

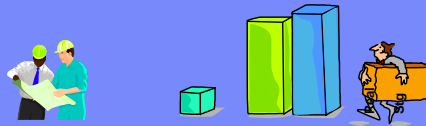


IBM Washington Systems Center

Performance Tuning for WebSphere Version 5 on z/OS

zSTSU
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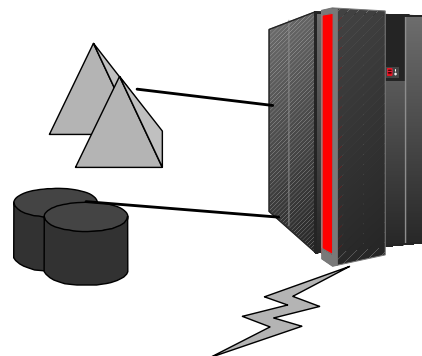
Agenda

- **Engineer for Performance**
 - ▶ Hardware Resources & Configuration
 - ▶ Software Levels
 - ▶ Systems, Subsystems, & Security
 - ▶ System Topology - Client/Server placement
 - ▶ Application Server Configuration Options
- **Tune your Runtime**
 - ▶ Workload Manager Controls
 - ▶ Java Tuning
 - ▶ System Monitors and Application Monitors
 - ▶ Isolating Performance Problems
- **Resources**
 - ▶ Tools
 - ▶ Documentation



Hardware Configuration

- **z990 provides superior performance**
 - ▶ Cycle speed, Super scalar, IEEE FP, Crypto, New hw instructions
- **zSeries Application Assist Processor (zAAP) reduces TCO**
- **More Storage required than traditional workloads**
 - ▶ Real storage (Paging is BAD!)
 - Default working set about 350 Mb per server region (256 Mb heap)
 - Minimum entry system 512 Mb (light load, sandbox)
 - Real world application, 1 Gb or more
- **Coupling Facility for production**
 - ▶ RRS Logstreams, RACF, Error logs, DB2
- **Cached DASD**
 - ▶ System Libraries, HFS
 - ▶ Application Data
- **OSA Express on zSeries 990**
 - ▶ Speeds up to 1GbEthernet with QDIO



Software Configuration - Latest Software Levels Perform Best:

■ WebSphere V5 vs. V4

- ▶ Up to 25% improved throughput with Ping Stateless Session Bean (TX req'd)
- ▶ Up to 50% improvement with "Ping Update CMP Integer" (TX Req'd)
- ▶ Improved scalability
- ▶ Reduced real storage requirements in common area

■ WebSphere V 5.0.2

- ▶ Dynamic Cache enhancements
- ▶ Deferred Write operations for EJB 2.0 CMPs
- ▶ Customizable PMI

■ WebSphere V 5.1

- ▶ EJB 2+, CMPs, AXIS, JMX, SubPool elimination

■ Java 1.3.1 SDK SR-20, 21, 22, 23, & 1.4.1

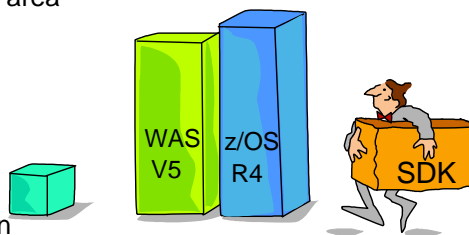
- ▶ JIT & GC performance enhancements

■ DB2 & JDBC Drivers

- ▶ See Info APARs II13299 (DB2) & II13309 (JDBC)

■ z/OS Release 4

- ▶ ICSF, XES (CFRM, DB2) performance enhancements

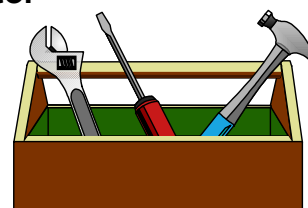


System Tuning

- | | |
|--|---|
| <ul style="list-style-type: none"> ■ z/OS or OS/390® ■ Workload Manager ■ UNIX System Services & HFS ■ TCP/IP ■ Language Environment (LE) ■ System Logger & RRS ■ Tracing & Logging | <ul style="list-style-type: none"> ■ Security & RACF® ■ Java ■ SMF ■ GRS ■ Library Search Order ■ Other . . . |
|--|---|

■ Performance Tuning guidance in the WebSphere Application Server V5.1 "InfoCenter"

- ▶ Performance and Troubleshooting sections
- ▶ "Performance Tuning and Monitoring" PDF



Tune for effective use of storage:

- **Need large servant regions** (set REGION=0M on proc)
 - ▶ **Biggest single affect on storage use**
 - Default SR heap (256 Mb requies ~350 meg)
 - Also affects GC time (server delays)
 - ▶ **Tune your Java heaps**
 - Default heap size = 128 Mb for controllers, 256 Mb for servants
 - See "Tuning the JVM Heap" (later)
 - ▶ **Tune LE heap size (app. server proc)**
 - HEAP(40M,5M)
 - ▶ **May have to control Maximum # of Servant Regions**
- **Define more auxiliary storage (Page packs)**
 - ▶ **Test systems with 512Mb (& lower) perform okay with good paging resources**
- **Put recommended libraries in LPA & LNKLST**
 - ▶ **In the configuration dialog, indicate they are in LNKLST/LPA**
 - ▶ **Put WebSphere libraries (SBBOLPA & SBBLOAD) into LPA if multiple cells**
 - ▶ **Put LE runtime library (CEE.SCEELPA) in your LPALSTxx concatenation**

UNIX System Services & HFS Tuning

- **Make sure you allow enough sockets**
 - ▶ Update BPXPRMxx parmlib member
 - Set MAXFILEPROC high enough
 - Impacts OMVS kernel storage, only set as high as needed
 - Applies to all USS user processes
 - Optionally, can set this at user level using RACF
 - Set MAXSOCKETS for the AF_INET filesystem high enough
 - At least as high as MAXFILEPROC
 - No major OMVS kernel storage impact
- **HFS (Hierarchical File System)**
 - ▶ Product HFS (/usr/lpp/WebSphere/...)
 - Mount Read/Only
 - ▶ Configuration HFS
 - Separate HFS for each node - **make sure it is owned by the right system** (if sharable)
 - Can be shared HFS for testing, Sharable for fail-over
 - ▶ File Caching
 - Use SMF 92 records for tuning
 - ▶ zFS
 - May improve performance

Security is not "free" but can be tuned . . .

