



# *Parte 9: Virtualization & Cloud Computing*

Corso di: Sistemi Distribuiti, 2015  
Lauree in: Ingegneria Informatica,  
delle Telecomunicazioni ed Informatica di Scienze

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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
- ⌈ SaaS Solutions
- ⌈ PaaS Solutions
- ⌈ ICARO project





# Datacenter, definition

## 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.





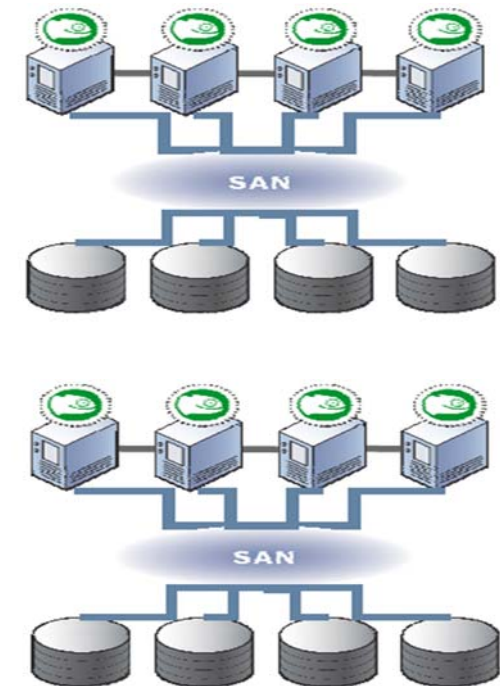
# Server





# Infrastructure, definition

- ✓ A set of datacenter and clusters
- ✓ 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 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/VM OS at level of disk block
  - ♣ The OS has to format with its own file system
  - ♣ Possible protocols: low level IP, iSCSI, Fiber, etc.



# 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

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

- Power, conditioning, network connection, etc.

- ♣ not scalable, to scale up frequently implies hardware change/re-eng.

- Data duplication, migration, distribution of activities among HW

- Balancing or workload, add more HW, sharing databases, etc.





# Final Motivations

- ⌈ Reduction of costs for HW and operating system SW maintenance.
  - ♣ High costs to guarantee high availability: 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**

- ♣ 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





# Infrastructure as a Service, IaaS

- ∟ 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
- ∟ 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.




# 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.*



# Structure

- [ Elements of cloud Computing
- [ Virtualization 
  - ♣ emulation, para-virtualization
  - ♣ virtual resources
  - ♣ snapshots
- [ Cloud Computing
- [ High Availability
- [ vSphere Infrastructure
- [ Security on the Cloud
- [ Conversions among VM and physical machines
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- [ ICARO Project



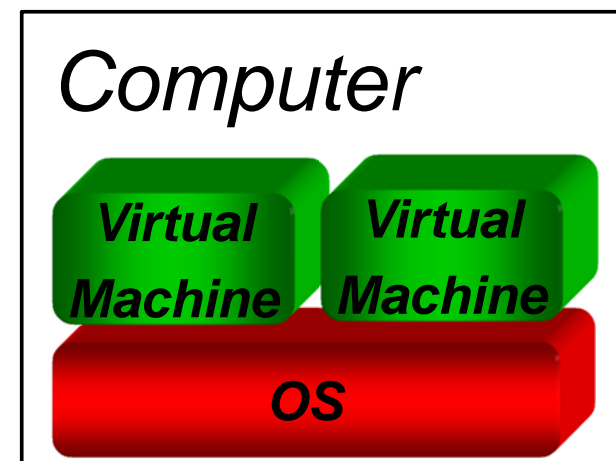
# Concept of Virtual Server

↳ 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"

↳ 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 correspondign OS VM



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

↳ **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..
- ♣ HD: space, speed (7.2, 15Kgiri), security level/RAID, type SAS/SATA, SCSI
- ♣ Network features:
  - ➔ Number of connections/cards, number of IP addresses, static/DHCP
  - ➔ Transfer rate: minimum guaranteed, maximum possible, down/upload
  - ➔ Maximum transferred bytes: per day, per month, etc.
- ♣ NAS/SAN, Network area storage/SAN, fiber/internet: size, RAID, etc.

↳ **Software:**

- ♣ Operating systems
- ♣ 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

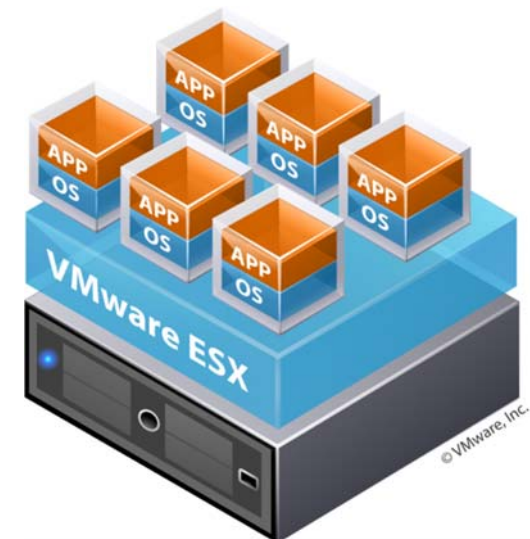
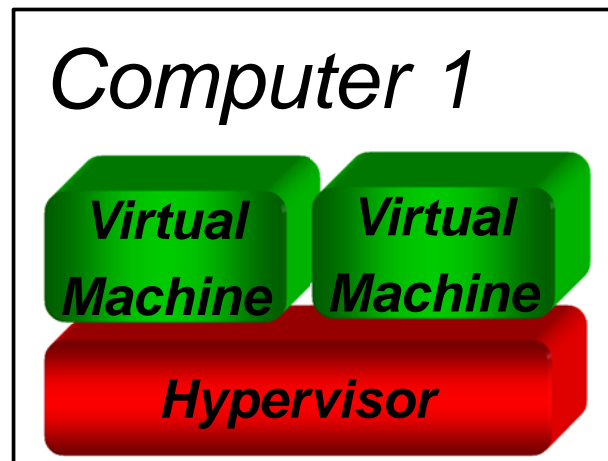
## Virtual Machine:

- ♣ 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
- ℓ 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

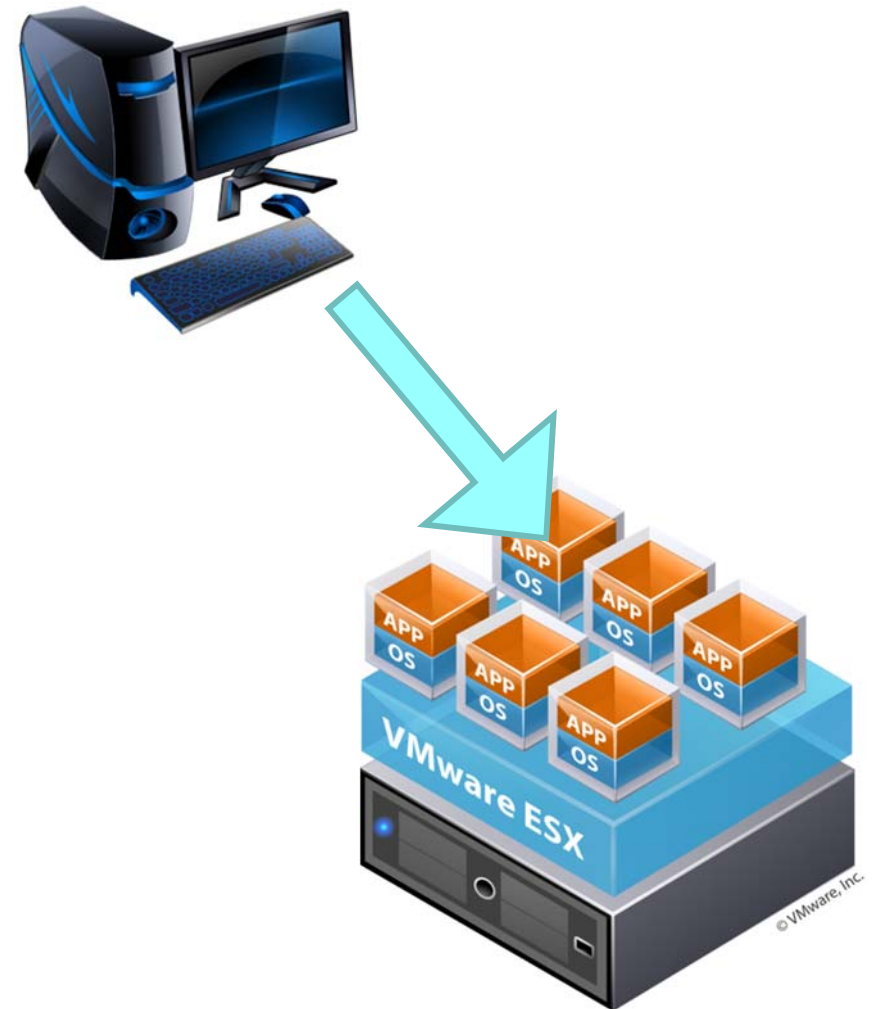






# The Virtualization

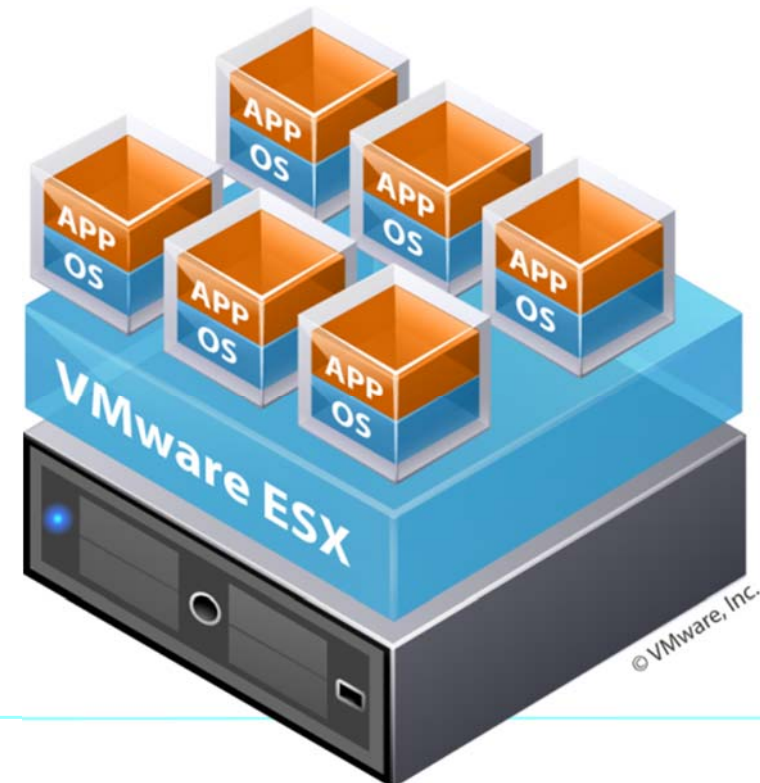
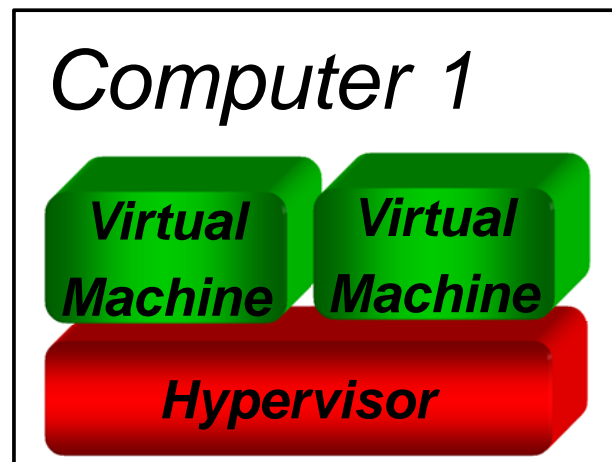
- Process by which it is possible to create a virtual machine, VM,
- For example by:
  - ♣ An installation DVD
  - ♣ Cloning a physical machine (P2V)





# The Hypervisor

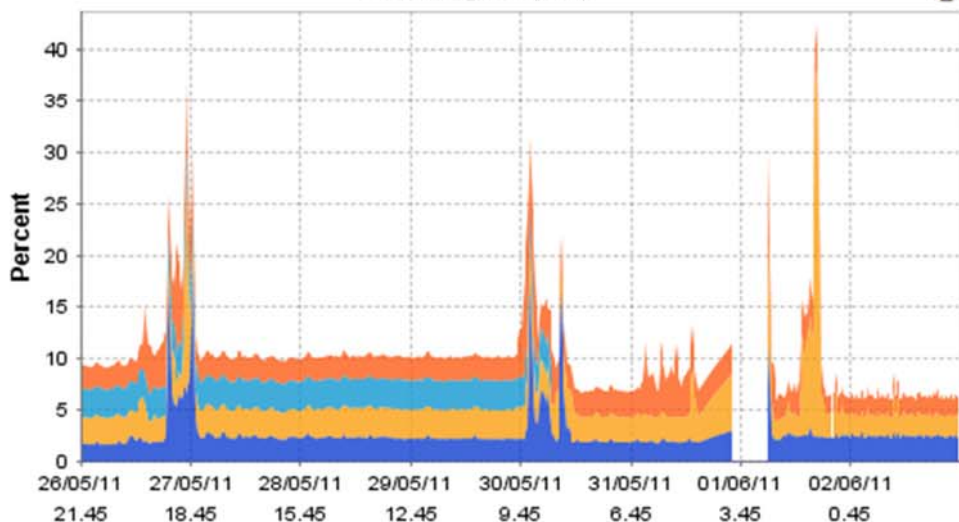
- It is the essential OS, that can be installed in a Host and can put in execution and manage one or more VM
- The Host is a server HW that host the Hypervisor
- ESX of VMware is an Hypervisor.





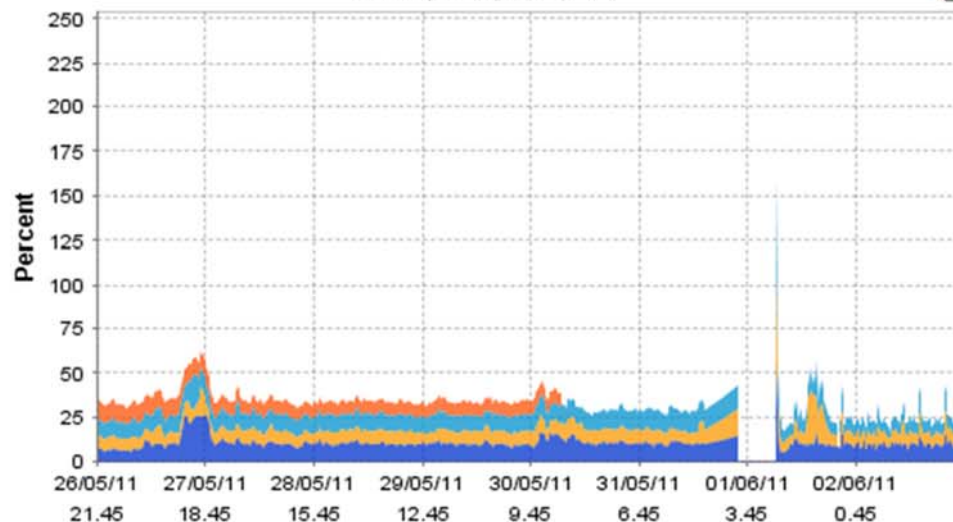
# Performance Analysis of VM on the Host

CPU Usage (Top 10)



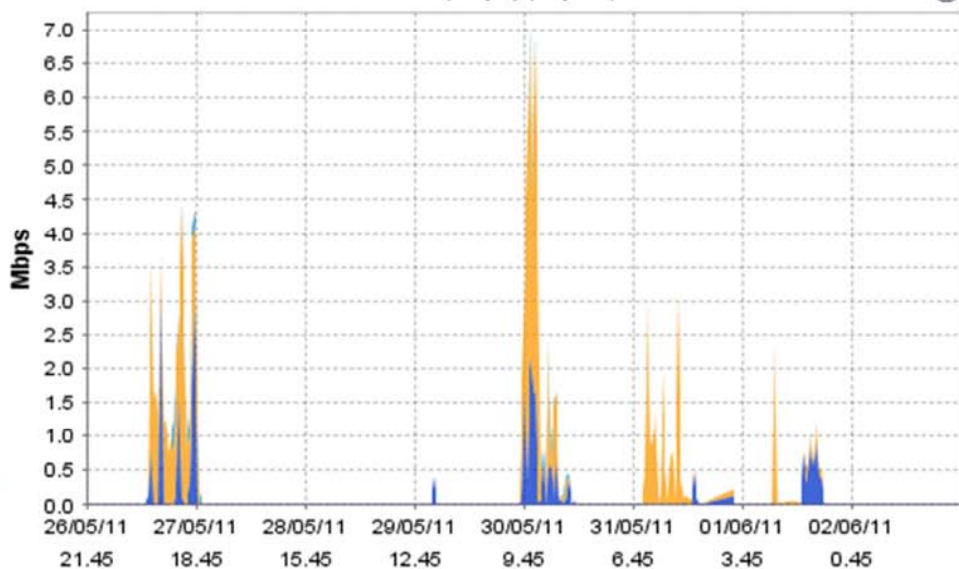
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■ bpnetmardaniele-2-running

Memory Usage (Top 10)



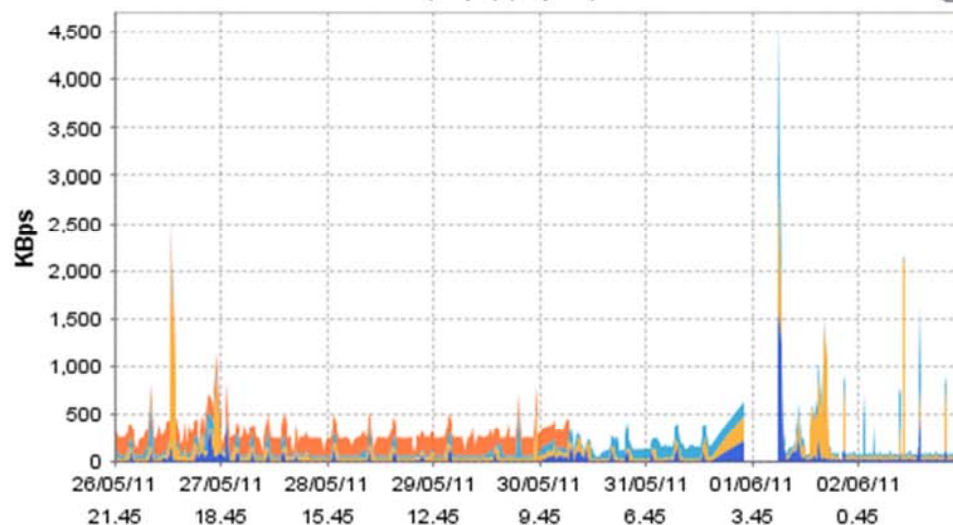
■ testinterop.eclap.eu-running ■ test.eclap.eu-running ■ bpnetmardaniele-2-running  
■ test.eclap.eu-old

Network (Mbps) (Top 10)



■ test.eclap.eu-running ■ bpnetmardaniele-2-running ■ testinterop.eclap.eu-running

Disk (KBps) (Top 10)



■ testinterop.eclap.eu-running ■ test.eclap.eu-running ■ bpnetmardaniele-2-running  
■ test.eclap.eu-old



# 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,



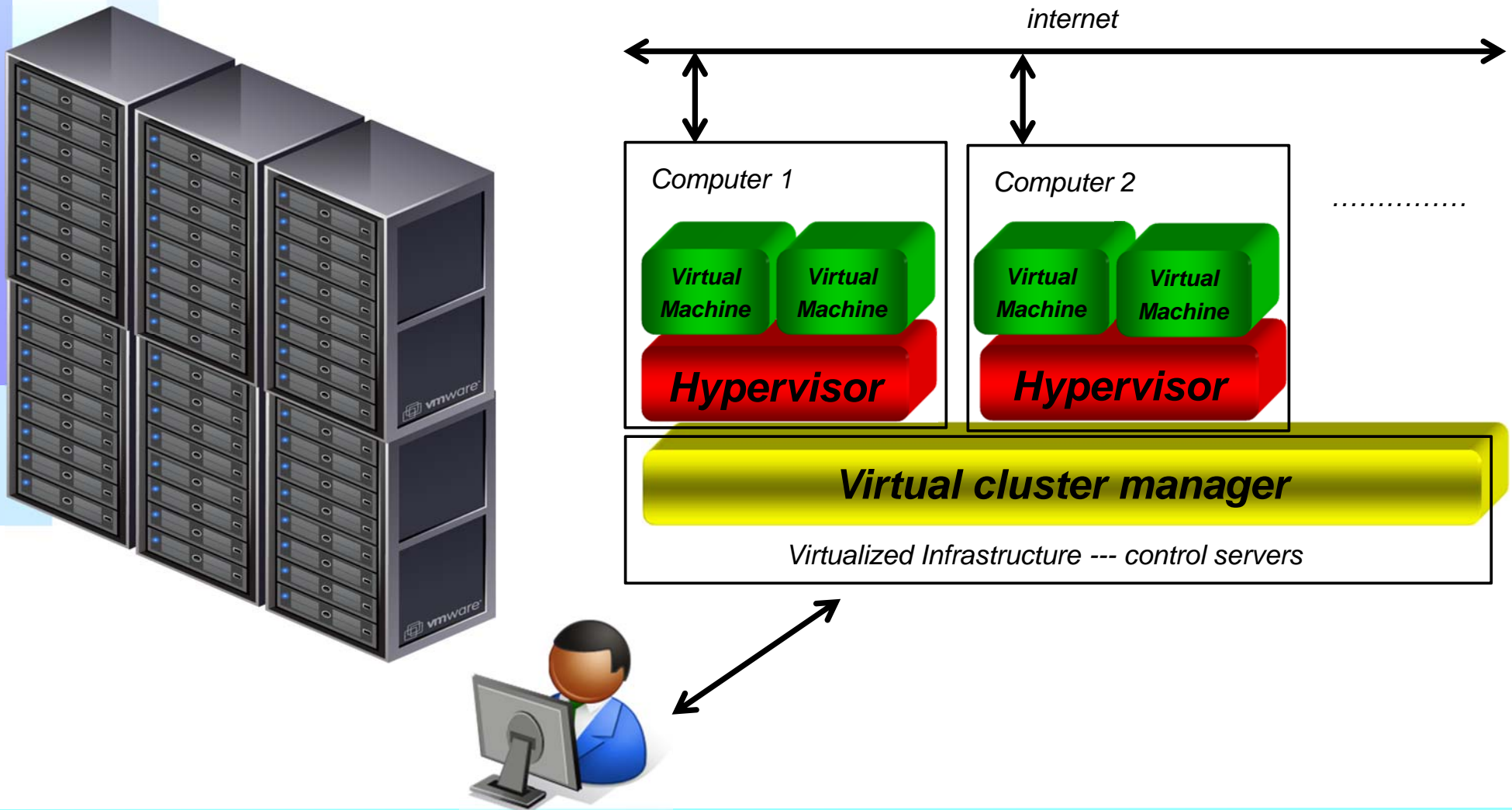
# Software/Components preinstalled into rented Computers/VMs

- [ **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



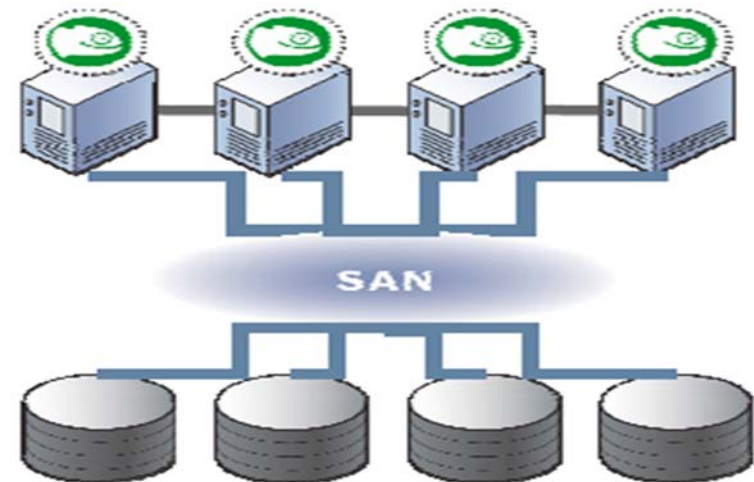




# Clusters, definition

## For Cluster, it is typically intended:

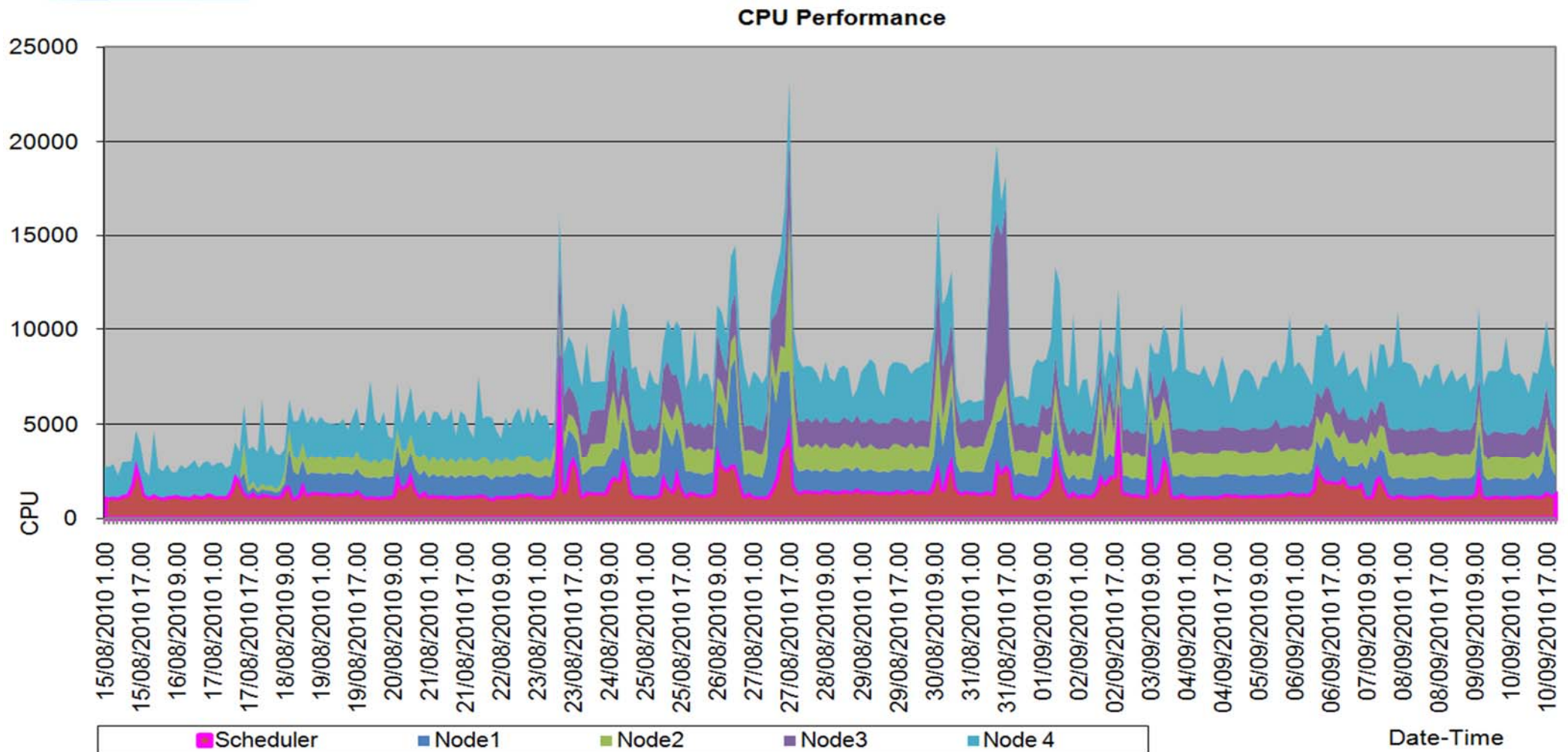
- ♣ Several kinds of computers and/or VMs used to compose a group of resources, that can be managed together, and may be sharing the same domain or not.
- ♣ a set of computers/VMs into a datacenter which are dedicated to a unique problem, for example:
  - ➔ A microgrid, an Hadoop cluster, .....
  - ➔ 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

## 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

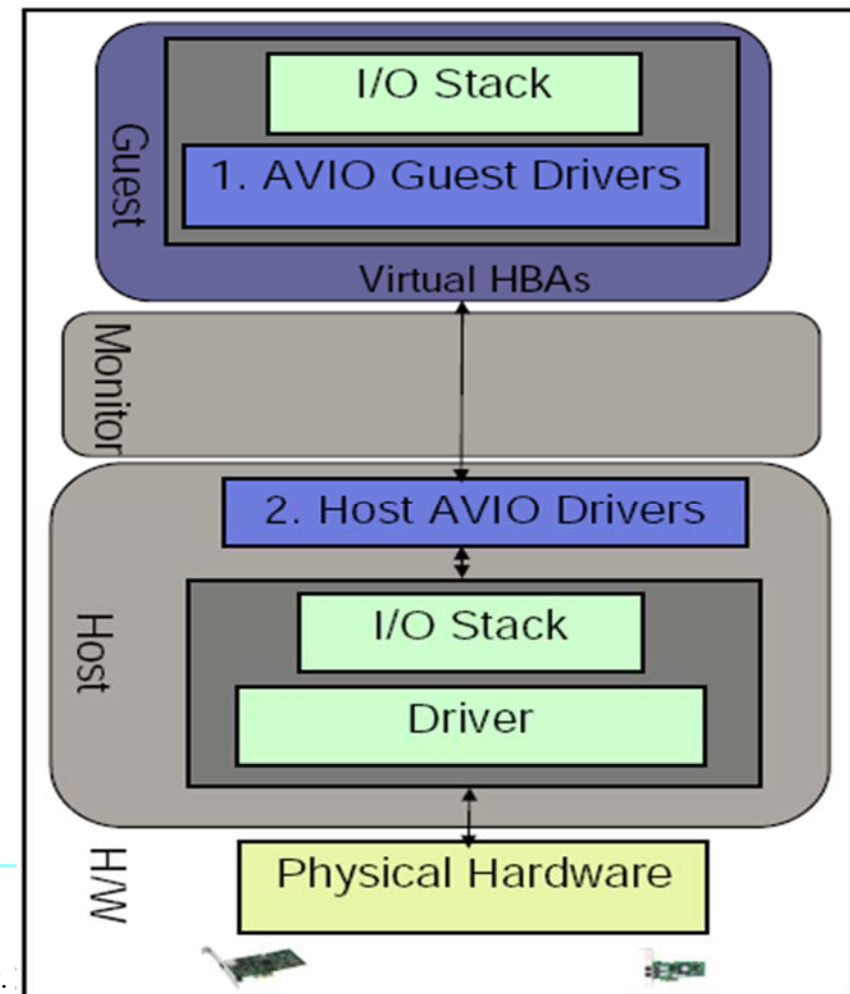
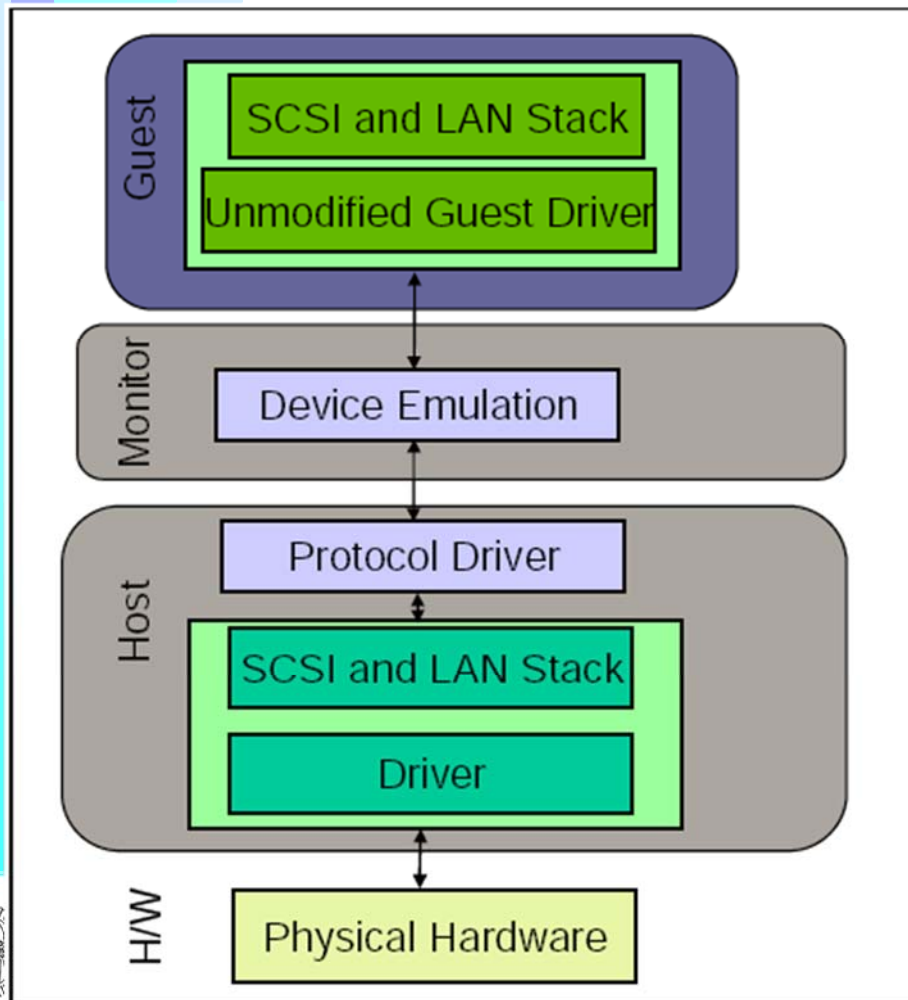
## Paravirtualization (total or only on some devices)

- ♣ 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





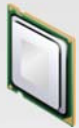
# “Speeds and Feeds”

## 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 Purpose Built Scheduler

- Lowest CPU overhead

#### Hardware Assist Page Sharing Ballooning

- Maximum memory efficiency

#### VMXNET3 VMDirectPath I/O

- Wirespeed network access

#### Storage stack optimization VMDirectPath I/O

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

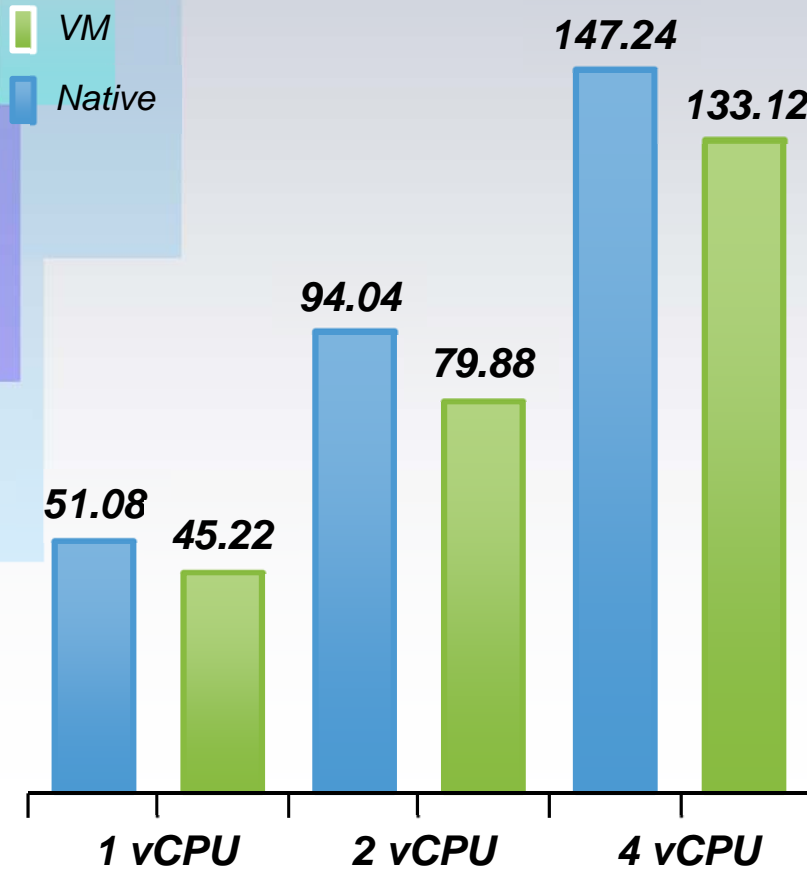
■ Current ■ NEW





# ESX 4.0 Performance with SQL Server 2008

Relative Scaling Ratio



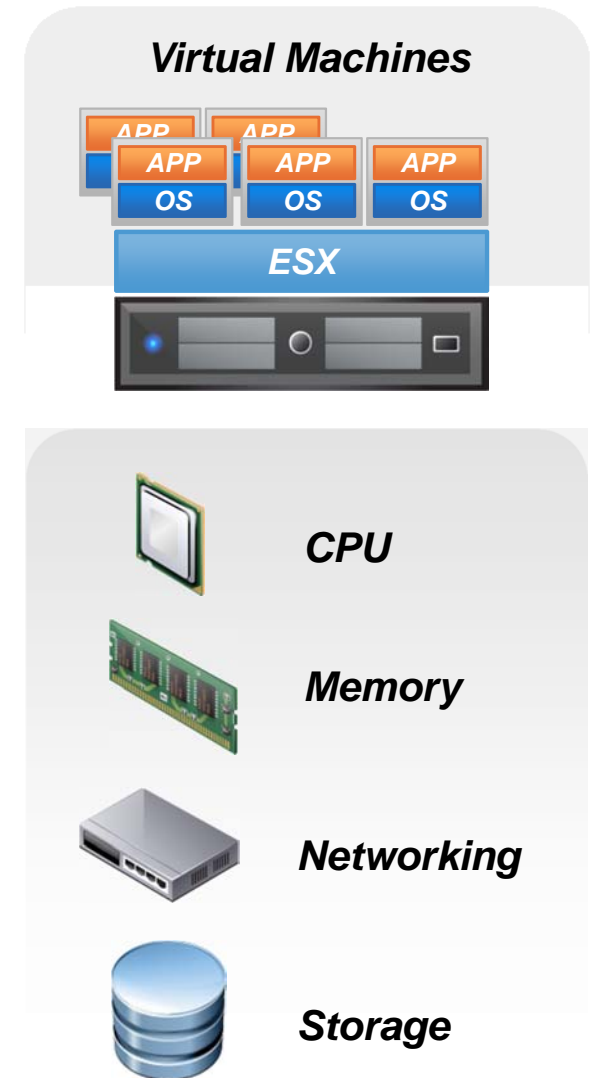
- ESX achieves 90% of native performance on 4.0 vCPU VM
- Workload transaction latency unchanged between ESX 4.0 and Native



