IBM DB2 for z/OS and Workload Manager Intersection: Understanding the Basics

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Agenda

• Workload Manager (WLM) Overview
• How WLM affects DB2
  o Defining DB2 Address Spaces to WLM
  o WLM: Four Types of DB2 work
    • Local Attach
    • DDF and Enclaves
      – What is an enclave?
      – Classifying DDF work
    • Sysplex Query Parallelism
    • Stored Procedures and Application Environments
      – External stored procedures in WLM managed address spaces
      – DB2 9 for z/OS and native SQL procedures
  o Other WLM interaction with DB2
    • Autonomic DB2 buffer pool sizing
    • Sysplex Workload Balancing
WLM is the priority and resource manager for z/OS and, therefore, for DB2 on z/OS
DB2 and Workload Manager

- WLM manages DB2 address spaces
  - DB2 subsystem address spaces: MSTR, DBM1, IRLM, DIST
  - DB2 stored procedure address spaces for external stored procedures
  - How WLM manages these address spaces can affect DB2 application performance

- WLM manages DB2 workflow
  - Priority and performance of allied tasks that call DB2
    - CICS, IMS, batch, TSO, WebSphere, MQSeries
  - DB2 distributed and stored procedure workload

- DB2 professional should have a basic understanding of WLM
Service Definition

Address Spaces

Service Definition

Service Policy 1

Service Policy 2

Service Policy 3

Classification Rules

Workload A

Service Class 1

Service Class 2

Service Class 3

Service Class 4

Workload B

Service Class 5

Workload C

Service Class 6

Service Class 7

Workload x

Service Class x1

Report Class a

Report Class b

Report Class c

Only 1 Service Policy can be active at any time
WLM Terminology

- A Service Definition
  - Consists of one or more Service Policies
- A Service Policy
  - Contains several Workloads
  - One Service Policy is active at a time in an LPAR or Parallel Sysplex
- Each Workload (arbitrary collection)
  - Consists of one or more Service Classes
- Each Service Class
  - Has at least one Period and each Period has one Goal
  - If more than one period, all but last have a Duration
- A Goal may be one of five types:
  - System, Average Response Time, % Response Time, Execution Velocity, Discretionary
- Address spaces and transactions are assigned to service classes by Classification Rules
WLM Concepts – Service Class and Classification

• Classification
  o Assignment of incoming work to a service class, and optional report class
  o Based on a wide variety of filters, or qualifiers

• Service Class
  o Set or group of related work
    • Production CICS, IMS, and DB2 address spaces might be in same service class: STCHI or PRODHI
    • Separate Report Classes can report on CICS, IMS, DB2
  o A service class can combine goals of different types in multiple periods
    • A Period is the combination of Importance (IMP), Goal and Duration
    • A service class period is the target of WLM measurement and management actions
WLM Classification Rules

WLM assigns work to a service class based on qualifiers that apply to the subsystem from which the work arrived.
Subsystems Types Used for Classification

- Subsystems follow one of three transaction type models
- Need to understand how this affects the value of figures shown in workload activity report
  * SYSH is used for LPAR load balancing

<table>
<thead>
<tr>
<th>Transaction Type</th>
<th>Allowable Goal Types</th>
<th>Allowable # of Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address space oriented</td>
<td>Response Time Execution Velocity Discretionary</td>
<td>Multiple</td>
</tr>
<tr>
<td>Enclave</td>
<td>Response Time Execution Velocity Discretionary</td>
<td>Multiple</td>
</tr>
<tr>
<td>CICS/IMS</td>
<td>Response Time</td>
<td>1</td>
</tr>
</tbody>
</table>
WLM Concepts – Importance

- For most work, importance 1 (IMP 1) is highest and importance 5 (IMP 5) is lowest.
- WLM applies resources to IMP 1 first.
- If IMP 1 work meets its goals, then WLM will apply resources to IMP 2 work, then IMP 3, etc.
- Some service trickles down to DISCRETIONARY
- SYSTEM and SYSSTC are internal service classes for system tasks and have the highest dispatching priorities
- SYSOTHER is the default service class for unclassified work and runs at a DISCRETIONARY goal
- Note: Not all work is “most important”
WLM Concepts – Goal Types

- **System** goals
  - SYSTEM and SYSSTC service classes have fixed dispatching priorities above IMP 1
- **Response time goals**
  - **Average response time**, including queue time and execution time
  - **Percentile response time**, reduces impact of outliers
    - E.g. 90% of transactions complete within 0.7 seconds
- **Execution Velocity** goals, or ‘velocity goals’
  - Velocity goals are intended for work for which response time goals are not appropriate, such as address spaces or long running jobs
  - How fast work should run relative to other work requests when ready, without being delayed for CPU, storage, or I/O
  - Expressed as a number, e.g. 60 or 40
    - Value of 60 means ‘ready’ work runs 60% of the time
  - Differentiate velocity goals within an importance level by 10
  - Appropriate velocity goal depends on number of engines (CPs)
- **Discretionary** – appropriate for low priority, long-running work
WLM Concepts and DB2