- **WebSphere runs with security on by default**
 - ▶ Always collects and carries credential information
- **SAF classes can be enabled or disabled to control security**
 - ▶ Disabled SAF classes: negligible overhead
 - ▶ Enabled SAF classes: number of profiles in class will affect performance
- **Keep RACF classes and other info in memory**
 - ▶ RACLIST CBIND, EJBROLE, FACILITY, PTKDATA, SERVER, STARTED
 - ▶ Use VLF for ACEEs, GTS, and UID/GIDs
- **EJBROLE Class**
 - ▶ Only activate the EJBROLE class if you are using EJBROLES
 - ▶ More EJBROLES on a method will give you more access checks
- **Disable SAF calls for successful HFS accesses**
 - ▶ Define the BPX.SAFFASTPATH facility class
 - Don't use if you need to audit successful HFS accesses, or use the IRRSXT00 exit

Security - authentication options

- **Local (RACF) Userid and Password authentication**
 - ▶ Highly optimized, most efficient way to authenticate a user
- **SSL security authentication**
 - ▶ Requires Global Security
 - ▶ Use IBM @server™ zSeries™ hardware assists to improve performance on z/OS
 - Cryptographic coprocessors and PCI crypto cards
 - ▶ Reduce excessive SSL hand shakes for subsequent transactions in SSL sessions.
 - Set session timeout value high enough: `com_ibm_CSI_perform_ssl_sys_v3_timeout=`
 - Use the SID (SSL ID) for non-persistent sessions (e.g., .NETclients) & increase SID cache
 - *Activating zSeries Cryptographic Services for WebSphere Techdocs TD100745*
- **Global Security & other mechanisms ...**
 - ▶ J2EE - Role-based authentication
 - ▶ Java 2 - access to resources by applications
 - ▶ JAAS (Java Authentication & Authoriz'n Service) - RYO authentication & authorization
 - ▶ TAI (Trust Association Interceptors)- depends on what does your exit does
 - ▶ SSO (Single Sign On) - LTPA or ICSF - credentials in cookies
 - ▶ Performance implications vary depending on specific implementations

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Server Topology Decisions

- **Client location**
 - ▶ Remote vs. Local
- **Server(s) location**
 - ▶ Number & Configuration
- **Web Tier**
 - ▶ Cache static objects
 - ▶ Firewalls for DMZ
 - ▶ Authentication
- **HTTP servers**
 - ▶ HTTP vs. IIOP
 - ▶ Reverse Proxies
 - ▶ Use HTTP transport
- **DNS**
- **D-VIPA (Sysplex Distributer)**
- **Database servers**

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Optimize application object flows

Deploy related applications in the same server:

1. Avoid application calls from one system to another
2. Provide a local replica of any required application server.
3. Deploy applications in the same server, because local calls are even faster.

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Reduce unnecessary IIOF Flows

The diagram illustrates the flow of IIOF (Inter-ORB Invocation) between different components. A "Thin" Client (browser) connects to a Web Tier (HTTP Server) via HTTP. The Web Tier then connects to an EJB Server in z/OS via IIOF. A "Thick" Java Client connects to a WAS Server in z/OS via IIOF. The WAS Server then connects to the EJB Server via IIOF. The WAS Server contains a CR (Container Resource) and SR (Servlets, JSPs, EJBs). The EJB Server contains a CR and SR (EJBs).

- ▶ Avoid IIOF calls from one system to another
 - ▶ Serialization/deserialization overhead can be excessive!
- ▶ Use the 'pass by reference' check box via the admin console as follow:
 - ▶ Servers->Application Servers->your_app_server->Orb Service; check 'pass by reference'


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WebSphere Application Server 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

The diagram shows three configurations:

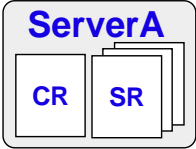
- MVS TEST:** A single Base Application Server with Daemon, Server, CR, and SR components.
- MVS SYSA and MVS SYSB:** Network Deployment configurations. Each has a Daemon, Dep.Mgr, and Node Agent. MVS SYSA has Server1A and Server2A. MVS SYSB has Server1B and Server2B. Server1A and Server1B are grouped into Cluster1. Server2A and Server2B are grouped into Cluster2. Each server contains CR and SR components.

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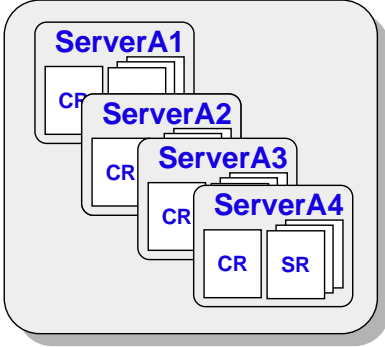
WAS for z/OS implements two layers of clustering:


- ▶ **Inner cluster - Server Instance**
 - Controller region - communication endpoint (HTTP, IIOF, 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.
- ▶ **Cell consists of one or more clusters.**
 - Confined to one Parallel Sysplex

Application Server:

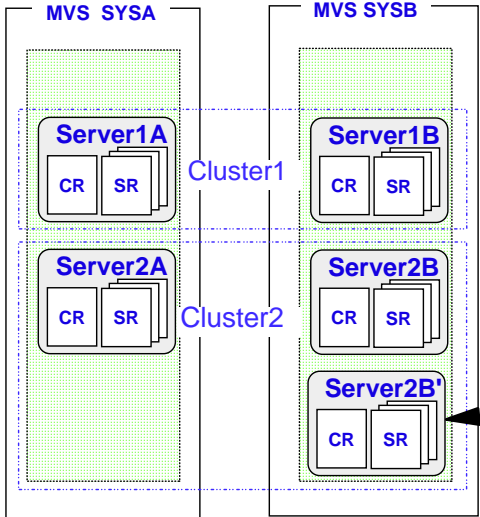


Server Cluster with 4 members:



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Clustered Servers



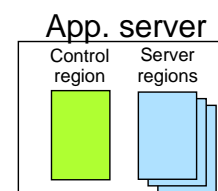
- ▶ **Multiple instances of the same application server:**
 - ▶ Increases Availability:
 - ▶ Remove single point of failure
 - ▶ Allows rolling updates.
 - ▶ Can improve performance
 - ▶ On multiple systems (horizontal scaling)
- ▶ **However:**
 - ▶ Multiple instances on the same system normally won't improve performance.

connectionFactory caching for J2C Connections

- **Exploit connectionFactory caching**
 - ▶ New J2C preference setting for Business Integration that will generate code so the JNDI lookup for the J2C connection factory will be cached in the generated service proxy and EJB.
 - ▶ The J2C resource adapter has to be enabled to get this support; IMS™ and CICS® ECI services takes advantage of this performance improvement.
- **New setting with WAS 5.1**
 - ▶ Requires CTG 5.1 & IMS 2.2.0.
 - ▶ Requires an updated WSIF(Web Services Invocation Framework) - J2C runtime.
- **Specify in WSAD-IE 5.1:**
 - ▶ Select Window->Preferences
 - ▶ Select Business Integration -> J2C
 - ▶ Select check box for caching J2C ConnectionFactory

Replication - Managing the Number of Servant Regions

- **Adminconsole: Appl. Server >> "Server Instances"**
 - ▶ **Check "Multiple Instances Enabled"**
 - Otherwise, WLM will only start 1 servant region for this application server
 - If not checked, and Min/Max > 1, HTTP ports are not opened (bug?)
 - ▶ **"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 start-up or if you have limited real storage . . .
 - ▶ **WLM Static Application Environments not used if DAE APAR OW54622 applied**
- **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.**
 - ▶ **Remember to account for the default CB-type service class and enclaves that may originate outside WebSphere servers and are classified by other classification rules such as the IBM HTTP Server (IHS).**

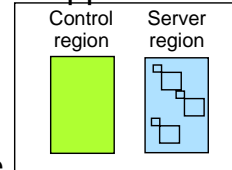


Managing the # of Threads

■ Workload Profile in adminconsole:

- ▶ Servers >> Application Servers >> server_name >> ORB Service >> Advanced Settings >> "Workload Profile"
 - ISOLATE (1 thread)
 - NORMAL (3 threads)
 - CPUBOUND (# of CPs, minimum of 3)
 - IOBOUND (Number of CPs*3, Min=5, Max=30)
 - LONGWAIT (40)
 - Can be over-riden with variable: `private_bboo_longwait_override`
- ▶ 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
- ▶ You may have to experiment with these values and the number of servant regions to optimize your performance.
 - Too many servant regions take excessive storage
 - Too many threads in a JVM creates interference & more frequent GC.