# 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 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

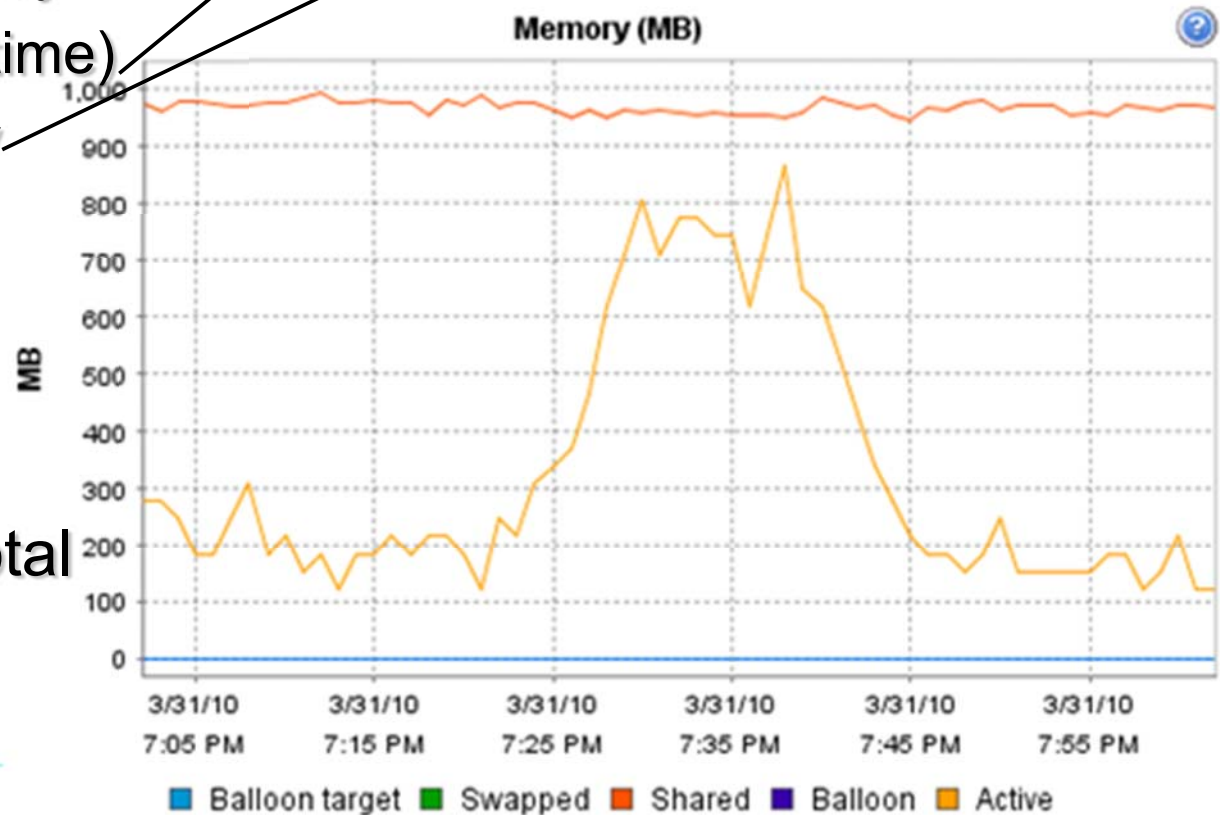


## Memory

- ♣ 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





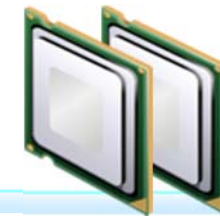
# VM: Memory Definitions



- ⌈ **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



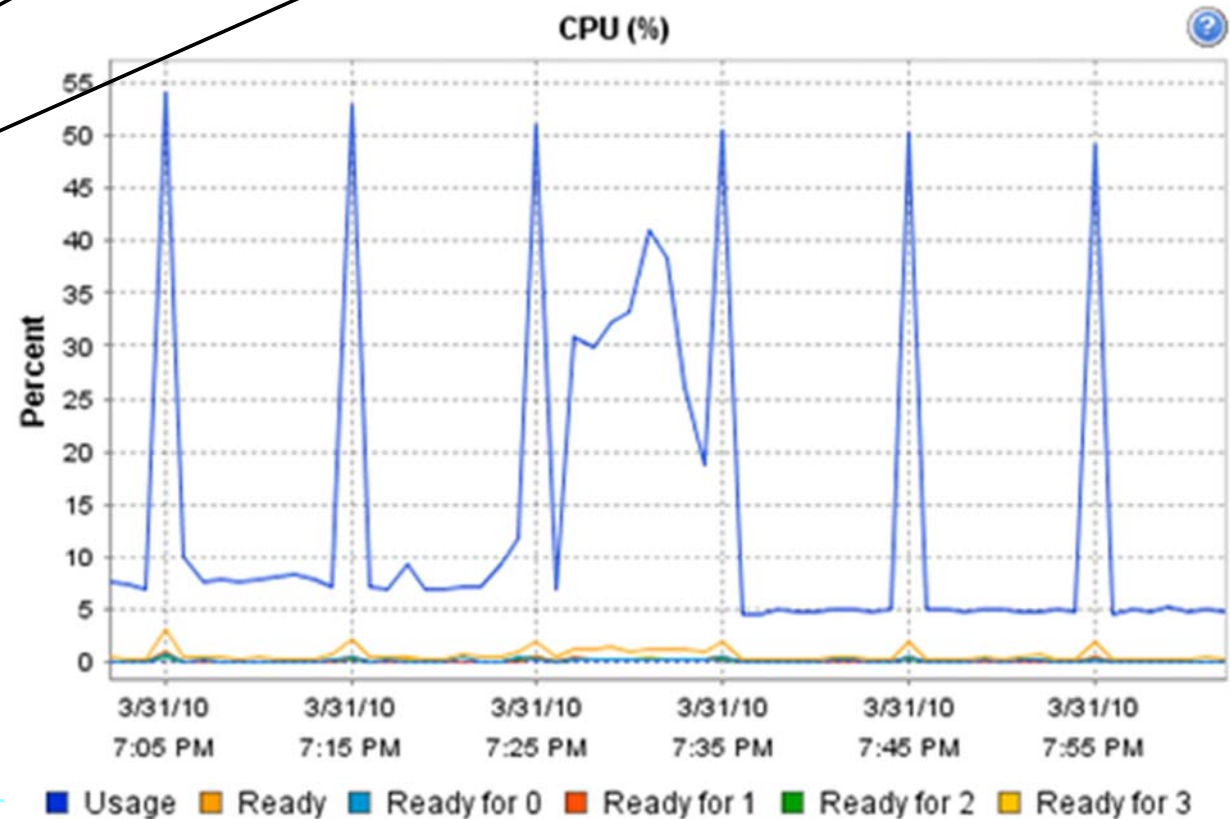
## Memory

- ♣ Total host Clock
- ♣ For each VM
  - ➔ Max #cks/s host
  - ➔ Reserved #cks/s
  - ➔ Used #cks/s
  - ➔ Limited #cks/s



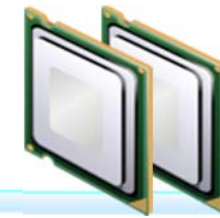
Ck/s → Hz

1 GHz → 1000 MHz

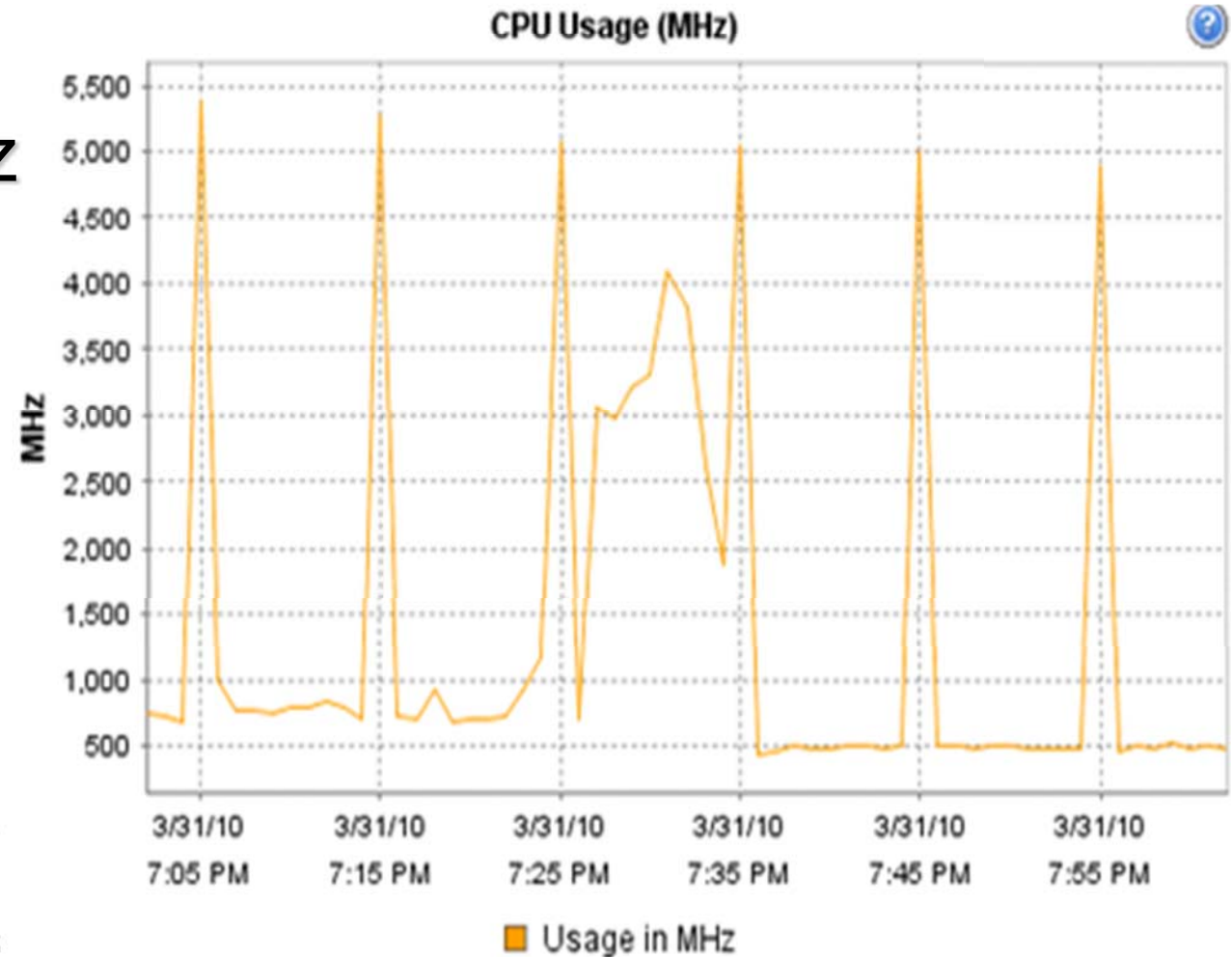




# Model for CPU



- ✓ 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:**

π 1 CPU 1300 Mhz, 400 Mhz reserved

π 1 Gbyte RAM max, 400 Mbyte reserved

π 2 network cards, 2 IPs

## **VM2:**

π 2 CPU 1300 Mhz, 800 Mhz reserved

π 1 Gbyte RAM max, 400 Mbyte reserved

π 2 network cards, 2 IPs



# Virtual Resources, 2/2

## 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:

π 1 CPU 1300 Mhz, 400 Mhz reserved

π 1 Gbyte RAM max, 400 Mbyte reserved

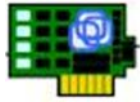
π 2 network cards, 2 IPs

### VM2:

π 2 CPU 1300 Mhz, 800 Mhz reserved

π 1 Gbyte RAM max, 400 Mbyte reserved

π 2 network cards, 2 IPs



# Model for network



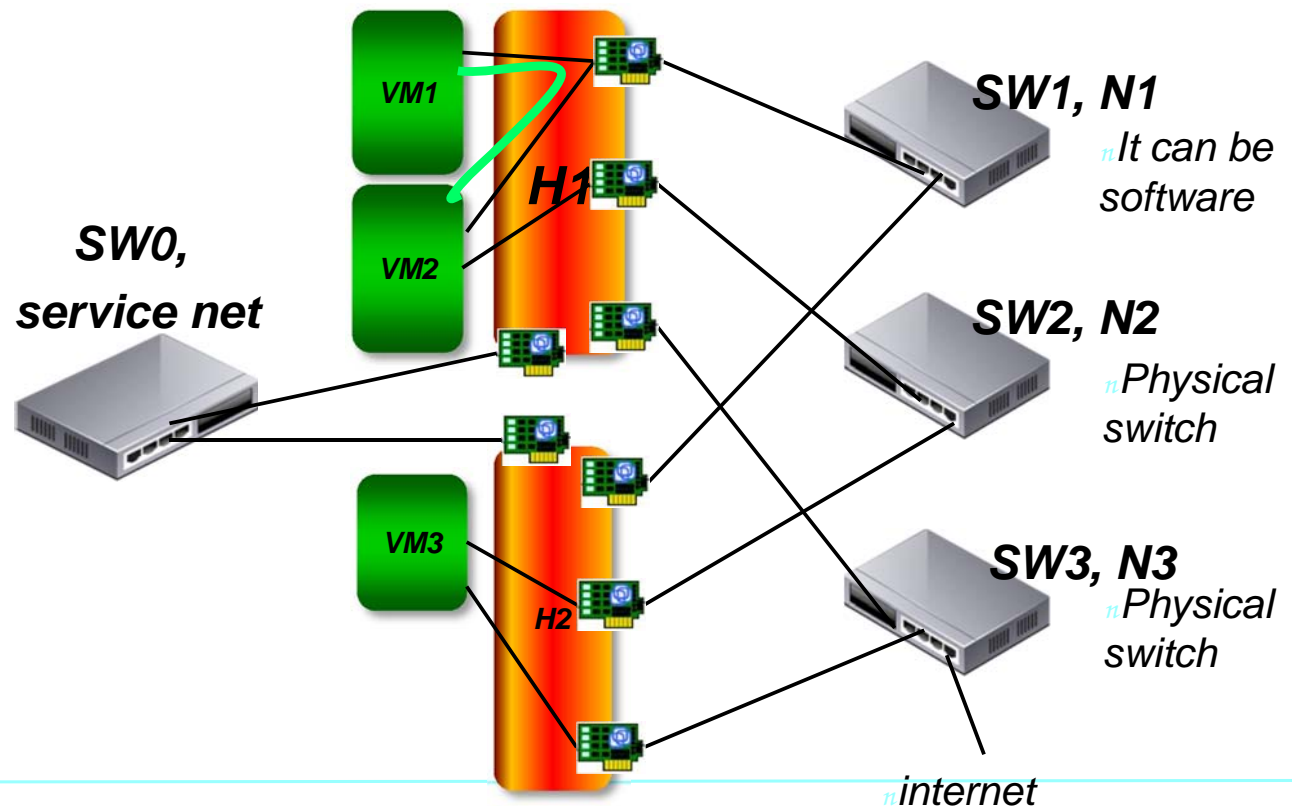
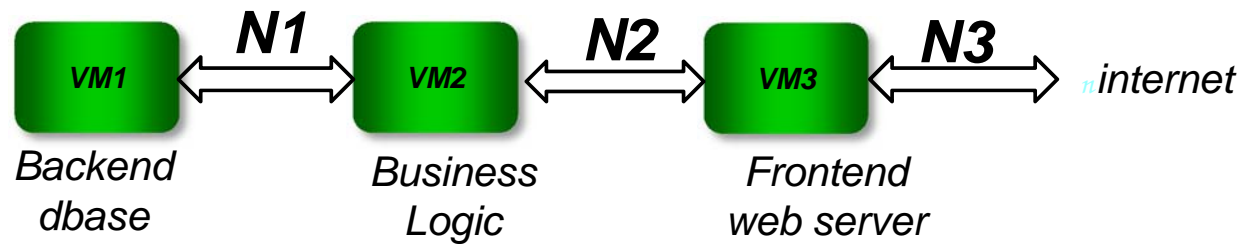
- ∩ An host may have multiple network cards with one physical IP each or some of them bridged
- ∩ Each single VM may have:
  - ♣ access to a number of networks (physical or virtual)
  - ♣ Installed multiple network cards
    - ➔ Each card can have one IP and may be connected to a network
- ∩ This means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

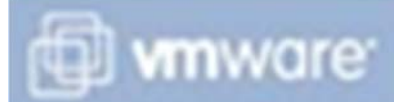
- Example of allocation of a three tiers solution
- 3 different networks (N1, N2, N3)
- 2 Host: H1, H2
- 3 VM: VM1, VM2, VM3
- SW1 is convenient to be software (full virtual). If it is HW, the VM1 can be moved from H1 to H2, dynamically
- SW2 could be fully virtual if VM3 is moved on H1





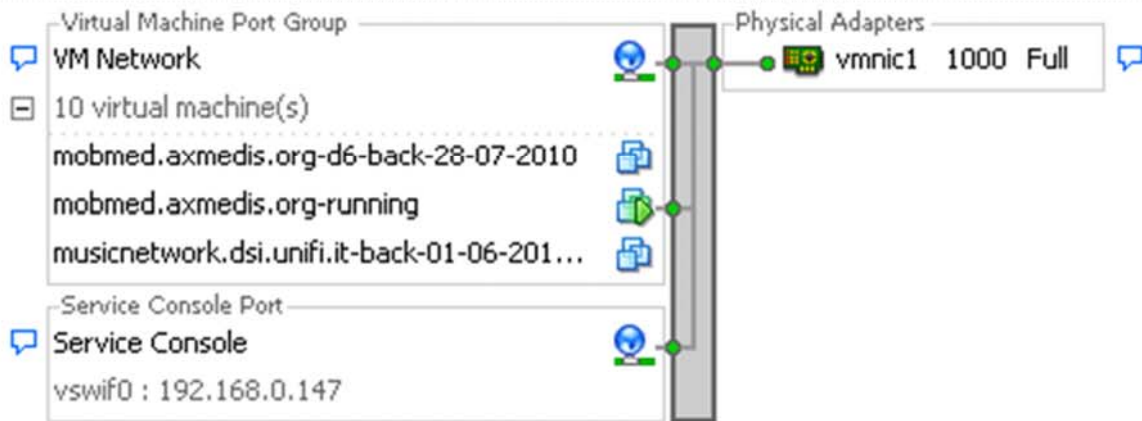


# Network and Virtual Networks



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...





# Model for HD, Storage



## Storage:

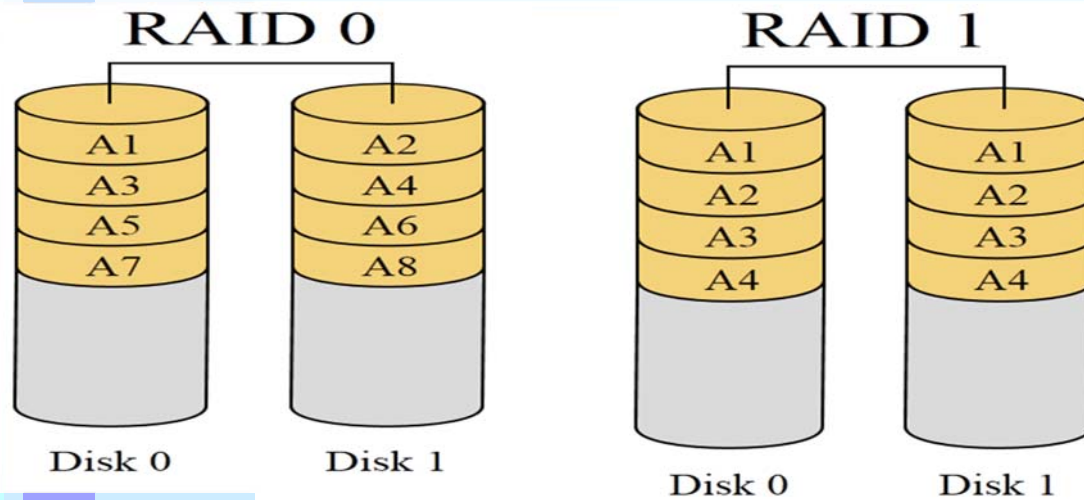
- ♣ HD contained into VM
- ♣ SAN: External to VM and mounted for their usage
- ♣ In any case connected with some Operating Systems (may be dedicated)

## HD with fault tolerant solution:

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

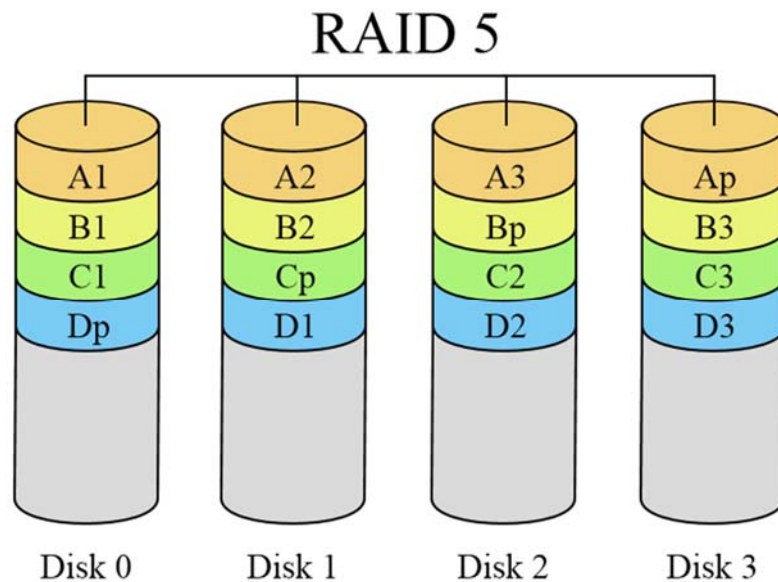


# Internal replications: HD RAID



*n RAID 0: HD0+HD1*

*n RAID 1: HD0 cloned on HD1*



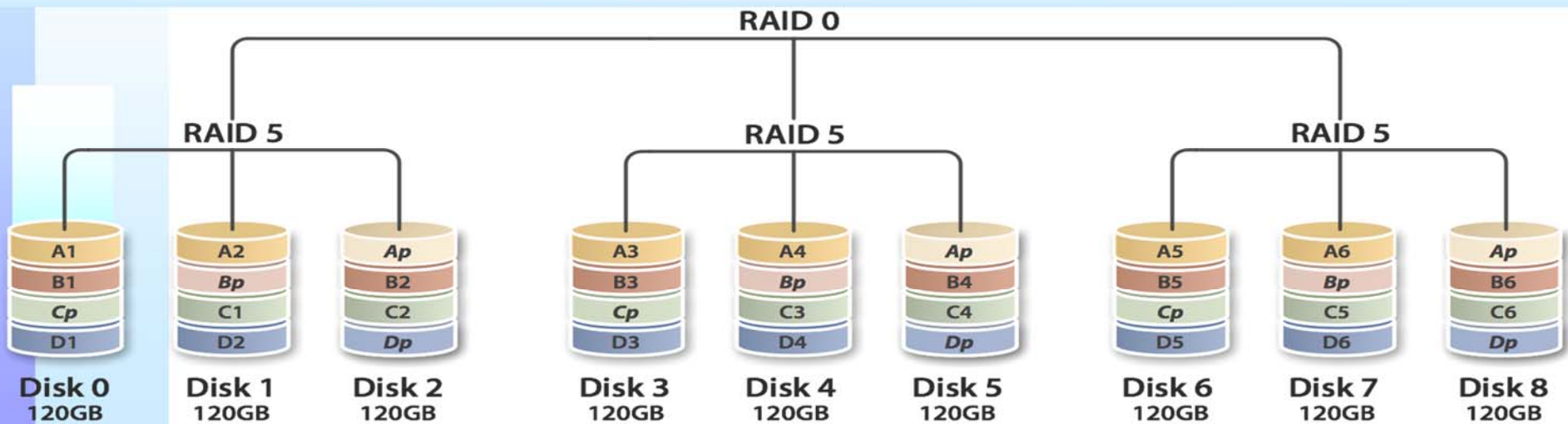
*n RAID 5: gestione del guasto di un disco*

*n valido fino a 14*

*n 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:

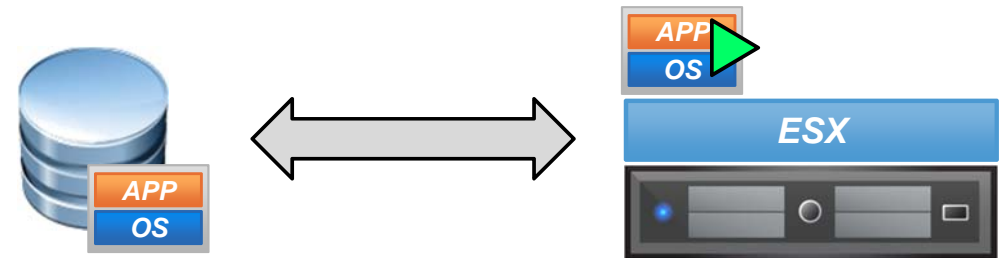
- ♣ Size: 6 over 9 HD, you lose a HD per R5
- ♣ Read/Write speed up:  $n(m - 1) \times \text{HD}$   
→  $n=3, m=3 \rightarrow 6x$  in this case



# Simple configuration

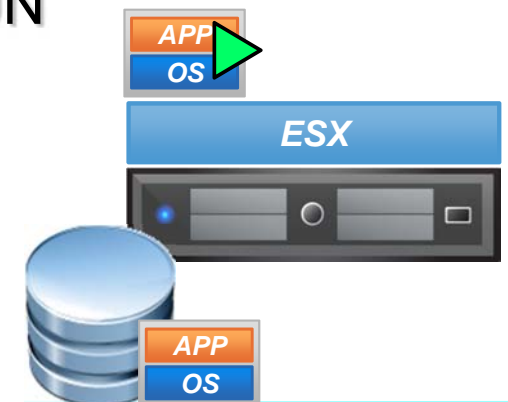
VM stored on a storage and executed on a remote hypervisor host

- ♣ At the start is uploaded on ESX memory and RUN
- ♣ Each write is passed back to the storage
- ♣ 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





# Model for storage consumption



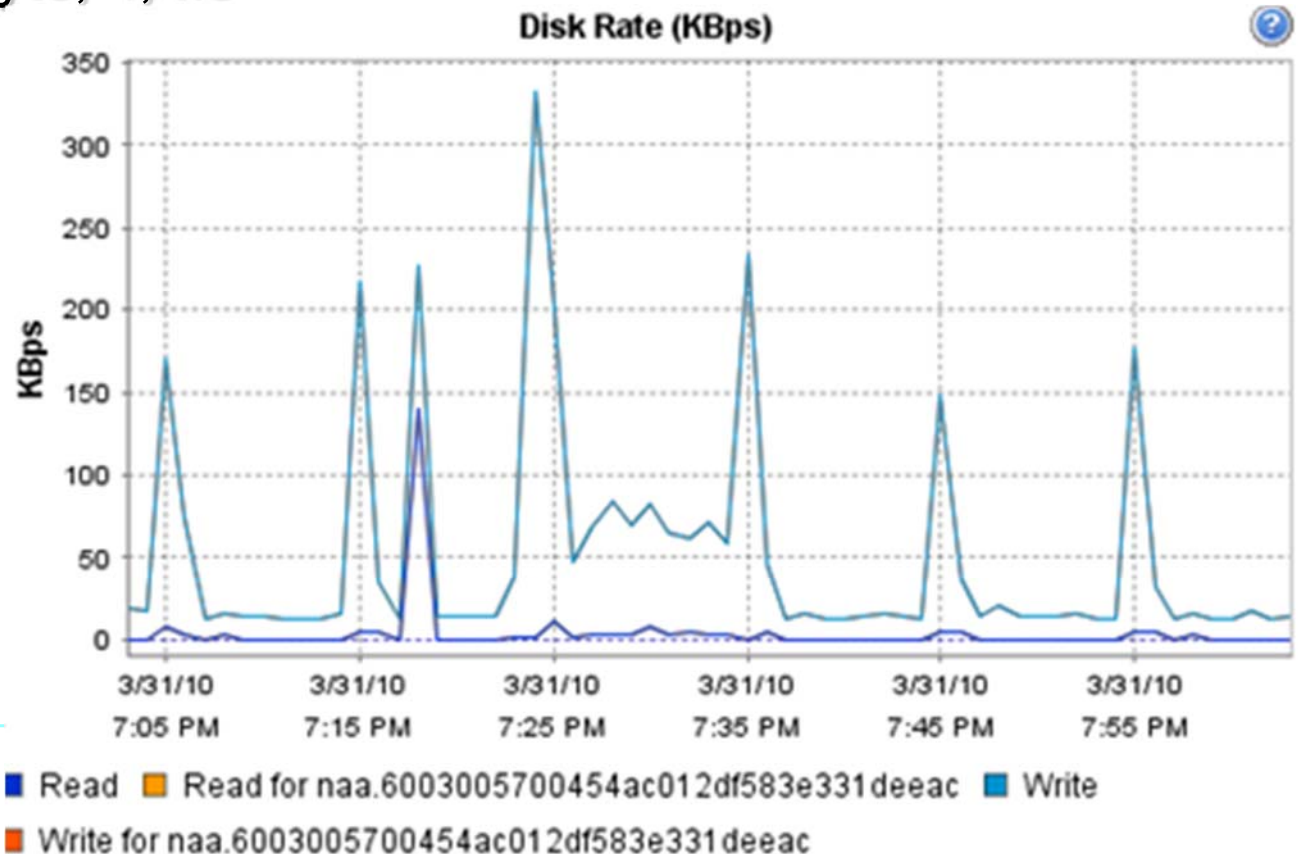
## HDD Typical:

- ♣ 100 Mbyte per sec. (high/max value)
- ♣ 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
- ♣ 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)



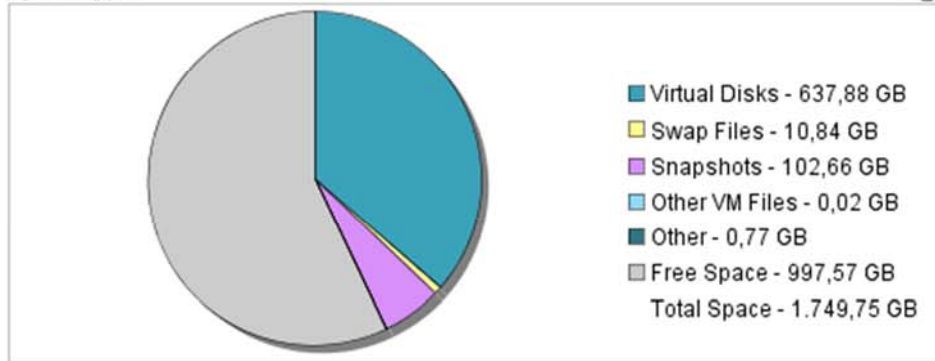
# Examples



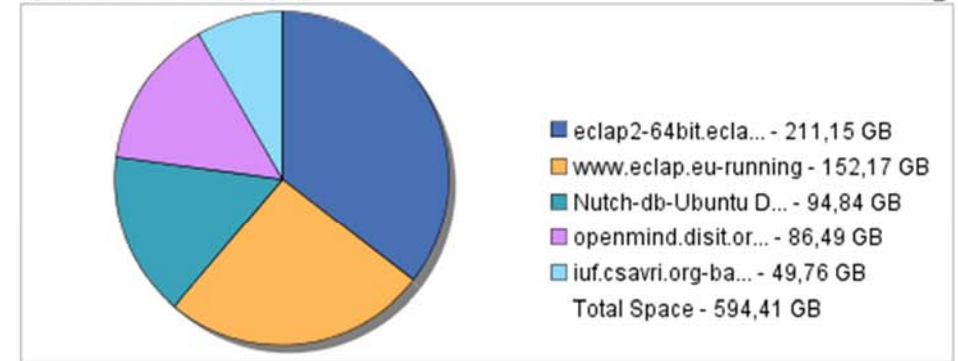
## Host

Space Utilization for 145-Storage-A-4

By File Type

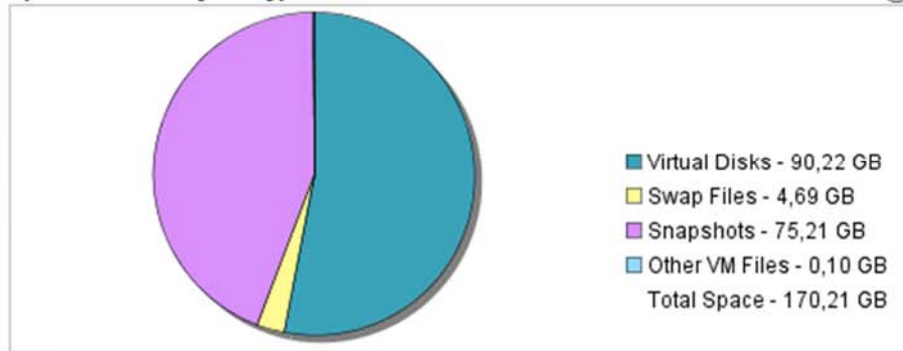


By Virtual Machines (Top 5)

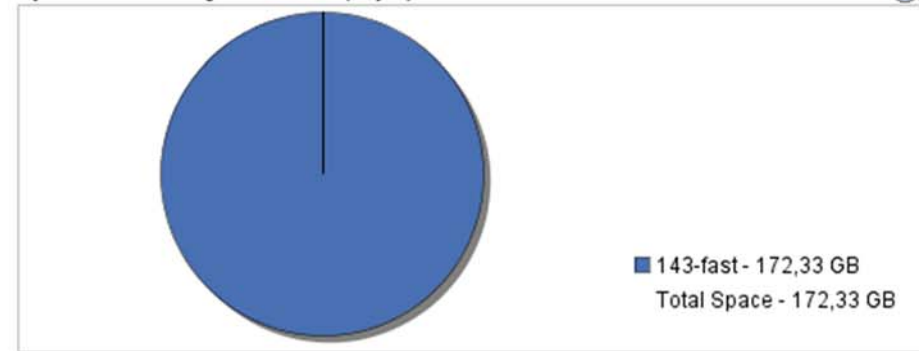


## Virtual Machine

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 lost of performed snapshots

