VM Right-Sizing Best Practice Guide

Prepared by

Jason Gaudreau, Senior Technical Account Manager
VMware Professional Services
jgaudreau@vmware.com
<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Comments</th>
<th>Reviewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/13/2014</td>
<td>Jason Gaudreau</td>
<td></td>
<td>VMware</td>
</tr>
</tbody>
</table>
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>4</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>4</td>
</tr>
<tr>
<td>Resource Consumption</td>
<td>5</td>
</tr>
<tr>
<td>vCPU SMP</td>
<td>5</td>
</tr>
<tr>
<td>NUMA</td>
<td>7</td>
</tr>
<tr>
<td>Memory Configuration</td>
<td>8</td>
</tr>
<tr>
<td>Reservations</td>
<td>9</td>
</tr>
<tr>
<td>Limits</td>
<td>10</td>
</tr>
<tr>
<td>Shares</td>
<td>10</td>
</tr>
<tr>
<td>Business Approval</td>
<td>10</td>
</tr>
<tr>
<td>Resource Reclamation</td>
<td>10</td>
</tr>
<tr>
<td>Reclamation Workflow</td>
<td>12</td>
</tr>
<tr>
<td>Sample Reclamation Letter</td>
<td>13</td>
</tr>
<tr>
<td>VM Recertification</td>
<td>13</td>
</tr>
<tr>
<td>Recertification Workflow</td>
<td>14</td>
</tr>
<tr>
<td>Sample Recertification Letter</td>
<td>14</td>
</tr>
<tr>
<td>vCenter Operations Manager</td>
<td>15</td>
</tr>
<tr>
<td>Right-Sizing Report</td>
<td>15</td>
</tr>
<tr>
<td>Idle Virtual Machines Report</td>
<td>17</td>
</tr>
<tr>
<td>Resources</td>
<td>17</td>
</tr>
</tbody>
</table>
Introduction

Virtualization helped datacenters provide rapid deployment, increased business continuity, and provided a tremendous amount of capital savings with the reduction of hardware. However, with the substantial benefits and ease of deployment came virtualization sprawl and resource proliferation. “Right Sizing” is the process of reclaiming under-utilized resource components, such as compute and memory resources. In conjunction, there should be a process in place to validate that a guest virtual machine is still required by the business, this is typically considered a recertification.

Right-sizing virtual machines is the process of optimizing the infrastructure resources being utilized by the guest virtual machine. Right-sizing can be increasing or decreasing guest resources; to either increase performance of applications that are starving for memory and/or vCPU, or decreasing wasted resource capacity to increase host efficiency and density.

A regular right-sizing lifecycle on a quarterly or semi-annual basis can ensure maximum performance of your workloads and efficient use of your underlying hardware. But, in order to make certain you don't impact the business, you are going to want a structured process to understand the application workload.

Executive Summary

In the past 35 years, IT organizations have evolved from a narrowly focused data processing elements to a function that supports, and in many cases, drives, nearly every area of a company. But with this increase in technology dependency, the number of applications and therefore servers, supported by IT increased dramatically, placing strains on datacenter floor space, power, and operational support. Over the past 15 years, virtualization has helped businesses make the most out of their technology investments, became a disruptive technology in datacenter consolidation, and relieved pressure on IT operations.

However, without IT governance in place to measure the efficiency of the hosting resources, IT organizations are now faced with virtual machine sprawl and resource waste. At one of my accounts, they have seen an 81% growth rate in virtual servers over the past five years. Adding nearly 2,000 virtual machines in the past two years. That places a tremendous amount of stress on IT operations staff and the infrastructure resources.

It is very important to properly size your virtual machines from a vCPU and memory perspective to get the most out of your virtualization infrastructure, while keeping application users happy with the performance. We also need to ensure there is a life-cycle management process for the virtual machine. This is done by having a mature right-sizing and recertification process in place, and using tools like vCenter Operations Manager to understand the guest workload.
Resource Consumption

VMware supports running Monster VMs. Application performance is based on four infrastructure measures. Today, virtual machines on vSphere 5.5 can scale to 64 vCPUs, 1 TB of memory, 62 TB of storage, and 1 million storage IOPS. The benefits of this large scale is that resource-intensive applications that are mission critical to your business perform very well on vSphere. VMware has measured the resource requirements of more than 700,000 production applications running on x86 servers, and vSphere was able to support more than 99 percent of those applications.