• Importance
  o Production DB2 address spaces (MSTR, DBM1, DIST, WLM) should be defined with Importance 1 (IMP 1)
  o Non-production DB2 address spaces in a production LPAR should be defined with lower importance: IMP > 1.
    • Consider relative to other production work
  o Production DDF transactions should generally be defined with IMP below that of production DB2 address spaces
  o IRLMs should be defined in SYSSTC

• Goals for DB2 work
  o System - IRLM in SYSSTC
  o Velocity goals are appropriate for started tasks or long-running work
    • DB2 address spaces should have velocity goals and only a single period in the service class (MSTR, DBM1, DIST, WLMx)
  o Response time goals are appropriate for transactions, including most DDF work
    • Percentile response time – e.g. 90% complete in 0.5 seconds
    • Average response time – e.g. average response time is 0.5 seconds
  o Discretionary: below IMP 5. Not appropriate for DB2 work
### WLM Importance Levels and DB2, an example

<table>
<thead>
<tr>
<th>Importance Level</th>
<th>Description</th>
<th>DB2 Address Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMP 1 Highest</td>
<td>Highest priority after SYSSTC</td>
<td>DB2PMSTR, DB2PDBM1, DB2PDIST, DB2PWLMx</td>
</tr>
<tr>
<td>IMP 2 High</td>
<td>High priority</td>
<td>Production DDF txns</td>
</tr>
<tr>
<td>IMP 3 Medium</td>
<td>Medium priority</td>
<td></td>
</tr>
<tr>
<td>IMP 4 Low</td>
<td>Low priority work</td>
<td>Low priority work</td>
</tr>
<tr>
<td>IMP 5 Lowest</td>
<td>Lowest priority work</td>
<td>Lowest priority work</td>
</tr>
<tr>
<td>DISCRETIONARY</td>
<td>管理工作在所有其他重要级别之后获得服务</td>
<td></td>
</tr>
<tr>
<td>SYSOTHER</td>
<td>Default service class</td>
<td></td>
</tr>
</tbody>
</table>

- Importance 1 is highest priority after SYSSTC
- DB2 address spaces should have velocity goals and a single period defined
- Non-production DB2s could be IMP 2 or IMP 3 or IMP 4 if in same LPAR (or Parallel Sysplex) with production DB2
- Discretionary work gets service after all other importance levels
  - Not appropriate for DB2 address spaces
  - Not recommended for DB2 work
  - Very little service if CPU 100% busy
Service Class: Assigning Types of Goals - example only

**CICS, IMS or TSO transactions**

*E.g. average response time goal*

Transactions complete < 0.7 seconds

**Production DDF Transactions**

*Percentile response time goal, single period*

IMP 2; 90% complete < 0.5 seconds

**Non-production DDF:** response time goals in first period, response time or velocity in second period

*Period 1: IMP 3, 90% complete < 0.5 seconds*

*Period 2: IMP 4, 90% complete < 4 seconds*

*Period 3: IMP 5, Vel = 40*

**DB2 Address Spaces**

*Velocity goal; IMP 1*

Exec Vel = 70

Single period
Service Class: Period Switch – example

- All transactions assigned to this service class start in Period 1
  - WLM manages the transactions in period 1 to the percentile response time goal of 90% completing in half a second, with an importance of 3
- Transactions that accumulate 300 service units (DUR = 300) before completing migrate to Period 2 (a new service class period)
  - WLM manages the transactions in period 2 to the goal of 90% completing in 4 seconds, with an importance of 4. [That is, 90% of those that did not complete in period 1.]
- Transactions that accumulate 900 service units (DUR 300 + DUR 600) before completing migrate to Period 3 (a new service class period).
  - WLM manages the transactions in period 3 to a velocity goal of 40, with an importance of 5.