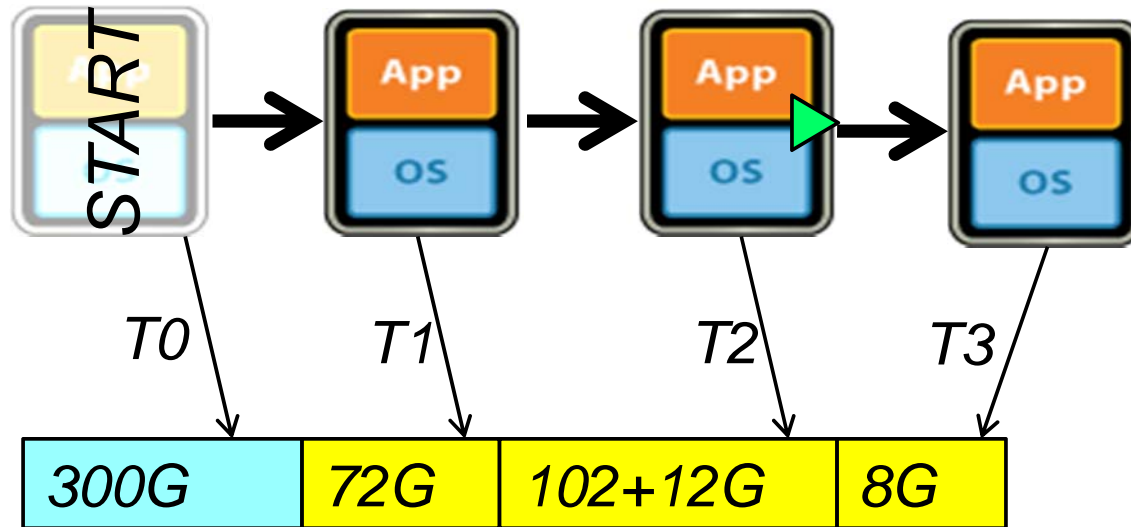


# Snapshot process



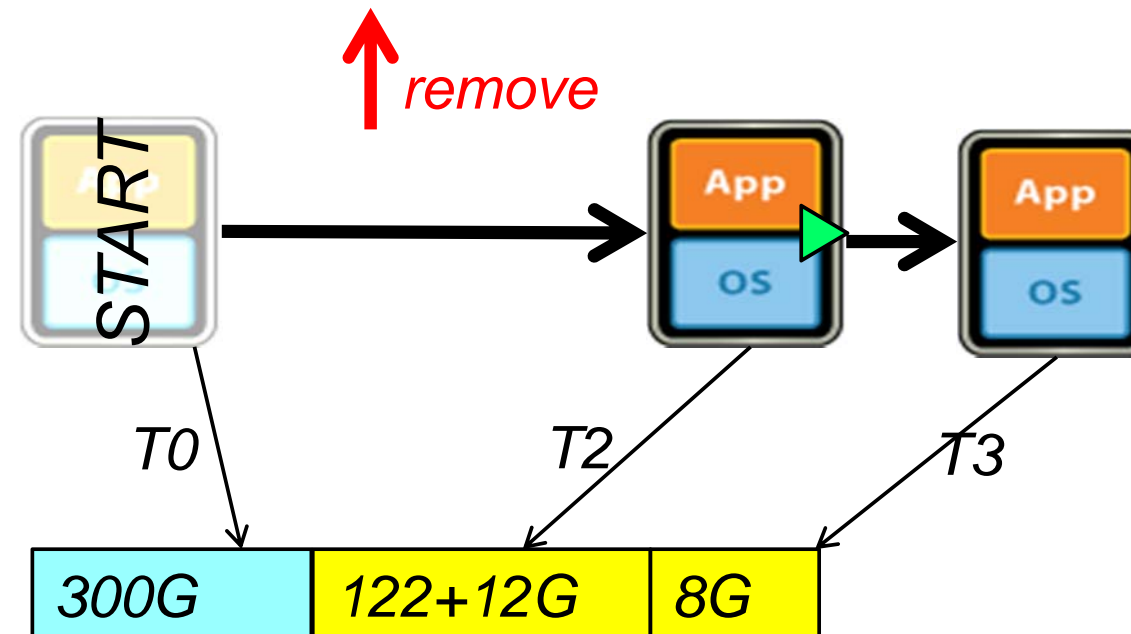
## Original version

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



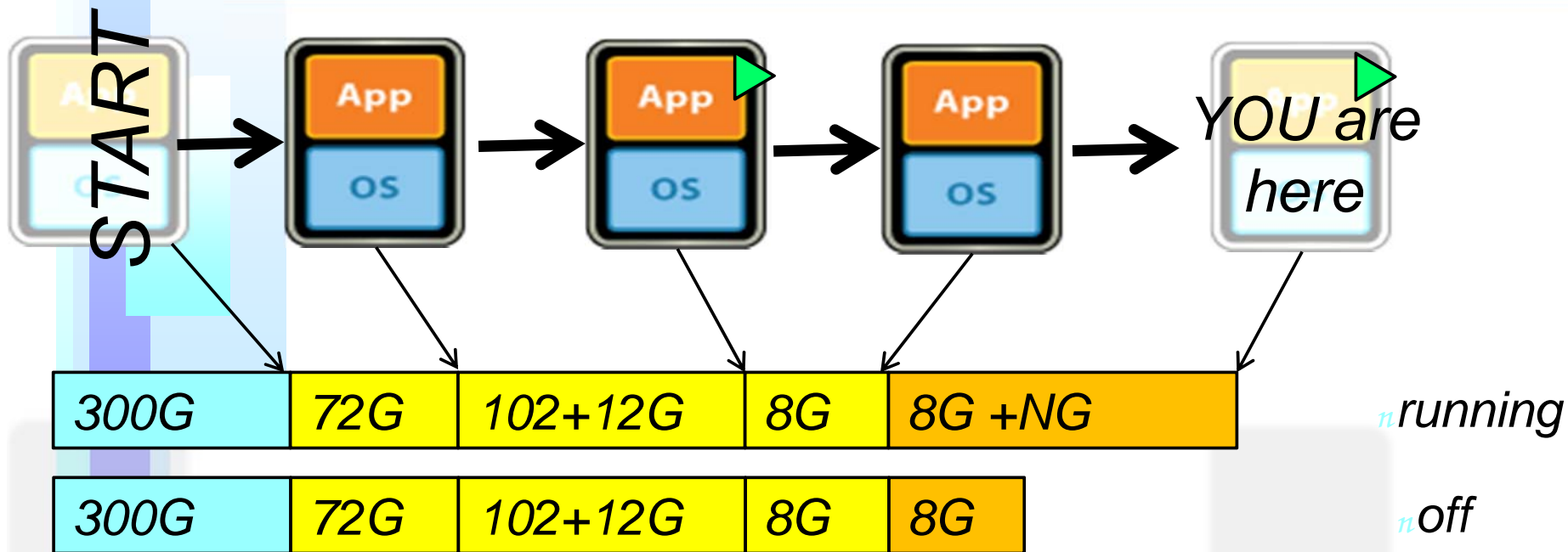
## After T1 Rimoval

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





# Virtual Machine: Snapshots, 1/3

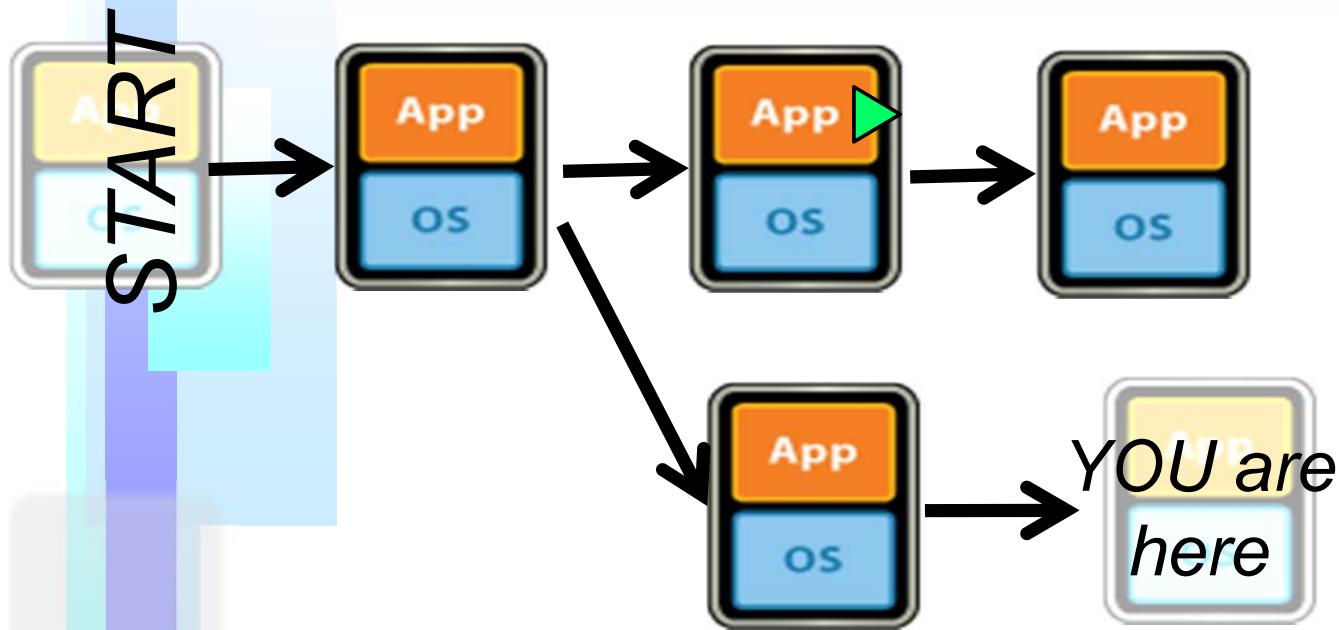


*When a number of snapshots are in place:*

*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!*

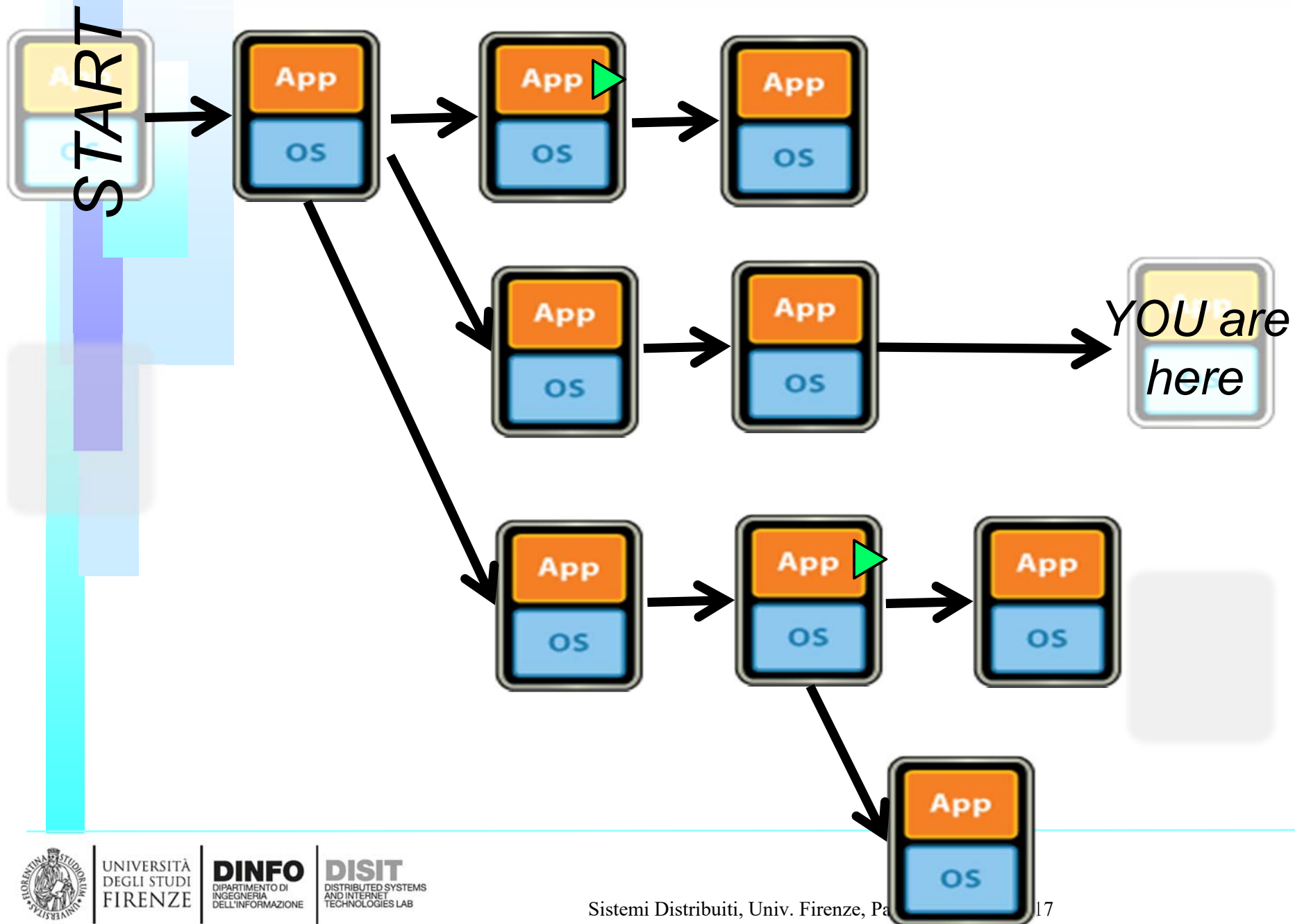


# Virtual Machine: Snapshots, 2/3





# 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

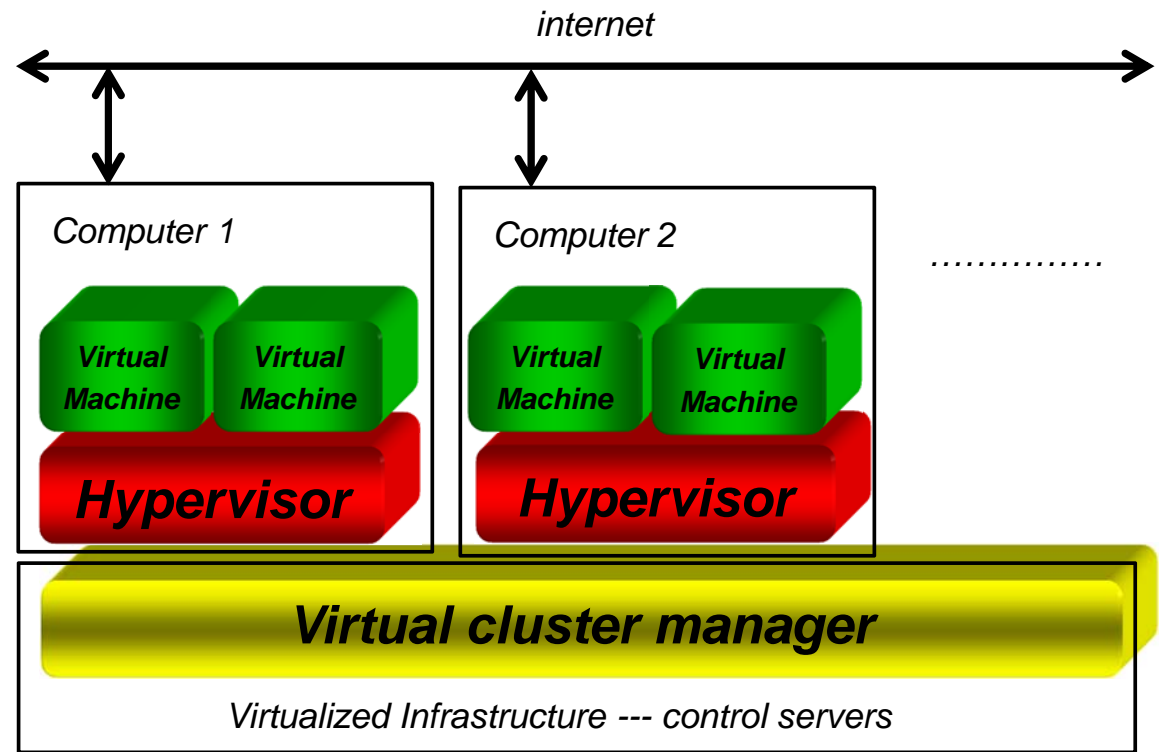






# Cloud Computing with VMs

## 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

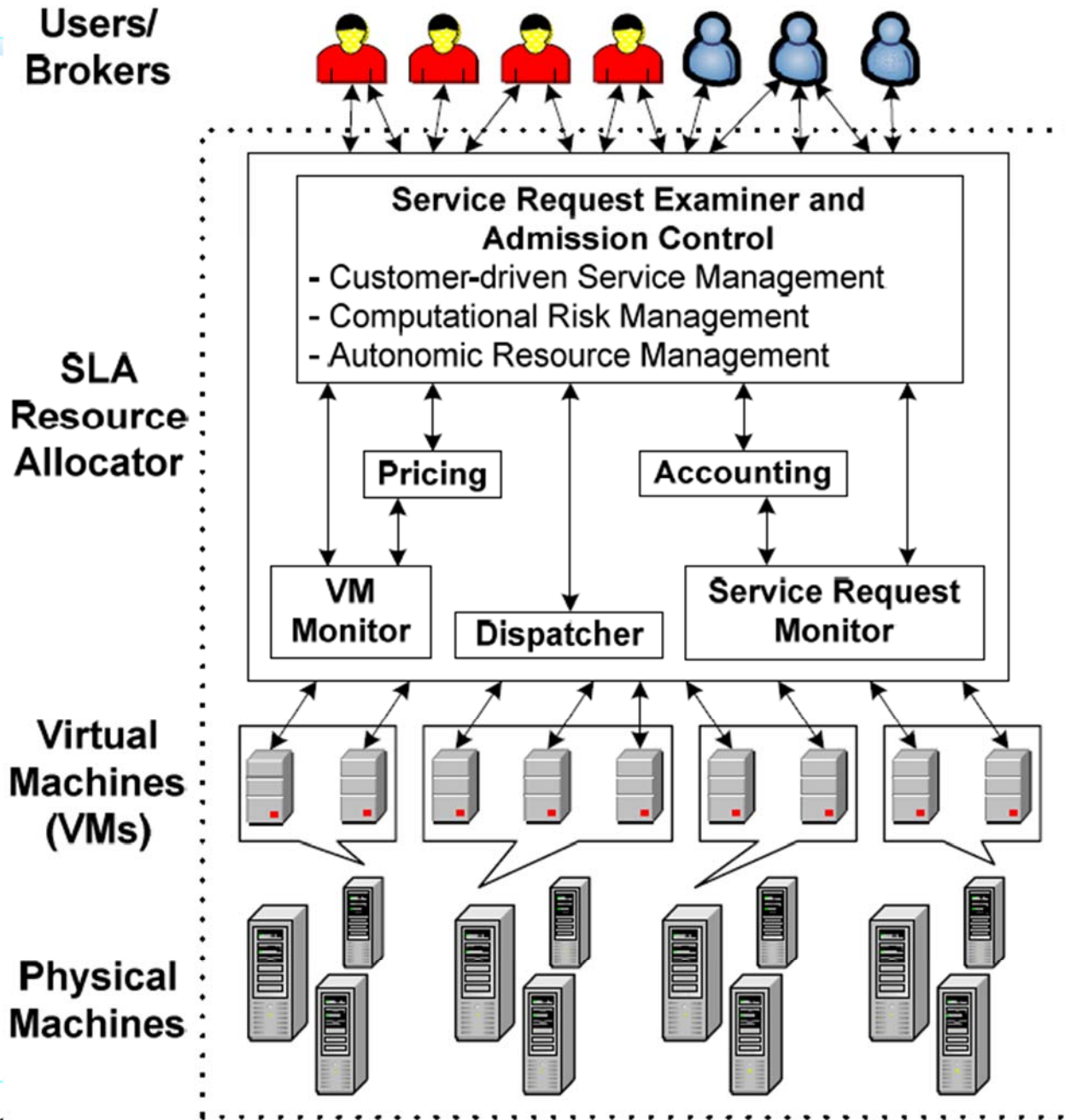
⌈ Subset of grid computing where the allocated process are virtual computers

⌈ **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

- ⌈ **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 no 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<br>Property                           | <u>Amazon</u><br>Elastic Compute<br>Cloud (EC2)     | <u>Google</u><br>App Engine      | <u>Microsoft</u><br>Live Mesh                                   | <u>Sun</u><br>Network.com<br>(Sun Grid)     | <u>GRIDS Lab</u><br>Aneka   |
|--|---|----------------------------------|---|---|---|
| <b>Focus</b>                                 | Infrastructure                                      | Platform                         | Infrastructure  | Infrastructure                              | Software Platform for enterprise Clouds   |
| <b>Service Type</b>                          | Compute, Storage (Amazon S3)                        | Web application                  | Storage   | Compute                                     | Compute   |
| <b>Virtualisation</b>                        | OS Level running on a Xen hypervisor                | Application container            | OS level  | Job management system (Sun Grid Engine)     | Resource Manager and Scheduler  |
| <b>Dynamic Negotiation of QoS Parameters</b> | None  | None                             | None  | None  | SLA-based Resource Reservation on Aneka side.   |
| <b>User Access Interface</b>                 | 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   |
| <b>Web APIs</b>                              | Yes   | Yes                              | Unknown   | Yes   | Yes   |
| <b>Value-added Service Providers</b>         | Yes   | No                               | No  | Yes   | No  |
| <b>Programming Framework</b>                 | 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 solutions 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

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.

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.

- ♣ 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

## Classificazione NIST

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

## Business Process as a Service (BPaaS)

- ♣ Aggiunto in seguito

## Everything as a Service (XaaS)

- ♣ Middleware as a Service !!!!

**Cloud Application**  
*Software as a service*

**Cloud Platform**  
*Platform as a service*

**Cloud Infrastructure**  
*Infrastructure as a service*



# Infrastructure as a Service (IaaS)

- ⌈ 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.
- ⌈ 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.

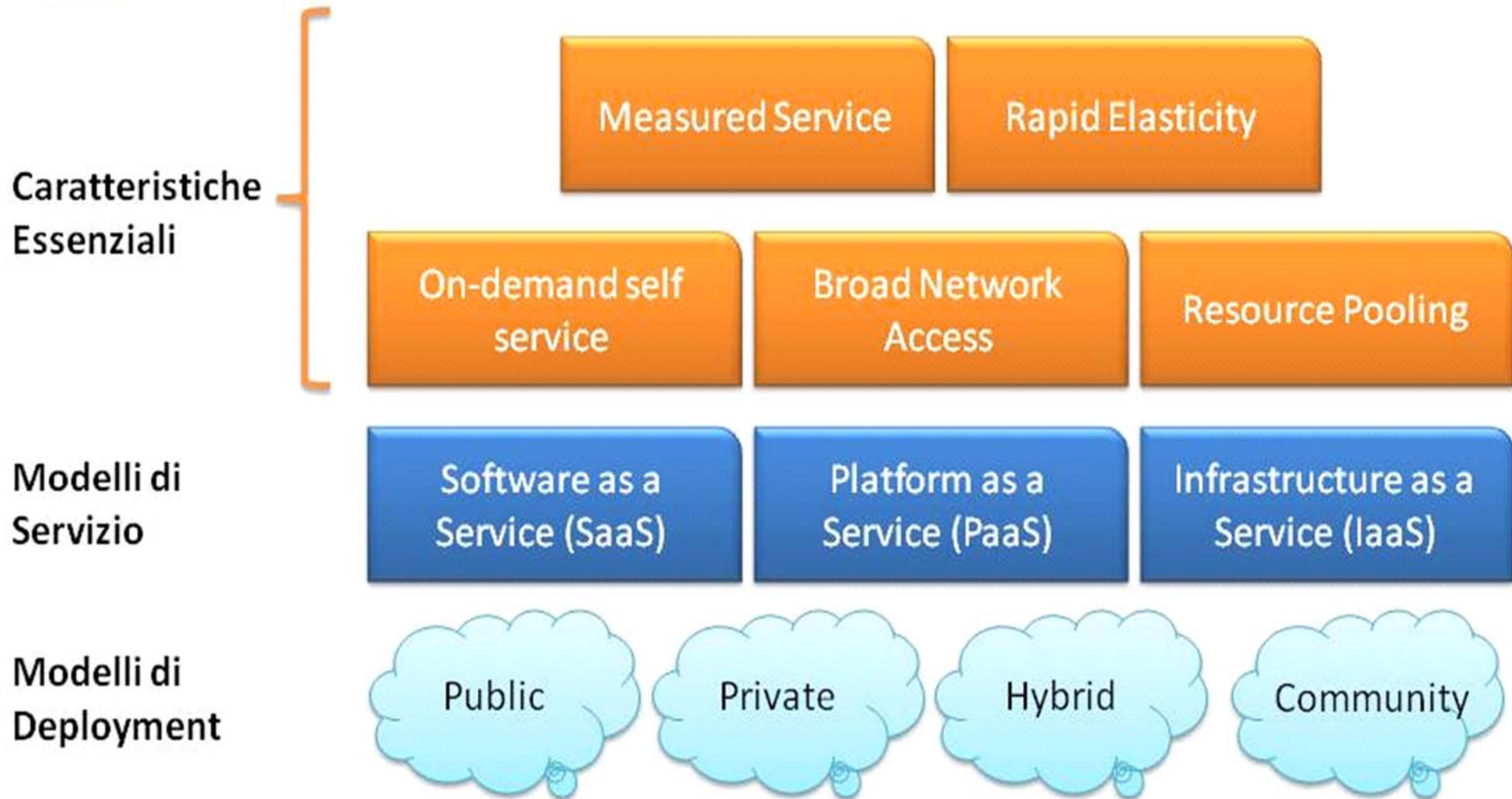


# Business Process as a Service (BPaaS):

- ⌈ 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








# 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
- [ vCenter, datacenters and cluster management
- [ Comparison among virtual computing solutions
- [ How to work with Virtual Machines
- [ IaaS solutions, SaaS Solutions, PaaS Solutions
- [ ICARO project



# High Availability

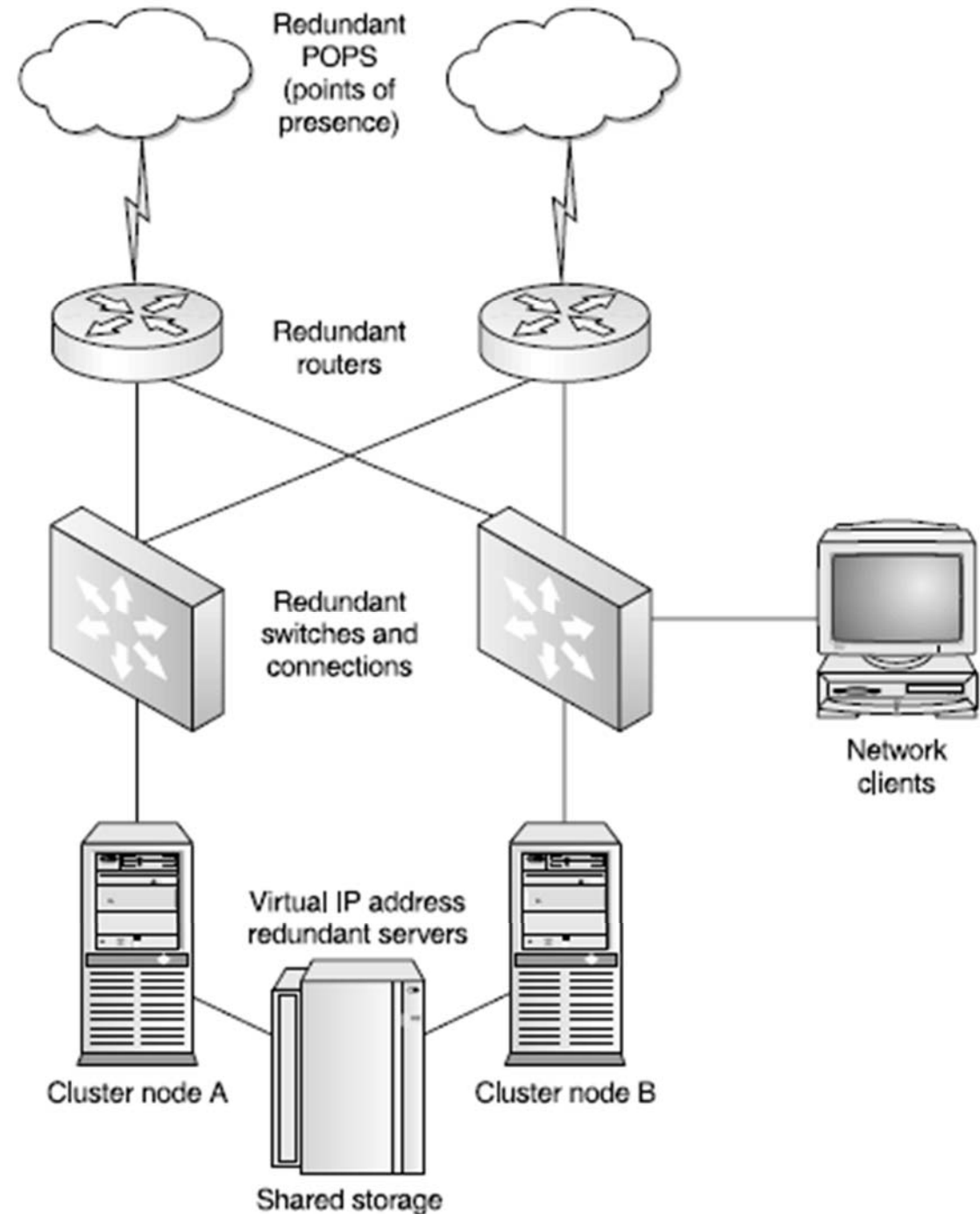
The high availability has to be guaranteed only by the integration of features of:

- ♣ ***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





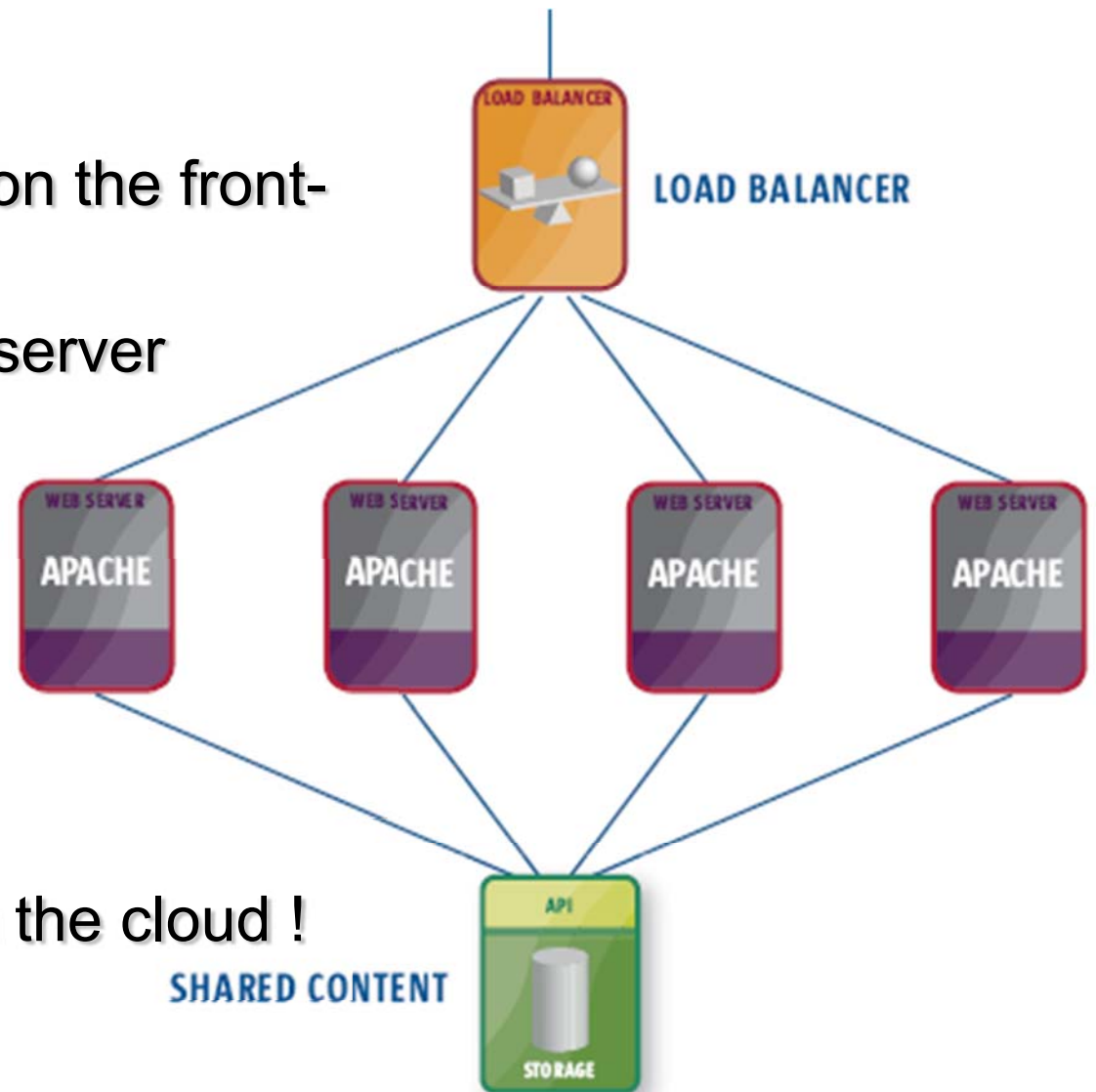
# High Availability

- ✓ 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**



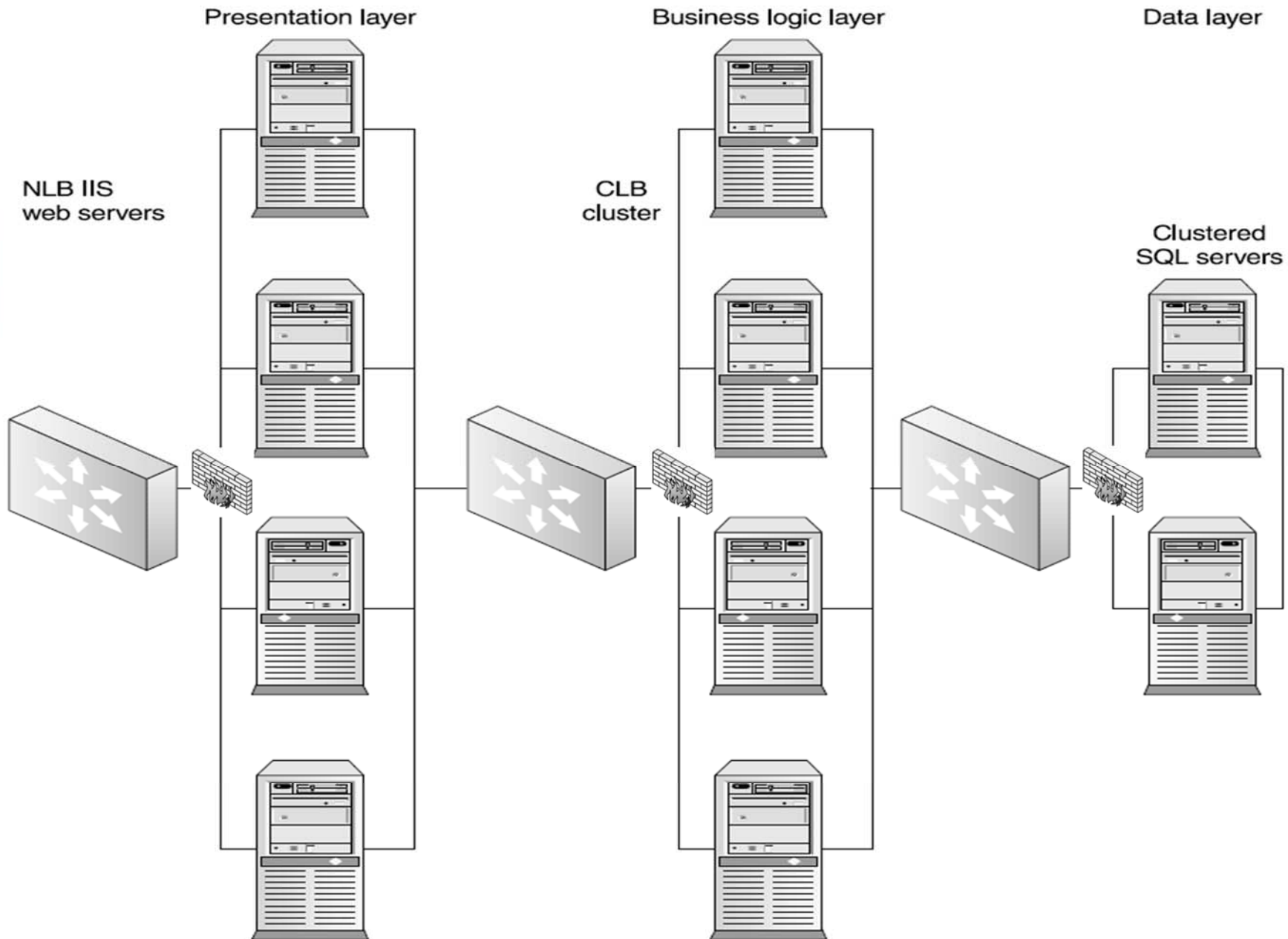
# High Availability: Load Balancing

- 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 !