![Figure 1 vSphere Resource Growth](image)

Although the benefits of being able to scale-up resources to meet the requirements of demanding applications are clear, there are some drawbacks for scaling-up those resources if they are not being utilized by the virtual machine. If you overprovision a virtual machine with the intention of allowing the vSphere scheduler to manage the underlying system resources, you will be impacting the overall system performance, efficiency and density.

**vCPU SMP**

VMware Virtual Symmetric Multiprocessing (Virtual SMP) enhances virtual machine performance by enabling a single virtual machine to use multiple physical processor cores simultaneously. The biggest advantage of an SMP system is the ability to use multiple processors to execute multiple tasks concurrently, thereby increasing throughput. Only workloads that support parallelization can really benefit from SMP.

The virtual processors from SMP-enabled virtual machines are co-scheduled. That is, if physical processor cores are available, the virtual processors are mapped one-to-one onto physical processors and are then run simultaneously. In other words, if one vCPU in the virtual machine is running, a second vCPU is co-scheduled so that they execute synchronously.
If multiple idle physical CPUs are not available when the virtual machine wants to run, the virtual machine remains in a special wait state. The time a virtual machine spends in this wait state is called *ready time*.

Even idle processors perform a limited amount of work in an operating system. In addition to this minimal amount, the ESX host manages these “idle” processors, resulting in some additional work by the hypervisor. These low-utilized vCPUs compete with other vCPUs for system resources.

VMware conducted a lab test using a single threaded CPU intensive process as a fixed workload to benchmark the inefficiency. The benchmark was then run using multiple virtual machines with different vCPU's assigned to the virtual machine and left idle, simulating an oversizing of the virtual machine.

![Figure 2 CPU Efficiency Single Thread](image)

The resulting data demonstrates that “CPU Efficiency” decreases as the virtual machines were assigned additional idle vCPUs. This highlights the fact that there is a small amount of waste, but that doesn’t become visible until very large virtual machine configurations are under-utilized.

Next, VMware repeated the same benchmark, but this time ensured that each additional vCPU that was assigned to the virtual machine was also running the CPU intensive process. This simulated a right-sized virtual machine that was using all vCPUs.
The resulting data demonstrates that “CPU Efficiency” was constant as the virtual machines were scaled-up to meet the application demand. This highlights the fact that there is no measurable waste when virtual machines are using all their assigned vCPU.

**NUMA**

Non-Uniform Memory Access (NUMA) compatible systems contain multiple nodes that consist of a set of processors and memory. The access to memory in the same node is local, while access to the other node is remote. Remote access can take longer because it involves a multi-hop operation. In NUMA-aware applications, there is an attempt to keep threads local to improve performance.

When a virtual machine is powered on, ESXi assigns it a home node. A virtual machine runs only on processors within its home node, and its newly allocated memory comes for the home node as well. Unless a virtual machine’s home node changes, it uses only local memory, avoiding the performance penalties associated with remote memory access to other NUMA nodes.

<table>
<thead>
<tr>
<th>VM Scale UP Test</th>
<th>Multi-Threaded</th>
<th>No Waste</th>
<th>Host CPU Utilization</th>
<th>VM CPU Utilization</th>
<th>Score</th>
<th>Score per vCPU</th>
<th>CPU Efficiency Compared to 1 Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>4x 32 Way VMs</td>
<td></td>
<td></td>
<td>99%</td>
<td>97%</td>
<td>40659.79</td>
<td>317.65</td>
<td>101%</td>
</tr>
<tr>
<td>4x 16 Way VMs</td>
<td></td>
<td></td>
<td>97%</td>
<td>95%</td>
<td>39416.28</td>
<td>615.88</td>
<td>100%</td>
</tr>
<tr>
<td>4x 8 Way VMs</td>
<td></td>
<td></td>
<td>84%</td>
<td>82%</td>
<td>34010.19</td>
<td>1062.82</td>
<td>100%</td>
</tr>
<tr>
<td>4x 4 Way VMs</td>
<td></td>
<td></td>
<td>43%</td>
<td>41%</td>
<td>17039.58</td>
<td>1064.97</td>
<td>100%</td>
</tr>
<tr>
<td>4x 2 Way VMs</td>
<td></td>
<td></td>
<td>22%</td>
<td>21%</td>
<td>8517.99</td>
<td>1064.75</td>
<td>100%</td>
</tr>
<tr>
<td>4x 1 Way VMs</td>
<td></td>
<td></td>
<td>12%</td>
<td>10%</td>
<td>4316.91</td>
<td>1079.23</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Figure 3 CPU Efficiency Multi-Thread*
In applications that scale out, it is beneficial to size the virtual machines with the NUMA node size in mind. For example, in a system with four quad-core processors and 128 GB of memory (Figure 4), sizing the virtual machine to four virtual CPUs and 32 GB or less (ex. NUMA Node 3) means that the virtual machine does not have to span multiple nodes.