“Service units” is a hardware independent measure of CPU consumption. If your transaction consumes 1000 service units on a z9, it should consume 1000 service units on a z196.
Service Class Example

- Several goal types defined into periods

```
Service-Class     Notes     Options     Help
------------------------------------------------------------------------------
Row 1              Create a Service Class

Command ==> __________

Service Class Name . . . . . . DDFTEST   (Required)
Description . . . . . . . . DDF Test Transactions
Workload Name . . . . . . SAMPLE   (name or ?)
Base Resource Group . . . . . .  (name or ?)
Cpu Critical . . . . . . . NO     (YES or NO)

Specify BASE GOAL information. Action Codes: I=Insert new period,
E=Edit period, D=Delete period.

-- Period --                  ----------- Goal -----------
Action  #   Duration  Imp.     Description
_____ _____ _______ _______  __________
     1   300     3       90% complete within 00:00:00.500
     2   600     4       90% complete within 00:00:04.000
     3    _____  5       Execution velocity of 40
```
WLM Managed Delays

- WLM can only affect work by adjusting these resources:
  - Processor (dispatching priority)
  - Non-paging DASD I/O (IOSQ, subchannel pending, control unit queue)
  - Storage (paging, swapping)
  - Tasks (multi-programming level, server address space creation, batch initiation)
    - Example: WLM managed stored procedure address spaces
- WLM cannot manage, for example:
  - User delay (coffee breaks)
  - Network delay
WLM Concepts: Performance Index (PI)

- Service Class periods are compared by calculating a Performance Index (PI) for each.
- PI gives WLM a common way to track how well the work is doing regardless of goal type.
- Importance parameter:
  - Defined as part of the Service Class - 1 (high) to 5 (low).
  - Assigned to a Service Class Period.
  - A way to prioritize critical goals.
  - For work at the same importance level, WLM attempts to equalize the PIs.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Interpretation</th>
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<tbody>
<tr>
<td>The PI equals 1</td>
<td>The work in the period is meeting its goal exactly.</td>
</tr>
<tr>
<td>The PI is less than 1</td>
<td>The work is doing better than its goal.</td>
</tr>
<tr>
<td>The PI is more than 1</td>
<td>The work is missing its goal.</td>
</tr>
</tbody>
</table>
**RMF Workload Activity Report**

- **Achieving the goal**
  - Percentile response time: 80% in 1 second

<table>
<thead>
<tr>
<th>REPORT BY: POLICY=FLOYD WORKLOAD=ONLINES SERVICE CLASS=WEBUSERS CRITICAL: =NONE RESOURCE GROUP=-NONE PERIOD=1 IMPORTANCE=2</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRANSACIONS</td>
</tr>
<tr>
<td>AVG</td>
</tr>
<tr>
<td>MIL</td>
</tr>
<tr>
<td>ENDED</td>
</tr>
<tr>
<td>END/S</td>
</tr>
<tr>
<td>$SWAPS</td>
</tr>
<tr>
<td>EXCTD</td>
</tr>
<tr>
<td>AVG ENC</td>
</tr>
<tr>
<td>REM ENC</td>
</tr>
<tr>
<td>MS ENC</td>
</tr>
<tr>
<td>GOAL: RESPONSE TIME 000.00.01.00 FOR 80%</td>
</tr>
</tbody>
</table>

- **PI = 0.5**
RMF Workload Activity Report

• Response time distribution
  o Goal is sixth ‘bucket’

<table>
<thead>
<tr>
<th>TIME</th>
<th>NUMBER OF TRANSACTIONS</th>
<th>PERCENT</th>
</tr>
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<tbody>
<tr>
<td>≤ 00.00.00.500</td>
<td>296</td>
<td>93.7</td>
</tr>
<tr>
<td>≤ 00.00.00.600</td>
<td>299</td>
<td>94.6</td>
</tr>
<tr>
<td>≤ 00.00.00.700</td>
<td>300</td>
<td>94.9</td>
</tr>
<tr>
<td>≤ 00.00.00.800</td>
<td>301</td>
<td>95.8</td>
</tr>
<tr>
<td>≤ 00.00.00.900</td>
<td>303</td>
<td>96.4</td>
</tr>
<tr>
<td>≤ 00.00.01.000</td>
<td>305</td>
<td>96.5</td>
</tr>
<tr>
<td>≤ 00.00.01.100</td>
<td>306</td>
<td>96.8</td>
</tr>
<tr>
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<td>≤ 00.00.01.400</td>
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<tr>
<td>≤ 00.00.01.500</td>
<td>308</td>
<td>97.5</td>
</tr>
<tr>
<td>≤ 00.00.02.000</td>
<td>311</td>
<td>98.4</td>
</tr>
<tr>
<td>≤ 00.00.04.000</td>
<td>314</td>
<td>99.4</td>
</tr>
<tr>
<td>&gt; 00.00.04.000</td>
<td>316</td>
<td>100</td>
</tr>
</tbody>
</table>

o Entries range from less than half of goal to greater than four times goal
RMF Workload Activity Report