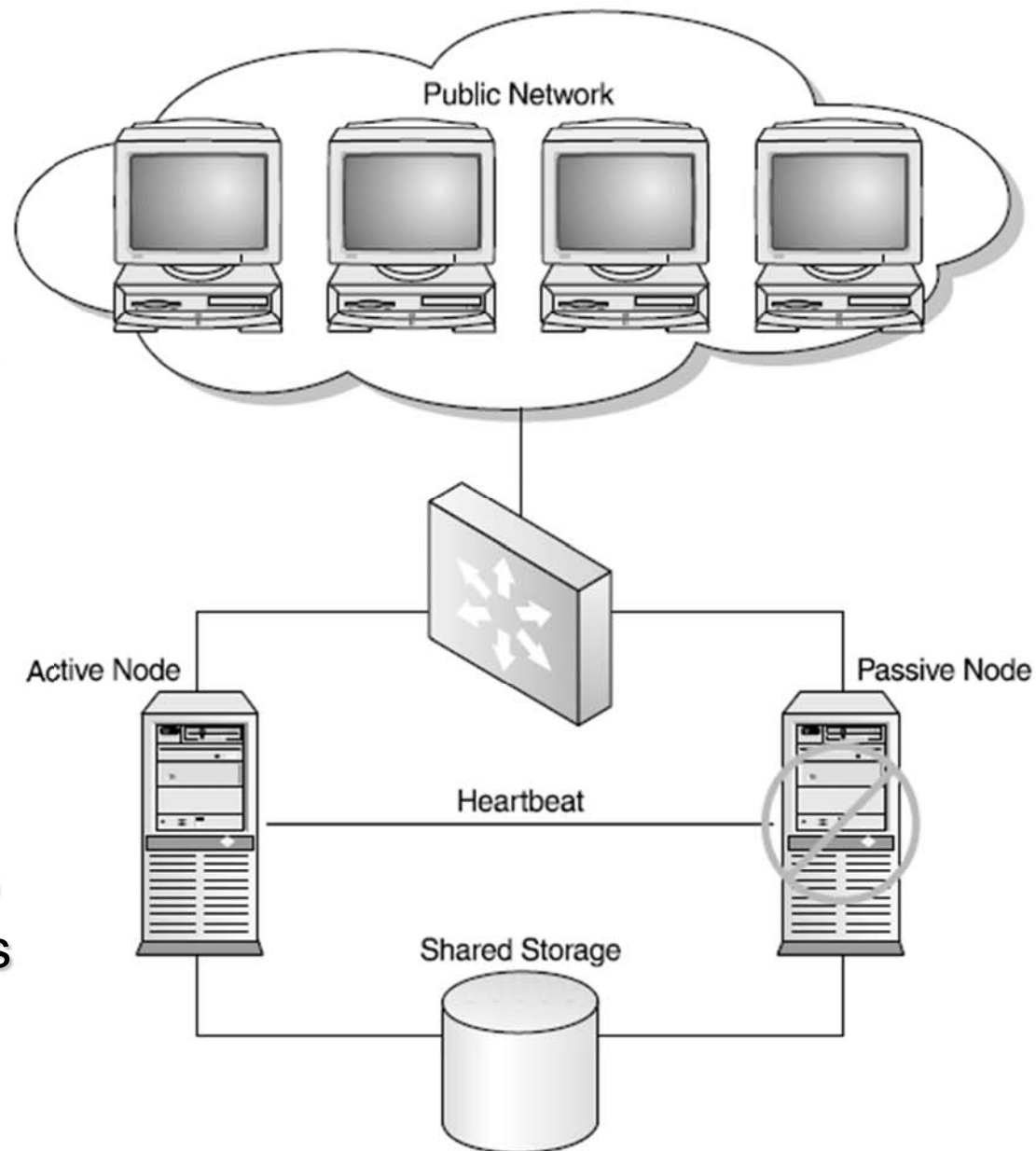
# Balancing multi-tier, 3-tier





# 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







# High Availability: Hot spare, hw

## Three separate networks cards

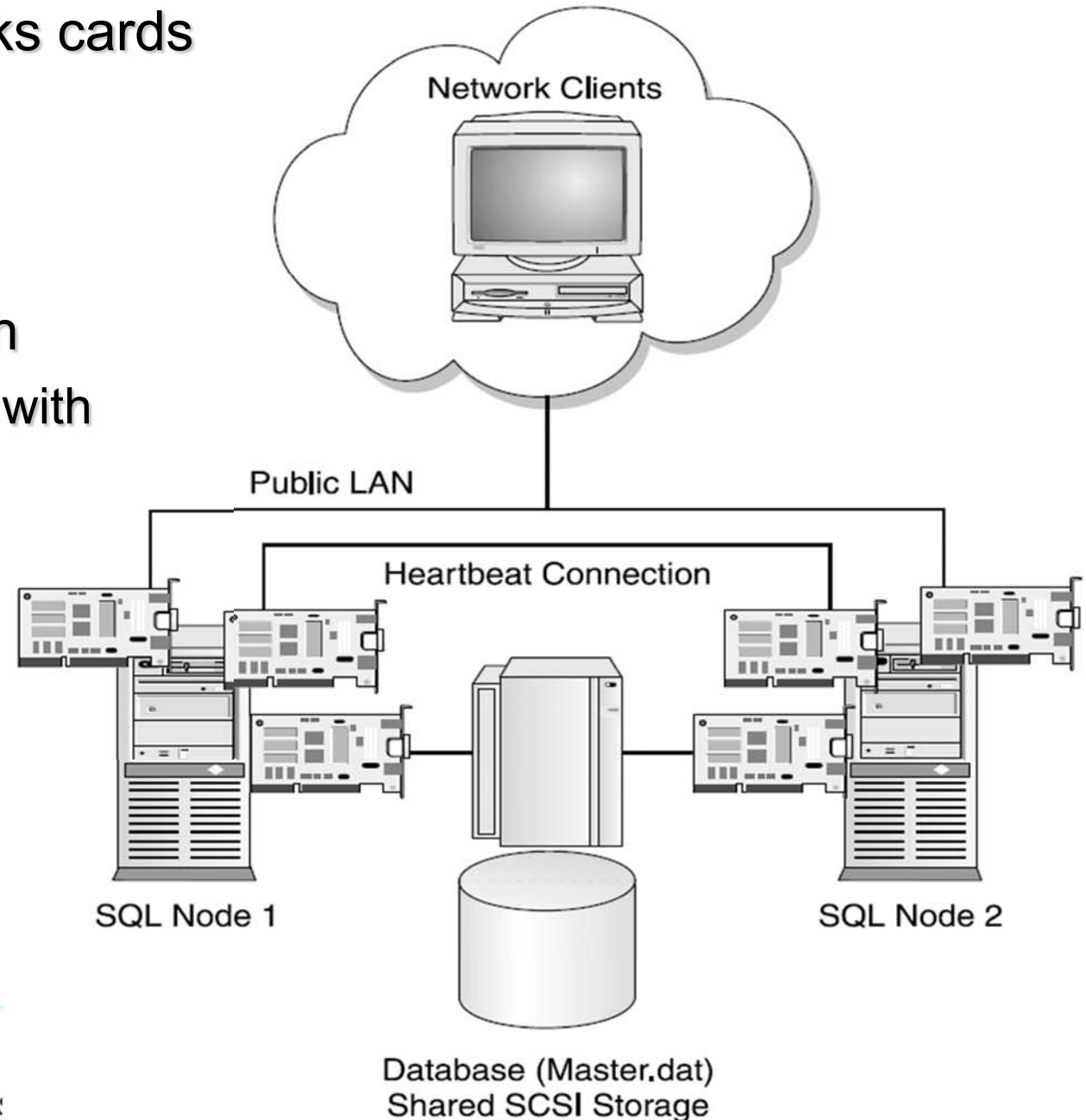
- ♣ Front end
- ♣ Heartbeat
- ♣ Database NAS/SAN

## UPS/APC solutions with

- ♣ 2 UPS, each of which with network card

## NAS/SAN

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

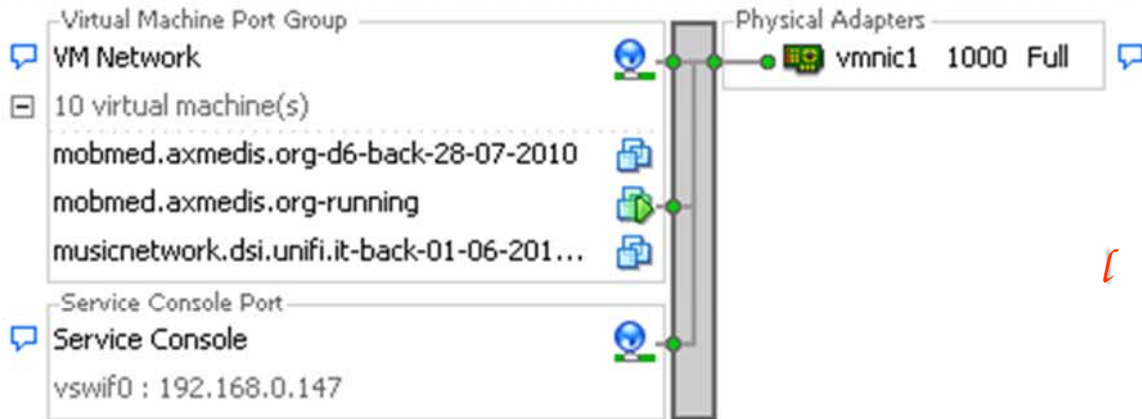




# Network and Virtual Networks

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

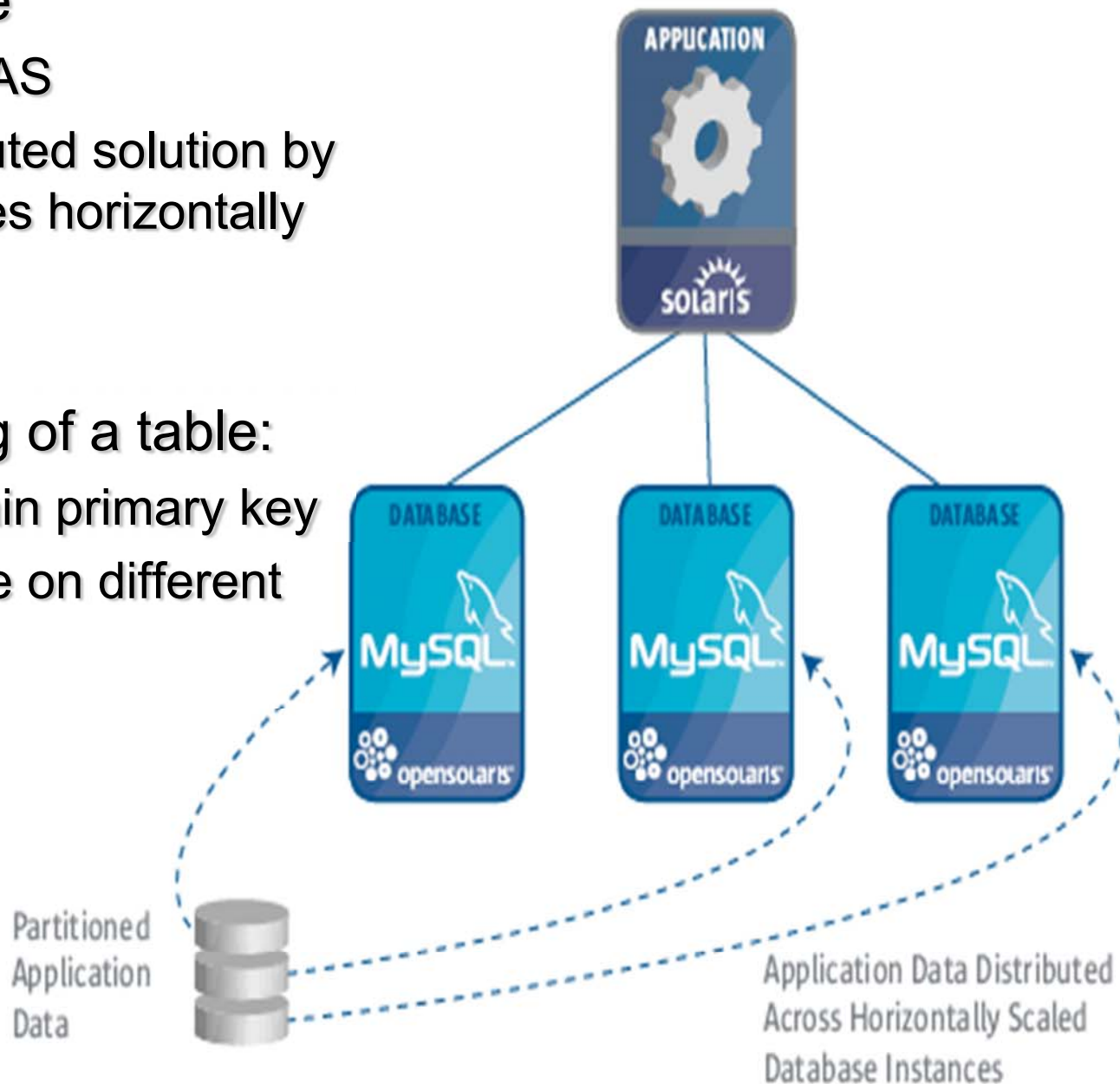
Remove... Properties...






# 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





# Structure

- ⌈ Elements of cloud Computing
- ⌈ Virtualization
- ⌈ Cloud Computing
- ⌈ High Availability
- ⌈ vSphere Infrastructure 
  - ♣ Vmotion
  - ♣ Power Management
  - ♣ Resource Scheduling
  - ♣ Fault Tolerance
- ⌈ 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
- ⌈ ICARO project



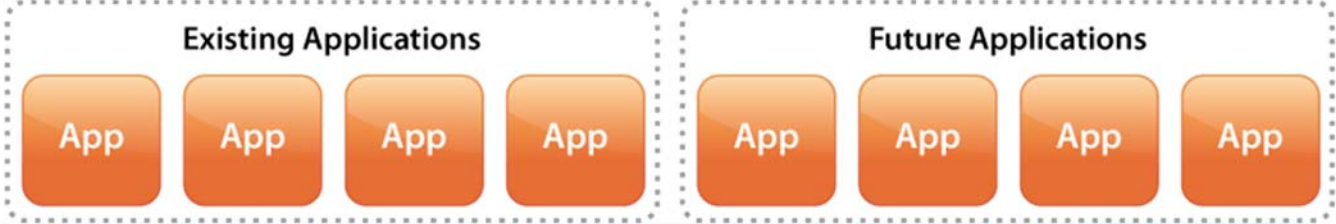
# vSphere 4 infrastructure of VMware

## High level features:

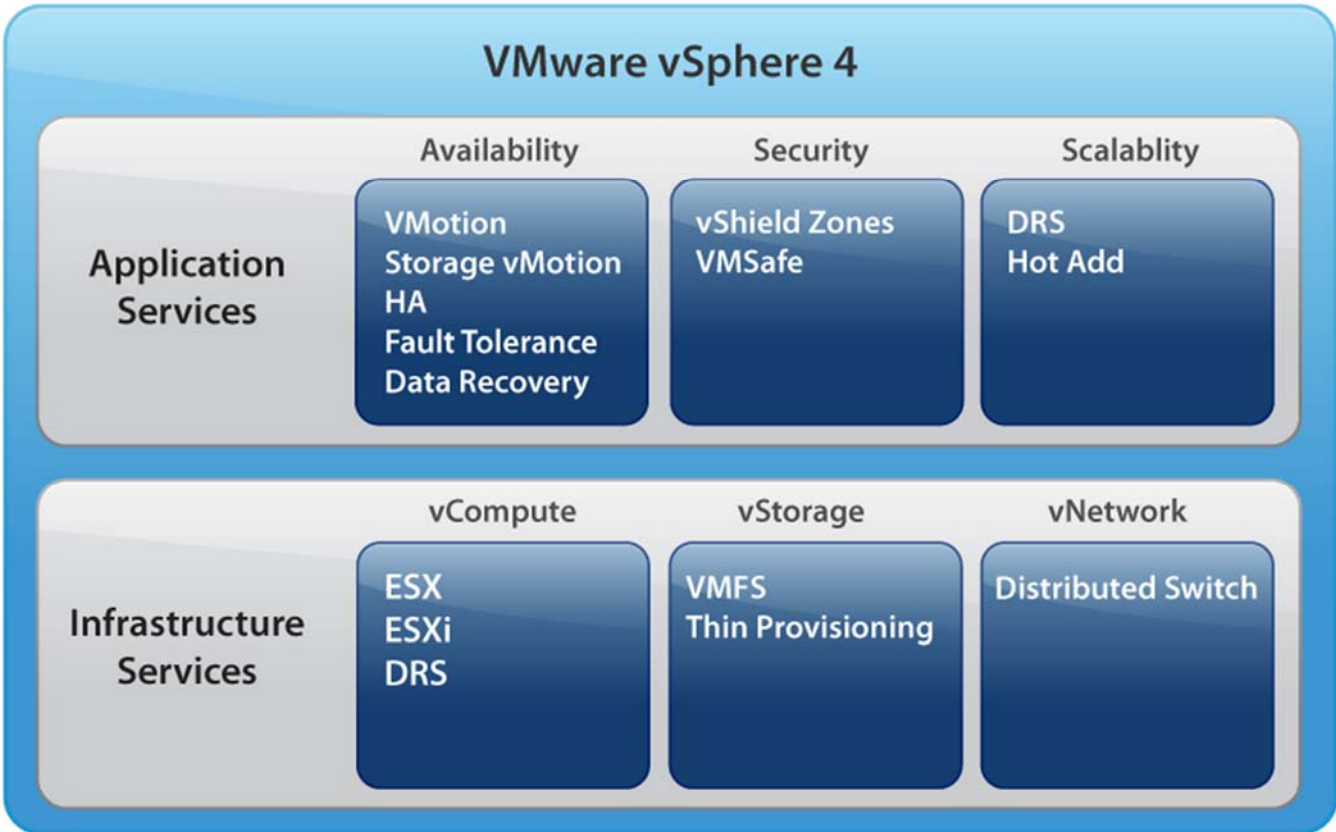
- ♣ HA: high availability
- ♣ DRS: Distributed Resource Scheduling
- ♣ Creating Fault Tolerance architectures
- ♣ DPM: datacenter power management, based on VMotion
- ♣ Converting VM into VM for infrastructure, from physical to VM
- ♣ vApp: are Virtual Application Services
- ♣ Cloning and Moving VM
-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

## Low level features:

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

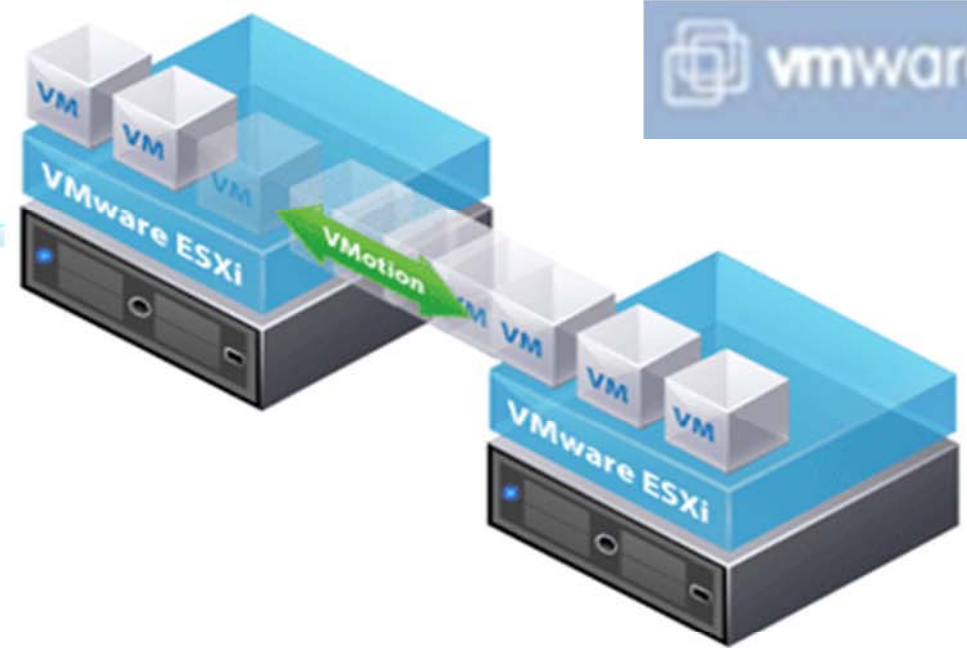


# Summary of VMware vSphere 4.0





# VMotion of VMware vSphere

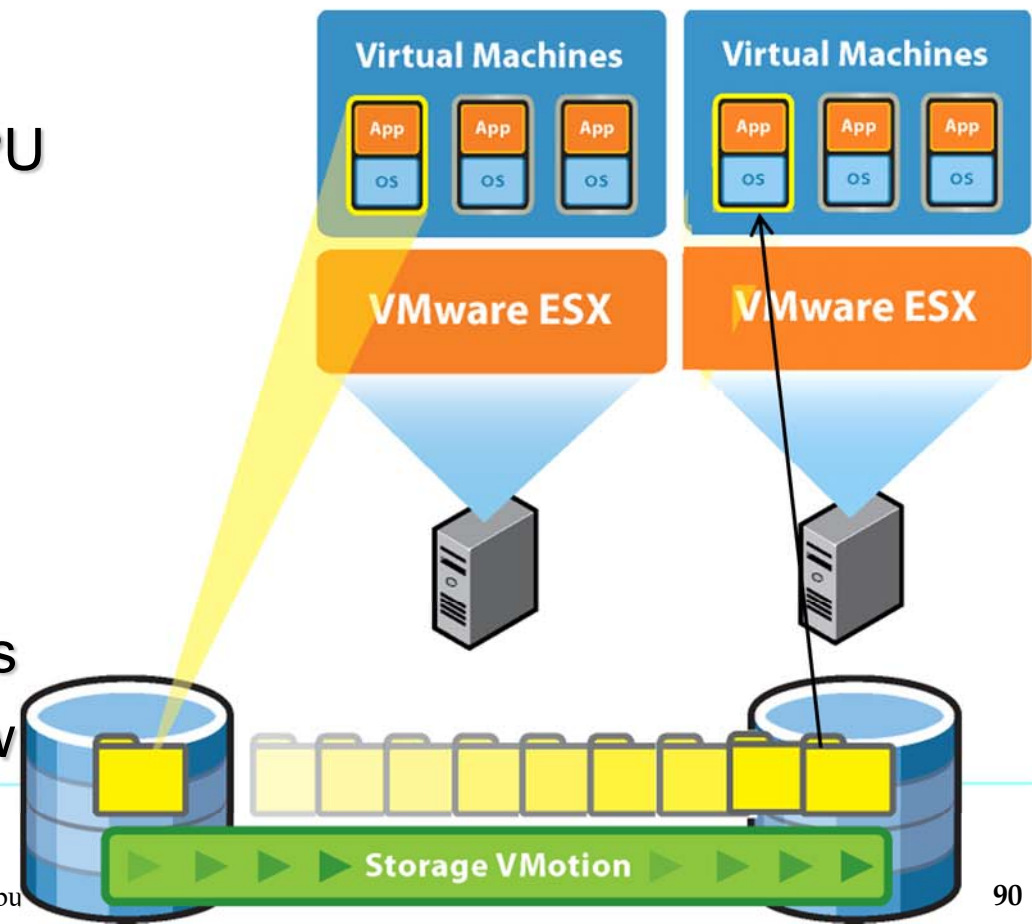


## you need:

- ❁ 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**

## Steps:

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



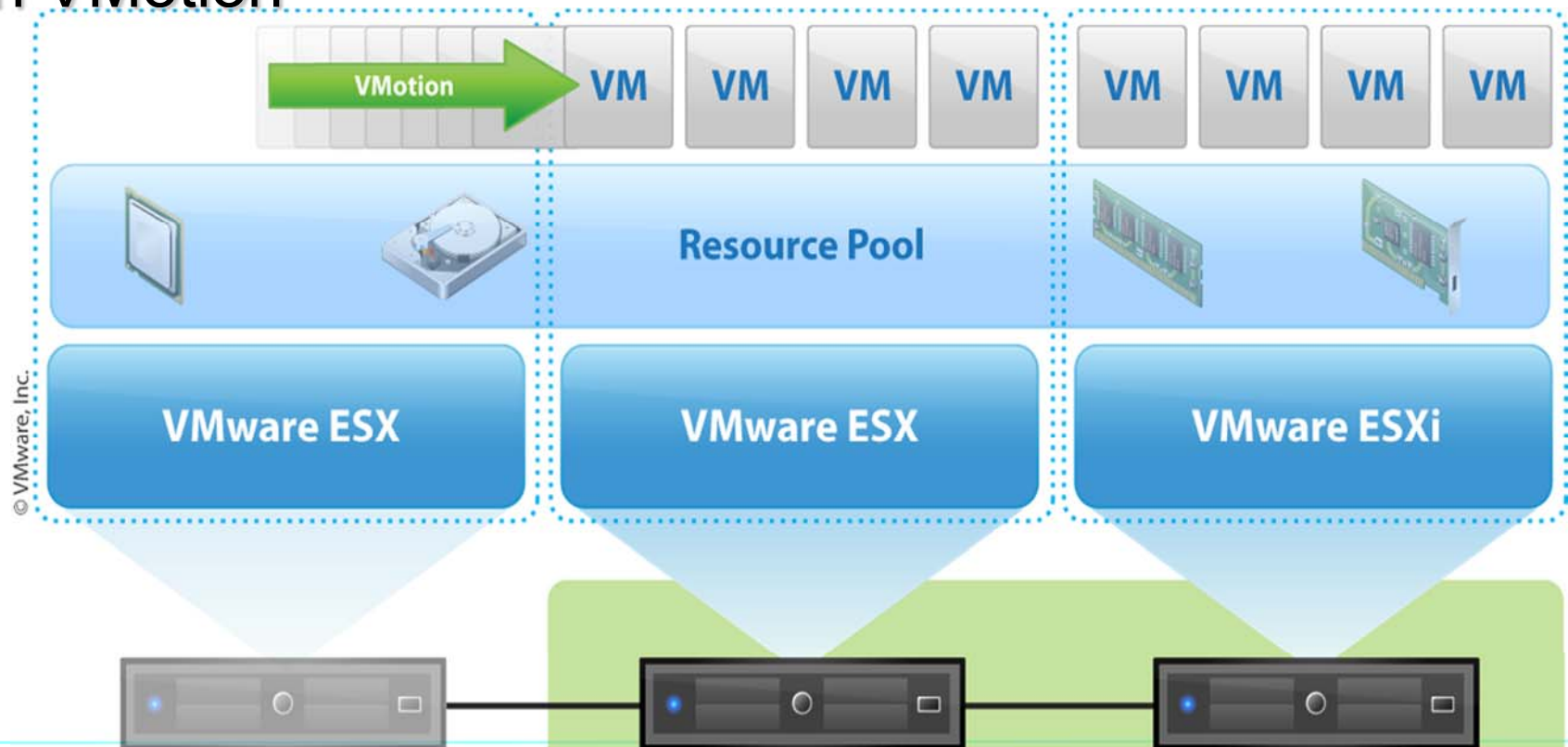


# VMware DPM, Power Management

✓ DPM consolidates workloads to reduce power consumption

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

✓ Based on VMotion

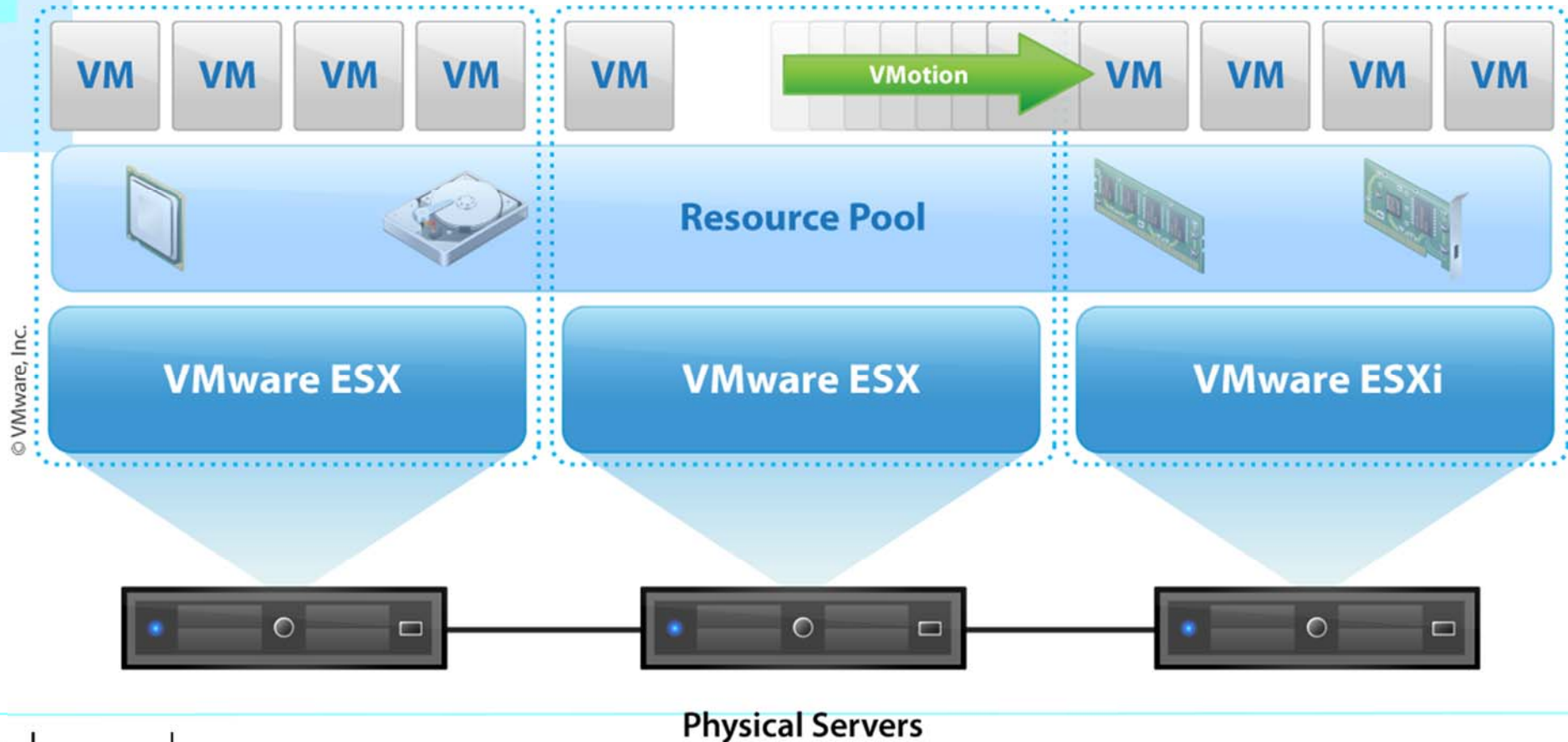






# VMware DRS, Distrib. Res. Scheduling

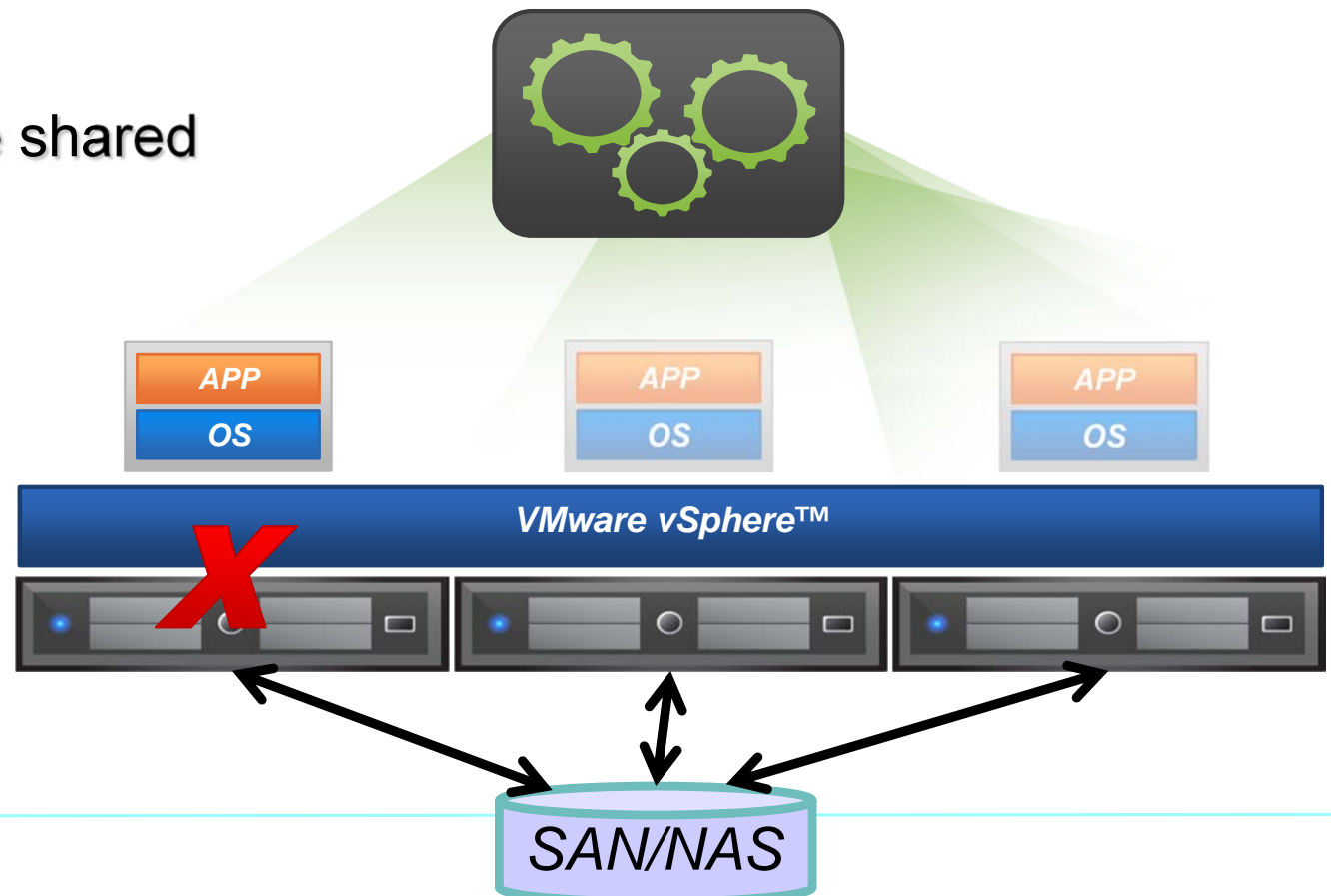
- ✓ DRS is used to balance the workload among Hosts
- ✓ Moving VMs is a tools for balancing the workload on Hosts





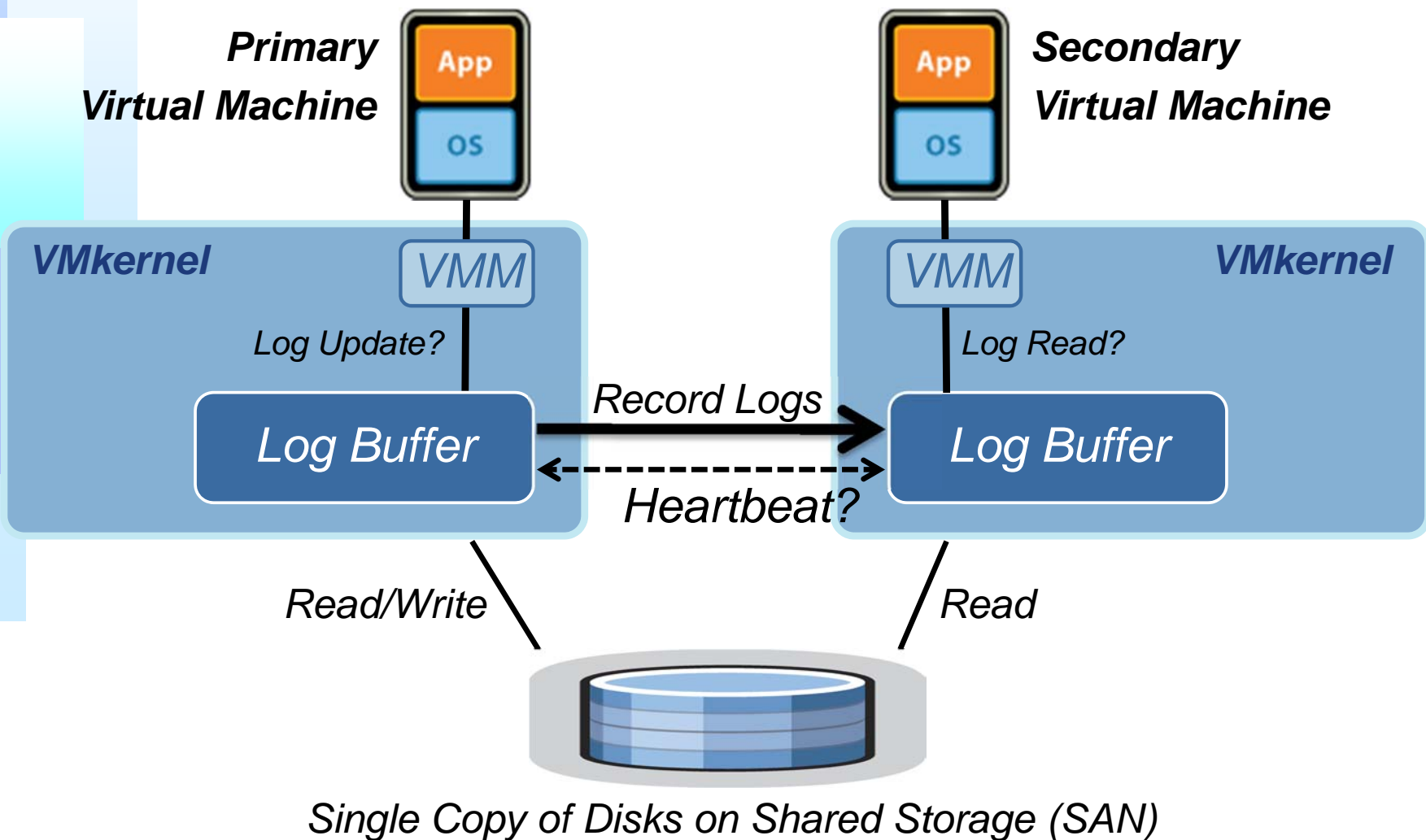
# VMware Fault Tolerance, FT

- ❑ 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

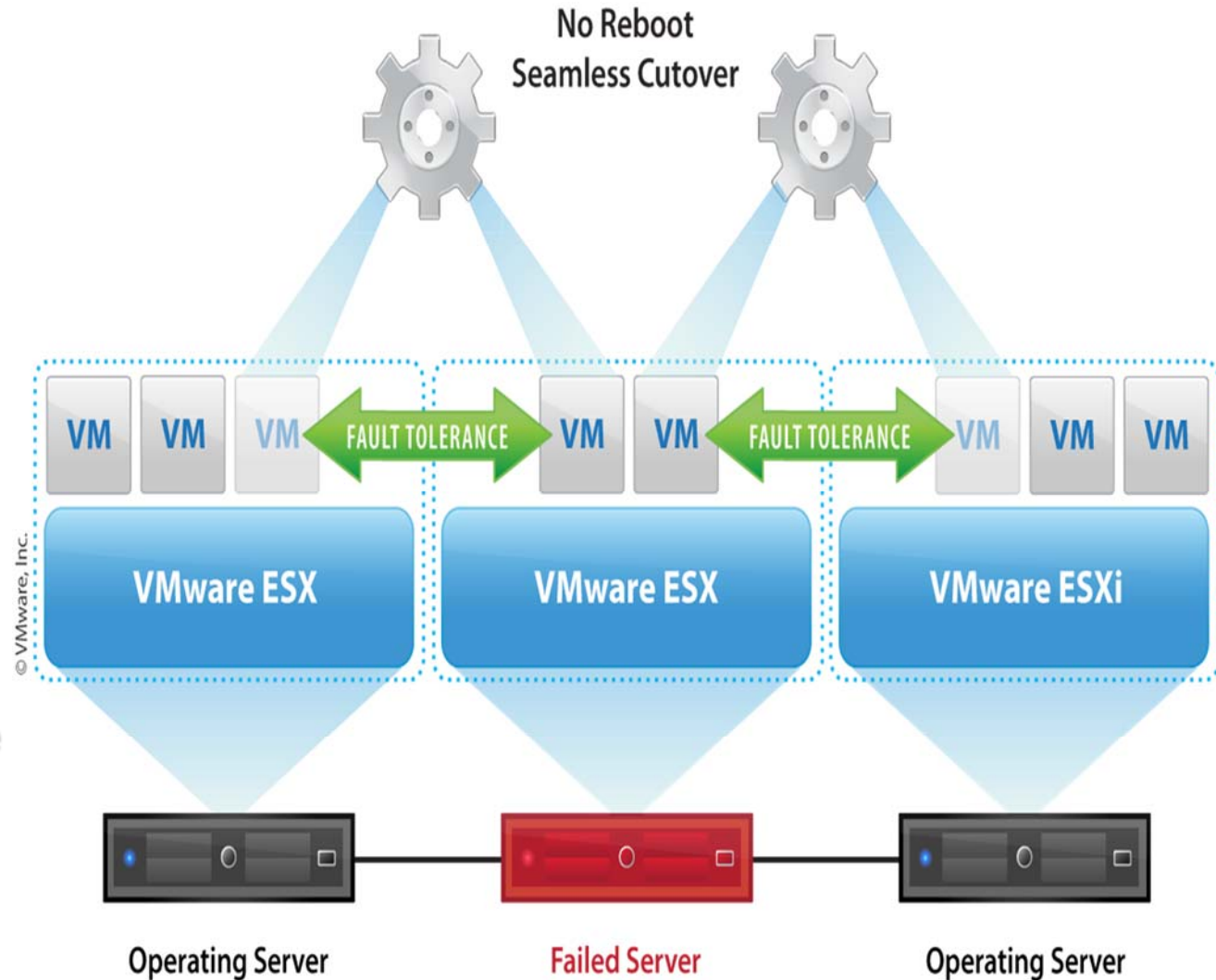


Single Copy of Disks on Shared Storage (SAN)