App. server



Classifying Work with WLM

- Started Tasks
- OMVS work
- Transactions (changes with WAS 5.1)
 - ▶ CB work
 - ▶ IWEB (IHS)
 - ▶ Differentiation by URL
 - ▶ MDBs
 - ▶ Network QoS
- Resource managers:
 - ▶ DB2
 - ▶ CICS
 - ▶ IMS
 - ▶ MQ
 - ▶ other

WLM Subsystem Type Selection List for Rules			
Action	Type	Description	Default Service
—	CB	CB Class'n w/WLM Trans. CLASSES	CBCLASS
—	CICS	Use Modify to enter YOUR rules	
—	DB2	Use Modify to enter YOUR rules	
—	DDF	Use Modify to enter YOUR rules	DB_DDF
—	IMS	Use Modify to enter YOUR rules	
—	IWEB	IWEB rules	IWEBFAST
—	JES	Batch Classification Rule	BAT_MED
—	OMVS	E_Biz Classification Rule	EBIZ_DEF
—	STC	Started Task Classification Rule	OPS_DEF
—	TSO	TSO Classification Rule	TSO_DEF

WLM - Classifying WebSphere Address Spaces

- **Control Regions** (Daemon, Node Agent, Deployment Manager, App. Servers)
 - ▶ Classify as SYSSTC or high velocity
- **Application Server Regions**
 - ▶ Classify with velocity goal, high enough to get started quickly
 - Work is actually classified under the application environment

- **Sample STC Classification Rules:**

- ▶ Use Report Classes to track important Started Tasks:

#	Qualifier type	Qualifier name	Starting position	Service Class	Report Class
1	TN	WSAPP1C		OPS_HI	RWSAPP1C
1	TN	WSAPP1S		OPS_MED	RWSAPP1S
1	TN	WS%%C		OPS_HI	RWSCTLRG
1	TN	WS%%S		OPS_MED	RWSSVRRG

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

Controller start-up Procedure with WAS V.5.0.1:

- **Additional step added to Contol Region Proc:**

- APPLY step - applyPTF.sh checks to see if service has been applied to WebSphere and run the "update files" for the new service.
- Output written to .../properties/service/logs/applyPTF.out'
- Classify server controller jobnames with WLM OMVS Classification rules.
- Performance of apply step improved in V.5.0.2

```
//WSACR PROC ENV=,PARMS=' ',Z=WSACRZ
// SET ROOT='/wasv5config/wscell'
// SET FOUT='properties/service/logs/applyPTF.out'
//APPLY EXEC PGM=BPXBATCH,REGION=0M,PARM=...
//STDOUT DD PATH='&ROOT./&ENV..HOME/&FOUT.',PATHOPTS=...
//STDERR DD PATH='&ROOT./&ENV..HOME/&FOUT.',PATHOPTS=...
//*
//BBOCTL EXEC PGM=BBOCTL,COND=(8,EQ),REGION=0M,TIME=MAXIMUM,...
//BBOENV DD PATH='&ROOT/&ENV/was.env'
// INCLUDE MEMBER=&Z
```

- **OMVS Classification rules - see Flash10243**

Type	Qualifier Name	Start	Service	Report
1	TN	T5*	EBIZ_DEF	RPTACR
1	TN	WS*	EBIZ_HI	RPTACR

WLM - Classifying WebSphere Transactions

- **Subsystem type = CB using the following criteria:**
 - ▶ **Server name (CN)**
 - ▶ **Server instance name (SI)** - not useful because instances share work
 - ▶ **Userid assigned to the transaction (UI)** - usually not useful
 - ▶ **Transaction class (TC)** - assigned from env. vars or a "URI mapping file":
 - server > Adv.Settings > Transaction Class Mapping => protocol_http_transport_class_mapping_file= (points to HFS file - see next foil)
- **Percentage response time goal is recommended**
 - ▶ Ex. 80% of trans less than 0.5 seconds (or high velocity default service class)
 - ▶ Avoid multi-period Goals - 2nd & subsequent periods are not aggressively managed.
 - ▶ 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 .
 - ▶ Control region maintains "internal queues" based on the service class:
 - A server region may switch queues if needed to, based on demand

HTTP Classification by Virtual host, Port, or URI example (old format before WAS 5.1):

Transaction Class Mapping file format:

```

TransClassMap <host>:<port> <uritemplate> <tclass>
TransClassMap www.ibm.com:80 /Webap1/myservlet TCLASS1
TransClassMap www.ibm.com:* /Webap1/myservlet TCLASS2
TransClassMap *:443 * * TCLASS3
TransClassMap *:* /Webap1/myservlet TCLASS4
TransClassMap www.ibm.com:* /Webap5/* TCLASS5
TransClassMap * * * TCLASS6
  
```

CB Classification Rules:

Qualifier #	Qualifier type	Qualifier name	Start position	Service Class	Report Class
Default:					
				CBMED	RCBDEFLT
1	CN	WSPROD	1	CBMED	RWSPROD
2	. TC	. TCLASS1		CBFAST	RWSPRD1
2	. TC	. TCLASS2		CBMED	RWSPRD2
2	. TC	. TCLASS5		CBSLOW	RWSPRD5
1	CN	WSTEST	1	CBSLOW	RTSTEST
2	. TC	. TCLASS5		CBSLOW	RTSTST5

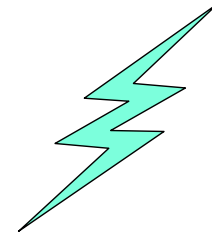
Examples:

- a. `www.ibm.com:80/Webap1/myservlet => TCLASS1 => CBFAST (RWSPRD1)`
 b. `www.ibm.com:443/Webap1/xservlet => TCLASS2 => CBMED (RWSPRD2)`

Classifying Network QoS

■ Network Quality of Service (QoS)

- ▶ Appl. Server >> WebContainer >> Adv. Settings >> Network QoS
 - HOST - host name or IP address
 - URI - part of the URL after host (& port)
 - HOSTURI - combination of host and URI
 - TCLASS - use a transaction class mapping file (see below)
- ▶ Sets variable `protocol_http_transport_network_qos`
- ▶ For `...qos=TCLASS`, specify a "Transaction Class Mapping" file.
 - `protocol_http_transport_class_mapping_file = /...`
- ▶ Communication server PolicyRule classifies work based on
 - `ibm-ApplicationData = /account/order.html`
- ▶ Routers must be able to identify QoS Type of Service (ToS)



WLM - Classifying Message Driven Beans (MDBs)

■ WLM Transaction Class based on:

- ▶ Listener Port (Endpoint), and/or
- ▶ Message Selector (XML tags) . . .

