BEAWebLogic
Server®

WebLogic Server Performance and Tuning

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Introduction and Roadmap

This section describes the contents and organization of this guide—*WebLogic Server Performance and Tuning*.

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Document Scope and Audience

This document is written for people who monitor performance and tune the components in a WebLogic Server platform. It is assumed that readers know server administration and hardware performance tuning fundamentals, the WebLogic Server platform, XML, and the Java programming language.

Guide to this Document

- This chapter, Chapter 1, "Introduction and Roadmap," introduces the organization of this guide.

- Chapter 3, "Top Tuning Recommendations for WebLogic Server," discusses the most frequently recommended steps for achieving optimal performance tuning for applications running on WebLogic Server.

- Chapter 2, "Performance Tuning Roadmap," provides a roadmap to help tune your application environment to optimize performance:

- Chapter 4, "Operating System Tuning," discusses operating system issues.

- Chapter 5, "Tuning Java Virtual Machines (JVMs)," discusses JVM tuning considerations.

- Chapter 6, "Tuning WebLogic Server," contains information on how to tune WebLogic Server to match your application needs.

- Chapter 7, "Tuning the WebLogic Persistent Store," provides information on how to tune a persistent store.

- Chapter 8, "DataBase Tuning," provides information on how to tune your data base.

- Chapter 9, "Tuning WebLogic Server EJBs," provides information on how to tune applications that use EJBs.

- Chapter 10, "Tuning JDBC Applications," provides information on how to tune JDBC applications.

- Chapter 11, "Tuning Logging Last Resource," provides information on how to tune Logging Last Resource transaction optimization.

- Chapter 12, "Tuning WebLogic JMS," provides information on how to tune applications that use WebLogic JMS.

- Chapter 13, "Tuning WebLogic JMS Store-and-Forward," provides information on how to tune applications that use JMS Store-and-Forward.

- Chapter 14, "Tuning WebLogic Message Bridge," provides information on how to tune applications that use the Weblogic Message Bridge.

- Chapter 15, "Tuning Resource Adapters," provides information on how to tune applications that use resource adaptors.

- Chapter 16, "Tuning Web Applications," provides best practices for tuning WebLogic Web applications and application resources:

- Chapter 17, "Tuning WebLogic Tuxedo Connector," provides information on how to tune applications that use WebLogic Tuxedo Connector.

- Appendix A, "Related Reading: Performance Tools and Information," provides an extensive performance-related reading list.

- Appendix B, "Using the WebLogic 8.1 Thread Pool Model," provides information on using execute queues.

- Appendix C, "Capacity Planning," provides an introduction to capacity planning.

Performance Features of this Release

WebLogic Server 9.0 introduces the following performance enhancements:

- Support for CommonJ Timer and Work Manager API Specification. WebLogic Server 9.0 supports part of the BEA and IBM Joint Specifications (CommonJ) described at http://dev2dev.bea.com/technologies/commonj/index.jsp. In particular, this release implements the Timer and Work Manager 1.1 Specification, available at http://dev2dev.bea.com/technologies/commonj/twm/index.jsp.

- Server self-tuning for production environments. New self-tuning capabilities simplify the process of configuring WebLogic Server for production environments with service level requirements that vary over time or by application. Self-tuning helps prevent deadlocks during periods of peak demand. Self-tuning features are also useful if your WebLogic Server environment hosts multiple applications with different performance and availability requirements—for example, allowing you to allocate a greater percentage of resources to a user-facing order processing application than to a back-end inventory management application.

- New overload protection increases availability. New overload features protect a server instance from out-of-memory (OOM) exceptions, execute queue overloads, increasing the availability of a server or a cluster.

- Query Caching provides a cache to store results from arbitrary non-primary key finders for EJB 2.0 CMP read-only beans. This feature may increase the performance of read-only beans up to an order of magnitude by avoiding database hits. Query caching also works for internal finders used to implement container-managed relationships where the target is a read-only bean and for the newly introduced SQL finders. See "Tuning WebLogic Server EJBs" on page 9-1.

- Comprehensive monitoring and diagnostic tools. See "Understanding WLDF Configuration" in *Configuring and Using the WebLogic Diagnostic Framework*.

- The WebLogic Server Persistent Store, which provides a built-in, high-performance storage solution for subsystems and services that require persistence. See "Using the WebLogic Persistent Store" in *Configuring WebLogic Server Environments*.

- Logging Last Resource (LLR) optimization can significantly improve transaction performance by safely eliminating some of the 2PC XA overhead for database processing, especially for two-phase commit database insert, update, and delete operations. See "Understanding the Logging Last Resource Transaction Option" in *Configuring and Managing WebLogic JDBC*.

- JMS Unit-of-Order enables concurrent processing of multiple ordered sets of messages within a single destination. See "Using Message Unit-of-Order" in *Programming WebLogic JMS*.

- JMS Store-and-Forward provides higher performance when forwarding messages between WebLogic Server 9.X domains. See "Understanding the Store-and-Forward Service" in *Configuring and Managing WebLogic Store-and-Forward*.

For a comprehensive listing of the new WebLogic Server features introduced in release 9.0, see "What's New in WebLogic Server 9.0" in *Release Notes*.

Related Documentation

For related information about administering and tuning WebLogic Server, see Appendix A, "Related Reading: Performance Tools and Information."

CHAPTER **2**

Performance Tuning Roadmap

Performance tuning WebLogic Server and your WebLogic Server application is a complex and iterative process. The following sections provide a tuning roadmap and tuning tips for you can use to improve system performance:

- "Performance Tuning Roadmap" on page 2-1
- "Tuning Tips" on page 2-6

Performance Tuning Roadmap

The following steps provide a roadmap to help tune your application environment to optimize performance:

1. "Understand Your Performance Objectives" on page 2-1
2. "Measure Your Performance Metrics" on page 2-2
3. "Locate Bottlenecks in Your System" on page 2-4
4. "Minimize Impact of Bottlenecks" on page 2-4
5. "Achieve Performance Objectives" on page 2-6

Understand Your Performance Objectives

To determine your performance objectives, you need to understand the application deployed and the environmental constraints placed on the system. Gather information about the levels of activity that components of the application are expected to meet, such as:

- The anticipated number of users.