# 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.





# 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, SaaS Solutions, PaaS Solutions
- ⌈ ICARO project



# Security on the cloud

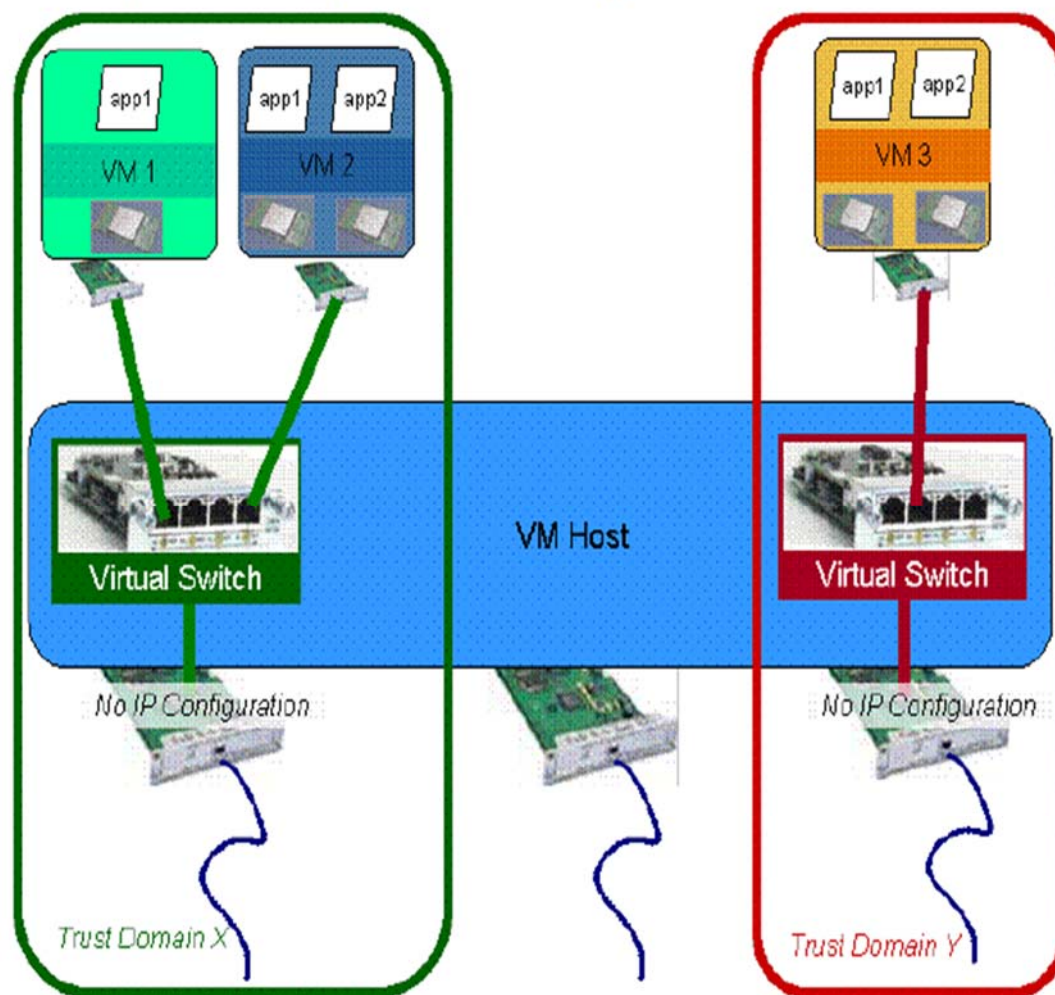
- ⌈ Protecting VMs from external access
- ⌈ Protecting VMs each other in the cloud
- ⌈ Technologies:
  - ♣ Accessing to other VM via dedicated virtual networks, using Virtual Networking, Virtual Switch
  - ♣ Avoiding shared disk, at least using authenticated connections
  - ♣ Using Firewall
  - ♣ Communicating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



# Virtual Networking

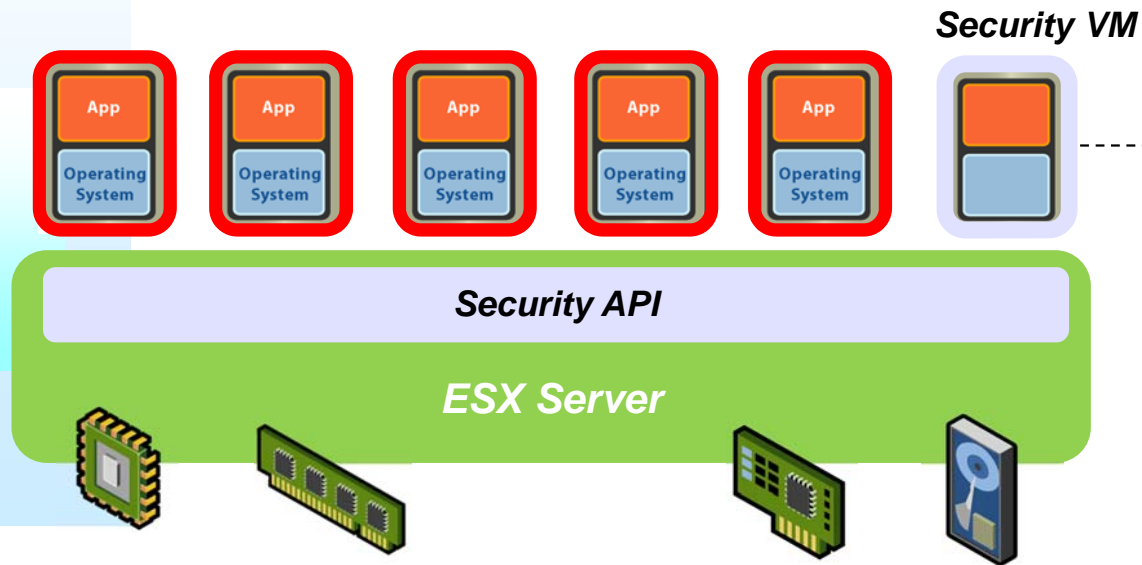
- Per isolare meglio dei guest OS da altri che non sono nello stesso trust domain
- isolare i virtual switch dei singoli trust domain.
- Solo i guest che condividono lo stesso domain hanno schede di rete virtuali sullo stesso virtual switch.
- virtual switch su porte logiche del sistema host che non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

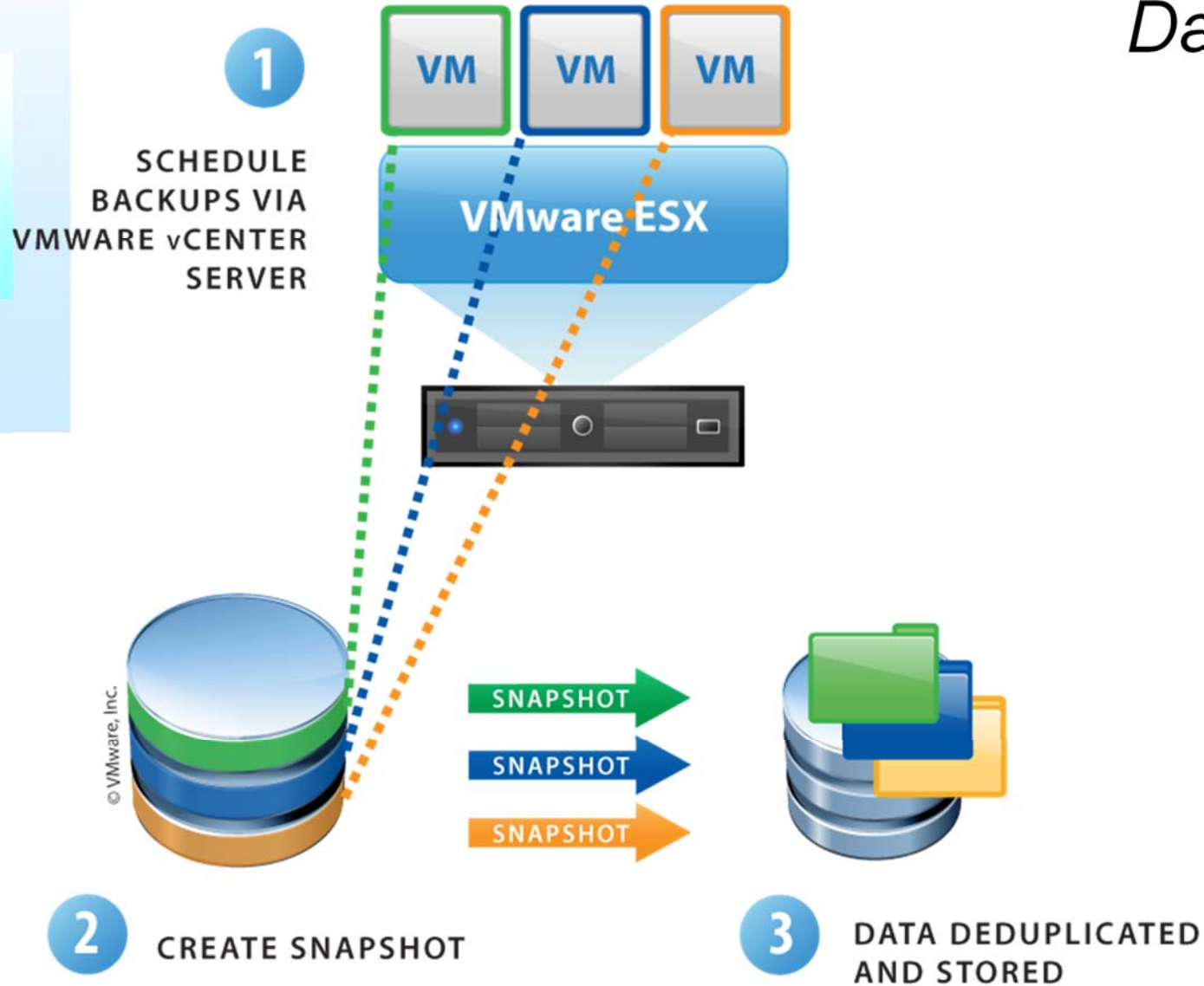




# VMware vSphere

## Data Recovery

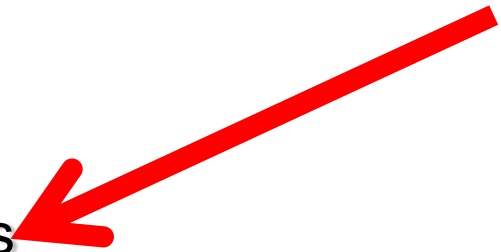
*Backup Only*





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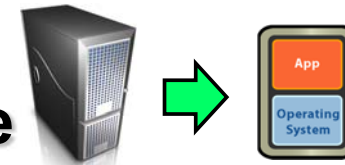




# VM Converter, the migration

## 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

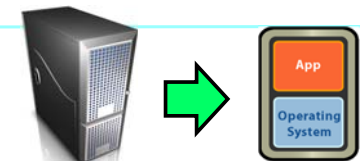
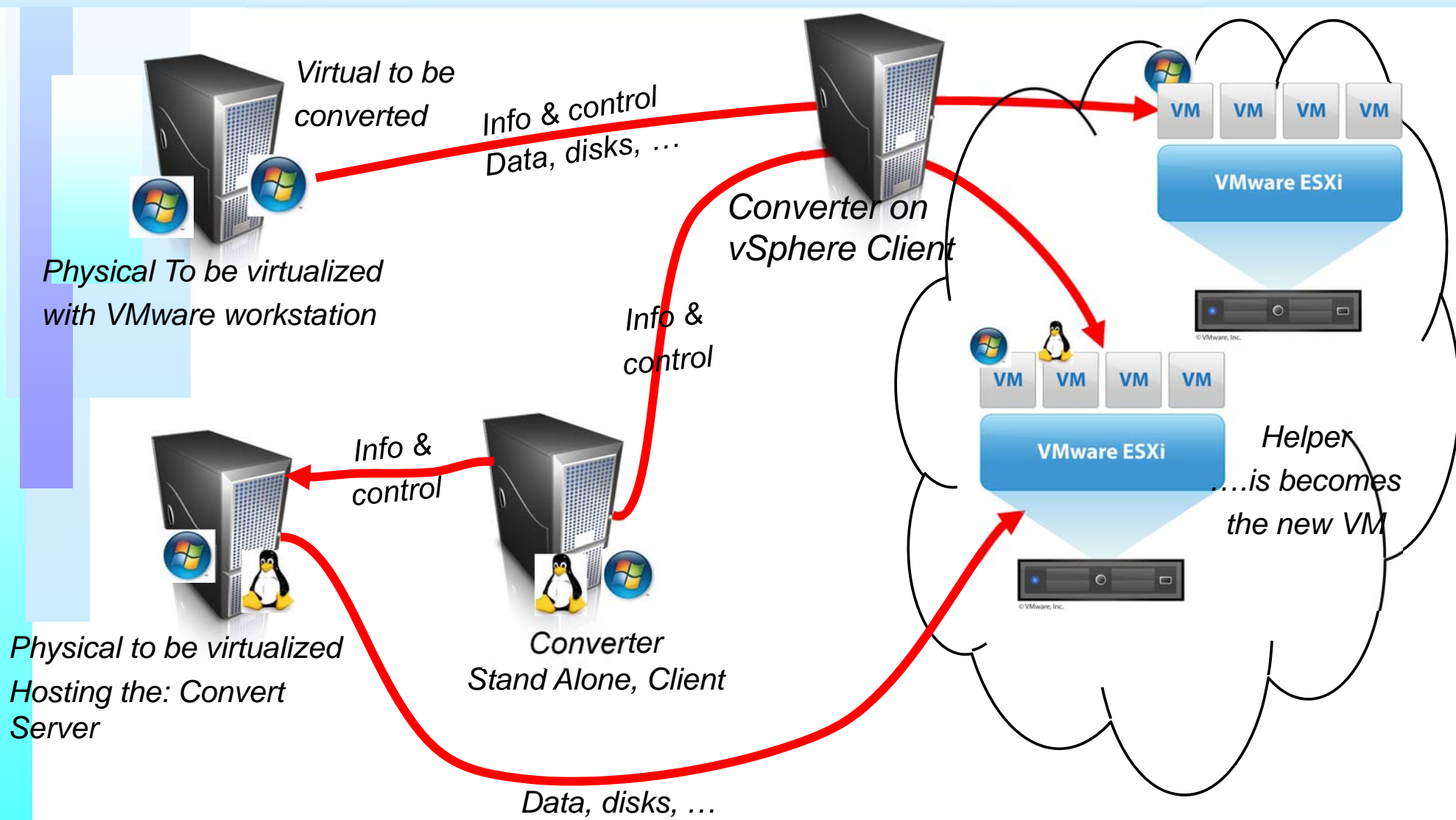
### V2V, from Virtual → to Virtual



- ♣ 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
- ♣ .....

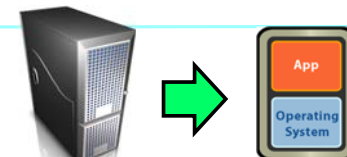
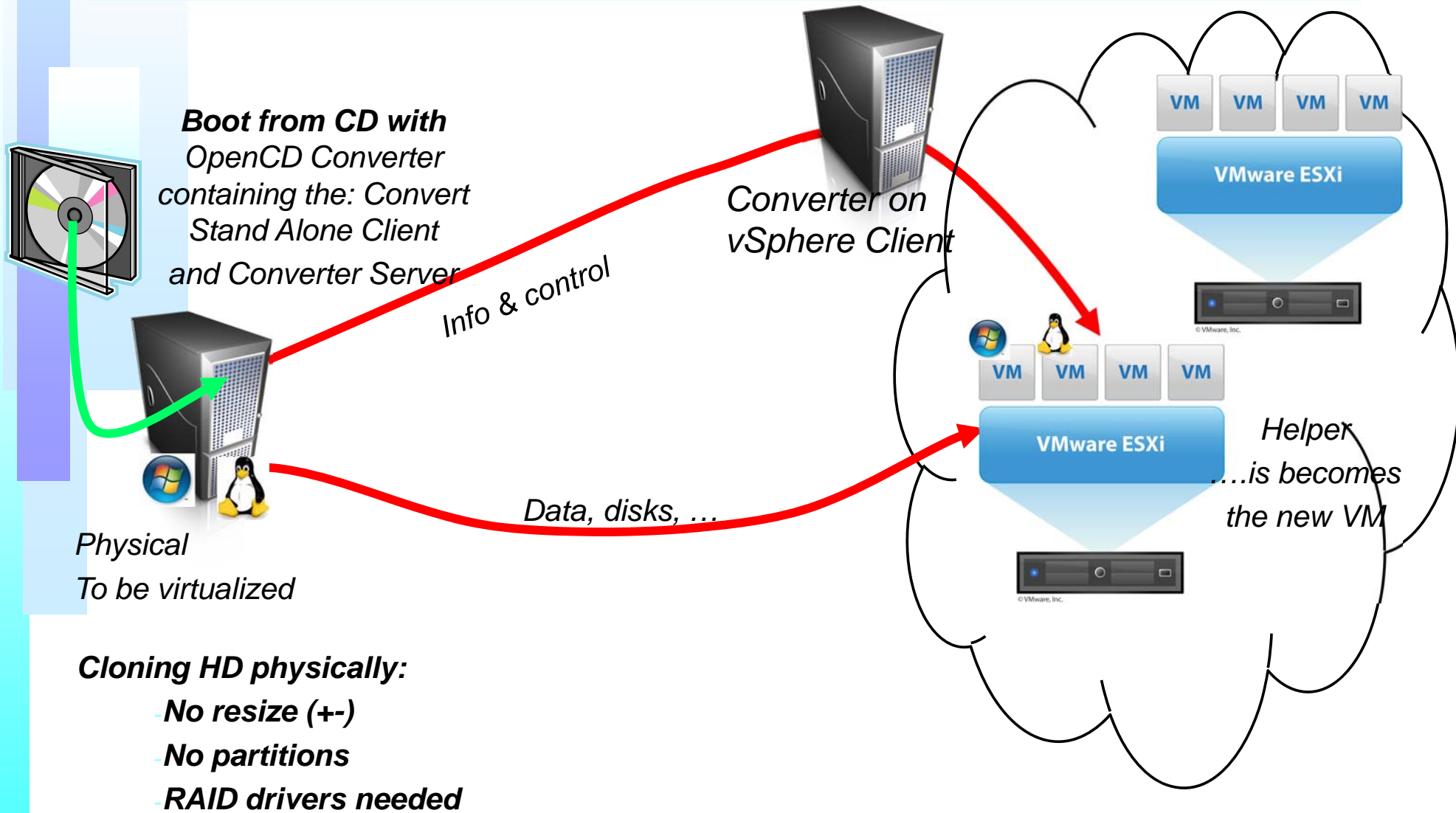


# P2V, vConverter vSphere





# 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

## [ 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.

## [ First step:

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

## [ 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



## Third step:

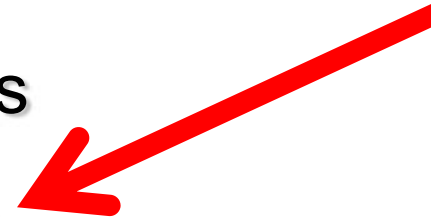
- ♣ Reboot the new machine as Virtual machine
  - ➔ Then install the VMware tools on the VM from the vCenter or from the VMware Workstation hypervisor.
  - ➔ Revise the general config, network, etc.
  - ➔ See if it possible to use paravirtualized drivers instead of physical drivers.
- ♣ If the converted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

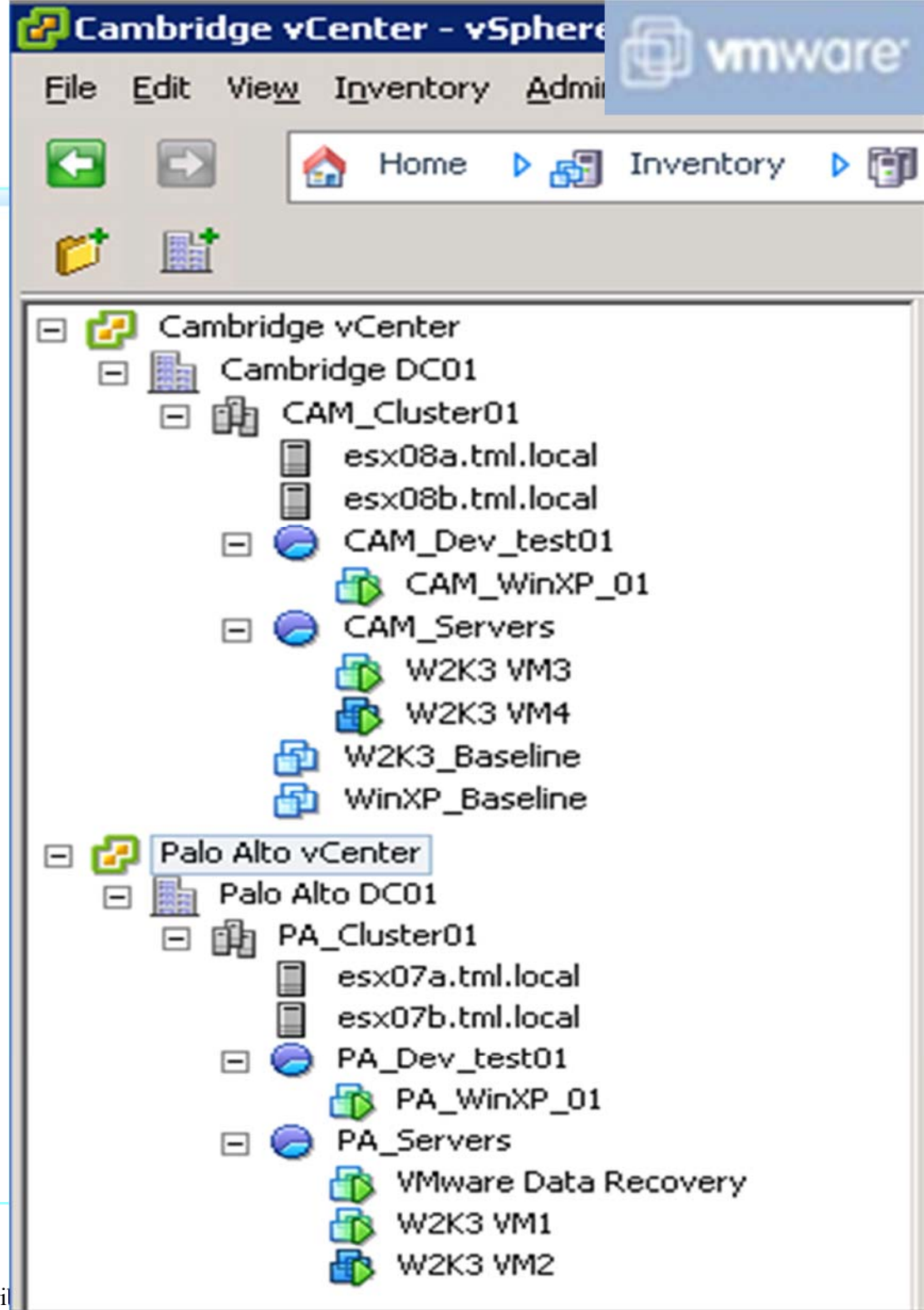
➔ VM3

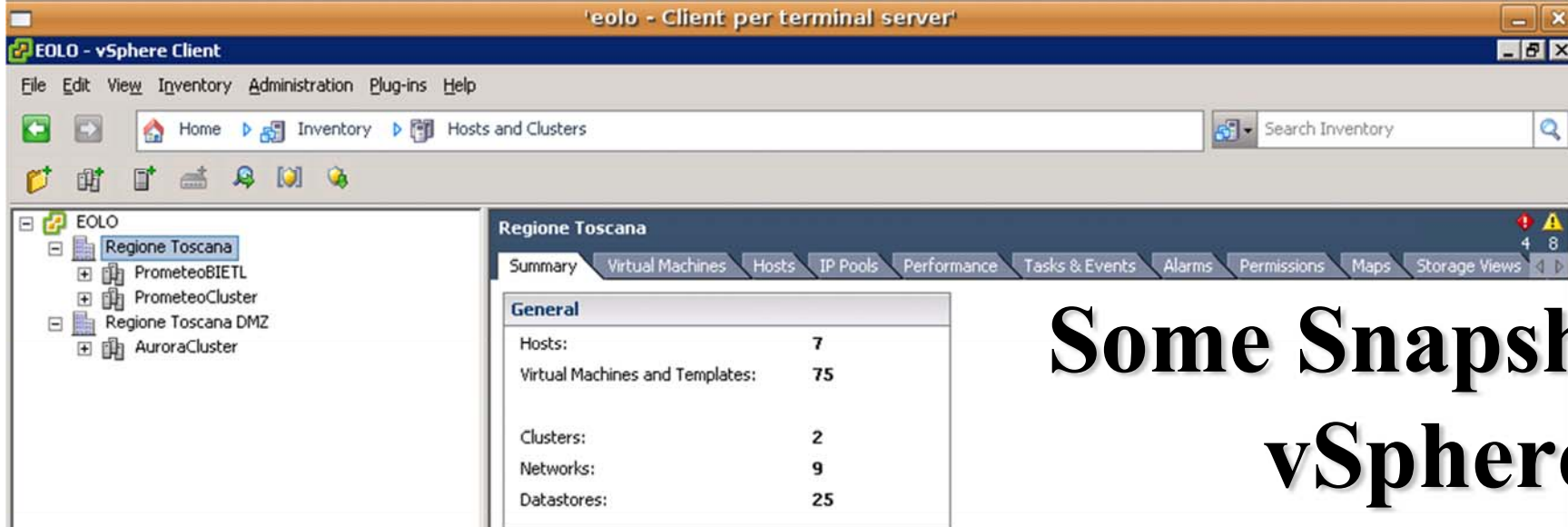
➔ VM4

♣ Cluster01

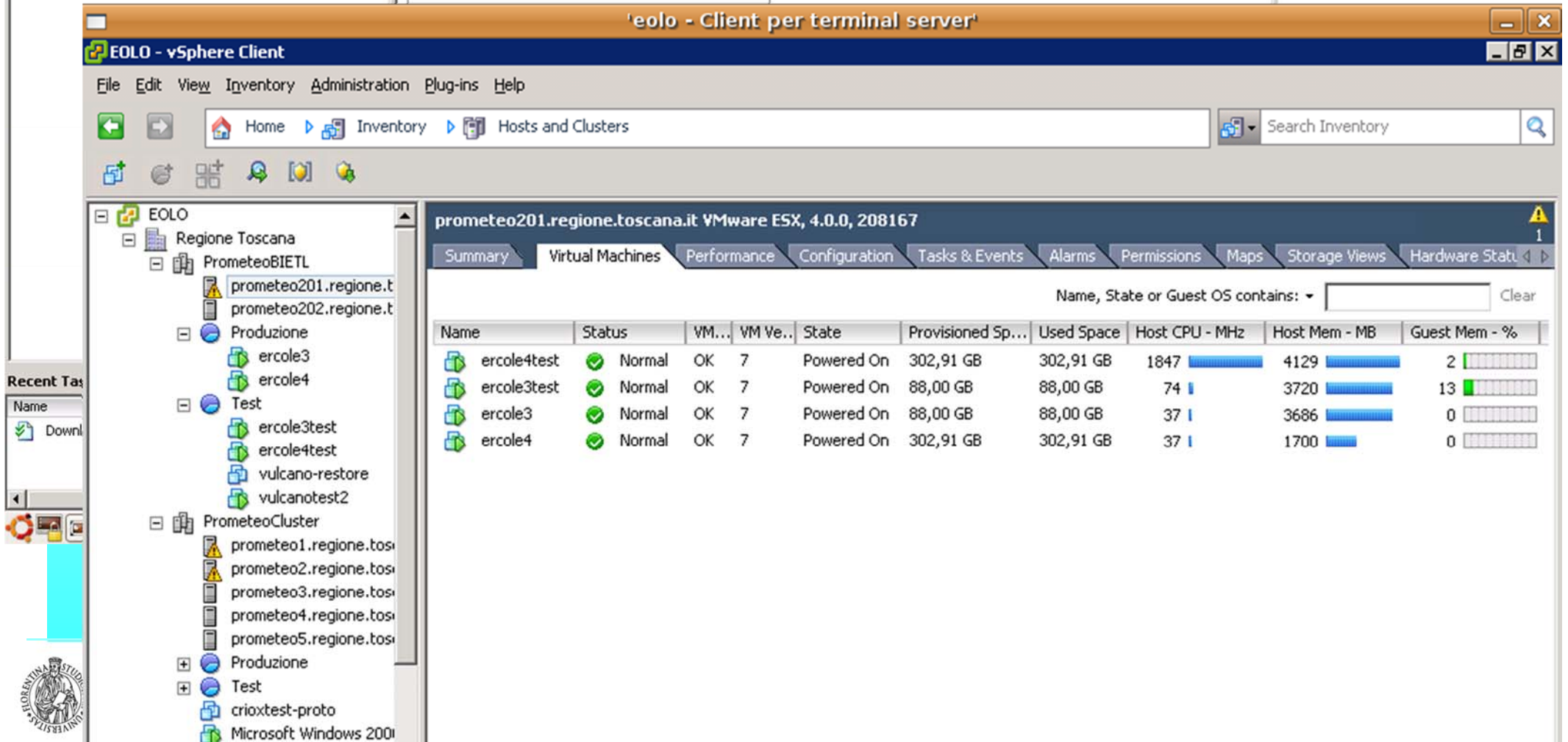
➔ H2..

➔ ...





# Some Snapshots of vSphere





# 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
- Datstore**
- SCSI Volume (LUN)
- NAS Mount
- SCSI Adapter
- SCSI Target (Array Port)

Update View

Zoom

Virtual Machines Performance Configuration Tasks & Events Alarms Permissions Maps Storage View

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

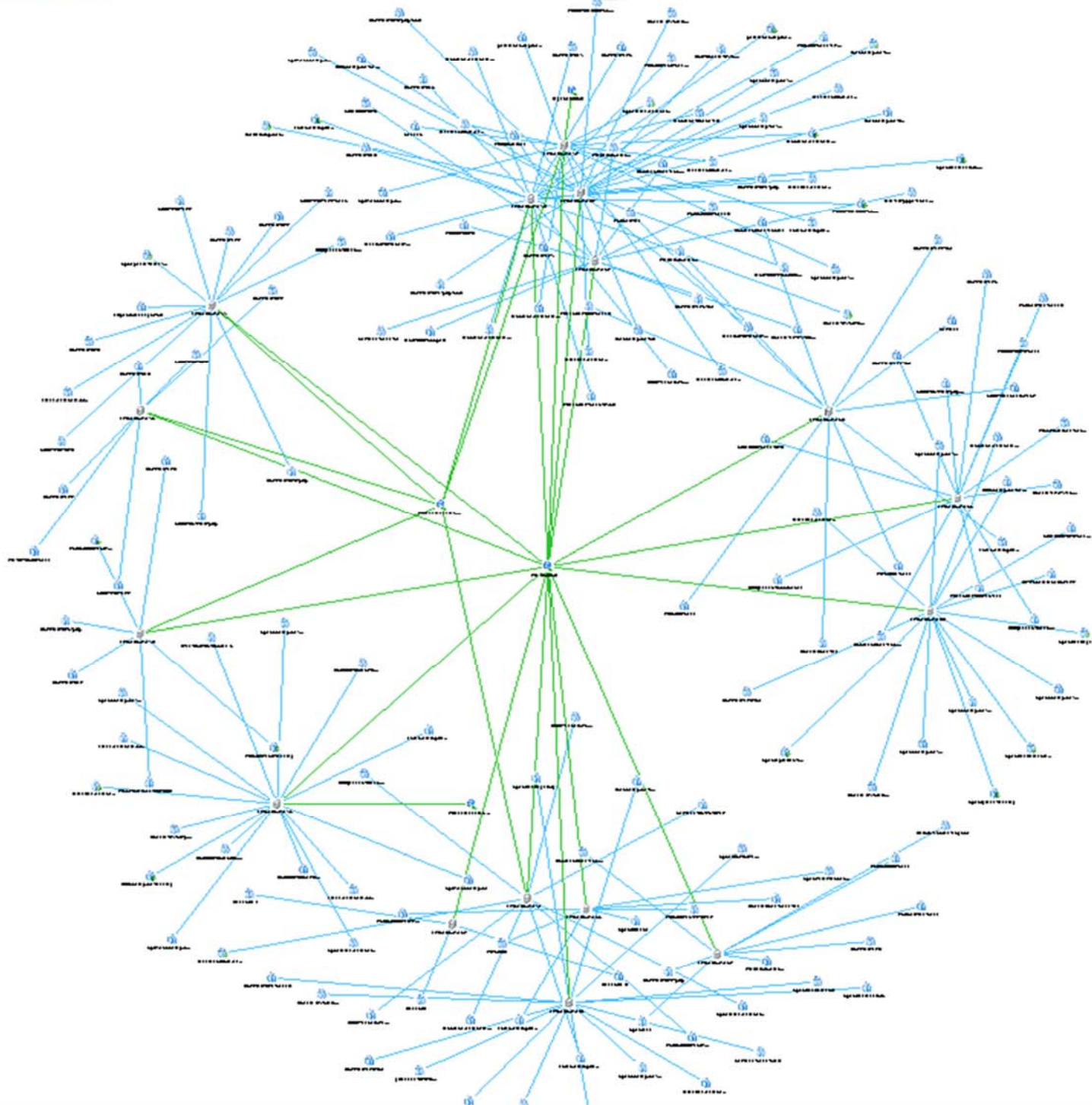
Show all Virtual Machines VM or Multipathing Status contains:

| VM                                   | Multipathing Status   | Space Used | Snapshot Space |
|--------------------------------------|-----------------------|------------|----------------|
| <a href="#">Train01_WindowsXP_01</a> | Partial/No Redundancy | 1.94 GB    | 0.00 B         |
| <a href="#">VM2-XP</a>               | Partial/No Redundancy | 3.38 GB    | 0.00 B         |
| <a href="#">VM4-RHEL5</a>            | Partial/No Redundancy | 8.10 MB    | 0.00 B         |
| <a href="#">VM2-W2K3</a>             | Partial/No Redundancy | 4.50 GB    | 256.07 MB      |
| <a href="#">W2K3 Template</a>        | Partial/No Redundancy | 4.00 GB    | 0.00 B         |
| <a href="#">XP Template</a>          | 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

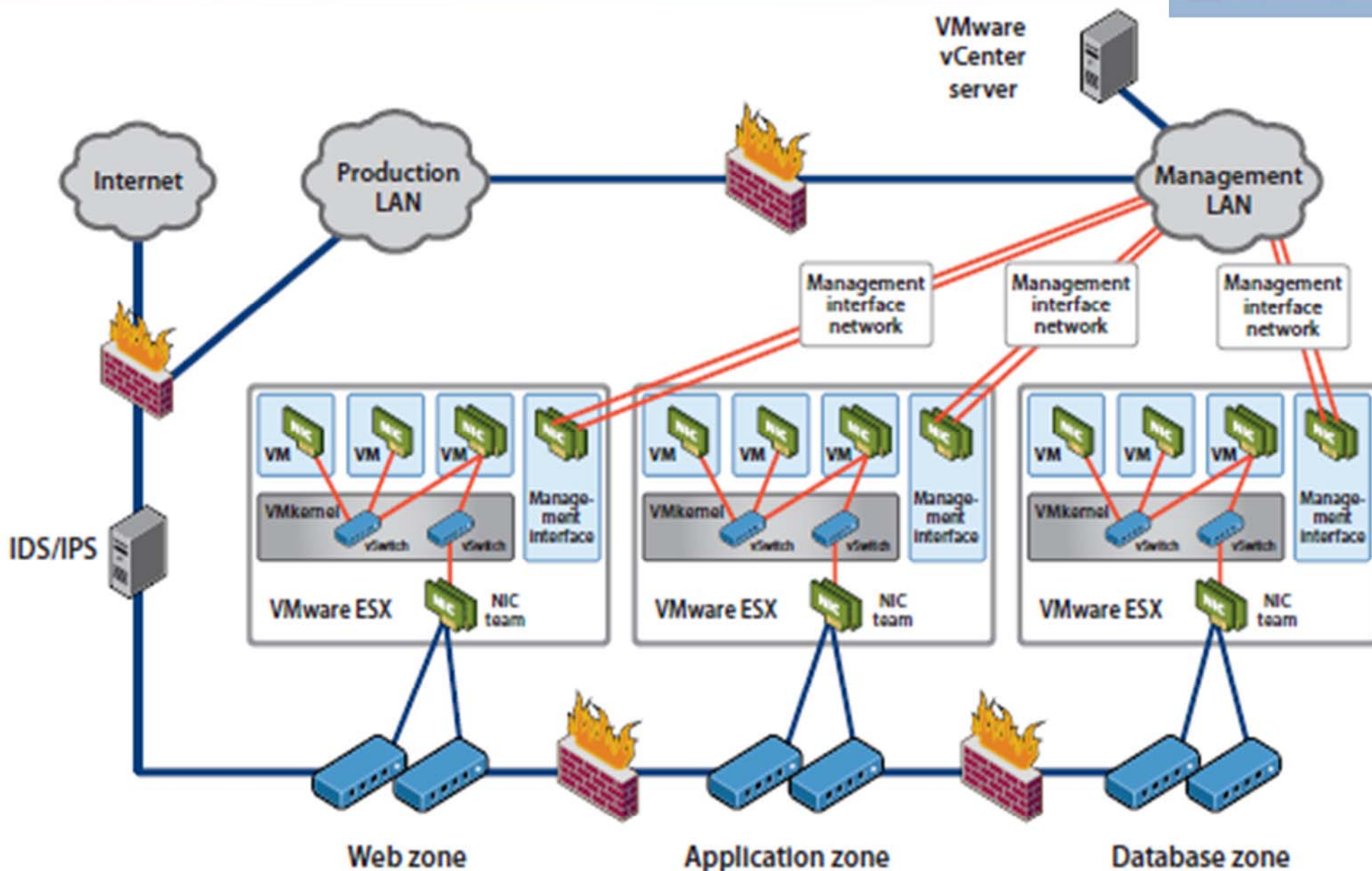


Figure 2 — Partially collapsed with separate physical trust zones



# 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 - Client per terminal server'

EOL - 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.toscan... prometeo2.regione.toscan... prometeo3.regione.toscan... prometeo4.regione.toscan... prometeo5.regione.toscan... Produzione Test criotest-proto Microsoft Windows 200... Microsoft Windows 200... nereide2test ubuntu-dsk Regione Toscana DMZ AuroraCluster aurora.regione.toscan... aurora1.regione.toscar... Produzione Test baccotest\_bk cassiopea3test cassiopeatest cerbero?