When working with application teams, many times their minimum processor requirements may be excessive. For this reason, VMware recommends reducing the number of vCPUs if monitoring shows the actual workload of the virtual machine is not benefiting from the increased virtual CPUs. Having virtual CPUs allocated, but sitting idle, reduces the consolidation level and efficiency of the vSphere host. Also, by reducing the number of virtual CPUs, a virtual machine may gain significant performance improvements by reducing CPU wait times and not requiring multi-hop operations with NUMA nodes.

**Memory Configuration**

vSphere virtualizes guest physical memory by adding an extra level of address translation. Shadow page tables make it possible to provide this additional translation with little overhead.

Managing the memory in the hypervisor enables memory sharing across virtual machines that have similar data (such as redundant copies of the same guest OS in memory pages), memory compression, and memory balloon technique, whereby virtual machines that do not need all the memory they were allocated give memory to virtual machines that require additional allocated memory.

Over-alloacting memory to virtual machines can waste memory unnecessarily, but it can also increase the amount of memory overhead required to run virtual machine, thus reducing the overall available memory for other virtual machines. Memory space overhead comes in two components:

- A fixed, system-wide overhead for the VMkernal
- Additional overhead for each virtual machine

Overhead memory includes space reserved for the virtual machine and various virtualization data structures, such as shadow page tables. Overhead memory depends on the number of vCPUs.

---

Figure 4 NUMA Architecture

In applications that scale out, it is beneficial to size the virtual machines with the NUMA node size in mind. For example, in a system with four quad-core processors and 128 GB of memory (Figure 4), sizing the virtual machine to four virtual CPUs and 32 GB or less (ex. NUMA Node 3) means that the virtual machine does not have to span multiple nodes.

When working with application teams, many times their minimum processor requirements may be excessive. For this reason, VMware recommends reducing the number of vCPUs if monitoring shows the actual workload of the virtual machine is not benefiting from the increased virtual CPUs. Having virtual CPUs allocated, but sitting idle, reduces the consolidation level and efficiency of the vSphere host. Also, by reducing the number of virtual CPUs, a virtual machine may gain significant performance improvements by reducing CPU wait times and not requiring multi-hop operations with NUMA nodes.

**Memory Configuration**

vSphere virtualizes guest physical memory by adding an extra level of address translation. Shadow page tables make it possible to provide this additional translation with little overhead.

Managing the memory in the hypervisor enables memory sharing across virtual machines that have similar data (such as redundant copies of the same guest OS in memory pages), memory compression, and memory balloon technique, whereby virtual machines that do not need all the memory they were allocated give memory to virtual machines that require additional allocated memory.

Over-alloacting memory to virtual machines can waste memory unnecessarily, but it can also increase the amount of memory overhead required to run virtual machine, thus reducing the overall available memory for other virtual machines. Memory space overhead comes in two components:

- A fixed, system-wide overhead for the VMkernal
- Additional overhead for each virtual machine

Overhead memory includes space reserved for the virtual machine and various virtualization data structures, such as shadow page tables. Overhead memory depends on the number of vCPUs.

---

Figure 4 NUMA Architecture

In applications that scale out, it is beneficial to size the virtual machines with the NUMA node size in mind. For example, in a system with four quad-core processors and 128 GB of memory (Figure 4), sizing the virtual machine to four virtual CPUs and 32 GB or less (ex. NUMA Node 3) means that the virtual machine does not have to span multiple nodes.

