z/OS Workload Manager (WLM)

- A contract between the installation and the z/OS operating system
  - Installation
    - Classifies work running on z/OS in distinct Service Classes
    - Defines goals that express the expectation of how work should perform
  - WLM
    - Uses goal definitions to manage work across all systems of a sysplex through distribution of resources
What is needed?

Parallel Sysplex plus WLM

Service definition structure
Service definition workload types

- Identify your workload(s) and categorize them

Classification rules

- Filters or qualifiers
- Subsystem type
- Userid
- Transaction name
- JES job class
- Account Info
- Source LU Name

<table>
<thead>
<tr>
<th>SERVICE CLASS</th>
<th>REPORT CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSOPRID</td>
<td>TSORPT</td>
</tr>
<tr>
<td>CICSPROD</td>
<td>MFG21</td>
</tr>
<tr>
<td>CICSTST</td>
<td>TSODEV</td>
</tr>
<tr>
<td>TSOPRD1</td>
<td>TSORP5</td>
</tr>
</tbody>
</table>
Example of a service class

Service Class: TSOPRD
Description: Normal TSO Work
Workload: TSO
Service Goal:
  Performance Period: 1
  Response Time: 80% AT 1.0s
  Importance: 3
  Duration: 800
  Performance Period: 2
  Discretionary

Service definition hierarchy
The WLM ISPF application

Choose service definition

Choose Service Definition

Select one of the following options.
1. Read saved definition
2. Extract definition from WLM couple data set
3. Create new definition

ENTER to continue
What is the IBM z/OS Management Facility?

The IBM z/OS Management Facility is now a part of z/OS V2.2 that provides support for a modern, Web-browser based management console for z/OS.

The z/OS Management Facility applications run on the z/OS enabling you to manage z/OS from z/OS

- Information is presented on a workstation using a browser

The z/OS Management Facility requires:

- z/OS Communications Server
- Security definitions (SAF)
- Other components and functions are required for specific z/OSMF plug-ins
- IBM 64-bit SDK for z/OS Java Technology Edition V7.1 or V8.0 • zIIP eligible!
z/OSMF 2.2 functions

- Notifications and Workflow *(R2.1)*
- Configuration category
  - Configuration Assistant for z/OS Communication Server application
  - Simplified configuration and setup of TCP/IP policy-based networking functions
- Links category
  - Links to resources - provides common launch point for accessing resources beyond z/OSMF
- Performance category
  - Capacity Provisioning (updated) manage connections to CPMs, view reports for domain status, 
    provide configuration and system policy
  - Resource Monitoring, System Status - provide integrated performance monitoring of 
    customer’s enterprise
- Workload Manager Policy Editor application
  - Facilitate the creation and editing of WLM service definitions, installation of WLM service definitions, and 
    activation of WLM service policies
- Problem Determination category
  - Incident Log - provide a consolidated list of SVC Dump related problems, along with details and 
    diagnostic data captured with each incident; facilitate sending the data for further diagnostics.
- Software category (updated)
  - Management: deployment of installed software simpler and safer, manage service levels and product 
    levels
- z/OS classic Interface category
- ISPF Task - integrate existing ISPF into z/OSMF to enable tasks from single interface and ability to launch to 
  ISPF functions directly
- z/OSMF Administration category
  - z/OSMF authorization services for administrator: dynamically add links to non-z/OSMF resources; 
    application linking manager(R13)
- z/OSMF Settings category (New)
  - Manage FTP destinations and systems

z/OSMF Workload Management

Service Definition Repository

- Integrated repository for service definitions
- Service definitions can be
  - Imported
  - Exported
  - Printed
  - Viewed or edited
  - Created or Copied
  - Installed on the sysplex
- Indications
  - If service definition is installed and active
  - If service definitions are being viewed or edited
  - If messages exist for a service definition

Click to view, edit, print, install a service definition
z/OSMF Workload Management
Editing Service Definitions

• Simplified creation, modification and review of service definitions
  – Policy elements are presented in tables
  – Tables can be filtered and sorted
  – Direct editing of policy elements within tables
  – Best-practice hints are displayed automatically while specifying policy elements
  – Several service definitions can be opened simultaneously
  – Cut, Copy, Paste of policy elements between service definitions

The structure of a service class

A service class is build from the following characteristics:

• Performance Period

• Duration

• Goal Type and Setting
  – Average Response Time
  – Response Time and Percentile
  – Velocity
  – Discretionary

• Importance
What is a WLM transaction?

