Using esxtop to Troubleshoot Performance Problems

The VMware esxtop tool provides a real-time view (updated every five seconds, by default) of ESX Server worlds sorted by CPU usage. The term world refers to processes running on the VMkernel. There are three types of worlds:

- **System**: The worlds that are needed to perform various system services. These include one idle world per physical CPU that runs when there is nothing else to run on that physical CPU, helper worlds for performing asynchronous tasks and driver worlds.

- **Service Console**: The world for the service console. It always runs on physical CPU0.

- **Virtual Machine**: The world for each virtual CPU. This is the world you look at when troubleshooting.

Also, esxtop displays information about the state of the physical server running an ESX Server. It lists CPU utilization for each physical processor, memory utilization, and disk and network bandwidth for each network and disk device available to the ESX Server machine.

Furthermore, esxtop lists CPU and memory utilization for each individual VMkernel world. Memory utilization is characterized by the type of memory (for example, shared, private, or swapped) that is being consumed. These CPU and memory statistics let you monitor the resource utilization for each of your virtual machines.

The following sections describe the process for troubleshooting a suspected performance problem at the virtualization layer (i.e., the ESX Server layer):

- Using esxtop on page 2
- Other Tools on page 6
Using esxtop

This section describes the necessary steps to troubleshoot your ESX Server machine performance problems using esxtop. The steps are:

- Getting Started
- Starting esxtop
- Examining CPU Usage
- Assessing Memory Usage
- Assessing Disk and Network Usage
- Exiting esxtop

Getting Started

Do the following before you start to troubleshoot a problem using esxtop:

1. Log on to the VMware Management Interface for the ESX Server machine in question. Refer to the online document, Logging Into the VMware Management Interface, for details.
   In the status monitor, under Virtual Machines, note the virtual machine IDs (or VMIDs) for all virtual machines running on the server.

   **Virtual Machines (6)**

<table>
<thead>
<tr>
<th>HB</th>
<th>Display Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ts-services eroom w2k server (DON'T DELETE) Powered on</td>
</tr>
<tr>
<td></td>
<td>Linux 100MB Powered off</td>
</tr>
<tr>
<td></td>
<td>w2k3entopen.dsk Powered off</td>
</tr>
<tr>
<td></td>
<td>supp073-VirtualCenter 1.0.0 Powered off</td>
</tr>
<tr>
<td></td>
<td>Debian31 with Apache Suspeaxed</td>
</tr>
<tr>
<td></td>
<td>supp072-VirtualCenter 1.1.1 Powered on</td>
</tr>
</tbody>
</table>

   Partial screen shot of the VMware Management Interface showing virtual machine IDs

2. Make certain you have an secure shell (SSH) client. Windows users can get a free SSH client from [http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html](http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html).

3. If you have ESX Server version 2.0.x, refer to the VMware Knowledge Base Answer ID 1078 for instructions on downloading and installing the VMware performance monitoring tools, esxtop and vmkusage. ESX Server version 2.1 and higher include esxtop and vmkusage. See Using vmkusage to Isolate Performance Problems on page 6 for a description of vmkusage.

Starting esxtop

Perform the following steps to start and set up esxtop.
1. Using a secure shell (SSH), log on to the ESX Server machine as root.
2. Enter `esxtop` in the SSH command line. The `esxtop` display appears.

   10:00:35am up 22:08, 16 users, load average: 0.05, 0.01, 0.00, 0.00
   CPUs: 3.99%, 1.95% = 2.72% used total
   CPUs: 3.97%, 0.43%, 1.91%, 0.04%
   Net: 3.0996% managed (MB), 27.03% free (KB) = 63.88% used total
   SWAP: 8.07% used (MB), 90.78% free (KB) = 0.00 MB/s, 0.00 MB/s
   VDISK vmba0:1: 0.00 r/s, 0.00 w/s, 0.00 MB/s, 0.00 MB/s
   VDISK vmba0:0: 0.00 r/s, 0.00 w/s, 0.00 MB/s, 0.00 MB/s
   NIC vml0: 0.00 r/s, 14.55 p/s/s, 0.00 MB/s, 0.01 MB/s

   CPU用了 1001: 0.00 p/s, 14.55 p/s/s, 0.00 MB/s, 0.01 MB/s

   VCPU   PID VTYPE VMEM RESERVE MAINT    VMEM
   128  128 idle  50.83 0.00 50.83 0.00
   128  128 idle  45.77 0.00 45.77 0.00
   128  128 idle  43.14 0.00 43.14 0.00
   127  127 console 2.31 0.00 2.31 0.00
   143  143 vmm 2.19 0.30 2.19 3.00
   143  143 vmm 2.75 0.32 2.75 3.00
   140  140 driver 0.00 0.00 0.00 0.00
   139  139 eset 0.00 0.00 0.00 0.00
   139  139 eset 0.00 0.00 0.00 0.00
   133  133 Buffer 0.00 0.00 0.00 0.00
   133  133 Buffer 0.00 0.00 0.00 0.00

   Note: The `esxtop` tool includes several interactive commands. To view a list of the interactive commands, enter h.