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

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

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          |

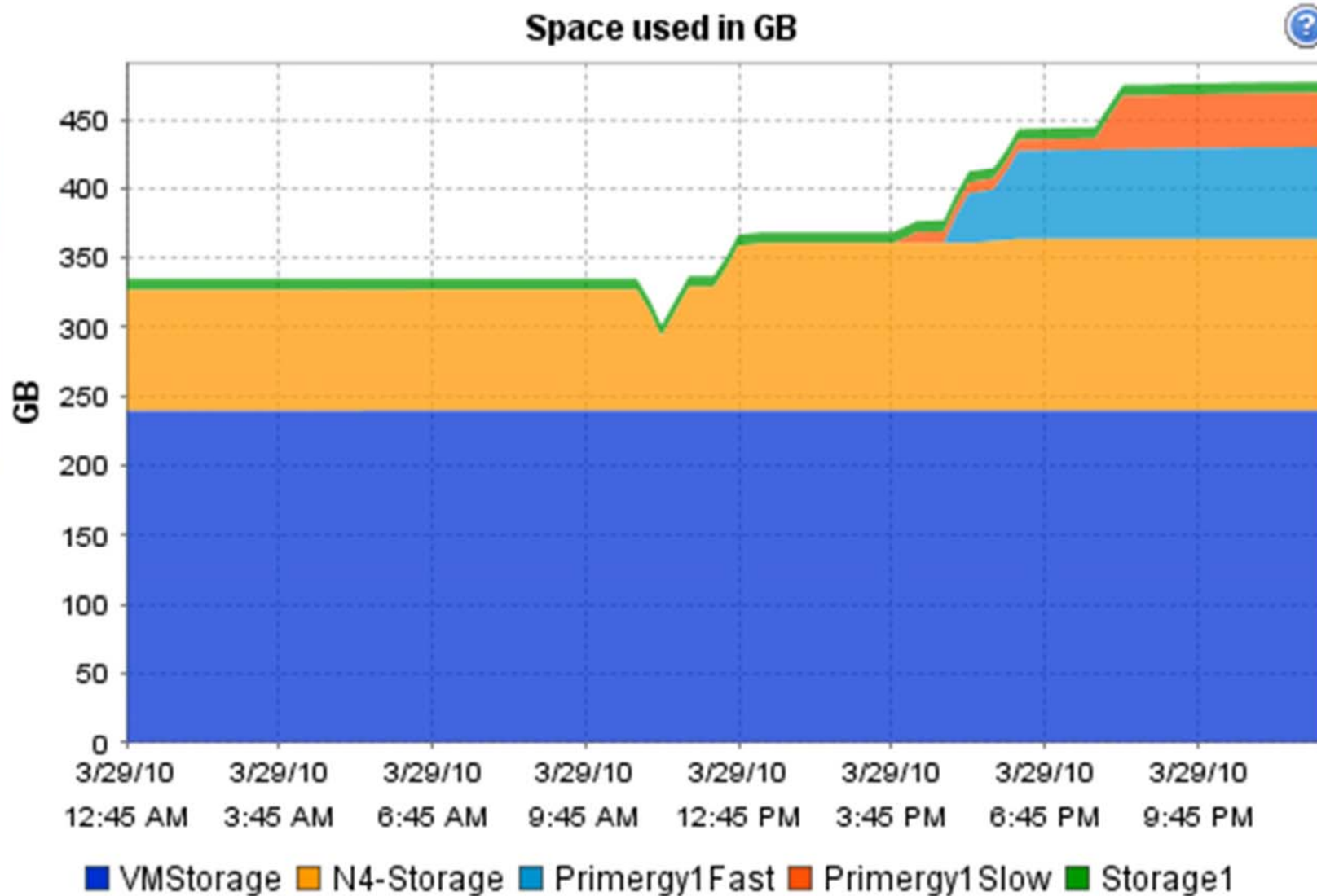
vmware

Recent Tasks

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



# Datacenter space consumed again time





# Performance Analysis, Single VM

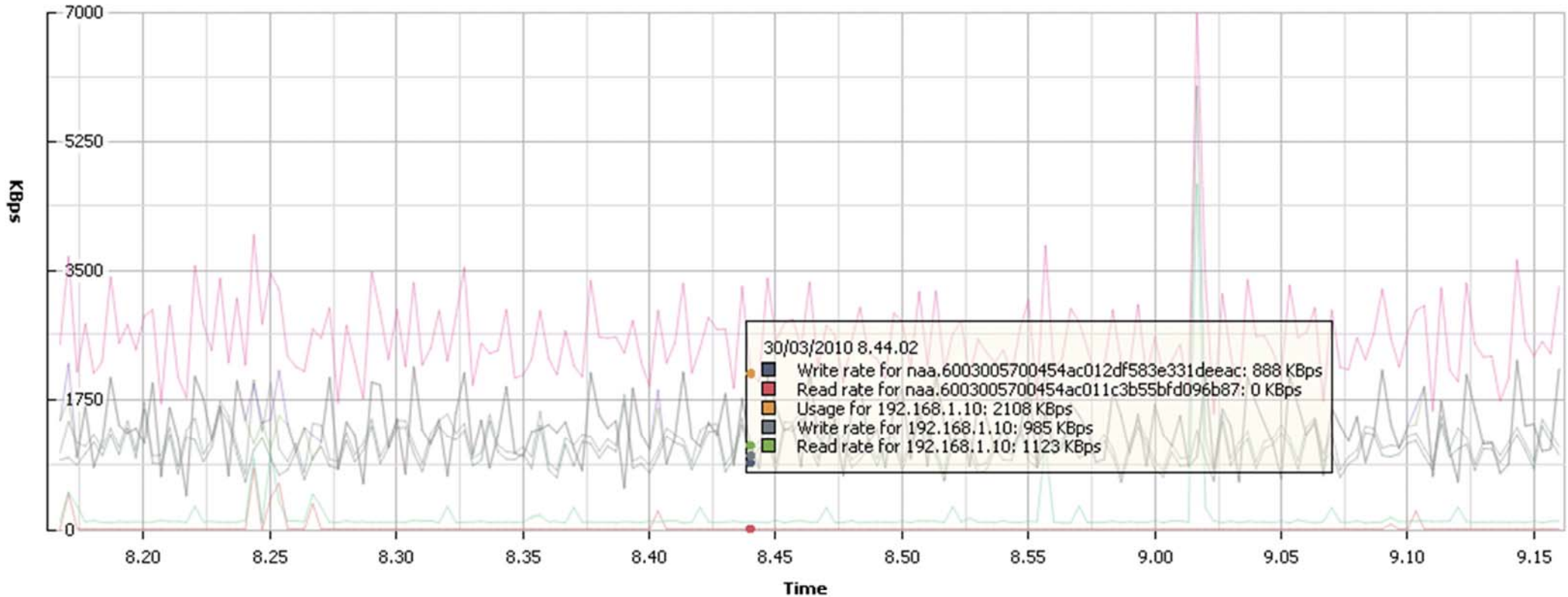
Getting Started Summary Virtual Machines Resource Allocation **Performance** Configuration Tasks & Events Alarms Permissions Maps Storage Views Hardware Status

Overview **Advanced**

Disk/Real-time, 30/03/2010 8.16.12 - 30/03/2010 9.16.12 [Chart Options...](#)

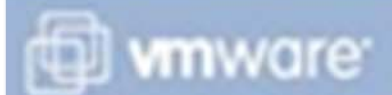
Graph refreshes every 20 seconds

Switch to:



## 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 |



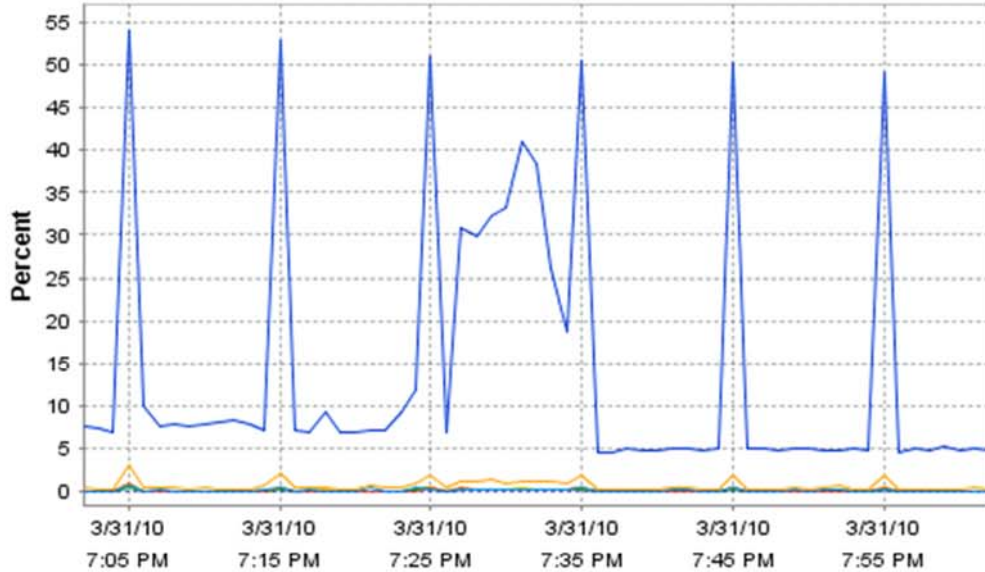


# Performance Analysis, Single VM



Realtime Summary for dpnet.axmedis.org

### CPU (%)



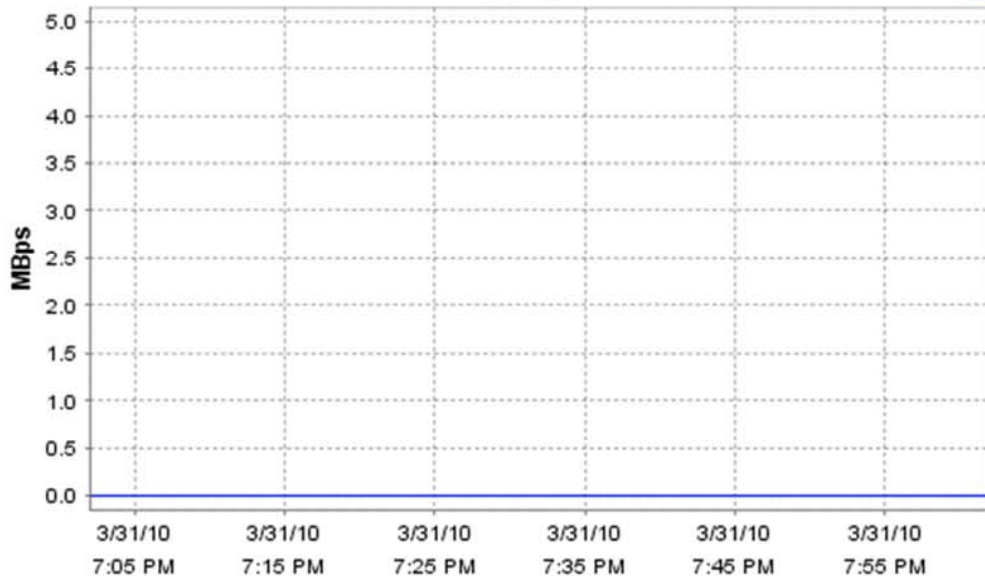
■ Usage ■ Ready ■ Ready for 0 ■ Ready for 1 ■ Ready for 2 ■ Ready for 3

### Memory (MB)



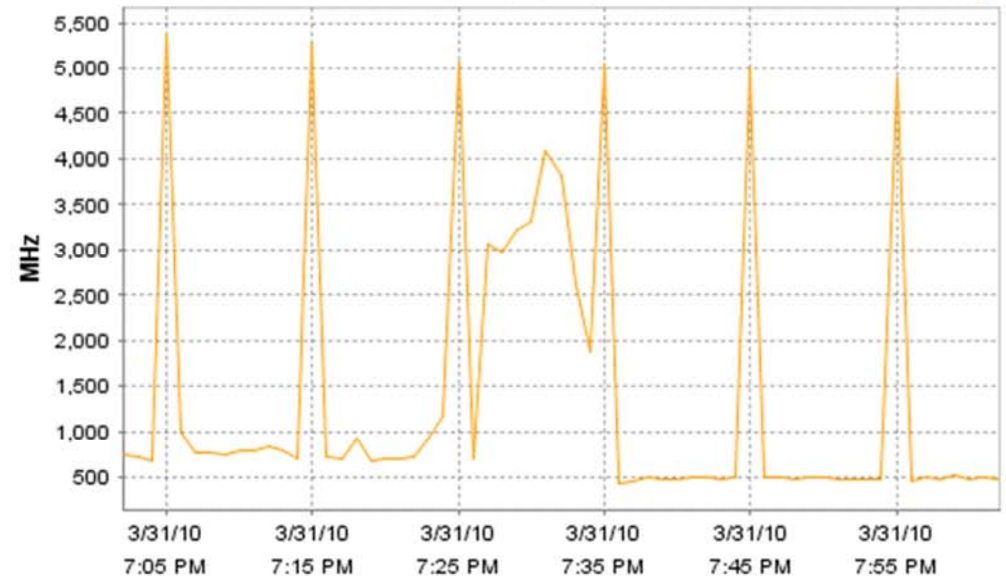
■ Balloon target ■ Swapped ■ Shared ■ Balloon ■ Active

### Memory (MBps)



■ Swap in rate ■ Swap out rate

### CPU Usage (MHz)



■ Usage in MHz



# Performance Analysis, Single VM

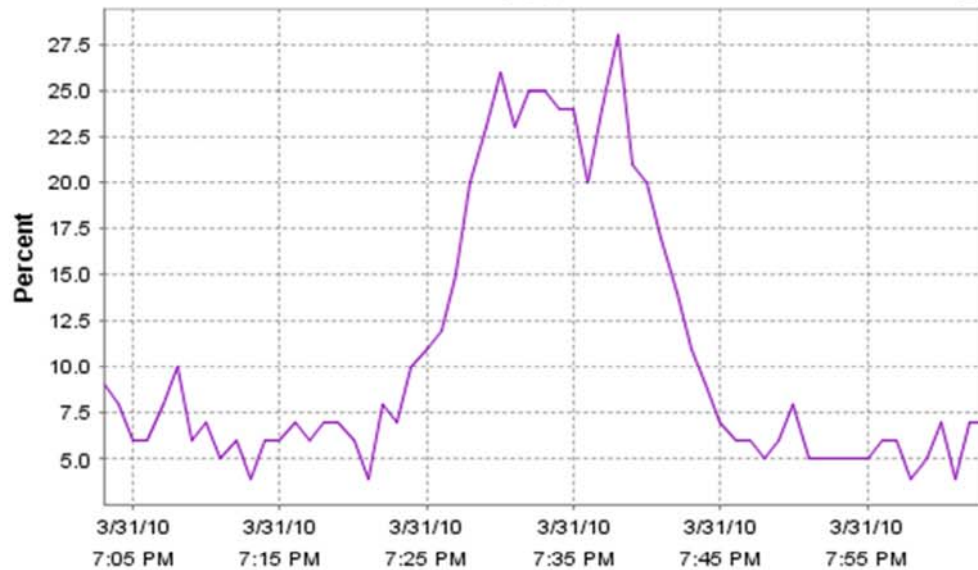
Getting Started Summary Resource Allocation Performance Tasks & Events Alarms Console Permissions Maps Storage Views



Overview Advanced

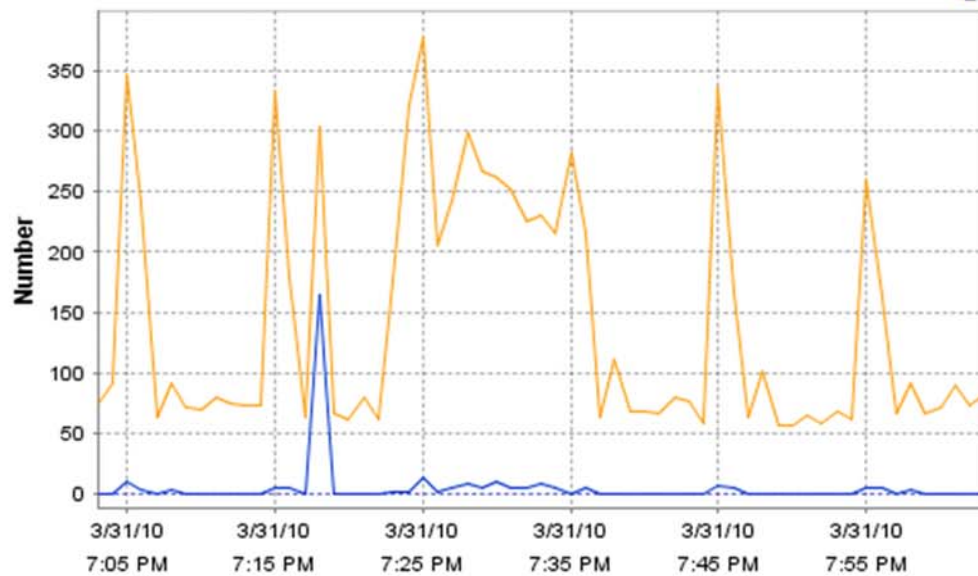
Swap in rate Swap out rate

### Memory (%)



Usage

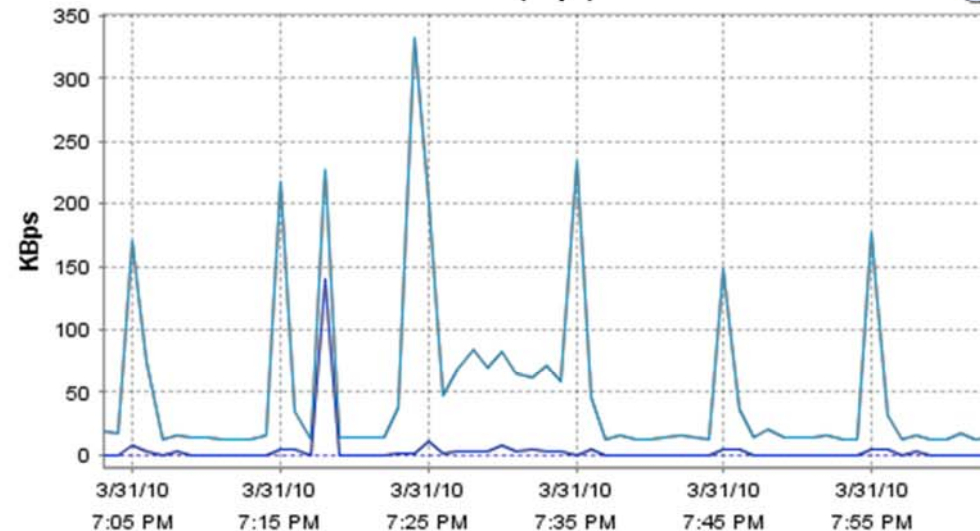
### Disk Requests (Number)



Read Write

Usage in MHz

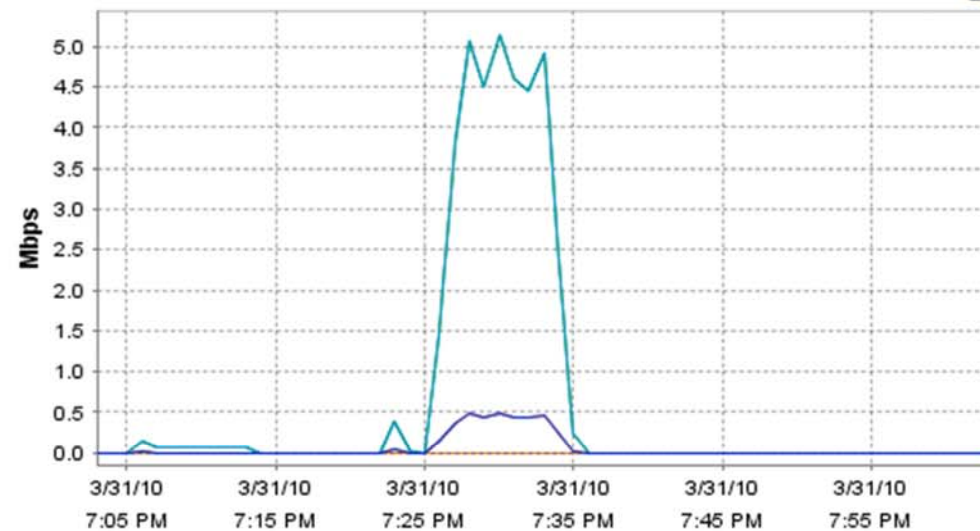
### Disk Rate (KBps)



Read Read for naa.6003005700454ac012df583e331deeac Write

Write for naa.6003005700454ac012df583e331deeac

### Network Rate (Mbps)



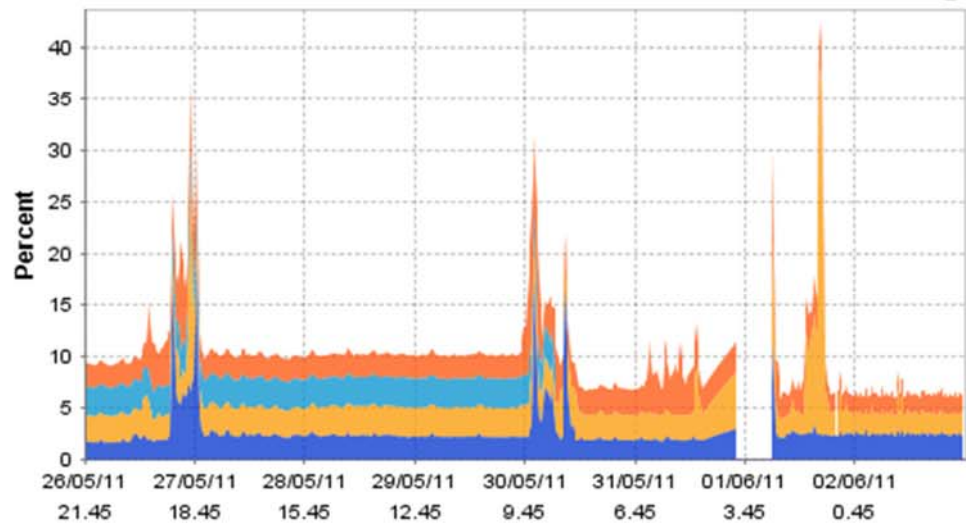
Transmitted for 4000 Transmitted for 4001 Received Transmitted

Received for 4000 Received for 4001



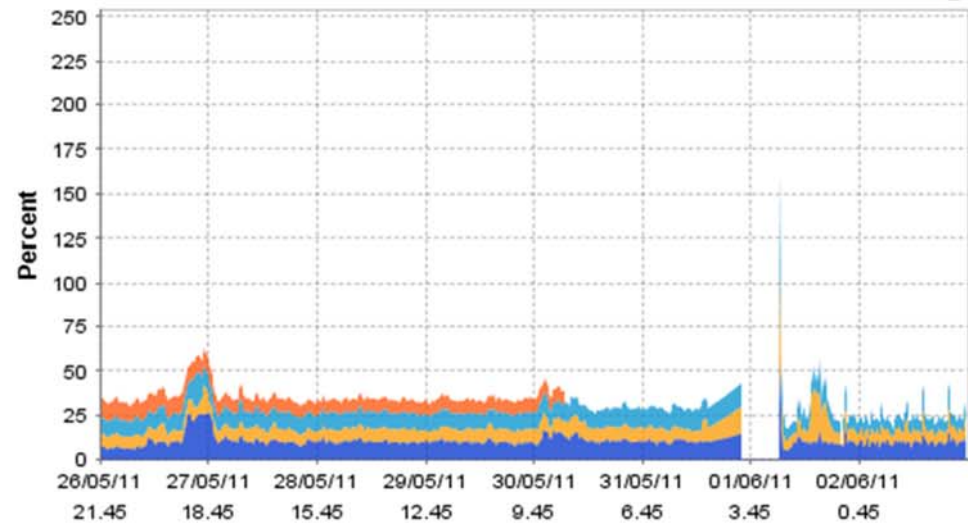
# Performance Analysis of VM on the Host

CPU Usage (Top 10)



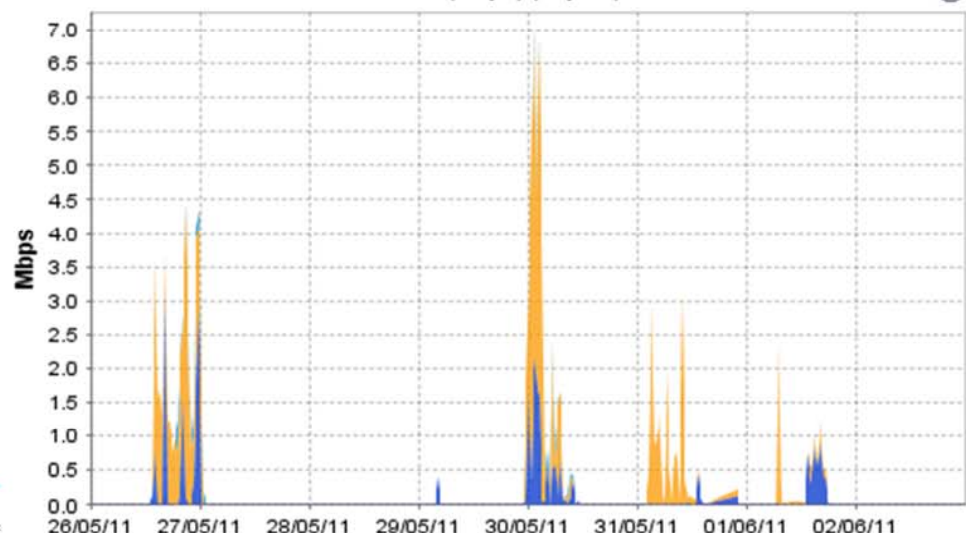
■ testinterop.eclap.eu-running ■ test.eclap.eu-running ■ test.eclap.eu-old  
■ bpnetmardaniele-2-running

Memory Usage (Top 10)



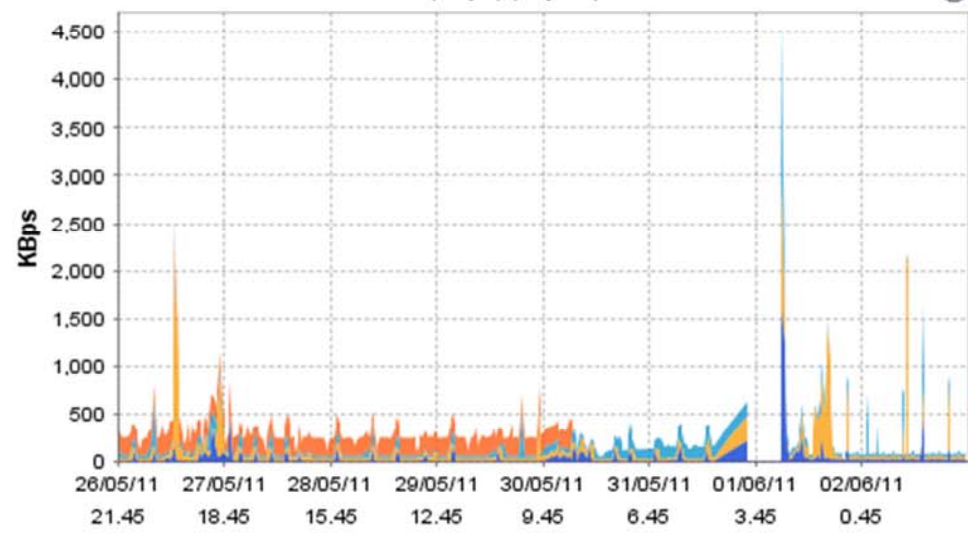
■ testinterop.eclap.eu-running ■ test.eclap.eu-running ■ bpnetmardaniele-2-running  
■ test.eclap.eu-old

Network (Mbps) (Top 10)



■ test.eclap.eu-running ■ bpnetmardaniele-2-running ■ testinterop.eclap.eu-running

Disk (KBps) (Top 10)



■ testinterop.eclap.eu-running ■ test.eclap.eu-running ■ bpnetmardaniele-2-running  
■ test.eclap.eu-old



# Problematiche del Monitoraggio

- [-] 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



# Monitorare perche'

## 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
- ♣ Shutdown di emergenza
- ♣ Network off/on
- ♣ Cambio di billing in base alla SLA
- ♣ Etc. etc.





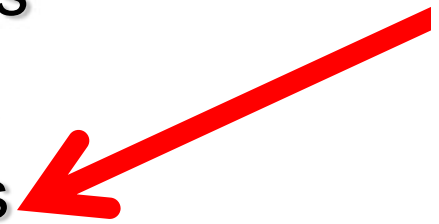
# Confronto fra sistemi di monitoring

| Requisiti  | Nagios (core)                                      | Ganglia (core)       | Zenoss (core)     | Zabbix 2.2.0                               | Hyperic HQ 4.6.6          |
|--|--|----------------------|-------------------|--|---------------------------|
| <b>PaaS/SaaS</b>                                 |  |                      |                   |  |                           |
| 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                         |
| <b>IaaS</b>                                      |  |                      |                   |  |                           |
| Monitoraggio Host (Low level Metrics)            | X  | X                    | X                 | X  | X                         |
| Monitoraggio Hypervisor (Low level Metrics)      | X  | X (+)                | X(^)              | X(\$?)                                     | X(°)                      |
| Agent per Hypervisor                             | X  | X (+)                | X(^)              | X(\$\$)                                    | X(°)                      |
| <b>Notifiche</b>                                 |  |                      |                   |  |                           |
| Eventi e notifica allarmi                        | X  | X                    | X                 | X  | X                         |
| <b>High Level Metrics</b>                        |  |                      |                   |  |                           |
| Definizione HLM                                  | X (**)   | X (+++)              | X(^)              | X(\$)                                      | X(°)                      |
| Calcolo HLM                                      | X (**)   | X (+++)              | X(^)              | X(\$)                                      | X(°)                      |
| Storage HLM                                      | X (**)   | X (+++)              | X(^)              | X  | X(°)                      |
| <b>Interoperabilità</b>                          |  |                      |                   |  |                           |
| SDK /API accesso dati                            | X  | X                    | X                 | X  | X                         |
| Plugin   | X  | X                    | X                 | X(\$)                                      | X                         |
| <b>Integrazione</b>                              |  |                      |                   |  |                           |
| Linguaggio                                       | C/CGI  | C, Perl, PHP, Python | Python under Zope | PHP,                                       | Java/C                    |
| DB Data Storage                                  | MySQL<br>(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                         |



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# 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](http://www.ctistrategy.com))

| Aspect                         | VMware vSphere 4  | Microsoft Hyper-V R2   |
|--------------------------------|---|--|
| Hosts                          |   |  |
| CPUs 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, SAN, NAS, iSCSI   | Direct, SAN, 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 | 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    |



| Aspect                                   | VMware vSphere 4  | Microsoft Hyper-V R2  |
|--|---|---|
| <b>Features</b>                          |   |   |
| 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

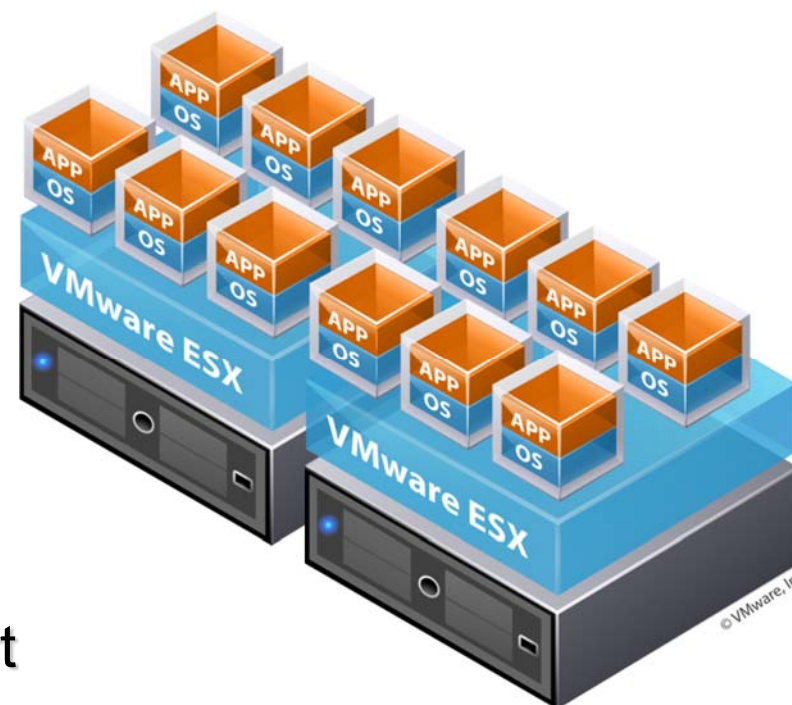
- ♣ MS Windows Remote Desktop
- ♣ X Terminal to linux

