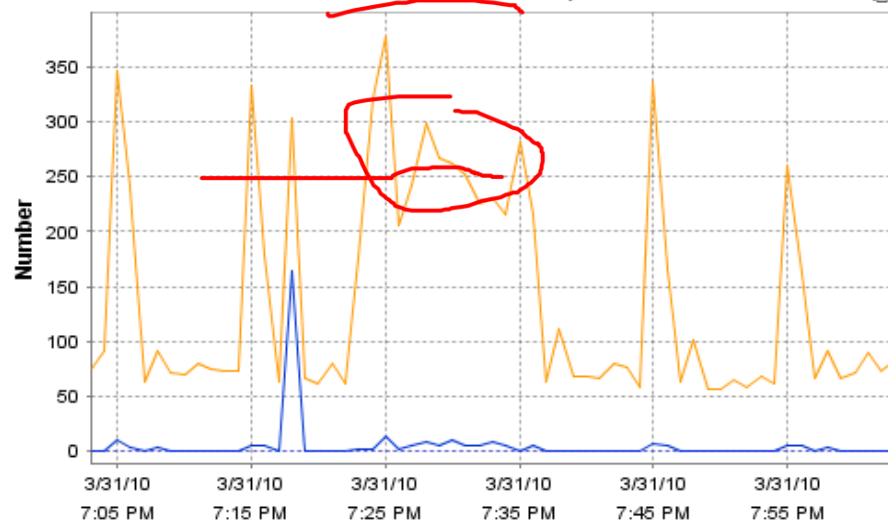


■ Usage in MHz

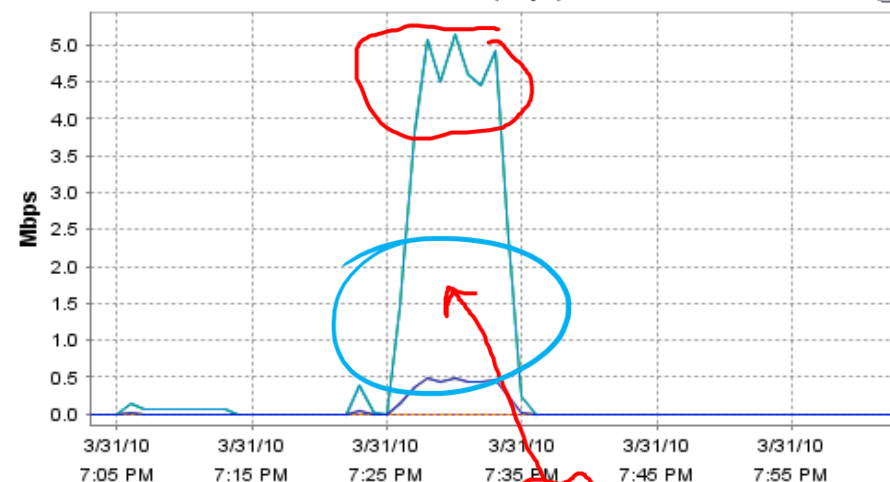
Disk Rate (KBps)

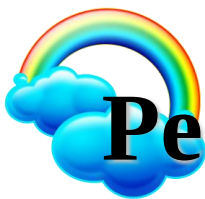


Disk Requests (Number)



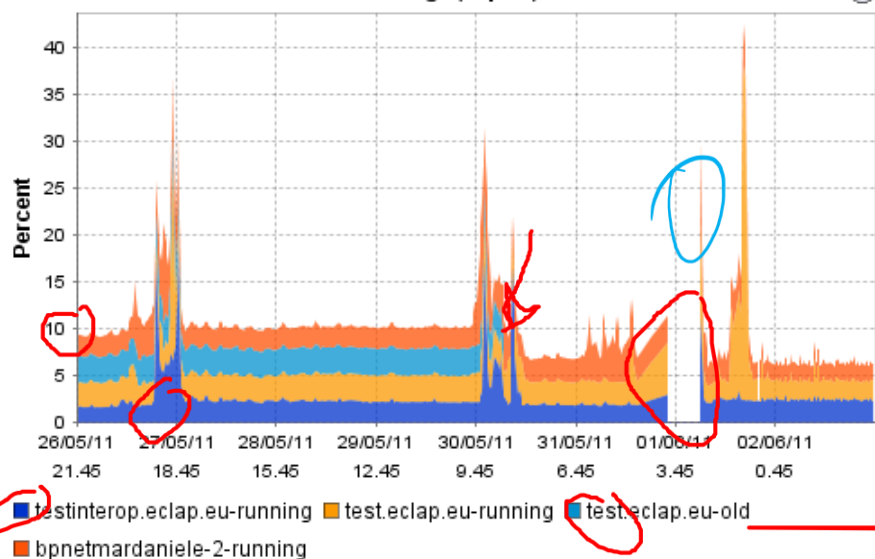
Network Rate (Mbps)



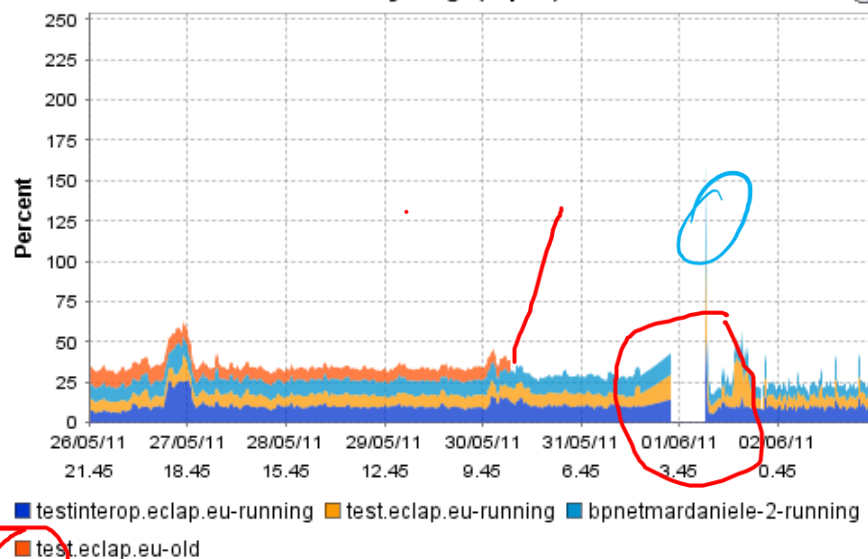


Performance Analysis of VM on the Host

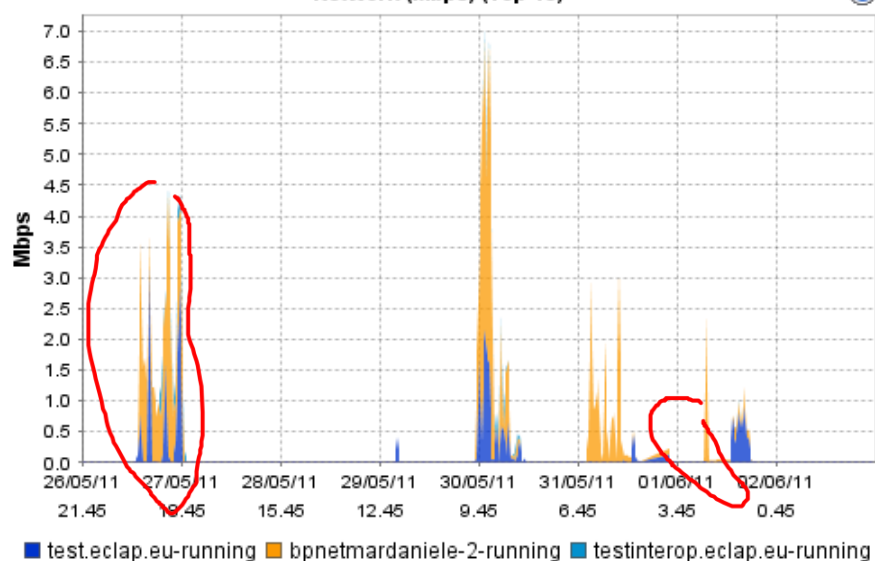
CPU Usage (Top 10)



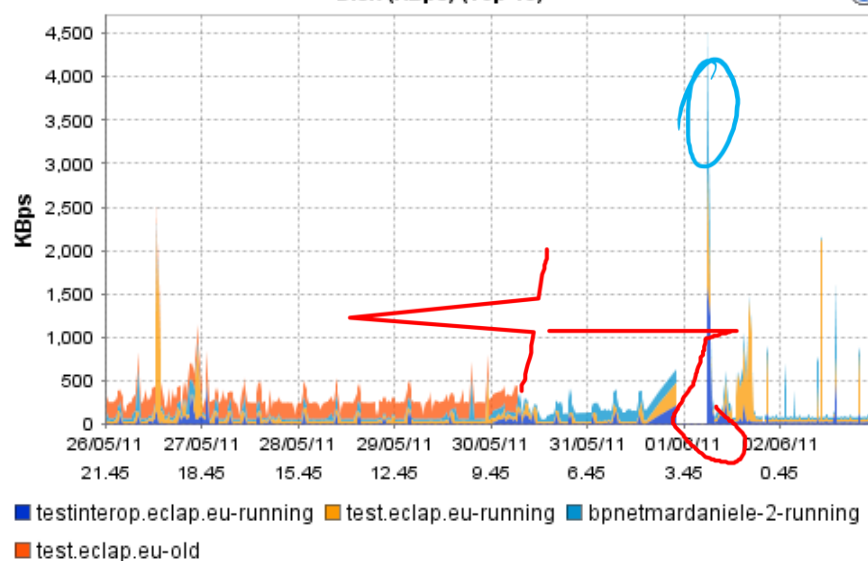
Memory Usage (Top 10)



Network (Mbps) (Top 10)



Disk (KBps) (Top 10)





Problematiche del Monitoraggio

I Parametri da monitorare: IaaS, PaaS, e SaaS:

- ♣ Condizioni e parametri di stato degli HOST
- ♣ Parametri di consumo degli HOST
 - Spazio storage, snapshots, etc.
- ♣ Condizioni e parametri di stato delle VM e del sistema operativo
- ♣ Parametri di consumo delle VM
 - Spazio disco, memoria, connessione

♣ Condizioni e parametri di stato delle applicazioni e dei servizi dentro le VM

♣ Parametri di consumo delle applicazioni e dei servizi dentro le VM:

→ E.g.: Numero di fatture, numero di utenti

HL
↑

SaaS



Monitorare perche'

I Actions:

- ♣ Allarmi gialli/rossi (75%/90%) se si superano soglie definite
- ♣ Invio di: email, sms, etc.
- ♣ Attivazione di riconfigurazioni, cambi di configurazione, estensioni di risorse
- ♣ Attivazione di moving *→ DRS / HA / FT*
- ♣ Shutdown di emergenza
- ♣ Network off/on
- ♣ Cambio di billing in base alla SLA
- ♣ Etc. etc.





Confronto fra sistemi di monitoring

Requisiti	Nagios (core)	Ganglia (core)	Zenoss (core)	Zabbix 2.2.0	Hyperic HQ 4.6.6
PaaS/SaaS					
Monitoraggio Virtual Machine (Low level Metrics)	X	X	X	X	X
Monitoraggio Applicazioni/Servizi Agent-Based	X	X	X(^)	X	X
Monitoraggio Applicazioni/Servizi Agent-Less	X	-	X	X	X
Agent WIN OS	X	X	X(^)	X	X
Agent/daemon Linux OS	X	X	X(^)	X	X
IaaS					
Monitoraggio Host (Low level Metrics)	X	X	X	X	X
Monitoraggio Hypervisor (Low level Metrics)	X	X (+)	X(^)	X(\$?)	X(^o)
Agent per Hypervisor Notifiche	X	X (+)	X(^)	X(\$\$)	X(^o)
Eventi e notifica allarmi	X	X	X	X	X
High Level Metrics					
Definizione HLM	X (**)	X (+++)	X(^)	X(\$)	X(^o)
Calcolo HLM	X (**)	X (+++)	X(^)	X(\$)	X(^o)
Storage HLM	X (**)	X (+++)	X(^)	X	X(^o)
Interoperabilità					
SDK /API accesso dati	X	X	X	X	X
Plugin	X	X	X	X(\$)	X
Integrazione					
Linguaggio	C/CGI	C, Perl, PHP, Python	Python under Zope	PHP,	Java/C
DB Data Storage	MySQL (via event broker con NDOutils o Merlin)	MySQL (++)	MySQL	MySQL, Oracle, PostgreSQL, SQLite, IBM DB2	MySQL, Oracle, PostgreSQL
FS Data Storage	RRD tool	RRD tool	-	-	-
Linux OS	X	X	X	X	X
Win OS	X (***)	X	-	X	X
Licenza	GPL	BSD	GPL	GPL	GPL
Web GUI	Nagios XI (*)	Ganglia Web 2.2.0+	X	X	X



Structure

- | Elements of cloud Computing
- | Virtualization
- | Cloud Computing
- | High Availability
- | vSphere Infrastructure
- | Security on the Cloud
- | Conversions among VM and physical machines
- | vCenter, datacenters and cluster management
- | Comparison among virtual computing solutions
- | How to work with Virtual Machines
- | IaaS solutions, PaaS Solutions, SaaS Solutions
- | ICARO project





Virtualization Solutions

| VMware vSphere

- ♣ Datacenter and VM management, a large range of OS

| Microsoft Hyper-V

- ♣ Based on Microsoft Windows Server 2008

| HP Integrity

- | Datacenter and VM management, x86, linux, etc.
- | No GUI for monitoring

| XEN

- ♣ Virtual machine monitor, hypervisor: Suse, RedHat, Sun Solaris, Debian
- ♣ X86, 64, PowerPC 970
- ♣ GPL licensing

| others

- ♣ SWsoft with its Virtuozzo
- ♣ IBM Power VM
- ♣ VirtualBox of Sun, open source



Comparison (www.ctistrategy.com)

Aspect	VMware vSphere 4	Microsoft Hyper-V R2
Hosts		
CPU supported	Recent AMD, Intel	Recent AMD, Intel
# CPU cores supported	64	64
Memory supported	Unlimited	2TB
I/O devices supported	IDE, SCSI, SAS, SATA, FC, 1Gb and 10Gb Ethernet, iSCSI, NFS, FCOE, Infiniband	IDE, SCSI, SAS, SATA, FC, 1Gb and 10Gb Ethernet, iSCSI, CIFS, FCOE, Infiniband
Memory optimization	Over-commit, transparent page sharing, ballooning, large memory pages	Standard Windows Server 2008 features
Platform support	Fewer vendors	More vendors
Supported storage of guest VMs	Direct, <u>SAN</u> , NAS, iSCSI	Direct, <u>SAN</u> , iSCSI
Number of nodes in a cluster	32 nodes if < 40 VMs per node	16



Comparison, 2

Aspect	VMware vSphere 4	Microsoft Hyper-V R2
Guest		
Operating systems supported	Asainux, CentOS, Debian, FreeBSD, OS/2, Solaris 10, SCO OpenServer, SCO Unixware, Windows Server, RHEL, SUSE, MS-DOS, Netware - <i>XP, Vista</i>	Windows Server, Vista, XP, SUSE Linux
Operating systems tools provided (per OS)	Yes, for most guests	Yes, for most guests
# virtual CPUs supported	8	4
# guests per host	256 running	512 (192 running)
# Amount virtual memory	255GB	64GB
Virtual NICs	10	Yes, limit unknown
# of snapshots	32 per VM (?)	50 per VM
Types of guests supported	32-bit, 64-bit, simultaneously	32-bit, 64-bit, simultaneously
Ability to hot-add disk images and external storage	Yes	Virtual SCSI devices only, not IDE

x CPU / host

x CPU / host



Aspect	VMware vSphere 4	Microsoft Hyper-V R2
Features		
VM move	Live	Live
Direct I/O	VMDirectPath I/O	-
VM synchronization	With limits (1 vCPU, many features disabled)	No
Directly boot from VM image	Only if ESXi installed	Yes
P to V	Included	Included
V to P	Included	Included
H/A via clustering and failover	Yes	Yes
Replication	Integration with 3rd party storage products	Yes (DFS-R)
Performance monitoring	Yes, vCenter Server	Yes, SC Operations Manager
Network features	Virtual switch, VLAN tagging, Network vMotion, Network traffic shaper, IPv6, CDP, NIC teaming	Standard Windows Server 2008 features
Storage features	Thin provisioning, consumption-based monitoring, reports and topology maps, LUN discovery, adaptive block sizing, storage vMotion	Standard Windows Server 2008 features
Patching of guests	vCenter Update Manager (both running and halted guests, Windows and some Unix)	Standard Windows Server 2008 features for booted Windows guests, Offline Machine Servicing Tool for halted Windows guests
Security	Layer 2 security policies, vShield, VMsafe 3rd party security products	Native firewall, 3rd party security products
Backups	Native via VMware Data Recovery, Support from major vendors	Native, Support from major vendors
Resource management	Yes, many options	Yes, some options
Physical server power on / off as needed	Via VMware DRS / DPM	No



Standards in Virtual Machine formats

| Virtual Machine formats on the HD

- | **OVF:** Open Virtualization Format, on the push of VMware
 - ♣ Format for VM

| VM disk format of VMware is a standard which is supported by:

- ♣ VMware workstation
- ♣ vSphere VMware
- ♣ VirtualBox of SUN





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How to WORK with VMs in the Cloud