When working with application teams, many times their minimum processor requirements may be excessive. For this reason, VMware recommends reducing the number of vCPUs if monitoring shows the actual workload of the virtual machine is not benefiting from the increased virtual CPUs. Having virtual CPUs allocated, but sitting idle, reduces the consolidation level and efficiency of the vSphere host. Also, by reducing the number of virtual CPUs, a virtual machine may gain significant performance improvements by reducing CPU wait times and not requiring multi-hop operations with NUMA nodes.

**Memory Configuration**

vSphere virtualizes guest physical memory by adding an extra level of address translation. Shadow page tables make it possible to provide this additional translation with little overhead.

Managing the memory in the hypervisor enables memory sharing across virtual machines that have similar data (such as redundant copies of the same guest OS in memory pages), memory compression, and memory balloon technique, whereby virtual machines that do not need all the memory they were allocated give memory to virtual machines that require additional allocated memory.

Over-alloacting memory to virtual machines can waste memory unnecessarily, but it can also increase the amount of memory overhead required to run virtual machine, thus reducing the overall available memory for other virtual machines. Memory space overhead comes in two components:

- A fixed, system-wide overhead for the VMkernal
- Additional overhead for each virtual machine

Overhead memory includes space reserved for the virtual machine and various virtualization data structures, such as shadow page tables. Overhead memory depends on the number of vCPUs.

---

Figure 4 NUMA Architecture

In applications that scale out, it is beneficial to size the virtual machines with the NUMA node size in mind. For example, in a system with four quad-core processors and 128 GB of memory (Figure 4), sizing the virtual machine to four virtual CPUs and 32 GB or less (ex. NUMA Node 3) means that the virtual machine does not have to span multiple nodes.

When working with application teams, many times their minimum processor requirements may be excessive. For this reason, VMware recommends reducing the number of vCPUs if monitoring shows the actual workload of the virtual machine is not benefiting from the increased virtual CPUs. Having virtual CPUs allocated, but sitting idle, reduces the consolidation level and efficiency of the vSphere host. Also, by reducing the number of virtual CPUs, a virtual machine may gain significant performance improvements by reducing CPU wait times and not requiring multi-hop operations with NUMA nodes.

**Memory Configuration**

vSphere virtualizes guest physical memory by adding an extra level of address translation. Shadow page tables make it possible to provide this additional translation with little overhead.

Managing the memory in the hypervisor enables memory sharing across virtual machines that have similar data (such as redundant copies of the same guest OS in memory pages), memory compression, and memory balloon technique, whereby virtual machines that do not need all the memory they were allocated give memory to virtual machines that require additional allocated memory.

Over-alloacting memory to virtual machines can waste memory unnecessarily, but it can also increase the amount of memory overhead required to run virtual machine, thus reducing the overall available memory for other virtual machines. Memory space overhead comes in two components:

- A fixed, system-wide overhead for the VMkernal
- Additional overhead for each virtual machine

Overhead memory includes space reserved for the virtual machine and various virtualization data structures, such as shadow page tables. Overhead memory depends on the number of vCPUs.

---

Figure 4 NUMA Architecture

In applications that scale out, it is beneficial to size the virtual machines with the NUMA node size in mind. For example, in a system with four quad-core processors and 128 GB of memory (Figure 4), sizing the virtual machine to four virtual CPUs and 32 GB or less (ex. NUMA Node 3) means that the virtual machine does not have to span multiple nodes.

When working with application teams, many times their minimum processor requirements may be excessive. For this reason, VMware recommends reducing the number of vCPUs if monitoring shows the actual workload of the virtual machine is not benefiting from the increased virtual CPUs. Having virtual CPUs allocated, but sitting idle, reduces the consolidation level and efficiency of the vSphere host. Also, by reducing the number of virtual CPUs, a virtual machine may gain significant performance improvements by reducing CPU wait times and not requiring multi-hop operations with NUMA nodes.

**Memory Configuration**

vSphere virtualizes guest physical memory by adding an extra level of address translation. Shadow page tables make it possible to provide this additional translation with little overhead.

Managing the memory in the hypervisor enables memory sharing across virtual machines that have similar data (such as redundant copies of the same guest OS in memory pages), memory compression, and memory balloon technique, whereby virtual machines that do not need all the memory they were allocated give memory to virtual machines that require additional allocated memory.