## Remote Solutions:

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

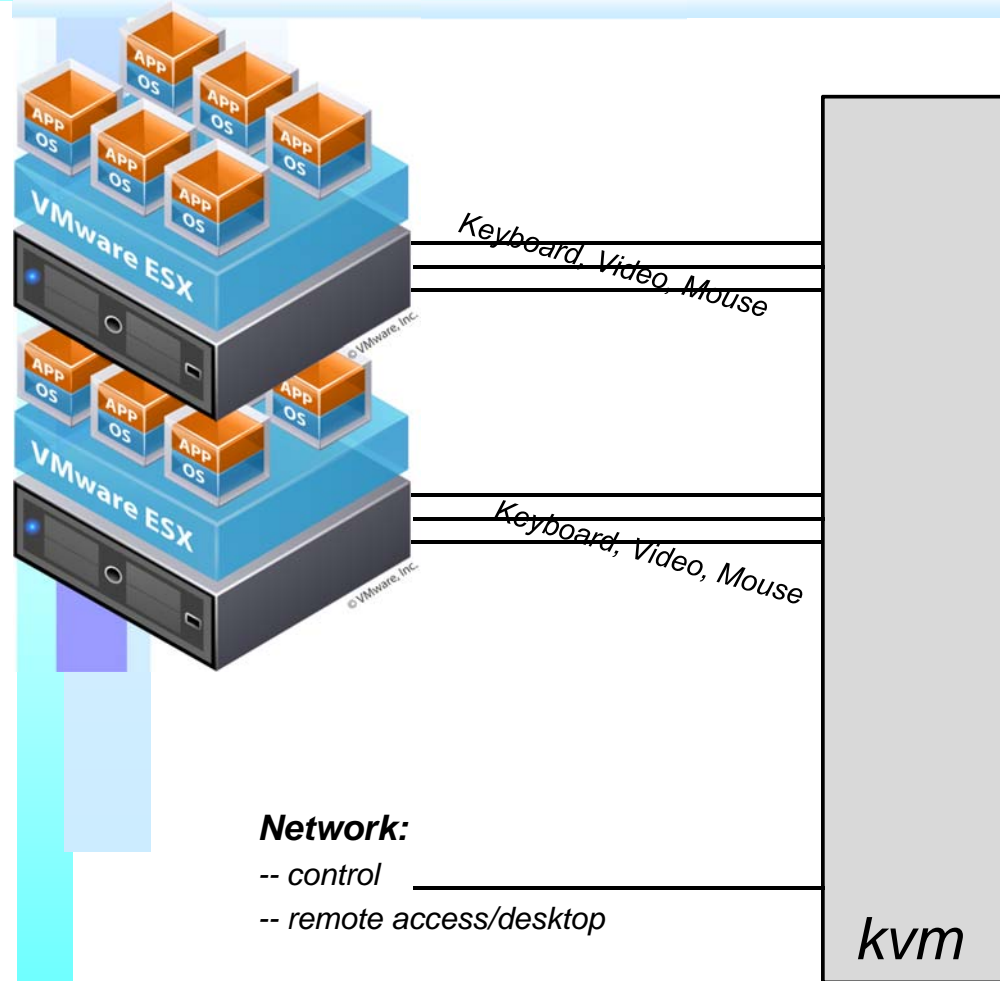
## Telnet, char based consol, SSH

VT100 terminal for example



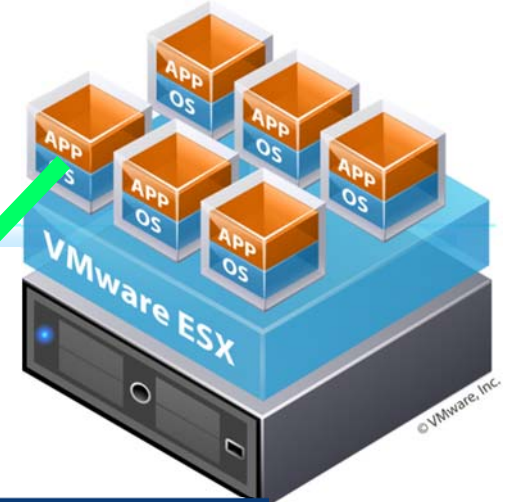


# KVM

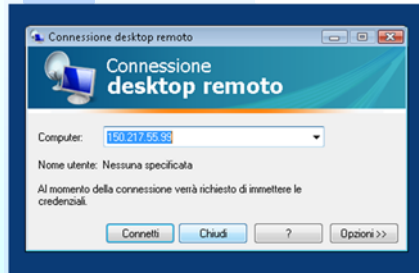




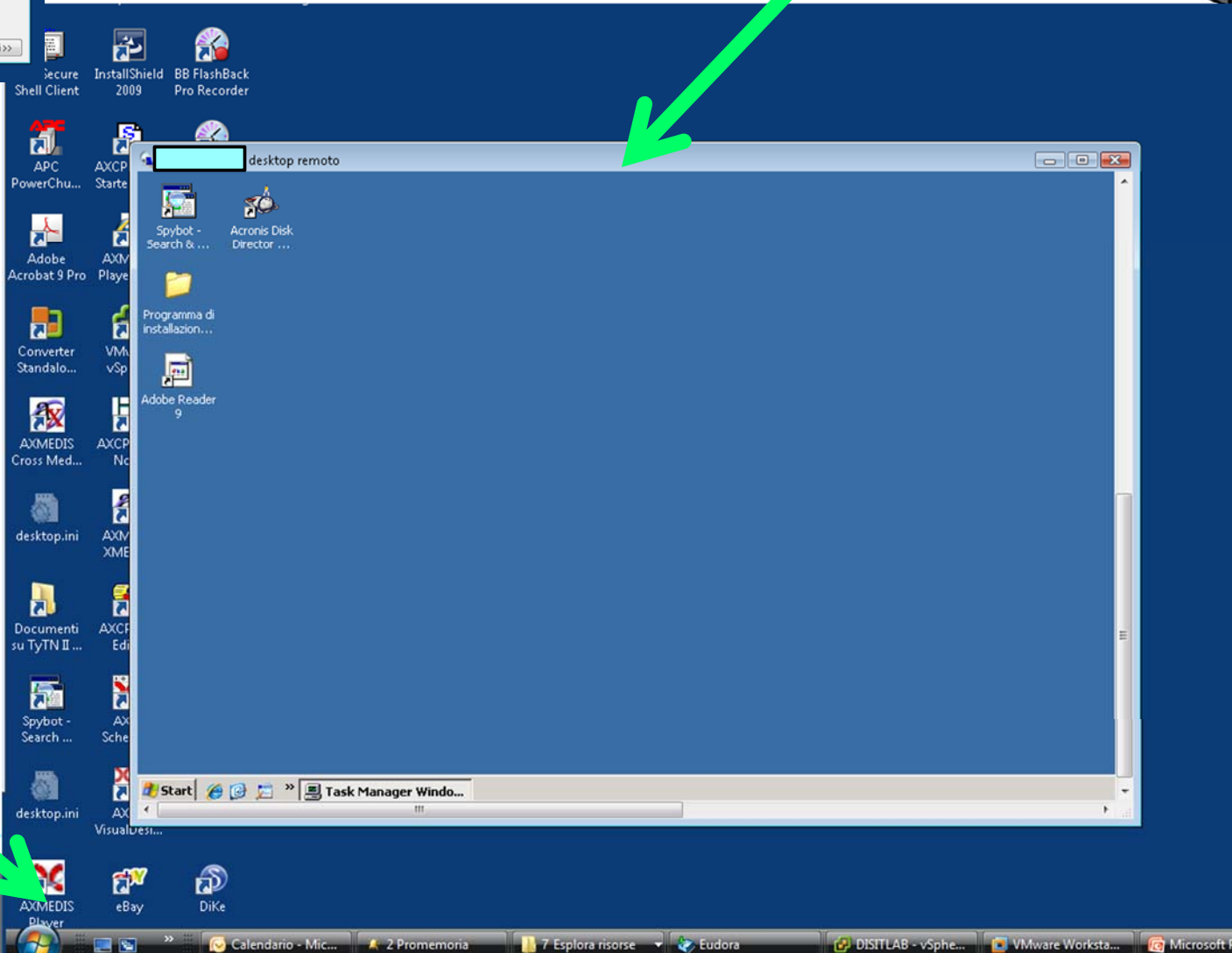
# Windows Remote Desktop



Remote machine  
Windows 2003



Local machine  
Windows Vista



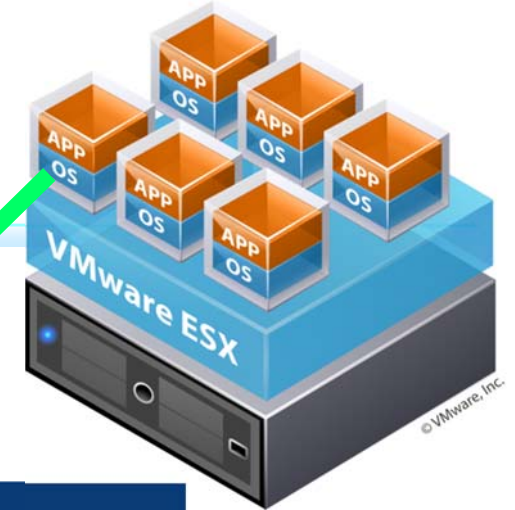
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DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE






# VNC remote connection

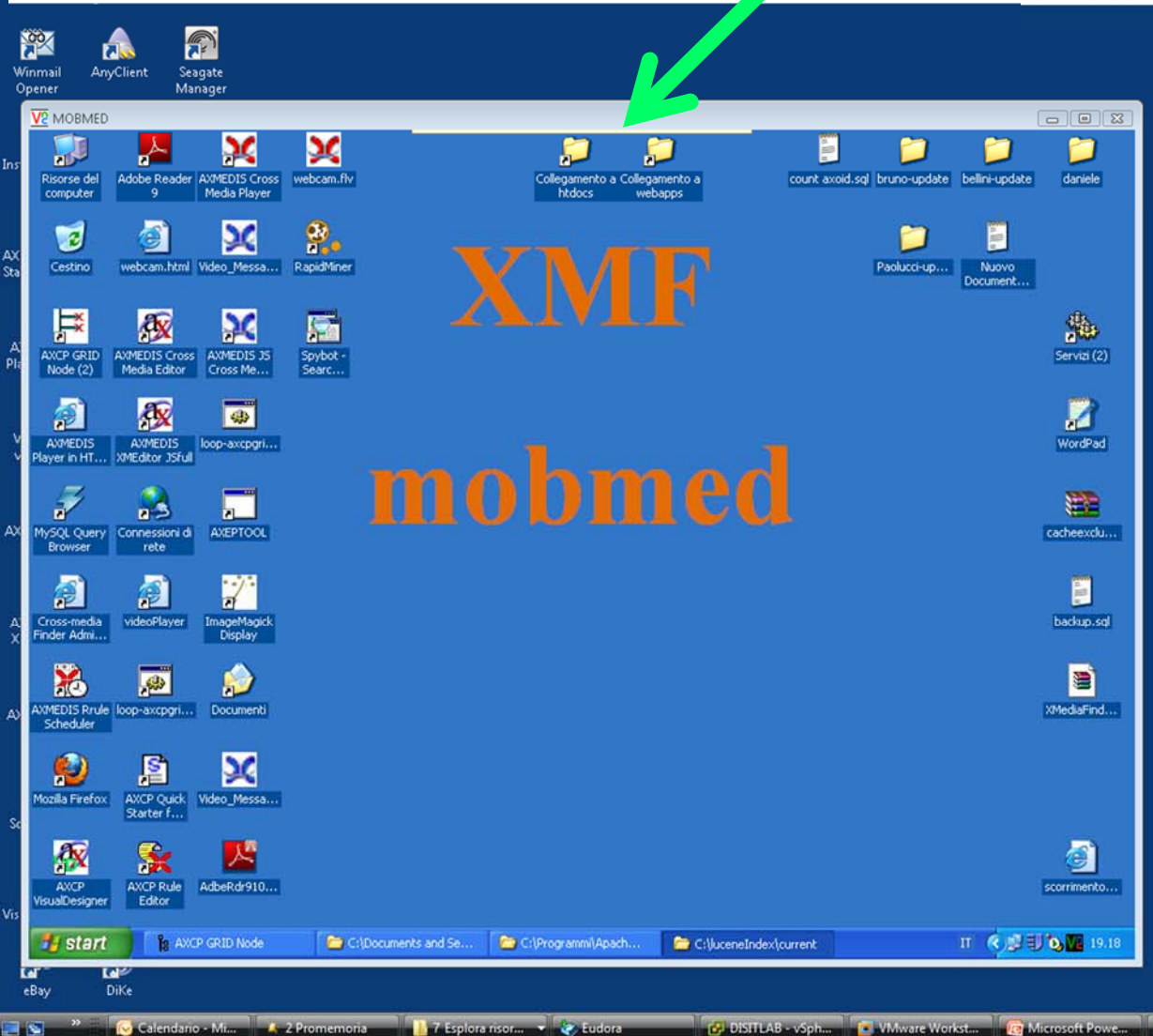


Remote machine  
Windows XP

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

 Username:  OK

Password:  Cancel



Local machine  
Windows Vista



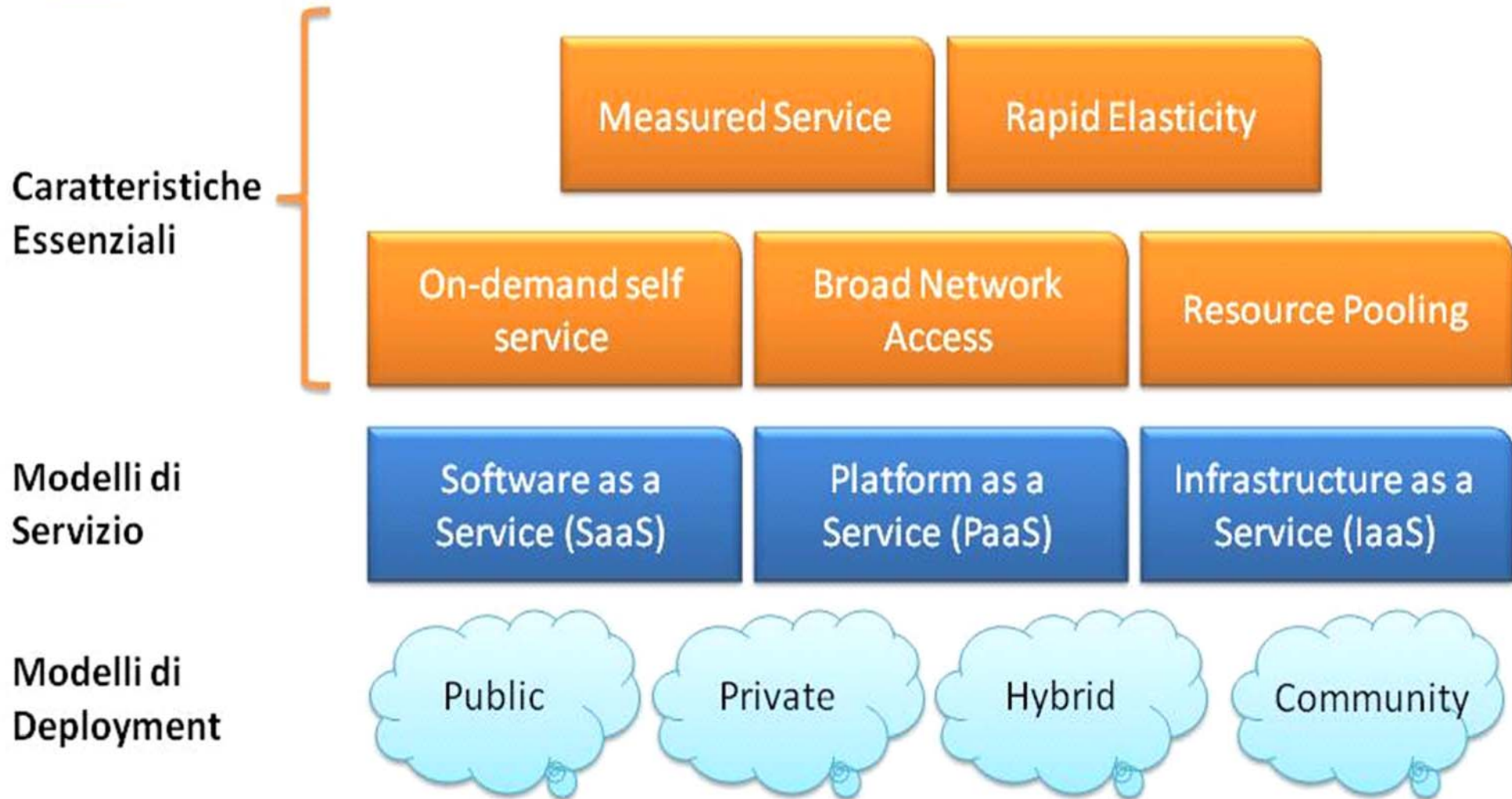


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- ⌈ PaaS Solutions
- ⌈ SaaS Solutions
- ⌈ ICARO project



# 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





# IaaS Solutions

- ⌈ Based on Virtualization
- ⌈ 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.



| 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)

- ℓ **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.
- ℓ **Dynamic SLA** – se viene offerta la possibilità di ridefinire gli SLA.
- ℓ **Certifications** – se il provider offer certificazioni sulla compliance/sicurezza come PCI o SAS 70.
- ℓ **Scale Up** – se è possibile lo scale up di single istanze di server, tramite l'aggiunta di memoria, extra CPU o storage.
- ℓ **Scale Out** – se è possibile fare il deploy veloce di nuove istanze dei server.
- ℓ **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.
- ℓ **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.
- ℓ **APIs** – se vi sono API per interagire con i server.
- ℓ **Free Tier** – se vengono offerte soluzioni di prova per il test dei servizi



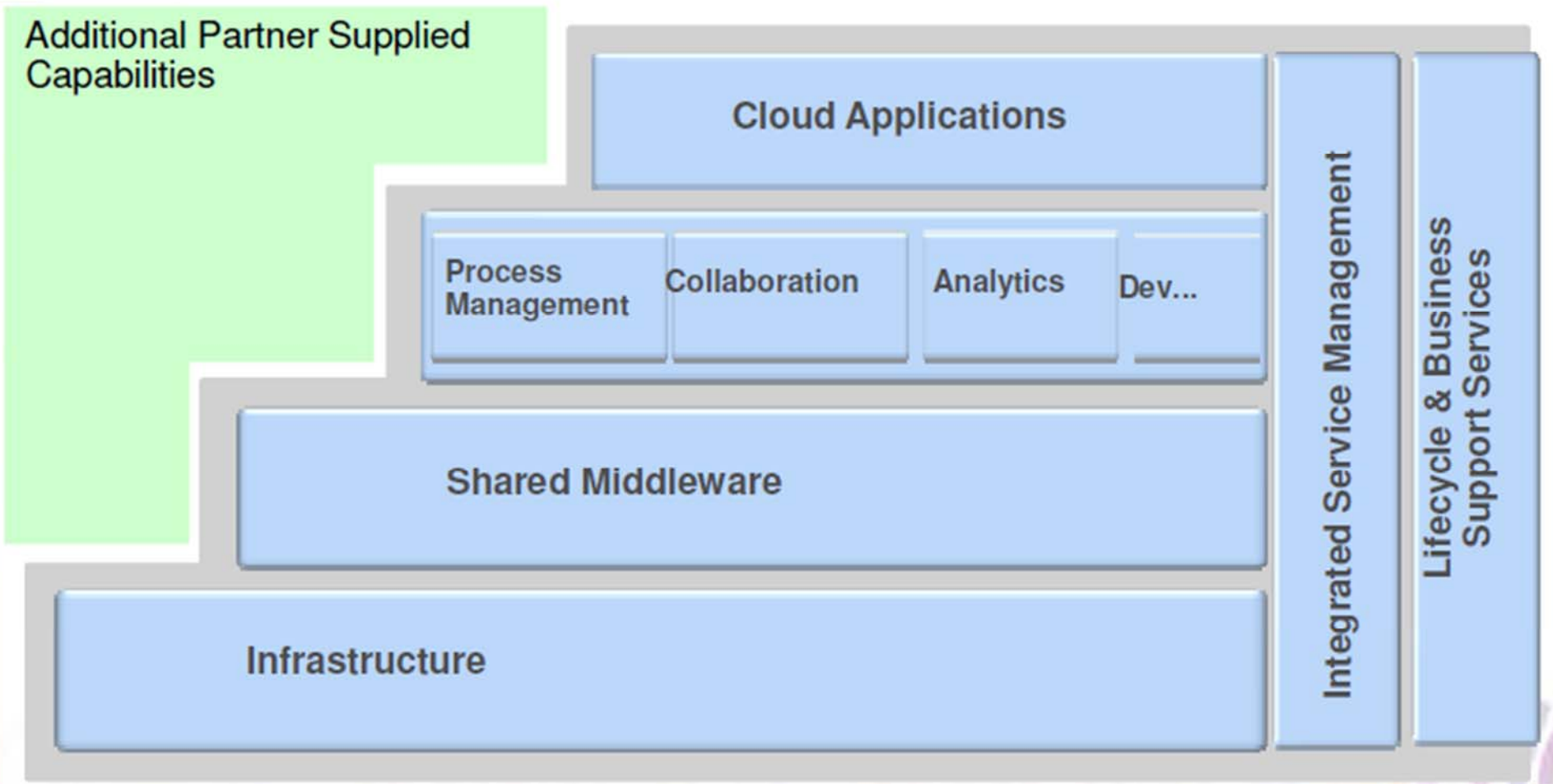
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# Platform as a Service (PaaS)

- ⌈ 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.



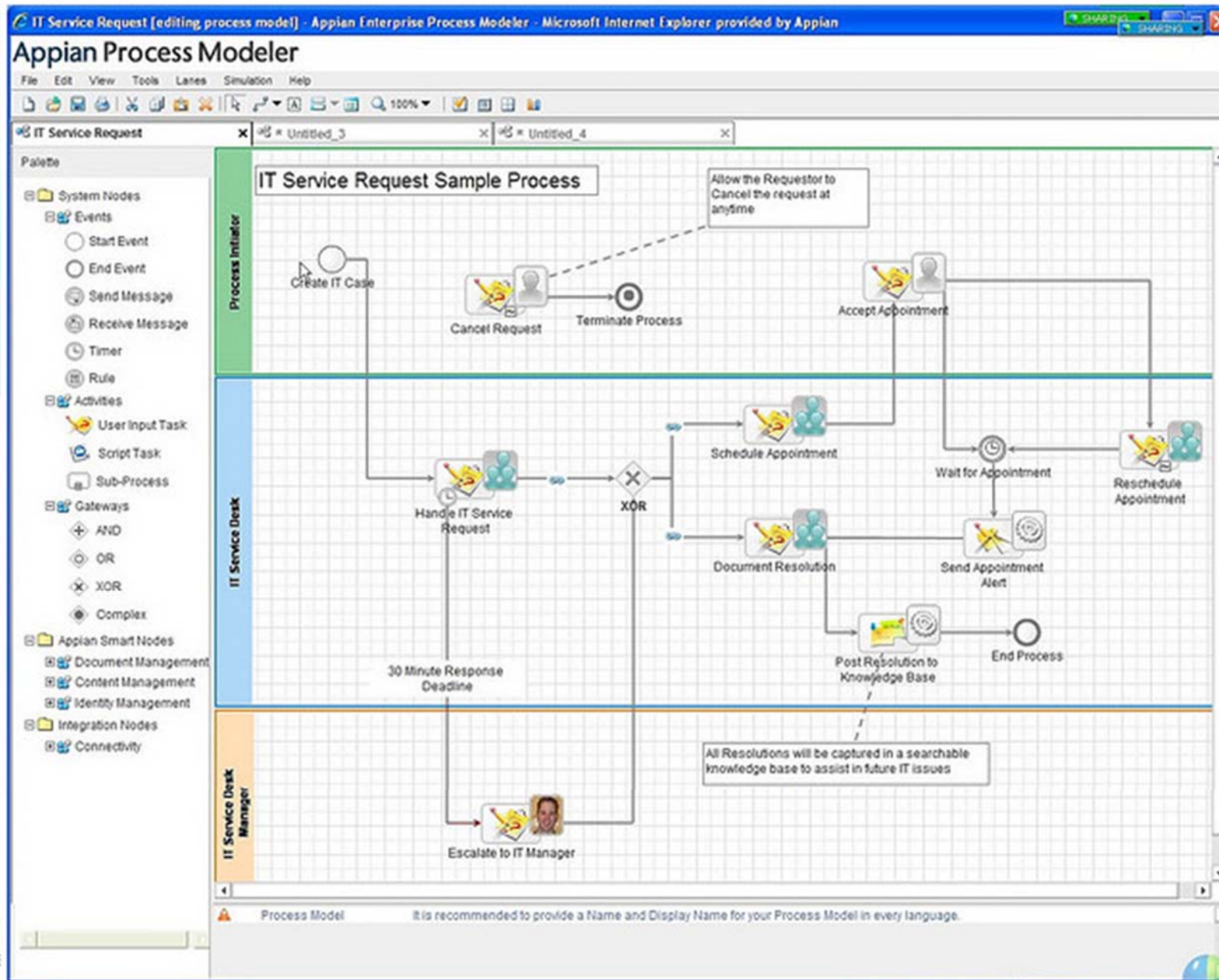


# PaaS

- ⌈ **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>)

| 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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# 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).

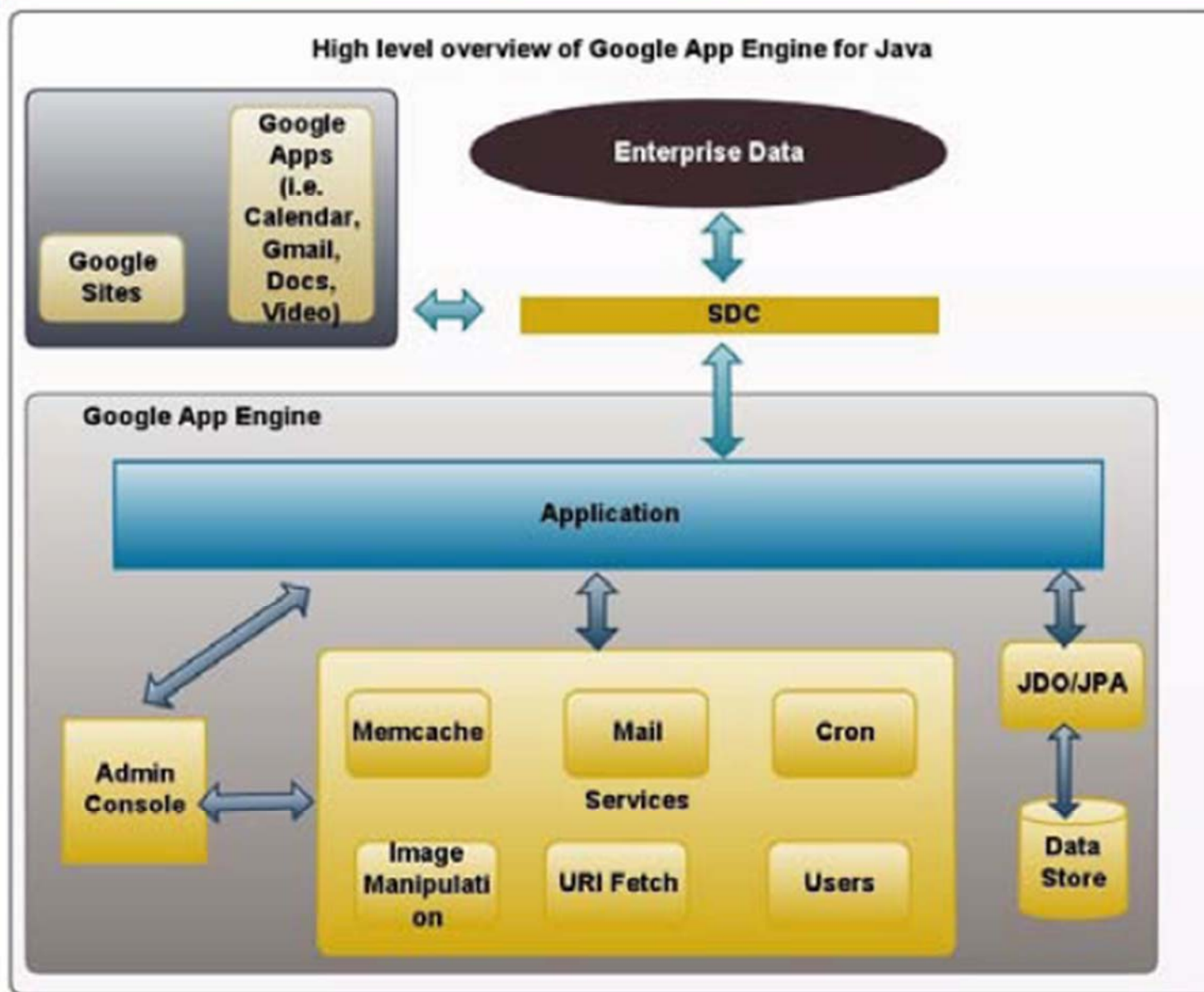


# Soluzioni SaaS

- ⌈ **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.



# 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                   | PaaS                    |  |   |                                |                 |   |                                   |      |   |  |  |
|---------------------------------|-------------------------|--|---|--------------------------------|-----------------|---|-----------------------------------|------|---|--|--|
| Platform                        | SalesForce Force.com    | Java, .NET, Ruby, PHP, Python, Perl, Adobe Flex e AIR      |   |                                |                 |   |                                   |      |   |  |  |
| 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 |  |  |
| Tecnologie                      | Rackspace Cloud Sites   | PHP, ASP, .NET   | Multi-tenant PaaS   | Rackspace Cloud Files/Aka mail | FTP/SFTP        | MySQL 5 & MS SQL Server 2008                  | object storage/CDN                |      | x |  |  |
| Cloud hosting                   | Microsoft Windows Azure | C#, Java, PHP, Ruby  |   |                                |                 |   |                                   | REST |   |  |  |
| Content Delivery Network (CDN)  | Jelastic                | Java   |   |                                | Maven, Git, SVN | Maria DB, MySQL, PostgreSQL, MongoDB, CouchDB |                                   |      | x |  |  |
| Repositories                    | Heroku                  | Ruby   |   |                                |                 | Amazon RDS (MySQL), MongoDB, Redis, CouchDB   |                                   |      |   |  |  |
| Databases                       | Google App Engine       | Java, Python   |   |                                |                 | Google Cloud SQL                              | JDBC, DB-API                      |      |   |  |  |
| APIs                            | Cumulogic               | Java, Spring   | Amazon EC2, OpenStack, CloudStack, EucaLypTus, VMware vSphere |                                | Git, SVN        | MySQL, MySQL cluster, MongoDB                 | REST                              |      | x |  |  |
| Dashboard/Console centralizzata | 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   |                                |                 |   |                                   |      |   |  |  |



# 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
- [-] SaaS Solutions
- [-] PaaS Solutions
- [-] ICARO project ←



# iCaro

## x Cloud Service Provider

**Paolo Nesi (UNIFI, DISIT Lab)**

**Feb 2015**





## ❑ 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



## □ PaaS, Platform as a Service:

- **Business:** vendita di VM a consumo ..
- **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.



## ❑ SaaS: Software as a Service (continua)

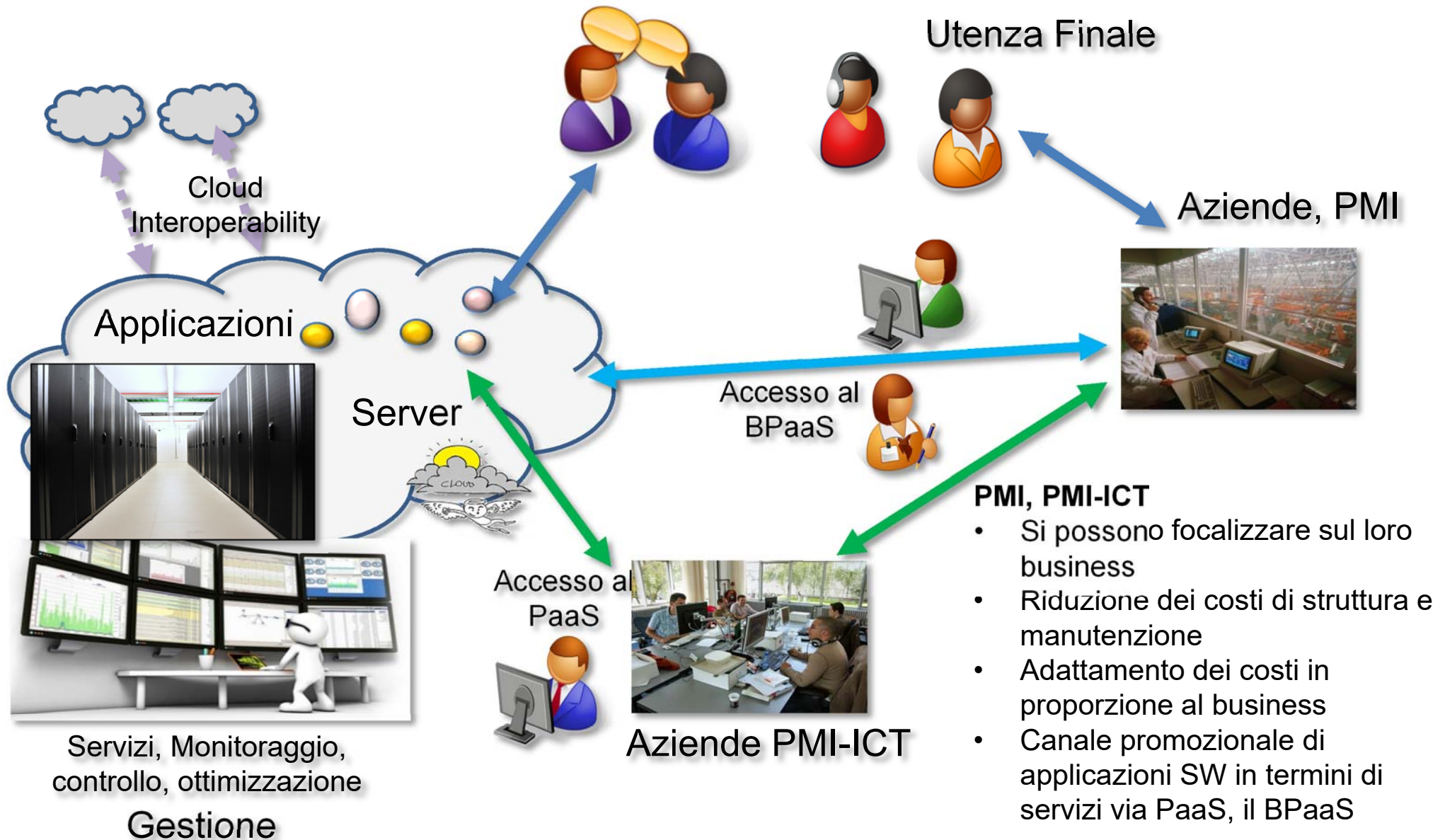
- ❑ **Monitoraggio:** soluzioni che dovrebbero permettere di
  - ❑ **controllare** non solo il consumo delle risorse a livello IaaS, PaaS ma anche gli aspetti SaaS dell'Applicazioni a consumo, per esempio le relazioni, i servizi interni, etc..
  - ❑ **Automatizzare** la configurazione del sistema di 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

- ❑ **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

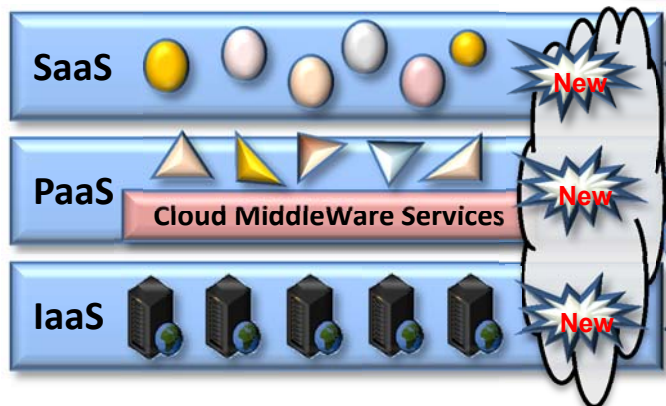
- ❑ *modello descrittivo per servizi e applicazioni*
- ❑ *sistema automatico di configurazione*
- ❑ *reasoner che prendere decisioni su configurazioni: consistenza e completezza*
- ❑ *soluzione di produzione del business, config automatica*
- ❑ *motore di intelligence per il cloud*
- ❑ *algoritmi per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



# Architettura ICARO

## Utenza Finale

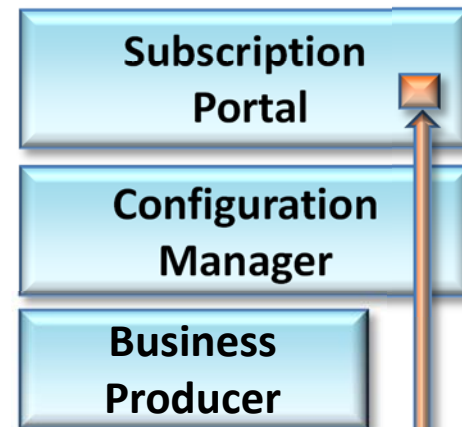
Application Access on  
iCaro cloud



### PMI

Access to BPaaS,  
Services Purchase

**SLA**



### Supervisor & Monitor

### PMI-ICT

Developers  
PaaS

### CMW SDK

### Smart Cloud

### Knowledge Base

Cloud  
Management

### Cloud Simulator



# Architettura ICARO

## Utenza Finale

Application Access on  
iCaro cloud

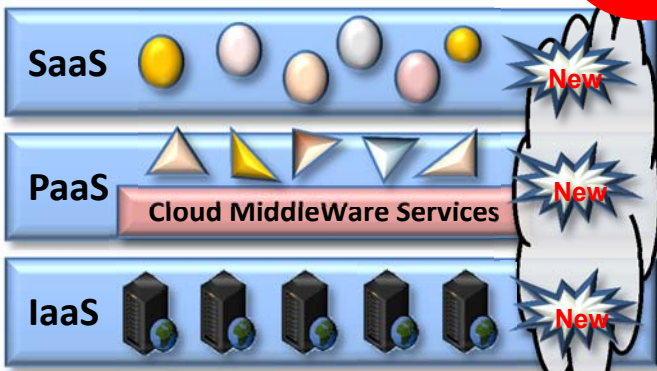
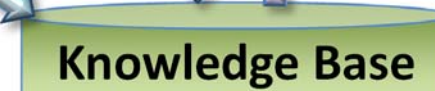
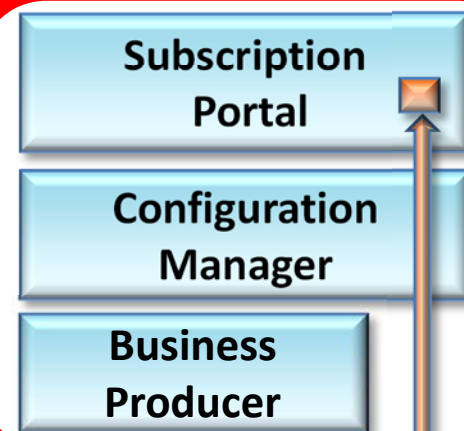


**PMI**  
 Access to BPaaS,  
 Services Purchase  
 SLA



## PMI-ICT

Developers  
PaaS





# Subscription Portal

- ❑ **Interfaccia di vendita di soluzioni a consumo**, che possono andare da Host, Machine 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.



