VM Performance Monitoring/Logging

• Although VI3 works proactively to avoid resource contention, maximizing performance requires benchmarking, analysis, and ongoing monitoring

• Before you begin monitoring, you need to define a performance envelope for each VM
  • Performance envelopes will have resource dependencies
  • Performance graphs and esxtop are primary interfaces for monitoring VM resource consumption and availability

• Virtualization assessments are critical to success!

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Document performance requirements per VM (your SLAs)

- Identify metrics you will monitor to ensure SLA is being met
- Identify an optimal numerical value for each metric
- Combined metrics describe the optimal performance envelope for each VM
Monitor for trends which might threaten your SLAs

- Identify metrics which are deviating
- Take action to reverse trends
- Set alarms to notify of deviations which threaten envelope boundaries
Tools for monitoring VM resource use - Graphs

The target (host or VM)

Units

Items being graphed

Export to Excel

Tear off this chart

Modify what is graphed

Statistics for displayed range

For personal informational use only!
Tools for monitoring VM resource use - esxtop

- Use esxtop to analyze ESX Server resource utilization
- Displays CPU utilization by default
- Can display memory, disk or network statistics
  - c  Displays CPU statistics panel
  - m  Displays memory statistics panel
  - d  Displays disk statistics panel
  - n  Displays network statistics panel
  - o, O Specify order of displayed fields
  - f, F Specify displayed statistics for panel
  - <space> Displays disk statistics
  - e  expand/roll up ID - show World IDs
Combining tools – esxtop and vm-support

• Use esxtop with vm-support together to capture and replay performance data while a problem is actually occurring

• Capture performance snapshots
  • `vm-support -S -i 10 -d 600`
  • `-i` Specifies an interval in seconds
  • `-S` Gather performance snapshots only
  • `-d` Specifies a duration in seconds

• Replay performance snapshots
  • `esxtop -R <vm-support-directory-path>`
Systems for optimizing VM CPU resource use

• Automatically managed by VMkernel
  • Load Balancing
  • Hyperthreading

• Configured by VM Owner
  • Virtual SMP – up to 4 VCPUs

• Adjustable by Administrator
  • Limit
  • Reservation
  • Share Allocation
  • Processor Affinity
VMkernel CPU load balancing

- A VM with 1 VCPU runs on only one physical CPU core at a time
- A 2-VCPU VM runs on two cores at a time, or none
- A 4-VCPU VM runs on four cores at a time, or none
- VMkernel dynamically schedules virtual machines and Service Console
  - Every 20 milliseconds, VMkernel looks for VMs to migrate
- Service Console always runs on CPU core 0
VMkernel’s use of Hyper-Threading

Hyper-Threading allows one Xeon or P4 to execute two threads simultaneously

- Each physical CPU presents two logical CPUs ("LCPUs")
- LCPUs are not as powerful as entire cores

VMkernel will intelligently schedule VCPUs onto LCPUs

- CPU-intensive VCPUs will automatically run in different PCPUs
  - The VMkernel refrains from using their PCPUs’ second LCPUs
VM-Specific HT Settings

• Individual VMs usage of hyper-threading can be set
  • Any – default, VM can share cores with others
  • None – VM cannot share cores, halt state invoked
  • Internal – VM’s LCPUs can share cores

• Non-default settings can have performance implications especially on low-CPU-count systems!

• ESX can quarantine “bad actors” by invoking none, or internal
  • Transparent to user disable by setting Cpu.MachineClearThreshold = 0
Are VMs being CPU-constrained? - Graphs

- If VM is constrained by CPU
  - Add shares or increase CPU reservation
  - VMotion this virtual machine
  - Shut down, VMotion, or remove shares from other virtual machines

