Abstract

• WebSphere Application Server (WAS) requires some basic Workload Manager (WLM) configuration on z/OS, but many other settings are required for optimal performance.

• This session will cover some advanced topics to help you get the most out of your WebSphere servers, as well as many management and operational tools, and recommendations to enhance your application server environment on z/OS.

• New features in the latest releases of WAS for z/OS and WLM will also be included.
Agenda

- WLM & WAS Interaction & Dependencies
  - Control Region / Servant Region Structure
  - Managing Threads, Servants, Servers & Clusters
  - Server Failover & Continuous System Operation
  - Work Classification – Transaction Classes & WLM Rules
- Tuning Recommendations & Best Practices
  - WLM Settings: Service Classes, Report Classes & Resource Groups
  - SMF Settings and RMF Tools
- Monitoring the Health of WebSphere & WLM
  - RMF Workload Activity Reports & Monitor III
  - SMF Records
- Misc. Topics - Appendix
  - Capping the amount of CPU for WebSphere
  - Start-up & Work Distribution Options
  - MVS & WLM Commands & Tools
  - Resources & References

Why WAS on z/OS? (Software configuration)

- **Mainframe** qualities of robustness - not 'Mainframe like'
  - Operating System - Isolation, Recovery, Architecture
  - **Optimizations** - Local TCP Stack Optimization (cross-memory)
    - Path-length and latency avoidance
    - SSL avoidance, Security and WLM context propagated
    - Type-2 resource managers (IMS, CICS, MQ, DB2)
  - **Workload Management** – zWLM, IRD, Sysplex Distributor
  - GDPS or DR - Recovery based on capacity not box duplication
  - **Capacity planning & Utilization** - WLM & RMF reporting
  - Storage management – DFSMS, Backup, File sharing
  - **Scalability** – WLM, MQ shared queues, DB2 data sharing, etc.
  - Secure, Manageable environment
  - **Thread affinity** reduces communication costs
    - Dispatch stays on same thread if app. components in same server

WLM is key to many of these qualities.
- **Benefits of “just showing up” on z/OS**
Why **WLM** (for WebSphere Application Server)?

- Queue & Route Work requests to Servant Regions.
- Classify Work according to Business Importance & Performance Goals.
- Balance Workloads across Servers.
- Provide Failover to available Servers.
- Enable Horizontal & Vertical Scaling.
- Isolate Servers for Planned Maintenance.
- Centralize Administration of Servers.
- Separate Controller (IBM code) from Servant (User code) for Higher Availability

**WAS Configuration Options**

- **Base Application Server**
  - Easy to set up & useful for testing
  - Responsive to server & application changes
  - Not suited for production
    - no clustering, single-systems config.

- **Network Deployment (ND)**
  - Managed by Deployment Manager & Node Agents
  - Multiple Application Servers
    - Group multiple AppServers into Clusters
  - **ND Required for:**
    - Multi-systems configuration & Clustering
    - Horizontal scaling for increased throughput
    - Continuous availability & fail-over
    - Rolling upgrades for continuous operations
WLM Queues Transaction Enclaves to Servants

- Understanding WLM & WAS
  - The big animal picture:

  WLM starts servants based on workload seen
  Parameters provide control over:
  - Minimum number of regions
  - Maximum number of regions

WebSphere Control Region Adjunct for Messaging

- Understanding Message Flows in CRA
  - The big animal picture:

  1. Listen for MDB in CRA MEs
  2. Schedule Message Token to CR
  3. CR schedules work to WLM Q
  4. Appl. MDB runs in SR
  5. ME retrieve msg using Token
  6. MDB dispatches in Appl. In SR
WAS for z/OS clustering:

- **Inner cluster - Server Instance**
  - Controller region - communication endpoint (HTTP, IIOP, MDB)
    - Performs work classification, security processing, queues to WLM
  - Servant region(s) - 1 or more address spaces (WLM managed)
    - JVM - Web & EJB container - where applications run
  - Isolated for availability & performance
  - Have identical runtime settings
  - Confined to a single z/OS system

- **Outer Cluster - Generic Server**
  - 1 or more server instances of a server.
  - All servers have the same applications
  - May have different runtime settings
  - May exist on multiple z/OS systems.

Clustered Servers

- **Horizontal (cross-LPAR) vs. Vertical (Same LPAR)**

  - **Multiple instances of the same application server:**
    - Increases Availability:
      - Remove single point of failure
      - Allows rolling updates.
    - **However:**
      - May improve performance with add’l Server Instances.
        - Only if LPAR provides more CPU Capacity (add’l engines)
      - Multiple instances on the same system usually won't improve performance, unless you have many (>50) CPs.
Replication - Managing the # of Servant Regions

- **Adminconsole: AppServer > Java Processes > Server Instances**
  - **Check "Multiple Instances Enabled"**
    - If you only have 1 servant, WLM puts all service classes into the one servant,
    - If checked, and Min=Max = 1, transactions from different service classes may hang.
  - "Minimum number of Instances"
    - Useful for avoiding delays to start up server regions
    - To keep work from coming in thru the protocol handler before SRs are ready, use protocol_accept_http_work_after_min_srs=1
  - "Maximum number of Instances"
    - Useful for limiting excessive server regions during server instance ramp-up or if you have limited real storage . . .
  - **Caution:** If you specify a maximum number of instances, WLM is restricted from starting more than this number of servant regions for this server instance.
    - The Maximum number must be >= number of service classes used by this application's transactions, or transactions will time out.
    - Account for default CB service class and enclaves that originate outside WebSphere.

Distributing HTTP Requests on multiple Servants

- **WLM uses a "hot server" strategy to route HTTP requests**
  - Route to servant regions which had recently dispatched work with threads available.
  - "hot servers" have pages in memory, application methods and cache full of data.
  - HTTP requests with session affinity are routed to the servant region where the session object(s) reside.