KVM solutions

- ♣ Local access via local KVM
- ♣ Local server access via HTTP

Windowing Terminal

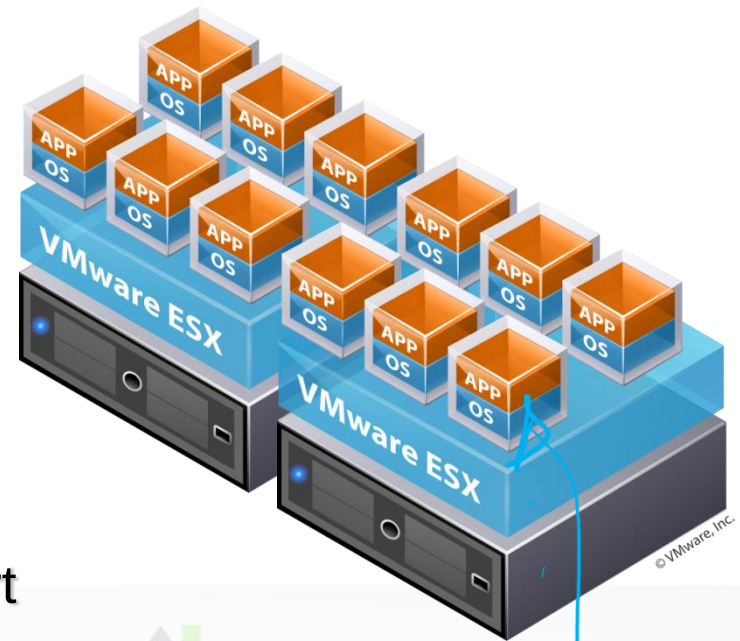
- ♣ MS Windows Remote Desktop
- ♣ X Terminal to linux

Remote Solutions:

- ♣ VNC, Radmin, etc.
- ♣ VNC: Also possible via HTTP port

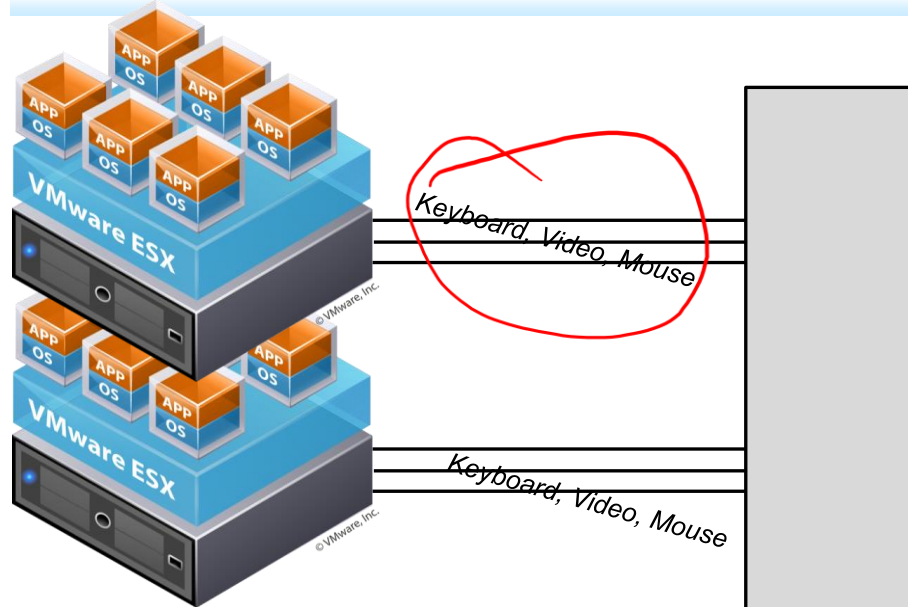
Telnet, char based consol, SSH

VT100 terminal for example





KVM



Network:

- control
- remote access/desktop

kvm





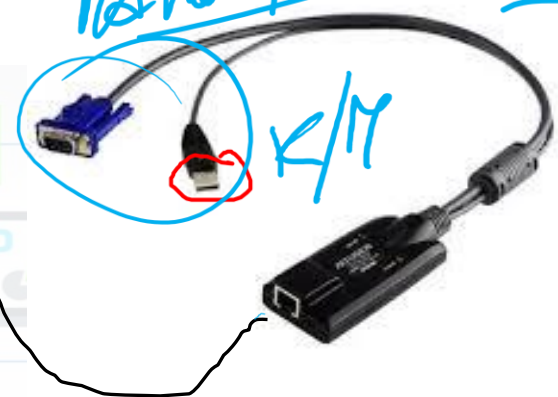
RJ45 KVM



K/M

RJ45

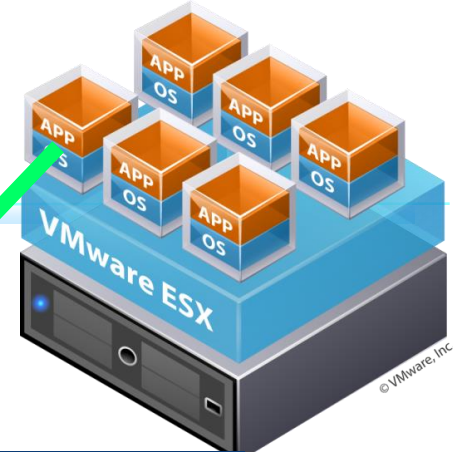
È un caso di rete
Ma non porta sepolchi
rete



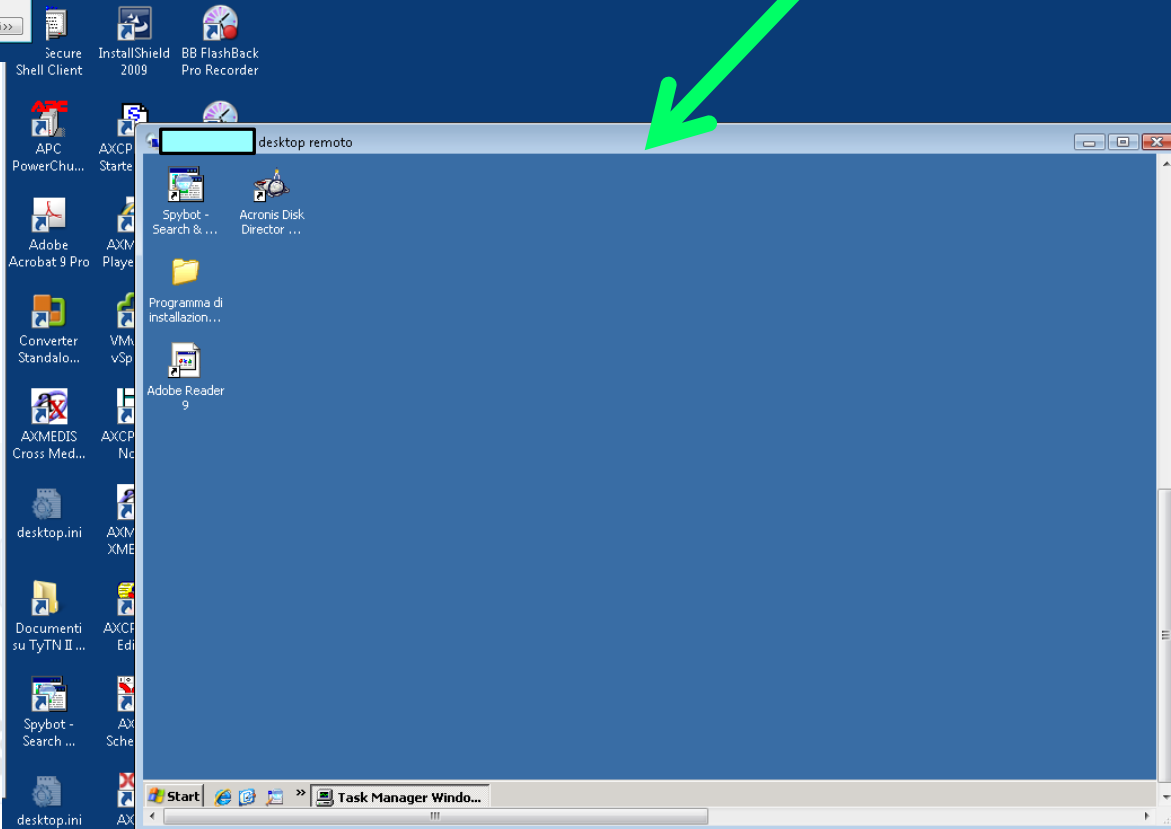
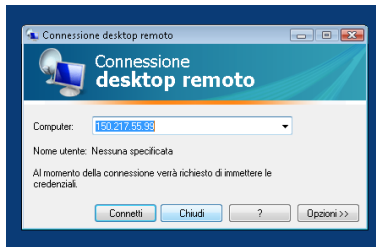
K/M



Windows Remote Desktop



n Remote machine
n Windows 2003

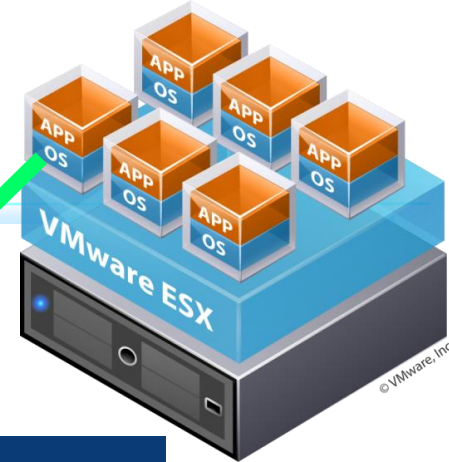


n Local machine
n Windows Vista





VNC remote connection



Remote machine
Windows XP

VNC Authentication: mobmed.axmedis.org [128-bit AES Encrypti...

Username: OK

Password: Cancel

Local machine
Windows Vista





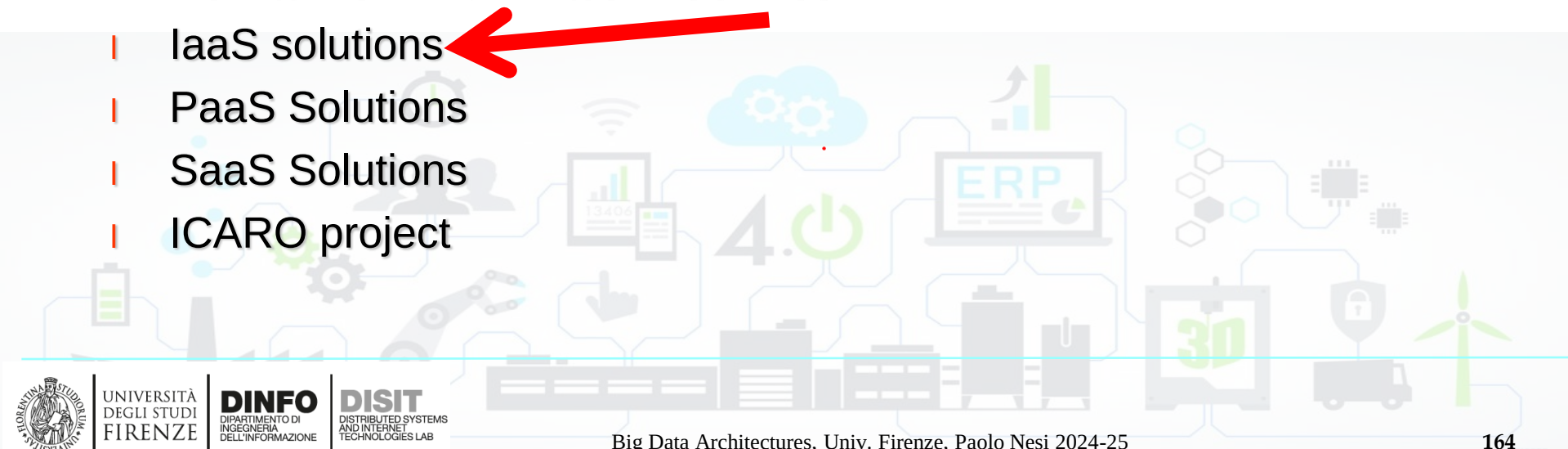
- | Targhet
- | Come si lavora a caldo





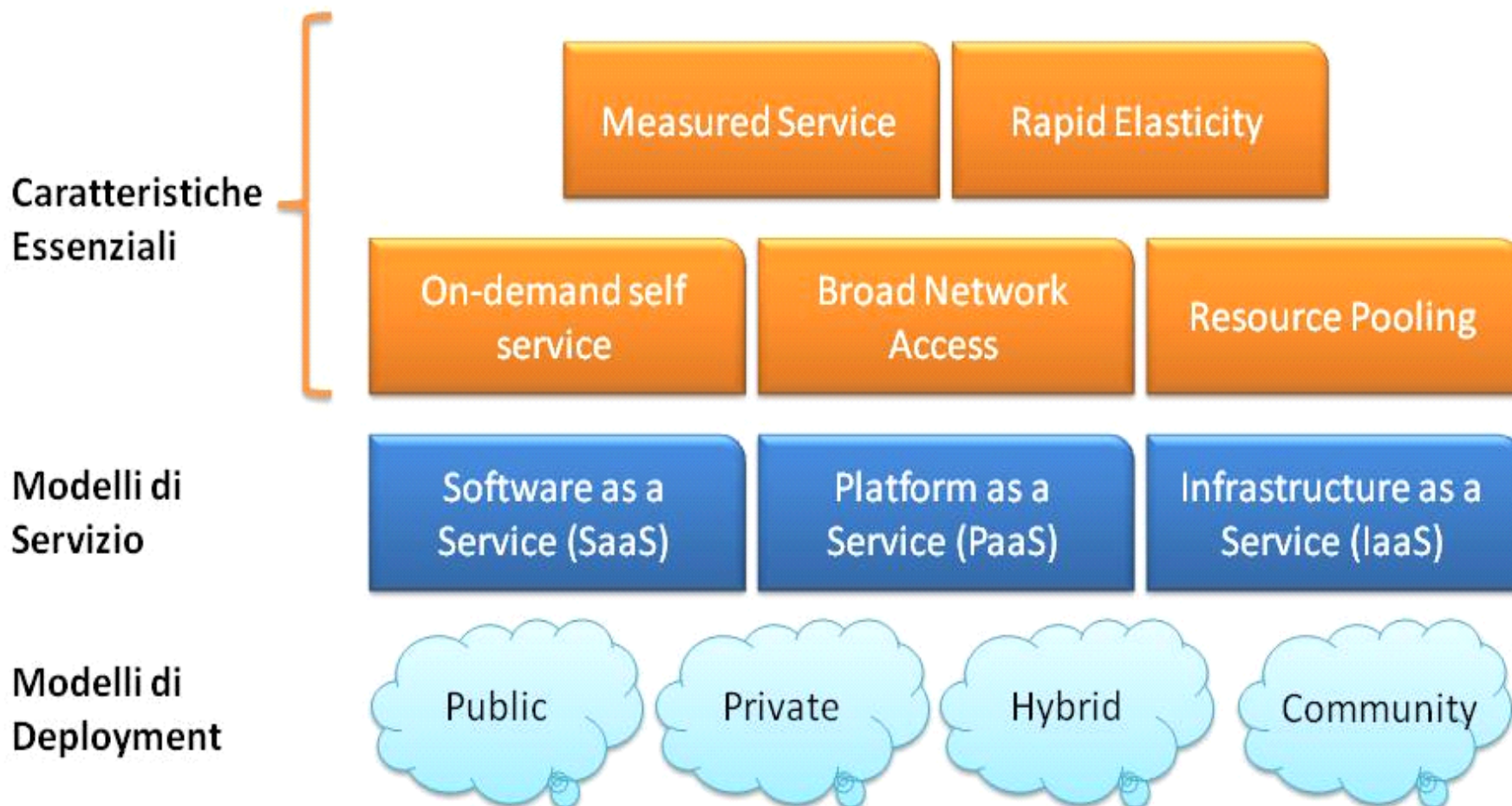
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- | PaaS Solutions
- | SaaS Solutions
- | ICARO project





Modello Generale





Infrastructure as a Service (IaaS)

- | erogazione di servizi infrastrutturali relativi a:
 - ♣ CPU come clock, storage as HD, rete, mem
 - ♣ altri elementi di base assolutamente indipendenti da servizi applicativi di qualunque tipo.
- | infrastruttura messa a disposizione dal provider per eseguire la propria applicazione:
 - ♣ Affitto di Server e/o macchine virtuali
 - ♣ pagamento in base al consumo dell'infrastruttura
 - ♣ lascia sotto la responsabilità dell'utente la gestione del sistema operativo, dell'eventuale middleware e della parte di runtime, oltre che dell'applicazione stessa.
- | Amazon EC2 è un esempio di servizio IaaS.



IaaS

- | Una serie di Host, VM e NAS/SAN
- | Un gestore di macchine virtuali
- | Un sistema per il deploy basato su templates
- | Un sistema di monitoring and alarm su risorse fisiche e parametri di hosts
- | Un sistema per l'accounting e il deploy automatico
- | Alcuni servizi per l'accesso diretto a Host e VM





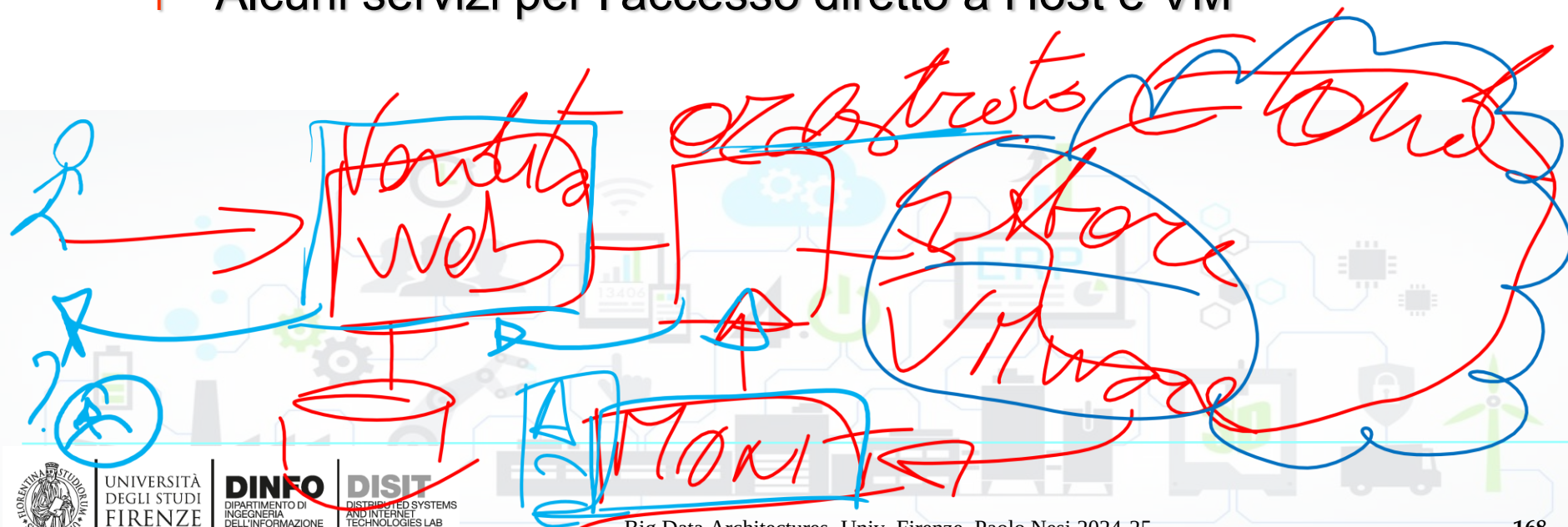
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SP

IP
Service ID

Host Resource → Billing





IaaS Solutions

- | Based on Virtualization *Cluster*
- | A set of Datacenters, Hosts, NAS/SAN, networks, etc.
- | IaaS commerciali come
 - Amazon's Elastic Compute Cloud (EC2) and Simple Storage Service (S3). Amazon EC2 è il leader del mercato dei provider IaaS.
- | Come Technology provider di soluzioni IaaS si hanno:
 - Oracle,
 - VMware: Vcenter, Vsphere, etc.;
 - **Nimbus**;
 - OpenNebula;
 - HP;
 - **Eucalyptus**; **Ubuntu** Enterprise Cloud (basato su Eucalyptus);
 - GoGrid;
 - Flexiscale;
 - UNISYS,
 - Enterprise Cloud Manager, ECM, on Hybrid.

