

Course Code : CSCN4023 Course Name: Managing Virtual Environment

## Module I:

### **Performance Management in a Virtual Environment**

# GALGOTIAS UNIVERSITY



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### Virtualization management:

Virtualization management is software that interfaces with virtual environments and the underlying physical hardware to simplify resource administration, enhance data analyses, and streamline operations.

### **Difficulties.....**

- Logistical Problems
- Interpersonal Issues
- Technological Difficulties

### Similarities of every virtual machine environments:

- 1. User interface
- 2. Streamline the virtual machine (VM) creation process
- 3. Monitor virtual environments
- 4. Allocate resources
- 5. Compile reports
- 6. Automatically enforce rules



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### **Responsibilities:**

**Provisioning :** Processing resource requests, creating templates, and configuring VMs.

**Compliance :** Securing and monitoring systems, identifying issues, and validating user access.

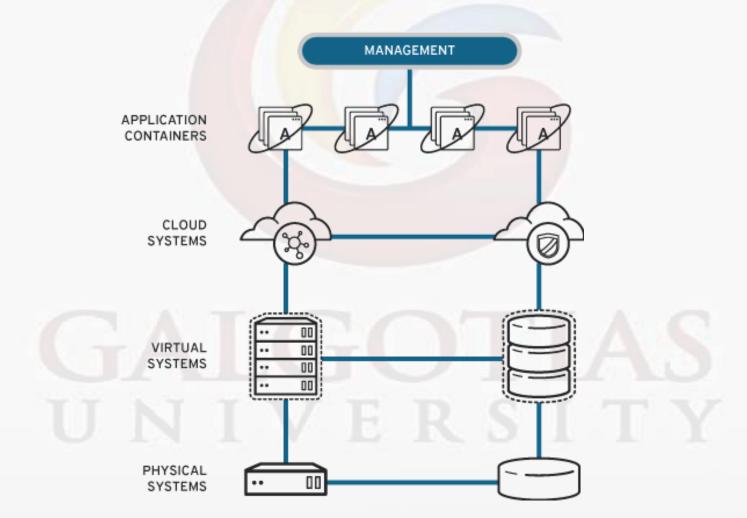
**Operations :** Retiring or reclaiming unused or underused physical resources, investigating bugs, and projecting future needs.

**Hybrid unification :** Implementing the other 3 responsibilities across virtual, private cloud, public cloud, and container environments.



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### Managing traditional virtual environments





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### Predominant factors that contribute to virtuality:

The richness of communication media

Distance between team members, both in time zones and geographical

dispersion

Organizational and cultural diversity

### Detriments....

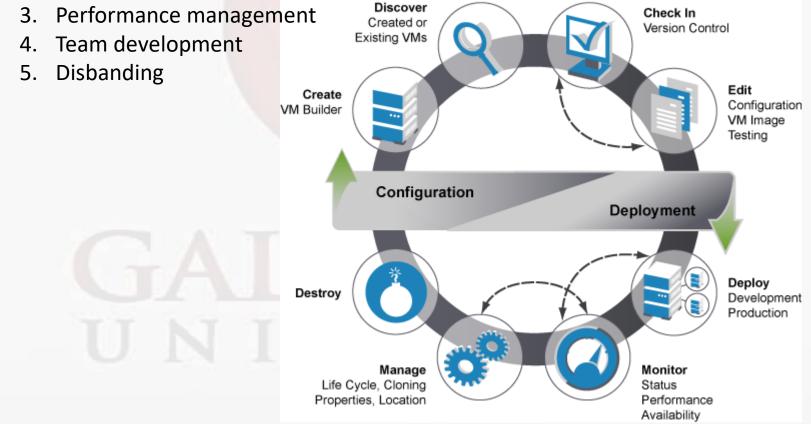
- Lack of potential for radical innovation
- The nature of the project may need to change
- ➤Sharing of knowledge



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### Life Cycle Stages of Virtual Management:

- 1. Preparations
- 2. Launch





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### **Types of Virtual Teams**

Type of Team	Description
Network	Team membership is diffuse and fluid; members come and go as needed. Team lacks clear boundaries with the organization.
Parallel	Team has clear boundaries and distinct membership. Team works in short term to develop recommendations for an improvement in a process or system.
<ul> <li>Project or Product</li> <li>Development</li> </ul>	Team has fluid membership, clear boundaries, and a defined customer, technical requirement, and output. Longer-term team task is nonroutine, and team has decision-making authority.
<ul> <li>Work, Functional, or Production</li> </ul>	Team has distinct membership and clear boundaries. Members perform regular and ongoing work, usually in one functional area.
Service	Team has distinct membership and supports ongoing customer, network activity.
Management	Team has distinct membership and works on a regular basis to lead corporate activities.
Action	Team deals with immediate action, usually in an emer- gency situation. Membership may be fluid or distinct.



