Introduction to z/OS Performance Measurement and Tuning Tips

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Abstract and Offer

- **Abstract**
  
  For a zNextGen person, z/OS performance measurement and tuning can be a big and intimidating area to explore. In the z/OS environment there are so many measurements available, and there are so many areas to be tuned. Where should one start to become quickly productive?

  During this presentation, Peter Enrico will discuss a variety of z/OS performance measurements and performance tuning recommendations to get any zNextGen person quickly productive and started on their journey to z/OS performance optimization.

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**Current 2011 Class Schedule**

- **WLM Performance and Re-evaluating of Goals**
  
  Instructor: Peter Enrico
  
  September 12 – 16, 2011    Baltimore, Maryland, USA

- **Parallel Sysplex and z/OS Performance Tuning**
  
  Instructor: Peter Enrico
  
  September 19 – 23, 2011    Dallas, Texas, USA

- **z/OS Capacity Planning and Performance Analysis**
  
  Instructor: Ray Wicks
  
  August 15 - 17, 2011    Columbus, Ohio, USA
Presentation Overview

- Quick Tip – Learn to Write!
- Quick Tip – Learn A Top Down Approach to Performance Analysis
- Quick Tip – Understand Your Workloads
- Quick Tip – Evaluate LPAR Weight Enforcement
- Quick Tip – Verify WLM Address Space Classification
- Quick Tip – Understand Coupling Facility Sync CPU Spin Seconds
- Quick Tip – Understand Which DASD I/O Logical Volumes to Concentrate On

Quick Tip – Learn to Write!

Documentation and communication are key to a performance assignment!

Write reports for your management and your team to let them know what you are doing.
Documentation and Communication

- One of the biggest mistakes made by those responsible for performance is failure to properly communicate.

- Performance personnel need to:
  - let others know what performance work is being done
  - let others know about performance findings, and to put those findings in context
  - let customers and management know about savings and cost
  - let everyone know the valuable job they are doing

- Document
  - The problem or area of concern
  - A proposed solution
  - An estimate in savings
    - Try to put this value in real monetary terms

- Let others know you accomplishments!
  - Let others know the work, accomplishments, and value being delivered by the company's investment in performance personnel

Quick Tip – Learn A Top Down Approach to Performance Analysis

Learn a logical approach to attack any performance problem:

- Long term analysis
- Capacity planning
- Real time performance management
- Etc.
Performance Analysis Fundamentals

- Each should be understood in the context of computer performance
  - Understanding workloads and their requirements
  - Understanding managed resources
  - Understanding and managing performance objectives
  - Knowledge and usage of performance controls
  - Ability to measure, monitor, and report
  - Common methodologies and techniques
    - For Capacity Planning
    - For Performance Management
    - For Performance Analysis
    - For Performance Tuning
  - Documentation and communication

The z Performance Environment

The following is a simplified view of the z/OS performance environment

- Monitors, Measurement Facilities, and reporters
- Configuration and Parameters and Workload Settings
- Performance of each z/OS Image / LPAR
- Performance of Sysplex
- Performance of each CEC
- Performance of DASD I/O Subsystem
- Physical & Logical Processors (GP, zAAPs, zIPs)
- Storage
- Channel, Logical Volume Control Unit, Cache, Etc.
- Monitoring And Reporting
  - Monitors
  - Logs and command output
  - Measurement records (such as SMF)
  - Post Processor Reports
  - Data reductions
- Coupling Facilities, Structures, XCF, etc.
Cookbook Approach to Performing a System Performance Analysis

- High level steps for revisiting your WLM setup and service definition
  - Step 1: Inventory Your Managed Resources
  - Step 2: Inventory System Workloads
  - Step 3: Understand Current WLM Definitions and System Parameters
  - Step 4: Learn How to Interpret Measurements
  - Step 5: Analyze the basic system resources
    - Processor, Storage, DASD I/O
  - Step 6: Analyze your WLM Service Definition and goals
  - Step 7: Analyze Sysplex communication and resources
    - XCF, Coupling Facility and Coupling Facility Structures
  - Step 8: Analyze your Subsystem work managers
    - CICS, IMS, DB2, WebSphere, MQ, etc, etc, etc...
  - Step 9: Analyze your applications
  - Step 10: Write a report

Quick Tip – Understand Your Workloads

Spend a day or two (or three (or four)) really learning about your workloads and their performance requirements, objectives, and expectations.

Who are your customers?
Workload Investigation Questions

- On z/OS, when investigating workload performance, at a very high level the following broad questions need to be asked:
  - What is the workload?
  - What type of address space is used by this workload?
  - What is the definition of the workload's transaction?
  - Why does this workload exist?
  - Who / what make up this workload?
  - When does the workload run?
  - Where does the workload run?
  - How does the workload run?
  - What are the performance challenges of the workload?