- **However, this can cause imbalances in some situations:**
  - "Hot" servant regions can get over-loaded with work
  - GC and loss of a servant region can impact many sessions.

- **Distribute HTTP requests evenly across servant regions:**
  - Specify 'wlm_stateful_session_placement_on=1' for the desired server(s) in Environment Variables in the adminconsole.
  - In WAS V6, this variable is over-riden by an Adminconsole setting:
    - Servers > Applications servers > server_name > Server Infrastructure > Administration > Administration Services > Additional Properties > Custom Properties > change 'WLMStatefulSession' to 'true'
  - Optimize the minimum and maximum number of servant regions.
    - May want to eliminate transaction class mapping.
  - Minimize the number of different service classes for these servers.
Managing the number of Threads in the JVM

**Workload Profile in adminconsole:**

- Servers >> Application Servers >> server_name >> ORB Service
  - ISOLATE (1 thread)
  - CPUBOUND (# of CPs-1, minimum of 3) - (GCPs, zAAPs, or zIIPs)
  - IOBOUND (Number of CPs*3, Min=5, Max=30) = Default
  - LONGWAIT (40)
  - CUSTOM (V7): Set with servant_region_custom_thread_count, Min 1, Max 100

  See message BBOO0234I in the controller job log to check the number.

- Allow for increased concurrency
- WebSphere for z/OS doesn't need threads as placeholders for work
  - WLM queues are used for that
- Plan for # of in and ready threads to be 2-3X the # of CPs
- Experiment with the # of servants to optimize your performance.
  - Too many servant regions take excessive storage
  - Too many threads in a JVM creates interference & more frequent GC.
- Display # of threads: SDSF PS panel, 'F <server>,DISPLAY,THREADS' or 'Display OMVS,PID=nnnnn' MVS commands

Classifying Work with WLM

- Started Tasks (STC)
- OMVS work
- Transactions (‘CB’ work )
  - HTTP by URL
  - MDBs
  - IIOP
  - SIP

**Resource Managers:**

<table>
<thead>
<tr>
<th>Action</th>
<th>Type</th>
<th>Description</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>__</td>
<td>CB</td>
<td>CB Class’n w/WLM Trans. CLASSes</td>
<td>CBCCLASS</td>
</tr>
<tr>
<td>__</td>
<td>CICS</td>
<td>Use Modify to enter YOUR rules</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>DB2</td>
<td>Use Modify to enter YOUR rules</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>DDF</td>
<td>Use Modify to enter YOUR rules</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>IMS</td>
<td>Use Modify to enter YOUR rules</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>IWEB</td>
<td>IWEB rules</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>JES</td>
<td>Batch Classification Rule</td>
<td>BAT_MED</td>
</tr>
<tr>
<td>__</td>
<td>OMVS</td>
<td>E_Biz Classification Rule</td>
<td>EBIZ_DEF</td>
</tr>
<tr>
<td>__</td>
<td>STC</td>
<td>Started Task Classification Rule</td>
<td></td>
</tr>
<tr>
<td>__</td>
<td>TSO</td>
<td>TSO Classification Rule</td>
<td></td>
</tr>
</tbody>
</table>

**WLM Subsystem Type Selection List for Rules**

- Default
**STC Rules - Classifying WebSphere Address Spaces**

- **Controller Regions** (Daemon, Node Agent, Deployment Manager, App. Servers)
  - Classify as High Importance & High Velocity

- **Application Server Regions**
  - Classify with velocity goal, high enough to get started quickly, lower than controllers
    - Work is actually classified under the application environment
    - Don’t use SYSSTC (Resources not accounted for)

**Sample STC Classification Rules:**

- Use Unique Report Classes to track important Started Tasks:

<table>
<thead>
<tr>
<th>Qualifier</th>
<th>Qualifier</th>
<th>Starting</th>
<th>Service</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td># type</td>
<td>name</td>
<td>position</td>
<td>Class</td>
<td>Class</td>
</tr>
<tr>
<td>1 TN</td>
<td>WSAPPLC</td>
<td></td>
<td>OPS_HI</td>
<td>RWSAPPLC</td>
</tr>
<tr>
<td>1 TN</td>
<td>WSAPPS</td>
<td></td>
<td>OPS_MED</td>
<td>RWSAPPS</td>
</tr>
<tr>
<td>1 TN</td>
<td>WS%%%C</td>
<td></td>
<td>OPS_HI</td>
<td>RWSCTRLG</td>
</tr>
<tr>
<td>1 TN</td>
<td>WS%%%S</td>
<td></td>
<td>OPS_MED</td>
<td>RWSSVRRG</td>
</tr>
</tbody>
</table>

- OPS_HI service class: Importance = 1, Velocity = 70
- OPS_MED service class: Importance = 2, Velocity = 40

**OMVS Rules - Controller start-up Procedure**

- **ApplyPTF step in the Contoller Region Proc:**
  - Checks to see if service has been applied to WebSphere & updates files for the new service.
  - Classify server controller jobnames with WLM OMVS rules.

**OMVS Classification rules – Use Started Task Jobname (TN)**

<table>
<thead>
<tr>
<th>--------Qualifier--------</th>
<th>-------Class--------</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Name</td>
</tr>
<tr>
<td>1 TN</td>
<td>WPSR*</td>
</tr>
<tr>
<td>1 TN</td>
<td>WTSR*</td>
</tr>
<tr>
<td>1 TN</td>
<td>WTSR*</td>
</tr>
</tbody>
</table>
CB Rules - Classifying WebSphere Transactions

- **Subsystem type = CB using the following criteria:**
  - Generic Server name (CN) - cluster transition name = the applenv name
  - Server Instance name (SI) - not useful because instances share work
  - Userid assigned to the transaction (UI) - usually not useful unless RunAs.
  - Transaction class (TC) - assigned by "Workload Classification" file.