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### Standard Organizational and Team Process

- Definitions of Requirements
- Estimates of Costs
- ➢Procurement
- ➤Team Charters
- ➢ Project Planning
- Documentation and Document Sharing
- ➢ Reporting
- ≻Controlling



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### Virtual Team Management Techniques

- 1. Define work systems
- 2. Establish multiple communication tools
- 3. Schedule regular meetings
- 4. Have clear and detailed deliverables
- 5. Make sure work hours overlap
- 6. Create a professional work environment
- 7. Choose (video) calls over chatting and emails
- 8. Find the right people to work with
- 9. Establish a meritocratic system
- 10. Use project management tools



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### **Graphical user interfaces of administrative systems**

- Lists, two-dimensional and on scrollable screens, typically using a windows program manager with many sublists showing printers, operating systems, physical sights, etc.
- 2. Tree diagrams showing the hierarchical relationships of the network system such as by showing the various geographical locations, the number of buildings at a location, the number of computers at each location, and the peripheral equipment associated with each computer and the systems being operated on each computer.
- 3. A hierarchical structure using folders and icons with each folder being a list of icons and with each icon by its color indicating the status of each unit.
- 4. Diagrams, with icons, of the various systems in a hierarchy.



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### **Elements of Virtual Management Environment**

**User:** An end user who belongs to an organization whose virtual images are hosted on a private cloud server. The user has been granted some access privileges to some specific virtual images at specific times. A user is asked to authenticate at the User Portal. After authentication, he/she is presented with a list of virtual images he/she can access. After the selection, the user is allowed access to the virtual image, which is protected by the SSL VPN server.

**User Portal:** The portal provides a list of VMs that the user is eligible to access. The user portal generates a request to the Cloud Server to instantiate the VMs and expects the details of the VMs.

**IDP:** Authentication provider or identity service/identity provider (IDP). The IDP is capable of authenticating the users; this may be done by name and password combination, advanced authentication methods or partner services by means of federation protocols. The IDP is the role generator. The IDP also applies the VM information it receives from User Portal and applies it on a partial policy to make it a meaningful policy.



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### Continued.....

**SSL VPN Server:** The central server, which provides the access to the VM and enforces the policies every time an access is made to the VM by the user.

**Policy Enforcer:** A policy evaluator. Takes the required input and evaluates the policy and responds with a result.

**Virtual Image Private Cloud Server:** The central server for hosting virtual images. It instantiates the VMs on an as-needed basis. After instantiating the VM image, the cloud server presents its IP Address, Port, and a secure Token from the VM. This token lives for a particular period of time and access to the VM image requires the token.



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### **Virtual Server Management**

Identify and solve performance issues, optimize resource utilization, prevent hardware failure, and maintain virtual servers at peak performance

### **Challenges of Virtual Server Management**

- VM Sprawl
   Network Traffic Congestion
   Server Hardware Issues
- Tool(s): "OpManager" for Vmware performance and issue monitoring
  - OpManager Performance Monitoring
  - PostgreSQL Database Statistics
  - OpManager Configuration Details
  - ➢ Fix Performance Problems Faster



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### Virtual Management Techniques

- 1. Virtual server monitoring
- 2. VM relationship mapping
- 3. Capacity planning
- 4. VMware workflow automation
- 5. VM migration tracking
- 6. Alerts via email and SMS
- 7. VM reports



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### VMware ESX Server and ESXi Server