- The number and size of requests.

- The amount of data and its consistency.

- Determining your target CPU utilization.

  Your target CPU usage should not be 100%, you should determine a target CPU utilization based on your application needs, including CPU cycles for peak usage. If your CPU utilization is optimized at 100% during normal load hours, you have no capacity to handle a peak load. In applications that are latency sensitive and maintain the ability for a fast response time is important, high CPU usage (approaching 100% utilization) can reduce response times while throughput stays constant or even increases because of work queuing up in the server. For such applications, a 70% - 80% CPU utilization recommended. A good target for non-latency sensitive applications is about 90%.

Performance objectives are limited by constraints, such as

- The configuration of hardware and software such as CPU type, disk size vs. disk speed, sufficient memory.

  There is no single formula for determining your hardware requirements. The process of determining what type of hardware and software configuration is required to meet application needs adequately is called capacity planning. Capacity planning requires assessment of your system performance goals and an understanding of your application. Capacity planning for server hardware should focus on maximum performance requirements. See "Capacity Planning" on page C-1.

- The ability to interoperate between domains, use legacy systems, support legacy data.

- Development, implementation, and maintenance costs.

You will use this information to set realistic performance objectives for your application environment, such as response times, throughput, and load on specific hardware.

Measure Your Performance Metrics

After you have determined your performance criteria in "Understand Your Performance Objectives" on page 2-1, take measurements of the metrics you will use to quantify your performance objectives. See "Load Testing Tools" on page A-6. The following sections provide information on measuring basic performance metrics:

- "Monitor Disk and CPU Utilization" on page 2-3

- "Monitor Data Transfers Across the Network" on page 2-3

Monitor Disk and CPU Utilization

Run your application under a high load while monitoring the:

- Application server (disk and CPU utilization)

- Database server (disk and CPU utilization)

The goal is to get to a point where the application server achieves your target CPU utilization. If you find that the application server CPU is under utilized, confirm whether the database is bottle necked. If the database CPU is 100 percent utilized, then check your application SQL calls query plans. For example, are your SQL calls using indexes or doing linear searches? Also, confirm whether there are too many ORDER BY clauses used in your application that are affecting the database CPU. See "Operating System Tuning" on page 4-1.

If you discover that the database disk is the bottleneck (for example, if the disk is 100 percent utilized), try moving to faster disks or to a RAID (redundant array of independent disks) configuration, assuming the application is not doing more writes then required.

Once you know the database server is *not* the bottleneck, determine whether the application server disk is the bottleneck. Some of the disk bottlenecks for application server disks are:

- Persistent Store writes

- Transaction logging (tlogs)

- HTTP logging

- Server logging

The disk I/O on an application server can be optimized using faster disks or RAID, disabling synchronous JMS writes, using JTA direct writes for tlogs, or increasing the HTTP log buffer.

Monitor Data Transfers Across the Network

Check the amount of data transferred between the application and the application server, and between the application server and the database server. This amount should not exceed your network bandwidth; otherwise, your network becomes the bottleneck. See "Setting TCP Parameters With the ndd Command" on page 4-2.

Locate Bottlenecks in Your System

If you determine that neither the network nor the database server is the bottleneck, start looking at your operating system, JVM, and WebLogic Server configurations. Most importantly, is the machine running WebLogic Server able to get your target CPU utilization with a high client load? If the answer is *no*, then check if there is any locking taking place in the application. You should profile your application using a commercially available tool (for example, JProbe or OptimizeIt) to pinpoint bottlenecks and improve application performance.

Tip: Even if you find that the CPU is 100 percent utilized, you should profile your application for performance improvements.

For more information about application profiling tools, see "Performance Analysis Tools" on page A-6.

Minimize Impact of Bottlenecks

In this step, you tune your environment to minimize the impact of bottlenecks on your performance objectives. It is important to realize that in this step you are minimizing the impact of bottlenecks, not eliminating them. Tuning allows you to adjust resources to achieve your performance objectives. For the scope of this document, this includes (from most important to least important):

- "Tune Your Application" on page 2-4
- "Tune your DB" on page 2-5
- "Tune WebLogic Server Performance Parameters" on page 2-5
- "Tune Your JVM" on page 2-5
- "Tune the Operating System" on page 2-5
- "Tuning the WebLogic Persistent Store" on page 7-1

Tune Your Application

To quote the authors of *Mastering BEA WebLogic Server: Best Practices for Building and Deploying J2EE Applications*: "Good application performance starts with good application design. Overly-complex or poorly-designed applications will perform poorly regardless of the system-level tuning and best practices employed to improve performance." In other words, a poorly designed application can create unnecessary bottlenecks. For example, resource contention could be a case of poor design, rather than inherent to the application domain.

For more information, see:

- "Tuning WebLogic Server EJBs" on page 9-1

- "Tuning JDBC Applications" on page 10-1

- "Tuning WebLogic JMS" on page 12-1

- "Tuning WebLogic JMS Store-and-Forward" on page 13-1

- "Tuning WebLogic Message Bridge" on page 14-1

- "Tuning Resource Adapters" on page 15-1

- "Tuning Web Applications" on page 16-1

- "Tuning WebLogic Tuxedo Connector" on page 17-1

Tune your DB

Your database can be a major enterprise-level bottleneck. Database optimization can be complex and vender dependent. See "DataBase Tuning" on page 8-1.

Tune WebLogic Server Performance Parameters

The WebLogic Server uses a number of OOTB (out-of-the-box) performance-related parameters that can be fine-tuned depending on your environment and applications. Tuning these parameters based on your system requirements (rather than running with default settings) can greatly improve both single-node performance and the scalability characteristics of an application. See "Tuning WebLogic Server" on page 6-1.

Tune Your JVM

The Java virtual machine (JVM) is a virtual "execution engine" instance that executes the bytecodes in Java class files on a microprocessor. See "Tuning Java Virtual Machines (JVMs)" on page 5-1.