- **Percentage response time goal is recommended**
  - Example: 80% of trans less than 0.5 seconds
  - Response time goals better than Velocity goals in a true production environment.
    - Velocity goals need to be re-calibrated with environmental changes (CPU, workload)
  - Default is SYSOTHER (discretionary)

- **Other considerations:**
  - Requests that already have enclave tokens, run under these enclaves, and with the service class assigned for this enclave.
  - WLM maintains "internal queues" for each service class:
    - A server region may switch queues if needed, based on demand.

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Workload classification file

- **Classification for transaction class (TC) of inbound work**
  - HTTP - host, port, URI
  - IIOP - application, module, component, and method name
  - MDB - message listener port, selector attribute

- **Migration/Coexistence:**
  - New classification document can coexist w/ old HTTP Transaction Class mapping file, but if it contains any HTTP classification rules, the old style document will not be used.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE Classification SYSTEM "Classification.dtd" >
<Classification schema_version="1.0">  
  <!-- IIOP Classification Rules -->
  <InboundClassification type="iiop"  
    schema_version="1.0" 
    default_transaction_class="A0">  
    <iiop_classification_info transaction_class="A1"  
      application_name="IIOPStatelessSampleApp" 
      module_name="StatelessSample.jar" 
      component_name="Sample20">  
      <iiop_classification_info transaction_class="A1B" 
        method_name="ping" 
        description="Ping method" />  
    </iiop_classification_info>  
  </InboundClassification>  
</Classification>
```
**Transaction Class maps to WLM Service Class**

- **AdminConsole:** click Environment > WebSphere Variables,
  - Select the level (Cell, Node, Cluster, or Server), Click “New”
  - Specify `wlm_classification_file` in the Name field, and location of workload classification document in the Value field. *(file must be in ASCII)*

```xml
<!--
  HTTP Classification Rules
-->
<InboundClassification type="http" schema_version="1.0"
  default_transaction_class="TCHTTP">
  <http_classification_info transaction_class="TCSNOOP"
    uri="/SuperSnoopWeb/SuperSnoop"
    description="SuperSnoop Servlet"/>
</InboundClassification>
```

**Workload Manager CB Classification Rules:**

<table>
<thead>
<tr>
<th>--------Qualifier--------</th>
<th>-------Class--------</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type       Name     Start</td>
<td>Service     Report</td>
</tr>
<tr>
<td>DEFAULTS: CBCLASS     RWASDEF</td>
<td></td>
</tr>
<tr>
<td>1  CN         H1*      ___</td>
<td>CBMED       RH1DEFLT</td>
</tr>
<tr>
<td>2  TC         TCSNOOP   ___</td>
<td>CBSLOW      RH1SNOOP</td>
</tr>
<tr>
<td>2  TC         TCHTTP   ___</td>
<td>CBCLASS     RH1HTTP</td>
</tr>
</tbody>
</table>

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**How is my Classification File working?**

- **Displaying Classification of Work Requests**

- **See if classification scheme is classifying work as expected:**
  - MVS oper command: F <server>,DISPLAY,WORK,CLINFO