- **Missing the goal**
  - Execution velocity: 60

<table>
<thead>
<tr>
<th>REPORT BY:</th>
<th>POLICY=FICY123</th>
<th>WORKLOAD=ONLINES</th>
<th>SERVICE_CLASS=WEBUSERS</th>
<th>RESOURCE GROUP=*NONE</th>
<th>PERIOD=2</th>
<th>IMPORTANCE=5</th>
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</thead>
<tbody>
<tr>
<td>-TRANSACTIONS-</td>
<td>TRANS-TIME</td>
<td>M/H/M .55.35.35.7</td>
<td>--DR&amp;D I/O--</td>
<td>----SERVICE----</td>
<td>--SERVICE TIMES--</td>
<td>----APPL %---</td>
</tr>
<tr>
<td>AVG 2.32</td>
<td>ACTUAL 11.413</td>
<td>SSHCRT 65.6</td>
<td>IOC 1</td>
<td>CPU 52.022</td>
<td>CP 5.73</td>
<td>AVG 4.60.50</td>
</tr>
<tr>
<td>MFL 2.32</td>
<td>EXECUTION 11.413</td>
<td>RESF 1.1</td>
<td>CPU 195213</td>
<td>SRB 0.004</td>
<td>AAFCP 0.00</td>
<td>TOTAL 921.00</td>
</tr>
<tr>
<td>ENDED 26</td>
<td>QUEUED</td>
<td>CORN 0.9</td>
<td>MSQ 0</td>
<td>ROI 0.00</td>
<td>TIPCP 5.17</td>
<td>SHARED 0.00</td>
</tr>
<tr>
<td>END/S 0.03</td>
<td>R/S AFFIN 0</td>
<td>DISC 0.1</td>
<td>SRB 14</td>
<td>TIT 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#SWAPS 0</td>
<td>INELIGIBLE</td>
<td>Q-PEND 0.1</td>
<td>TOI 195228</td>
<td>HST 0.000</td>
<td>AAF 0.00</td>
<td>--PAGE-IN RATES--</td>
</tr>
<tr>
<td>EXCTD 0</td>
<td>CONVERSION</td>
<td>IOSQ 0.0</td>
<td>SEC 206</td>
<td>AAF 0.00</td>
<td>TIP 0.0</td>
<td>N/A SINGLE 0.0</td>
</tr>
<tr>
<td>AVG ENC 0.32</td>
<td>STD DEV 12.128</td>
<td>TIP 0.0</td>
<td>N/A</td>
<td>BLOCK 0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REN ENC 0.00</td>
<td>MOV ENC 0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Goal:** EXECUTION VELOCITY 60.0%  VELOCITY MIGRATION: I/O MGMT 82.6% INIT MGMT 32.6%

<table>
<thead>
<tr>
<th>RESPONSE TIME</th>
<th>EX</th>
<th>PERF</th>
<th>AVG</th>
<th>------</th>
<th>USING%</th>
<th>------</th>
<th>EXECUTION DELAYS</th>
<th>%</th>
<th>------</th>
<th>%</th>
<th>------</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSTEM</td>
<td>VEL%</td>
<td>INDX</td>
<td>RDRSP</td>
<td>CPU</td>
<td>AAP</td>
<td>TIP</td>
<td>I/O</td>
<td>TOT</td>
<td>CPU</td>
<td>I/O</td>
<td>UNKN</td>
<td>IDLE</td>
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<tr>
<td>Prod</td>
<td>--N/A--</td>
<td>32.6</td>
<td>1.8</td>
<td>6.3</td>
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<td>0.8</td>
<td>3.6</td>
<td>3.4</td>
<td>0.2</td>
<td>16.4</td>
</tr>
</tbody>
</table>

- **PI = 1.8**
WLM Performance Heuristic Behavior

1. Measure delays (again, again & again...)

2. Compare reality with goal (as stated in WLM policy). Performance Index (PI) > 1 gets attention

3. Change priorities, based on delays (donor/receiver)

4. Wait 10 seconds for the effect

- Set accurate goals
  - Goals should correspond to how your business runs
  - Goals should be realistic
  - Loose goals (easily achieved) can cause poor performance because WLM sees the goals are met, so takes no action
WLM Service Class Periods

• WLM heuristic behavior is applied to service class periods
• WLM can effectively manage 25-30 **active** service class periods
  - If you have more than 30 active service class periods, WLM may not be able to adjust resources for all of them when the system is busy
  - It is when the system is busy that you want WLM to adjust resources to meet your business goals

• “Loose” goals are performance goals that are too easily achieved
  - Service class periods with loose goals are likely to have a PI < 1, so WLM will always perceive they are meeting their goals.
  - Service class periods with loose goals may have a PI < 0.7, in which case they may become a donor
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    • Sysplex Query Parallelism
    • Stored Procedures and Application Environments
      — External stored procedures in WLM managed address spaces
      — DB2 9 for z/OS and native SQL procedures
  o Other WLM interaction with DB2
    • Autonomic DB2 buffer pool sizing
    • Sysplex Workload Balancing
Defining DB2 Address Spaces to WLM