Key Workload Subsystem Types

- On z/OS there are many different types of workloads that run:
  - Some workloads are common to most installations
  - Other workloads are specific to certain industries
  - Other workloads are very customer specific

- But in general, when investigating workloads, the following the primary groupings to be investigated:
  - System and system support workloads
  - Interactive workloads
  - Batch workloads
  - Database management workloads
  - Legacy online transaction processing (OLTP) workloads
  - E-business transaction processing workloads
  - Distributed request workloads

- Each of these workloads have a number of different variations
  - Most interact some how with the others
Example: System and System Support Workloads

- **Who / What make up this workload?**
  - Required and usual address spaces that provide some operating system related function
  - Tools, facilities, and vendor products for system support purposes
  - Unix System Services Daemons providing operating system functions
  - Monitors – performance or other

- **Why is performance a concern for this workload?**
  - Much of the overall system performance and the performance of most other workloads directly depend on sufficient performance of these system workloads

- **Performance challenges**
  - Lots of miscellaneous address spaces that need investigation
  - When some of these address spaces need system resources, they need the resource right away

Example: System and System Support Workloads

- **Examples of system and system support workloads on z/OS include:**
  - Required high priority address spaces
    - MASTER, ALLOCAS, ANTMNAIN, BPXOINIT, CATALOG, CONSOLE, DUMPSRV, GRS, IOSAS, IXLOGGR, OMVS, PCHAIN, RASP, SMSPDSE, TRACE, XCFAS, WLM, etc.

  - Privileged address spaces for operating system functions
    - ANTSxxx, APPC, ASCH, JES2, RACF, ZFS, LLA, SMS, VLF, RRS, ENF, etc.

  - UNIX System Services daemons doing operating system work
    - INETD, TN3270, SYSLOGD, etc.

  - Monitors
    - Performance monitors by BMC, CA, IBM, and many other vendors
    - Other non-performance monitors by many vendors

  - Other
    - Many different z/OS products used for system support purposes
Example: Batch Workloads

- Who / What make up this workload?
  - Work requests that perform some function or data processing request.
  - These requests are run in a 'background' mode
    - Means that units of work generally have no human interaction
    - Work is 'scheduled' and run asynchronously

- Why is performance a concern for this workload?
  - There are many different types of batch workload and each has its own unique performance considerations and requirements

- Performance challenges
  - In most installations batch is one of the largest, if not the largest workloads
    - Typically consumes great amounts of system resources
  - Completion of many batch workloads is required within very strict windows of time

Example: Batch Workloads

- Examples of batch workloads on z/OS include:
  - Normal Production Jobs submitted by a Job Scheduler
  - Critical Path Jobs submitted through a Job Scheduler
  - Ad-hoc Jobs (possibly submitted by a Job Scheduler)
  - Development Jobs
  - Normal System Support Jobs
  - High-Priority System Support Jobs
  - Logs, Archival, Backup, and D/R Jobs (possibly submitted by a Job Scheduler or an appropriate Subsystem)
  - Quick Utility Jobs
  - Emergency of Hot Jobs
Example: Batch Workloads

- Jobs requiring setup include
  - Batch jobs that require input from media that is not normally online to a system
  - Batch jobs that require offline media to generate output have setup requirements that involve operator intervention

- May Include:
  - Manual tape mounts (reels or cartridges)
  - ATL/Silo Mounts- normally very quick unless media is not in the ATL
  - Virtual Tape Servers (VTS)- normally very quick unless data is not staged in the disc Cache
  - Direct SYSOUT Writers (not used much)- not normally quick if forms or print trains need to be inserted, or device is particularly slow

Quick Tip – Evaluate LPAR Weight Enforcement

Understand when weight enforcement is happening.

**Investigation:** If any LPAR is regular getting more than its weight because another LPAR is regularly demanding less than its weight

**Tuning:** If the LPAR regularly running below its weight suddenly demands its weight (CPU) then it will hurt the LPAR that is regularly enjoying more than his weight since that LPAR will have its weight enforced.

