Framework for Doing Capacity Sizing for System z Processors

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Share session: 2115

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<td>Multiprise*</td>
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<td>Performance Toolkit for VM</td>
<td>System x*</td>
<td>z/Vm*</td>
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<td>ESCON*</td>
<td>PowerPC*</td>
<td>System z</td>
<td>z/VSE</td>
</tr>
<tr>
<td>FICON*</td>
<td>PR/SM</td>
<td>System z9*</td>
<td>zSeries*</td>
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<td>Processor Resource/Systems Manager</td>
<td>System z10</td>
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Agenda

- CPU Sizing or Capacity Planning??
- End to End Process of CPU Sizing
  - Role of Performance Management
  - Describing the Current Environment
  - Specialty Processors
  - Estimation Confidence
  - Post-Install Analysis
- Summary

Suggested Follow-Up Sessions:
- 2110 – zPCR Capacity Sizing Lab – Part 1 Introduction and Overview
  - Wed 1:30 PM – John Burg
- 2111 – zPCR Capacity Sizing Lab – Part 2 Hands on Lab
  - Wed 4:30 PM – John Burn and Bradley Snyder
Is it Capacity Planning or CPU Sizing?

- Terms are often used interchangeably, but they mean different things, and imply different activities

- CPU Sizing
  - Done in preparation for a processor change
  - One time effort
  - Aimed at verifying a proposed change

- Capacity Planning
  - Ongoing, with system utilization checked against a multi-period plan
  - Evaluates new applications
  - Identifies and manages workload growth at a business function level
  - Goal of forecasting capacity upgrades 3-6 months in advance
End to End CPU Sizing Process

- Describe the steps and considerations in the process
  - Identify points where expectations should be clearly set
- Identify areas which cause increased complexity and may raise the risk associated with the plan
- Identify practical approaches to handling unknowns
  - Solicit input
  - Evaluate current system(s) performance
  - Create Capacity Relationships of Current Processors
  - Establish “End Game” configuration
  - Establish Capacity Relationships of Future Processors
  - Generate the Plan
  - Set Capacity Expectations
  - Identify Post-Install Requirements
Acceptable Use of MIPS

- It is acceptable to use a MIPS designation for a processor in the planning process as long as the capacity ratios between relative processors agrees with the output of a zPCR study!
  - Do Not use primitive LSPR data because these LSPR ratios do not include LPAR effects of specific processor configurations
  - zPCR is based on LSPR information but factors additional information into the relative capacity relationships it creates
    - zCP3000 uses zPCR for detailed capacity planning
**Multi-Image Table and Single Image Table**

- **Multi-image (MI) Processor Capacity Ratio table**
  - Average complex LPAR configuration for each model based on customer profiles
  - Most representative for vast majority of customers
  - Same workload assumed in every partition
  - z/OS only
  - Use for “high level” sizing
  - Used to develop the MSU rating

- **Single-image (SI) Processor Capacity Ratio table**
  - One z/OS partition equal in size to N-way of model (limit to max CPs supported by SCP version)
  - Representative for truly single image z/OS cases
  - Used as the base for zPCR LPAR Configuration Capacity Planning

- Workload impacts the mixes
**zPCR Workload Mixes**

- Do NOT use LSPR primitives to describe capacity relationships
  - z/OS V1R9 primitives:
    - ODE-B, CB-L, WASDB, OLTP-T, and OLTP-W
- IBM recommends using pre-built mixes
  - Most customer workloads will fit closely with one of several pre-built mixes in zPCR
  - z/OS V1R9 mixes are:
    - LoLO-Mix
    - CB-Mix
    - TM-Mix
    - TD-MIX
    - TI-Mix
    - Web-Mix
    - LSPR-MIX
### Low IO Workload MIX

<table>
<thead>
<tr>
<th>LPAR</th>
<th>SSCH Rate</th>
<th>USED MSU</th>
<th>SSCH/MSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS1</td>
<td>7,000</td>
<td>300</td>
<td>23.3</td>
</tr>
<tr>
<td>STST</td>
<td>650</td>
<td>35</td>
<td>18.9</td>
</tr>
<tr>
<td>Total</td>
<td>7,650</td>
<td>335</td>
<td>22.8</td>
</tr>
</tbody>
</table>

