Best Practices for Monitoring Databases on VMware

Dean Richards
Senior DBA, Confio Software
Who Am I?

- 20+ Years in Oracle & SQL Server
  - DBA and Developer
  - Worked for Oracle Consulting
  - Specialize in Performance Tuning
  - Oracle, SQL Server, Sybase, DB2 on VMware

- Product Architect and DBA for Confio Software
  - DeanRichards@confio.com
  - Makers of Ignite8 Response Time Analysis Tools
  - IgniteVM for Oracle/SQL/Sybase/DB2 on VMware
Agenda

- Virtualization at Confio
- Terms and Concepts
- Best Practices for Monitoring:
  - Memory
  - CPU
  - Storage
  - Network
- Summary
Why Virtualize?

- Too much physical horsepower
  - Most are drastically underutilized
  - Many are running at <10% CPU
  - Confio Before Virtualization - Pictures
  - Confio After Virtualization - Pictures
Confio “Datacenter”

- 50+ Small Machines
Server Utilization

- All machines are severely underutilized
- Most machines running at 1-5% CPU
Confio New “DataCenter”

- Here is what we virtualized everything to.
New VMware Server Utilization

- New utilization of larger servers
  - We still have a lot of room
Why Virtualize?

- Easier to manage fewer physical boxes
  - Manage physical resources on 2, 4 or 8 physical machines vs. 50-100 small boxes
  - vMotion enables automatic resource balancing

- Cheaper
  - More bang for the buck with bigger machines
  - Increased power efficiency
  - Less floor space
Databases on VMware

- Typically are supported by Database Vendor
  - If you have problems, vendor may ask you to reproduce on physical hardware
  - No bugs in any vendor support site related to VMware

- Most (95% says VMware) databases instances will be similar to native performance
  - [http://tinyurl.com/3e446rg](http://tinyurl.com/3e446rg) - TPC for Oracle
  - Fully saturated instances - 2-10% overhead
  - But, new hardware may be 10-30% faster

- Deploying databases on VMware is very similar to using physical servers
  - Monitoring the whole stack will take some change
VMware Architecture

- Picture courtesy of VMware
VMware Clusters

May be required to license all physical machines of cluster for the database

Picture courtesy of VMware
ESX and ESXi – the hypervisor and foundation for VMware products

Physical Host – underlying hardware where ESX is installed

Virtual Machine (VM) – container inside host that looks like a physical machine

vCenter Server – centralized management

vSphere Client – Admin and Monitoring
Concepts - Cluster

- Cluster – several physical hosts linked together
- vMotion – live migration of VM from one host to another – no loss of connectivity
- Distributed Resource Scheduler (DRS) – can automatically make sure hosts in a cluster have a balanced workload – uses vMotion
- High Availability (HA) – automated restart of VMs after host failure – several minutes of downtime
- Fault Tolerance (FT) – a mirrored copy of a VM on another host – takes over with no downtime
- Consolidated Backup – (VCB) – integrates with several 3rd party tools to backup a snapshot of the VM
Monitoring - vSphere

- Get access to vSphere client
  - Need a user account
  - http://<machine> - provides download link

- Why should I use vSphere?
  - Standard O/S Counters may be wrong!
Special Perfmon Counters on Windows VMs
### General
- **Manufacturer:** Dell Inc.
- **Model:** PowerEdge T610
- **CPU Cores:** 8 CPUs x 2.26 GHz
- **Processor Type:** Intel(R) Xeon(R) CPU E5520 @ 2.27GHz
- **Processor Sockets:** 2
- **Cores per Socket:** 4
- **Logical Processors:** 16
- **Hyperthreading:** Active
- **Number of NICs:** 2
- **State:** Connected
- **Virtual Machines and Templates:** 35
- **VMotion Enabled:** yes
- **VMware EVC Mode:** Disabled
- **FaultTolerance Enabled:** no
- **Active Tasks:**
- **Host Profiles:**
- **Profile Compliance:** N/A

### Resources
- **CPU usage:** 6064 MHz
- **CPU Capacity:** 8 x 2.26 GHz
- **Memory usage:** 35756.00 MB
- **Memory Capacity:** 49139.55 MB

### Datastores
- **Datastore:** Warning
  - Status: 1.36 TB
  - Capacity: 341.12 MB
- **NFS_Datastore:** Normal
  - Status: 125.02 GB
  - Capacity: 104.11 GB
vSphere – VM Performance
Memory Concepts