Features	ESX Server	ESXi Server
Service Utilities	Service console (esxcfg) – Linux based utility	Remote Command line Interface (RCLI)
Boot up timing (For server)	More time (more than 2 GB in size)	thin = fast installation + faster boot $(1 - 2 \text{ minutes})$
Purchasing Mode	Free of cost	Embedded as a hypervisor on flash drive or microchip
Security profiles	More number of security options	Setup is very easy and simplistic
Firmware Console	Service Console	Direct Console User Interface (DCUI)
Health Status	Third party tools are used	Built in health status
Patches	More number of patches are installed and more number of reboots	Less number of patches required with few number of reboots



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Getting Started Summary Virtual Ma	chines Resource Allocation Performance Con	figuration Getting Started Summary Virtual Mac	times Performance Configuration Tasks & Events Alarm
Hardware	Security Profile	Hardware	Security Profile
Health Status Processors Memory Storage Networking Storage Adapters	Services VMware VirtualCenter Agent NTP Daemon	Processors Memory Storage Networking Storage Adapters Network Adapters	Firewall Incoming Connections CIM Server CIM Secure Server SNMP Server SSH Server CIM SLP
Network Adapters		Software Licensed Features	aam Outgoing Connections Software ISCSI Client CIM SLP
Licensed Features Time Configuration DNS and Routing Virtual Machine Startup/Shutdown Virtual Machine Swapfile Location Security Profile System Resource Allocation Advanced Settings		Time Configuration DNS and Routing Virtual Machine Startup/Shutdown Virtual Machine Swapfile Location Security Profile System Resource Socation Advanced Settings	aam NTP Client VCB VMware License Client SNMP Server VMware VirtualCenter Agent Virtual Machine Delegate (Experimental) Read and write to virtual machine files using these credential User Name: root

Figure 1: ESXi Security Profile

**Figure 2:** VMware ESX Server (full) Security Profile



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### ESXi yellow firmware console / DCUI

Customize System	Configure Root Pas	sword
Configure Root Password Configure Lockdown Mode Configure Management Network Restart Management Network Test Management Network Configure Keyboard View Support Information View System Logs Restart Management Agents Reset Customized Settings	Not set To prevent unautho this system, set t the "root" login n	he password for
< <b>Up∕Down&gt;</b> Select	<enter> Change</enter>	<esc> Log Out</esc>



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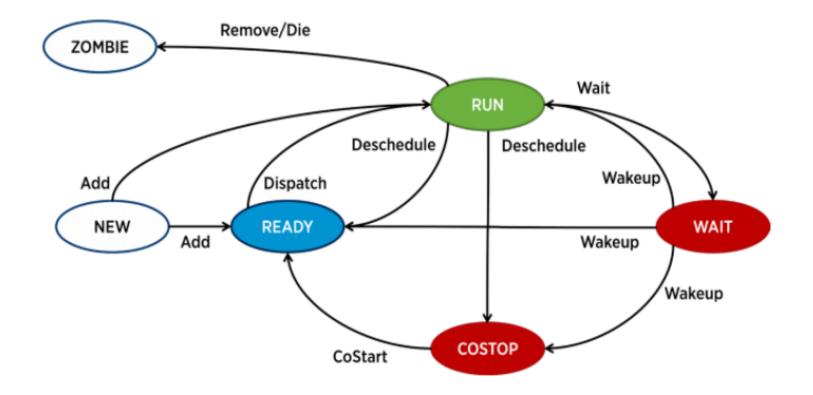
### ESXi Health Status

Health Status	Sensor	Status		Reading	-
Processors	F Processors	000	Normal	Trund.	
Memory	CPU1	000	Normal		
	CPU2	000	Normal		
Storage	Memory	000	Normal		
Networking	E B Storage	000	Normal		
Storage Adapters	Controller 0 (PERC 6/I Integrated)	000	Normal	Firmware Version : 6.0.1	
Network Adapters	Battery on Controller 0	000	Normal	Battery Status : Fully Ch	a
	Drive 0 in enclosure 32 on control	000	Normal		
Software	Drive 1 in enclosure 32 on control	000	Normal		
Licensed Features	RAID 1 Logical Volume 0 on contro	000	Normal		
Time Configuration	Port 0 on Controller 0	000	Normal		
DNS and Routing	Port 1 on Controller 0	000	Normal		
Virtual Machine Startup/Shutdown	Port 2 on Controller 0	000	Normal		
Virtual Machine Swapfile Location	Port 3 on Controller 0	000	Normal		
	Port 4 on Controller 0	000	Normal		
Security Profile	Port 5 on Controller 0	000	Normal		
System Resource Allocation	Port 6 on Controller 0	000	Normal		
Advanced Settings	Port 7 on Controller 0	000	Normal		
	🖻 🕉 Fan	000	Normal		
	FAN 4 RPM for System Board 1	000	Normal	7275 RPM	
	FAN 3 RPM for System Board 1	000	Normal	7200 RPM	
	FAN 2 RPM for System Board 1	000	Normal	7350 RPM	
	FAN 1 RPM for System Board 1	000	Normal	7425 RPM	
	E I Temperature	000	Normal	101205-0050-004	
	Ambient Temp for System Board 1	000	Normal	18 Degrees C	
	E 🗳 Power	000	Normal		
	Power Supply 1: Running/Full Pow		Normal	750 Watts	
	Power Supply 2: Running/Full Pow	000	Normal	750 Watts	