Maybe shift weight so assigned weights are based on regular running state.
Quick Tuning Tip – PR/SM Weight Enforcement

- What you need to get started:
  - Basic understanding of PR/SM, the LPAR configuration, LPAR weights, etc
  - Basic understanding PR/SM weight enforcement
  - Understanding of available SMF 70 PR/SM and z/OS CPU measurements
    - Several reporting packages
    - Or RMF (or CMF) Partition Data Report and RMF (or CMF) CPU Activity Report
  - A calculator or program to measure
    - Guaranteed LPAR share
    - Percentage of weight consumed
    - Delta between LPAR Utilization % and MVS Utilization %
  - Report to your manager
  - Pattern of weight enforcement

Example of RMF Partition Data Report

```
PARTITION DATA REPORT  PAGE 2

z/OS V1R9                SYSTEM ID SYP1            DATE 08/05/2009            INTERVAL 15.00.006
RPT VERSION V1R9 RMF      TIME 02.29.00              CYCLE 1.000 SECONDS

MVS PARTITION NAME                 LPARSP1       NUMBER OF PHYSICAL PROCESSORS           9                 GROUP NAME       N/A
IMAGE CAPACITY                         422                  CP 6                 LIMIT            N/A
NUMBER OF CONFIGURED PARTITIONS          5                  AAP 0
WAIT COMPLETION                         NO                  IFL 0
DISPATCH INTERVAL                  DYNAMIC                  ICF 0
IIP 3
--------- PARTITION DATA ----------------- -- LOGICAL PARTITION PROCESSOR DATA -- -- AVERAGE PROCESSOR UTILIZATION PERCENTAGES --

----MSU---- -CAPPING-- PROCESSOR- ----DISPATCH TIME DATA---- LOGICAL PROCESSORS  --- PHYSICAL PROCESSORS ---
NAME       S   WGT  DEF    ACT  DEF   WLM%  NUM   TYPE   EFFECTIVE       TOTAL       EFFECTIVE    TOTAL  LPAR MGMT  EFFECTIVE  TOTAL
LPARSP1    A    54    0    260  NO     0.0    5   CP    00.55.27.732  00.55.30.468       73.95    74.01      0.05      61.62  61.67
LPARSD1    A    12    0     35  YES    0.0    1   CP    00.07.26.536  00.07.28.786       49.61    49.86      0.04       8.27   8.31
LPARSM1    A     3    0      0  YES    0.0    1   CP    00.00.00.000  00.00.00.000 0.00     0.00 0.00 0.00 0.00
LPARSM2    A     3    0      0  YES    0.0    1   CP    00.00.00.000  00.00.00.000 0.00     0.00 0.00 0.00 0.00
LPARSP4    A    28    0    122  YES    0.0    2   CP    00.26.01.838  00.26.02.148       86.77    86.79      0.01      28.92  28.93
*PHYSICAL*                                                     00.00.08.517                           0.16              0.16
------------ ------------ ------ ------ ------
TOTAL                                                 01.28.56.106  01.29.09.922                           0.26      98.82  99.07

LPARSP1    A    54                            1   IIP   00.04.47.344  00.04.47.989       31.93    32.03      0.02      10.64 10.67
LPARSD1    A    12                            1   IIP   00.00.01.969  00.00.02.039        0.22     0.23      0.00       0.07   0.08
LPARSM2    A     3                            1   IIP   00.00.00.000  00.00.00.000 0.00     0.00 0.00 0.00 0.00
LPARSP4    A    28                            1   IIP   00.00.06.040  00.00.06.123        0.67     0.68      0.00       0.22   0.23
*PHYSICAL*                                                     00.00.02.329                           0.09              0.09
------------ ------------ ------ ------ ------
TOTAL                                                 00.04.55.355  00.04.58.482                           0.12      10.94 11.05
```
### LPAR Configuration, LPAR Weight% and Guaranteed Share CPs

#### Partition Configuration and Setup - CP Processors

<table>
<thead>
<tr>
<th>Partition Number</th>
<th>Processor Type</th>
<th>LPAR Name</th>
<th>Partition Mode</th>
<th>Num Logical Processors</th>
<th>Partition Weight</th>
<th>% Weight</th>
<th>Guaranteed CPs of Capacity</th>
<th>Capping</th>
<th>Def MSU Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 CP</td>
<td>LPARSP1</td>
<td>SHR</td>
<td>5</td>
<td>54</td>
<td>54.0%</td>
<td>3.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 CP</td>
<td>LPARSD1</td>
<td>SHR</td>
<td>1</td>
<td>12</td>
<td>12.0%</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3 CP</td>
<td>LPARSM1</td>
<td>SHR</td>
<td>1</td>
<td>3</td>
<td>3.0%</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 CP</td>
<td>LPARSM2</td>
<td>SHR</td>
<td>1</td>
<td>3</td>
<td>3.0%</td>
<td>0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5 CP</td>
<td>LPARSP4</td>
<td>SHR</td>
<td>2</td>
<td>28</td>
<td>28.0%</td>
<td>1.68</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 6                | 10             | 100%      | 100%           | 6.00                   |                  |          |                           |         |                 |