- DB2 address spaces are started tasks
  - To WLM, the DB2 address spaces have a subsystem type of “STC”
- IRLMs should be defined in service class SYSSTC
- Remaining DB2 address spaces should be assigned to a service class with a single period, a velocity goal and appropriate importance. For example,
  - Production: IMP 1
  - QA, Development and/or Test in same LPAR/Sysplex:
    - IMP > 1 (i.e. lower importance)
    - Adjust based on other production work, such as production batch
  - DB2 address spaces include $ssnm$MSTR, $ssnm$DBM1, $ssnm$DIST and $ssnm$WLMx for stored procedures
WLM: Four Types of DB2 Work

• 1: DB2 work that originates in another local subsystem:
  o Examples: CICS, IMS, TSO, WebSphere on z, MQ

• 2: DDF work requests
  o DDF requests use enclave SRBs

• 3: Sysplex Query Parallelism
  o Queries that DB2 creates by splitting a single, larger query and distributing it to other members of the data sharing group in a Parallel Sysplex® (PSX)

• 4: Stored Procedures
  o WLM managed stored procedures, which run in WLM Application Environments, are external stored procedures or DB2 V8 SQL Procedures
  o Native SQL Procedures in DB2 9 for z/OS
Type 1 - Local Attach

- DB2 SQL activity runs under dispatchable unit of invoker
  - IMS, CICS, TSO, Batch, etc.
  - Inherited classification class of invoker
  - Priority and management of home unit
  - Service attributed back to invoker
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Type 2 - DDF and Enclave SRBs

ssnmDIST (DDF)

- DDF priority requests
- Create Enclave
- Schedule SRB

Enclave SRB

PC-call to DBM1

STCHI

Vel = 70
Imp = 1

DDF rules

DDFDEF

RT = 5s avg
Imp = 3

DDFPRI

RT = 90%, 0.5 sec, IMP 2

SMF 72: RMF Workload Activity and Storage Data

SMF 30: Common Address Space Work accounting
What is an Enclave?
What is an Enclave?

The Enclave at Sheridan Pointe
What is an Enclave?

2010 Buick Enclave CX
What is an Enclave?

• A "business transaction" without address space boundaries
  o Two types: dependent and independent
  o System or sysplex scope
• Dependent enclaves
  o Logical extension of an existing address space transaction
  o Inherits service class from its owner's address space
• Independent enclave (e.g. DDF)
  o True SRM transaction
  o Separately classified and managed in service class
• Why do we need enclaves?
Why do we need enclaves?

• Prior to DB2 V4, all DDF work ran at the priority of the ssnmDIST address space
  o No differentiation between high priority work and low priority work
  o Unconstrained DDF work could cause ssnmDIST to monopolize CPU, affecting CICS, IMS, etc.
  o Reducing priority of ssnmDIST only partially successful
    • Resolved issues for CICS, IMS, etc., but…
    • All DDF work affected, even high priority work

• In DB2 V4, introduction of enclave support
  o Manage DDF work separately from the ssnmDIST address space
  o Differentiate between high priority and low priority DDF work
Enclave Characteristics

- Created by an address space (AS)
  - the “owner”; `ssnmDIST` for DBATs
- One AS can own many enclaves
- One enclave can include multiple dispatchable units (SRBs/tasks) executing concurrently in multiple address spaces (the "participants")
  - Enclave SRBs are preemptible, like tasks
  - All its dispatchable units are managed as a group
- Many enclaves can have dispatchable units running in one participant address space concurrently
- RMF produces separate Type72 SMF records for independent enclaves
  - Both Type72 and Type30 records produced for address spaces

SMF 30: Common Address Space Work accounting
SMF 72: RMF Workload Activity and Storage Data
Classifying DDF Work

- Define service classes and appropriate goals for DDF work
- DDF Classification Defaults
  - Defaults apply if you do not provide any classification rules for DDF work
  - Enclaves default to the SYSOTHER service class (i.e. discretionary goal) unless they can be assigned to a service class
- Managing DDF Work (Enclaves)
  - All goals are permitted
  - Transactions are subject to period switch
  - WLM manages an enclave with its own dispatching priority, etc.
  - Production DDF work:
    - Generally importance (IMP) below that of DB2 address spaces
    - Consider a single period goal
Enclaves Can Use Multiple Periods

Response time and Velocity measures

Dispatch Priority Working Set I/O Qing Multi Pgm Level

TRX

PERIOD 1
90% in 0.5 sec; IMP = 3
DUR=300

PERIOD 2
90% in 4 sec; IMP = 4
DUR=600

PERIOD 3
Ex Vol = 40
IMP = 5

• The DURation value defines period length in service units
• Within a service class, periods can use different goals, goal types, and importance
• In this example: Service class DDFTEST
• This is an example only: use multiple period service classes with caution.
What is a DDF Transaction?