Tune the Operating System

Each operating system sets default tuning parameters differently. For Windows platforms, the default settings are usually sufficient. However, the UNIX and Linux operating systems usually need to be tuned appropriately. See "Operating System Tuning" on page 4-1.

Achieve Performance Objectives

Performance tuning is an iterative process. After you have minimized the impact of bottlenecks on your system, go to Step 2, "Measure Your Performance Metrics" on page 2-2 and determine if you have met your performance objectives.

Tuning Tips

This section provides tips and guidelines when tuning overall system performance:

- Performance tuning is not a silver bullet. Simply put, good system performance depends on: good design, good implementation, defined performance objectives, and performance tuning.

- Performance tuning is ongoing process. Implement mechanisms that provide performance metrics which you can compare against your performance objectives, allowing you to schedule a tuning phase before your system fails.

- The object is to meet your performance objectives, not eliminate all bottlenecks. Resources within a system are finite. By definition, at least one resource (CPU, memory, or I/O) will be a bottleneck in the system. Tuning allows you minimize the impact of bottlenecks on your performance objectives.

- Design your applications with performance in mind:

  - Keep things simple - avoid inappropriate use of published patterns.

  - Apply J2EE performance patterns.

  - Optimize your Java code.

Top Tuning Recommendations for WebLogic Server

Performance tuning WebLogic Server and your WebLogic Server application is a complex and iterative process. To get you started, we have created a short list of recommendations to help you optimize your application's performance. These tuning techniques are applicable to nearly all WebLogic applications.

Tune Pool Sizes

Provide pool sizes (such as pools for JDBC connections, Stateless Session EJBs, and MDBs) that maximize concurrency for the expected thread utilization.

- For WebLogic Server releases 9.0 and higher—A server instance uses a self-tuned thread-pool. The best way to determine the appropriate pool size is to monitor the pool's current size, shrink counts, grow counts, and wait counts. See "Thread Management" on page 6-3.

- For releases prior to WebLogic Server 9.0— In general, the number of connections should equal the number of threads that are expected to be required to process the requests handled by the pool. The most effective way to ensure the right pool size is to monitor it and make sure it does not shrink and grow. See "Using the WebLogic 8.1 Thread Pool Model" on page B-1.

Use the Prepared Statement Cache

The prepared statement cache keeps compiled SQL statements in memory, thus avoiding a round-trip to the database when the same statement is used later. See "Cache Prepared and Callable Statements" on page 10-3.

Use Logging Last Resource Optimization

When using transactional database applications, consider using the JDBC data source Logging Last Resource (LLR) transaction policy instead of XA. The LLR optimization can significantly improve transaction performance by safely eliminating some of the 2PC XA overhead for database processing, especially for two-phase commit database insert, update, and delete operations. For more information, see "Tuning Logging Last Resource" on page 11-1.

Tune Connection Backlog Buffering

You can tune the number of connection requests that a WebLogic Server instance accepts before refusing additional requests. This tunable applies primarily for web applications. See "Tuning Connection Backlog Buffering" on page 6-11.

Tune the Chunk Size

A chunk is a unit of memory that the WebLogic Server network layer, both on the client and server side, uses to read data from and write data to sockets. A server instance maintains a pool of these chunks. For applications that handle large amounts of data per request, increasing the value on both the client and server sides can boost performance. See "Tune the Chunk Parameters" on page 6-10.

Use Optimistic or Read-only Concurrency

Use optimistic concurrency with cache-between-transactions or read-only concurrency with query-caching for CMP EJBs wherever possible. Both of these two options leverage the Entity Bean cache provided by the EJB container.

- Optimistic-concurrency with cache-between-transactions work best with read-mostly beans. Using verify-reads in combination with these provides high data consistency guarantees with the performance gain of caching. See "Tuning WebLogic Server EJBs" on page 9-1.

- Query-caching is a WebLogic Server 9.0 feature that allows the EJB container to cache results for arbitrary non-primary-key finders defined on read-only EJBs. All of these parameters can be set in the application/module deployment descriptors. See "CMP Entity Bean Tuning" on page 9-5.

Use Local Interfaces

Use local-interfaces or use call-by-reference semantics to avoid the overhead of serialization when one EJB calls another or an EJB is called by a servlet/JSP in the same application. Note the following:

- In release prior to WebLogic Server 8.1, call-by-reference is turned on by default. For releases of WebLogic Server 8.1 and higher, call-by-reference is turned off by default. Older applications migrating to WebLogic Server 8.1 and higher that do not explicitly turn on call-by-reference may experience a drop in performance.

- This optimization does not apply to calls across different applications.

Use eager-relationship-caching

Use eager-relationship-caching wherever possible. This feature allows the EJB container to load related beans using a single SQL statement. It improves performance by reducing the number of database calls to load related beans in transactions when a bean and it's related beans are expected to be used in that transaction. See "Tuning WebLogic Server EJBs" on page 9-1.

Tune HTTP Sessions

Optimize your application so that it does as little work as possible when handling session persistence and sessions. You should also design a session management strategy that suits your environment and application. See "Session Management" on page 16-3.

Tune Messaging Applications

BEA provides messaging users a rich set of performance tunables. In general, you should always configure quotas and paging. See:

- "Tuning the WebLogic Persistent Store" on page 7-1

- "Tuning WebLogic JMS" on page 12-1

- "Tuning WebLogic JMS Store-and-Forward" on page 13-1

- "Tuning WebLogic Message Bridge" on page 14-1

Operating System Tuning

Tune your operating system according to your operating system documentation. For Windows platforms, the default settings are usually sufficient. However, the Solaris and Linux platforms usually need to be tuned appropriately. The following sections describe issues related to operating system performance:

Basic OS Tuning Concepts

Proper OS tuning improves system performance by preventing the occurrence of error conditions. Operating system error conditions always degrade performance. Typically most error conditions are TCP tuning parameter related and are caused by the operating system's failure to release old sockets from a `close_wait` call. Common errors are "`connection refused`", "`too many open files`" on the server-side, and "`address in use: connect`" on the client-side.