Task Manager inside VM

VM’s CPU ready graph in VI Client
Are VMs being CPU-constrained? - esxtop

- Use esxtop to analyze ESX Server/VM CPU utilization
  - Display can also be sorted by %Used or %Ready
    - %Used is the actual CPU usage of the VM + overhead
    - %Ready is the time spent in the processor queue (watch above 5%)

```
mark@aluminum01:/opt/LGTOaam512/log
5:46:52pm up 1 day, 4:42, 55 worlds;  CPU load average: 1.53, 1.53, 1.53
PCPU(%): 99.24, 99.69 ; used total: 99.46
LCPU(%): 87.84, 11.40, 51.45, 48.24
CCPU(%): 1 us, 1 sy, 97 id, 0 wa ; cs/sec: 170

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</table>
• Run `vm-support -x` to show VM World IDs
Invoke esxtop and hit the `<e>` key followed by one of the the ids presented to expand and show the world IDs of the running VMs.
vm-support –x, -X, -Z

• vmsupport –x lists the world IDs of the VMs currently running on a given host

• Vm-support –X <world ID> will do some “interesting” things:
  • Generate a series of snapshots (300 seconds worth)
  • Capture a screenshot of the VM
  • Dump the core files/Abort the VM
  • Create a .tar archive in the /home directory of the user

• vm-support –Z <world ID>
  • Similar to –X but suspends the VM and adds the memory state to the core files
• Watch for asymmetrical CPU utilization
• Watch for sustained CPU utilization > %80!
  • IN ESX 3.x CPU loads above 80% will dramatically increase CPU Ready values
CPU Ready - caveats

• The objective of server consolidation is to drive CPU utilization higher.
  • With applications that are somewhat interactive, attempting to drive the utilization beyond 60 to 70 percent may result in a perceptible lag in user activities due to high induced ready time

• Ready time for a process in isolation cannot be identified as a problem.
  • It is normal for a system to accumulate some ready time even when overall CPU utilization is low.

• The best metrics for examining the health of a VM continue to be a combination of:
  • Ready time, CPU utilization, and application response time
## Systems for optimizing VM Memory resource use

- **Automatically managed by VMkernel**
  - Transparent Page Sharing
  - `vmmemctl` (balloon driver)
  - Use of VMkernel swap

- **Configured by VM Owner**
  - Maximum Size

- **Adjustable by Administrator**
  - Limit
  - Reservation
  - Share Allocation
Transparent memory page sharing

- VMkernel detects identical pages in VMs’ memory and maps them to the same underlying physical page
  - More than 30% shared w/ idle Win2K VMs
- No changes to guest OS required
- VMkernel treats the shared pages as copy-on-write
  - Read-only when shared
  - Private copies after write
- Page sharing is always active unless administratively disabled
vmmemct1: the balloon-driver mechanism

- Used to deallocate memory from selected virtual machines when RAM is scarce
- Not used unless there is competition for memory
- VMs with least shares are “balloonened” first and hardest
  - guest is forced to page out to its own paging area
  - VMkernel reclaims memory and distributes it according to shares
  - When memory demand eases, balloon deflates, guests can page in
VMkernel swap

• Each powered-on VM needs its own VMkernel swap file
  • Automatically allocated on first power-on
  • Default location: same VMFS volume as virtual machine’s boot disk
  • Size equal to the difference between the memory guaranteed to it, if any, and the maximum it can use
  • This file lets the VMkernel swap the VM out entirely if memory is scarce

• Use of VMkernel swap is a last resort
  • Performance will be noticeably slow
Are VMs being memory-constrained? - graph

**Performance Chart Legend**

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<tr>
<th>Key</th>
<th>Object</th>
<th>Measurement</th>
<th>Units</th>
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</table>

- If VM is constrained by memory
  - Add shares or raise memory reservation
  - VMotion this virtual machine
  - Shut down, VMotion, or remove shares from other virtual machines

**Task Manager inside VM**

**Check for high ballooning activity**
Are VMs being memory-constrained? - esxtop

- Use esxtop to analyze ESX Server/VM MEM utilization
  - Check the memory overcommitment values for the last 1-, 5-, and 15-minute intervals (Mem Overcommit average)
    - Value of 1.00 = 100% memory overcommitment
  - Check swap and ballooning activity
  - Paging > 200 – 300 I/O per second warrants investigation
Systems for optimizing VM disk resource use

- Not Automatically managed by VMkernel
- Configured by VM Owner
  - Distribution of VMDK files across SAN/VMFS infrastructure
- Adjustable by Administrator
  - Share Allocation
  - Shares are per host per LUN!

- Disk I/O is a big cause of VM performance problems
- VMkernel has no dynamic load balancing for FC SAN
- IP storage (iSCSI and NAS) complicates the picture
- DRS does not consider Disk and Network for dynamic load balancing calculations, so you have to!
Are VMs being disk-constrained? - graph

Do not excerpt or reproduce

- Disk-intensive applications can saturate the storage or the path
- If you suspect that a VM is constrained by disk access
  - Measure the effective bandwidth between VM and the storage
  - Measure the resource consumption using performance graphs
- To improve disk performance
  - Ensure VMware Tools is installed
  - Reduce competition
    - Move other VMs to other storage
    - Use other paths to storage
  - Reconfigure the storage
    - Ensure that the storage’s RAID level and cache configuration suit the application

For personal informational use only!
RAID attributes and LUNs/VMFS

- Capacity in storage subsystems is not simply a question of “space”
  - I/O intensive multi-threaded workloads love more disks
  - Random read-write workloads need more disks to scale well
- RAID-10 has ~50% more throughput than RAID-5 for random read/write workloads with a high % of writes
  - RAID-10 uses 2 physical disk I/O ops. per logical write request
  - RAID-5 uses 4 ops.
- Distribute VM’s .vmdk files accordingly
- Be careful using VMFS extents!
Are VMs being disk-constrained? - esxtop

Use esxtop to analyze ESX Server/VM disk utilization

Check:

- **LOAD** (Ratio of ESX Server VMKernel active commands plus ESX Server VMKernel queued commands to queue depth (adapter, LUN or world)).
- **ACTV** (Number of commands in the ESX Server VMKernel that are currently active)
- **QUED** (Number of commands in the ESX Server VMKernel that are currently queued) average >3 is worth investigating
Are VMs being disk-constrained? – esxtop-1

Do not excerpt or reproduce

- Use esxtop to analyze ESX Server/VM disk utilization

- Check:
  - Latency should be < 20ms transfer time for physical disk
  - Split I/Os should be < 1% of total disk I/O
Systems for optimizing VM network resource use

- Not Automatically managed by VMkernel
- Configured by VM Owner
  - VMware Tools installed
  - Connected to vSwitch with adequate resources
- Adjustable by Administrator
  - Traffic Shaping

- Two possible choke points
  - Regular TCP/IP “talk path” issues
  - IP storage performance issues
- IP storage resources are presented to the VM as local SCSI disk(s), same as FC storage resources.
  - Network resource saturation can have a “double whammy” effect
Are VMs being network-constrained? - graph

• Network-intensive applications will often bottleneck on path segments outside ESX Server
  • Example: WAN links between server and client

• If you suspect that a VM is constrained by the network
  • Confirm VMware Tools is installed
  • Measure the effective bandwidth between VM and its peer system
  • Examine performance graphs

• To improve network performance
  • Move VMs to another physical NIC
  • Traffic-shape other VMs
  • Reduce overall CPU utilization

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Are VMs being network-constrained? – 1

- Investigate network spikes
  - Keep a “penalty box” traffic shaped port group for bad actors
- Heavy network I/O can saturate CPU
  - CPU saturation can affect network performance too
- If you see network saturation – do something!
  - Add NICs to the team
  - Traffic shape less important VMs
Are VMs being network-constrained? - esxtop

- Use esxtop to analyze ESX Server/VM Network utilization
- Check:
  - %DRPTX Percentage of transmit packets dropped.
  - %DRPRX Percentage of receive packets dropped