*CSP
2° Livello*



Service Model	IaaS													
Infrastructure Feature	Amazon EC2	BitRefinery	GoDaddy	GoGrid	Hosting.com	NephoScale	OpSource	Rackspace	ReliaCloud	Softlayer	Terremark	Eucalyptus	OpenNebula	Nimbus
Pay As You Go	x		x	x		x	x	x		x	x			
Dynamic Service Level Agreement														
Certificazioni (e.g., PCI o SAS 70)	x	x			x		x	x	x	x	x			
Scale Up		x	x	x	x	x	x	x			x			
Scale Out	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Live Support		x	x	x	x	x	x	x	x					
Monitoring Tools	x		x		x		x	x		x			x	
APIs	x			x		x	x	x	x	x	x	x	x	x
Free Tier	x					x						x	x	
Highly customizable instances		x			x		x				x			
Cloud Burst													x	



IaaS confronto (legenda)

- | **Pay per use** – se si paga a consumo, in realtà molti provider hanno una filigrana di offerte più ampia, includendo anche piani mensili, sconti e promozioni ecc.
- | **Dynamic SLA** – se viene offerta la possibilità di ridefinire gli SLA.
- | **Certifications** – se il provider offer certificazioni sulla compliance/sicurezza come PCI o SAS 70.
- | **Scale Up** – se è possibile lo scale up di single istanze di server, tramite l'aggiunta di memoria, extra CPU o storage.
- | **Scale Out** – se è possibile fare il deploy veloce di nuove istanze dei server.
- | **Live Support** – può essere diviso in:
 - ♣ *Poor (n)* – solo forum di supporto for free; in alternativa a pagamento.
 - ♣ *Average (y)* – supporto 24×7 gratis (telefono, chat, forum).
 - ♣ *Extensive (y)* – offerte di supporto multiplo per ogni soluzione proposta.
- | **Monitoring** – può essere diviso in:
 - ♣ *Poor (n)* – nessuna soluzione di monitoring/alert integrata, sono necessari strumenti di terze parti da acquistare separatamente.
 - ♣ *Average (y)* – strumenti di monitoring minimali e senza servizi di alert.
 - ♣ *Extensive (y)* – soluzioni complete e integrate di strumenti di monitoring compresi nel prezzo.
- | **APIs** – se vi sono API per interagire con i server.
- | **Free Tier** – se vengono offerte soluzioni di prova per il test dei servizi



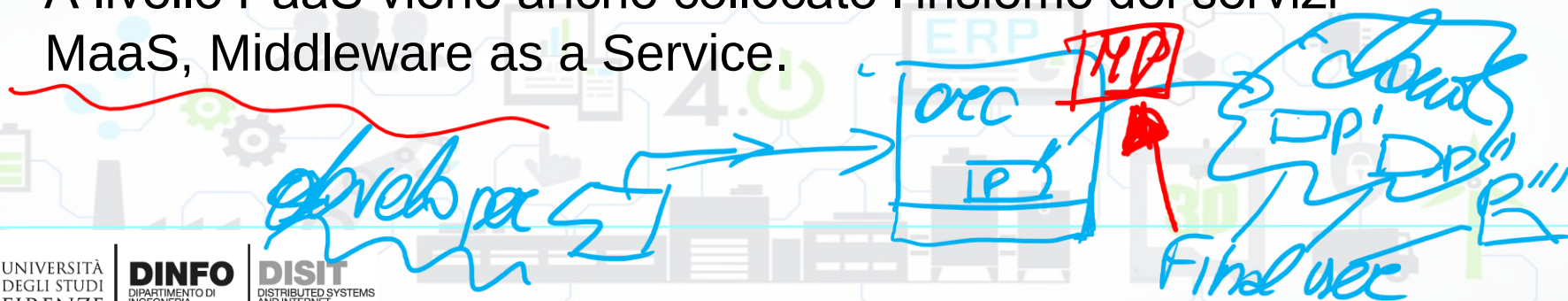
Structure

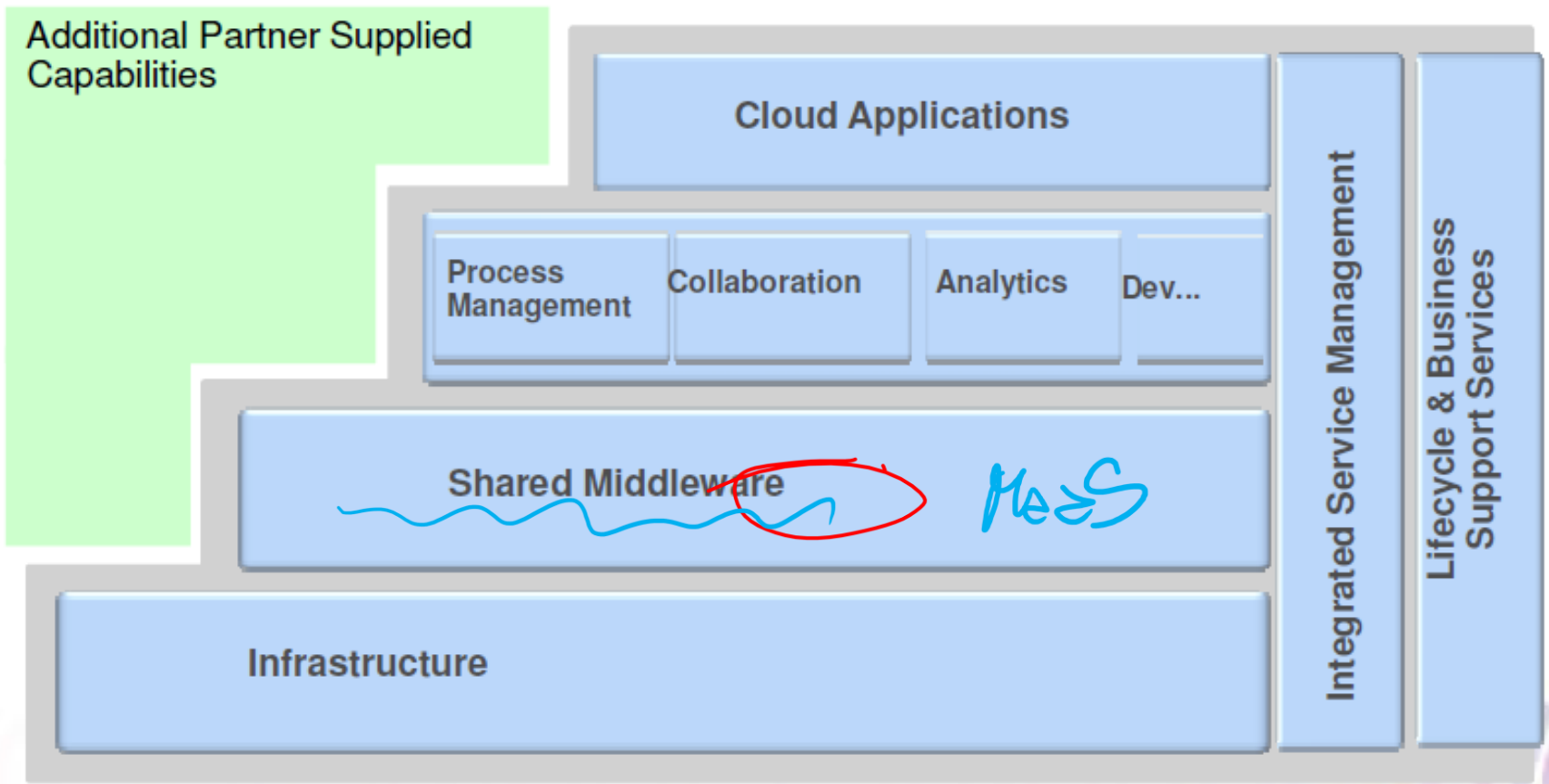
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Platform as a Service (PaaS)

- | erogazione di servizi applicativi di base come:
 - ♣ sistemi operativi, middleware, linguaggi,
 - ♣ tecnologie di base dati
 - ♣ ambiente runtime necessari per eseguire l'applicazione,
- | rimane sotto la responsabilità dell'utente,
 - ♣ applicazione
 - ♣ la definizione del modello (e.g., numero e dimensione dei server, datacenter, caratteristiche del networking) da utilizzare per l'esecuzione dell'applicazione.
- | Google AppEngine è un esempio di Platform as a Service.
- | A livello PaaS viene anche collocato l'insieme dei servizi MaaS, Middleware as a Service.







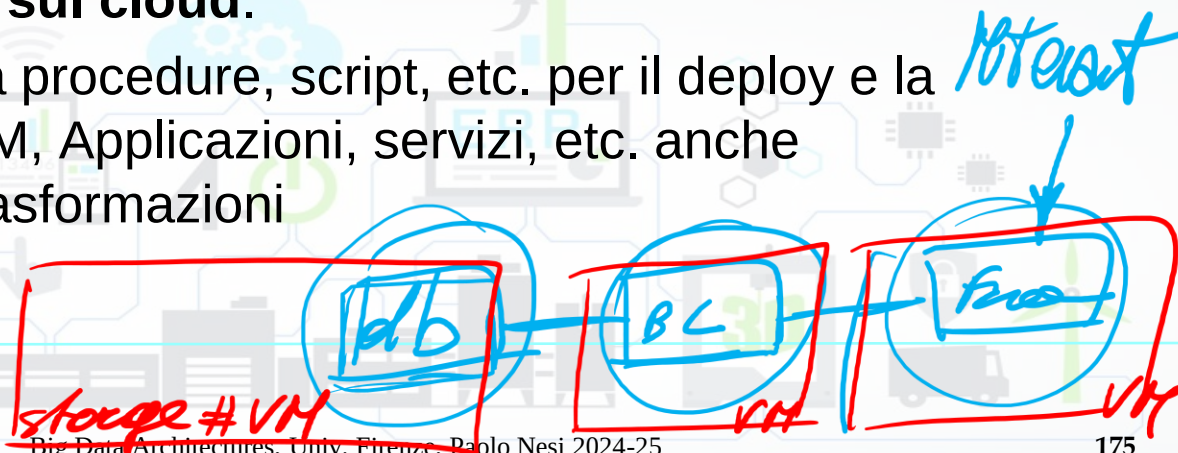
PaaS

- | **Middleware per accesso ai servizi di base**
 - ♣ **Middleware as a Service, MaaS**
 - ♣ **API per accesso a questi servizi**
- | **Sistema di sviluppo** per applicazioni che possono usare le API
- | **Servizi e risorse base**

- | **Business Process Modeling:**

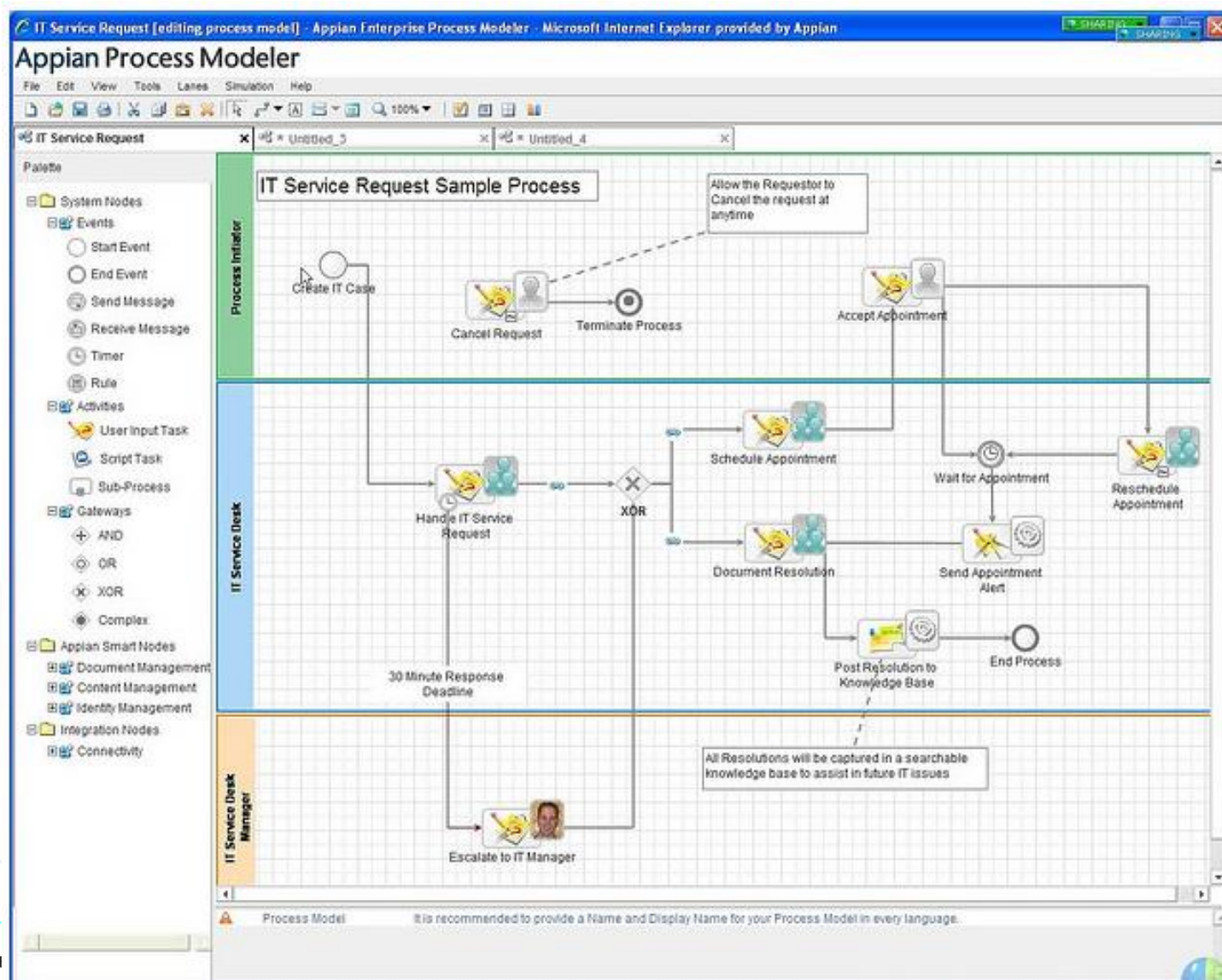
- ♣ **permette definire come allocare e configurare le macchine virtuali ed i servizi sul cloud.**
- ♣ **A livello SaaS:** Crea procedure, script, etc. per il deploy e la configurazione di VM, Applicazioni, servizi, etc. anche riconfigurazioni e trasformazioni

- | **Processo di lavoro**





Appliant Process Modeler





Alcuni esempi di PaaS

- | Google App Engine (<https://appengine.google.com/>) detto anche GAE
- | Windows Azure Platform (<http://www.microsoft.com/windowsazure/>)
- | Force (<http://www.salesforce.com/platform/>)
- | Oracle Fusion Middleware (<http://www.oracle.com/it/products/middleware/index.html>)
- | Eccentex AppBase (<http://www.eccentex.com/platform/features.html>)
- | 3Tera AppLogic (<http://www.ca.com/us/cloud-platform.aspx>)



PaaS										Service Model
SalesForce Force.com	Java, .NET, Ruby, PHP, Python, Perl, Adobe Flex e AIR									Platform Feature
Red Hat OpenShift	Java, Java EE, Python, Perl, PHP, Ruby	Multi IaaS Provider (AWS, etc.)			Git, SSH, rsync	MySQL, MongoDB, MemBase, Memcache	REST	x		
Rackspace Cloud Sites	PHP, ASP, .NET	Multi-tenant PaaS	Rackspace Cloud Files/Aka mail	FTP/S	MySQL 5 & MySQL Server 2008	object storage/ CDN		x		
Microsoft Windows Azure	C#, Java, PHP, Ruby					REST				
Heroku	Java			Maven, Git, SVN	Maria DB, MySQL, PostgreSQL, MongoDB, CouchDB			x		
Google App Engine	Java, Python				Amazon RDS (MySQL), MongoDB, Redis, CouchDB	JDBC, DB-API				
CumLogic	Java, Spring	Amazon EC2, OpenStack, CloudStack, EucaLypTus, VMware vSphere		Git, SVN	MySQL, MySQL cluster, MongoDB	REST		x		
Cloudify	Java, .NET, Groovy, Ruby, C++, Node.js, Spring (more soon)	deploy su qualsiasi IaaS e BYON (bring-your-own-nodes)		Git	Cassandra, MongoDB, MySQL, HSQL	CLI, REST, Web		x		
CloudFoundry	Java Spring, Groovy Grails, Ruby Rails Sinatra, Node.js			Git	MongoDB, MySQL, Redis	CLI				
CloudBees	Java			Maven, Git, SVN	MySQL	REST, CLI		x		
AWS Elastic Beanstalk	Java	AWS Cloud								



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Software as a Service (SaaS)

- | **erogazione di servizi** applicativi accessibili indipendentemente dalla collocazione e dal tipo di device utilizzato.
- | **Non sono eseguite** applicazioni del cliente
 - ♣ il cliente paga il diritto (mediante licenza o canone di affitto) di utilizzo di un'applicazione messa a disposizione dal provider, senza preoccuparsi di come essa venga realizzata e gestita nel cloud.
- | Il cliente deve scegliere la corretta applicazione che soddisfi le sue necessità
- | Salesforce.com Customer Relationship Management (CRM) è un esempio di soluzione in cui il software è venduto in modalità as a service.