#### Partition Configuration and Setup - zIIP Processors

<table>
<thead>
<tr>
<th>Partition Number</th>
<th>Processor Type</th>
<th>LPAR Name</th>
<th>Partition Mode</th>
<th>Num Logical Processors</th>
<th>Partition Weight</th>
<th>% Weight</th>
<th>Guaranteed CPs of Capacity</th>
<th>Capping</th>
<th>Def MSU Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 zIIP</td>
<td>LPARSP1</td>
<td>SHR</td>
<td>1</td>
<td>54</td>
<td>55.7%</td>
<td>0.557</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2 zIIP</td>
<td>LPARSD1</td>
<td>SHR</td>
<td>1</td>
<td>12</td>
<td>12.4%</td>
<td>0.124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4 zIIP</td>
<td>LPARSM2</td>
<td>SHR</td>
<td>1</td>
<td>3</td>
<td>3.1%</td>
<td>0.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5 zIIP</td>
<td>LPARSP4</td>
<td>SHR</td>
<td>1</td>
<td>28</td>
<td>28.9%</td>
<td>1.28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 5                | 4.00           | 97        | 100%           | 1.00                   |                  |          |                           |         |                 |

### Percentage of LPAR weight consumed

- Value is not reported on any post processor report and few monitors
  - Need to manually calculate it

- Percentage of weight consumed helps us understand:
  - If a partition regularly consumes more or less than its guaranteed share
    - If > 100% then LPAR consumed more than its guaranteed share
      - Example: 150% means LPAR consumed 1.5 times its guaranteed share
    - If < 100% then LPAR had less demand for CPU than guaranteed share
      - Example: 50% means LPAR only consumed 50% of its weight
  - Insights into if weights are being enforced
  - Which LPARs are competing for CPU

- Reminder, when processor demand of LPARs is greater than physical CPU capacity
  - Weights are enforced
What was percentage of LPAR weight consumed?

- **Scenario 2:**
  - Assume SYSA had 100% demand for its 4 logical capacity
  - SYSB, and SYSC each had 0% demand for their logical capacity
  - SYSA guaranteed 50% of 4 physicals but used 100% of 4 physicals
    - So consumed 200% of its weight
  - SYSB guaranteed 25% of 4 physicals but used 0% of 4 physicals
    - So consumed 0% of its weight

Assume the following utilizations:

<table>
<thead>
<tr>
<th>Physical</th>
<th>Logical</th>
<th>%Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSA</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>SYSB</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>SYSC</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Reminder:
- 25% of 4 CPUs = 100% of 1 CPU

Calculating percentage of weight consumed

- Calculating the percentage of weight consumed

- % LPAR Weight Consumed =

  \[
  \frac{\text{(Total Physical CPU Busy %)}}{\text{LPAR Guaranteed Share}} \times 100
  \]

- Where:
  - Total Physical CPU Busy %
    - From RMF Partition Data report
  - LPAR Guaranteed Share
    - \( \frac{\text{(LPAR's Weight))}}{\text{(Sum all LPAR's Weights))}} \times 100 \)

- Example: LPARSP1:
  - If LPARSP1 is 61.67% Total Physical Processor Busy
  - And is guaranteed share is 54%
  - Then % Weight Consumed = \( \frac{61.67%}{54%} \times 100 = 114.2\% \)
LPAR Utilization for CEC by LPAR Over Time

Percentage Weight Enforcement
RMF CPU Activity Report - Page 1

- Provides information on active processors
  - Configuration information
    - Processor Model, number of CPUs, CPU serial number
  - Resource usage and load calculations
    - Processor online time percentage
    - CPU Busy % - LPAR view and MVS view
    - I/O Interrupt activity - interrupt rate, interrupts handled by TPI

**CPU ACTIVITY**

```
CPU 2094  MODEL 706  H/W MODEL S18  SEQUENCE CODE 0000000000000D63FC  HIPERDISPATCH=N/A

---CPU--- ---------------- TIME % ---------------- LOG PROC      --I/O INTERRUPTS--
NUM  TYPE    ONLINE    LPAR BUSY    MVS BUSY   PARKED     SHARE     % VIA TPI
0    CP     100.00    74.03        100.0      ---- --     64.8       7.01 / 98.99
1    CP     100.00    74.03        100.0      ---- --     64.8       6.80 / 99.00
2    CP     100.00    74.02        100.0      ---- --     64.8       6.69 / 99.02
3    CP     100.00    74.02        100.0      ---- --     64.8       6.49 / 99.04
4    CP     100.00    73.95        100.0      ---- --     64.8       8402 / 23.06
TOTAL/AVERAGE          74.01        100.0                 324.0     8429 / 23.30

C    IIP    100.00    32.00        31.96      ---- --     100.0
TOTAL/AVERAGE          32.00        31.96                 100.0
```

**LPAR Busy % vs MVS Busy %**

```
LPAR CP Busy% vs MVS CP Busy% for System

MVS.Bus,PC  LPAR.Bus,PC
```

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Quick Tip – Verify WLM Address Space Classification

Understand your WLM service definition and settings.