■ Adminconsole: Environment >> Manage WebSphere Variables

`endpoint_config_file=.../MDBClassMap.xml`

```
<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE InboundClassification SYSTEM "InboundClassification.dtd">
<InboundClassification type="mdb" version="1.0">
  <endpoint type="messagelistenerport"
    name="IVPListenerPort"
    defaultclassification="MDBX">
    <classificationentry selector="Customer='Good' "
      classification="MDB1"/>
    <classificationentry selector="Customer='Bad' "
      classification="MDB2"/>
    <classificationentry selector="Customer='Ugly' "
      classification="MDB3"/>
  </endpoint>
</InboundClassification>
```

See Techdocs article [WP100387 "WLM Classification of MDBs"](#)

WLM Classification of Work Requests in WAS 5.1

- **New with WAS V5.1 service level W510200 (refresh PTF)**
- **Workload Classification document: common .xml file for transaction classification (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 supercedes old MDB classification file.
 - ▶ 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.
- **See Techdocs article WP100449**

```
<?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"
      description="Sample20 EJB Classification">
    <iiop_classification_info transaction_class=""
```

Displaying WLM Classification of Work Requests

- **MVS oper command: F <server>,DISPLAY,WORK,CLINFO**

```
F X5SR02A,DISPLAY,WORK,CLINFO
BBOO0277I CLASSIFICATION COUNTERS FOR IIOP WORK
BBOO0278I CHECKED 14, MATCHED 14, USED 0, COST 0, DESC: IIOP Default
BBOO0278I CHECKED 14, MATCHED 3, USED 0, COST 0, DESC: sample
BBOO0278I CHECKED 3, MATCHED 1, USED 1, COST 3, DESC: a1a
BBOO0278I CHECKED 2, MATCHED 1, USED 1, COST 4, DESC: a1b
BBOO0278I CHECKED 1, MATCHED 1, USED 1, COST 5, DESC: a1c
BBOO0278I CHECKED 11, MATCHED 11, USED 0, COST 0, DESC: other
...
BBOO0279I FOR IIOP WORK: TOTAL CLASSIFIED 14, WEIGHTED TOTAL COST 95
BBOO0277I CLASSIFICATION COUNTERS FOR HTTP WORK
BBOO0278I CHECKED 0, MATCHED 0, USED 0, COST 0, DESC: HTTP Default
BBOO0278I CHECKED 0, MATCHED 0, USED 0, COST 0, DESC: n
...
BBOO0279I FOR HTTP WORK: TOTAL CLASSIFIED 0, WEIGHTED TOTAL COST 0
BBOO0188I END OF OUTPUT FOR COMMAND DISPLAY,WORK,CLINFO
```

Java Tuning

- **Java level is reported in servant region joblog**
 - ▶ Keep current with the latest SDK
 - ▶ This also indicates if the JIT is enabled or not
- **Make sure the JIT is enabled**
 - ▶ Ensure that Disable JIT is not selected in JVM for each server.
 - ▶ Number of references (or loop iterations) before keeping JITed code in LE Heap:
 - IBM_MIXED_MODE_THRESHOLD=nnnn
(default = 2000 for 131 SDK; 800-1107 for 141 SDK)
- **Turn off JRAS debugging support**
 - ▶ Turn off in adminconsole - Set com.ibm.*=all=disable
 - Note: you may be tracing and not know it if TRACEBUFFLOC=BUFFER
 - Verify by looking in SYSOUT dataset
- **Do not use the debug version of Java**
- **Make your CLASSPATH more efficient**
 - ▶ Make sure you only point to classes you need
 - ▶ Put frequently referenced classes first
- **Other tips:** www.ibm.com/servers/eserver/zseries/software/java/

New zSeries Application Assist Processor (or zAAP)

New specialty assist processor dedicated exclusively to execution of Java workloads under z/OS® – e.g. WebSphere®

- Available on IBM z990 & z890, & future zSeries servers only
- Used by workloads with Java cycles: WAS 5.1, CICS® /TS 2.3, IMS™ V8 ,DB2®
 - Executes Java code with no changes to applications
- Priced significantly below General Purpose CPs.
- Up to 1 zAAP per general purpose processor in an LPAR
- Prerequisites:
 - z/OS 1.6 (or z/OS.e 1.6)
 - IBM SDK for z/OS, Java 2 Technology Edition, V1.4* with PTFs UQ88783, UQ90449...
 - Processor Resource/Systems Manager™ (PR/SM) must be enabled.
- Traditional IBM zSeries software charges unaffected
- Sub-capacity eligible IBM software charges can be reduced
- zAAP feature available now; software planned for Sept. 24th, 2004 w/ z/OS 1.6

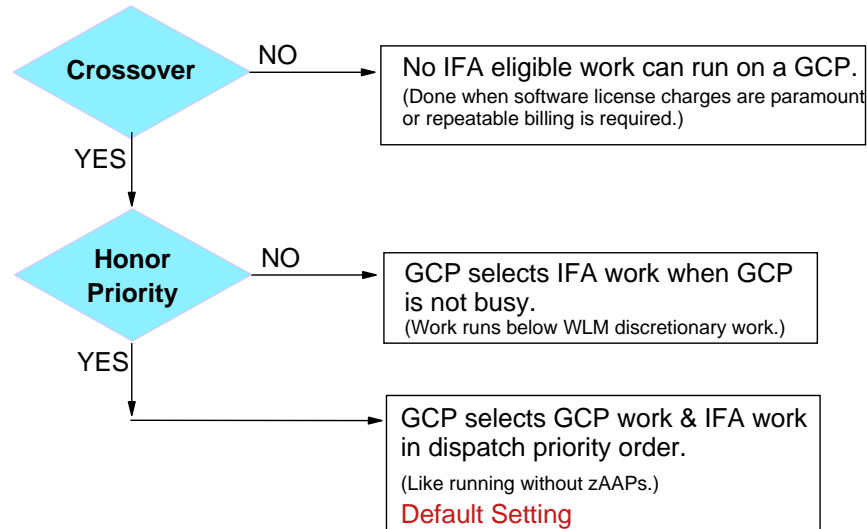
Objective: Enable integration of new Java based Web applications with core z/OS backend database environment for high performance, reliability, availability, security, and lower total cost of ownership

Always use zAAPs or not...?