In most cases, these errors can be prevented by adjusting the TCP `wait_time` value and the TCP queue size. Although users often find the need to make adjustments when using tunnelling, OS

tuning may be necessary for any protocol under sufficiently heavy loads. The following sections provide information on tuning parameters for various operating systems.

Note: Although the following sections provide information on tuning parameters that BEA has determined can enhance application performance, BEA recommends following your OS vendor's tuning documentation for tuning parameter values and monitoring performance changes when changing tuning parameters in your local environment. Another resource which may provide helpful tuning information is the All SPEC jAppServer2004 Results Published by SPEC web page. It provides the OS tuning parameters used for each reported WebLogic Server benchmark.

Solaris Tuning Parameters

The following sections provide information on tuning Solaris operating systems:

Setting TCP Parameters With the ndd Command

This section lists important TCP tuning parameters that when tuned, can enhance application performance:

- `/dev/tcp tcp_time_wait_interval`

- `/dev/tcp tcp_conn_req_max_q`

- `/dev/tcp tcp_conn_req_max_q0`

- `/dev/tcp tcp_ip_abort_interval`

- `/dev/tcp tcp_keepalive_interval`

- `/dev/tcp tcp_rexmit_interval_initial`

- `/dev/tcp tcp_rexmit_interval_max`

- `/dev/tcp tcp_rexmit_interval_min`

- `/dev/tcp tcp_smallest_anon_port`

- `/dev/tcp tcp_xmit_hiwat`

- `/dev/tcp tcp_recv_hiwat`

- `/dev/ce instance`

- `/dev/ce rx_intr_time`

Tip: Use the `netstat -s -P tcp` command to view all available TCP parameters.

Set TCP-related tuning parameters using the `ndd` command, as demonstrated in the following example:

```
ndd -set /dev/tcp tcp_conn_req_max_q 16384
```

Setting Parameters In the /etc/system File

This section lists important `/etc/system` file tuning parameters that when tuned, can enhance application performance. Each socket connection to the server consumes a file descriptor. To optimize socket performance, you may need to configure your operating system to have the appropriate number of file descriptors. Therefore, you should change the default file descriptor limits, as well as the hash table size and other tuning parameters in the `/etc/system` file.

Note: You must reboot your machine anytime you modify `/etc/system` parameters.

- `set rlim_fd_cur`

- `set rlim_fd_max`

- `set tcp:tcp_conn_hash_size`

- `set shmsys:shminfo_shmmax` **Note:** This should only be set for machines that have at least 4 GB RAM or higher.

- `set autoup`

- `set tune_t_fsflushr`

CE Gigabit Network Card Settings

This section lists important CE Gigabit Network Card tuning parameters that when tuned, can enhance application performance:

- `set ce:ce_bcopy_thresh`

- `set ce:ce_dvma_thresh`

- `set ce:ce_taskq_disable`

- `set ce:ce_ring_size`

- `set ce:ce_comp_ring_size`

- `set ce:ce_tx_ring_size`

Additional Solaris Tuning Information

For more information about Solaris tuning options, see:

- *Solaris Tunable Parameters Reference Manual* (Solaris 8), at
  `http://docs.sun.com/app/docs/doc/806-6779`

- *Solaris Tunable Parameters Reference Manual* (Solaris 9), at
  `http://docs.sun.com/app/docs/doc/806-7009`

- *Solaris Tunable Parameters Reference Manual* (Solaris 10), at
  `http://docs.sun.com/app/docs/doc/817-0404`

Linux Tuning Parameters

This section lists important Linux tuning parameters that when adjusted, can enhance application performance:

- `/sbin/ifconfig lo mtu`

- `kernel.msgmni`

- `kernel.sem`

- `fs.file-max`

- `kernel.shmmax`

- `net.ipv4.tcp_max_syn_backlog`

For more information about Linux tuning, you should consult your Linux vendor's documentation. Also, the Ipsysctl Tutorial 1.0.4, at `http://ipsysctl-tutorial.frozentux.net/ipsysctl-tutorial.html`, describes all of the IP options provided by Linux.

HP-UX Tuning Parameters

This section lists important HP-UX operating system tuning parameters that when adjusted, can enhance application performance:

- `tcp_conn_req_max`

- `tcp_xmit_hiwater_def`

- `tcp_ip_abort_interval`

- `tcp_rexmit_interval_initial`

- `tcp_keepalive_interval`

For more HP-UX tuning information, see the *Tunable Kernel Parameters* reference documentation, at `http://docs.hp.com/hpux/onlinedocs/TKP-90203/TKP-90203.html`.

Windows Tuning Parameters

For Windows platforms, the default settings are usually sufficient. However, under sufficiently heavy loads it may be necessary to adjust the `MaxUserPort` and `TcpTimedWaitDelay`. These parameters determine the availability of user ports requested by an application.

By default, ephemeral (that is, short-lived) ports are allocated between the values of 1024 and 5000 inclusive using the `MaxUserPort` parameter. The `TcpTimedWaitDelay` parameter, which controls the amount of time the OS waits to reclaim a port after an application closes a TCP connection, has a default value of 4 minutes. During a heavy loads, these limits may be exceeded resulting in an `address in use: connect` exception. If you experience `address in use: connect` exceptions try setting the `MaxUserPort` and `TcpTimedWaitDelay` registry values under the `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters` key:

```
MaxUserPort = dword:00004e20 (20,000 decimal)
TcpTimedWaitDelay = dword:0000001e (30 decimal)
```

Increase the value of the `MaxUserPort` parameter if the exception persists.

For more information about Windows 2000 tuning options, see:

- The Microsoft Windows 2000 TCP/IP Implementation Details white paper, at `http://www.microsoft.com/windows2000/techinfo/howitworks/communications/networkbasics/tcpip_implement.asp`.

- The Windows 2000 Performance Tuning white paper at `http://www.microsoft.com/technet/prodtechnol/windows2000serv/maintain/optimize/perftune.mspx`.