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## Host CPU Co-Scheduler World





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## **CPU Key Performance Indicators**

### CPU Key Performance Indicators for ESXi Hosts

- Ready Time
- Utilization
- Load Average

### CPU Key Performance Indicators for Virtual Machines

- Ready Time (%RDY)
- Co-Stop (%CSTP)
- Swap Wait (%SWPWT)
- Memory Limited (%MLMTD)



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## Example: Identifying CPU Constraint

The %USED and %RDY columns of the restop command output indicate CPU overcommitment.

	🚽 root									
	10:24:00		p 16:22, 46 world			age 2	.08, 0.78,	0.29		
					1: 100.00					
	CCPU(%):	1 u	s, 2 sy, 97 id	, 01	Ja ;	cs/se	c: 196			
	ID	GID	NAME	NMEM	*USED	₹SYS	*OVRLP	∜ RUN	*WAIT	*RDY
	1	1	idle	2	0.00	0.00	0.00	0.00	0.00	200.00
(	2	2	system	5	0.00	0.00	0.00	0.00	500.00	0.00
	6	6	console	1	4.78	0.00	0.01	4.79	93.80	1.47
	7	7	helper	13	0.01	0.00	0.00	0.01	1300.00	0.02
	8	8	drivers	7	0.01	0.00	0.00	0.01	700.00	0.02
	12	12	vmware-vmkauthd	1	0.00	0.00	0.00	0.00	100.00	0.00
	15	15	memhog-linux-sm	7	64.68	0.00	0.16	64.84	477.30	158.32
	17	17	kernelcompile-u	5	64.44	0.01	0.11	64.74	365.69	69.91
	18	18	memhog-linux	5	65.62	0.00	0.14	65.76	378.65	55.93



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## When to Right Size Virtual Machine vCPUs

### What is Co-Stop?

When a VM with multiple vCPUs must stop processing on one or more vCPUs.

### Why does Co-Stop Occur?

The fastest sibling vCPU stops itself when it's slowest sibling vCPU on the VM violates a threshold. This is due to "skew" between sibling vCPUs. The vCPUs co-start when the slowest sibling begins to make progress. It progresses because scheduling opportunities are available once the fastest vCPUs are co-stopped.

### How do I resolve CPU Co-Stop issues?

Right size your VM's vCPUs. When in doubt, mimic the physical host CPU topology to take advantage of physical/virtual NUMA.

## Consider "Wide and Flat" vCPU allocations.

For configurations for VMs with greater than 8 vCPUs, allocate "X" number of virtual sockets and a single virtual core.



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### The factors Affecting CPU performance are :

- >Multiple cores
- ➤Cache memory,
- $\succ$  clock speed,
- ➤word length,
- ➤address bus width,
- $\triangleright$  data bus width.