```c
F H5SR01D,DISPLAY,WORK,CLINFO
BB000281I CLASSIFICATION COUNTERS FOR HTTP WORK
BB000282I CHECKED 27976, MATCHED 27976, USED 816, COST 4, DESC: HTTP Default
BB000282I CHECKED 27976, MATCHED 9053, USED 9053, COST 2, DESC: H5Servlets
BB000282I CHECKED 18923, MATCHED 9021, USED 9021, COST 3, DESC: H5EJBs
BB000282I CHECKED 9902, MATCHED 9086, USED 9086, COST 4, DESC: H5JSPs
BB000283I FOR HTTP WORK: TOTAL CLASSIFIED 27976, WEIGHTED TOTAL COST 84777
BB000188I END OF OUTPUT FOR COMMAND DISPLAY,WORK,CLINFO
```

- **CHECKED** - Number of times the rule has been examined.
- **MATCHED** - Number of this times that this rule has been matched by the request.
- **USED** - Number of times that this rule has actually been used.
- **COST** - Number of compares that required to determine if this is the correct rule to use.
- **WEIGHTED COST** - Number of times each rule was used multiplied by the cost, or number of rule compares that were done, and adding up across all rules.
- **Reduce the cost by re-arranging your Classification File.**
WLM Classification Guidelines

• Service Classes used to meet goals
  – Do not let work default to discretionary goals.
  – Set realistic (achievable) goals.
  – Assumes there is displaceable work when resources constrained.
  – Use Velocity for Address Spaces, Response Time for enclaves.
  – Avoid multi-period service classes for disparate work in the same server.
  – Avoid too many Service Classes.
  – Understand difference between Business Trans & RMF Trans.
    • WID Quality of Service: Activity Properties can change Scope of Transaction and RMF numbers. (New Tran, Participate, Commit Before/After Tran …)
    • Changes Ratio of Business Tran to RMF Trans

• Report Classes distinguish among items of interest
  – Do not lump components together.
  – Use RMF RCPER(rc*) to show Resp. time distribution, Delay break-out, etc.

WLM key to Configuring for Availability

Application availability based on sysplex availability principles.
• First Principle - "One" is a lonely number
• "Two" entities with failure isolation (Three are better!)
Application availability is dependent upon:
• Sysplex componentry - SYSPLEX distributor, data sharing, etc.
• Non-sysplex components - Edge servers, DNSs, routers, etc.
• Configuration changes & Operational procedures - Service upgrades, Backups, etc.

Ensure clients can always get to the server

Intelligent Routing:
• WLM-aware vs. Round-Robin
• Session Affinity within Server Instance and across Server Instances (Systems)
• Network Dispatcher (MNLB) load balances
• IHS or Web Server with WAS AE plug-in (rev-proxy)
• Sysplex Distributor good for TCP/IP load balancing
**Workload Management & Availability**

**Multiple Server Instances provide Continuous Operation**
- Cluster Horizontally across multiple LPARs (& Hardware Engines)
- Allows for Planned and Un-Planned Outages

**Multiple Servants also allow for Continuity**
- WLM will restart a Servant Region if one fails, or if killed by an operator (Cancel cmd, or SDSF ‘K’ action char.)
- Server Instances (Controller Regions) can be re-started by ARM (Automatic Restart Manager) or your System Automation Product
- Insulates from Garbage Collection interruptions.

**Recent Study:**
- More Servants vs. More Threads (depends on many variables)

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**Performance Monitoring & Debugging**

- **CPU resources**
  - Understand where the CPU time is spent & how to measure/account for it

- **I/O & Storage resources**
  - RMF & SMF Records

- **Performance Problem Determination**
  - Response time delays
  - CPU delays
Where is CPU Time Accounted?

- **Controller Region**
  - Communications End-point: Receives IIOP/HTTP/SSL request
  - Security authorization for IIOP requests
  - Classifies & Queues Request to WLM queue

- **Servant Region**
  - Selects work from WLM for a given Service Class
  - Some Java Garbage Collection
  - (plus any application created threads)

- **Enclaves**
  - J2EE Application code executes under an enclave (in JVM)
    - Includes JDBC & JNI calls
    - Type 2 drivers - DB2 CPU time charged to the Enclave
    - Type 4 drivers - DB2 CPU time charged to the DDF address space
  - Use SDSF ENClaves panel, or RMF Monitor to display

**Note: Difference between Reporting & Management Classes**
- All work is Managed by WLM according to the CB-assigned Service Class
- CPU time is Reported (Charged) to Enclave only if it is part of the transaction.
  - e.g., Garbage Collection is managed to the CB-assigned Service/Reporting Class, but CPU time charged to the servant region's STC-assigned Service/Reporting Class.

RMF Monitor 1 Workload Activity Report

- **Transactions/second**
  - AVG=MPL=AVG ENC = # of enclaves in the period
  - (If not, others using this S.C.)
  - “Business Tran” may not = "RMF Tran"

- **Response times**
  - Actual R.T. ~= Execution R.T. (includes waiting on WLM)
  - QUEUED delays

- **CPU & Service Rates**
  - CPU service Times
  - APPL% = # of engines (CPs) in service (report) class broken out by GCP, zAAP & zIIP
  - CPUsec/Tran = CPU/ENDED

- **Delays**
  - QMPL means waiting for Servant Region (WLM)
  - Use RMF RCPER(rc*) to show Resp. time distribution, Delay break-out, etc.
Isolating problems – RMF Delays

WLM Delay Monitoring States:
