z/VM Capacity Planning Overview

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Introduction

• Objectives:
  • Provoke thought and ultimately action about Capacity Planning
  • Concepts and approaches will be covered, not so much the mechanics

• Companion Piece:
  • z/VM Performance Metrics – also available from the author

• Time permitting – dialogue on what can IBM do to help in this space?
Companion Piece – z/VM Performance Metrics

- Lists the top 50+ metrics that we find useful, along with descriptions on them
- Where appropriate, includes which:
  - monitor record contains the information
  - Performance Toolkit report displays the information
  - OMEGAMON XE workspace for managing the information
- Rules of Thumb given in some cases

**Total Processor Utilization:** (Monitor: D0/R2; Toolkit: FCX100 CPU; OMEGAMON: System workspace under headings of Percent CPU). This is the processor utilization from the VM perspective and includes CP, VM System, and Virtual CPU time. It is often beneficial to break this down into the three components:
  - **System Time:** This is the processor time used by the VM control program for system functions that are not directly related to any virtual machine. This should be less than 10% of the total processor time for the z/VM LPAR.
  - **CP Processor Time:** This is the processor time used by the VM control program in support of individual virtual machines.
  - **Virtual Processor Time:** (Emulation Time): This is processor time consumed by the virtual machine and the applications within it.
More to Performance

Performance Management (Tuning)

Performance Engineering (Test Analysis)

Capacity Planning

Business Planning
Real vs. Virtual Planning

• Capacity planning for 'real' resources is one thing, but how do we incorporate 'virtual' resources?

• Need to address “Overhead” or management costs
  • Define 'overhead'
  • z/VM Control Program processor time?
  • System Management virtual machines?

• Virtual ≠ Free

• Need to address peaks
  • Averages alone are not sufficient

• Define what is acceptable – “capacity lag” or impact to SLA
  • Acceptable overcommitment of resources is very dependent on:
    • Workload
    • Environment
    • SLA
Looking at Resources

- Utilization Metrics: metrics of interest to determine utilization & distribution of resources
- Indicator Metrics: metrics that relate to thresholds or the degree of constraint and pain the system is expressing
- Quality Measures: something that indicates workload and response time and whatever is important to the business
  - Well defined and defined throughout all the disciplines
  - Something that can be mapped to other metrics to indicate a sweet spot
Real Processor Resources

• Real Processor Resources are perhaps easiest to measure and manage

• Utilization Metrics:
  • LPAR Overhead Time
  • System CPU Time
  • CP CPU time associated with virtual machines
  • Virtual CPU time associated with virtual machines

• Indicator Metrics:
  • System Spin Time (Wall clock, not processor measure)
  • LPAR Suspend Time
  • CPU Wait

• Need to handle Specialty Engines
  • Measure each type
  • Mixed speeds?
  • Changing speeds?

• Keep in mind processor resource limits can pop up elsewhere
  • e.g. Both ends of a HiperSockets connection require processor

• Compare or prorate based on workload (transaction rates).
Virtual Processor Resources

- Utilization Metrics:
  - CP CPU Time
  - Virtual CPU Time
  - Total CPU Time

- Potentially also include:
  - Processes within Linux
  - Linux Steal time
  - At very least have the above available from Performance Engineering for comparison if z/VM totals look abnormal.

- Again, make accommodations for Specialty Engines
  - Real and Virtual

- Indicator Metrics:
  - CPU Wait
  - Diagnose x'44'
  - Diagnose x'9C'
Linux View: %Steal

• Current Linux distributions (RHEL 5 & SLES 10) report %Steal as well as pct User and pct System

• %Steal: Linux view of percent of time that it had work to run but was unable to run.
  • z/VM was dispatching other virtual machines, compare to %CPU Wait in z/VM state sampling.
  • z/VM was executing on behalf of the Linux virtual processor, compare to CP CPU usage of the Linux virtual machine
  • Linux yielded its time slice to z/VM via diagnose 0x9C instead of spinning on a formal spin lock. Examine diagnose rates.
  • The z/VM partition was unable to run due to another logical partition being dispatched at the LPAR level.
Other Processor Planning Thoughts

- Need to have some measure of work or throughput
- Best to determine cost per <something meaningful to everyone>
  - Performance Engineering
  - Business Planning
  - Performance Management
  - Capacity Planning
- Establish in Performance Engineering testing what the target cost / transaction
- Bring in Business Planning to determine target or range of transaction load
- Capacity Planning projects requirements based on above two
- Performance Management folks can help identify problems when things do not track.
- This is a continuous process
- I prefer computing CPU seconds, but if you want to convert to some “MIPS” number or “IFLS” or “Computing Units” feel free. Just make sure everyone uses the same conversion numbers.
Real Memory