- A WLM transaction represents a WLM "unit of work"
  - Basic workload entity for which WLM collects a resource usage value
  - Foundation for statistics presented in workload activity report
  - Represents a single subsystem "work request"
- Subsystems can implement one of three transaction types
  - **Address Space**:
    - WLM transaction measures all resource used by a subsystem request in a single address space
    - Used by JES (a batch job), TSO (a TSO command), OMVS (a process), STC (a started task) and ASCH (single APPC program)
  - **Enclave**:
    - Enclave created and destroyed by subsystem for each work request
    - WLM transaction measures resources used by a single subsystem request across multiple address spaces and systems
    - Exploited by subsystems - Component Broker (WebSphere), DB2, DDF, IWEB, MQ Workflow, LDAP, NETV, TCP
  - **CICS/IMS Transactions**
    - Neither address space or enclave oriented - special type
    - WLM transaction measures resource used by a single CICS/IMS transaction program request

Response time goals

- **Average Response Time Goal**
  - Defines the average transaction response time for all ended transactions
  - Example: Average response time = 1 second

  \[
  \text{Average Response Time} = \frac{\text{Sum of elapsed time for ended transactions}}{\text{Number of ended transactions}}
  \]

- **Percentile Response Time Goal**
  - Defines the number of transactions ending with a response time lower than or equal to the time value
  - Example: Goal = 80% < 2 sec

  \[
  \text{Percentile Response Time} = \frac{\text{No. of transactions ended with time} \leq \text{goal}}{\text{Number of ended transactions}}
  \]

*Measured in a given interval
Velocity goals

Transaction Flow

<table>
<thead>
<tr>
<th>CPU</th>
<th>I/O</th>
<th>DELAY</th>
<th>CPU</th>
<th>IDLE</th>
<th>I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

Sampling times

Measurement interval

Velocity = \frac{(\text{CPU Using} + \text{I/O Using}) \times 100}{\text{CPU Using} + \text{I/O Using} + \text{WLM Delay}^*}

= \frac{11 \times 100}{11 + 4} = 73\%

*Delay = \text{CPU Delay} + \text{I/O Delay} + \text{Paging Delay} + \text{MPL Delay} + \text{A/S Delay}

Goal type: Discretionary

WLM-defined Goal Type to run the work and apply resources only when there are resources left over.

- Discretionary Workload receives resources from:
  - Higher importance work
  - Overachieving its goal if giving resources will not cause goals to be missed

- Runs in lowest MTTW dispatching priority

- Always last period in a service class
Multiple periods and velocity goals

- The DURation value defines period length in service units
- Each period can use different goals, goal types, and importance
- Not supported for CICS and IMS transactions

importance

- Importance is relevant when system is overloaded
- WLM uses it to decide which workload goals are most important to satisfy
- Generally importance decreases across multiple periods

- Workload Importance
  - SYSTEM
  - SYSTC
  - 1 - HIGHEST
  - 2 - HIGH
  - 3 - MED
  - 4 - LOW
  - 5 - LOWEST
  - DISCRETIONARY
  - SYSOTHER

PERIOD 1
- 70% in 1 sec
- IMP=2
- DUR=700

PERIOD 2
- 5 sec avg
- IMP=3
- DUR=1500

PERIOD 3
- VEL=10
- IMP=4

response time and velocity measures

DP
Working Set
I/O Qing
MPL
System goals and dispatching priority

WLM-defined Goal Types that are automatically assigned to certain types of workload recognized by WLM.

- **SYSTEM**
  - z/OS system address spaces created at IPL.
  - Highest dispatching priority.
- **SYSSTC**
  - You assign important STCs
  - Second highest dispatching priority.
- **SYSOTHER**
  - Catcher for forgotten subsystem definitions.
  - Same as discretionary. Lowest dispatching priority.