- BTE = begin-to-end phase (Controller view)
- EXE = execution phase (Servant view)
- DISP - waiting for response from a distributed server
- LOCL - waiting for session w/ server on the local system
- SYSP - waiting for TCP/IP session establish w/ local system
- REMT - waiting for TCP/IP session establish w/ remote system
- SSLT* - waiting for SSL session in controller
- REGT* - waiting for thread in controller
- WORK* - waiting to register work in controller
- OTHER - waiting for DNS or TCP/IP
- TYP1 - EJB Collaborator
- TYP2 - J2C Connector
- TYP3 - RMI/IIOP
- TYP4 - OTS call to RRS
- TYP5 – DNS or ZIOP channel

New buckets defined in WLM:
- TYP6 - TYP10 (for future use)

Zero in:
Right tool for the problem?

Adds up to 100%

SMF Record Types

30 – Common Address Space Work
- Enclave CPU time charged to originating A.S. (CRs)
- Transaction I/O and Storage Measurements in CRs
- House-keeping CPU & I/O in SRs

72.3 – Workload Activity Records for RMF
- Transaction CPU & I/O broken out by S.C & R.C.

120 – WebSphere Application Server – Subtypes:
- Server_Activity
- Server_Interval
- EJB_Activity
- EJB_Interval
- Web_Activity
- Web_Interval
- Request Activity (WAS V.7)
New SMF 120 Records

- **WebSphere for z/OS creates SMF 120 records.**
  - Issues with prior versions of WebSphere for z/OS:
    - Insufficient user/request information for Chargeback
    - Not extendable
    - Costly to record, Not dynamically controlled
  - **WebSphere Version 7 introduces new subtype-9**
    - Dynamically enabled/disabled
    - Contains more information for chargeback
    - Show Bytes transferred, Elapsed Times, CP, zAAP, zIIP times
    - Low overhead
    - Extendable with user inserted sections

**WebSphere Version 7 introduces new subtype-9**

- Dynamically enabled/disabled
- Contains more information for chargeback
- Show Bytes transferred, Elapsed Times, CP, zAAP, zIIP times
- Low overhead
- Extendable with user inserted sections

**SMF Record Interpreter** available from the WebSphere Application Server for z/OS Web site at:


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**WAS V7 SMF Browser for SMF 120.9 Records**

- Sample Output

<table>
<thead>
<tr>
<th>SMF -Record Time</th>
<th>Server</th>
<th>Bean/WebAppName</th>
<th>Bytes</th>
<th># of El.Time</th>
<th>CPU_Time(uSec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 120.9</td>
<td>H1SR01B</td>
<td>STC20577-HTTP</td>
<td>3 2626 2192</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 4 120.9          | H1SR01B | STC20577-HTTP | 4 3120 2467 |

REQUEST Recs: Avg Bytes, TranCount & Times = 205 621 120 3 2231 1580

HFS EXCP Counts in SMF, RMF & SDSF

SMF 30 Records – USS Process Section

SMF 74.6 Records – RMF HFS Statistics

• EXCPs for HFS/zFS calculated similar to the way other I/O is calculated for cached control units.
  – Each 4k block read/written charged 1 EXCP count.
  – Directory lookups on the HFS are also charged.

• HFS file system optimizes performance by caching file activity and often avoiding I/O.
  – Therefore, EXCP counts are much higher than the number of physical I/Os performed.

More WLM & WebSphere Options

• Misc. Topics
  – Capping the Resources used by WebSphere
  – Server Start-up Options
  – WebSphere Routing Options
  – Sysplex Distributor & WLM Routing Options
  – WebSphere V7 Enhancements

• Appendices
  – MVS Commands & Displays
  – WLM Tools
  – Resources & References
Controlling WebSphere Workload License Charges

- **Limit WebSphere to a Maximum amount of MSUs**
  - Customer wants to Control the Budget for Software Pricing based on MSUs
  - Useful for *Getting Started SubCapacity* (GSLS) Pricing
  - Useful in Test or Development Environments;
  - Not in Production where Performance Matters!

- **Isolate an LPAR for WebSphere Work, and use:**
  - PR/SM Capping, or . . .
  - Group Capacity limits (4-hour moving Average)

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WLM Startup Options for WebSphere

- **Number of Servers:** `server_name` > Java and process management > Server instance.
  - Select the Multiple instances enabled field.
  - Minimum Number and Maximum Number of Instances.

- **`protocol_accept_http_work_after_min_srs`**
  - Wait for minimum number of servants ready before starting HTTP transport channels.
    - **True (1):** HTTP transport channels start when minimum number of servants is ready for work.
    - **False (0):** HTTP transport channels start when the controller starts.

- **`protocol_accept_iio_p_work_after_min_srs`**
  - **True (1):** IIOP transport channels start when minimum number of servants is ready for work.
  - **False (0):** IIOP transport channels start when the controller starts.

- **`wlm_servant_start_parallel`**: (New with WAS V7)
  - **True:** After first servant is initialized, server starts remaining address spaces in parallel.
  - **False:** Server starts all servant address spaces sequentially.
WLM Workload Distribution Options

- **Even distribution of HTTP requests**: `server_name` > Server Infrastructure/Administration > Administration services > Additional Properties > Custom properties > Check “WLMStatefulSession” property.
  
  (general property `wlm_stateful_session_placement_on` is ignored.)

- **server_use_wlm_to_queue_work**
  
  Specifies whether WLM is used for workload queuing.
  