Other Operating System Tuning Information

For more information about HP-UX, and AIX tuning options, refer to the following Web sites:

- For AIX tuning information, see the *AIX 5L Version 5.2 Performance Management Guide*, at
  `http://publib16.boulder.ibm.com/pseries/en_US/aixbman/prftungd/prftungd`
  `.htm`.

- Maximum memory for a user process — Check your operating system documentation for the maximum memory available for a user process. In some operating systems, this value is as low as 128 MB. Also, refer to your operating system documentation.For more information about memory management, see Chapter 5, "Tuning Java Virtual Machines (JVMs)."

Tuning Java Virtual Machines (JVMs)

The Java virtual machine (JVM) is a virtual "execution engine" instance that executes the bytecodes in Java class files on a microprocessor. How you tune your JVM affects the performance of WebLogic Server and your applications. envelope

The following sections discuss JVM tuning options for WebLogic Server:

- "JVM Tuning Considerations" on page 5-2
- "Which JVM for Your System?" on page 5-2
- "Garbage Collection" on page 5-3
- "Enable Spinning for IA32 Platforms" on page 5-12

JVM Tuning Considerations

Table 5-1 presents general JVM tuning considerations for WebLogic Server.

Table 5-1 General JVM Tuning Considerations

Tuning Factor	Information Reference
JVM vendor and version	Use only production JVMs on which WebLogic Server has been certified. This release of WebLogic Server supports only those JVMs that are J2SE 5.0-compliant.
	The Supported Configurations pages at `{PLATFORM}/index.html` are frequently updated and contains the latest certification information on various platforms.
Tuning heap size and garbage collection	For WebLogic Server heap size tuning details, see "Garbage Collection" on page 5-3.
Choosing a GC (garbage collection) scheme	Depending on your application, there are a number of GC schemes available for managing your system memory, as described in "Choosing a Garbage Collection Scheme" on page 5-4.
Mixed client/server JVMs	Deployments using different JVM versions for the client and server are supported in WebLogic Server. See the support page for Mixed Client/Server JVMs, at `{PLATFORM}/index.html#mix`.
UNIX threading models	Choices you make about Solaris threading models can have a large impact on the performance of your JVM on Solaris. You can choose from multiple threading models and different methods of synchronization within the model, but this varies from JVM to JVM.
	See "Performance Documentation For the Java Hotspot Virtual Machine: Threading" on Sun Microsystems' Web site at `http://http://java.sun.com/docs/hotspot/threads/threads.html`.

Which JVM for Your System?

Although this section focuses on Sun Microsystems' J2SE 5.0 JVM for the Windows, UNIX, and Linux platforms, the BEA JRockit JVM was developed expressly for server-side applications and

optimized for Intel architectures to ensure reliability, scalability, manageability, and flexibility for Java applications. For more information about the benefits of using JRockit on Windows and Linux platforms, see Introduction to JRockit JDK, at http://e-docs.bea.com/wljrockit/docs50/intro/index.html.

For more information on JVMs in general, see the Introduction to the JVM specification, at http://java.sun.com/docs/books/vmspec/2nd-edition/html/Introduction.doc.html#3057. For links to related reading for JVM tuning, see Appendix A, "Related Reading: Performance Tools and Information."

Changing To a Different JVM

When you create a domain, if you choose to customize the configuration, the Configuration Wizard presents a list of JDKs that WebLogic Server installed. From this list, you choose the JVM that you want to run your domain and the wizard configures the BEA start scripts based on your choice. After you create a domain, if you want to use a different JVM, see "Changing the JVM That Runs Servers" at {DOCROOT}/server_start/overview.html#ChangingJVM.

Garbage Collection

Garbage collection is the VM's process of freeing up unused Java objects in the Java heap. The following sections provide information on tuning your VM's garbage collection:

- "VM Heap Size and Garbage Collection" on page 5-3

- "Choosing a Garbage Collection Scheme" on page 5-4

- "Using Verbose Garbage Collection to Determine Heap Size" on page 5-5

- "Specifying Heap Size Values" on page 5-7

- "Automatically Logging Low Memory Conditions" on page 5-11

- "Manually Requesting Garbage Collection" on page 5-11

- "Requesting Thread Stacks" on page 5-12

VM Heap Size and Garbage Collection

The Java heap is where the objects of a Java program live. It is a repository for live objects, dead objects, and free memory. When an object can no longer be reached from any pointer in the

running program, it is considered "garbage" and ready for collection. A best practice is to tune the time spent doing garbage collection to within 5% of execution time.

The JVM heap size determines how often and how long the VM spends collecting garbage. An acceptable rate for garbage collection is application-specific and should be adjusted after analyzing the actual time and frequency of garbage collections. If you set a large heap size, full garbage collection is slower, but it occurs less frequently. If you set your heap size in accordance with your memory needs, full garbage collection is faster, but occurs more frequently.

The goal of tuning your heap size is to minimize the time that your JVM spends doing garbage collection while maximizing the number of clients that WebLogic Server can handle at a given time. To ensure maximum performance during benchmarking, you might set high heap size values to ensure that garbage collection does not occur during the entire run of the benchmark.

You might see the following Java error if you are running out of heap space:

```
java.lang.OutOfMemoryError <<no stack trace available>>
java.lang.OutOfMemoryError <<no stack trace available>>
Exception in thread "main"
```

To modify heap space values, see "Specifying Heap Size Values" on page 5-7.

To configure WebLogic Server to detect automatically when you are running out of heap space and to address low memory conditions in the server, see "" on page 5-13.

Choosing a Garbage Collection Scheme

Depending on which JVM you are using, you can choose from several garbage collection schemes to manage your system memory. For example, some garbage collection schemes are more appropriate for a given type of application. Once you have an understanding of the workload of the application and the different garbage collection algorithms utilized by the JVM, you can optimize the configuration of the garbage collection.

Refer to the following links for in-depth discussions of garbage collection options for your JVM:

- For an overview of the garbage collection schemes available with Sun's HotSpot VM, see Tuning Garbage Collection with the 5.0 Java Virtual Machine, at http://java.sun.com/docs/hotspot/gc5.0/gc_tuning_5.html.