The WLM View

Address Spaces, and the transactions inside

© Copyright IBM Corporation 2012
### DDF and Enclave SRBs

**ssnmDIST (DDF)**
- Enclave SRB
- DDF production requests
- DDF default requests
- STC rules
- DDF rules
- PC-call to DBM1
- RT=50%, Imp=1
- RT=85%, Imp=3
- Vel = 50%
- PCcall to DBM1

**Sandwich Enclave SRB**
- Non-swappable
- STCHI
- SMF 72
- SMF 30

**DDF rules**
- DDFPROD
- DDFDEF
- SMF 72

### DB2 Local Attach

**TOR** → **AOR** → **DB2**
- PC

**IMS** → **CT** → **MPR** → **DB2**
- PC

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
WebSphere App Server Use of Enclaves

WAS on z/OS transactions, arriving at the Control Region, each run in an enclave that is classified under the "CB" rules.

CICS / IMS Transactional Goal Management

Use of CICS or IMS classification rules is optional.
Goals: System-wide view

**BATCHPRD**
- AVG R/T: 5 min
  - IMP = 3

**LONGBAT**
- VEL = 25
  - IMP = 3

**TSODEV**
- 90% in 1 sec
  - IMP = 2
- 70% in 4 sec
  - IMP = 3
- VEL = 35
  - IMP = 4

**TSOPROD**
- 90% in 1 sec
  - IMP = 1
- 70% in 4 sec
  - IMP = 2
- VEL = 35
  - IMP = 3

**IMSDEV**
- VEL = 50
  - IMP = 3

**JUNQUE**
- DISCRNRY
  - IMP = __

**CICSNOOR**
- AVG R/T = 0.150 s
  - IMP = 1

**CICSBIG**
- AVG R/T = 5 s
  - IMP = 1

**SYSTEM**
- GOAL
  - IMP =

**BATCHPRD**
- VEL = 25
  - IMP = 3

**LONGBAT**
- VEL = 25
  - IMP = 3

**TSODEV**
- 90% in 1 sec
  - IMP = 2
- 70% in 4 sec
  - IMP = 3
- VEL = 35
  - IMP = 4

**TSOPROD**
- 90% in 1 sec
  - IMP = 1
- 70% in 4 sec
  - IMP = 2
- VEL = 35
  - IMP = 3

**IMSDEV**
- VEL = 50
  - IMP = 3

**JUNQUE**
- DISCRNRY
  - IMP = __

**CICSNOOR**
- AVG R/T = 0.150 s
  - IMP = 1

**CICSBIG**
- AVG R/T = 5 s
  - IMP = 1

**SYSTEM**
- GOAL
  - IMP =

Typical goals (1 of 3)

<table>
<thead>
<tr>
<th>Workload</th>
<th>Service Class</th>
<th>Goal</th>
<th>Period</th>
<th>Duration</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSO</td>
<td>TSOPROD</td>
<td>80% within 1 second</td>
<td>1</td>
<td>500</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80% within 10 seconds</td>
<td>2</td>
<td>10000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=5</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>TSODEV</td>
<td></td>
<td>80% within 1 second</td>
<td>1</td>
<td>400</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=20</td>
<td>2</td>
<td>10000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=20</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>BATCH</td>
<td>BATP</td>
<td>VEL=15</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BATDEV</td>
<td>VEL=10</td>
<td>1</td>
<td></td>
<td>4/D</td>
</tr>
<tr>
<td></td>
<td>BATNOR</td>
<td>AVG=1 min</td>
<td>1</td>
<td>200K</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=10</td>
<td>2</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>
## Typical goals (2 of 3)

<table>
<thead>
<tr>
<th>Workload</th>
<th>Service Class</th>
<th>Goal</th>
<th>Period</th>
<th>Duration</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CICS</td>
<td>CICSNOR</td>
<td>90% within 0.2 second</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CICSSPCL</td>
<td>70% within 0.1 second</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CICSLow</td>
<td>Average 5 seconds</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IMS</td>
<td>IMSNOR</td>
<td>90% within 0.4 second</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMSHOT</td>
<td>80% within 0.2 secs</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IMSLOW</td>
<td>Average 5 seconds</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>DDF</td>
<td>DB1A</td>
<td>70% within 0.5 second</td>
<td>1</td>
<td>2000</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=10</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DB1B</td>
<td>VEL=10</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>APPC</td>
<td>APP1</td>
<td>70% within 0.5 second</td>
<td>1</td>
<td>1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=20</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