Architetture SaaS

- | **Interfacce esterne**
- | **L'insieme di API**, rappresentano i metodi con cui le applicazioni possono venir relazionate con altri servizi o software,
 - ♣ Cloud support for mobile, come Apple
 - ♣ Push service come Apple
- | **Middleware** è lo strumento che permette all'applicazione di sfruttare tutti i servizi e le risorse di livello più basso
- | **Ci puo' essere un Business Producer** per effettuare il deploy automatizzato di Software a servizio.
 - ♣ Tali soluzioni devono tenere conto dello sviluppo dei programmatori e delle SLA (con i corrispondenti parametri di consumo da monitorare).



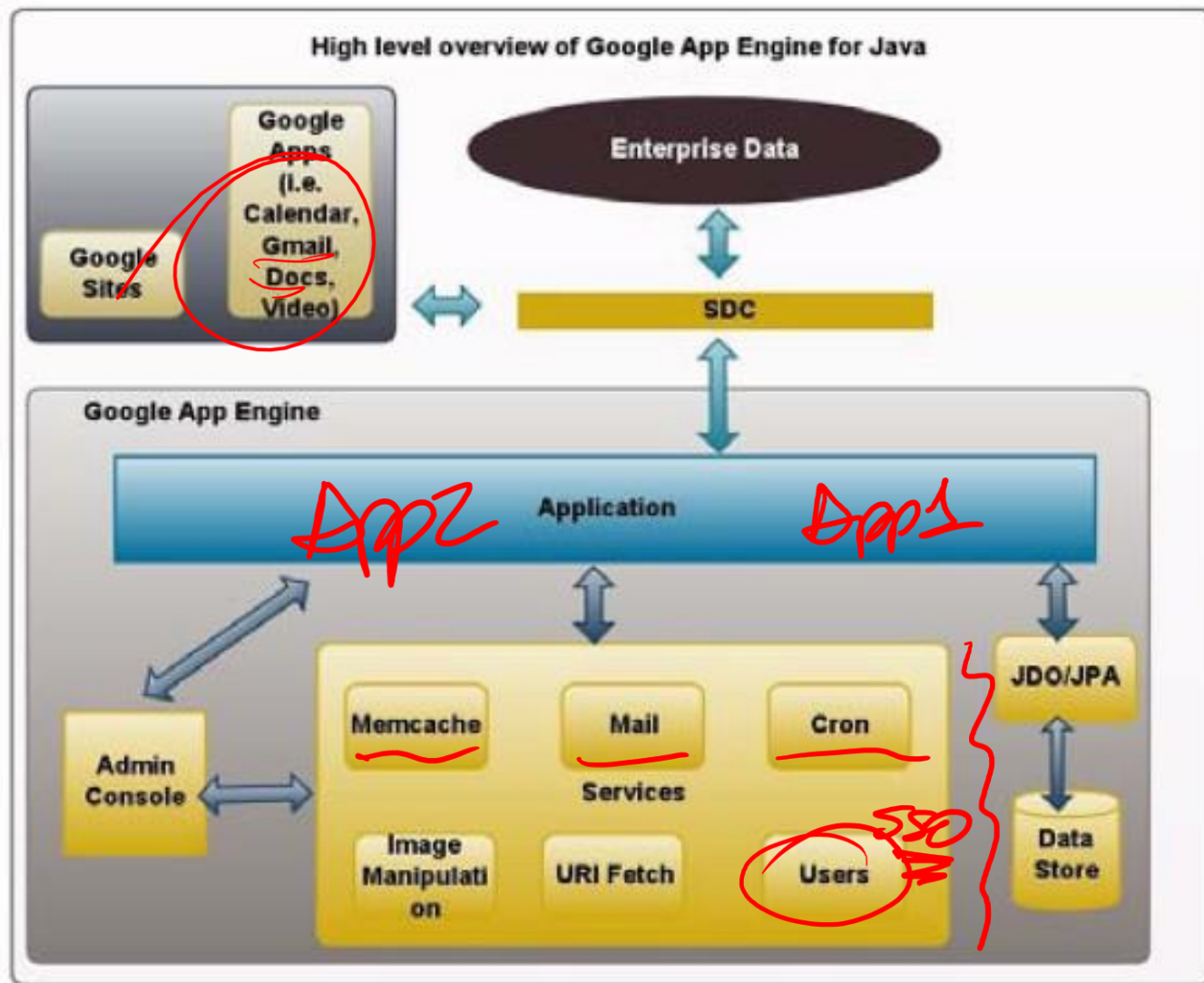
Soluzioni SaaS

- | **Google Apps** (Google) - Google offre gratuitamente ai privati i propri servizi applicativi come:
 - ♣ Google Documents, GMail, Calendars, Sites.
- | **Oracle CRM On Demand** in grado di supportare tipologie di offerta sia in multi tenancy sia in single tenancy
- | **SalesForce.com** (Salesforce) - Customer Relationship Manager.
- | **Zoho Office** (Zoho) - Propone un insieme di applicazioni mirate alle aziende. Il portfolio di servizi prevede più di 20 applicazioni tra cui ad esempio posta elettronica, office app CRM
- | **IBM LotusLive** (IBM) - Consiste di una raccolta di soluzioni di collaborazione aziendale online e servizi di social networking.

MS 365



GAP: Google App Engine





GAP: Google App Engine

- | **Datastore:** un database non relazionale distribuito e scalabile, accessibile attraverso un set di API e gestibile attraverso il pannello di controllo dell'applicazione. Il servizio di base su BigTable, un sistema proprietario per l'archiviazione di dati strutturati.
- | **Google accounts:** un set di API che permette l'autenticazione di utenti attraverso account Google.
- | **URL Fetch:** API che permette di ricavare risorse sul web.
- | **Mail:** API che permette l'invio di e-mail.
- | **Memcache:** sistema di caching di tipo chiave-valore. I contenuti di tale cache sono condivisi tra le varie istanze in esecuzione dell'applicazione.
- | **Image manipulation:** API utilizzabile per la manipolazione di immagini.
- | **Tasks:** Lo sviluppatore ha inoltre la possibilità di schedare task secondo determinati orari o utilizzare una coda di task per permettere alla propria applicazione di eseguire delle operazioni di background mentre delle richieste web vengono servite.

Service Model	SaaS					
Software	Aplicor	NetSuite	Microsoft Dynamics	RightNow	Salesforce .com	
Feature						
Campaign Management	X	X	X	X	X	
Lead management	X	X	X	X	X	
Event Management	X			X		
Pay Per Click (PPC) integration	X	X			X	
E-mail con trackable link e click-through	X	X	X	X	X	
Account Management	X	X	X	X	X	
Contact Management	X	X	X	X	X	
Opportunity Management	X	X	X	X	X	
Competitive Intelligence	X					
Sales Analytics	X	X	X	X	X	
Data Deduplication		X				
Ticket/case/incident management	X	X	X	X	X	
Email to case creation	X			X	X	
Routing	X	X	X	X	X	
Escalation	X	X	X	X	X	
Customer Surveys	X	X		X	X	
Knowledge base	X	X		X		
Self Service Portal	X	X	X	X	X	
Dashboard	X	X	X	X	X	
Ad Hoc Report Writer	X	X	X	X	X	
Data Warehouses	X				X	
OLAP	X		X		X	
Groupware Integration	X	X	X	X	X	
Partner relationship management	X	X		X		
E-commerce Suite		X				
Sales Order Processing	X	X				
Workflow Designer	X			X		
Offline Edition	X	X			X	
Enterprise Resource Planning	X	X	X			
Certifications	ISO, NIST	SAS70			SAS70	
SLA with Guarantee	X					



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iCaro

x Cloud Service Provider

Paolo Nesi (UNIFI, DISIT Lab)

Feb 2015



COMPUTER
GROSS



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❑ IaaS, Infrastructure as a Service:

- ❑ **Business:** vendita di host a consumo
- ❑ **Gestione:** limitata al parco degli Host → **vari Gestori**
- ❑ **Monitoraggio** delle risorse → varie soluzioni di monitoraggio per gli utenti finali e per l'amministratore,
 - ❑ spesso integrate con il Gestore
 - ❑ configurazione di monitoraggio automatizzabile
 - ❑ ~~Dati di monitoraggio accessibili via API del Gestore~~
- ❑ **Costi di gestione:**
 - ❑ ~~accettabili~~ con una buona automazione se mono datacenter con Gestore monomarca, etc.. Altrimenti i costi salgono...
 - ❑ Difficili da gestire se vi sono aspetti di contrattuali stringenti da tenere sotto controllo



Contesto PaaS

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❑ PaaS, Platform as a Service:

- ❑ **Business:** vendita di VM a consumo .. *Platform*
- ❑ **Gestione** di template con sistemi operativi → vari Gestori
- ❑ **Monitoraggio** delle risorse → varie soluzioni di monitoraggio,
 - ❑ spesso non molto connesse con il vostro cliente finale
 - ❑ Difficile automazione della soluzione di monitoraggio, ma possibile
 - ❑ Dati di monitoraggio accessibili via API delle piattaforme o tramite il sistema di monitoraggio
- ❑ **Costi di gestione:**
 - ❑ **accettabili** con una discreta automazione se mono datacenter e gestore monomarca, etc..
 - ❑ Non trascurabili quando vi sono aspetti di contrattuali stringenti da tenere sotto controllo





❑ SaaS: Software as a Service

❑ Business:

- ❑ vendita a consumo di soluzioni software di terzi:
 - ❑ tipicamente software con licenze standard, mensili o annuali
 - ❑ a consumo significa anche con licenze specifiche: numero di utenti, numero di fatture, etc.
- ❑ COME: Applicazioni singola VM FINO A configurazioni Multi-tier complesse
 - ❑ Le semplici applicazioni a singola VM sono vendibili con svariate configurazioni, l'uso di template è molto limitato
 - ❑ Le configurazioni complesse possono avere decine di servizi, connessioni virtuali, aspetti contrattuali complessi, spesso customizzazioni rilevanti, etc....
 - ❑ Le configurazioni two tier, sono in numero elevato e costo molto in configurazione

❑ Gestori: in questo caso sono soluzioni che

- ❑ **Aiutano** a predisporre le applicazioni in modo che possano essere gestite in modo semplice: questi vanno da quelli che fanno tutto a quelli che definiscono linee guida complesse che solo tramite una programmazione spinta permettono di automatizzare il processo, anche tramite vari step a mano
- ❑ **Allocano** (deploy) e configurano le applicazioni software in modo automatico nel cloud in base a varie pattern. Questi gestori permettono di definire delle procedure di deploy (workflow) anche con parametri, in alcuni casi hanno un sistema di monitoraggio integrato anche se non sofisticato.



Contesto SaaS, 2/2

192

❑ SaaS: Software as a Service (continua)

❑ Monitoraggio: soluzioni che dovrebbero permettere di

- ❑ **controllare** non solo il consumo delle risorse a livello IaaS, PaaS ma anche gli aspetti SaaS dell'Applicazioni a consumo, per esempio le relazioni, i servizi interni, etc..
- ❑ **Automatizzare** la configurazione del sistema di monitoraggio: sia per singole che VM che per business complessi con varie VM e Servizi collegati
 - ❑ **Definire** delle metriche di alto livello che possano mostrare il vero comportamento del sistema
 - ❑ **Valutarle** in modo automatico valori collegati al contratto
- ❑ **Esportare** i dati di monitoraggio verso gli amministratori e anche verso i clienti finali

❑ Costi di gestione: molto elevati se vengono svolte a mano le:

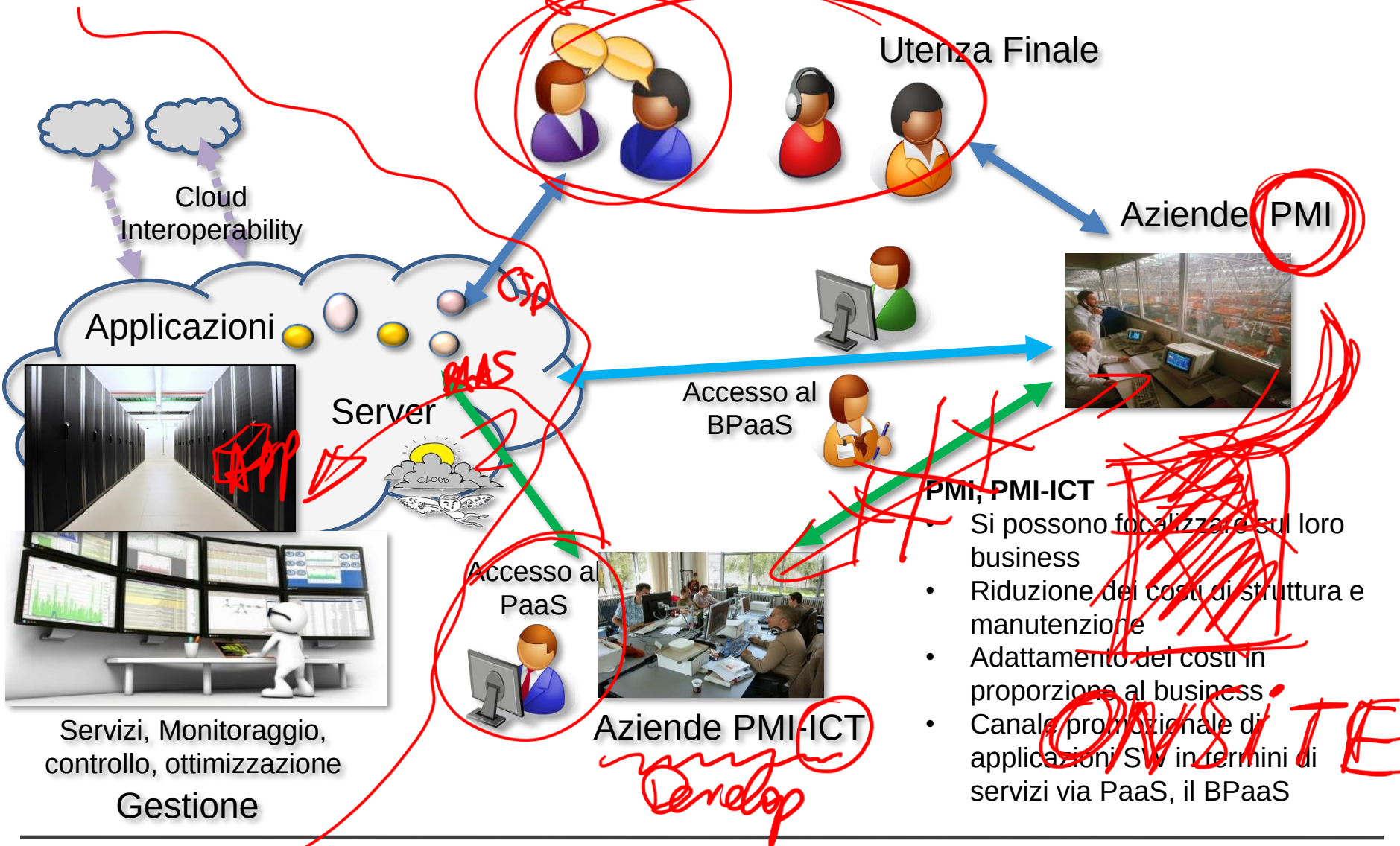
- ❑ operazioni di configurazione, allocazione e deploy su cloud
- ❑ operazioni di configurazione del monitoraggio: basso e alto livello, connessione fra ogni singola metrica e il contratto
- ❑ valutazioni sui cambi di configurazione, connessione fra ogni singola metrica e il contratto
- ❑ riconfigurazioni sulla base di valutazioni complesse e strategie non formalizzate
- ❑ ...