**Investigation:** Understand where your work is being classified.

**Tuning:** Verify where things are being classified
- You will learn lots about your workloads
- You will learn lots about your WLM configuration

Quick Tuning Tip – Verify WLM Classification

- **What you need to get started:**
  - Basic understanding of Workload Manager, service classes, importance level, goals, etc.
  - Basic understanding of WLM classification rules
  - Understand your WLM service definition
    - Visit my website (www.epstrategies.com) to convert your WLM service definition to HTML format
  - Understanding of available SMF 30 Address Space SMF records
    - You will need a SMF data reductions program
  - SMF 30 records to verify the classification of address spaces
    - Note: Different exercise to verify classification of enclaves
  - Make sure work is being classified as expected
    - If nothing else, you will learn lots about your workloads and WLM management of your workloads
Overview of WLM Service Definition

Service Definition

Workload

ONLINE
- SC=B RC=RB
- SC=C RC=RC
- SC=D RC=RD
- SC=A RC=RA

Workload

SYSTEM
- SC=O RC=RO
- SC=P RC=RP
- SC=M

Policy01
- SC overrides

Policy02
- SC overrides

Classification Rules to Service Class

Service Classes
- have goals and importance

ASCH
- CB
- CICS
- DB2
- DDF
- IMS
- IWEB
- JES
- LSFM
- MQ
- NETV
- OMVS
- SOM
- STC
- TSO
- SYSH

Miscellaneous Controls
- Service Definition Coefficients
- I/O Management

Resource Groups

Workload

BATCH
- SC=F RC=RF
- SC=H RC=RH
- SC=E RC=RE

Workload

SYSPROG
- SC=N RC=RN
- SC=M

Workload

NEWWORK
- SC=NEWWORK
- RC=NEWMQ
- RC=NEWLFSM

Workload

RGRP01
- Minimum=100
- Maximum=1500

RGRP02
- Minimum=0
- Maximum=1000

Understand Current WLM Definition

- Understand your current WLM service definition
  - It is your starting point for reevaluation of goals

- Items to consider:
  - How many and what service classes and service class periods defined
  - What are the goals and importance levels of the work of the periods
    - How do all these relate to each other?
  - Are report classes being used and if so, how many report classes are there?
  - Are there application environments or scheduling environment defined?
  - What are the classification rules?
    - Do all subsystems have classification rules
  - Are resource groups being used?
    - For what purpose
  - Are critical controls (such as CPU or storage being used)
  - Etc.
### WLM Policy Editor

#### Policy Editor Interface:

- **Service Definition:** "Z\_*_\_**_** Service Definition Editor - C:\Program Files\IBM Service Definition Editor\Sample.xml"
- **Resource Groups:** "G001\_\_**_** Resource Groups Editor - C:\Program Files\IBM Resource Groups Editor\Sample.xml"
- **WLM Policies:** "WLM Policies Editor - C:\Program Files\IBM WLM Policies Editor\Sample.xml"

#### Policy Configuration:

- **Service Name:** "Z\_*_\_**_** Service Name Editor - C:\Program Files\IBM Service Name Editor\Sample.xml"
- **WLM Resource Groups:** "WLM Resource Groups Editor - C:\Program Files\IBM WLM Resource Groups Editor\Sample.xml"

#### Policy Details:

- **Policy Name:** "WLM Policy Name Editor - C:\Program Files\IBM WLM Policy Name Editor\Sample.xml"
- **Policy Description:** "WLM Policy Description Editor - C:\Program Files\IBM WLM Policy Description Editor\Sample.xml"
Easier Way: Convert Your Service Definition to HTML

- When cleaning up your service definition it may help to have it in an easy to read and analyze format

- Convert your WLM service definition to HTML for readability and reference

1. Using the WLM ISPF application:
   - 'File' option at top of screen
   - Sub option 'Print as GML'
   - Creates a flat file of service definition with GML formatting tags

2. Download GML version of WLM Service Definition to workstation as text file

3. Go to www.epstrategies.com and select WLM Tool button to convert

4. Follow instructions - select file and fill in email address

5. Presto! HTML file will be emailed to you within minutes

WLM Service Definition in HTML Format

Table of Contents

- Service Definition PLAN00
  - Overview
  - Service Characteristics
  - Service Definition Options
  - Workload and Service Class Descriptions
  - Classification Groups
  - Classification Rules
  - ASCQ NPSN Transactions
  - OR Use Module to enter YOUR rules
  - ONS
  - IFP Use Module to enter YOUR rules
  - DF PNL procedure/rule entry processor
  - IMQ Use Module to enter YOUR rules
  - TWR Use Module to enter YOUR rules
  - JCL Entry Entry
  - CLFPM Use Module to enter YOUR rules
  - OHPF Open MSG
  - SCM Use Module to enter YOUR rules
  - STO started Tasks
  - TSO TSO User
  - Accelerator Environment
  - Service Definition Service Class/Node
Use SMF 30 Records to Verify Classification