■ New SYS1.PARMLIB(IEAOPTxx) Options

- ▶ IFACROSSOVER = YES | NO
- ▶ IFAHONORPRIORITY = YES | NO

GCP - General Purpose CP
IFA - zAAP CP



zAAP Planning, Tuning & Monitoring Considerations

- **CROSSOVER=NO can inhibit WebSphere Applications**
 - ▶ Make certain you have enough zAAP CPs, or Java apps can be delayed, or "hang"
- **Performance note:**
 - ▶ Excessive switching "java eligible" states can increase overhead.
- **Monitoring CPU (GCP & zAAP) Utilization**
 - ▶ SMF Type 72/79 records
 - ▶ RMF Workload Activity Report and RMF Monitor III
 - ▶ SDSF shows total CPU% for all processor types
- **For z890 processors, zAAP processors run at "full speed"**
 - ▶ zAAPs and GCPs may run at different speeds
 - ▶ Requires certain SMF data to be normalized to get correct capacity information
- **zAAP Projection Tool for Java 2 Technology Edition, SDK 1.3.1**
 - ▶ Runs in test environment (with WAS V5 or V4)
 - ▶ Useful in predicting number of zAAPs necessary for optimum configuration
 - ▶ Gathers usage information on % of Java in your workloads that could execute on zAAP
 - ▶ Available with Excel Workbook - See Techdocs WP100417, WP100431 & PRS929
- **See earlier sessions on zAAPs (Oct. 6th)**

New JVM Perf Option - Mapping jar files in memory

■ JAVA_MMAP_MAXSIZE=n

- ▶ Specifies the maximum-sized jar files (in MB) that will be memory mapped.
- ▶ Available in Java SDK 1.3.1 (SR17+) & 1.4.1
- ▶ The default is 0; that is, memory mapping is not used.
- ▶ Jar files 'n' meg or smaller will be accessed using a memory mapped file
- ▶ Restrictions: no NFS
- ▶ Make sure your region size (available private area) is large to fit the Java heap & all jar files in your classpath which fall under the max size criteria.
- ▶ Leave a little extra memory for other Java storage allocations which do not come from the Java Heap.
- ▶ Observed performance gain with JSPs: 5x ET, 3X CPUtime using JAVA_MMAP_MAXSIZE=20

Tuning your Java heap: Collect verboseGC statistics

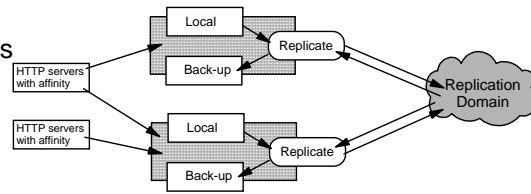
```
<AF[21]: Allocation Failure. need 32784 bytes, 32225 ms since last AF>
<AF[21]: managing allocation failure, action=1 (84320/131004928) (3145728/3145728)>
<GC(21): GC cycle started Wed Feb 27 22:46:11 2002
<GC(21): freed 99587928 bytes, 76 % free (102817976/134150656), in 118 ms>
<GC(21): mark: 103 ms, sweep: 15 ms, compact: 0 ms>
<GC(21): refs: soft 0 (age >= 32), weak 0, final 878, phantom 0>
<AF[21]: completed in 118 ms>
. . .
```

- ▶ Adminconsole: Server >> Process >> Servant >> JVM >> check "GC Verbose"
- ▶ Results appear in server region's //SYSOUT DD file
 - Don't specify JVM LOGFILE or output from multiple SRs will be meaningless.
- ▶ Key value: % free storage after each GC: **XX** % free
 - Run for a long time to make sure your application does not have a memory leak.
- ▶ Key value: allocated heap after each GC: free (XXXXXXXX/YYYYYYYY)
 - Steady state, this is your base Java heap requirement
 - Add some head room, perhaps 64meg - 128meg, to select max heap size
 - ◆ JVM_HEAPSIZE=xxx (XXXXXXXX + 64meg)
 - Normally it's best to set JVM_MINHEAPSIZE=JVM_HEAPSIZE
- ▶ Key value: % elapsed time spent in GC
 - ("completed in **XXX** ms" / "**YYYY** ms since last AF") < 2% ==> Heapsize is OK
- ▶ See TD101216 Tracing and Analyzing Java Garbage Collection... on Techdocs

Tuning HTTP Session Management

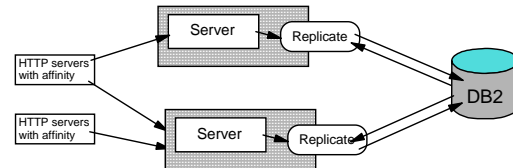
■ Memory-to-memory Session Replication

- ▶ Peer-to-peer with a local replicator
- ▶ Peer-to-peer with remote/isolated replicators
- ▶ Client/server with remote replicators
- ▶ Client/server with isolated replicators
 - (Session count, timeout, overflow)



■ Database Session persistence

- ▶ Several DB2 Tuning options:
 - Tablespace size & page sizes
 - Database & Multirow Schema settings



■ Replication Tuning Levels

- Very high - Only updated attribs, every 300 secs (optimized for performance)
- High - All attribs, every 300 secs
- Medium - Updated attribs, end of servlet
- Low - All attribs, end of servlet (optimized for failover)
- Custom - All attribs, every 10 secs

Tuning Session Management *(continued)*

■ Best practices for using HTTP Sessions (InfoCenter)

- ▶ Enable Security integration for securing HTTP sessions (use HTTPS)
- ▶ Release HttpSession objects w/ `javax.servlet.http.HttpSession.invalidate()` when finished.
- ▶ Avoid trying to save and reuse the HttpSession object outside of each servlet or JSP file.
- ▶ Implement `java.io.Serializable` interface for new objects to be stored in the HTTP session.
- ▶ The HttpSession API does not dictate transactional behavior for sessions. (Use EJBs.)
- ▶ Ensure the Java objects you add to a session are in the correct class path.
- ▶ Avoid storing large object graphs in the HttpSession object.
- ▶ Utilize Session Affinity to help achieve higher cache hits in the WebSphere App. Server.
- ▶ Maximize use of session affinity and avoid breaking affinity.
- ▶ Secure all of the pages (not just some) when applying security to servlets or JSP files that use sessions with security integration enabled, .
- ▶ Use manual update and either the `sync()` method or time-based write in applications that read session data, and update infrequently.
- ▶ Use EJB session beans to access EJB entity beans

Stolen from Bob St. John's session 2566 - Tues. @ 9:30
 ♣ "Performance Monitoring and Debugging for WebSphere V5 on z/OS"

Set performance expectations for your WAS applications

- **IBM rep. request pre-sale capacity sizing estimate from Techline**
 - ▶ Fairly detailed input required
 - ▶ Estimate is rough
- **Use a client emulator program to test your application**
 - ▶ Determine your CPU cost per transaction
 - ▶ Determine your application environment response time
 - ▶ Determine your client response time (in a measurement environment)
- **After your application goes into production**
 - ▶ Keep key historical data for the WAS application environment
 - Transaction rate, response time, 90% resp time, appl %
 - ▶ Keep key historical data for WAS servant region proc
 - appl %
- **WAS application monitors can help with keeping historical data and with detecting problems**

Performance Monitoring and Debugging

See Bob St. John's session 2566 - Tues. @ 9:30
 ♣ "Performance Monitoring and Debugging for WebSphere V5 on z/OS"

- **CPU resources**
 - ▶ Understand where the CPU time is spent & how to measure/account for it
- **Performance Monitors**
 - ▶ There are many from IBM and other vendors
- **Performance Problem Determination**
 - ▶ Response time delays
 - ▶ CPU delays
 - ▶ Memory usage

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Where is CPU Time Accounted?