**USED MSU =**

(Processor MSU Rating x CEC Utilization by LPAR)

Cannot use MSU value in multi-image table, use the CP calculator workload selection assistant tool within zPCR

- SSCH per Used MSU is <= 30
- Systems with a low I/O content should use proportionately higher amounts of WASDB and OLTP-W
- Most typical mix used by customers
Workload Mixes

- If multiple LSPR tables are necessary to characterize capacity, the five mixes can be used to assure consistency
  - The underlying LSPR workload primitives available in the various tables are different and cannot be used directly
  - Similar mixes of the same name are available in both the System z LSPR data and the legacy LSPR data and can be used

- LSPR-Mix is not intended to be useful for capacity planning purposes
  - Only simple average of five primitives used to generate software pricing

- LSPR Information can be found at:
Solicit Input and Document Assumptions

- Understand rational for the processor change
- Identify key parameters involved in the study
  - Data requirements
  - Specific time of day to evaluate capacity
  - Client defined MIPS ratings for current processors
    - Planning process will define MIPS ratings for proposed processors
  - Available information on growth rates or new workloads
- Identify key capacity guidelines, i.e.,
  - New processor can't be more than 90% busy
  - Certain LPARs can't be on the same footprint
  - Batch window can't elongate
  - Etc.
Obtain Performance Data

- CPU Sizing ASSUMES the system is well tuned
- Generally SMF Records 70:78 are used for Analysis
  - SMF 30 records sometimes used
- A good planning process will still make some rudimentary checks to evaluate the performance of the system
  - Latent demand in an LPAR
  - Latent demand in a CP (single TCB architectures)
  - Latent demand in Job queues
  - Consistently high utilization
  - Well-running I/O subsystem
  - No processor storage contention
  - Good z/OS capture ratio
- Evaluate the WLM setup to ensure the workloads have enough granularity to get a reasonable view of the system
  - Need to look at the report class granularity
Performance Data – Red Flags

- Uneven Utilization patterns
  - Could have been an outage, problem, holiday, etc.
  - Identify and decide if need to eliminate data
- Low utilization
  - Processor utilization affects the efficiency hardware and software
- High amounts of Latent Demand
  - Needs to be identified in the plan
- Poorly performing I/O subsystem
- Processor storage contention
A Few Charts can tell a lot....
Describe the Current Environment

- Identify current processors involved in the study
- Create a reference processor
  - Use only one CEC's input on processor size, even if more CECs are involved
- Pick pre-defined workload mix for each LPAR
  - Description of dominant LPAR is often sufficient
  - Verify the custom mix for each identified time period
    - Prime shift peak hour
    - Key batch window
    - Monthly/Quarterly/Yearly close

Pick 1 processor as the starting point

<table>
<thead>
<tr>
<th>Processor</th>
<th>MIPS</th>
<th>LPARs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2084-310</td>
<td>3,595</td>
<td>8</td>
</tr>
<tr>
<td>2094-708</td>
<td>4,224</td>
<td>4</td>
</tr>
<tr>
<td>2097-705</td>
<td>4,230</td>
<td>4</td>
</tr>
</tbody>
</table>
Generate Capacity Relationships of Current Processors

- Input into zPCR
  - Number of Partitions
  - Number of processors
    - Including Specialty CPs
  - Workload Mix
- Example with z9-708 as base
  - Relative capacity vs. 2094-701 set to 1.00

<table>
<thead>
<tr>
<th>Processor</th>
<th>Relative Capacity**</th>
<th>New MIPS</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2094-708</td>
<td>6.8784</td>
<td>4,224</td>
<td>With this base, z9-701 becomes 614.1 MIPS</td>
</tr>
<tr>
<td>2084-310</td>
<td>6.0672</td>
<td>3,726</td>
<td>Old rating of 3,595 MIPS</td>
</tr>
<tr>
<td>2097-705</td>
<td>6.8035</td>
<td>4,178</td>
<td>Old rating of 4,230 MIPS</td>
</tr>
</tbody>
</table>

** based on LOIO mix
**LPAR Impacts on Capacity**

- n-way and MP effects will impact capacity
- LPAR 3 is a uni, but the hardware is running as an 8-way shared processor and the capacity is of an 8-way shared processor
  - 5 GCPs, 2 zIIPs, 1 zAAPs
- Number and how busy they are will affect capacity
- Only zPCR can help determine what true capacity delivered is