- For a comprehensive explanation of the collection schemes available, see Improving Java Application Performance and Scalability by Reducing Garbage Collection Times and Sizing Memory Using JDK 1.4.1 at http://developers.sun.com/techtopics/mobility/midp/articles/garbagecollection2/.

- For a discussion of the garbage collection schemes available with the BEA JRockit JDK, see Using the BEA JRockit Memory Management System, at
  `http://e-docs.bea.com/wljrockit/docs50/userguide/memman.html`.

- For some pointers about garbage collection from an HP perspective, see Performance tuning Java™: Tuning steps, at
  `http://h21007.www2.hp.com/dspp/tech/tech_TechDocumentDetailPage_IDX/1,1701,1604,00.html`.

Using Verbose Garbage Collection to Determine Heap Size

The verbose garbage collection option (`verbosegc`) enables you to measure exactly how much time and resources are put into garbage collection. To determine the most effective heap size, turn on verbose garbage collection and redirect the output to a log file for diagnostic purposes.

The following steps outline this procedure:

1. Monitor the performance of WebLogic Server under maximum load while running your application.

2. Use the `-verbosegc` option to turn on verbose garbage collection output for your JVM and redirect *both* the standard error and standard output to a log file.

   This places thread dump information in the proper context with WebLogic Server informational and error messages, and provides a more useful log for diagnostic purposes.

   For example, on Windows and Solaris, enter the following:

   ```
   % java -ms32m -mx200m -verbosegc -classpath $CLASSPATH
   -Dweblogic.Name=%SERVER_NAME% -Dbea.home="C:\bea"
   -Dweblogic.management.username=%WLS_USER%
   -Dweblogic.management.password=%WLS_PW%
   -Dweblogic.management.server=%ADMIN_URL%
   -Dweblogic.ProductionModeEnabled=%STARTMODE%
   -Djava.security.policy="%WL_HOME%\server\lib\weblogic.policy"
   weblogic.Server
   >> logfile.txt 2>&1
   ```

   where the `logfile.txt 2>&1` command redirects both the standard error and standard output to a log file.

   On HPUX, use the following option to redirect `stderr stdout` to a single file:

   ```
   -Xverbosegc:file=/tmp/gc$$.out
   ```

where `$$` maps to the process ID (PID) of the Java process. Because the output includes timestamps for when garbage collection ran, you can infer how often garbage collection occurs.

3. Analyze the following data points:

   a. How often is garbage collection taking place? In the `weblogic.log` file, compare the time stamps around the garbage collection.

   b. How long is garbage collection taking? Full garbage collection should not take longer than 3 to 5 seconds.

   c. What is your average memory footprint? In other words, what does the heap settle back down to after each full garbage collection? If the heap always settles to 85 percent free, you might set the heap size smaller.

4. Review the New generation heap sizes (Sun) or Nursery size (BEA Jrockit).

   • For BEA Jrockit: see "BEA JRockit JVM Heap Size Options" on page 5-7.

   • For Sun: see "Java HotSpot VM Heap Size Options" on page 5-9.

5. Make sure that the heap size is not larger than the available free RAM on your system.

   Use as large a heap size as possible without causing your system to "swap" pages to disk. The amount of free RAM on your system depends on your hardware configuration and the memory requirements of running processes on your machine. See your system administrator for help in determining the amount of free RAM on your system.

6. If you find that your system is spending too much time collecting garbage (your allocated virtual memory is more than your RAM can handle), lower your heap size.

   Typically, you should use 80 percent of the available RAM (not taken by the operating system or other processes) for your JVM.

7. If you find that you have a large amount of available free RAM remaining, run more instances of WebLogic Server on your machine.

   Remember, the goal of tuning your heap size is to minimize the time that your JVM spends doing garbage collection while maximizing the number of clients that WebLogic Server can handle at a given time.

Note: JVM vendors may provide other options to print comprehensive garbage collection reports. For example, you can use the BEA JRockit JVM `-Xgcreport` option to print a comprehensive garbage collection report at program completion, see "Viewing Garbage

Collection Behavior", at
http://e-docs.bea.com/wljrockit/docs50/userguide/memman.html.

Specifying Heap Size Values

System performance is greatly influenced by the size of the Java heap available to the JVM. This section describes the command line options you use to define the heap sizes values.You must specify Java heap size values each time you start an instance of WebLogic Server. This can be done either from the java command line or by modifying the default values in the sample startup scripts that are provided with the WebLogic distribution for starting WebLogic Server.

- "Tuning Tips for Heap Sizes" on page 5-7

- "BEA JRockit JVM Heap Size Options" on page 5-7

- "Java HotSpot VM Heap Size Options" on page 5-9

Tuning Tips for Heap Sizes

The following section provides general guidelines for tuning VM heap sizes:

- The heap sizes should be set to values such that the maximum amount of memory used by the VM does not exceed the amount of available physical RAM. If this value is exceeded, the OS starts paging and performance degrades significantly. The VM always uses more memory than the heap size. The memory required for internal VM functionality, native libraries outside of the VM, and permanent generation memory (for the Sun VM only: memory required to store classes and methods) is allocated in addition to the heap size settings.

- When using a generational garbage collection scheme, the nursery size should not exceed more than half the total Java heap size. Typically, 25% to 40% of the heap size is adequate.

- In production environments, set the minimum heap size and the maximum heap size to the same value to prevent wasting VM resources used to constantly grow and shrink the heap. This also applies to the New generation heap sizes (Sun) or Nursery size (BEA Jrockit).

BEA JRockit JVM Heap Size Options

Although BEA JRockit provides automatic heap resizing heuristics, they are not optimal for all applications. In most situations, best performance is achieved by tuning the VM for each application by adjusting the heaps size options shown in Table 5-2.