- **SMF 30 job / address space identification information**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF30JBN</td>
<td>Job or session name.</td>
</tr>
<tr>
<td>SMF30PGM</td>
<td>Program name (taken from PGM= parameter on EXEC card).</td>
</tr>
<tr>
<td>SMF30STM</td>
<td>Step name (taken from name on EXEC card).</td>
</tr>
<tr>
<td>SMF300IF</td>
<td>User-defined identification field.</td>
</tr>
<tr>
<td>SMF30JNM</td>
<td>JES Job identifier.</td>
</tr>
<tr>
<td>SMF30STN</td>
<td>Step number (first step = 1, etc.).</td>
</tr>
<tr>
<td>SMF30LCS</td>
<td>Job class (blank for TSO/E session or started tasks).</td>
</tr>
<tr>
<td>SMF30ESN</td>
<td>Substep number. This field is set to zero for non-z/OS UNIX System Services steps. When the z/OS UNIX System Services exec function is requested, a new substep is begun and this value is incremented.</td>
</tr>
<tr>
<td>SMF30EXN</td>
<td>Program name. For a z/OS UNIX program, this contains the UNIX program that was run or the 8 character name of an MVS program that was run.</td>
</tr>
<tr>
<td>SMF30ASI</td>
<td>Address Space identifier.</td>
</tr>
</tbody>
</table>

SMF 30 Measurements to Correlate to SMF 72.3

- Can also use SMF 30 WLM information to correlate measurements to the SMF 72.3 records

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF30TTS</td>
<td>Number of system resources manager (SRM) transactions.</td>
</tr>
<tr>
<td>SMF30WM</td>
<td>Workload name.</td>
</tr>
<tr>
<td>SMF30SCN</td>
<td>Service class name.</td>
</tr>
<tr>
<td>SMF30GRN</td>
<td>Resource group name.</td>
</tr>
<tr>
<td>SMF30RCN</td>
<td>Report class name.</td>
</tr>
<tr>
<td>SMF30ETC</td>
<td>Independent enclave transaction count.</td>
</tr>
</tbody>
</table>

- Use Service Class name and Report Class name to correlate measurements to the SMF 72.3 records
Great Exercise (for Any Workload)

- Using the SMF 30 measurements, it is easy to create a cross reference spreadsheet to gain insights into the following:
  - Mapping of which address spaces were active on which system and how many intervals of time
    - For every address space SMF 30.2 or 30.3 record, create a CSV file that contains Address Space Name, Service Class name, Report Class Name, and system where address space ran.
  - Mapping of what programs ran
    - z/OS programs
    - Could expand to include Unix System Services programs
    - Etc.
  - Mapping of address spaces to WLM Service Classes and Report Classes
    - Helps with review and verification of WLM classification rules
  - See following slides for some examples.

Create a SMF30.2 to WLM Mapping
**Example:**
Investigate Address Spaces in PS_BATHI

<table>
<thead>
<tr>
<th>ADDRESS_NAME</th>
<th>RC_NAME</th>
<th>RC_TYPE</th>
<th>JOB_NAME</th>
<th>AS_NAME</th>
<th>AS_TYPE</th>
<th>SYSPRM</th>
<th>LPS</th>
<th>DPATCH</th>
<th>SYSPRM</th>
<th>LPS</th>
<th>DPATCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PS_BATHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200</td>
<td>300</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PS_BATHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>125</td>
<td>150</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PS_BATHI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Example:**
Investigate Address Spaces in STCDEF

<table>
<thead>
<tr>
<th>ADDRESS_NAME</th>
<th>RC_NAME</th>
<th>RC_TYPE</th>
<th>JOB_NAME</th>
<th>AS_NAME</th>
<th>AS_TYPE</th>
<th>SYSPRM</th>
<th>LPS</th>
<th>DPATCH</th>
<th>SYSPRM</th>
<th>LPS</th>
<th>DPATCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>STCDEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>STCDEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25</td>
<td>24</td>
<td>24</td>
<td>24</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>STCDEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>STCDEF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Example:
Investigate Address Space Names Ending in MSTR

Quick Tip – Understand Coupling Facility Sync CPU Spin Seconds

What is the cost to z/OS for doing Coupling Facility synchronous requests?

**Investigation:** Determine how many CPU seconds were spent ‘spinning’ for the processing of coupling facility synchronous requests.