  1: if you are using stateless application models.
  
  0: if you are using conversational application models

- **server_work_distribution_algorithm**
  
  This is only used if `server_use_wlm_to_queue_work=false`.
  
  0: Hot thread algorithm is used. (not recommended.)
  
  1: The round robin algorithm is used. This is the default.

More WLM Options for WebSphere

- **control_region_wlm_dispatch_timeout**
  
  - Limits the amount of time a client request waits on the WLM queue, as well as the time required for the application component to process the request.

- **protocol_iip_local_propagate_wlm_enclave**
  
  - Propagate the WLM enclave associated with currently dispatched request on an outbound IOP request made to another server on the same z/OS system.

- **control_region_timeout_save_last_servant**
  
  - Specifies whether the controller terminates the last available servant when a timeout situation occurs.
WLM WebSphere Routing Level algorithm

- New support in z/OS 1.9 uses displaceable CP capacity of systems as basis for routing work.
  - Function enabled on z/OS 1.6 and above with OA16486.
- In the past, WLM routing algorithm was round-robin.
- New IEAOPT parameter WASROUTINGLEVEL
  - =1 Use the old Round-Robin routing algorithm. (the default)
  - =0 Use LPAR capacity when making routing decisions.
    - “Over committed” systems shouldn’t get additional work.
    - WLM will avoid systems that are in 'stress' (real storage shortage.)
    - May change routing recommendations compared to current behavior.
- Keep the same WASROUTINGLEVEL option on all systems of the sysplex.
- This applies only to the Daemon Routing IIOP requests.

Sysplex Distributor WLM Routing Options

- VIPADISTribute DISTMethod=
  - BASEWLM – Route based on available GCP capacity.
  - SERVERWLM – Include zAAP/zIIPs in routing recommendations
  - WEIGHTEDActive – Balance requests proportional to connection weight.
  - ROUNDROBIN – (Ignore WLM routing.)
- OPTLOCAL (value) – Use local Server if Available & Healthy
  - Avoids traffic-routing through Sysplex Distributor.
  - Value=0: always use local connection (Req’d if ROUNDROBIN)
  - Value=1: use local connection unless server WLM weight=0
  - Value=2-16: multipliers to favor the local server’s WLM weight

Recommendations (?)
- While it may seem good to route based on available capacity, Overhead is significantly reduced if the work stays on the local system.
- Stateful sessions reduce flexibility & may create imbalance
Appendices
1. MVS Commands & Displays
2. WLM Tools
3. Misc. WLM Options
4. Resources & References

MVS Modify <server> Command - Help

F <server>,HELP
THE COMMAND MODIFY MAY BE FOLLOWED BY ONE OF THE FOLLOWING KEYWORDS:
CANCEL - CANCEL THIS CONTROL REGION
TRACEALL - SET OVERALL TRACE LEVEL
TRACEBASIC - SET BASIC TRACE COMPONENTS
_TRACEDETAIL - SET DETAILED TRACE COMPONENTS
_TRACESPECIFIC - SET SPECIFIC TRACE POINTS
_TRACEINIT - RESET TO INITIAL TRACE SETTINGS
TRACENONE - TURN OFF ALL TRACING
TRACETOSYSPRINT - SEND TRACE OUTPUT TO SYSPRINT (YES/NO)
DISPLAY - DISPLAY STATUS
TRACE EXCLUDE SPECIFIC - EXCLUDE SPECIFIC TRACE POINTS
JAVACORE - GENERATE JVM CORE DUMP
HEAPDUMP - GENERATE JVM HEAP DUMP
JAVATDUMP - GENERATE JVM TDUMP
TRACEJAVA - SET JAVA TRACE OPTIONS
TRACETOTRCPFILE - SEND TRACE OUTPUT TO TRCPFILE (YES/NO)
MDBSTATS - MDB DETAILED STATISTICS
PAUSELISTENERS - PAUSE THE COMMUNICATION LISTENERS
RESUMELISTENERS - RESUME THE COMMUNICATION LISTENERS
STACKTRACE - LOG JAVA THREAD STACK TRACEBACKS
TIMEOUTDUMPACTION - SET TIMEOUT DUMP ACTION
TIMEOUTDUMPACTIONSESSION - SET TIMEOUT DUMP ACTION SESSION
TIMEOUT_DELAY - SET TIMEOUT DELAY VALUE
WLM_MIN_MAX - RESET WLM MIN/MAX SERVANT SETTINGS
SMF - SET SMF120 OPTIONS
DPM - DISPATCH PROGRESS MONITOR
**MVS Modify <server>,Display,Help**

F <server>,DISPLAY,HELP
THE COMMAND DISPLAY, MAY BE FOLLOWED BY ONE OF THE FOLLOWING KEYWORDS:
SERVERS - DISPLAY ACTIVE CONTROL PROCESSES
SERVANTS - DISPLAY SERVANT PROCESSES OWNED BY THIS CONTROL PROCESS
LISTENERS - DISPLAY LISTENERS
CONNECTIONS - DISPLAY CONNECTION INFORMATION
TRACE - DISPLAY INFORMATION ABOUT TRACE SETTINGS
JVMHEAP - DISPLAY JVM HEAP STATISTICS
WORK - DISPLAY WORK ELEMENTS
ERRLOG - DISPLAY THE LAST 10 ENTRIES IN THE ERROR LOG
MODE - DISPLAY THE EXECUTION BITMODE
THREADS - DISPLAY THREAD STATUS
WLM - DISPLAY WLM SETTINGS
SMF - DISPLAY SMF120-9 SETTINGS AND STATUS
FRCA - DISPLAY FRCA INFORMATION
DFM - DISPLAY DISPATCH PROGRESS MONITOR SETTINGS
END OF OUTPUT FOR COMMAND DISPLAY,HELP

Display a list of all the keywords you can use with the modify timeoutdumpacation or timeoutdumpactionsession command:

f <server>,timeoutdumpactionsession=help
BBOO0178I MODIFY TIMEOUTDUMPACTIONSESSION= MAY BE FOLLOWED BY ONE OF
THE FOLLOWING KEYWORDS:
BBOO0179I SVCDUMP - SVC DUMP
BBOO0179I JAVACORE - JAVA CORE DUMP
BBOO0179I NONE - NO DUMP

**MVS Modify Command to Display Work**

F <server_name>,DISPLAY,WORK,HELP
BBOO0178I THE COMMAND DISPLAY,WORK, MAY BE FOLLOWED BY ONE OF
THE FOLLOWING KEYWORDS:
BBOO0179I EJB - DISPLAY EJB REQUEST COUNT INFORMATION
BBOO0179I SERVLET - DISPLAY SERVLET REQUEST COUNT INFORMATION
BBOO0179I MDB - DISPLAY MDB REQUEST COUNT INFORMATION
BBOO0179I SIP - DISPLAY SIP REQUEST COUNT INFORMATION
BBOO0179I SUMMARY - DISPLAY SUMMARY REQUEST COUNT INFORMATION
BBOO0179I ALL - DISPLAY ALL REQUEST COUNT INFORMATION