<table>
<thead>
<tr>
<th>LPAR 1</th>
<th>LPAR 2</th>
<th>LPAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>z/OS</td>
<td>z/OS</td>
<td>z/OS</td>
</tr>
<tr>
<td>Weight = 400</td>
<td>Weight = 200</td>
<td>Weight = 100</td>
</tr>
<tr>
<td>LCP</td>
<td>LCP</td>
<td>LCP</td>
</tr>
<tr>
<td>LCP</td>
<td>LCP</td>
<td>LCP</td>
</tr>
<tr>
<td>zIIP</td>
<td>zIIP</td>
<td>zIIP</td>
</tr>
<tr>
<td>zAAP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Capacity Planning and LPAR

- Examples of single z9 CEC with multiple LPAR configurations
  - On z10 with HIPERDISPATCH=YES, or z9 with IRD Vary CPU Management, logical engine configuration will closely match what is guaranteed by LPAR weight

- ITRRs shown are relative to z9-701 set at 1.00

<table>
<thead>
<tr>
<th>Case</th>
<th>Mode</th>
<th># of LPs</th>
<th>LP x LCP</th>
<th>LCP</th>
<th>ITRR</th>
<th>% Change</th>
<th>LCP:PCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>2094-720</td>
<td>1</td>
<td>1 x 20</td>
<td>20</td>
<td>14.78</td>
<td>Base</td>
<td>1:1</td>
</tr>
<tr>
<td>1</td>
<td>2094-720</td>
<td>2</td>
<td>2 x 10</td>
<td>20</td>
<td>15.62</td>
<td>5.7%</td>
<td>1:1</td>
</tr>
<tr>
<td>Base</td>
<td>2094-710</td>
<td>6</td>
<td>3 x 10 2 x 3 1 x 2</td>
<td>38</td>
<td>8.04</td>
<td>Base</td>
<td>3.8:1</td>
</tr>
<tr>
<td>1</td>
<td>2094-710</td>
<td>6</td>
<td>3 x 3 2 x 2 1 x 1</td>
<td>14</td>
<td>8.58</td>
<td>6.7%</td>
<td>1.4:1</td>
</tr>
<tr>
<td>2</td>
<td>2094-710</td>
<td>10</td>
<td>10 x 1</td>
<td>10</td>
<td>8.52</td>
<td>5.97%</td>
<td>1:1</td>
</tr>
</tbody>
</table>
Impact of Specialty CPs

- ICF and IFL Impact
  - For ICF engines
    • within 10% of the performance of a stand-alone CF of the same processor family
    • zPCR is the best source
  - ICF and IFL partitions use specialty Cps that compete for resources in their own CP Pool

- Impact of Specialty Engines on GP CPUs
  - Impact will vary based on utilization of specialty CP's
    • Can be slight (less than 10%) to the impact of a full n-way impact of another GP CPU
  - Capacity is characterized as independent partitions with their own LCPs that compete for resources within their assigned CP pool
    • Estimation given in zPCR assumes specialty processors are 90% busy
      - Example: impact of 6 zAAPs running at 50% busy
## Specialty CP Example

<table>
<thead>
<tr>
<th>Partition Type</th>
<th>2094-712 with 6 zAAPs</th>
<th>2094-712 with no zAAPs</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCPs</td>
<td>LCPs</td>
<td>Capacity</td>
</tr>
<tr>
<td>GP</td>
<td>12</td>
<td>12</td>
<td>5,349</td>
</tr>
<tr>
<td>zAAP</td>
<td>6</td>
<td>7</td>
<td>2,712</td>
</tr>
</tbody>
</table>

- z9 processor with 6 zAAPs
  - 2 LPARs defined
    - 1 with all 6 zAAPs
    - 1 with 1 zAAP
- zAAPs are running at 50% busy
  - Physically 50% busy, combined usage of both LPARs
- Capacity of GP CPU without zAAPs is 11% more than with
  - Addition of 597 MIPS
- If zAAPs are only 50% busy, than GP CP capacity is expected to be 5,648 instead of 5,349
  - Any loss of GP CP capacity is made up by 2,712 MIPS added by zAAPs
**LPAR Utilization Cautions**