- **Configured** – amount of RAM given to VM
- **Reservation** – guarantees amount of RAM (default 0)
  - A reservation of 2GB means 2GB of physical memory must be available to power on the VM
- **Limit** – limits amount of RAM (default unlimited)
- **Shares** – priority of getting RAM
- **Ballooning** – unused memory that was given back for use on other VMs
- **Swapping** – memory (could be active) given back forcibly for use on other VMs
- **Shared Memory** – identical memory pages are shared among VMs
How does memory allocation work
VM Memory Details

Host Memory

- Consumed: 2.01 GB
- Overhead Consumption: 78.00 MB

Guest Memory

- Private: 1.92 GB
- Shared: 3.94 GB
- Swapped: 0.00 MB
- Compressed: 0.00 MB
- Ballooned: 0.00 MB
- Unaccessed: 139.00 MB
- Active: 491.00 MB

Resource Settings

- Reservation: 1.00 GB
- Limit: 2.00 GB
- Configured: 6.00 GB
- Shares: Normal (61440)
### Host Memory Utilization

#### CPU
- Configured Reservation: 0 MHz
- Reservation Type: Expandable
- Used Reservation: 2000 MHz
- Available Reservation: 11850 MHz

#### Memory
- Configured Reservation: 0 MB
- Reservation Type: Expandable
- Used Reservation: 1620.98 MB
- Available Reservation: 25666.62 MB

#### View
- CPU
- Memory
- Storage

<table>
<thead>
<tr>
<th>Name</th>
<th>Reservation - MB</th>
<th>Limit - MB</th>
<th>Shares</th>
<th>Shares Value</th>
<th>% Shares</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEBOX2</td>
<td>0</td>
<td>Unlimited</td>
<td>Normal</td>
<td>30200</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>SEBOX1</td>
<td>0</td>
<td>Unlimited</td>
<td>Normal</td>
<td>30200</td>
<td>24</td>
<td>N/A</td>
</tr>
<tr>
<td>Dean_Win2008_64</td>
<td>1024</td>
<td>3072</td>
<td>Normal</td>
<td>61440</td>
<td>50</td>
<td>N/A</td>
</tr>
</tbody>
</table>
O/S Counter Problem

This is what the O/S thinks, but it is based on 6GB. Because of 2GB limit, the correct utilization is 83%.
Database Tips with Memory

- Set Memory Reservation $\geq$ Database Memory
  - If limits are used, do not exceed this amount for DB
  - Leave room for O/S and other things
- Be careful about overcommitting in production
  - Can be less careful in dev/test/stage
- Set CPU/MMU Virtualization to Automatic
  - Use hardware assisted memory management if you can
- Large Pages are Supported in VMware
Charts in vSphere
Monitoring - Memory

- Primary Metric – Swapping, Ballooning
- Secondary Metrics – VM & Host Memory Utilization, VM Memory Reservation, VM Memory Limit

Rules
- If Any Swapping is occurring
  - Host needs more memory because it cannot satisfy current demands
  - Lessen demands for memory – lower reservations where possible
- Excessive Ballooning
  - May be ok for now, but could be a pending issue
- VM Memory Utilization High
  - May not be a problem now unless Guest O/S swapping is occurring
  - If VM is limited, may want to increase memory this VM can get
- If Host Memory Utilization High
  - May not be a problem now if no swapping or ballooning
  - Could be a problem soon for all VMs on this host
CPU Concepts

- Configured – Number of vCPU
  - Think in terms of clock speed (# vCPU * GHz)
- Reservation – amount of CPU guaranteed
- Limit – limits the amount of CPU
- Shares – sets priority for this VM
- Databases are not typically CPU bound
  - Use only the vCPUs required
  - If not known, start with 1 or 2 and increase later
  - vSphere attempts to co-schedule CPUs
  - If you have 4 vCPU, 4 physical cores need to be available to start processing
  - This is handled much better in ESX 4.x
VM CPU Utilization

CPU

Host CPU

0 MHz

- Consumed: 338.00 MHz
- Active: 338.00 MHz

Resource Settings

- Reservation: 2.00 GHz
- Limit: 3.00 GHz
- Shares: Normal (2000)

Help

Edit
VM CPU Details

Configuration Issues
The default password for the root user on the host seesxbox.confio.local