3. Enter the `r` command. The Field Select page appears.

   Current Field Order: ABCDEfghijklmnopqrstuvwxyz
   Toggle Fields with a-x, any other key to return: i

   * A: VCPUs = CPU Id
   * B: VMs = VM Id
   * C: VCPUs = VCPUs Type
   * D: VMs = VM Name
   * E: READY = CPU Ready
   * f: VCPUs = CPU System
   * g: UNIT = CPU Unit
   * h: CPU = CPU Last Used
   * i: AFFINITY = CPU Affinity
   * j: HIERARCHY = CPU Hierarchy
   * k: MIN = CPU Shares Min
   * l: MAX = CPU Shares Max
   * m: SHARED = CPU Shares Allocated
   * n: SHARED = CPU Shares Effective Min
   * o: EFFECTIVE = CPU Effective Usage
   * p: FREE = FREE On Efficiency
   * q: UNHAND = UNHAND On Efficiency
   * r: SWAP = SWAP On Efficiency
   * s: SWAP = SWAP Min (MB/s)
   * t: SWAP = SWAP Min (MB/s)
   * u: THP = THP On Efficiency
   * v: SHARED = SHARED On Efficiency
   * w: PRIV = PRIV On Efficiency
   * x: OVERHEAD = OVERHEAD On Efficiency

4. Enter r to toggle on the SWPD field.
5. Press any key other than a through x to see the esxtop display again.

<table>
<thead>
<tr>
<th>Time</th>
<th>CPU</th>
<th>Load Average</th>
<th>Memory Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:32pm up 1 day, 11:32, 15 minutes, load average: 0.94, 0.03, 0.03, 0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPUS</td>
<td>5.88s</td>
<td>4.13s</td>
<td>3.77s</td>
</tr>
<tr>
<td>UCPU</td>
<td>0.24s</td>
<td>1.87s</td>
<td>2.31s</td>
</tr>
<tr>
<td>MMU</td>
<td>88,094 managed KB, 271360 free KB : 88.11% used total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWAP</td>
<td>0KB free, 103780 KB used</td>
<td>0.00 MB/s, 0.00 MB/s</td>
<td></td>
</tr>
<tr>
<td>TASK</td>
<td>0.00 MB/s, 6.72 KB/s, 0.00 MB/s, 0.02 MB/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIC vmnic0: 0.00 pK/s, 33.70 pK/s, 0.00 MB/s, 0.02 MB/s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIC vmnic0: 0.00 pK/s, 33.70 pK/s, 0.00 MB/s, 0.02 MB/s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** You can also run esxtop in batch mode. For example, use the command:

```
[root]# esxtop -b -n iterations > logfile.
```

For detailed command reference information, enter man esxtop on the SSH command line.

**Examining CPU Usage**

This section describes how to assess system CPU loading, percentage of individual CPU use and individual virtual machine CPU use.

**Load Average Line**

Examine the load average on the first line to determine the amount of use for all physical CPUs on the ESX Server machine. The load averages are displayed for five-second, and one-, five- and fifteen-minute intervals.

A load average of 1.00 means that the ESX Server machine's physical CPUs are fully utilized, and a load average of 0.5 means they are half utilized. On the other hand, a load average of 2.00 means that you either need to increase the number of CPUs or decrease the number of virtual machines running on the ESX Server machine because the system as a whole is overloaded.

**PCPU Line**

Examine the PCPU line for the percentage of individual physical CPU use for CPU0 and CPU1 respectively (for a dual-processor machine). The last value is the average percentage for all of the physical CPUs.

As a rule of thumb, 80.00% is a desirable usage percentage, but bear in mind that different organizations have varying standards with respect to how close to capacity they run their servers. 90% should be considered a warning that the CPUs are approaching an overloaded condition.
You can enter the interactive c command to toggle the display of the PCPU line. If hyper-threading is enabled, the LCPU line appears whenever the PCPU line is displayed. The LCPU line shows the logical CPU use.