Over-alloacting memory to virtual machines can waste memory unnecessarily, but it can also increase the amount of memory overhead required to run virtual machine, thus reducing the overall available memory for other virtual machines. Memory space overhead comes in two components:

- A fixed, system-wide overhead for the VMkernal
- Additional overhead for each virtual machine

Overhead memory includes space reserved for the virtual machine and various virtualization data structures, such as shadow page tables. Overhead memory depends on the number of vCPUs.
and the configured memory for the guest operating system. As an example, a running virtual
machine with two vCPU and 16 GB of memory may consume approximately 143 MB of memory
overhead. The graph below shows the configured memory in the first column and the number of
vCPUs in the first row, the rows underneath show the amount of memory overhead in megabytes.

```
<table>
<thead>
<tr>
<th>Memory (MB)</th>
<th>1 VCPU</th>
<th>2 VCPUs</th>
<th>4 VCPUs</th>
<th>8 VCPUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>20.29</td>
<td>24.28</td>
<td>32.23</td>
<td>48.16</td>
</tr>
<tr>
<td>1024</td>
<td>25.90</td>
<td>29.91</td>
<td>37.86</td>
<td>53.82</td>
</tr>
<tr>
<td>4096</td>
<td>48.64</td>
<td>52.72</td>
<td>60.67</td>
<td>76.78</td>
</tr>
<tr>
<td>16384</td>
<td>139.62</td>
<td>143.98</td>
<td>151.93</td>
<td>168.60</td>
</tr>
</tbody>
</table>
```

*Figure 5 Sample Overhead Memory on Virtual Machines*

Another aspect to keep in mind, when you configure the memory size for the guest virtual
machine, it creates a virtual swap file of equal size that is located with the virtual machine’s
configuration file. These swap files can add up as you grow your virtual environment and it can
consume a significant amount of storage capacity.

Proper sizing of memory for a virtual machine is based on many factors. Some applications are
consistent in how they utilize resources and may not perform as expected with vSphere memory
management techniques. Others, such as Web servers, have periods where resources can be
reclaimed and are perfect candidates for higher consolidation ratios. For virtual machines running
Search and SQL services that consume more memory resources than other applications,
memory reservations may be considered to guarantee that those services have the resources
they require while still allowing for high consolidation ratios of other virtual machine workloads.

In all cases, making sure the memory resources are being used effectively helps maximize the
technology investment in the infrastructure hardware, while ensuring peak performance for
business partners.

In conclusion, for many companies, there is an enormous disconnect between the application
owners that believe they need a certain amount of resources for their virtual machines and IT
operations ability to have a business process in place to make sure those resources are being
used wisely and efficiently.

**Reservations**

Reservations are the guaranteed minimum amount of host resources allocated to a virtual
machine to avoid overcommitment. It ensures the virtual machine has sufficient resources to run
efficiently. vCenter Server or ESXi allows you to power on a virtual machine only if there are
enough unreserved resources to satisfy the reservation of the virtual machine. The server
guarantees that amount even when the physical server is heavily loaded. After a virtual machine
has accessed its full reservation, it is allowed to retain that amount of memory and the memory is
not reclaimed, even if the virtual machine becomes idle.

For example, assume you have 2 GB of memory available for two virtual machines. You specify a
reservation for 1 GB of memory for VM1 and 1 GB of memory for VM2. Now each virtual machine
is guaranteed to get 1 GB of memory if it needs it. However, if VM1 is only using 500 MB of
memory and hasn’t accessed all the memory, than VM2 can use 1.5 GB of memory until VM1’s
resource demand increases to 1 GB.
If an application that is customer facing or mission critical, needs a guaranteed memory allocation; the reservation needs to be specified carefully because it may impact the performance of other virtual machines and significantly reduce consolidation ratios.

![Virtual Memory Configuration Diagram]

**Limits**

A limit is the upper threshold of the host resources allocated to a virtual machine. A server will never allocate more resources to a virtual machine than the limit. The default is set to unlimited, which means the amount of resources configured for the virtual machine when it is created becomes the effective limit. For example, if you configured 2 GB of memory when you created a virtual machine but set a limit of 1 GB, the virtual machine would never be able to access more than 1 GB of memory even when the application demand required more resources. If this value is misconfigured, users may experience application performance issues even though the host has plenty of resources available.