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### **Memory Key Performance Indicators:**

- 1. Transparent Page Sharing (TPS)
- 2. Ballooning
- 3. Memory Compression
- 4. Swapping

### VM Memory: (Intra VM and Inter VM)

- 1. Virtual Memory
- 2. Guest Physical Memory
- 3. Physical Memory
- Mem.ShareScanTime
- Mem.ShareScanGHz



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### **Guest Memory Basics:**

✓ Memory Size
✓ Allocated Memory
✓ Active Memory
✓ Idle Memory
✓ Free Memory

### Potential Memory Problems:

✓ Too much / Little vMemory
 ✓ vSwap
 ✓ Balloon
 ✓ NUMA
 ✓ Resource Pools
 ✓ Reservation, Limits and Shares
 ✓ Limited Hosts / VM Memory Resources
 ✓ Too Many VMs on a Host



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If hosts free memory drops toward the following threshold	Threshold	Use the following reclamation technique
High	6%	None
Soft	64% of MinFreePct	Ballooning
Hard	32% of MinFreePct	Ballooning & Compression
Low	16% of MinFreePct	Ballooning, Compression 8 Swapping



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## Key Metrics to Monitor:

## Host swapping

- vSphere Client
  - Memory swap in rate
  - Memory swap out rate
- resxtop/esxtop
  - SWAP / MB
  - SWR/s and SWW/s
  - SWCUR and SWTGT
  - %SWPWT

## Host ballooning

- vSphere Client
  - Balloon
- resxtop/esxtop
  - MEMCTL/MB
  - MCTL?
  - MCTLSZ
  - MCTLTGT

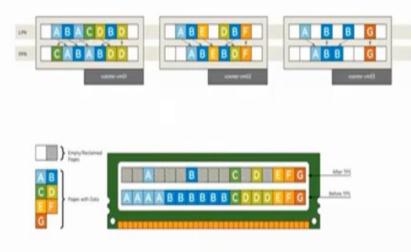


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# Transparent Page sharing (TPS)

Transparent Page sharing shares memory pages on same or across multiple VMs running on the same host.

**Transparent Page Sharing** 



"sched.mem.pshare.salt" – *Controlling the ability to do TPS* 

Mem.ShareForceSalting,0:To enable TPS on all the VM

**Mem.ShareForceSalting**, 1: Preventing VM with other VM by restricting settings

Mem.ShareForceSalting,2:To enable TPS on some specific set of VMs

**vm**ware



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## Ballooning

- Ballooning: can be used when we have VMware Tools running
- Can cause performance increase or decrease as the Guest VM has to use its own memory technique swapping etc.

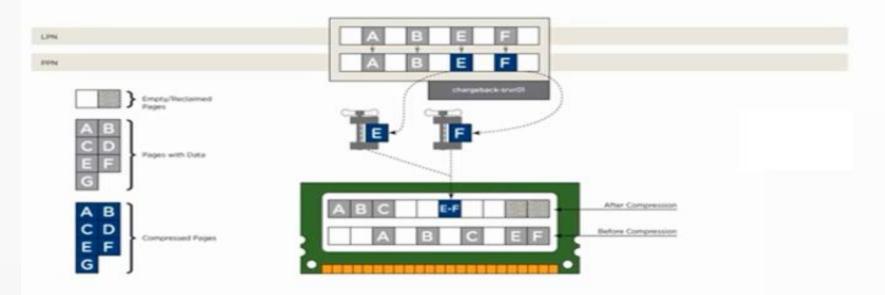
LPN PPN	
A B C D E F Pause (k)	



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### Memory compression

 Host compress the memory but this has an impact as the compress memory takes longer time to get access read / write.





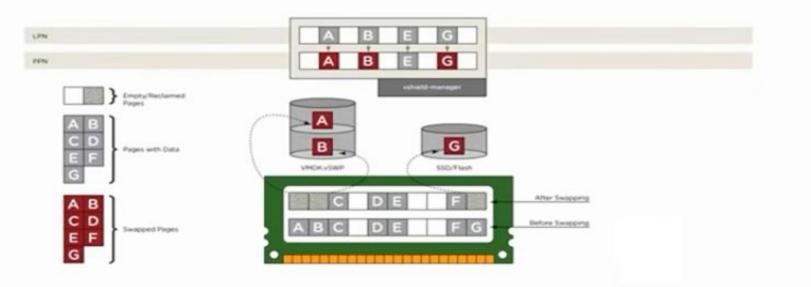


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## Swapping

- Host swapping memory this is used as a last resort as can cause serious performance issues.
- \* The memory is written to the physical disk