**Virtual Machine CPU Usage**

A virtual machine world is listed as vmm in the WTYPE column. The world ID (WID) corresponds to the VMID in the VMware Management Interface Status Monitor (see Getting Started on page 2). For virtual machines with one virtual CPU (VCPU), the VCPUID and WID is the same. For virtual machines with two VCPUs, there are two VCPUIDs associated with one WID. For example:

<table>
<thead>
<tr>
<th>VCPUID</th>
<th>WID</th>
<th>WTYPE...</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
<td>135</td>
<td>vmm...</td>
</tr>
<tr>
<td>136</td>
<td>135</td>
<td>vmm...</td>
</tr>
</tbody>
</table>

Use the WID and VMID values as cross references to identify a specific virtual machine's display name.

Use the following steps to assess virtual machine CPU usage.

1. Examine the %READY field for the percentage of time that the virtual machine was ready but could not get scheduled to run on a physical CPU. Under normal operating conditions this value should remain under 5%.

2. Examine the %USED field for the percentage of physical CPU resources used by a VCPU. If the physical CPUs are running at full capacity, you can use %USED to identify a virtual machine that is using a large amount of physical CPU resources.

3. Examine the %EUSED field for the percentage of the maximum physical CPU resource usage a virtual machine is currently using. The %EUSED value is calculated as follows:

   \[
   \%EUSED = \%USED \times (\text{# of VCPUs} \times 100) / \text{max}
   \]

   In this formula:
   - \# of VCPUs is the number of VCPUs configured in a virtual machine.
   - max is the maximum percentage of CPU resources allocated to a virtual machine. The default is 100.

   The following table shows how %EUSED increases as the value of max decreases for a virtual machine with a constant physical CPU usage of 40% (i.e., %USED = 40).

<table>
<thead>
<tr>
<th>%USED</th>
<th>Number of VCPUs</th>
<th>Maximum % of Physical CPU Allocated</th>
<th>%EUSED (in Bold)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>1</td>
<td>100</td>
<td>40*{(1*100)/100 = 40}</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>80</td>
<td>40*{(1*100)/80 = 50}</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>50</td>
<td>40*{(1*100)/50 = 80}</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
<td>40</td>
<td>40*{(1*100)/40 = 100}</td>
</tr>
</tbody>
</table>

%EUSED is an useful indicator of how close a virtual machine is to saturating the physical CPUs. If a virtual machine consistently saturates the physical CPUs (i.e., it uses 100% of the physical CPU resources), you can fix it by either:

- Decreasing the number of virtual machines running on an ESX Server machine.
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- Moving the virtual machine to a different ESX Server machine that has more physical CPU resources, and increasing the value of max.

Assessing Memory Usage

Look at the percentage of maximum memory actively used by a virtual machine listed in the %MEM column. Also, note the amount of swapped memory used by a virtual machine listed the SWPD column. Using some swap space is not necessarily bad, because the pages swapped out could be inactive; however, the use of swap space is a clue that you could be losing performance due to active swapping. If the swap percentage increases, there could be a performance problem. If the maximum system memory or swap space is exceeded, additional virtual machines will not power up and you may need to reconfigure memory and swap space.

Assessing Disk and Network Usage

Examine the DISK and NIC lines for disk activity. If the throughput is either not meeting expectations or approaching the maximum capacity of the hardware device, there is a potential for a performance bottleneck.

Exiting esxtop

Enter q to exit esxtop.

Other Tools

Using vmkusage to Isolate Performance Problems

The vmkusage tool displays historical graphs that show physical server and virtual machine system statistics. These graphs show the most recent data, as well as daily and weekly views. The tool generates the graphs as Web pages that you can view by going to http://<ESXservername>.<your_company>.com/vmkusage.

The data is collected every minute, and the graphs are refreshed every five minutes. The Web pages generated by the vmkusage tool show CPU utilization and memory utilization, as well as network and disk bandwidth. You can use this information to isolate performance problems.

Using the VMware Management Interface to Detect CPU and Memory Performance Problems

The VMware Management Interface is a Web-based management tool that lets you monitor the status of virtual machines running on an ESX Server machine. Refer to the ESX Server 2 Administration Guide for a complete description of using the VMware Management Interface.

To use the VMware Management Interface:

- You must know the ESX Server machine’s name or IP address.
- You must have a valid user name and password on that server.

Status Monitor

The status monitor provides system and virtual machine status information that is averaged over five minutes and is refreshed every 90 seconds. Status indicators that are consistently red indicate a system or virtual machine configuration or capacity problem.
Memory
The Memory page displays system and virtual machine memory and swap space information. As with the status monitor, information in red indicates a problem with the system or virtual machine configuration or capacity.