BBOO0179I CLINFO - DISPLAY WORK CLASSIFICATION INFORMATION
BBOO0188I END OF OUTPUT FOR COMMAND DISPLAY,WORK,HELP

WebSphere Operator Display Commands to determine:
Work, Queued or Active  + Deltas provided between invocations:
F H2SR01B,DISPLAY,WORK
BBOO0255I TIME OF LAST WORK DISPLAY 2008/06/12 14:32:15.215714
BBOO0261I TOTAL REQUESTS TO SERVER 414120 (DELTA 316139)
BBOO0262I TOTAL CURRENT REQUESTS 9
BBOO0263I TOTAL REQUESTS IN DISPATCH 9
BBOO0268I TOTAL TIMED OUT REQUESTS 0 (DELTA 0)
BBOO0188I END OF OUTPUT FOR COMMAND DISPLAY,WORK

+ More coming in V7 (See below) . . .
WLM Dynamic Application Environments

D  WLM,DYNAPPL=*  
IWM029I  12.57.17  WLM DISPLAY 590  
DYNAMIC APPL. ENVIRON. NAME  STATE  STATE DATA  
F6SR01  AVAILABLE  
ATTRIBUTES: PROC=F6ASRA  SUBSYSTEM TYPE: CB  
SUBSYSTEM NAME: F6SR01A  NODENAME: F6CELL  
F6SR01ADJUNCT  AVAILABLE  
ATTRIBUTES: PROC=F6CRAA  SUBSYSTEM TYPE: CB  
SUBSYSTEM NAME: F6SR01A  NODENAME: F6CELL  

V  WLM,DYNAPPL=F6SR01,RESUME | QUIESCE | REFRESH  

Dynamic WLM Env’s Started and Stopped Dynamically, but can be used to:  
• QUIESCE - WLM stops the server address spaces.  
• RESUME - WLM starts the server address spaces.  
• REFRESH - WLM stops the server address spaces, and starts new ones.

Displaying Threads & CPU Time Used:  
D  OMVS,PID=nnnn,BRL, or  
SDSF – PS panel, D action character  
(output goes to Syslog.)  

BPX0040I 13.27.01 DISPLAY OMVS 506  
USER  JOBNAME  ASID  PID  PPID  STATE  START  CT_SECS  
H2ASRU  H2SR01BS 0021 197284  84083363  HR---- 10.24.55 2231.967  
THREAD_ID  TCB@  PRI_JOB  USERNAME  ACC_TIME  SC  STATE  
1450F940000000000 008D6AD0  WLM  36.296  IPT  YU  
1451AE000000037 008C90A8  WLM  8089  WRT  JR  V  
1451BD1000000038 008C5E88 WLM  70.820  CLO  JR  V  
1451CC2000000039 008C60D0 WLM  70.586  CLO  JR  V  
1451DB300000003A 008C62F0 WLM  71.462  CLO  JR  V  
1451EA400000003B 008C6510 WLM  351.265  WRT  JR  V  
1451F9500000003C 008C6730 WLM  69.749  CLO  JR  V  
145208600000003D 008C6950 WLM  348.383  CLO  JR  V  
145217700000003E 008C6B70 WLM  348.176  CLO  JR  V  
145226800000003F 008C6E00 WLM  70.408  CLO  JR  V  
145244A000000040 008C8098 WLM  69.230  CLO  JR  V  
1451A80E000000037 008C90B8  WLM  387PTC  JR  V  

CPU Time (Secs)  
Worker Threads
WLM Tools

WLM Tools – WLMQUE & WLMOPT

### WLMQUE – Application Env. Monitor

**Selection:**  >HELP< >SAVE< >OVW< >ALL<

**System:** SYSB  **Sysplex:** WSCPLEX  **Version:** z/OS 010900  **Time:** 13:03:24

<table>
<thead>
<tr>
<th>ApplEnv_ Type</th>
<th>SubName_ WMAS</th>
<th>Del</th>
<th>Dyn</th>
<th>NQ</th>
<th>QLen</th>
<th>Str</th>
<th>Hav</th>
<th>Unb</th>
<th>Trm</th>
<th>Min_</th>
<th>Max__</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2SR01</td>
<td>CB</td>
<td></td>
<td></td>
<td>0054</td>
<td>No</td>
<td>Yes</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**WorkQue_ Del**  **Wnt**  **Hav**  **ICnt**  **QueIn_ QueOut QueLen QueTot__**  **Act_ Idl__**

<table>
<thead>
<tr>
<th><strong>0021</strong></th>
<th><strong>Wnt</strong></th>
<th><strong>Have</strong></th>
<th><strong>PEU</strong></th>
<th><strong>ICnt</strong></th>
<th><strong>WUQue____</strong></th>
<th><strong>Aff</strong></th>
<th><strong>AffQue</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>9</td>
<td>9</td>
<td>0</td>
<td>216669</td>
</tr>
</tbody>
</table>

**Key:**

- **NQ** - Number of work queues (service classes)
- **QLen** - Total number of currently queued requests
- **QueIn** - Number of Requests inserted into work queue since last refresh
- **QueOut** - Number of Requests taken from queue since last refresh
- **QueLen** - Current queue length
- **QueTot** - Total number of requests seen so far
- **Binding** - Server class (work queue) from which the server AS selects work.
  - Shows dashes if the server address space is unbound
- **Have** - Number of instances which can select work
- **PEU** - Parallel execution units: number of defined server instances for the subsystem (for example: NUMTCB)

---

### WLMOPT

**WLM OPT Settings**  >SAVE<

**System:** SYSB  **Version:** z/OS 010900  **OPT:** 00  **Time:** not issued

<table>
<thead>
<tr>
<th>OPT-Parameter:</th>
<th>Value:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABNORMALTERM</td>
<td>No</td>
<td>Abnormal term. used in routing rec.</td>
</tr>
<tr>
<td>BLWLTRPCT</td>
<td>5</td>
<td>CPU cap. to promote blocked work</td>
</tr>
<tr>
<td>BLWLINTHD</td>
<td>60</td>
<td>Time blocked work waits for help</td>
</tr>
<tr>
<td>CCCAWMT</td>
<td>490000</td>
<td>Alternate wait management time value</td>
</tr>
<tr>
<td>ZAAPAWMT</td>
<td>12000</td>
<td>AWM time value for zAAPs</td>
</tr>
<tr>
<td>ZIIPAWMT</td>
<td>12000</td>
<td>AWM time value for zIIPs</td>
</tr>
<tr>
<td>CNTCLIST</td>
<td>No</td>
<td>Clist commands count individually</td>
</tr>
<tr>
<td>CPENABLE</td>
<td>Yes</td>
<td>Specifies w/ directed VIO is active</td>
</tr>
<tr>
<td>DVIO</td>
<td>Yes</td>
<td>Specifies w/ directed VIO is active</td>
</tr>
<tr>
<td>ERV</td>
<td>500,CB</td>
<td>Eng res. CPU Service and DP</td>
</tr>
<tr>
<td>IFAHONORPRIORITY</td>
<td>Yes</td>
<td>Specifies w/ zAAP work can run on CPs</td>
</tr>
<tr>
<td>IIPHONORPRIORITY</td>
<td>Yes</td>
<td>Specifies w/ zIIP work can run on CPs</td>
</tr>
<tr>
<td>INITIMP</td>
<td>0,FE</td>
<td>INITIMP value and DP for initiators</td>
</tr>
<tr>
<td>MCCACFTH</td>