- Utilization Metrics:
  - NonPageable
  - Pageable
  - Minidisk Cache
  - Misc

- Don't forget Expanded Storage for systems prior to z/VM 6.3

- Indicator Metrics:
  - Prior to z/VM 6.3:
    - Emergency Scan on Demand Scan
    - Emergency Scan failures
  - Available List(s) going empty
Virtual Memory

- Types of Virtual Memory:
  - Virtual Machines
  - NSS/DCSS
  - Virtual Disks in Storage
  - PTRM and other System Utility Spaces

- Virtual Machine Utilization Metrics:
  - Defined virtual memory
  - Backed virtual memory
  - Resident virtual memory
  - Estimated WSS

- Indicator Metrics:
  - Paging Rates (Reads and Writes)
  - Loading User
  - Page Wait (Asynchronous and Synchronous)

- A guest pages may exist on both DASD and Real Memory

- Private DCSSs are considered part of the virtual machine for most metrics, while Shared DCSSs have their own metrics.
Memory Overcommitment

- Gather data to determine a curve such as below
  - Performance Engineering
  - Tracking Production
  - Artificially limiting amount of real memory

- Result is a Virtual to Real ratio for your workload that is edge of green/yellow.
  - For example, let's say it is 1.8. If you are going to increase workload by adding 30GB of virtual, then you need to add real memory to keep the ratio at 1.8 or lower.
Other Thoughts on Memory Planning

• What is the right 'over commitment' number? It depends.
  • Definition of virtual and real in the question.
  • Constraints of SLAs
    • All transactions sub-second vs. 99% of transactions sub-second
  • How much can performance features improve things
    • Workloads that are sized poorly at start have more room for improvement
  • Paging configuration

• See http://www.ibm.com/vm/perf/tips/memory.html for additional information
Network

- Session of its own
- Real Level
- Virtual Level
- Link Aggregation
  - Aggregates total sessions across multiple OSD chpids
  - Does not spread load of a single TCP/IP application session across those chpids.
- Beware of measuring a single session as multiple sessions is where the bandwidth value is.
- Limits/Thresholds/Quality Measures
  - Buffer Overflow counters
Real I/O

• Utilization Metrics:
  • Channel Utilization
  • Device I/O Rates
    • System I/Os
    • User Driven I/Os
  • Device Utilization
  • Access Density (I/Os per GB space)

• Indicator Metrics:
  • Device Queuing
  • Error Rates
  • IOP Statistics
Virtual I/O

- Utilization Metrics
  - Virtual I/O per Guest
  - I/Os avoided due to MDC or VDisk

- Indicator Metrics
  - Various levels in software stack where I/O queuing can occur
  - Virtual I/O to Virtual CPU Ratio

- Caution:
  - %IOA (Asynchronous I/O Wait) in Performance Toolkit and similar field in Linux includes time of I/O processing.
    - I/O is relatively slow
    - %IOA may only show up when there is CPU activity or wait on CPU, so a high %IOA isn’t necessarily bad.
SSI: Capacity Planning

• Great flexibility in managing multiple LPARs
  • Previously, if you split work across LPARs and had an imbalance, it was more difficult to rebalance
  • With SSI, virtual machines can run anywhere in the cluster without a lot of additional work

• Greater responsibility in planning, at two levels
  • Individual members
    • Need to ensure sufficient capacity and resources for the workload on each member
    • Track growth in requirements to limits of the member
  • Cluster-wide
    • Track growth in requirements of overall cluster to the limits of that cluster
    • Need to ensure sufficient white space for planned outages where LGR will be used to move workload out of a given member.

The “Getting Started With Linux” book has been updated with SSI and LGR planning tips.
SSI & LGR: Planning Relocations

• Need white space for planned outages where you move work off of a given member.

• How will work move off the member?
  • Use existing HA solutions to redirect work to existing servers on other members or elsewhere in enterprise.
  • Use LGR to move to another member.
  • Log off and then logon to another member.
  • Shutdown non-critical virtual machine for duration of the planned outage.

• To where do you move the virtual machines?
  • To a single member or multiple members?
  • To a member on same CEC or another CEC?
  • To a member held in reserve (such as a DR LPAR)?
  • It’s not just one z/VM image anymore
Other Considerations for Planning

• “The bucket gets heavier as you add water.”
  • Destination system may become more constrained as you continue to relocate virtual machines to it.

• “Get the big rocks in first.”
  • In general, it is better to move the virtual machines generating the greatest memory load first.
    • Larger virtual machines
    • Virtual machines with higher page change rate
SSI & LGR: Planning White Space

- **CPU**
  - Shared logical processors?
  - Adjust LPAR weight settings?
  - Vary on additional engines?