## Typical goals (3 of 3)

<table>
<thead>
<tr>
<th>Workload</th>
<th>Service Class</th>
<th>Goal</th>
<th>Period</th>
<th>Duration</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMVS</td>
<td>UNIX1</td>
<td>80% within 0.5 second</td>
<td>1</td>
<td>500</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VEL=20</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>TRNMGTR</td>
<td>VEL50I1</td>
<td>VEL=50</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>STC</td>
<td>STCHI</td>
<td>VEL=40</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STCMED</td>
<td>VEL=15</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STCLOW</td>
<td>VEL=5</td>
<td>1</td>
<td>5/D</td>
<td></td>
</tr>
</tbody>
</table>
The classification process

Getting to the classification rules

<table>
<thead>
<tr>
<th>File</th>
<th>Utilities</th>
<th>Notes</th>
<th>Options</th>
<th>Help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definitions Menu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definition data set . . .</td>
<td>'SYSADM1.WLMSRVC.DEFPDS'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definition name . . .</td>
<td>myfirst1</td>
<td>Required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description . . . . . .</td>
<td>My first service definition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Select one of the following options . . . __

1. Policies
2. Workloads
3. Resource Groups
4. Service Classes
5. Classification Rules
6. Classification Groups
7. Report Classes
8. Service Coefficients
9. Application Environments
10. Scheduling Environments

Command ==> _______________________________________________

F1=Help F2=Split F3=Exit F9=Swap F10=Menu Bar F12=Cancel
Subsystems follow one of three transaction type models
Need to understand how this affects the value of figures shown in workload activity report

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

* SYSH is used for LPAR load balancing

Workload qualifiers supported by WLM (1 of 2)
## Workload qualifiers supported by WLM (2 of 2)

| Scheduling Environment Name (SE) |   | * |   |   |   |   |   |   | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Subsystem Collection Name (SSC)   |   | * |   | * |   |   |   |   |   | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Subsystem Instance (SI)           |   | * |   | * |   | * | * | * | * | * | * | * | * | * | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Subsystem Parameter (SPM)         |   |   |   | * |   | * | * | * | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Sysplex Name (PX)                | * | * | * | * | * | * | * | * | * |   |   |   |   |   |   |   |   |   |   |   |   |   | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| System Name (SY)                 | * |   |   |   |   |   |   |   |   |   | * | * | * | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Transaction Class/Job Class (TC)  | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Transaction Name/Job Name (TN)    | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * | * |
| Userid (UI)                      | * | * | * | * | * | * | * | * | * |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

### Example of batch classification rules

- **Subsystem Type**: JES
- **Description**: Batch classification rules

<table>
<thead>
<tr>
<th>Qualifier</th>
<th>Type</th>
<th>Name</th>
<th>Service</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>A</td>
<td>BATCHMED</td>
<td>BATCHA_</td>
<td></td>
</tr>
<tr>
<td>TC</td>
<td>D</td>
<td>BATCHHI</td>
<td>BATCHD_</td>
<td></td>
</tr>
<tr>
<td>TC</td>
<td>X</td>
<td>BATCHMED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td>PAYROLL</td>
<td>BATCHHI</td>
<td>PAYROLL_</td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td>PAYUPDT</td>
<td>BATCHHI</td>
<td>PAYROLL_</td>
<td></td>
</tr>
<tr>
<td>UI</td>
<td>SYSPROG1</td>
<td>BATCHHI</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Subsystem type defaults**: BATCHLOW
- **Optional report classes**
Performance index

- Separate PI is calculated for each service class period, across all sysplex hosts
- Different calculations produce a comparable value from different goal types

z/OS Workload Manager (WLM) Summary

- A contract between the installation and the z/OS operating system
  - Installation
    - Classifies work running on z/OS in distinct Service Classes
    - Defines goals that express the expectation of how work should perform
  - WLM
    - Uses goal definitions to manage work across all systems of a sysplex through distribution of resources