Obiettivi di ICARO

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- ❑ **Ridurre i costi di gestione** in caso di configurazioni complesse: IaaS, PaaS, SaaS, PBaaS, automatizzando i processi di
 - ❑ **Vendita delle soluzioni su cloud**
 - ❑ **Configurazioni integrate: IaaS, PaaS, SaaS, PBaaS**
 - ❑ Config e Deploy di applicazioni complesse, multitier ...
 - ❑ Config e gestione di soluzioni di monitoraggio a livello di metriche integrate per aspetti: IaaS, PaaS, SaaS, PBaaS, business, SLA
 - ❑ **Controllo e monitoraggio dei sistemi, Business Level, SLA level**
 - ❑ **Ri-configurazione sulla base della valutazione di condizioni complesse**
- ❑ Le soluzioni **Cloud attuali** sono spesso:
 - ❑ rigide, provocano inerzie notevoli all'adattamento rispetto a nuove esigenze, ad incrementi di carico/mercato, etc.
- ❑ **ICARO ha inteso sviluppare soluzioni per avere:**
 - ❑ *Ridurre i costi e fornire maggiore flessibilità sul Cloud*
 - ❑ *Adattare il loro parco software alle nuove esigenze*
 - ❑ *Fornire servizi a consumo: Business Process as a Service, BPaaS*





Obiettivi Tecnici, overview

195

- ❑ modello descrittivo per servizi e applicazioni
- ❑ sistema automatico di configurazione
- ❑ reasoner che prendere decisioni su configurazioni: consistenza e completezza
- ❑ soluzione di produzione del business, config automatica
- ❑ motore di intelligence per il cloud
- ❑ algoritmi per il monitoraggio del comportamento di servizi e applicazioni: IaaS, PaaS, SaaS,...
- ❑ soluzione PaaS di tipo evoluto → SaaS
- ❑ algoritmi per la valutazione di modelli di costo e di business
- ❑ adeguamento dell'architettura su alcune applicazioni
- ❑ algoritmi di ottimizzazione della gestione del cloud

KPI



Cloud Orchestration

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- ❑ *the ability to instantly manage, automate and streamline all elements of a cloud platform including the management of physical and virtual resources*
- Una piattaforma di orchestrazione consente ai cloud service provider di separare le risorse virtuali da quelle fisiche
- Attraverso il software, il cliente è in grado di riconfigurare un server in pochi minuti
- Se un progetto è finito o in pausa, il server può essere usato per altri compiti
- Attraverso un pannello di controllo o un API il cliente accende/spenge quello che desidera, e il software fa il resto



- **Orchestration:** è un concetto fondamentale del Cloud Computing, spesso confuso con quello di *Automation*
- L'automazione non basta
- Diventa necessario orchestrare i processi
 - si mettono assieme i vari aspetti della gestione del cloud
 - semplificare la gestione dell'automazione e trovare un bilanciamento per gestire hypervisor, l'utilizzazione delle risorse, disponibilità, scalabilità, prestazioni, sulla base dei requisiti business, con l'intento di fornire servizi velocemente e in modo efficace
 - Gestire workload tramite un'interfaccia singola, in modo da garantire efficienza, controllo e scalabilità
 - Identifica i task automatici che compongono un processo e ne assicura la riusabilità all'interno delle operazioni
 - Semplifica la produzione, il provisioning, il de-provisioning
 - Permette di non fare azioni ripetitive manualmente

Orchestration vs Automation

	Automation	Orchestration
Numero di task coinvolti	Riguarda un singolo task	Combina i singoli task in processi
Pre-requisiti per le prestazioni	I task automatici devono essere eseguiti in sequenza, in accordo alle linee guida sulla sicurezza, con gli opportuni permessi	L'orchestration assicura le prestazioni di ciascuno dei task automatici in un ordine definito, all'interno del workflow
Error-proneness (propensione all'errore)	Richiede molto lavoro di coding, con il rischio di errori nell'esecuzione manuale dei comandi	Elimina gli errori ottimizzando la quantità di codice richiesto. Riutilizza i blocchi di codice in modo da eliminare le ridondanze
Utilizzazione delle risorse	I task automatici esistono come entità autonome, e quindi sfruttano le risorse indipendentemente: spreco delle risorse	Enumera le risorse, IAM (Identity and Access Management) roles, i tipi di istanze, ecc. in modo da ridurre i tempi e fornire risultati più precisi
Esempio	Avviare o configurare un web server	Combina i task automatici in un singolo workflow in modo da soddisfare le richieste

Orchestration

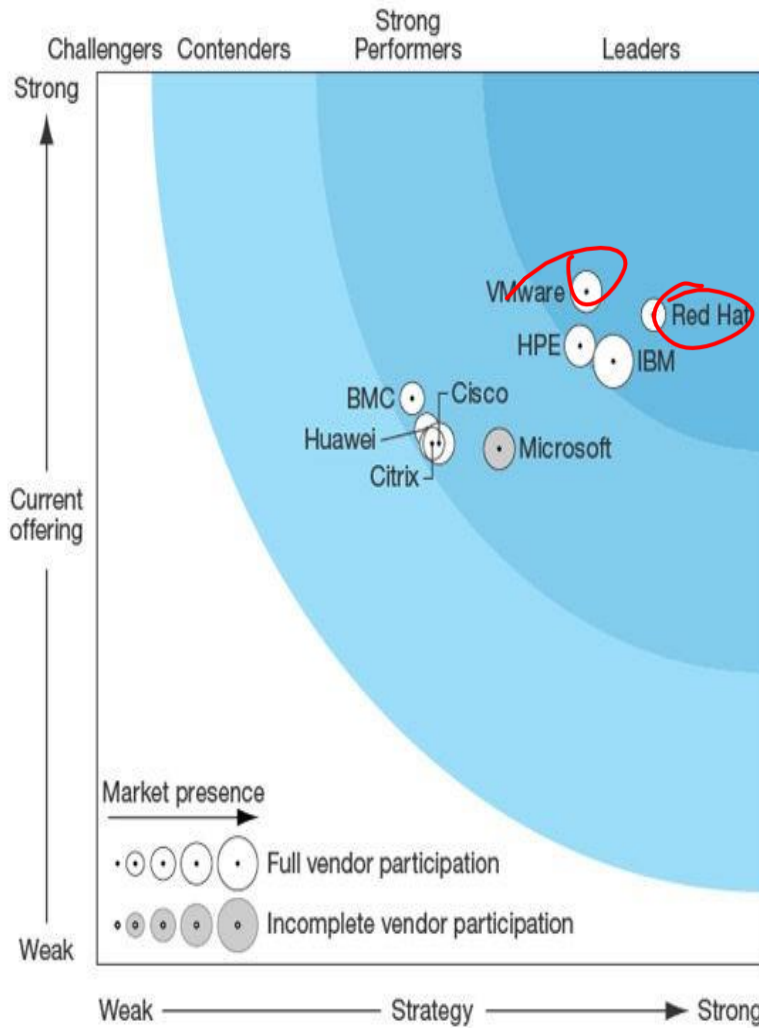
**Cloud Orchestration =
Automation + Integration
+ Best Practices**

Automation = automazione di specifici task

Orchestration = automazione di processi e workflow

Reference

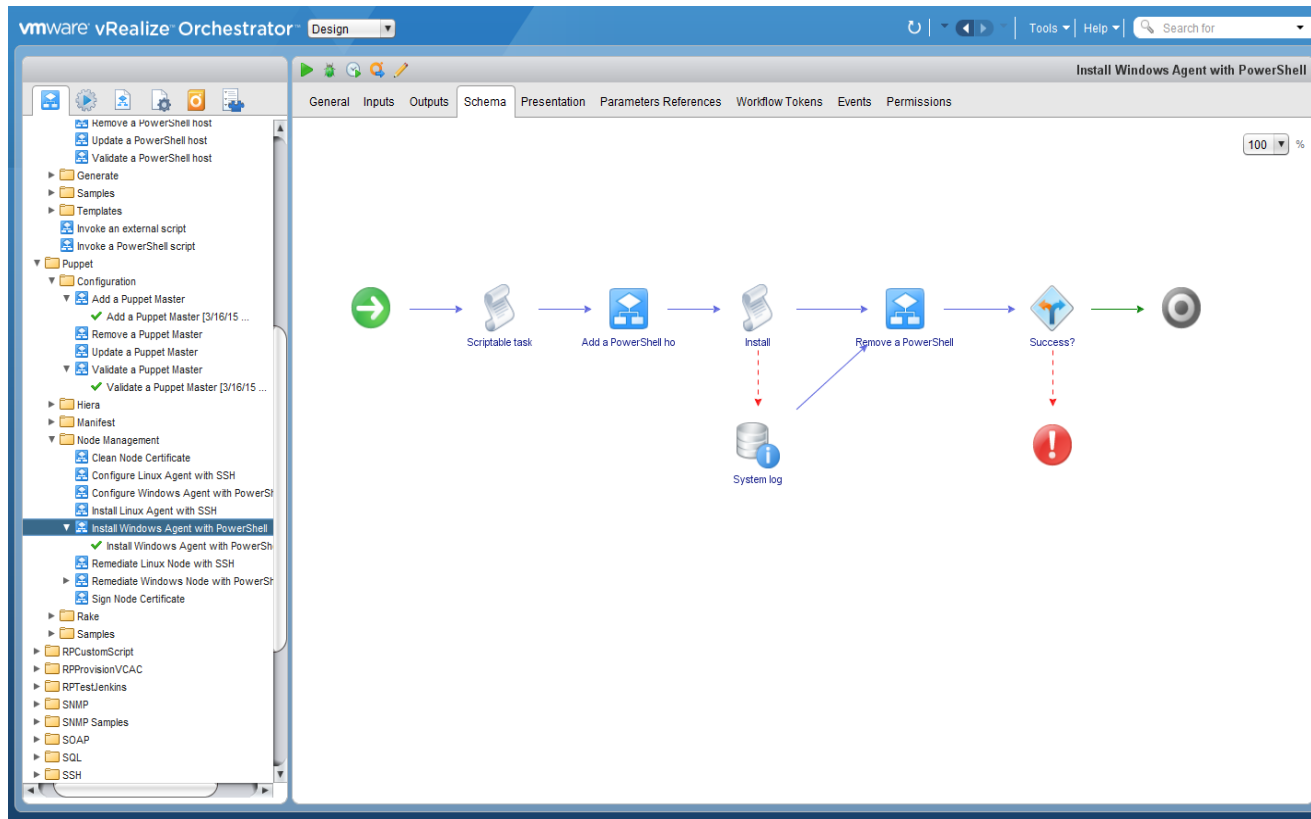
Mercato



- In pochi anni sono state sviluppate centinaia di soluzioni per il cloud management (e molte specificamente per l'orchestrazione dei processi cloud)*
- Però i cloud leader (quelli che si dividono la fetta maggiore del mercato) sono pochi*

vRealize: workflow schema

Workflow Schema, è una rappresentazione grafica che mostra il workflow come un diagramma che interconnette gli elementi del workflow. È l'elemento più importante di un workflow perché ne determina la logica



vmware®

vRealize: workflow schema elements



Start Workflow, il punto di inizio del workflow. Tutti i workflow contengono questo elemento (e soltanto uno). Ha un output e nessun input e non può essere ri **vmware** lo schema.



Scriptable task, task di tipo generale per la scrittura di funzioni Javascript.



Decision, una funzione booleana. Riceve un input e restituisce true/false. Il tipo di decisione che l'elemento prende dipende dal tipo di input parameter, e condiziona la direzione del flusso che il workflow prende.



Custom decision, una funziona booleana. Riceve diversi input e li processa in accordo allo script definito restituendo true/false.



Decision activity, una funzione booleana. Esegue un workflow e collega i suoi output parameter a un percorso true/false.



User Interaction, consente agli utenti di passare nuovi parametri di input al workflow. Permette di definire il modo in cui i presentare la richiesta bloccante di parametri di input e impostare vincoli (e.g., range, timeout). Consente di impostare permessi in modo da definire quali utenti possono impostare i parametri.

vRealize: workflow schema elements



Waiting timer, utilizzato per workflow che richiedono tempi di esecuzione lunghi. Quando il workflow arriva al waiting timer entra in stato di attesa. Si può impostare una data alla quale il workflow riprende l'esecuzione. Mentre è in attesa della data, il workflow è nello stato *waiting-signal*.



Waiting event, utilizzato per workflow che richiedono tempi di esecuzione lunghi. Quando il workflow arriva al waiting event entra in stato di attesa. Si può definire un trigger event che il workflow si aspetta per poter riprendere l'esecuzione. Mentre è in attesa dell'evento il workflow è nello stato *waiting-signal*.



End workflow, il punto finale di un workflow. Si possono avere end workflow multipli in uno schema, che rappresentano le possibili uscite prodotte da esso. Hanno un input e nessun output.



Thrown exception, crea un'eccezione e ferma il workflow. Può comparire molte volte in un workflow. Ha un parametro di input (solo di tipo String) e nessun output. Quando il workflow raggiunge un elemento Exception entra nello stato *failed*.

vRealize: workflow schema elements



Workflow note, consente di annotare le varie sezioni di un workflow.



Action element, invoca un'azione dalla libreria delle azioni dell'Orchestrator. Quando il workflow raggiunge questo element esegue l'azione.



Workflow element, avvia un workflow in modo sincrono. Il workflow originario continua la sua esecuzione solo dopo che è completata quella del workflow invocato.



Foreach element, esegue un workflow da ogni elemento di un array. Per esempio, si può eseguire un'operazione di rename di tutte le Virtual Machine di una cartella.



Asynchronous workflow, avvia un workflow in modo asincrono. Il workflow originario non attende il completamento dell'esecuzione di quello invocato, ma continua la sua esecuzione.

vRealize: workflow schema elements



Schedule workflow, crea un task per eseguire il workflow a un tempo prestabilito e poi il workflow continua la sua esecuzione.



Nested workflows, esegue workflow multipli simultaneamente. Si può scegliere di annidare workflow locali o remoti, cioè che risiedono su differenti Orchestrator server. Si possono eseguire workflow con differenti credenziali. Il workflow attende il completamento di tutti i workflow prima di riprendere la sua esecuzione.



Handle error, gestisce gli errori per uno specifico elemento del workflow. Il workflow può gestire l'errore creando un exception, chiamando un altro workflow, o eseguendo uno script.



Default error handler, gestisce gli errori del workflow che non sono gestiti dallo standard error handler.



Switch, commuta verso workflow alternativi, sulla base di un parametro o di un attributo.

Chef

Chef, è un potente strumento di *configuration management* per la gestione di infrastrutture attraverso il codice. Automatizza la configurazione, il deploy, e la gestione delle applicazioni

- Utilizza *cookbook* per determinare come ogni nodo deve essere configurato
- Un cookbook consiste di molte “ricette” (recipe); una ricetta è uno script di automazione per un particolare servizio scritto in Ruby
- *Chef Client*, è un agent che gira su un nodo ed esegue i task che lo configurano
- Chef può gestire qualunque cosa può eseguire un client Chef (macchine fisiche, container, istanze cloud-based)
- *Chef server*, è il repository per tutti i dati di configurazione. Sia il client che il server Chef comunicano in modo sicuro, utilizzando una combinazione di chiavi pubbliche e private, che assicurano che il server risponda soltanto alle richieste del client

Chef

- Facile da installare (utilizza un third-party installer)
- È utilizzato particolarmente per l'automazione a livello OS, come il deploy dei server, l'applicazione di patch
- Richiede esperienza di programmazione
- Ha una curva di apprendimento molto ripida, una volta superata la quale offre potenza e flessibilità

Puppet

Puppet, è simile a Chef. Richiede l'installazione di un master server e un client agent nei nodi

- Si possono scaricare e installare i moduli necessary tramite comandi Puppet. Come Chef, offre una versione enterprise che consente di avere funzionalità aggiuntive
- Chef e Puppet svolgono le stesse funzioni di base, ma utilizzano un approccio differente. Chef è un sistema più integrato e monolitico, mentre Puppet consiste di diversi servizi. Questo rende Chef in un certo senso più facile da configurare e gestire
- È pensato per gli amministratori di sistema che necessitano di specificare configurazioni come dipendenze, mentre Chef è fatto per gli sviluppatori che scrivono il codice per il deploy
- Dipende fortemente dal proprio Domain Specific Language (DSL) per la definizione di regole di configurazione, mentre il DSL di Chef è solo un “supplemento” a Ruby, linguaggio utilizzato per le ricette Chef
- È utilizzato per la mid-level automation (e.g., installare database, avviare Apache)

OpenStack



- *OpenStack*, è una piattaforma di cloud computing open source (licenza Apache), utilizzata principalmente come soluzione Infrastructure as a service (IaaS)
- Consiste in una serie di progetti interconnessi che controllano insieme di risorse di processing, storage, rete, attraverso un data center
- Gli utenti gestiscono le risorse attraverso una dashboard web-based, strumenti a riga di comando, oppure API RESTful
- È un progetto congiunto iniziato nel 2010 fra Rackspace Hosting e NASA. È gestito dalla OpenStack Foundation (organizzazione no-profit). Ne fanno parte più di 200 aziende (e.g., IBM, Canonical, Cisco, Dell, EMC, Ericsson, Hewlett-Packard, Huawei, Intel, Mellanox, Mirantis, Oracle, Red Hat, SUSE Linux, VMware, Yahoo)
- I componenti principali sono: Nova (compute), Cinder (block storage), Glance (image library), Swift (object storage), Neutron (network), Keystone (identity), Heat (orchestration tool)

OpenStack (Heat)



- *Heat*, è un meccanismo di orchestrazione conosciuto come progetto *Orchestration for OpenStack on OpenStack* (OOO).
- Fornisce un'orchestrazione basata su template per descrivere un'applicazione cloud tramite l'esecuzione di appropriate chiamate alle API OpenStack, che generano applicazioni nel cloud
- Integra altri componenti core di OpenStack in un template
- I template consentono la creazione della maggior parte dei tipi di risorse OpenStack (*instances, floating IPs, volume, security group, user*) così come funzionalità più avanzate come *instance high availability, instance autoscaling, nested stack*
- Alternativo alla scrittura di uno script per la gestione delle risorse in OpenStack (setting up dei server, aggiunta volumi, gestione reti, ecc.)
 - Si crea un Heat template che specifica l'infrastruttura richiesta
 - In caso di cambiamenti futuri al servizio si può modificare il template Heat e l'engine di Heat farà i cambiamenti necessari quando il template verrà rieseguito