Table 5-2 BEA JRockit JVM Heap Size Options

Setting the Nursery	-Xns	Optimally, you should try to make the nursery as large as possible while still keeping the garbage collection pause times acceptably low. This is particularly important if your application is creating a lot of temporary objects.
		The maximum size of a nursery cannot exceed 95% of the maximum heap size.
Setting minimum heap size	-Xms	BEA recommends setting the minimum heap size (-Xms) equal to the maximum heap size (-Xmx) to minimize garbage collections.
Setting maximum heap size	-Xmx	Setting a low maximum heap value compared to the amount of live data decrease performance by forcing frequent garbage collections.
Setting garbage collection	-Xgc: parallel	
Performs adaptive optimizations as early as possible in the Java application run.	-XXaggressive:memory	To do this, the bottleneck detector will run with a higher frequency from the start and then gradually lower its frequency. This options also tells BEA JRockit to use the available memory aggressively.

For example, when you start a WebLogic Server instance from a `java` command line, you could specify the BEA JRockit VM heap size values as follows:

```
$ java -Xns10m -Xms512m -Xmx512m
```

The default size for these values is measured in bytes. Append the letter 'k' or 'K' to the value to indicate kilobytes, 'm' or 'M' to indicate megabytes, and 'g' or 'G' to indicate gigabytes. The example above allocates 10 megabytes of memory to the Nursery heap sizes and 512 megabytes of memory to the minimum and maximum heap sizes for the WebLogic Server instance running in the JVM.

For detailed information about setting the appropriate heap sizes for WebLogic's JRockit JVM, see Tuning the JRockit JVM, at
`http://edocs.bea.com/wljrockit/docs50/tuning/index.html`.

Other BEA JRockit VM Options

BEA provides other command-line options to improve the performance of your BEA JRockit VM. For detailed information, see BEA JRockit JDK Command Line Options by Name, at `http://e-docs.bea.com/jrockit/docs50/options.html`.

Java HotSpot VM Heap Size Options

You achieve best performance by individually tuning each application. However, configuring the Java HotSpot VM heap size options listed in Table 5-3 when starting WebLogic Server increases performance for most applications.

These options may differ depending on your architecture and operating system. See your vendor's documentation for platform-specific JVM tuning options.

Table 5-3 Java Heap Size Options

Task	Option	Comments
Setting the New generation heap size	`-XX:NewSize`	As a general rule, set `-XX:NewSize` to be one-fourth the size of the heap size. Increase the value of this option for larger numbers of short-lived objects.
		Be sure to increase the New generation as you increase the number of processors. Memory allocation can be parallel, but garbage collection is not parallel.
Setting the maximum New generation heap size	`-XX:MaxNewSize`	Set the maximum size of the New Generation heap size.
Setting New heap size ratios	`-XX:SurvivorRatio`	The New generation area is divided into three sub-areas: Eden, and two survivor spaces that are equal in size.
		Configure the ratio of the Eden/survivor space size. Try setting this value to 8, and then monitor your garbage collection.
Setting minimum heap size	`-Xms`	As a general rule, set minimum heap size (`-Xms`) equal to the maximum heap size (`-Xmx`) to minimize garbage collections.

Table 5-3 Java Heap Size Options (Continued)

Task	Option	Comments
Setting maximum heap size	`-Xmx`	Set the maximum size of the heap.
Setting Big Heaps and Intimate Shared Memory	`-XX:+UseISM` `-XX:+AggressiveHe ap`	See http://java.sun.com/docs/hotspot/ism .html

For example, when you start a WebLogic Server instance from a `java` command line, you could specify the HotSpot VM heap size values as follows:

```
$ java -XX:NewSize=128m -XX:MaxNewSize=128m -XX:SurvivorRatio=8 -Xms512m
-Xmx512m
```

The default size for these values is measured in bytes. Append the letter 'k' or 'K' to the value to indicate kilobytes, 'm' or 'M' to indicate megabytes, and 'g' or 'G' to indicate gigabytes. The example above allocates 128 megabytes of memory to the New generation and maximum New generation heap sizes, and 512 megabytes of memory to the minimum and maximum heap sizes for the WebLogic Server instance running in the JVM.

Other Java HotSpot VM Options

Sun provides other standard and non-standard command-line options to improve the performance of your VM. How you use these options depends on how your application is coded.

Test both your client and server JVMs to see which options perform better for your particular application. The Sun Microsystems Java HotSpot VM Options document provides information on the command-line options and environment variables that can affect the performance characteristics of the Java HotSpot Virtual Machine. See http://java.sun.com/docs/hotspot/VMOptions.html.

For additional examples of the HotSpot VM options, see:

- Standard Options for Windows (Win32) VMs at http://java.sun.com/j2se/1.5.0/docs/tooldocs/windows/java.html.

- Standard Options for Solaris VMs at http://java.sun.com/j2se/1.5.0/docs/tooldocs/solaris/java.html.

- Standard Options for Linux VMs at http://java.sun.com/j2se/1.5.0/docs/tooldocs/linux/java.html.

Sun Microsystems' Java Virtual Machine document provides a detailed discussion of the Client and Server implementations of the Java virtual machine for J2SE 5.0. See `http://java.sun.com/j2se/1.5.0/docs/guide/vm/index.html`.

Automatically Logging Low Memory Conditions

WebLogic Server enables you to automatically log low memory conditions observed by the server. WebLogic Server detects low memory by sampling the available free memory a set number of times during a time interval. At the end of each interval, an average of the free memory is recorded and compared to the average obtained at the next interval. If the average drops by a user-configured amount after any sample interval, the server logs a low memory warning message in the log file and sets the server health state to "warning."

To log low memory conditions:

1. In the left pane of the console, expand **Environment > Servers**.

2. On the **Summary of Servers** page, select the server instance for which you will configure log low memory conditions.

3. On the **Configuration > Tuning** tab, update as necessary:

   Low Memory GCThreshold—Threshold at which the server instance logs a low memory warning and changes the health state to warning.

   Low Memory Sample Size—Number of times the server instance samples free memory during the **Low Memory Time Interval**.

   Low Memory Time Interval—Amount of time, in seconds, that defines the interval over which the server instance determines average free memory values.

4. Click **Save**.

5. Reboot the server instance to use the new low memory detection values.

Manually Requesting Garbage Collection

You may find it necessary to manually request full garbage collection from the Administration Console. When you do, remember that garbage collection is costly as the JVM often examines every living object in the heap.