```
mark@aluminum01:/home/mark

8:44:06pm up 1 day, 7:39, 55 worlds; CPU load average: 0.03, 0.03, 0.03

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```
Using alarms

VirtualCenter alarms report changes in host or VM state

But, they need thresholds that **mean something**!

Alarms are indicated in the inventory

Status determined by threshold levels in alarm definition

View of VMs’ CPU and memory utilization on selected host

For personal informational use only!

For personal informational use only!
Creating a VM-based alarm

- Right-click on a VM and choose “Add Alarm…”

**Name and describe the new alarm**

- Click any field to modify

**Percentages**

- Powered on, powered off, suspended

For personal informational use only!
Creating a host-based alarm

- Right-click on a host and choose “Add Alarm…”

Name and describe the new alarm

Click any field to modify

Percentages Connected, disconnected, not responding
Alarm reporting options

- Use the **Reporting** pane to avoid needless re-alarms

![Alarm Settings](image)

- Avoid small fluctuations
- Avoid repeats
Actions to take when an alarm is triggered

- Use the **Actions** pane to send external messages or to respond to problems proactively

*Only available for VM-based alarms*
Using alarms to monitor CPU and memory usage

• Default alarms, defined at the top of the inventory

• Add custom alarms anywhere in the inventory
Configure VC notifications

- Choose **Administration ➔ Server Settings**
- Click **Mail** to set SMTP parameters
- Click **SNMP** to specify trap destinations
Collecting Log Files

**Recommended processes**

- Use “Export Diagnostics Data” via VI Client
- Can be used when logged into VC or an individual ESX host
- Browse to place the vcsupport-date-time.zip file

**Use the Generate VirtualCenter Server log bundle program**

- The result vcsupport-date-time.zip file is placed on the VC Server desktop
- All Programs -> VMware -> Generate VirtualCenter log bundle

**If this way fails to transfer the dumps the dump files are located in**

- /var/lib/vmware/hostd/docroot/downloads
- Archive name: esxsupport-*.tgz
Collecting Log Files

• Alternative methods
  • Manually execute `vm-support` on the ESX Server host
    • Gathers individual ESX host logs and config. Information
    • `-w` sets the working directory for `vm-support`
    • `-f` can force it to be a VMFS!
  • Manually execute `vc-support.wsf` on VirtualCenter Management Server
    • Gathers VMware Registry keys
    • `vpxd.cfg` file
    • Windows event logs
    • Crash dumps, DRS dumps
    • Installation/upgrade logs, database logs and VI client logs
Controlling VM Logs