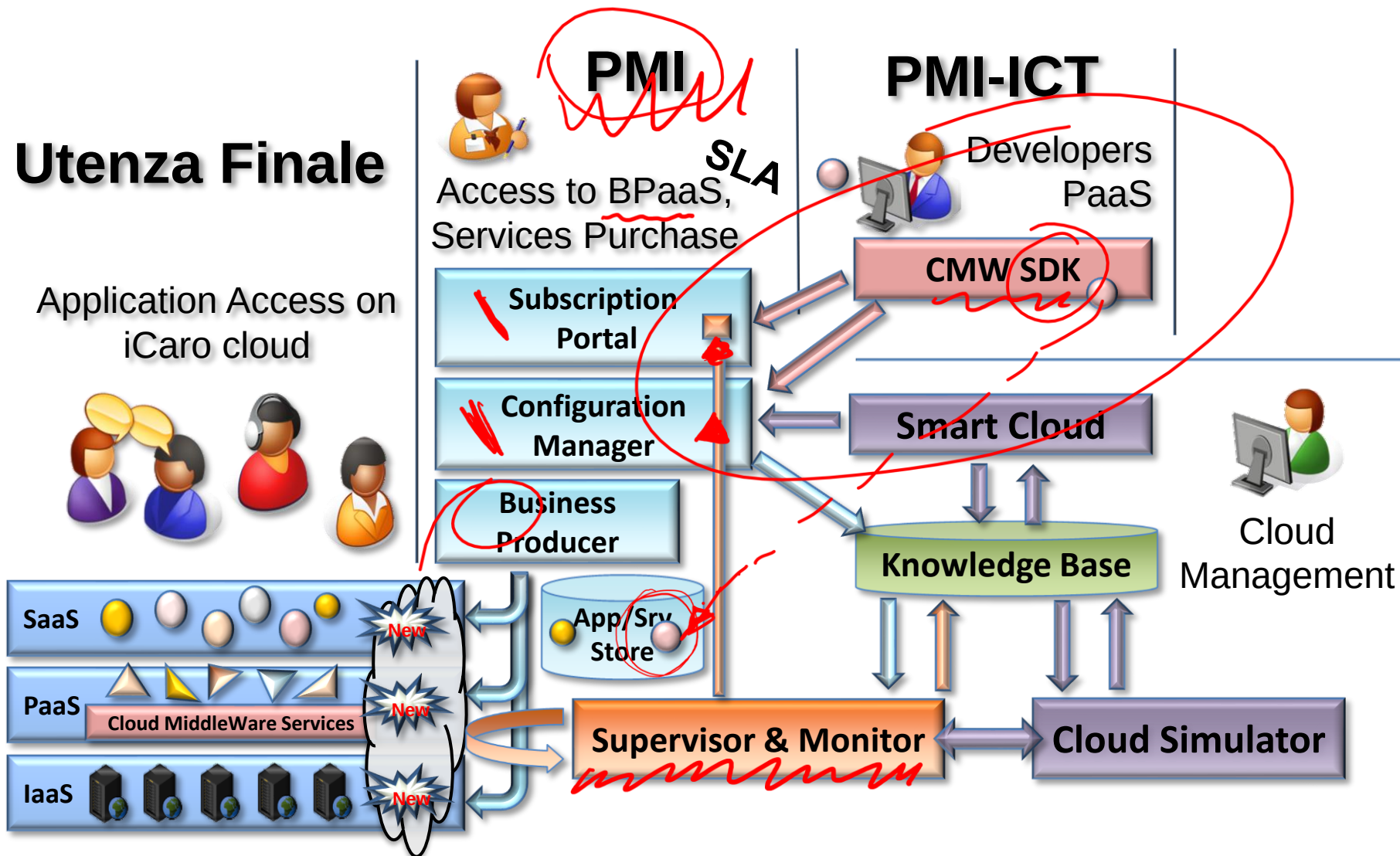


Architettura ICARO

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Utenza Finale

Application Access on
iCaro cloud





Architettura ICARO

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Utenza Finale

PMI

Access to BPaaS,
Services Purchase

SLA

PMI-ICT

Developers
PaaS

CMW SDK

Application Access on
iCaro cloud

Subscription
Portal

Configuration
Manager

Business
Producer

Smart Cloud

Knowledge Base

Cloud
Management

SaaS

PaaS

IaaS

Cloud MiddleWare Services

App/Srv
Store

Supervisor & Monitor

Cloud Simulator



Subscription Portal

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- ❑ Interfaccia di **vendita di soluzioni a consumo**, che possono andare da Host, Macchine Virtuali, applicazioni e combinazioni complesse.
 - ❑ Svariate possibili configurazioni di applicazioni: ERP, CRM, etc.,
- ❑ **Soluzioni offerte con varie tipologie di contratti di servizio** (Service Level Agreement, SLA) e relativi parametri per il calcolo dei costi a consumo: rete, disco, fatture, email, etc.
- ❑ **produzione automatica dei pattern/configurazioni** complesse composte da: VM, applicazioni Web e non solo, servizi sulla base di buone pratiche, profiling, applicazioni legacy, e servizi per connessione con applicazioni on site remote, etc.
- ❑ **Il Business Producer:**
 - ❑ evoluzione dei tradizionali orchestrator, che tramite workflow permettono di eseguire la procedura di deploy delle applicazioni sul Cloud.
 - ❑ lavora con VCO VMware,
 - ❑ può essere esteso ad altre soluzioni di mercato.



Progetto iCaro

La piattaforma cloud per l'accelerazione
del business delle PMI toscane
[CUP 6408.30122011.026000074]

Subscription Portal

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iCaro Portal
La piattaforma cloud per l'accelerazione del business delle PMI toscane

Home Offerta I Miei Servizi Partners

Applicazione LAMP
Con questo servizio puoi attivare un sito di commercio elettronico basato su Magento o PrestaShop, oppure un CMS Drupal, un CRM VTiger o l'applicazione Ines as a Service

Una tantum	€ 180,00	Al mese	€ 78,00
Ricorrenza:	Codice:	Descrizione:	Quantità Pre. Unitario Totale
Una tantum	MOCLSVIM-ATT	My Virtual Server Intel Start-up	1 € 180,00 € 180,00
Al mese	MOCLSVIM	My Virtual Server Intel 1Gb Ram incluso Licenza Windows Server	1 € 21,00 € 21,00
Al mese	MOCLSVIM-1GBRAM	My Virtual Server Intel 1Gb Ram aggiuntiva	2 € 15,00 € 30,00
Al mese	MOCLSVIM-1CPU	My Virtual Server Intel Virtual CPU aggiuntiva	1 € 15,00 € 15,00
Al mese	MOCLSVIM-1GB-CAP	My Space 1GB SAN per VM @High Capacity & Availability	120 € 0,10 € 12,00

ICARO

Home Offerta Control Panel Blog Launchers

Launchers / Generic Launcher

Login
Benvenuto UtenteX
Logout

Generic Deployment Portlet
JOOMLA
Joomla è uno strumento che permette la creazione e la pubblicazione di siti Internet dinamici, in maniera semplice e veloce, ma anche con grandi potenzialità e sicurezza. Un pannello di controllo ricco di icone e con grafica accattivante ci guida nell'inserimento dei contenuti e nella configurazione delle caratteristiche del sito, fra sondaggi e notizie, gallerie fotografiche, blog e molto altro. Tutte queste operazioni possono essere effettuate senza scrivere o modificare una riga di codice.

Media sessioni contemporanee: 3
Massimo sessioni contemporanee: 3
Dimensioni Storage File: 10
Dominio del sito:
e-mail amministratore:
Tempo medio di risposta atteso: <8s

iCaro Subscription Portal

Home Offerta I Miei Servizi

Contratto	Servizio	Cod. Cliente	Nome Cliente	Data Richiesta	Data Consegna	Stato	
30257	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:45	27/06/2014 12:46	DEPLOYED	MON
30256	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:43	27/06/2014 12:43	DEPLOYED	MON
30255	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:42	27/06/2014 12:42	DEPLOYED	MON
30254	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:39	27/06/2014 12:39	DEPLOYED	MON
30253	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:37	27/06/2014 12:38	DEPLOYED	MON
30252	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:30	27/06/2014 12:30	DEPLOYED	MON
30251	Dummy Joomla Farm	CC001	Nome cliente	27/06/2014 12:28	27/06/2014 12:28	DEPLOYED	MON

Accesso al BPaaS



- ❑ Strumento tecnico per la **generazione e gestione automatizzata delle configurazioni**
- ❑ **Configurazioni e SLA complesse** con regole di adattamento che includono la gestione automatizzata delle operazioni di deploy e update sul cloud tramite Business Producer.
 - ❑ Business Producer può essere un cloud manager di mercato.
- ❑ **Il Configuration Manager, CM**
 - ❑ comunica le configurazioni e le SLA allo Smart Cloud che le verifica, e che eventualmente provvede a suggerire al CM eventuali modifiche ed adattamenti.
 - ❑ richiede grafici e dati al sistema di monitoraggio, S&M.



Backoffice del Business

Sistema | **Anagrafica** | **Strumenti** | **Manuale** | **Quadro Sinottico**

Utilizzo Sistema

CPU % 62, Mem % 69, Banda % 96

Coda Lavori

Codice	Descrizione	Inizio	Stato
004	Workbook W004	13-12-2013 12:00:01	Completato
005	Workbook W005	13-12-2013 12:10:01	In corso
006	Workbook W006	13-12-2013 13:00:01	Pendente

Giornale Sistema

1/23/2014 11:17:11 AM GetServiceParameters: pServiceId=5
1/23/2014 11:36:12 AM GetServiceFeatures
1/23/2014 11:36:12 AM GetFeatures
1/23/2014 11:36:12 AM GetServices
1/23/2014 11:36:16 AM GetServiceParameters: pServiceId=5
1/23/2014 12:32:13 PM LoadDashboard
1/23/2014 12:40:42 PM GetServiceFeatures
1/23/2014 12:40:42 PM GetFeatures
1/23/2014 12:40:42 PM GetServices
1/23/2014 12:41:45 PM LoadDashboard

Utilizzo CPU Servizi

Bar chart showing CPU usage for VDC01 to VDC07.

Sistema pronto

ServiceEdit

10.254.101.217/CM/EditService?pServiceId=9

Applicazioni: Lettore Web Spotify, Regex Tutorial, utility, internal tools, vmware, cisco, windows, linux, sdn, design pattern, good resources, holiday

BillingFrequency: 1000
Visibility: VISIBLE
Status: ACTIVE

N. Codice	Descrizione	Q.tà	Prezzo	Valuta
1	SW005 Joomla Farm	1	1	EUR

Provisioning Workflow ID: 283a09da-b2b1-4dd1-a208-c5745d86454d
Deprovisioning Workflow ID:

Caratteristiche

Condizioni di vendita

Prezzo unitario: 350
Valuta: EUR
Tariffazione: FIXED

Parametri del servizio

Nome	Parametro	Valore	Modifica	Elimina
nfsSize	Dimensioni Storage File (GB)	30	Modifica	Elimina
NFSVmlpAddress	NFS Fixed, valid IP Address		Modifica	Elimina
webFrontend	Nodi Front-End	1	Modifica	Elimina
dbSize	Dimensione Database Server	20	Modifica	Elimina
farmId	Identificativo della farm	MyFarm001	Modifica	Elimina
nfsVmlpAddress	IP della macchina virtuale	10.254.101.82	Modifica	Elimina
mysqlVmlpAddress	IP del DB MySQL	10.254.101.83	Modifica	Elimina
haproxyVmlpAddress	IP del proxy HA	10.254.101.84	Modifica	Elimina
joomlaVmlpAddress	IP della macchina Joomla	10.254.101.85	Modifica	Elimina
resourcePool	VMWare Resource Pool		Modifica	Elimina
haproxyPublicIpAddress	IP pubblico della macchina HA proxy	212.19.117.149	Modifica	Elimina
haproxyPublicSubnetMask	Subnet Mask relativa a IP pubblico di HA Proxy	255.255.255.240	Modifica	Elimina



- ❑ **produzione automatica dei pattern/configurazioni**
complesse composte da: VM, applicazioni Web e non solo, servizi sulla base di buone pratiche, profiling, applicazioni legacy, e servizi per connessione con applicazioni on site remote, etc.
 - ❑ Il Business producer è un'evoluzione dei tradizionali orchestrator, che tramite workflow permettono di eseguire la procedura di deploy delle applicazioni sul Cloud.
- ❑ **Il Business Producer:**
 - ❑ nella sperimentazione ICARO lavora con VCO VMware,
 - ❑ può essere esteso ad altre soluzioni di mercato.

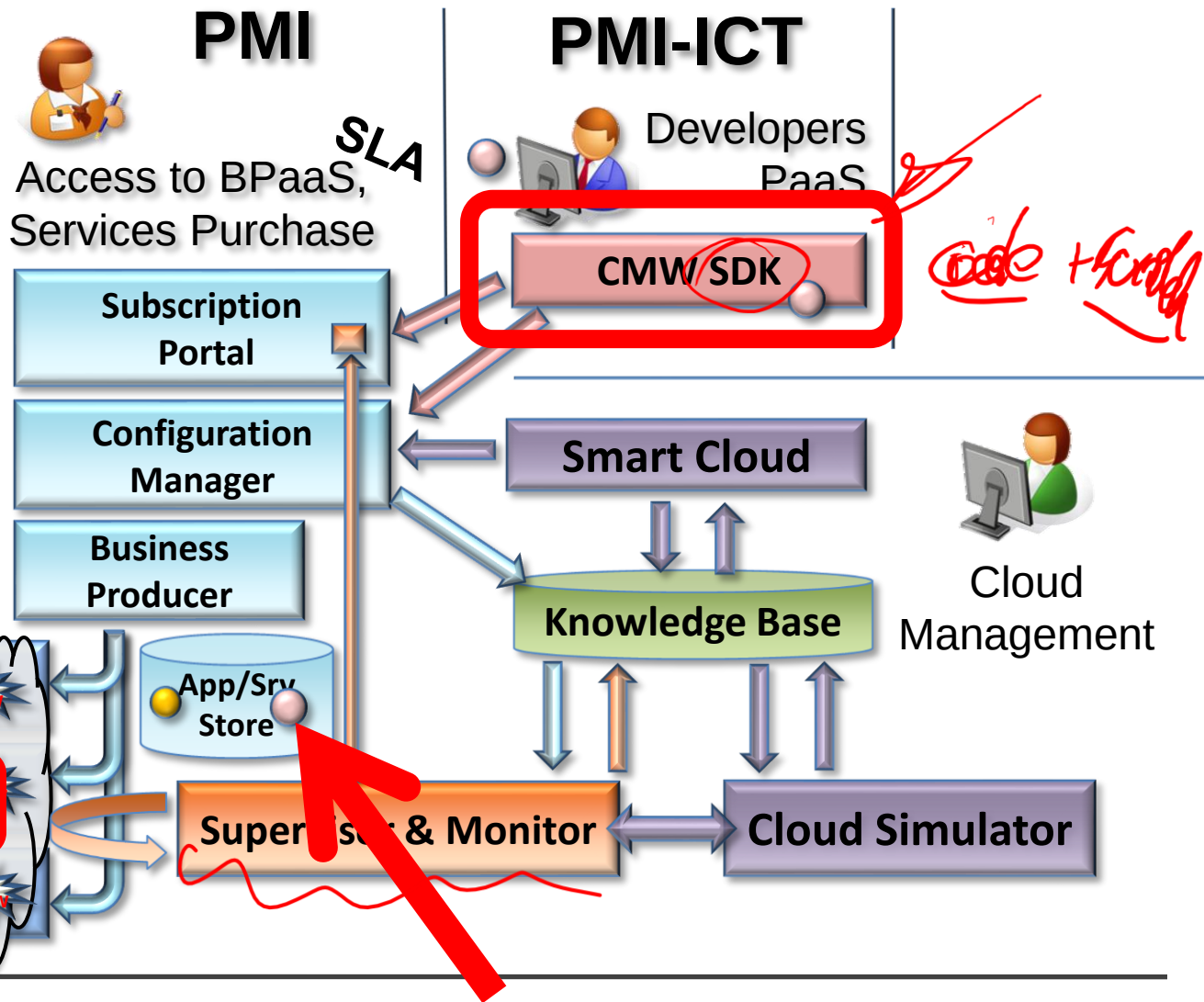


Architettura ICARO

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Utenza Finale

Application Access on
iCaro cloud





Cloud Middleware & Cloud Middleware SDK

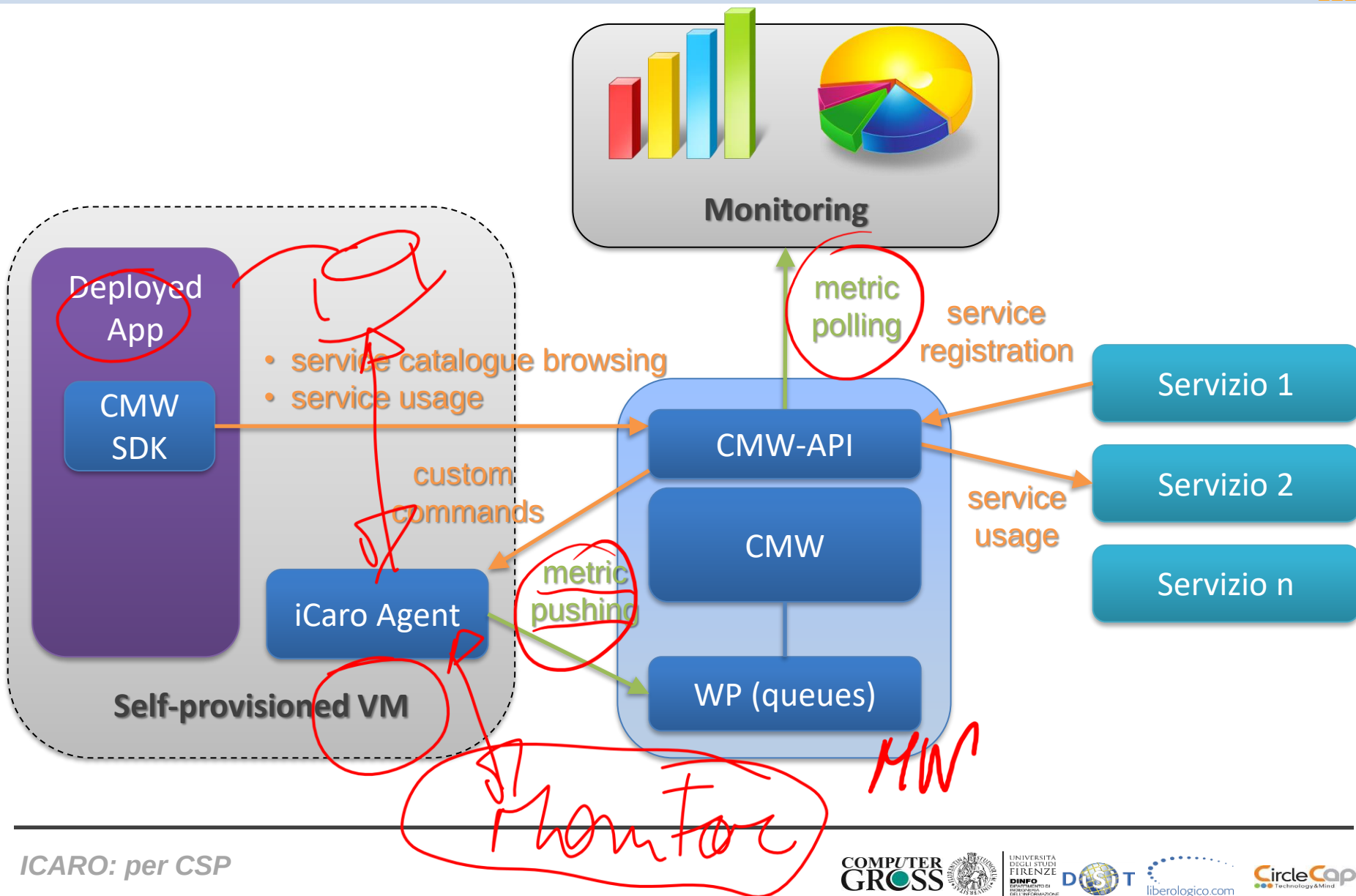
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- ❑ **Supporto per lo sviluppo** (in Java e PHP) che consente a Sviluppatori di Applicazioni ICT di:
 - ❑ **Adattare le applicazioni** per essere gestite, vendute in ottica di consumo su ICARO.
 - ❑ utilizzare, mediante un sistema di messaggistica asincrona, uno o più servizi presenti nel catalogo gestito dal modulo CMW (es. postgresSQL, SQL Server, SMTP server, Object Storage).
 - ❑ recuperare i valori attuali delle "metriche applicative" inerenti i servizi offerti da CMW (es. dimensione di un database, numero mail inviate, ecc.).