**Threads: ZPARM CMTSTAT = Inactive**

<table>
<thead>
<tr>
<th>DRDA unit-of-work 1</th>
<th>DRDA unit-of-work 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queue time</td>
<td>Execution time</td>
</tr>
<tr>
<td>Active</td>
<td>Inactive</td>
</tr>
<tr>
<td>Enclave transaction managed by SRM</td>
<td>Enclave transaction managed by SRM</td>
</tr>
</tbody>
</table>

**Threads: ZPARM CMTSTAT = Active**

Database thread is active from creation until termination

Enclave transaction managed by SRM exhibits conversational behavior
What Goals Should I Use?

- **CMTSTAT=INACTIVE** and **DBAT** is pooled (Connection inactive)
  - DDF creates one enclave per active interval
  - Response times do not include user think time
  - Response time goals and multiple periods can be used
    - But multiple periods with different importance can lead to issues with locks and latches

- **CMTSTAT=ACTIVE**
  - DDF creates one enclave for the life of the thread
  - Enclave response time includes user think time
  - Response time goals should not be used
  - Multiple periods should not be used
What if the DBAT cannot be pooled at COMMIT?

- If only reason is KEEPDYNAMIC = YES
  - Same as top of previous slide: one enclave per interval, response times do not include user think time, response time goals are appropriate
- If because CURSOR WITH HOLD, DGTT or LOB LOCATOR:
  - Thread stays active after COMMIT
    - Subject to period switching
    - Subject to idle thread timeout (IDTHTION in DSNZPARM)
  - Percentile response time goals may be appropriate

What about DB2 10 for z/OS High Performance DBATs?

- DBAT remains active after commit, but enclave deleted, accounting record cut, and idle thread timer reset
- One enclave per interval, response time goals are appropriate
DDF Classification Rules, example

- Classification by Subsystem Instance (SI), Process Name (PC - application program), Accounting Information (AI), and Userid (UI)

<table>
<thead>
<tr>
<th>Subsystem-Type</th>
<th>Xref</th>
<th>Notes</th>
<th>Options</th>
<th>Help</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Modify Rules for the Subsystem Type**

- **Subsystem Type:** DDF
- **Fold qualifier names:** Y (Y or N)
- **DDF work requests:**

**Action codes:**
- A = After
- C = Copy
- M = Move
- I = Insert rule
- B = Before
- D = Delete row
- R = Repeat
- IS = Insert Sub-rule

**Qualifier**

<table>
<thead>
<tr>
<th>Action</th>
<th>Type</th>
<th>Name</th>
<th>Start</th>
<th>Service</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SI</td>
<td>DB9A</td>
<td>___</td>
<td>DDFDEF</td>
<td>RSSL</td>
</tr>
<tr>
<td>2</td>
<td>PC</td>
<td>TRX*</td>
<td>___</td>
<td>DDFDEF</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>AI</td>
<td>T0T0A*</td>
<td>56</td>
<td>DDFPROD</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>UI</td>
<td>PA0LOR3</td>
<td>___</td>
<td>DDFTOT</td>
<td>RNISANTI</td>
</tr>
<tr>
<td>1</td>
<td>SI</td>
<td>D9C*</td>
<td>___</td>
<td>DDFDEF</td>
<td>RD9CG</td>
</tr>
<tr>
<td>2</td>
<td>UI</td>
<td>PA0LOR3</td>
<td>___</td>
<td>DDFTEST</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PC</td>
<td>DB2J*</td>
<td>___</td>
<td>DDFPROD</td>
<td></td>
</tr>
</tbody>
</table>