- **Controller Region**
 - ▶ Communications End-point: Receives IIO/HTTP/SSL request
 - ▶ Classifies & Queues Request to WLM queue
 - WLM then . . .
 - Manages queued requests
 - Starts/stops Servant Regions as necessary
 - Monitors system resources
 - Manages to installation goals
- **Servant Region**
 - ▶ Selects work from WLM for a given Service Class
 - ▶ Java Garbage Collection
 - ▶ JNI calls
- **Enclaves**
 - ▶ J2EE Application code executes under an enclave (in JVM)
 - ▶ Use SDSF ENClaves panel, or RMF Monitor to display

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RMF Monitor 1 Workload Activity Report

- **Transactions/second**
 - ▶ $AVG=MPL=AVG\ ENC = \# \text{ of enclaves in the period}$
- **Response times**
 - ▶ Actual R.T. \approx Execution R.T. (includes time waiting on WLM queue)
 - ▶ No delays of interest (yet)
- **CPU & Service Rates**
 - ▶ CPU service units, & Service/Sec.
 - ▶ $TCB / ENDED = \text{Mips/Tran.}$
 - ▶ $APPL\% = \# \text{ of engines (CPs) required to drive the work in the service (report) class}$
- **Delays**
 - ▶ QMPL means waiting for Servant Region (WLM)

```

REPORT BY: ... REPORTCLASS=RWSCTLRG - Control Region
TRANSACTIONS  TRANS.-TIME  SS.TTT  ---SERVICE--  --SERVICE RATES--
AVG  1.00  ACTUAL  0  IOC  0  ABSRPTN  89615
MPL  1.00  EXECUTION  0  CPU  522567  TRX SERV  89615
ENDED  0  QUEUED  0  MSO  10159K  TCB  39.9
END/S  0.00  R/S AFFINITY  0  SRB  61728  SRB  4.7
#SWAPS  0  INELIGIBLE  0  TOT  10743K  RCT  0.0
EXCTD  0  CONVERSION  0  /SEC  89630  IIT  0.0
AVG ENC  0.00  STD DEV  0  HST  0.0
REM ENC  0.00  APPL %  37.2

REPORT BY: ... REPORTCLASS=RWSRVRG - Server Regions
TRANSACTIONS  TRANS.-TIME  SS.TTT  ---SERVICE--  --SERVICE RATES--
AVG  2.00  ACTUAL  0  IOC  0  ABSRPTN  122075
MPL  2.00  EXECUTION  0  CPU  143957  TRX SERV  122075
ENDED  0  QUEUED  0  MSO  29113K  TCB  11.0
END/S  0.00  R/S AFFINITY  0  SRB  12460  SRB  1.0
#SWAPS  0  INELIGIBLE  0  TOT  29270K  RCT  0.0
EXCTD  0  CONVERSION  0  /SEC  244192  IIT  0.0
AVG ENC  0.00  STD DEV  0  HST  0.0
REM ENC  0.00  APPL %  10.0


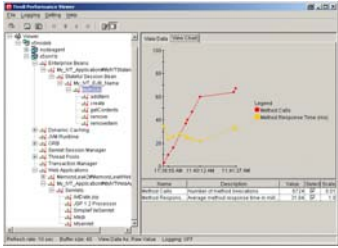
REPORT BY: ... REPORTCLASS=RWSAP1ENC - WebSphere Enclaves (Transactions)
TRANSACTIONS  TRANS.-TIME  SS.TTT  ---SERVICE--  --SERVICE RATES--
AVG  241.52  ACTUAL  276  IOC  0  ABSRPTN  115
MPL  241.52  EXECUTION  272  CPU  3343K  TRX SERV  115
ENDED  106717  QUEUED  4  MSO  6  TCB  255.5
END/S  890.32  R/S AFFINITY  0  SRB  0  SRB  0.0
#SWAPS  0  INELIGIBLE  0  TOT  3343K  RCT  0.0
EXCTD  0  CONVERSION  0  /SEC  17  IIT  0.0
AV ENC  241.52  STD DEV  66  HST  0.0
REM ENC  0.00  APPL %  212.9

EX  PERF  AVG  --USING%--  ----- EXECUTION DELAYS % -----
VEL  INDX  ADRSP  CPU  I/O  TOTAL  CPU  QMPL
GOAL  40.0%
ACTUALS  45.3%  .89  13.4  0.1  0.0  36.1  23.3  12.6
    
```

PERFWS300

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Performance Monitoring and Management Solutions

- **IBM:** Tivoli Performance Viewer (shipped with WAS V5)
- **Tivoli:** IBM Tivoli Monitoring for Transaction Performance, and IBM Tivoli Monitoring for Web Infrastructure - www.ibm.com/tivoli
- **IBM/Candle:** PathWAI(TM) Monitor for WebSphere Application Server - www.candle.com
- **IBM/Cyanea:** Cyanea/One, WSAM - www.cyanea.com
- **Wily Technology:** Introscope® - www.wilytech.com
- **BMC Software:** MAINVIEW® for WebSphere Application Server - www.bmc.com
- **Quest Software:** PerformaSure (& JProbe) - www.quest.com
- **& many others**
 - ▶ WebSphere Performance Management Business Partner Solution Finder: http://www.ibm.com/software/webservers/pw/dhtml/wsperformance/performance_bpsolutions.html

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Tivoli® Decision Support for OS/390®

- **Another SMF reporting tool**
 - ▶ Tivoli Decision Support for OS/390 + "System Performance Feature"
 - ▶ Version 1.6 - Program Number 5695-101
 - ▶ aka Performance Reporter (PR) for MVS, SLR, EPDM
- **Two basic functions:**
 - ▶ Collecting systems management data into a DB2 database from SMF
 - Including WebSphere Application Server V5 for z/OS
 - ▶ Data Reporting: Generates graphic & tabular reports from its DB2 database.