- Lightly weighted LPARs might need more capacity when moving to newer processors
- Explore potential LPAR consolidation
  - Reduce need to run z/OS on uniprocessor
  - Virtual storage constraints need to be reviewed
  - Places greater emphasis on doing CICS consolidation to make fewer, larger CICS regions which can use more of the CP's capacity

- Understanding the impacts of LPAR on a uni-processor
  - Managing CPU-Intensive Work on Uniprocessor LPARs - white paper WP100925

- Running IBM System z at High Utilization
  - Running and how to manage processors at high utilizations – white paper WP101208
Estimation Confidence

- Major Configuration Changes
  - Accuracy of zPCR model for an upgrade is +/- 5% of the estimate
  - Variability comes from multiple sources
    - Workload mix used is an estimate, actual workload can vary throughout time
    - Interactions of LPAR peaks and valleys
    - Efficiency of buffering techniques which impact I/O, and hence quantity of interrupts, which drives rate of preemption
    - Hardware changes made after LSPR benchmarks

- Minor Configuration Changes
  - Adding 1 LPAR, 1 engine, or changing number of LCP
  - Much higher confidence
  - Newer versions of zPCR will include information on scope of change

- Capacity decisions should be made with knowledge of the confidence factors
**MIPS Tables vs. zPCR Detailed LPAR Configuration Capacity Planning**

- Objective: Upgrade z9 to z10 with like capacity and add 1 zlIP engine to largest LPAR for future workload growth and 3 new LPARs for Development and Testing

### MIPS Table - LSPR Multi-Image z/OS 1.9 LSPR MIX

<table>
<thead>
<tr>
<th>Processor</th>
<th>N-way</th>
<th>MIPS TABLE</th>
<th>MSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>2094-608</td>
<td>8-way</td>
<td>3,204</td>
<td>428</td>
</tr>
<tr>
<td>2097-704</td>
<td>4-way</td>
<td>3,237</td>
<td>401</td>
</tr>
</tbody>
</table>

**Equivalent Capacity Expected**

z9 3204 MIPS vs. z10 3237 MIPS = +1.0%

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**zPCR LPAR Configuration Capacity Planning**

**8 LPARs, 8GCPs, 0 zlIP**

<table>
<thead>
<tr>
<th>Processor</th>
<th>2094-608</th>
</tr>
</thead>
</table>

**Capacity Received**

- 3,158 vs. 3,013 = -4.6%
- +5% Capacity Received

**3,158 vs. 3,164 = +0.2%**

**-5% Capacity Received**

**3,158 vs. 2,862 = -9.4%**

---

**11 LPARs, 4GCPs, 1 zlIP**

<table>
<thead>
<tr>
<th>Processor</th>
<th>2097-704</th>
</tr>
</thead>
</table>

**z10 MIPS with 11 LPARs and 1 zlIP via zPCR**

<table>
<thead>
<tr>
<th>Processor</th>
<th>3,013 GCP MIPS</th>
</tr>
</thead>
</table>

**3839 Total MIPS**

**+22%**
IBM System z Capacity Planning in a nutshell

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

Use zPCR to model before and after configurations
Post Install Analysis

- Success Factors:
  - Evaluation is done as close to the install of the new processor as possible
    - Rebuild the capacity expectations to match the installed configuration
  - Critical applications are isolated into WLM definitions which allow a clear view of capacity
- Performance data is retained and available for analysis
- Changes not included in capacity estimation but should be factored
  - Change in operating system or middleware levels
  - Maintenance
  - Change in processor storage (impacts sort-based workloads)
  - Buffer pool changes
  - Use of dynamic SQLs
  - Rebinding of SQL on new processor
Summary

- Long ago, LPAR environments and associated complexity have caused straight MIPS charts to become obsolete.
- Don't use primitives!!
  - Highly recommended to use pre-built mixes in zPCR and zCP3000.
- Understand the current system performance and latent demand indicators of an upgrade.
- Use tools like zPCR / zCP3000 to get the best view of expected capacity.
- Set expectations with knowledge of confidence factors.
  - Confidence factor of +/- 5% on all upgrades.