**Defaults:**
- DDFDEF
- DDFPROD
- DDFTOT

**Notes:**
- BOTTOM OF DATA
## DDF Work Classification Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting Information</td>
<td>AI</td>
<td>Can be passed from a DB2 Client via Client Information APIs</td>
</tr>
<tr>
<td>Correlation Information</td>
<td>CI</td>
<td>DB2 Connect assigns application program name by default but application can set via Client Information APIs</td>
</tr>
<tr>
<td>Collection Name</td>
<td>CN</td>
<td>Collection name of the first SQL package accessed by the DRDA requester in the unit of work</td>
</tr>
<tr>
<td>Connection Type</td>
<td>CT</td>
<td>Always 'DIST ' for DDF server threads</td>
</tr>
<tr>
<td>Package Name</td>
<td>PK</td>
<td>Name of the first DB2 package accessed by the DRDA requester in the unit of work</td>
</tr>
<tr>
<td>Plan Name</td>
<td>PN</td>
<td>'DISTSERV' for DDF server threads accessed via DRDA requesters unless requester is another DB2 for z/OS, then requester’s PLAN name</td>
</tr>
<tr>
<td>Procedure Name</td>
<td>PR</td>
<td>Name of the procedure called as the first request in the unit of work</td>
</tr>
<tr>
<td>Process Name</td>
<td>PC</td>
<td>Client application name by default but can be set via Client Information APIs</td>
</tr>
<tr>
<td>Subsystem Collection Name</td>
<td>SSC</td>
<td>Usually the DB2 data sharing group name</td>
</tr>
<tr>
<td>Subsystem Instance</td>
<td>SI</td>
<td>DB2 server's MVS subsystem name</td>
</tr>
<tr>
<td>Sysplex Name</td>
<td>PX</td>
<td>Name assigned to sysplex at IPL</td>
</tr>
<tr>
<td>Userid</td>
<td>UI</td>
<td>DDF server thread's primary AUTHID</td>
</tr>
<tr>
<td>Subsystem Parameter</td>
<td>SPM</td>
<td>Beginning in V8: the concatenation of client userid and workstation</td>
</tr>
</tbody>
</table>

- Not very useful
- Widely used, some limitations
- Most granular control; See next page.
Workload Classification Attributes - Client

- ODBC/CLI/VB/ADO ... applications
  - Use SQLSetConnectAttr on:
    - SQL_ATTR_INFO_ACCTSTR - accounting string (AI)
    - SQL_ATTR_INFO_APPLNAME - application name (PC)
    - SQL_ATTR_INFO_USERID - client userid
    - SQL_ATTR_INFO_WRKSTNNNAME - client workstation name
- Non-ODBC... use sqleseti Administrative API function
- IBM Data Server Driver for JDBC and SQLJ (Type 2 or Type 4 connectivity)
  - Use methods against connection class instance
    - setClientUser, setClientApplicationInformation, setClientWorkStation, setClientAccountingInformation
Client Information – WebSphere example

• Setting client information values in WebSphere, example

  o  WSConnection conn = (WSConnection) ds.getConnection();
     Properties props = new Properties();
     props.setProperty(WSConnection.CLIENT_ID, "user123");
     props.setProperty(WSConnection.CLIENT_LOCATION, "127.0.0.1");
     props.setProperty(WSConnection.CLIENT_ACCOUNTING_INFO, "accounting");
     props.setProperty(WSConnection.CLIENT_APPLICATION_NAME, "appname");
     props.setProperty(WSConnection.CLIENT_OTHER_INFO, "cool stuff");
     conn.setClientInformation(props); conn.close()

• Refer to Info Center for WebSphere for further information
Type 3 – Sysplex Query Parallelism; WLM sees as “DB2”

Complex query originates here

Portions of complex query arrive on participant systems, classified under "DB2" rules, and run in enclave SRBs

Sysplex Query Parallelism: DB2 Data Sharing

PARTITIONED TABLESPACE
Agenda

• Workload Manager (WLM) Overview
• How WLM affects DB2
  o Defining DB2 Address Spaces to WLM
  o WLM: Four Types of DB2 work
    • Local Attach
    • DDF and Enclaves
      – What is an enclave?
      – Classifying DDF work
    • Sysplex Query Parallelism
    • Stored Procedures and Application Environments
      – External stored procedures in WLM managed address spaces
      – DB2 9 for z/OS and native SQL procedures
  o Other WLM interaction with DB2
    • Autonomic DB2 buffer pool sizing
    • Sysplex Workload Balancing
Type 4 - DB2 External Stored Procedures

Task
- Listens for requests coming from outside of the system
- Creates independent enclave
- Schedules enclave SRB

Task
- Creates dependent enclave
- Continuation of transaction CHARLIE

CALL SP1

StoredProcedure execute as TCBs in WLM-managed address space(s)
- TCBs not zIIP-eligible
DB2 and WLM: External Stored Procedures

- Application Environments (AE) defined in WLM policy
  - Describes JCL for stored procedure address spaces
  - WLM starts an address space for each work queue, or unique combination of service class period and AE
    - If DDFPROD transaction issues CALL STPROC1, one address space
    - If DDFTEST transaction issues CALL STPROC1, different address space
  - Determines number of address spaces for a work queue: 1 or ANY
    - If ANY, WLM may start additional server address spaces
    - Depends on whether the service class period is meeting its PI
- Cross memory from DBM1 to WLMx, plus schedule TCB
Native SQL Procedures (beginning with DB2 9 for z/OS)