	A	B	C	D	E	F	G	H	I
	TIME	Bean Name	METHOD NAME	Method Calls	Resp_time (Av)	Resp_time (Max)	CPU_SEC (Av)	CPU_SEC (Min)	CPU_SEC (Max)
1	1:42 PM	rTestCase4SB	getInfo:java.lang.String,int	4,307	0.446	7.487	0.073	0.002	1.867
2	1:42 PM	QueryMgrBean	getCommDevices:com.dhl.network.cust	148,786	0.007	0.512	0.003	0.000	0.109
3	1:42 PM	rTestCase1SB	getInfo:java.lang.String,int	6,995	0.266	4.670	0.036	0.002	1.211
4	1:42 PM	rTestCase2SB	getInfo:java.lang.String,int	16,685	0.065	0.466	0.013	0.001	0.047
5	1:42 PM	rTestCase7SB	getInfo:java.lang.String	1,588	0.051	0.741	0.017	0.002	0.231
6	1:42 PM	rTestCase3SB	getInfo:java.lang.String,java.lang.	16,715	0.065	0.677	0.013	0.002	0.212
7	1:42 PM	rTestCase6SB	getInfo:java.lang.String,java.lang.	14,103	0.024	0.404	0.002	0.002	0.033
8	1:42 PM	rTestCase5SB	getInfo:java.lang.String,int	6,952	0.037	0.448	0.007	0.001	0.037
9	1:42 PM	QueryMgrBean	getContacts:com.dhl.network.custome	148,786	0.006	0.625	0.001	0.000	0.202
10	1:42 PM	QueryMgrBean	getAddressesFirst:com.dhl.network.c	76,783	0.022	0.523	0.002	0.000	0.188
11	1:42 PM	QueryMgrBean	getAccountBillingDetailsByBusinessI	12,920	0.004	0.246	0.002	0.001	0.033
12	1:42 PM	QueryMgrBean	getAccounts:com.dhl.network.custome	53,104	0.046	1.587	0.004	0.001	0.197
13	1:42 PM	QueryMgrBean	getCustomerAgreements:com.dhl.netwo	6,952	0.012	0.161	0.002	0.001	0.002
14	1:42 PM	QueryMgrBean	getAccountAssignedToAgreementByBus	14,103	0.021	0.404	0.002	0.002	0.026
15				461,434					
16				3,845	per second				
17									

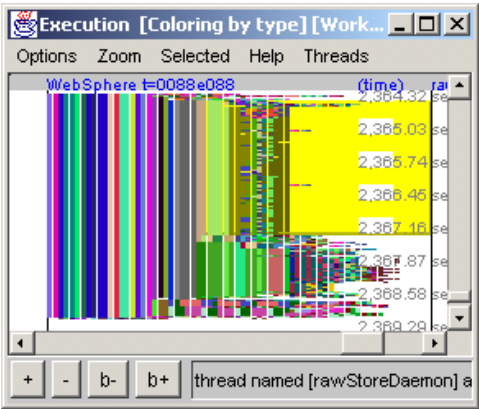
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Isolating problems

Zero in:
Right tool for
the problem?

- **Memory leaks**
 - ▶ VerboseGC
 - ▶ Tivoli Performance Viewer (shipped with WAS 5.0.1 for z/OS)
 - ▶ JInsight (IBM Alphaworks) - www.alphaworks.ibm.com/formula/jinsight
 - ▶ WSAD Profiling
 - ▶ WebSphere Application Monitor (WSAM - Cyanea/One)
 - ▶ JProbe (Quest) - www.quest.com/jprobe/
 - ▶ others . . .

- **Time spent & Delays:**
 - ▶ WSAD Profiling
 - ▶ JInsight
 - ▶ JProbe
 - ▶ WSAM
 - ▶ Wily Introscope
 - ▶ SMF, others . . .



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Isolating problems

Zero in:
Right tool for
the problem?

- **Time spent & CPU activity at method level:**
 - ▶ WSAM, and other application monitors
 - ▶ SMF 120 data (turn on activity records only for diagnostics)
 - General viewer: www.ibm.com/software/webservers/appserv/zos_os390/ - "Trials & Betas"
 - Summary viewer: See PRS752 "Performance Summary Report for SMF 120 ..." on Techdocs

```

WSC SMF 120 Performance Summary V500 Date: Thu Oct 31 12:00:02 EDT 2003 SysID: SYSD
- record subtypes: 1:Svr_Act. 3:Svr_Int. 5:EJB_Act. 6:EJB_Int. 7:Web_Act. 8:Web_Int.
SMF -Record Time Server Bean/WebAppName # of El.Time(mSec) WLM_Encl_CPU_Time(uSec)
Numbr -Type hh:mm:ss Instance Method/Servlet Calls Avg Max Avg. Max. Min
1-----1-----2-----3-----4-----5-----6-----7-----8-----9-----0-----
359 120.6 19:00:02 T5SRV1 MY_IVT_ApplicationMyIVTStatelessSession.jar
    remove: 5 1 2 758 1472 378
    getContent: 5 0 0 304 338 283
    create: 5 15 65 11177 31661 911
    removeItem: java.lang.String 5 0 1 355 391 300
    addItem: java.lang.String 15 0 0 330 609 284
360 120.8 19:00:02 T5SRV1
    ivtservlet 3 1 1 845 1202 650
    ivtejb 3 115 301 62691 146527 18265
    SimpleFileServlet 29 33 314 2544 18659 1712
    JSP 1.2 Processor 3 4041 12095 1414156 4234288 3747
    /ivtDate.jsp 3 141 420 60952 179122 1587
My_IVT_Application#MyIVTWebApp.war
    
```

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Isolating CPU problems

Zero in:
Right tool for
the problem?

- **CPU usage at the detailed level:**
 - ▶ SMF 120 records provide CPU usage at the method level
 - ▶ CPU Time service (WSC program) can be used for your own detailed measurements
 - See PRS621 "CPU Time-used function for Java applications on z/OS" on Techdocs
 - See TD101339 "How-to find CPPU TimeUsed in your WAS V5 for z/OS"
 - ▶ WAS V5 has method **SmfJActivity.obtainTotalCpuTimeUsed()** in pmi.jar

```
import com.ibm.ws390.sm.smf.SmfJActivity;
...
    long startTime;
    long stopTime;
    long cpuTime;
    startTime = SmfJActivity.obtainTotalCpuTimeUsed();

    < main Java code or method calls here >

    stopTime = SmfJActivity.obtainTotalCpuTimeUsed();
    cpuTime = stopTime - startTime;
    System.out.println("CPU Time: " + cpuTime + " microseconds");
...
```

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Isolating problems - Delays

Zero in:
Right tool for
the problem?

- **WLM Delay Monitoring States:**
 - 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

* Added w/ APARs for WLM OW51848 & RMF OW52227

RMF V1R2 Work Manager Delays - WLMGL - Workload Activity Report

		RESP	STATE SAMPLES BREAKDOWN (%)						STATE		
SUB	P	TIME	--ACTIVE--	READY	IDLE	-----WAITING FOR-----			SWITCHED SAMPL(%)		
TYPE		(%)	SUB	APPL		TYP4	REGT	LOCL	LOCAL	SYSPL	REMO
CB	BTE	0.0	26.9	0.0	0.0	65.4	3.8	3.8	0.0	0.0	0.0
CB	EXE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adds up to 100%

	EX	PERF	AVG	--USING%--		----- EXECUTION DELAYS % -----		
GOAL	VEL	INDX	ADRSP	CPU	I/O	TOTAL	CPU	QMPL
ACTUALS	45.3%	.89	13.4	0.1	0.0	36.1	23.5	12.6

More Tools . . .