CMW, CMW-SDK, WP: Architettura

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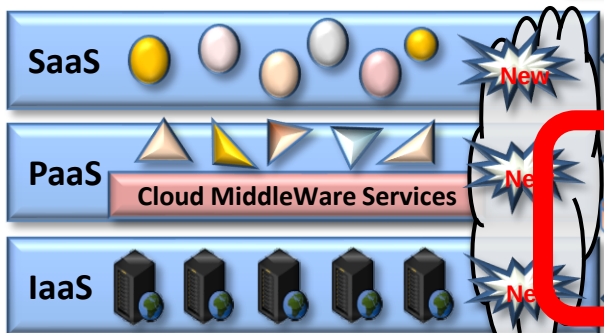


Architettura ICARO

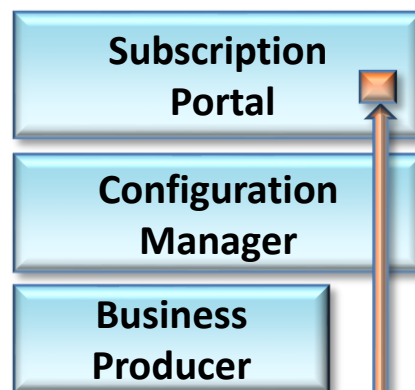
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Utenza Finale

Application Access on
iCaro cloud



PMI
Access to BPaaS,
Services Purchase



PMI-ICT
Developers
PaaS



CMW SDK

Smart Cloud

Knowledge Base



Cloud
Management

Supervisor & Monitor

Cloud Simulator



Supervisor & Monitor

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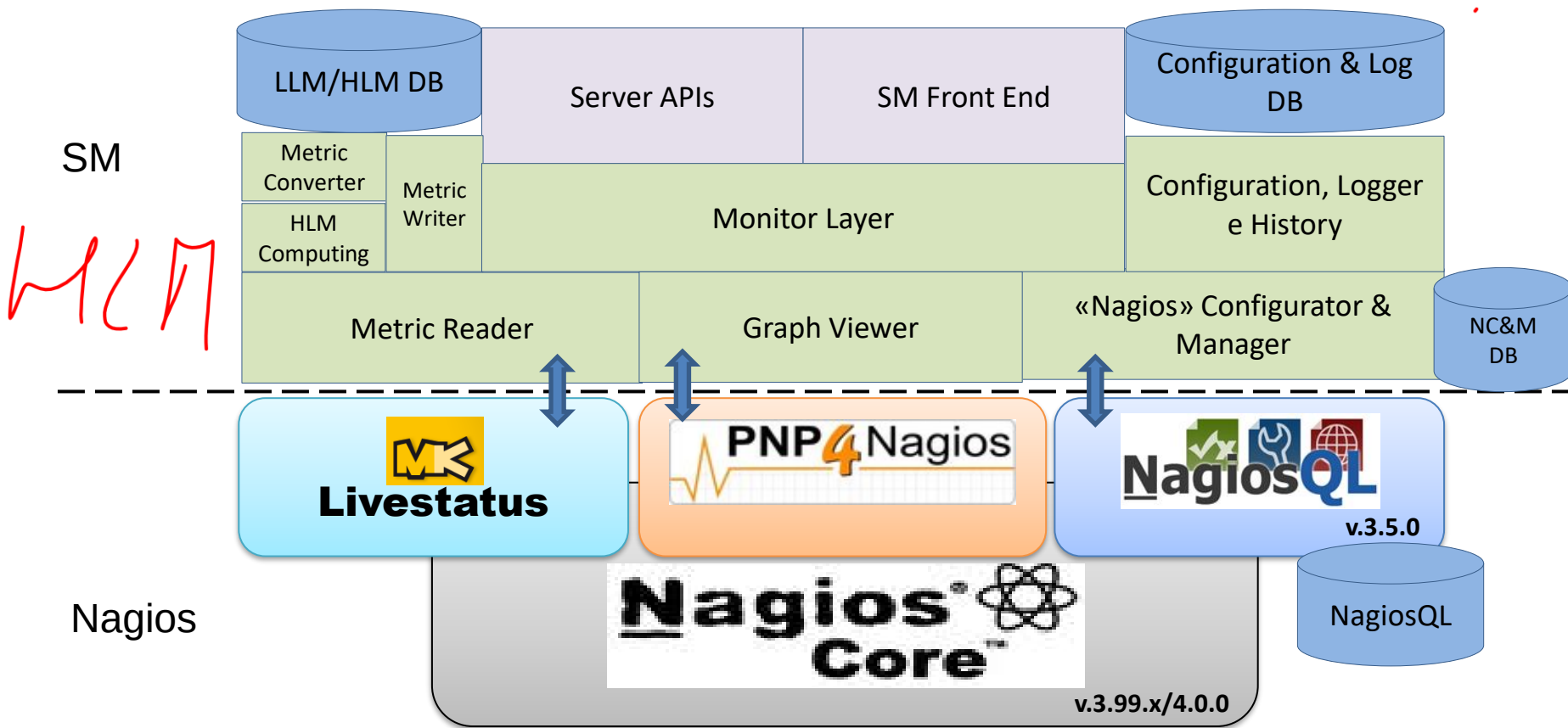
- ❑ **Supervisione e monitoraggio delle risorse e dei consumi** in modo integrato analizzando e tenendo sotto controllo:
 - ❑ risorse cloud ai livelli: IaaS, SaaS, PaaS, BPaaS;
 - ❑ metriche applicative di Applicazioni e Servizi single/multi-tier: standard e caricati tramite il PaaS;
 - ❑ metriche definite in relazione alle SLA;
 - ❑ servizi interni ed esterni anche locati in altri cloud e sistemi, come supervisione dello stato dei processi: http, ftp, reti, server esterni, Web App Server, etc.
- ❑ **Il Supervisor & Monitor:**
 - ❑ è configurato in modo automatico dalla Knowledge Base
 - ❑ in ICARO utilizza il tool Nagios ed è in grado di controllare e configurare Nagios in modo automatizzato e di accedere in remoto alle funzionalità dei suoi componenti
 - ❑ Livello di astrazione del monitoraggio: possibilità di utilizzare differenti sistemi di monitoraggio di basso livello

WORKFLOW
→ Self Monitor



SM – Architettura & Nagios

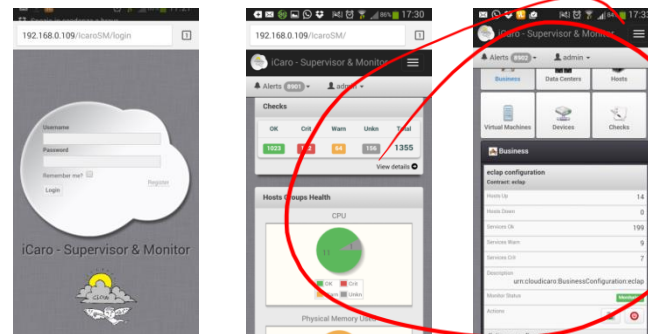
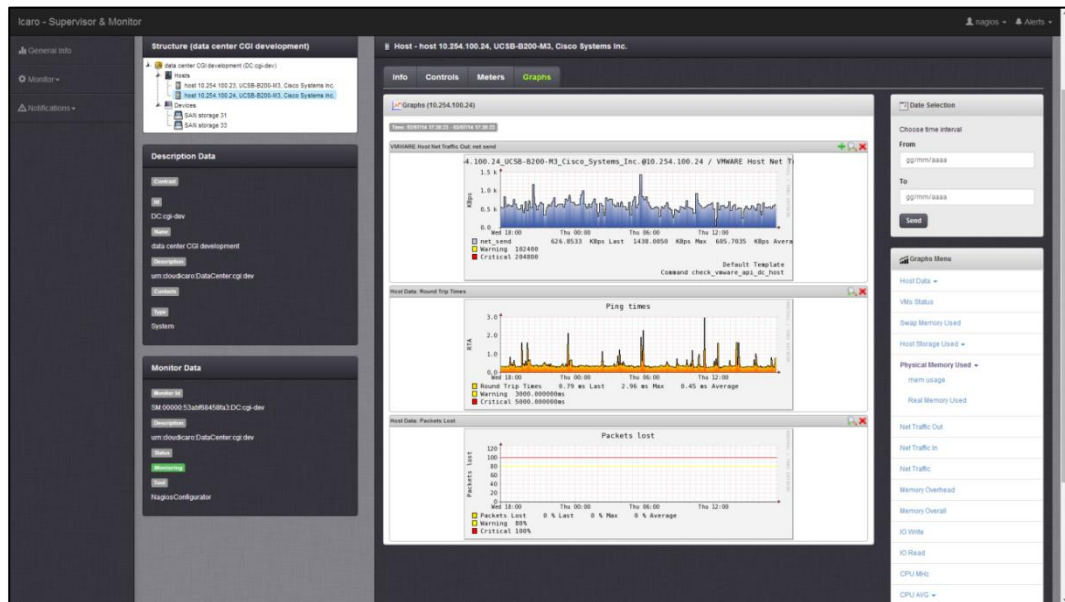
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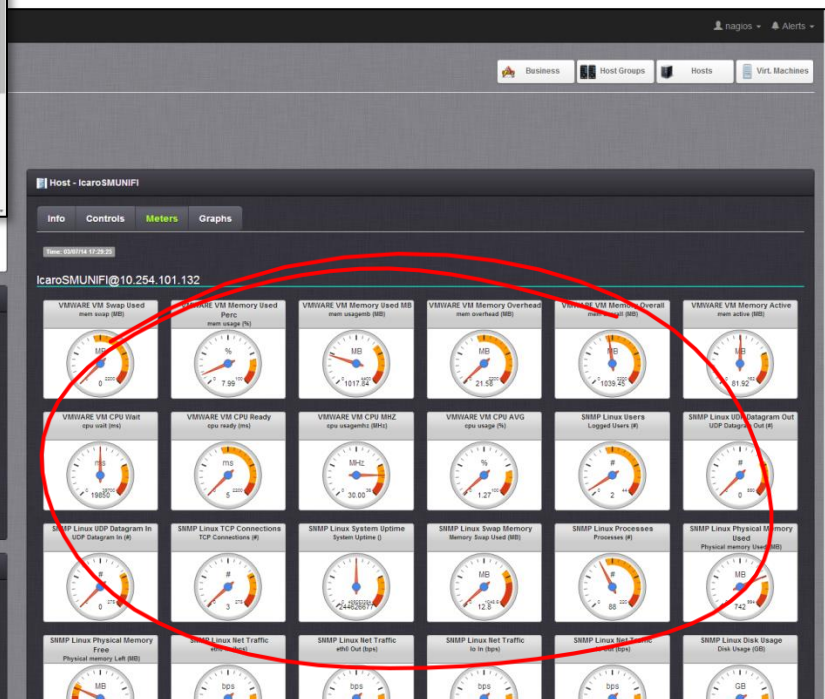
Supervisor & Monitor Front-End

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...on Mobile Devices

- Monitoraggio del Business
- Su PC e Mobile
- Completamente automatizzato



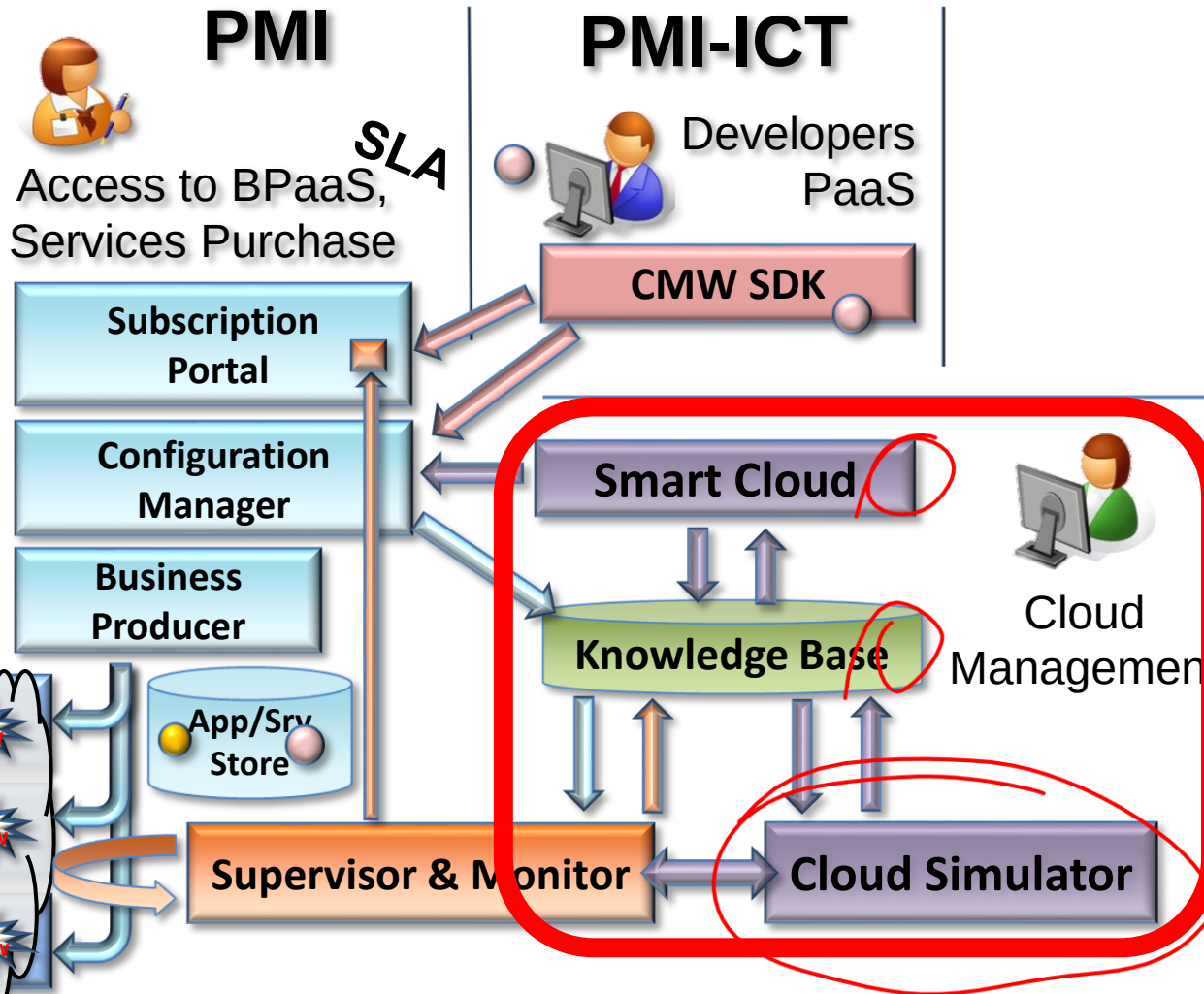
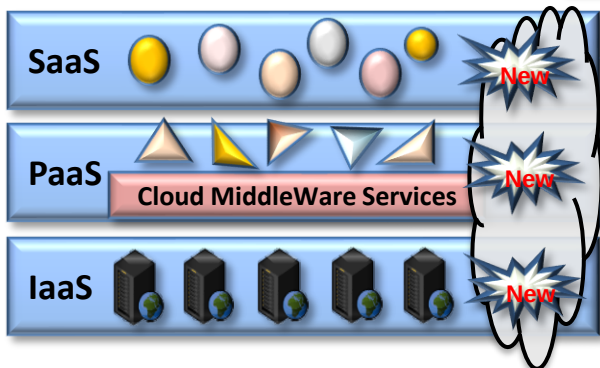