The SQL procedure logic runs in the DBM1 address space
Enclave SRB mode; DB2PWLMx not involved, no TCB schedule delay

Execution from remote thread eligible for zIIP at same percentage as DDF Enclave SRB
WLM Considerations – Example: Stored Procedures

- The original assumption
  - All work requests inserted by DB2 (example – Stored Procedures) were independent requests

- The reality
  - Procedures may recursively call other procedures
  - The processing may be inter-dependent

- The newer logic
  - DB2 tells WLM about dependent stored procedure requests
  - WLM gives dependent requests priority
    - WLM may make adjustments, if needed
WLM Considerations For Nested Stored Procedure Requests

- Triggers, Stored Procedures, and UDFs actions may be nested, sometimes multiple layers of nesting
- DB2 tells WLM about dependent stored procedure requests
  - WLM may give dependent requests priority, if needed
  - WLM may start server regions more aggressively, if needed
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DB2 and zIIP Processors

- Work on z/OS may have all or a portion of its resource usage on an enclave SRB
  - Enclave SRB work may be directed to the zIIP
- Certain types of DB2 work may take advantage of zIIP, including
  - DRDA - Queries that access DB2 for z/OS via DRDA over TCP/IP
    - Complex parallel queries
    - DB2 utilities for index maintenance
      - LOAD, REORG, and REBUILD
    - DB2 V10 – Sequential prefetch eligible for zIIP processor
- WLM and new enclave structures to manage zIIP related workload – work dependent enclave
**WLM Contention Management**

- WLM Contention Management helps addressing chronic or long lasting contention situations
  - WLM provides interfaces to allow resource managers (for example – DB2) to signal contention situations
  - WLM has had the ability to promote (increase the DP) for a short duration to resolve the issue
- DB2 example scenario
  - Lock/latch contention in DB2 may impact performance
  - Often contention may be resolved with a short boost of resource
  - DB2 may notify WLM if a contention occurs
  - WLM may optionally raise the priority for the holder to complete the work
- WLM can promote units of work for longer periods of time, and promote them to the priority of the highest-priority units of work waiting for a resource they are holding.
DB2 V9 for z/OS: WLM Automatic Buffer Pool Size Adjustment

- PK75626 enables capability as well as the WLM delay monitoring support
- Requires z/OS 1.9 and above with WLM APARs OA18461 and OA32631 applied
- Triggered when buffer pool is defined or altered with AUTOSIZE(YES)
  - VPSIZE at the time of AUTOSIZE setting governs the possible size range for buffer pool
    - e.g. VPSIZE(10000) would allow WLM to adjust its size from 7500 to 12500
    - WLM will only request the alteration if new size within range (minimum size adjustment is 64)
    - WLM can decrease size when real storage demand affected
- Buffer pools adjusted based on WLM goal attainment of service classes that buffer pool size affects, e.g. lots of random I/O.
  - This is a WLM policy adjustment decision
DB2 and WLM: Sysplex Workload Balancing

- WLM monitors DB2 and LPAR: e.g. CPU, CSA, DB2’s PI
- DB2 builds weighted server list of members of the DB2 data sharing group
- On initial connection request to Group DVIPA:
  - Sysplex Distributor (SD) finds an available DB2 member
  - Client connects to that member
- That DB2 member sends weighted server list to client periodically
  - Subsequent connection requests use server list, not SD
  - If that member is stopped (or fails) client users server list to reroute and connect to available DB2 member
Resources

- Redbooks
  - *DB2 9 for z/OS: Distributed Functions*
    - SG24-6952-01
  - *System Programmer’s Guide to: Workload Manager*
    - SG24-6472-03
Questions
Acknowledgements

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  o Glenn Anderson, IBM Learning Services
  o Ed Woods, IBM Tivoli
  o Bill Schray, IBM ATS
  o Brad Snyder, IBM ATS
  o Kathy Walsh, IBM ATS
Top DB2 for z/OS Communities

• World of DB2 for z/OS  http://db2forzos.ning.com/

• DB2 10 LinkedIn  http://linkd.in/IBMDB210

• DB2 for z/OS What’s On LinkedIn  http://linkd.in/kd05LH

• DB2 for z/OS YouTube  http://www.youtube.com/user/IBMDB2forzOS

• WW IDUG LinkedIn Group  http://linkd.in/IDUGLinkedIn

• IDUG.ORG  http://www.idug.org

• DB2 for z/OS Exchange Forum  http://ibm.co/DB2zHotline
Communities

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    • Business Analytics bit.ly/AnalyticsCommunity
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