**Shares**

Shares specify the relative priority for a virtual machine to the host's resources. If the host's memory is overcommitted, and a mission critical virtual machine is not achieving an acceptable performance level, the virtualization administrator can adjust the virtual machine's shares to escalate the relative priority so that the hypervisor will allocate more host memory to the mission critical virtual machine.

The shares can be selected in a Low, Normal, or High value; which specifies the shares value respectively in a 1:2:4 ratio.

**Business Approval**

**Resource Reclamration**

Right-sizing of virtual machines, should be done on a routine basis; such as monthly, quarterly, or semi-annually. This is done to ensure application owners and business partners have an opportunity to control virtual machine costs and help make the underlying infrastructure to run efficiently.
This process should be a collaboration and not done in a silo. The impact of right-sizing a virtual machine and not understanding the application requirements can have a serious impact on production systems. For instance, an application batch process may run on a quarterly, semi-annual, or annual basis; and a database may perform at 0 to 5 percent utilization, all but a few days of the year (seasonal workloads). Also, if an application team has a new system that hasn’t gone “live”, the virtual machine may look like it is underutilized because the user load has not occurred on the virtual machine.

There should be several steps when working on a right-sizing lifecycle.

- Alert the application owner or business partner of the overprovisioned virtual machine based on trends and reports
- Gain agreement to adjust resource overprovisioning
- Adjust resources
- Notify application owner of adjustments and verify that there were no incidents after the virtual machine was right-sized

Virtual machine capacity management establishes and maintains a safe and reliable amount of resource capacity, while making sure that company assets are fully utilized for capital realization.
Reclamation Workflow

1. Start reclamation process by running reports.
2. Determine the recommended vCPU and Memory configuration.
3. Calculate overage resource cost.
4. Send report to application owner.
5. Application owner reviews report.
6. Approval (Yes/No).
   - Yes: Schedule resource adjustment.
   - No: Provide justification.
7. Notify IT leadership.
8. Approval (Yes/No).
   - Yes: Complete resource adjustment.
   - No: End.
Sample Reclamation Letter

Dear Application Owner,

Every quarter we perform a reclamation process on our virtual machines to right-size them for underutilized resources. This operation provides us an opportunity to maximize the efficiency of the virtual machines and the underlying servers hosting the resources. According to our analysis, your virtual machine VMAPP-001 can be configured with 2 vCPU and 2 GB of memory. This could increase the overall performance of your virtual machine by decreasing the amount of ready time needed for scheduling the 4 virtual CPUs that are presently configured.

In addition, you would be reducing the annual virtual machine chargeback for VMAPP-001 by $475.20 a year.

We recognize that there may be monthly, quarterly, or seasonal workloads that we are not taking into account. If you could provide us with justification for the current virtual machine configuration, we will review our reports and request an exception approval from senior leadership.

If you would like further information on the current virtual machine resource utilization, please reply to reclamation-dl@corp.org and we will assign an infrastructure engineer to work with you.

Thank you for working with us on maintaining peak efficiency on our hosting platform. We would appreciate a response in 15 days, which would be October 16, 2014. If we don’t receive a response, we will send an email to the department head asking to review of the reclamation and approval to right-size the resource.

Best regards,
Operations Team

VM Recertification

Why is recertification such an important process? Before we abstracted the operating system away from the physical resources with the hypervisor, we had a regular server refresh process, this process was typically performed on a three year cycle before we had to purchase extended maintenance from the platform vendor. During the server refresh process, the application that was operating on that physical server needed to be migrated to the new compute resource. The application owner was advised of the upcoming server replacement and he had to work with infrastructure services to move the application; or notify them that the resource was no longer needed.

That isn’t the case with virtualization, when an underlying server host is refreshed the virtual machines are not reviewed for retirement. Instead, the virtual machines are live migrated to the new host in the cluster and the legacy resource is retired. This leads to virtual machine sprawl and lack of lifecycle management for the virtual machines.