**Tuning:** Ensure within guidelines; determine most expensive structure if there is a problem.
Quick Tuning Tip – CF Host Effect Spin Seconds

- What you need to get started:
  - Basic understanding of the coupling environment, structures, and exploiters
  - Basic understanding of coupling facility synchronous request processing and its effects on processor consumption
  - Understanding of available SMF 74.4 Coupling Facility measurements
    - Several reporting packages
    - Or RMF (or CMF) Coupling facility report
  - A calculator or program to measure the CPU cost to z/OS for executing Coupling Facility synchronous requests
  - Report to your manager the cost due to Coupling Facility Synchronous spin CPU seconds
    - By measurement interval for the system
    - By structure

Performance Analyst View of CF Resource

- **z/OS Processing**
  - S/W processing to make CF request
  - Request a sub-channel
  - Request a path
  - Data transfer over link
  - On return, S/W processing to handle CF request

- **Coupling Facility Processing**
  - Link time (i.e. time on path)
  - CF busy processing request

![Diagram of CF Resource](image)
CF Synchronous Request Processing

- Requesting processor spins waiting for CF request to complete
- Two types of sync requests
  - Those that must continuously run as synchronous
    - Lock requests - XES spins
  - Those that start out as sync
    - But converted to async if doing so helps performance
    - Sync cache/list requests - XES changes to async

Impacts response time of sender, and performance of sending system

Host Effect Seconds Over Time

CF Host Effect Analysis - Estimated Host Seconds Breakdown for System over Time
CF Synchronous Request Processing

- Synchronous requests cause the requesting CPU to spin waiting for a response from the CF. Thus, performance is heavily dependent on a number of factors:
  - Speed of requesting CPU
    - Larger processor will 'waits faster' for a response
  - Subchannel busy conditions
  - Path busy conditions
  - Time it takes to transmit data to the CF
    - CF link performance
    - Speed of data over link
    - Distance - Geographically dispersed parallel Sysplex?
  - Speed of CF processor
    - Shared LPAR?
    - Dedicated CF?

CF Subchannel Activity

- CPU seconds consumed due to sync immediate Spin
  - Sync Immediate requests cause processor issuing the request to 'spin'
  - How many CPU seconds did the sending LPAR spend spinning?
    - Logical processor unavailable to other work running in the same LPAR
    - Physical processor that logical processor is dispatched to is unavailable to other LPARs
  - It is helpful to understand capacity consumed to these spinning conditions

\[
\text{CPU Seconds Spinning} = \left( \frac{\#\text{ REQ Sync} \times (\text{Sync Service Time})}{1,000,000} \right)
\]
CF Subchannel Activity

- % Effective Utilization due to sync immediate Spin
  - Sync Immediate requests cause processor issuing the request to ‘spin’
  - What % CPU utilization did the sending system spend spinning?
    - When a sync immediate request encounters a busy condition it results in a ‘spin’ condition
  - It is helpful to understand the percent of an engine (processor busy) that was devoted to these spinning conditions
    \[
    \text{% Proc Spent Spinning} = \left( \frac{\text{# Sync}}{\text{Sync Service Time} \times \text{Sync Service Time Interval Seconds} \times \text{LP} \times \text{Million}} \right) \times 100
    \]

---

Same exercise could be done on a structure by structure basis

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Quick Tip – Understand Which DASD I/O Logical Volumes to Concentrate On

What is the cost to z/OS for doing Coupling Facility synchronous requests?

Investigation: Determine how many CPU seconds were spent ‘spinning’ for the processing of coupling facility synchronous requests.

Tuning: Ensure within guidelines; determine most expensive structure if there is a problem.

Quick Tuning Tip – Calculate I/O Intensity

- What you need to get started:
  - Basic understanding of DASD I/O subsystem environment
  - Basic understanding of primary I/O response time component measurements
    - Reported on a logical volume basis
    - WLM Service Class and Report Class basis
    - Etc.
  - Understanding of I/O Intensity and Queue Intensity
    - Several reporting packages
  - A calculator or program to calculate I/O intensity values
    - Note: Must be calculated on a DASDplex basis
    - In other words, never look at I/O performance a system at a time. Any logical volume must be examined at the DASDplex level (by merging all measurements)
  - Concentrate on logical volumes with the highest I/O queuing intensity
Results of a Typical DASD I/O Analysis

- It is always critical to do a I/O subsystem analysis
  - Logical volumes impacting the workloads the most
  - Evaluation of I/O technologies
  - I/O balancing

- Typical SMF measurements analyzed for an I/O analysis include:
  - SMF 74.1 - Device Activity measurements
  - SMF 74.5 - Cache Control Unit measurements

- These give you a DASD I/O logical volume analysis from the logical volume point-of-view

- A detailed analysis provides exceptional benefit

Ways of Looking at I/O Performance from an I/O Subsystem Point-of-View

- DASDplex level for all data
- Logical Volume level
  - Problem logical volumes (severe and warnings)
  - Response Time and Queue Time component analysis, I/O Intensity and Queuing Intensity analysis
  - Caching statistics