- **I/O**
  - Ensure sufficient resources at all levels:
    - Channel, switch, control unit, device
  - Shared channels?

- **Memory white space is not as easy to manage**
  - Ensure sufficient paging space and concurrency or data rate capability
  - Increase real memory over commitment?
  - Temporarily decrease size of some virtual machines?
  - Use Dynamic Memory Upgrade?
    - No downgrade available
Data Collection Considerations

- Keep all groups in mind and in agreement
  - The value of your data increases when it can be combined with other data.
- Volume of data
- Retention time
- Granularity or interval of data
- Correlation with other data
- Time zone considerations
- Terminology
Methods of data collection

• Do It Yourself

• Performance Toolkit Summary/Trend/Histlog

• IBM Tivoli OMEGAMON XE on z/VM and Linux

• Shipping to z/OS
z10 Capacity Planning in a nutshell

Don’t use “single-number tables” for capacity comparisons!

Use zPCR and/or zCP3000 to model before and after configurations

Work with IBM technical support for capacity planning!

Customers can now use zPCR
IBM Techline: Complete topology from z/VM data

Processor View for Generic Customer

ProcID SAMPLE1  
2097-706

ProcID SAMPLE2  
2097-706

z/VM:VM01  
z/VM:VM02

z/OSZOS-1  
z/OSZOS-2

z/OSZOS-3  
z/OSZOS-4

z/OSZOS-21  
z/OSZOS-22

z/OSZOS-23  
z/OSZOS-24

z/OSZOS-25  
z/VM:VM01

CF11  
CF12  
CF13  
CF14

CF21  
CF22  
CF23  
CF24
IBM Techline: Example of CPU Analysis

The graph shows the accumulated IFL MIPS consumed for each selected ProcID/Partition by sample.

The accumulated columns represent the average and maximum for the ProcIDs/Partitions listed so far. So the second line would be the average and maximum for the first two entries. Hence the bottom line, would be the average and maximum for all partitions together.

The study interval is 12/17/09 at 16:00 and is the 90th percentile interval from the Prime shift. This is shown on the graph as a solid line. The value at this point is 28,576 MIPS.

The MIPS ratio of the maximum to the study interval is 1.01. This means that when the study interval grows to the maximum value, the peak would be about 29248. Keep in mind that this is very fuzzy. You should look at this as a value ±5% or on the interval [27784, 30768] MIPS.

The reference processor is set to a 2094-701 with an assumed capacity of 602.0 MIPS.
IBM Techline: Memory Summary Example

```
<table>
<thead>
<tr>
<th>Description</th>
<th>Virtual Memory</th>
<th>CMMA Active</th>
<th>WSS Intv</th>
<th>WSS Min</th>
<th>WSS Max</th>
<th>Memory Used Intv</th>
<th>Memory Used Min</th>
<th>Memory Used Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>LXPS3061</td>
<td>1.707</td>
<td>0</td>
<td>1.491</td>
<td>409</td>
<td>1.707</td>
<td>1.259</td>
<td>346</td>
<td>1.504</td>
</tr>
<tr>
<td>LXPS3139</td>
<td>5.120</td>
<td>1</td>
<td>5.120</td>
<td>5.120</td>
<td>5.120</td>
<td>4.605</td>
<td>4.443</td>
<td>4.891</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interval</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Memory Sum</td>
<td>53,521</td>
<td>53,521</td>
</tr>
<tr>
<td>WSS Total</td>
<td>52,472</td>
<td>52,862</td>
</tr>
<tr>
<td>DPA</td>
<td>142,090</td>
<td>142,090</td>
</tr>
<tr>
<td>Memory Utilization %</td>
<td>36.9%</td>
<td>31.4%</td>
</tr>
<tr>
<td>Memory Overcommit</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Available Queue</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>CS&lt;&gt;ES Page Rate</td>
<td>603</td>
<td>2</td>
</tr>
</tbody>
</table>
```

**File**

**System** **Workloads** **Performance**

Express Memory Sizes As: ☐ MB ☐ Pages

**Analysis**

```
LPAR ES 20,480 MB
LPAR CS 143,360 MB
```
IBM Techline Support

- IBM Techline Support – z/VM Capacity Planning

- Contact your IBMer for in-depth analysis

- See free tools such as zPCR for processor sizing

- Thanks to following for info on Techline and ATS Offerings:
  - Gretchen Frye
  - Liz Holland
Summary

• You have to Plan to do Capacity Planning if you want to do it successfully.

• Otherwise, it becomes Capacity Scrambling.

• Lots of resources available to help from IBM and Others.
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