# Subscription Portal

**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             |
|-----------------|-----------------------|--|---------------------|
| <b>Quantità</b> | <b>Prez. Unitario</b> | <b>Totale</b>  |                     |
| Una tantum      | MCCLSVIM-ATT          | My Virtual Server Intel Start-up                               | 1 € 180,00 € 180,00 |
| Al mese         | MCCLSVIM              | My Virtual Server Intel 1Gb Ram incluso Licenza Windows Server | 1 € 21,00 € 21,00   |
| Al mese         | MCCLSVIM-1GBRAM       | My Virtual Server Intel 1Gb Ram aggiuntiva                     | 2 € 15,00 € 30,00   |
| Al mese         | MCCLSVIM-1CPU         | My Virtual Server Intel Virtual CPU aggiuntiva                 | 1 € 15,00 € 15,00   |
| Al mese         | MCCLSAN1GB-CAP        | My Space 1GB SAN per VM @High Capacity & Availability          | 120 € 0,10 € 12,00  |

**ICARO**

Home Offering 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 ti 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:

Massimo sessioni contemporanee:

Dimensioni Storage File:

Dominio del sito:

e-mail amministratore:

Tempo medio di risposta atteso:

**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 <b>MON</b> |
| 30256     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:43 | 27/06/2014 12:43 | DEPLOYED <b>MON</b> |
| 30255     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:42 | 27/06/2014 12:42 | DEPLOYED <b>MON</b> |
| 30254     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:39 | 27/06/2014 12:39 | DEPLOYED <b>MON</b> |
| 30253     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:37 | 27/06/2014 12:38 | DEPLOYED <b>MON</b> |
| 30252     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:30 | 27/06/2014 12:30 | DEPLOYED <b>MON</b> |
| 30251     | Dummy Joomla Farm | CC001        | Nome cliente | 27/06/2014 12:28 | 27/06/2014 12:28 | DEPLOYED <b>MON</b> |

## 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.



# Configuration Manager

Sistema Anagrafica Strumenti Manuale Quadro Sinottico

**Utilizzo Sistema**

CPU % Mem % Banda %

01 02 03 04 05 06 07

**Utilizzo CPU Servizi**

50% 40% 30% 20% 10% 0%

VDC01 VDC02 VDC03 VDC04 VDC05 VDC06 VDC07

Sistema pronto

**Coda Lavori**

| Codice | Descrizione   | Inizio              | Stato                                |
|--------|---------------|---------------------|--------------------------------------|
| 004    | Workbook W004 | 13-12-2013 12:00:01 | <span style="color: green;">■</span> |
| 005    | Workbook W005 | 13-12-2013 12:10:01 | <span style="color: green;">■</span> |
| 006    | Workbook W006 | 13-12-2013 13:00:01 | <span style="color: green;">■</span> |

**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
  
```

## Backoffice del Business

Generic Launcher - iCaro x 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:

Visibility:

Status:

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

Caratteristiche

Condizioni di vendita

Prezzo unitario:

Valuta:

Tarifazione:

Provisioning Workflow ID:

Deprovisioning Workflow ID:

Parametri del servizio

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

IT 16:10





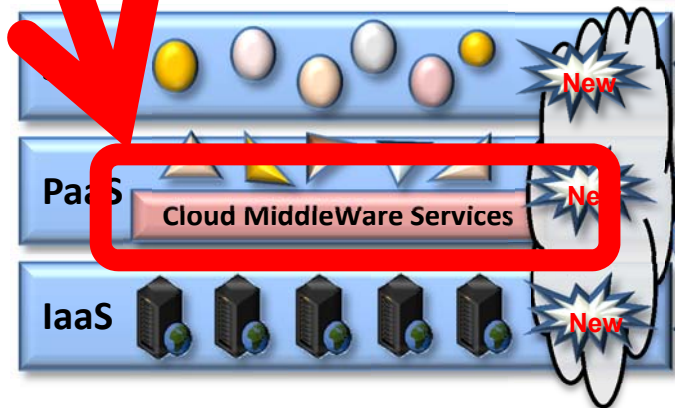
- ❑ **produzione automatica dei pattern/configurazioni**  
complesse composte da: VM, applicazioni Web e non solo, servizi sulla base di buone pratiche, profiling, applicazioni legacy, e servizi per connessione con applicazioni on site remote, etc.
  - ❑ Il Business producer è un'evoluzione dei tradizionali 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

## Utenza Finale

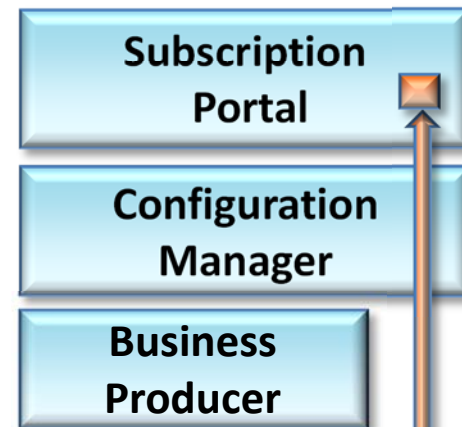
Application Access on  
iCaro cloud



### PMI

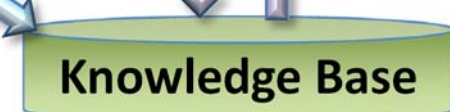
Access to BPaaS,  
Services Purchase

**SLA**

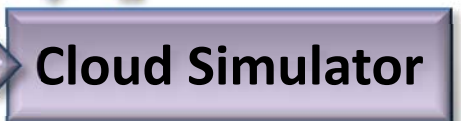


### PMI-ICT

Developers  
PaaS



Cloud  
Management





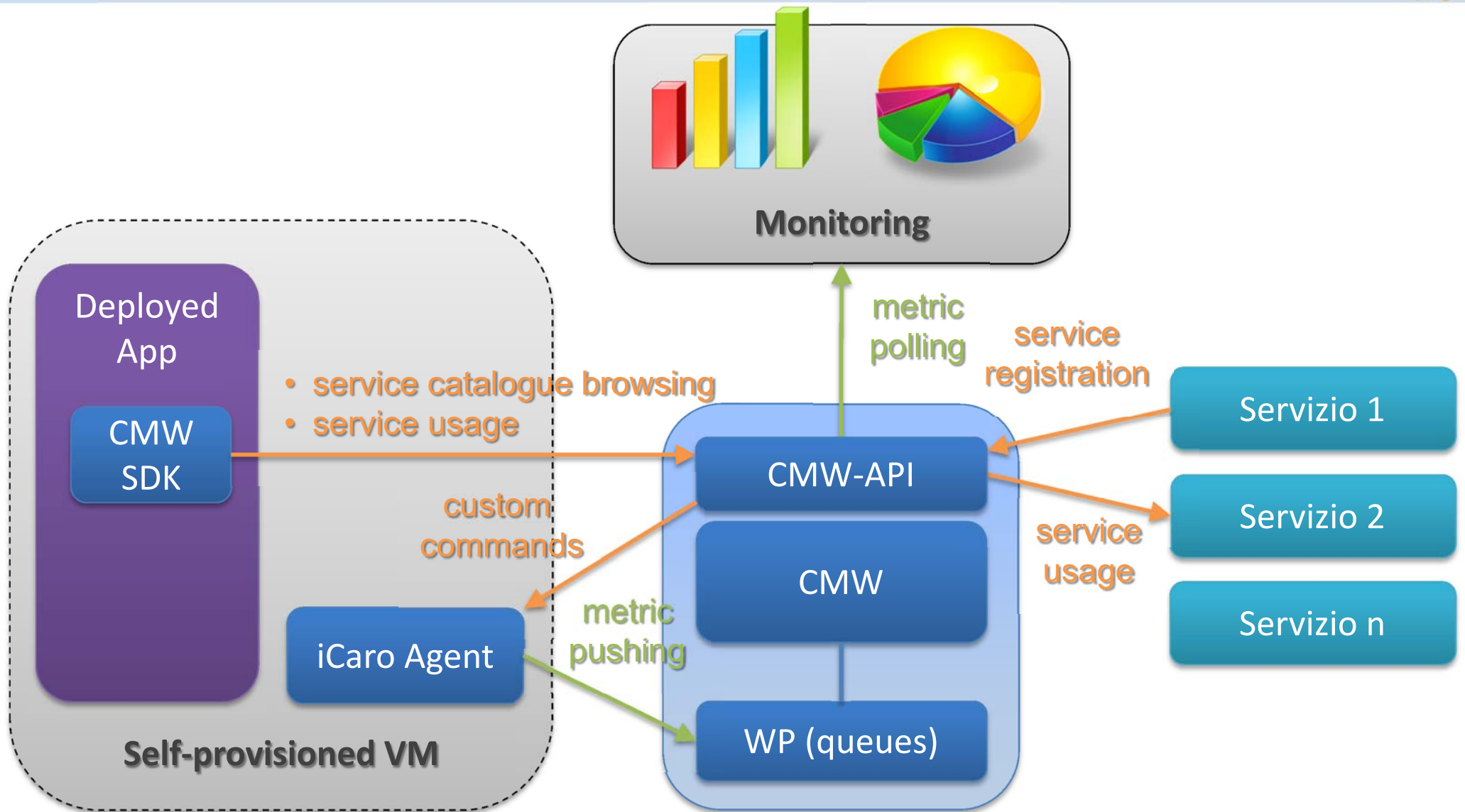
# Cloud Middleware &

## Cloud Middleware SDK

- ❑ **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. postgresQL, 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

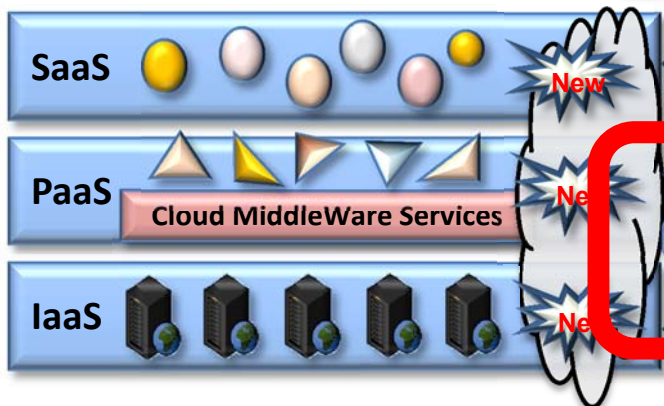




# Architettura ICARO

## Utenza Finale

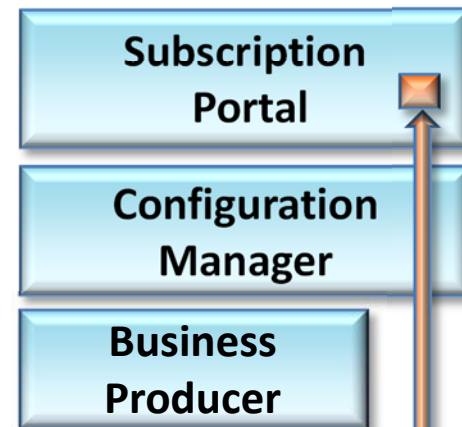
Application Access on  
iCaro cloud



### PMI

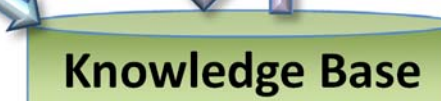
Access to BPaaS,  
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**SLA**

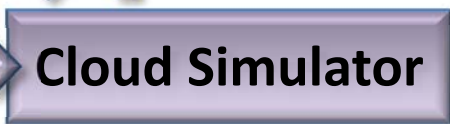


### PMI-ICT

Developers  
PaaS



Cloud  
Management



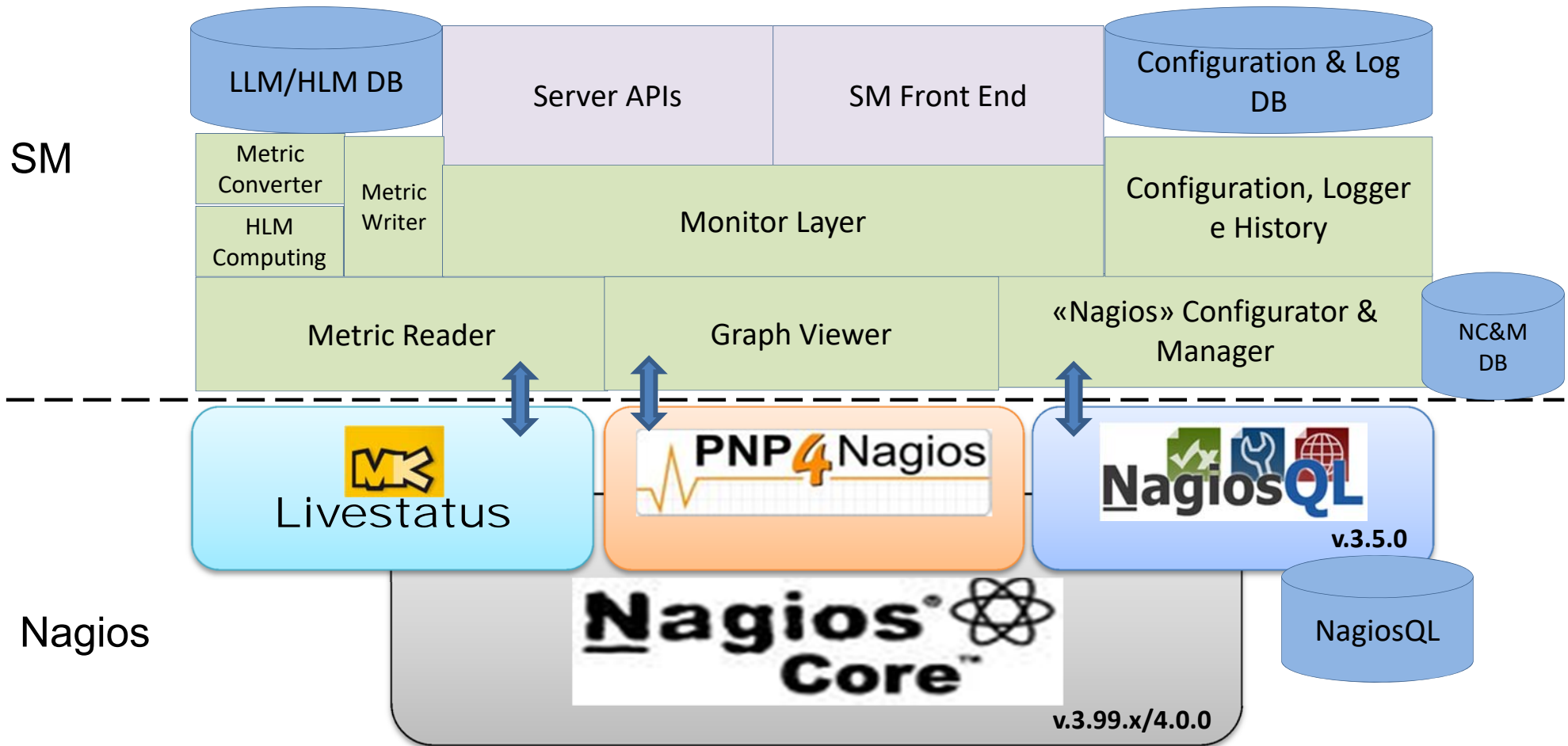


# Supervisor & Monitor

- ❑ **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

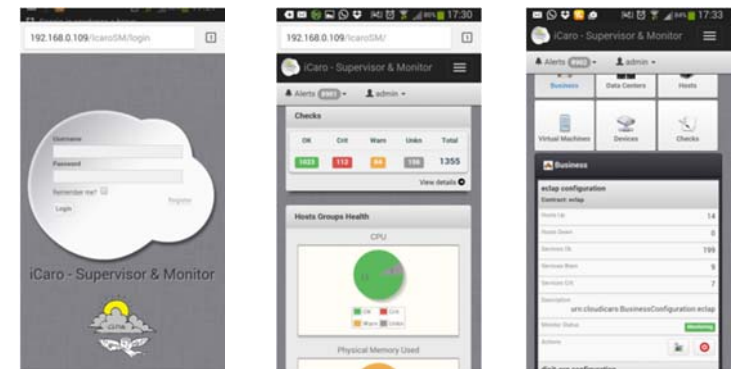
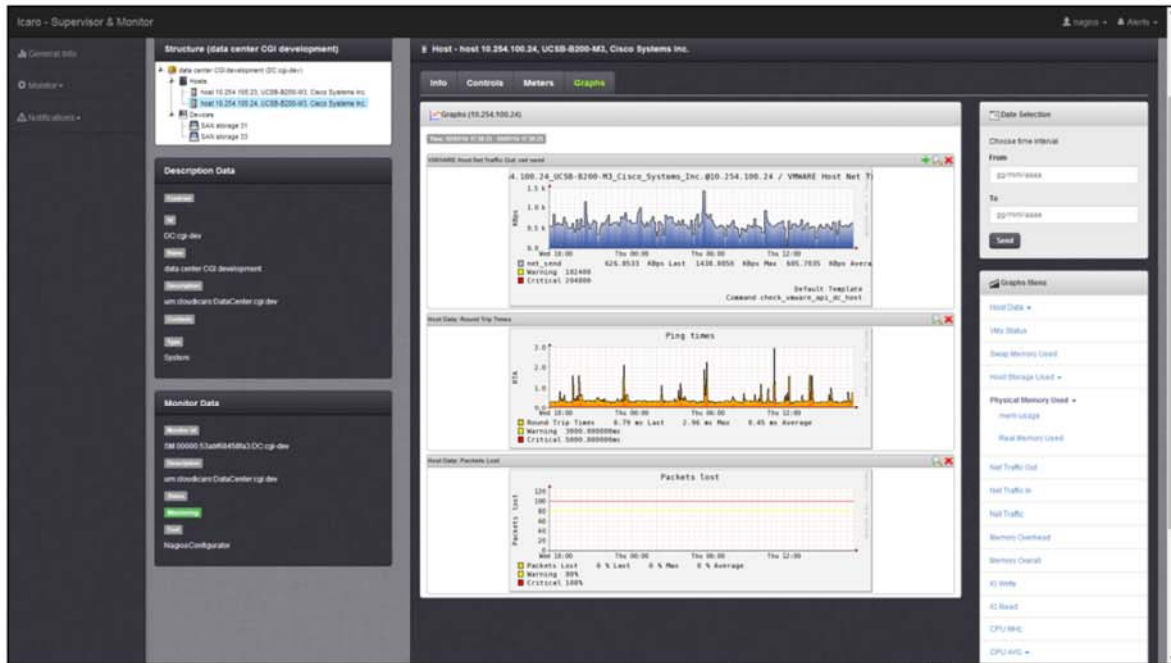


# SM – Architettura & Nagios





# Supervisor & Monitor Front-End



...on Mobile Devices

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



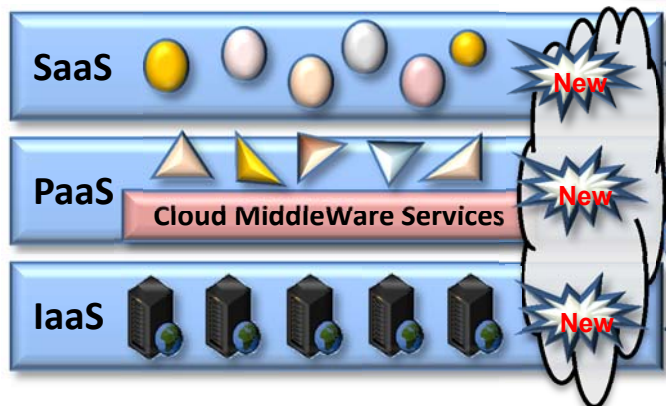




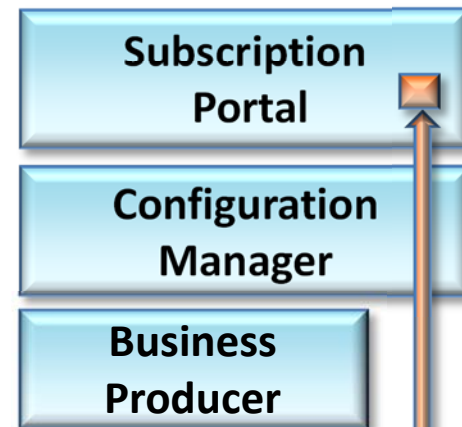
# Architettura ICARO

## Utenza Finale

Application Access on  
iCaro cloud



**PMI**  
 Access to BPaaS,  
 Services Purchase



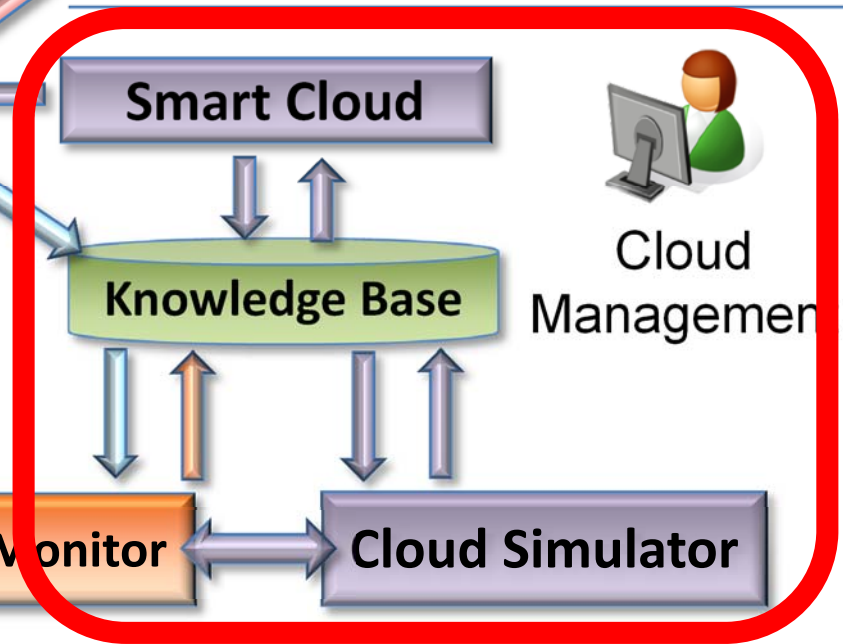
Supervisor & Monitor

## PMI-ICT



Developers  
PaaS

CMW SDK





# Smart Cloud Engine

- ❑ **Processi AUTOMATICI per**
  - ❑ Verifica e validazione di consistenza e completezza delle configurazioni
  - ❑ Controllo della salute e del comportamento IaaS, PaaS, SaaS, Business, SLA con metriche complesse
  - ❑ Supporto alle decisioni per Scaling, cloning, migrazione e riconfigurazione
  - ❑ Processi di ottimizzazione
- ❑ Usa come modello la KB

The dashboard includes the following tiles:

- Hosts**: Represented by a server rack icon.
- VMs**: Represented by a cube icon with 'VM' text.
- SLA Alerts**: Represented by a document icon.
- Apps**: Represented by a blue cube icon with 'OS' text.
- Metrics**: Represented by a gauge icon.
- Alerts**: Represented by a green waveform icon.
- NICs**: Represented by a green circuit board icon.
- Scheduler**: Represented by a blue globe icon.
- Cluster**: Represented by a server rack icon.

Below the tiles is a table of job execution logs:

| Job ID | Host               | Start Time          | Service 1                                | Service 2                                | Configuration                                 | Status  | Service 3                                | Service 4                                |
|--------|--------------------|---------------------|--|--|---|---------|--|--|
| 21252  | ubuntu141838030107 | 2014-12-12 18:47:08 | um.cloudicaro.ServiceLevelAgreement.3063 | um.cloudicaro.ServiceLevelAgreement.3063 | #isNonConcurrent-Halse; #slaid-run.cloudicaro | SUCCESS | um.cloudicaro.ServiceLevelAgreement.3063 | um.cloudicaro.ServiceLevelAgreement.3063 |
| 21251  | ubuntu141838030107 | 2014-12-12 18:47:08 | um.cloudicaro.ServiceLevelAgreement.3035 | um.cloudicaro.ServiceLevelAgreement.3035 | #isNonConcurrent-Halse; #slaid-run.cloudicaro | SUCCESS | um.cloudicaro.ServiceLevelAgreement.3035 | um.cloudicaro.ServiceLevelAgreement.3035 |
| 21250  | ubuntu141838030107 | 2014-12-12 18:46:32 | um.cloudicaro.ServiceLevelAgreement.3065 | um.cloudicaro.ServiceLevelAgreement.3065 | #isNonConcurrent-Halse; #slaid-run.cloudicaro | SUCCESS | um.cloudicaro.ServiceLevelAgreement.3065 | um.cloudicaro.ServiceLevelAgreement.3065 |
| 21249  | ubuntu141838030107 | 2014-12-12 18:46:08 | um.cloudicaro.ServiceLevelAgreement.3055 | um.cloudicaro.ServiceLevelAgreement.3055 | #isNonConcurrent-Halse; #slaid-run.cloudicaro | SUCCESS | um.cloudicaro.ServiceLevelAgreement.3055 | um.cloudicaro.ServiceLevelAgreement.3055 |

At the bottom, there are two summary boxes:

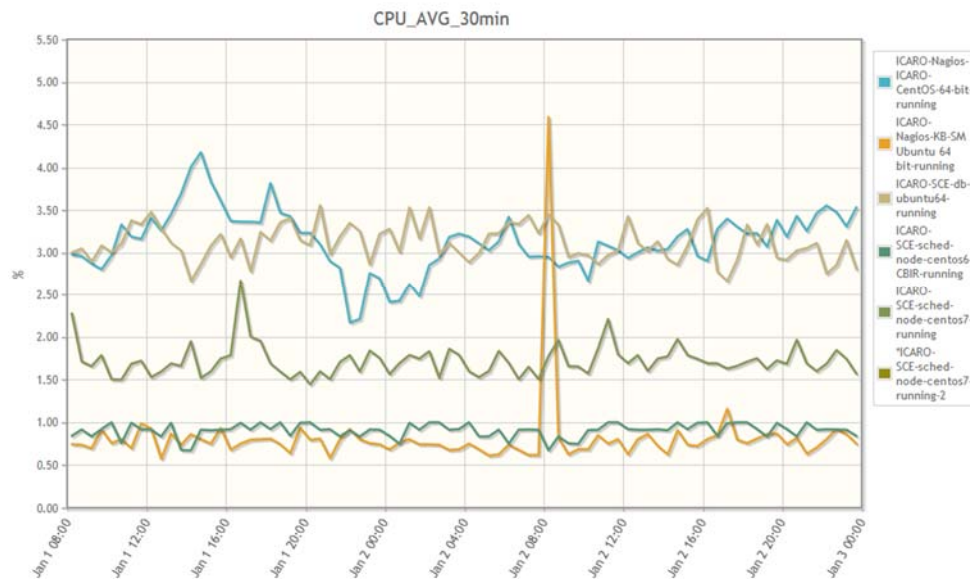
- Currently executing jobs:** 1 job (JobName: Clustered-ym, Number of jobs executed: 495, Running since: Fri Dec 12 11:48:01 CET 2014, Scheduler instance: kb.ku.its14133003.037, Scheduler name: SCE, Scheduler status: ok, Scheduler started: yes, Standby mode: no).
- CPU load:** 0.074657282153303, CPU load JVM: 0.24533881624458-4, Committed virtual memory: 2086435784, Free physical memory: 1562734162, Free swap space: 423288348, Number of processors: 4, Operating System architecture: x86\_64, Operating System name: Linux, Operating System version: 3.15.0-24-generic, Process CPU time: 642326000, System load average: 3.0, Total physical memory: 41482207383, Total swap space: 4232883488.

Navigation buttons at the bottom include: Jobs, Triggers, New Job, New Job (demand), New Trigger, Start Scheduler, Standby Scheduler, Shutdown Scheduler, Force Shutdown Scheduler, Pause Triggers, Resume Triggers, Nodes Status, Nodes Log, Log, Truncate Catalog.

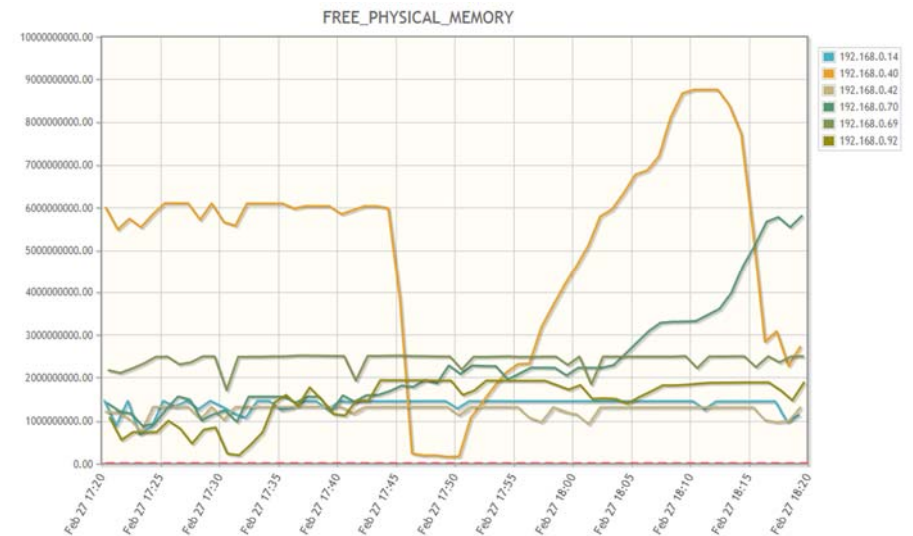


# Smart Cloud Engine

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



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



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



# Smart Cloud Engine

- 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           | Slas   | 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-153287db-d922-40d3-83ac-7057a174e040 | Network Traffic AVG       |             |                     | urn:cloudicaro:Virtual               | DISIT-ICARO-Nagios-               | urn:cloudicaro:HostM                 |                    |
| 2015-02-27 17:13:55 | urn:cloudicaro:ServiceLevelAgreement:icaro-disit | urn:icaro:cloud:ServiceMetric-4fb07e53-e182-4217-81d3-8b236cedce9  |                           |             |                     |                                      |                                   |                                      |                    |
| 2015-02-27 16:43:57 | urn:cloudicaro:ServiceLevelAgreement:icaro-disit | urn:icaro:cloud:ServiceMetric-1b683b27-872c-4c21-8a1e-0e39017de7e9 |                           |             |                     |                                      |                                   |                                      |                    |

**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

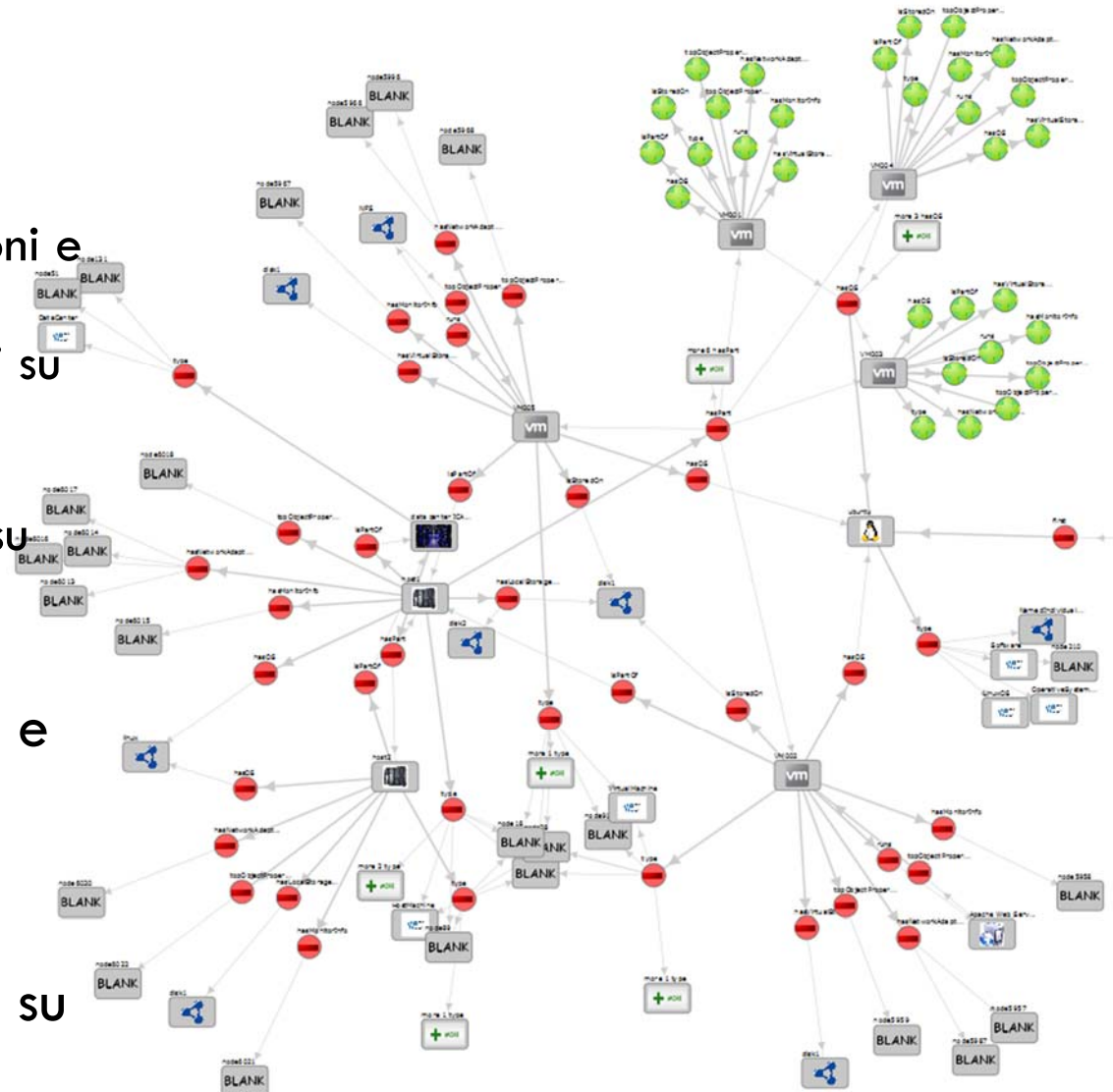
IF Metric CPU AVG 30min of SLA urn:cloudicaro:ServiceLevelAgreement:log IS 60 % ABOVE THE THRESHOLD FOR 3 h

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

**Confirm**



- ❑ **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>

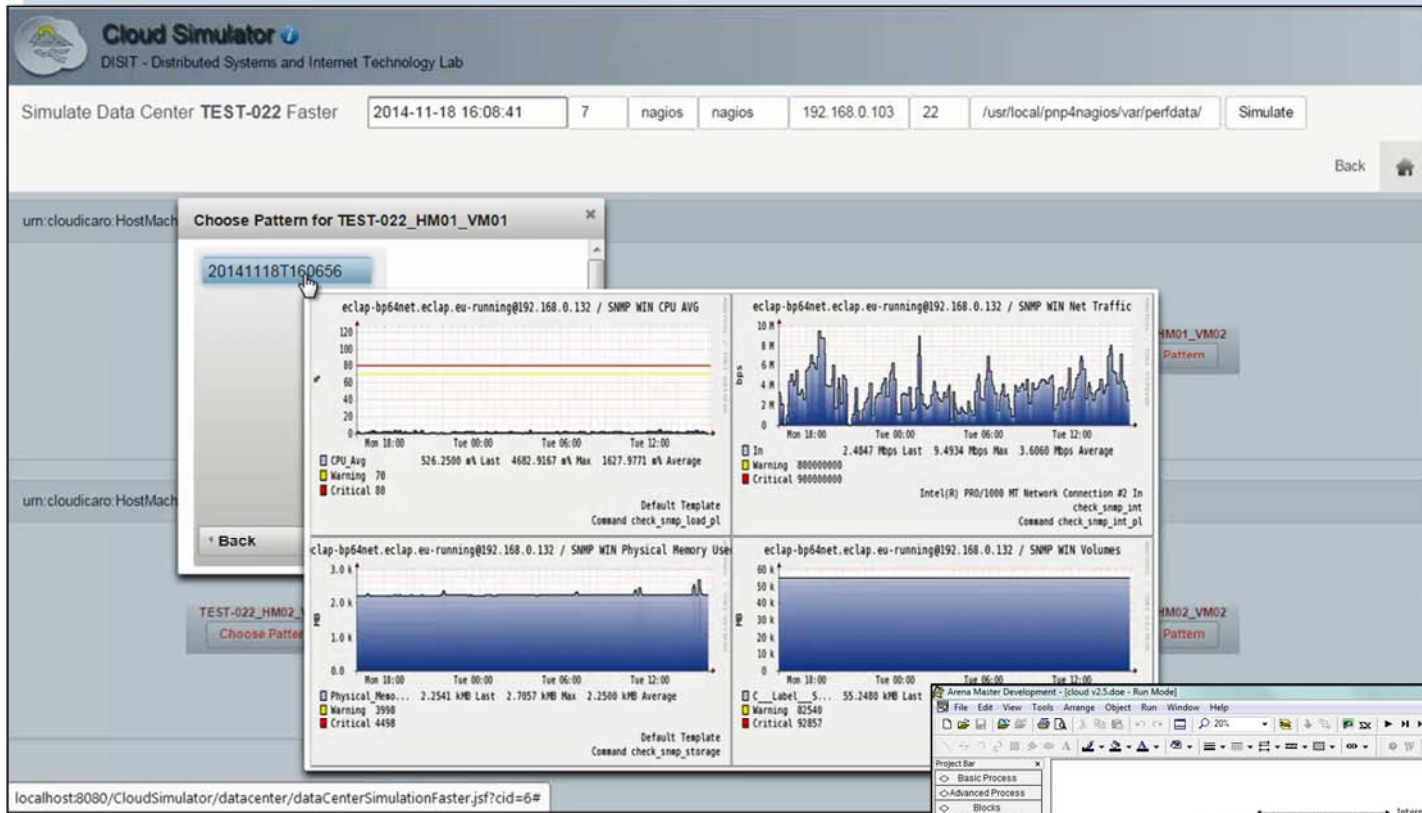




- ❑ **Permette di**
  - ❑ **Simulare** il comportamento di carico di datacenter complessi
  - ❑ **creare situazioni di carico** partendo da andamenti di carico reali dallo storico del sistema di monitoraggio
  - ❑ **studiare** gli effetti del carico sulle risorse di base a livello IaaS
- ❑ **Produce 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

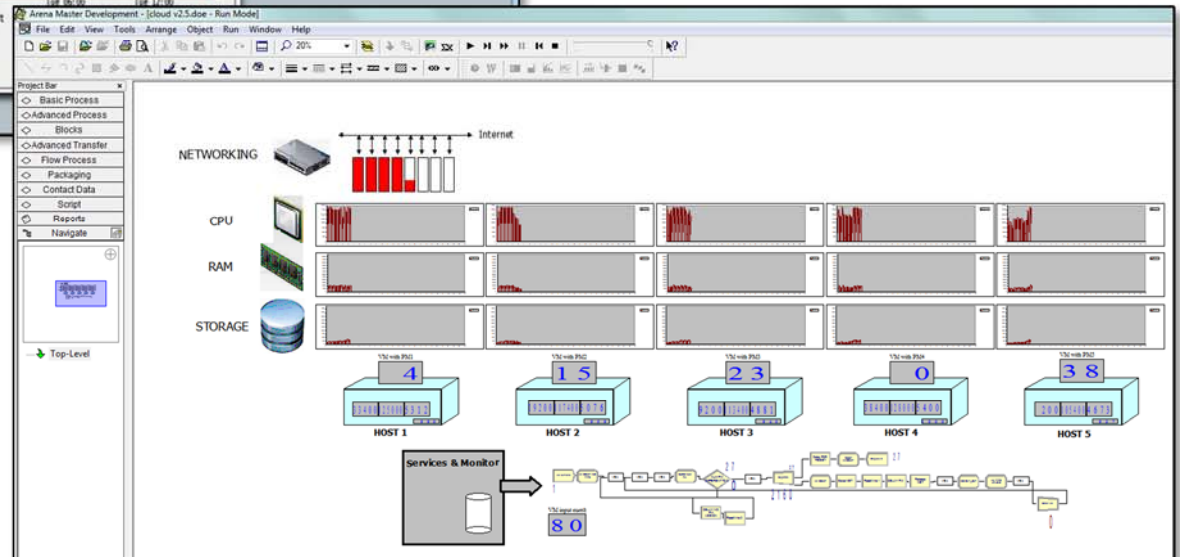


# Cloud Simulator



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

**Identificare allocazioni ottime delle risorse**





- ❑ **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**





- ❑ 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](http://www.hp.com/go/integrityvm)
- [ Microsoft Hyper-V: <http://www.microsoft.com/hyper-v-server/en/us/default.aspx>
- [ **“Windows Server 2008 Hyper-V Technical Overview”** - <http://download.microsoft.com/download/4/2/b/42bea8d6-9c77-4db8-b405-6bfffce59b157/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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