Recertification of the virtual machines should be practiced on an annual basis. This helps reduce the amount of virtual machines in the environment providing capital effectiveness with better utilization of the hosting resources, and improves operational efficiency by reducing the amount of virtual machines the infrastructure operations team has to support.
Recertification Workflow

1. Start recertification process by running reports
2. Determine VMs that haven't been recertified in the past year
3. Send notification to application owner of VM recertification
   - application owner reviews notification
   - Recertify
     - Yes/No Response
       - Yes: Schedule VM retirement
       - No: Notify application owner of adjustment
4. Update Showback and Asset Management Systems
5. Retire VM

Sample Recertification Letter

Dear Application Owner,

Every year we perform a recertification process to ensure the virtual machines are still required by the application owner and business unit. This process provides us an opportunity to maximize the efficiency of the hosting infrastructure by retiring unneeded virtual machines.

If you retire this virtual machine, you would be reducing the annual virtual machine chargeback by $1,914.61 a year.

If we don't hear from you in the next 30 days, which would be October 16, 2014, we will assume the virtual machine is still needed and mark it as recertified.

If you would like further information, please reply to recertification-dl@corp.org and we will work with you to answer any questions.

Thank you for working with us on maintaining peak efficiency on our hosting platform.
Best regards,
Operations Team

vCenter Operations Manager

Right-Sizing Report

Capacity management includes establishing and preserving a safe and reliable amount of resources to meet the business demand. Demand management is an important factor of providing reliable computing services. It calls for a variety of non-IT oriented skills and knowledge, and is therefore an often-neglected area. However, it is becoming significantly more important as virtual machine growth weighs down IT staffing ratios and infrastructure budgets. For large organizations, most capacity management is done with spreadsheets; fortunately vCenter Operations Manager provides data to better account for needed resources and underutilized capacity.

The calculations for virtual machines that vCenter Operations Manager considers Oversized are found in the Configuration screen. In the default policy, it considers a virtual machine oversized when the amount of CPU demand is below 30% and/or when the amount of memory demand is below 30%. By default, the range of data it is going to analyze is 30 weeks, which is roughly 7 ½ months. This can be changed on the Manage Display Settings.

![Figure 7 Oversized VM Configuration](image-url)
To produce a report that shows the oversized virtual machines, on the Reports tab of VMware vCenter Operations Manager, click the Run Now button for the Oversized Virtual Machine Report for the specific cluster.

![Oversized Virtual Machines Report](image)

Figure 8 Oversized Virtual Machines Report

vCenter Operations Manager produces a detailed report by policy on the configured amount of resources and the recommended configured resources. Again, you want to make sure you understand the application workload and take into account any application requirements.

![Cluster: Gold Cluster](image)

Figure 9 Oversized Virtual Machines

For a more detailed understanding of the usage in vCenter Operations Manager, we can go to the Operations tab and select the All Metrics button. Under the Metric Selector for the virtual machine, select the specific counter you want to look at for demand and specify the date range to analyze. This will give you a greater detail into the CPU and memory demand for the virtual machine, and help you understand if there are any scheduled application workloads that hit peak utilization at certain times of the week, month, or quarter.
Idle Virtual Machines Report

vCenter Operations Manager identifies machines that have capacity that use below a certain threshold for a significant portion over the lifetime of the virtual machine. Another report that can be very helpful when starting the recertification process is the Idle Virtual Machines report, it shows virtual machines that have had a significant amount of idle time, which may indicate that the application on the virtual machine is no longer in use.

Cluster: Gold Cluster

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>Policy</th>
<th>CPU Demand</th>
<th>CPU % Idle Time</th>
<th>Disk I/O Usage</th>
<th>Disk I/O % Idle Time</th>
<th>Network I/O Usage</th>
<th>Network I/O % Idle Time</th>
<th>Memory Consumed</th>
<th>Total Virtual Disk Space Configured</th>
<th>Provisioned Disk Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>vCloud Connector Node</td>
<td>Gold</td>
<td>87 MHz</td>
<td>90%</td>
<td>6.6 KBps</td>
<td>98%</td>
<td>1.3 KBps</td>
<td>99%</td>
<td>313 MB</td>
<td>50 GB</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 11 Idle Virtual Machines

Resources

The CPU Schedule in VMware vSphere 5.1
The Performance Cost of SMP – The Reason for Rightsizing
Virtualizing Business-Critical Applications on vSphere
vSphere Resource Management Guide
Performance Monitoring and Analysis