### Host Swapping





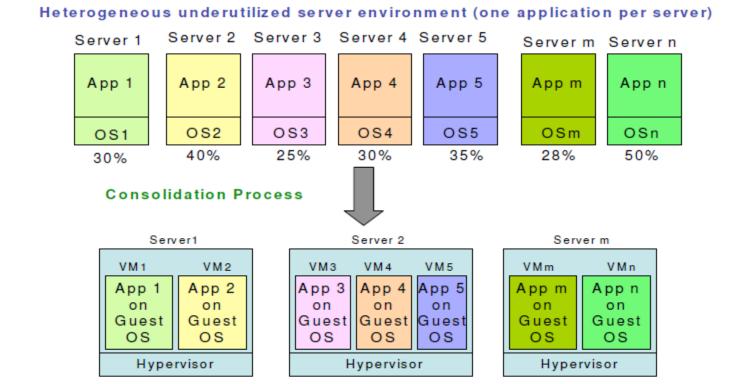


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### **Application Performance Management in Virtualized Server Environments**

1.Server Sprawl 2. Server Virtualization 3. VM Migrations

4. Maintain Levels 5. SAN and SLA



Homogeneous server environment with virtual machines and high utilization



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### **System Management Functions:**

✓ Observation of Performance Key Metrics
 ✓ Dynamic Re-allocation of SLA

### **CPU Contention**

✓ Increase the guest's CPU priority
 ✓ CPU quota
 ✓ Run fewer guests on the host

•Steal Time (/proc/stat → "%st")

•Response Time



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### **Application Performance Issues**

### Symptoms:

- ✓ Services running in guest virtual machines respond slowly.
- ✓ Applications running in the guest virtual machines respond intermittently.
- ✓ The guest virtual machine may seem slow or unresponsive.
- The guest operating system boots slowly
- Applications running in virtual machines perform poorly
- ✓ Applications running in virtual machines take a long time to launch
- ✓ Applications running in virtual machines frequently become unresponsive
- Multi-user services have long transaction times or can handle less simultaneous users than expected

### Causes: (Bottleneck Areas)

- ✓ CPU Constraints
   ✓ Memory Over commitment
   ✓ Storage Latency
- ✓ Network Latency



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### **CPU constraints**

- 1. Examine the *load average* on the first line of the command output. (1.00, 0.5, 2.00)
- 2. Examine the %READY field for the percentage of time that the virtual machine was ready but could not be scheduled to run on a physical CPU. (Under 5%)

•CPU Limit

•Resource Pool

Increase the number of physical CPUs on the host

Decrease the number of virtual CPUs allocated to the host



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### Memory overcommitment:

- 1. Examine the *MEM overcommit avg* on the first line of the command output.
  - ✓ Increase the amount of physical RAM on the host
  - Decrease the total amount of RAM allocated to all of the virtual machines on the host
- 2. Determine whether the virtual machines are ballooning and/or swapping.

### To detect any ballooning or swapping:

- 1. Run esxtop.
- 2. Type **m** for memory
- 3. Type **f** for fields
- 4. Select the letter J for Memory Ballooning Statistics (MCTL)
- 5. Look at the MCTLSZ value

# MCTLSZ (MB) displays the amount of guest physical memory reclaimed by the balloon driver.

- 1. Type **f** for Field
- 2. Select the letter for Memory Swap Statistics (SWAP STATS).
- 3. Look at the SWCUR value. SWCUR (MB) displays the current Swap Usage.



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### Storage Latency:

- Determine whether the problem is with the local storage and Migrate the virtual machines to a different storage location
- ✓ Reduce the number of Virtual Machines per LUN.
- ✓ Look for log entries in the Windows guests that look like this:

The device, \Device\ScsiPortO, did not respond within the timeout period.

- ✓ Using esxtop, look for a high DAVG latency time.
- ✓ Determine the maximum I/O throughput you can get with the iometer command.
- Compare the iometer results for a VM to the results for a physical machine attached to the same storage.



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### Network latency:

 $\checkmark$  Test the maximum bandwidth from the virtual machine with the Iperf tool. ✓ Run Iperf with a machine outside the ESXi/ESX host. (PM Verification) ✓ Run Iperf with another machine outside the ESXI/ESX host on the same VLAN on the same physical switch. (Reproducing problem)  $\checkmark$  Run Iperf between 2 VMs on the same ESX server/portgroup/vswitch.  $\checkmark$  If the result is good, you can exclude a CPU, memory or storage issue. ✓ Proper Configuration ✓ Shares and Limits Configuration ✓ Traffic Shape Configuration