General
- Manufacturer: Dell Inc.
- Model: PowerEdge T605
- CPU Cores: 8 CPUs x 1.994 GHz
- Processor Type: Quad-Core AMD Opteron(tm) Processor 2350
- License: vSphere 4 Enterprise Plus Licensed for 2 physical CPU...
- Processor Sockets: 2
- Cores per Socket: 4
- Logical Processors: 8
- Hyperthreading: Inactive
CPU Metrics

- Primary Metric – VM Ready Time
- Secondary Metrics – VM CPU Utilization, Host CPU Utilization
- Rules
  - If VM Ready Time > 10-20%
    - If Host CPU Utilization is high => Need more CPU resources on Host
    - If Host CPU Utilization ok => VM is limited, give more CPU resources
  - If VM CPU Utilization high (sustained over 80%)
    - May not be a problem now if no ready time
    - Could be a problem soon for this VM
  - If Host CPU Utilization high (sustained over 80%)
    - May not be a problem now if no ready time on any VM
    - Could be a problem soon for all VMs on this host
    - Balance VM resources better
Storage Concepts

- The VM is a set of files on shared storage
- All nodes of cluster will access the same storage
- VMFS - VMware File System
- Datastore – access point to storage
- Storage issues are usually related to configuration and not capabilities of ESX
- Follow best practices from storage vendor
- Create dedicated datastores for databases
  - More flexibility
  - Bad SAN planning cannot be fixed by datastores
  - Isolate data and log activity
Monitoring - Storage

- **Primary Metrics** – Host maxTotalLatency, Host Device Latency (by device), VM Disk Commands Aborted, VM Command Latency

- **Secondary Metrics** – Host Disk Read Rate, Host Disk Write Rate, VM Disk Usage Rate

- **Rules**
  - If Host Latency >= 20-30 ms
    - Review Device Latencies to understand which one has latencies
    - Review Disk Read / Write rates
    - If Close to Storage Capacity - Overloaded Storage
    - Otherwise - Slow Storage
  - If VM Command Latency >= 30ms only for your VM
    - Tune Disk I/O intensive processes on database
    - Are Memory / CPU issues causing I/O problems
Network Concepts

- vSwitch – software switch inside Vmkernel
  - Can be tied to 1 or more NICs
- VMware can handle > 30GB / sec
- Databases are not typically network constrained
  - Typically well below 100 MB / sec
- If you need more bandwidth, consider VMXNET paravirtualized network adapter
  - Installed into guest O/S capable of 1Gbps
  - Minimizes overhead between VM and Host
  - Requires VMware Tools
Monitoring - Network

- Primary Metric – Dropped Receive Packets, Dropped Transmit Packets
- Secondary Metrics – Network Rate
- Rules
  - If any packets are being dropped
    - Look for errors on the Host’s NIC
    - See if one NIC is getting all traffic
    - Understand which VM is causing the most traffic and reduce it
  - If Network Rate is getting close to maximum for hardware
    - Understand which VM is causing load
    - May need to get better network hardware
vSphere Shortcomings

- Too much information
  - 100s of counters – no indication of importance

- Not enough detailed data
  - Keeps details only for a day by default – rolls to hourly
  - Expand this and GUI performance becomes issue

- GUI performance
  - vSphere is slow and frustrating at times

- Graphs are isolated
  - Can only see one type of chart at a time
  - Hard to mix Memory, CPU, Storage, etc
http://www.confio.com/demo

- Username / Password – demo/demo
Layers and Annotations
This Layer shows Database Response Time Metrics

This Layer shows Database Health Metrics

This Layer shows O/S and Virtual Machine Metrics

This Layer shows Metrics for the Physical Host

This Layer shows Metrics for the Storage Layer
Tooltip: Another VM (ProdServerB) moved onto this Physical Host.
VM CPU Ready Time

Percentage of time that the virtual machine was ready to use CPU resources, but could not get scheduled to run on the physical CPU.

**Solutions**

If VM Ready Time is high, check Host CPU Usage:

- **Host CPU Usage is Normal**: This implies that the VM has *under-allocated CPU resources*.

  1. Check to see if the VM has been configured with a CPU Limit. Consider raising or removing the limit.

    *You can use the ESXTOP VMware utility to check the %MLMTD metric which shows how much...*
Confio Software

- Award Winning Performance Tools
- Ignite8 for Oracle, SQL Server, DB2, Sybase
- IgniteVM for Databases on VMware
  - Download at www.confio.com

Provides Answers for
- What changed recently that affected end users
- What layer (VM or DB) is causing the problem
- Who and How should we fix the problem

Download free trial at www.confio.com