■ Workload simulators

- ▶ WebSphere Studio Workload Simulator
 - www.ibm.com/software/awdtools/studioworkloadsimulator/
- ▶ MS WASTress Tool - www.microsoft.com/technet/default.mspx
 - TechNet Home > IT Solutions > Intranet > Downloads
- ▶ Loadrunner - www.mercuryinteractive.com
- ▶ Silk - www.seguc.com
- ▶ Web Performance Tool (aka WPT, AKStress)
 - <http://www.alphaworks.ibm.com/tech/wptools>

■ Java tools

- ▶ Javdump formatters - see IBM SDK, Java™ 1.3.1 Diagnostics Guide
- ▶ GC awk script - see TD101216 on Techdocs

■ HTTP sniffers

- ▶ tcpmon - org.apache.axis.utils

■ MVS Sysprog tools

- ▶ MXI - <http://www.mximvs.com/>

Some Benchmark Experiences

The best tuned system cannot fix a bad application

■ Java Heap required by application

- ▶ Use JVM Verbose GC reports for information
- ▶ Application requires much larger JVM heap
- ▶ Application has a memory leak

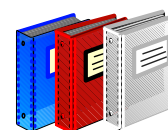
■ Inefficient Application Code

- ▶ Application 'swallows' errors, making them invisible
- ▶ Application use of storage and caching, caching algorithm used
- ▶ Resource bundles or property files read for every transaction
- ▶ Frequent, Verbose logging to Un-owned HFS
- ▶ String handling, data conversions ASCII <->EBCDIC
- ▶ Check WebSphere error log for errors and correct

Resources

Resources & References

- **WebSphere for z/OS "home page"**
 - ▶ ibm.com/software/webservers/appserv/zos_os390/
 - ▶ WebSphere InfoCenter
 - <http://publib.boulder.ibm.com/infocenter/wasinfo/index.jsp>
 - Download a copy onto your workstation - See Techdocs FQ102912
- **Redbooks:** www.redbooks.ibm.com
 - *Monitoring WebSphere Application Performance on z/OS* - SG24-6825
 - *Writing Optimized Java Applications for OS/390* - SG24-6541
- **Techdocs** - White Papers, Hints & Tips
 - ▶ ibm.com/support/techdocs
 - Guides on Configuration, Installation, Operations, Tuning, Debugging
- **Build a library of WAS & Java for z/OS pubs**
 - ▶ Developers & Sysprogs need access to z/OS specific information
 - ▶ Information is perishable and time sensitive
 - Out of date information is like no information or bad information.



Education

■ Courses by IBM Learning Services, ITSO, & WSC

www.ibm.com/services/learning/

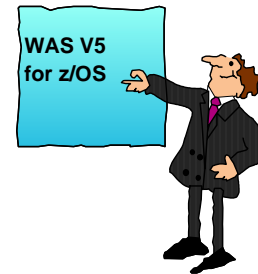
- ▶ ES685 - WAS V5 Implementation Workshop (4.5 days)
- ▶ ES690 - "WebSphere for z/OS V5 Update" (2.0 days)
- ▶ OZ850 - "Maximizing WebSphere for z/OS V5 Performance" (4.5 days)

Wildfire Workshops:

- ▶ WBSR5 - WebSphere V5 for z/OS Workshop "Gen 5" (3 days)
- ▶ WSW05 - Security Workshop: WAS V5 for z/OS (2.5 days)
- ▶ WBIZ5 - WBISF Install and Cust'n: WAS V5.1 for z/OS (2.5 days)

■ Conferences & User Group Meetings

- ▶ SHARE & Regional User Groups
- ▶ zSeries Expo
- ▶ Large Systems z/OS Update



WAS V5 for z/OS Performance articles on Techdocs

- FLASH10243 Classify the Application Control Region in WLM OMVS rules
- WP100386 Activating z990 Cryptographic Services for WebSphere
- WP100387 WLM Classification of Message Driven Bean Enclaves in WAS for zOS
- WP100395 Using J2C Connectors & WAS V5 for z/OS to access CICS or IMS Trans: Performance Best practices
- WP100417 z/OS Performance: Capacity Planning for zAAP Processors
- WP100431 Installing the zAAP Projection Tool Instrumented SDK in WAS for z/OS V5
- WP100449 WLM Classification of Work Requests in WebSphere for zOS V5.1.

- PRS752 Performance Summary Report for SMF 120 records from WAS V.5 for z/OS
- PRS804 Performance Engineering & Tuning WebSphere Version 5 for z/OS
- PRS829 Configuring & Troubleshooting the WAS for z/OS V 5 HTTP Server Plugin
- PRS929 zAAP processor capacity planning training : An Overview of the zAAP Tool

ATS/WSC TechDocs - <http://www.ibm.com/support/techdocs>

Continued . . .

WAS V5 z/OS Performance articles on Techdocs - cont'd

- TD101124 WLM Dynamic Application Environments with WebSphere for z/OS V5
- TD101151 How to Classify Transactions in WebSphere for z/OS V5
- TD101152 Manage the Number of Servant Regions with WebSphere for z/OS V5
- TD101199 Enabling the WSAD Application Profiler in a WAS 5.0 for z/OS
- TD101216 Tracing and Analyzing Java Garbage Collection in WebSphere for z/OS V5
- TD101242 Setting up the Tivoli Performance Viewer with WebSphere V.5.0.1 for z/OS
- TD101338 How to Display Work in WebSphere Application Server V 5
- TD101339 How to find the CPU Time Usage in your WAS V5 for z/OS java programs
- TD101529 Application Migration Perform Guide - Migrating to WAS 5.0.2 for z/OS
- TD101645 Tivoli Performance Viewer Security for WebSphere V5 for z/OS
- TD101663 Enabling WebSphere Application Server 5.0.2 for z/OS to use the DB2 Universal JDBC Driver
- TD101703 Disabling the Deployment Manager Timeout Values in WAS for z/OS V5

- FQ102864 How big should my /tmp directory for WebSphere V5 for z/OS?
- FQ102865 How do I turn on SMF 120 recording for WebSphere V5 for z/OS?
- FQ102962 Where can I find good diagnostic guide for IBM Java SDK 1.3.1?

ATS/WSC TechDocs - <http://www.ibm.com/support/techdocs>

Other Resources . . .

- **Developer's Domain** (WebSphere & Java Best Practices, Help, Docs & Tools)
 - ▶ www-136.ibm.com/developerworks/websphere/
- **Java Specifications** (J2EE, EJB, JSP, Servlet, JNDI) Papers
 - ▶ java.sun.com/j2ee/docs/
- **Java Community Process**
 - ▶ jcp.org/
- **z/OS Home Page**
 - ▶ www.ibm.com/servers/eserver/zseries/zos
- **Publications** on-line (view, print, order books)
 - ▶ www.ibm.com/servers/eserver/zseries/zos/bkserv
 - ▶ www.ibm.com/servers/eserver/zseries/softcopy