<td>400,800</td>
<td>LOW, HIGH central threshold</td>
</tr>
<tr>
<td>MCCFXEPR</td>
<td>92 %</td>
<td>% of storage fixed within first 16MB</td>
</tr>
<tr>
<td>MCCFXTPR</td>
<td>80 %</td>
<td>% of online storage fixed</td>
</tr>
<tr>
<td>PROJECTCPU</td>
<td>No</td>
<td>CPU projection for zAAPs and zIIPs</td>
</tr>
<tr>
<td>RCCFXTT</td>
<td>66,72</td>
<td>Low, High Logical MPL threshold</td>
</tr>
<tr>
<td>RCCFXET</td>
<td>82,88</td>
<td>Low, High Physical MPL threshold</td>
</tr>
<tr>
<td>RMPTTOM</td>
<td>3000</td>
<td>SRM invocation interval</td>
</tr>
<tr>
<td>VARYCPU</td>
<td>Yes</td>
<td>VARYCPU is enabled</td>
</tr>
<tr>
<td>VARYCPUMIN</td>
<td>1</td>
<td>VARYCPUMIN value</td>
</tr>
<tr>
<td>WASROUTINGLEVEL</td>
<td>0</td>
<td>WebSphere Routing Level</td>
</tr>
</tbody>
</table>
Resources & References

WebSphere V6, V7 InfoCenter

www.ibm.com/software/webservers/appserv/was/library/

– Download a copy onto your workstation

WebSphere for z/OS "home page"

www.ibm.com/software/webservers/appserv/zos_os390/

WLM Home Page

www.ibm.com/servers/eserver/zseries/zos/wlm/

z/OS Home Page

www.ibm.com/servers/eserver/zseries/zos

Developer's Domain (WebSphere & Java Best Practices, Help, Docs & Tools)

www.ibm.com/developerworks/websphere/
Education

• Courses by IBM Learning Services, ITSO, & WSC
  www.ibm.com/services/learning/
  ▶ OZ850 - Maximizing WebSphere for z/OS V6 Performance (4.5 Days)

Wildfire Workshops:
  ▶ WBSR7 - WebSphere V7 for z/OS Workshop "Gen 7" (3 days)
  ▶ WSW07 - Security Workshop: WAS V7 for z/OS (2.5 Days)

• IBM Education Assistant
  www.ibm.com/software/info/education/assistant/

• Conferences & User Group Meetings
  ▶ SHARE & Regional User Groups
  ▶ zSeries Expo
  ▶ Large Systems z/OS Update
  ▶ WebSphere Virtual Usergroup

Redbooks: www.redbooks.ibm.com
• Systems Programmer’s Guide to: Workload Manager – SG24-6472
• Performance Monitoring & Best Practices for WAS on z/OS - SG24-7269
• Monitoring WebSphere Application Performance on z/OS - SG24-6825
• WebSphere for z/OS V6 Problem Determination - SG24-6880
• WebSphere V6 Scalability & Performance Handbook - SG24-6392
• WebSphere for z/OS CICS & IMS Connectivity Performance – REDP-3959

ATS/WSC TechDocs - www.ibm.com/support/techdocs
• WP100678 Diagnosing Performance Problems with WAS on z/OS
• WP100558 Optimizing WebSphere for z/OS Performance
• TD103548 Capacity Planning for zAAP and zIIP Specialty Engines
• TD103036 Performance and tuning tips for WebSphere Application Server for z/OS
• TD102730 Classify the Application Control Region in WLM OMVS rules
• TD102454 How to find the CPU Time Usage in WAS V6 for z/OS java programs
• PRS752 Performance Summary Report for SMF 120 records from WAS V.5 for z/OS
• PRS2494 Performance Engineering for WAS V.6 for z/OS
• PRS3317 WLM Configuration & Advanced Topics for WAS on z/OS (This Presentation!)
WSC WebSphere z/OS-related Sessions

Mike Cox
1485 Wed 4:30 - 5:30 Java Exploitation of z/OS and Parallel Sysplex
1452 Thu 11:00 - 12:00 JinsightLive for System z - Do You Know What your Application is Doing?

John Hutchinson
1480 Sun 3:00 - 4:00 WebSphere Application Server on z/OS - WSC Guidelines for a Healthy WAS Runtime
1446 Mon 9:30 - 10:30 WebSphere Process Server on z/OS V6.1 Configuration and Troubleshooting
1458 Tue 3:00 - 4:00 WLM Configuration & Advanced Topics for WebSphere Application Server on z/OS

Mike Kearney
1437 Thu 4:30 - 5:00 WebSphere for z/OS V7: LDAP and Multiple Security Domains
1463 Thu 6:00 - 7:00 WebSphere Application Server for z/OS Security Topics

Mike Loos
1460 Mon 4:30 - 5:00 Avoiding the Potholes on the WebSphere Application Server for z/OS On Ramp
1473 Wed 11:00 - 12:00 Using the Jython Scripting Language with WSADMIN
1445 Wed 3:00 - 4:00 WebSphere Application Server Advanced Configurations on z/OS
1450 Thu 9:30 - 10:30 Installing and Configuring ITCAM for WebSphere Application Server on z/OS

Don Bagwell
1462 Sun 4:30 - 5:30 WebSphere Application Server Introduction and Concepts for Beginners
1476 Mon 11:00 - 12:00 Introduction to Default Messaging in IBM WebSphere Application Server
1496 Mon 1:30 - 2:30 Understanding Front-End HTTP Options for WebSphere on z/OS
1447 Mon 3:00 - 4:00 WebSphere for z/OS -- I'm No Longer a Dummy But...
1456 Wed 9:30 - 10:30 WebSphere z/OS - Washington Systems Center Best Practices

Paul Houdé
1449 Mon 3:00 - 4:00 Configuring the WebSphere Portal Server on z/OS
1455 Wed 8:00 - 9:00 WebSphere for z/OS PMT in the new WebSphere Configuration Tools
1432 Thu 11:00 - 12:00 IHS vs WAS Apache based HTTP Server Comparisons

WSC Wildfire Classes

Washington Systems Center IBM Americas Advanced Technical Support

WebSphere Application Server for z/OS Version 7.0 - (WBSR7)
Security Workshop: WebSphere Application Server for z/OS V 7.0 (WSW07)
Deploying WebSphere Centric Products on Linux for zSeries - (LINX6)
z/OS JAVA Exploiters and JAVA Batch Workshop - (ZJAV1)
WebSphere Process Server V6 for z/OS Implementation Workshop - (ZWPS6)
WebSphere Message Broker for z/OS Version 6 Workshop - (WMB06)
Customizing Linux and the Mainframe for Oracle DB applications – (LXOR6)

Please contact your IBM sales representative to discuss enrollment

See the following techdoc for workshop descriptions:
http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/PRS1778
Questions?