Number of log files kept

Max log file size
Stopping VM Logging

Uncheck

Disable VMware Tools logging
VirtualCenter Installation Logs

- Install logs are located in the `%TEMP%` directory of the user that installed software
  - vmllic.log - test results for served license file during install
  - redist.log - MDAC and QFE rollup install results
  - vmmsde.log - MSDE installation log
  - vmls.log - License server installation log
  - vmosql.log - Creation of database/trans logs for VCDB
  - vminst.log - Log of VC server installation and subtasks
  - VCDatabaseUpgrade.log - Details of upgrading from VC 1.x DB
  - vmmsi.log - VI client installation log
VirtualCenter Log File Locations - \textit{vpxd} Logs

- **Location**: \texttt{%TEMP\%\textbackslash vpx}
  - \texttt{%USERPROFILE\%\textbackslash Local Settings\textbackslash TEMP\#}
  - \texttt{%USERPROFILE\%\textbackslash Local Settings\textbackslash TEMP}
  - \texttt{%SystemRoot\%\textbackslash Temp}
- **Naming**: \texttt{vpxd-#.log} (# is one digit, 0-9)
- \texttt{vpxd-index} contains the # of the currently active log file
- Logs rotate each time \texttt{vpxd} is started, and also when it reaches 5 MB in size
VirtualCenter Log File Locations - vpxa Logs

- VC agent on ESX host
- Location: /var/log/vmware/vpx
- Naming: vpxa-#.log (# is one digit, 0-9)
- vpxa.cfg can be used to modify logging behavior
Log Options for vpxd & vpxa

Modify the vpxa and vpxd configuration files to control logging

- C:\D and S\All Users\Application Data\VMware\VMware VirtualCenter\vpxd.cfg
- etc/vmware/vpxa.cfg files to enhance logging

Parameters:
- Level - Can be trivia, verbose, info, warning, error, or none
- maxFileSize - Maximum log file size in bytes
- maxFileNum - Number of log files held
Miscellaneous VirtualCenter Log File Locations

• Core dumps
  • %USERPROFILE%\Application\Data\VMware

• License Server
  • %ALLUSERSPROFILE%\Application Data\VMware\VMware License Server\lmgrd.log
  • Resets each time the service starts; no rotation

• DRS
  • %TMP%\vpx\drmdump\cluster#
  • 20MB or up to 200 log files “#purposeActions.dump”

• Remote Console
  • %TEMP%\vmware-%USERNAME%\ vmware-%USERNAME%-pid.log

• Web Access
  • C:\Program Files\VMware\VMware VirtualCenter 2.0\tomcat\logs
VI Client Log File Locations - VI Client Logs

- **Location**: %TEMP%\vpx
- **Naming**: viclient-#.log (# is one digit, 0-9)
- Logs rotate each time VI Client is started
VMotion Errors

• VMotion errors in the vpxd and vpxa logs are tagged with “[MIGRATE]”. For example:

  [2006-06-07 16:11:17.627 ‘App’ 1864 error] [MIGRATE]
  (474991424) VMotion failed:

  • Migration ID appears in parenthesis after [MIGRATE]
  • log messages found in vpxd, vpxa, hostagent and VMX logs
  • Migration ID is also used to identify VMotions in
    • /proc/vmware/migration/history
VMware HA Logging

Check logs:

- `/opt/LGTOaam512/log/*`
- Some HA cluster information is logged to the vpxd log file (on the VirtualCenter Management server)
- Check the `/var/log/vmware/vpx/vpxa.log` file on the ESX Server host

Command-line tools may also be helpful

- `tail -f <log_file>`
VMware HA Host Naming and Addressing

A list of hosts that exist in the cluster can be found in /opt/LGTOaam512/config/vmware-sites

AAM creates a cached copy of the /etc/hosts file called /etc/FT_HOSTS

It may be necessary to delete this file and click “Reconfigure for HA”
License Server logs

Check the log file in:

- %ALLUSERSPROFILE%\Application Data\VMware\VMware License Server\lmgrd.log

Log viewer is also available in LMTOOLS under the “Config Services” tab

Check the log under:

- %ALLUSERSPROFILE%\Application Data\Macrovision\FLEXlm

Check the “Server Diags” tab in LMTOOLS. Click on "Perform Diagnostics" to see all licensed features and details
ESX Server 3.x License Configuration

- `/etc/vmware/license.cfg`
  - Contains host license configuration

- `/etc/vmware/vmware.lic`
  - Contains the unserved license file as uploaded by the VI Client
  - This file is a zero-byte file when licenses are obtained using a license server only