- Logical Control Unit (LCU) Level
  - Problem LCUs (severe and warnings)
  - Response Time and Queue Time component analysis, I/O Intensity and Queuing Intensity analysis
  - Caching Statistics

- Control Unit (CU)
  - Problem CUs (severe and warnings)
  - Response Time and Queue Time component analysis, I/O Intensity and Queuing Intensity analysis
  - Caching Statistics
Overview of Components of I/O Response Time

- DASD I/O requests and their response times
  - SSCH Rate - Total number of start sub-channel instructions
    Can think of this as the number of DASD I/O requests
  - RESP - Average DASD I/O response time (ms)

- I/O Response Time = IOSQ time + PEND time + Disconnect time + Connect time

DASD I/O Response Time Measurements

- Measures shown are the I/O responses times broken into their four major components
  - IOSQ - IOSQ time is a delay time accumulated while the I/O is still in MVS and is waiting for a UCB to allow the I/O against the device
  - PEND - PEND is a delay time that usually occurs on devices with allegiance to multiple systems, and I/O are delayed waiting for the other system to complete its I/O
  - DISC - Disconnect time occurs when an I/O is being setup to complete
  - CONN - Connect times occurs as the data is being written out to the device. High disconnect times occur for a variety of reasons.

\[ \text{DASD I/O response time} = \text{IOSQ} + \text{PEND} + \text{DISC} + \text{CONN} \]
Intensity

- When it comes to I/O many analysts make the mistake on concentrating on the following:
  - Poor I/O response times
  - Logical volumes with the most activity

- It is better to look at the calculated *Intensity* values
  - A great measurement to gain insight into what component / workload to concentrate your analysis on

- **Intensity** = (Rate) * (Average Response Time)
  - Example: I/O Intensity = (I/O Rate) * (CONN + DISC + PEND + IOSQ)
  - Example: Queuing Intensity = (I/O Rate) * (DISC + PEND + IOSQ)

Calculating I/O Intensity and Queue Intensity

- Evaluating I/O performance based mainly on I/O response times is insufficient
  - Must take I/O rate into consideration
  - Since frequency of I/O influences the impact of the I/O response times

- **Intensity** is a useful measure of the impact I/O may be having on the system

  - **I/O Intensity** = (I/O Rate) * (Average I/O Response Time)
  - **Queue Intensity** = (I/O Rate) * (Average I/O Response Time - CONN Time)

- Intensities can be calculated for
  - Logical Volumes (on DASDplex basis)
  - Control Units
  - LCUs
  - Service Class Period, Service Class, Report Class, Workload, WLM Service Policy (or system)
  - Etc.

- Regularly monitor
Why calculate intensity values?

- Common I/O guideline: DASD I/O response times should be 3 milliseconds or below (on average)

- Example 1:
  - Logical volume TSO001 has a 18 ms I/O response time with 10 I/Os per second
    - CONN = 12, DISC = 5, PEND = 2, and IOSQ = 1
    - I/O Intensity = (18 ms) * (10 I/O per second) = 180
    - I/O Queue Intensity = (6 ms) * (10 I/O per second) = 60

- Example 2:
  - Logical volume DBA022 has a 4 ms I/O response time with 1000 I/Os per second
    - CONN = 1, DISC = 2.5, PEND = 0.5, and IOSQ = 0
    - I/O Intensity = (4 ms) * (1000 I/O per second) = 4000
    - I/O Queue Intensity = (3 ms) * (1000 I/O per second) = 3000

Example: Note Top LVs based on I/O Response Time
Example: Note Top LVs based on I/O Intensity

Example: Note Top LVs based on I/O Queue Time
Example: Note Top LVs based on I/O Queue Intensity

Presentation Overview

- Quick Tip - Learn to Write!
- Quick Tip - Learn A Top Down Approach to Performance Analysis
- Quick Tip - Understand Your Workloads
- Quick Tip - Evaluate LPAR Weight Enforcement
- Quick Tip - Verify WLM Address Space Classification
- Quick Tip - Understand Coupling Facility Sync CPU Spin Seconds
- Quick Tip - Understand Which DASD I/O Logical Volumes to Concentrate On
Current 2011 Class Schedule

- **WLM Performance and Re-evaluating of Goals**
  - Instructor: Peter Enrico
  - September 12 - 16, 2011  
    Baltimore, Maryland, USA

- **Parallel Sysplex and z/OS Performance Tuning**
  - Instructor: Peter Enrico
  - September 19 - 23, 2011  
    Dallas, Texas, USA

- **z/OS Capacity Planning and Performance Analysis**
  - Instructor: Ray Wicks
  - August 15 - 17, 2011  
    Columbus, Ohio, USA