Architettura ICARO

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Utenza Finale

Application Access on
iCaro cloud



📄 Usa come modello la KB

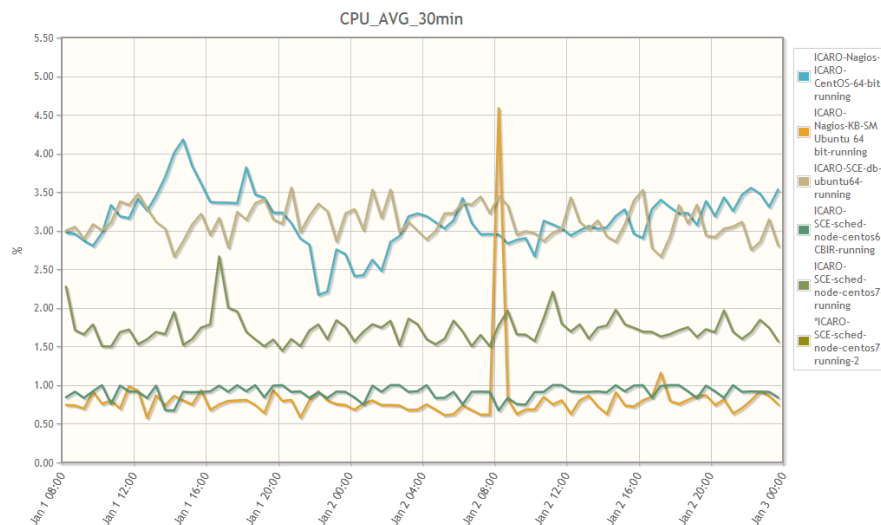




Smart Cloud Engine

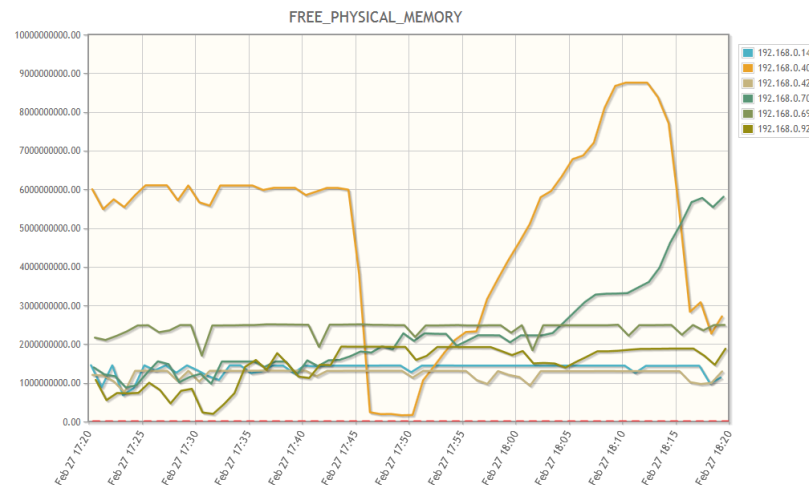
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- Report degli allarmi relativi alle singole SLA;
- Grafici delle metriche combinati per SLA o singoli;



- Visualizzazione dello stato del cluster sia in forma aggregata che per singolo parametro (memoria, cpu, swap ecc.);

- Notifica delle VM che non producono dati in legenda;
- Definizione intervalli temporali;





Smart Cloud Engine

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- Visualizzazione eventi di allarme sia in forma aggregata che per singola metrica (data, soglia, valore misurato, configurazione ecc.)
- Strategy Condition Editor per l'Elastic Cloud
 - definizione di regole booleane di complessità arbitraria per l'attivazione di procedure di scaling, controllo, autoregolazione ecc.
 - vincoli su metriche e SLA, VM, Business Configuration con impostazione di soglie (%)

Smart Cloud Engine DISIT - Distributed Systems and Internet Technology Lab									
Timestamp	Slr	Metric	Metric Name	Metric Unit	Metric Timestamp	Vm	Vm Name	Host Machine	Value
2015-02-27 18:13:57	urn:cloudicaro:ServiceLevelAgreement:icaro-disit	urn:icaro:cloud:ServiceMetric-d8b284f0-d4e6-4420-806b-0712afe5d29c	Network Traffic AVG 30min	bps	2015-02-27 18:09:03	urn:cloudicaro:VirtualMachine-vm-966	DISIT-ICARO-Nagios-64-bit-running	urn:cloudicaro:HostMachine-disit-143	516437.77449260856
2015-02-27 17:43:56	urn:cloudicaro:ServiceLevelAgreement:icaro-disit	urn:icaro:cloud:ServiceMetric-f53287db-d922-40d3-83ac-7057a174e040	Network Traffic AVG 30min	bps	2015-02-27 17:43:56	urn:cloudicaro:VirtualMachine-vm-966	DISIT-ICARO-Nagios-64-bit-running	urn:cloudicaro:HostMachine-disit-143	516437.77449260856
2015-02-27 17:13:55	urn:cloudicaro:ServiceLevelAgreement:icaro-disit	urn:icaro:cloud:ServiceMetric-4fb07e53-e182-42f7-81d3-8b236cedce9	Network Traffic AVG 30min	bps	2015-02-27 17:13:55	urn:cloudicaro:VirtualMachine-vm-966	DISIT-ICARO-Nagios-64-bit-running	urn:cloudicaro:HostMachine-disit-143	516437.77449260856
2015-02-27 16:43:57	urn:cloudicaro:ServiceLevelAgreement:icaro-disit	urn:icaro:cloud:ServiceMetric-1b683b27-872c-4c21-8a1e-ee39017de7e9	Network Traffic AVG 30min	bps	2015-02-27 16:43:57	urn:cloudicaro:VirtualMachine-vm-966	DISIT-ICARO-Nagios-64-bit-running	urn:cloudicaro:HostMachine-disit-143	516437.77449260856

Add Elastic Job Constraints

Match **ALL**

IF Metric **CPU AVG 30min** of **SLA** **urn:cloudicaro:ServiceLevelAgreement:disit-lab** IS **10** % **ABOVE** THE THRESHOLD FOR **30** min

Match **ANY**

IF Metric **Disk Usage AVG 30min** of **VM** **eclap-bp64net.eclap.eu-running** IS **20** % **ABOVE** THE THRESHOLD FOR **30** min

IF Metric **Memory Used AVG 30min** of **SLA** **urn:cloudicaro:ServiceLevelAgreement:disit-org** IS **30** % **ABOVE** THE THRESHOLD FOR **1** week

Match **ANY**

IF Metric **Network Traffic AVG 30min** of **BC** **urn:cloudicaro:context:BusinessConfiguration:icaro-dev** IS **40** % **ABOVE** THE THRESHOLD FOR **4** day

IF Metric **CPU AVG 30min** of **SLA** **urn:cloudicaro:ServiceLevelAgreement:eclap** IS **50** % **BELOW** THE THRESHOLD FOR **1** h

IF Metric **CPU AVG 30min** of **SLA** **urn:cloudicaro:ServiceLevelAgreement:log** IS **60** % **ABOVE** THE THRESHOLD FOR **3** h

IF Metric **CPU AVG 30min** of **SLA** **urn:cloudicaro:ServiceLevelAgreement:siimobility** IS **70** % **ABOVE** THE THRESHOLD FOR **1** month

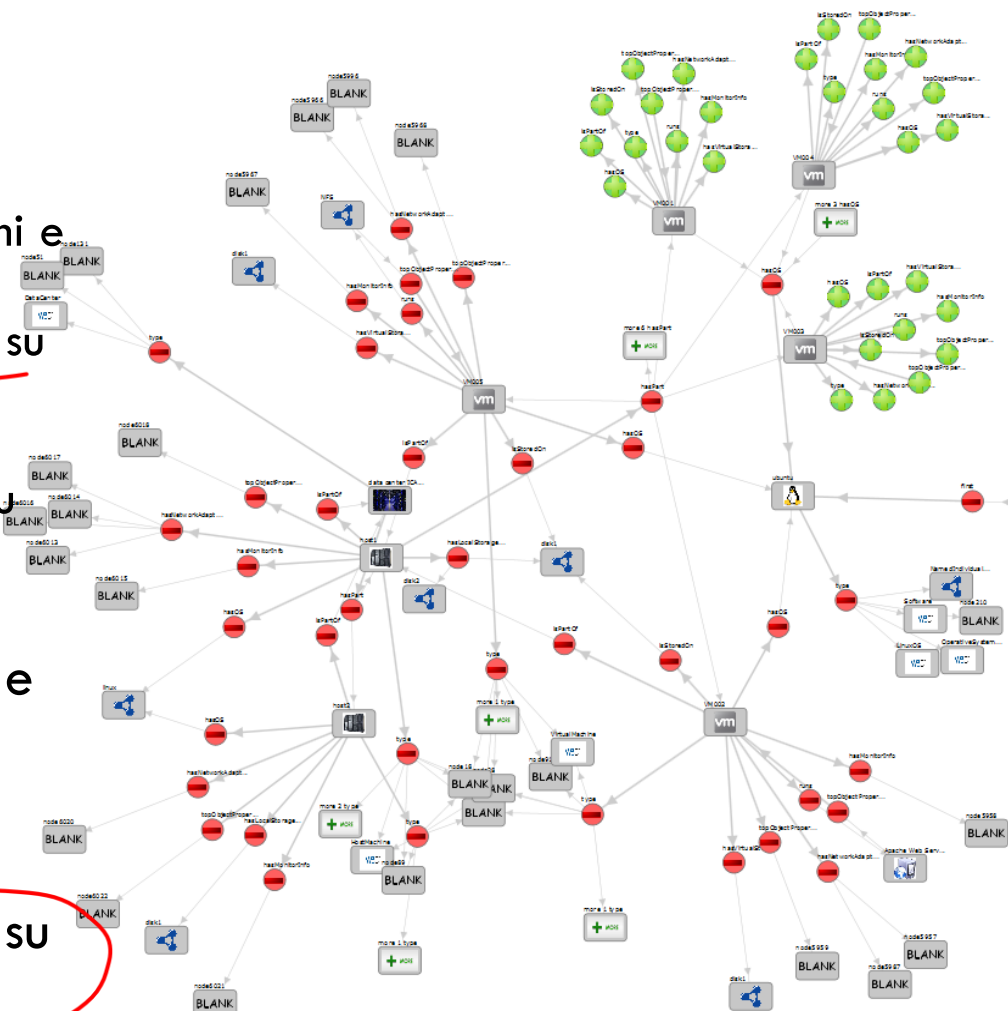
Confirm



Knowledge Base & Tools

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- ❑ **Via API Rest riceve le configurazioni e le variazioni**
- ❑ **Modello di Cloud intelligence**
 - ❑ Formalizzazione di configurazioni e SLA (Service Level Agreement)
 - ❑ reasoner supporto alle decisioni su configurazioni: consistenza e completezza
 - ❑ adeguamento dell'architettura su alcune applicazioni
- ❑ **Tecnologia**
 - ❑ Knowledge base: RDF store e inference engine
 - ❑ Smart Cloud Ontology:
<http://www.disit.org/5604>
 - ❑ Esempio di dato accessibile su <http://log.disit.org>





Cloud Simulator

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❑ Permette di

❑ **Simulare** il comportamento di carico di datacenter complessi

❑ **creare situazioni di carico** partendo da andamenti di carico reali dallo storico del sistema di monitoraggio

❑ **studiare** gli effetti del carico sulle risorse di base a livello IaaS

❑ **Produce andamenti Simulati** accessibili e analizzabili da Supervisor & Monitor come dallo Smart Cloud Engine

❑ **Si integra** con

❑ Lo Smart Cloud Engine per l'esecuzione di processi di controllo e valutazione e

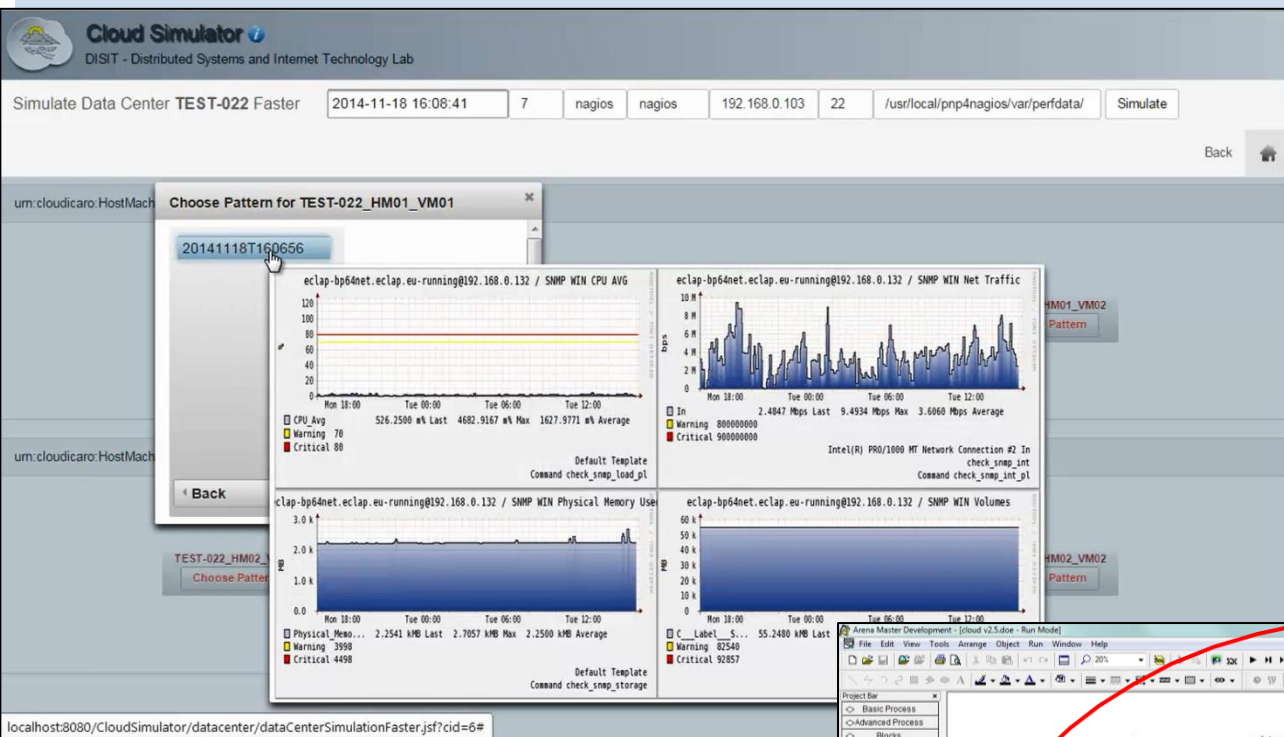
❑ la Knowledge Base per gestione delle configurazioni e dei dati, navigazione nella rappresentazione complessa del cloud

❑ Il Supervisor & Monitor per l'accesso ai dati di monitoraggio, e la produzione di grafici



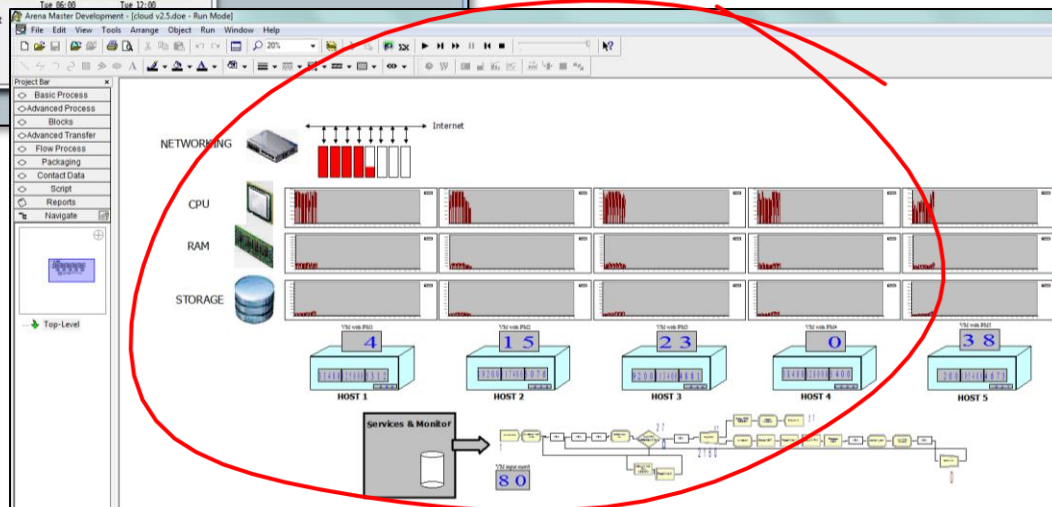
Cloud Simulator

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**Simulare il
comportamento
di carico di
datacenter
complessi**

**Identificare
allocazioni ottime
delle risorse**





Vantaggi di ICARO

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- ❑ **Automazione** di svariati aspetti di gestione cloud
 - ❑ gestire con: SM, KB, SCE, gestori e data center diversi
 - ❑ allocare applicazioni in modo automatizzato
 - ❑ Vendere configurazioni complesse con costi di produzione e gestione ridotti.
- ❑ **Ridurre i costi** automatizzando i processi di
 - ❑ **Vendita delle soluzioni su cloud**
 - ❑ **Configurazione, integrando: IaaS, PaaS, SaaS, PBaaS**
 - ❑ Config e Deploy di applicazioni SaaS anche complesse...
 - ❑ Config e gestione di soluzioni di monitoraggio a livello di metriche integrate: IaaS, PaaS, SaaS, PBaaS, business, SLA
 - ❑ **Controllo e monitoraggio dei sistemi, Business Level, SLA level**
 - ❑ **Ri-configurazione sulla base della valutazione di condizioni complesse**



Portabilità e Interoperabilità

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- ❑ La soluzione CM e SP vanno calate sul particolare Orchestrator anche se sono in larga parte indipendenti da questo ma sono dipendenti dai modelli di business del Cloud Service provider.
- ❑ La parte CMW è agnostica rispetto ai processi di deploy
- ❑ La soluzione di monitoraggio, SM, è trasportabile su altri monitor di basso livello, oggi usa Nagios
- ❑ La soluzione Smart Cloud, SCE-KB, è agnostica rispetto al gestore e completamente integrata con SM



- ❑ Versione completa della slide:
<http://www.disit.org/6587>
- ❑ ICARO project official web page dove in documenti vi sono documenti accessibili e video:
<http://www.cloudicaro.it/>
- ❑ Altra documentazione accessibile su
 - ❑ Video overview: <http://www.disit.org/6558>
 - ❑ Page with Smart Cloud Videos: <http://www.disit.org/6544>
 - ❑ ICARO page at DISIT <http://www.disit.org/5482>





References

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- | **HP:** www.hp.com/go/integrityvm
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- | **“Windows Server 2008 Hyper-V Technical Overview”-**
<http://download.microsoft.com/download/4/2/b/42bea8d6-9c77-4db8-b405-6bffe59b157/Hyper-V%20Technical%20Overview.docx>
- | **Comparison of Hypervisors by VMware -**
<http://www.vmware.com/technology/whyvmware/architectures.html#c132894>
- | **“VMware vSphere 4” Datasheet -** <http://www.vmware.com/products/vsphere/>
- | **ICARO project:** <http://www.disit.org/5482>, <http://www.cloudicaro.it/en/>

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