To request garbage collection:

1. In the left pane of the console, expand **Environment > Servers**.

2. On the **Summary of Servers** page, select the server instance for which you will request garbage collection.

3. Expand the **Monitoring > Performance** tab.

4. Click **Garbage Collect**.

Requesting Thread Stacks

You may find it necessary to display thread stacks while tuning your applications.

To display a thread stack:

1. In the left pane of the console, expand **Environment > Servers**.

2. On the **Summary of Servers** page, select the server instance for which you will request garbage collection.

3. Expand the **Monitoring > Performance** tab.

4. Click **Dump Thread Stacks**.

Enable Spinning for IA32 Platforms

If you are running a high-stress application with heavily contended locks on a multiprocessor system, you can attempt to improve performance by using spinning. This option enables the ability to spin the lock for a short time before going to sleep.

Sun JDK

Sun has changed the default lock spinning behavior in JDK 5.0 on the Windows IA32 platform. For the JDK 5.0 release, lock spinning is disabled by default. For this release, BEA has explicitly enabled spinning in the environment scripts used to start WebLogic Server. To enable spinning, use the following VM option:

```
-XX:+UseSpinning
```

BEA JRockit

The BEA JRockit VM automatically adjusts the spinning for different locks, eliminating the need set this parameter.

Note: In the BEA JRockit 8.1 SDK release, spinning was adjusted by setting
`-XXenablefatspin` option.

Tuning WebLogic Server

The following sections describe how to tune WebLogic Server to match your application needs.

Setting Java Parameters for Starting WebLogic Server

Java parameters must be specified whenever you start WebLogic Server. For simple invocations, this can be done from the command line with the `weblogic.Server` command. However, because the arguments needed to start WebLogic Server from the command line can be lengthy and prone to error, BEA recommends that you incorporate the command into a script. To simply this process, you can modify the default values in the sample scripts that are provided with the WebLogic distribution to start WebLogic Server, as described in "Specifying Java Options for a WebLogic Server Instance" at `{DOCROOT}/server_start/overview.html#JavaOptions`.

If you used the Configuration Wizard to create your domain, the WebLogic startup scripts are located in the *domain-name* directory where you specified your domain. By default, this directory

is *BEA_HOME*\user_projects\domain*domain-name*, where *BEA_HOME* is the directory that contains the product installation, and *domain-name* is the name of the domain directory defined by the selected configuration template. For more information about creating domains using the Configuration Wizard, see "Creating Domains Using the Configuration Wizard" at http://e-docs.bea.com/common/docs90/confgwiz/intro.html.

You need to modify some default Java values in these scripts to fit your environment and applications. The important performance tuning parameters in these files are the JAVA_HOME parameter and the Java heap size parameters:

- Change the value of the variable JAVA_HOME to the location of your JDK. For example:

```
set JAVA_HOME=C:\bea\jdk150_03
```

- For higher performance throughput, set the minimum java heap size equal to the maximum heap size. For example:

```
"%JAVA_HOME%\bin\java" –server –Xms512m –Xmx512m -classpath
%CLASSPATH% -
```

See "Specifying Heap Size Values" on page 5-7 for details about setting heap size options.

Development vs. Production Mode Default Tuning Values

You can indicate whether a domain is to be used in a development environment or a production environment. WebLogic Server uses different default values for various services depending on the type of environment you specify. Specify the startup mode for your domain as shown in the following table.

Table 6-1 Startup Modes

Choose this mode	when . . .
Development	You are creating your applications. In this mode, the configuration of security is relatively relaxed, allowing you to auto-deploy applications.
Production	Your application is running in its final form. In this mode, security is fully configured.

Table 6-2 lists the performance-related configuration parameters that differ when switching from development to production startup mode.

Table 6-2 Differences Between Development and Production Modes

Tuning Parameter	In development mode . . .	In production mode . . .
SSL	You can use the demonstration digital certificates and the demonstration keystores provided by the WebLogic Server security services. With these certificates, you can design your application to work within environments secured by SSL. For more information about managing security, see "Configuring SSL" in *Securing WebLogic Server*.	You should not use the demonstration digital certificates and the demonstration keystores. If you do so, a warning message is displayed.
Deploying Applications	WebLogic Server instances can automatically deploy and update applications that reside in the domain_name/autodeploy directory (where domain_name is the name of a domain). It is recommended that this method be used only in a single-server development environment. For more information, see "Auto-Deploying Applications in Development Domains" in *Deploying Applications to WebLogic Server*.	The auto-deployment feature is disabled, so you must use the WebLogic Server Administration Console, the weblogic.Deployer tool, or the WebLogic Scripting Tool (WLST). For more information, see *Deploying Applications to WebLogic Server* .
JDBC Connection Pool: `MaxCapacity`	The default capacity is 15 connections.	The default capacity is 25 connections.

For information on switching the startup mode from development to production, see Change to Production Mode in the *Administration Console Online Help*.

Thread Management

WebLogic Server provides the following mechanisms to manage threads to perform work.

- "Tuning a Work Manager" on page 6-4

Tuning a Work Manager

In this release, WebLogic Server allows you to configure how your application prioritizes the execution of its work. Based on rules you define and by monitoring actual runtime performance, WebLogic Server can optimize the performance of your application and maintain service level agreements (SLA).

You tune the thread utilization of a server instance by defining rules and constraints for your application by defining a Work Manger and applying it either globally to WebLogic Server domain or to a specific application component. The primary tuning considerations are:

- "How Many Work Managers are Needed?" on page 6-4

- "What are the SLA Requirements for Each Work Manager?" on page 6-4

See Using Work Managers to Optimize Scheduled Work in *Configuring WebLogic Server Environments*.

How Many Work Managers are Needed?

Each distinct SLA requirement needs a unique work manager.

What are the SLA Requirements for Each Work Manager?

Service level agreement (SLA) requirements are defined by instances of request classes. A request class expresses a scheduling guideline that a server instance uses to allocate threads. See "Understanding Work Managers" in *Configuring WebLogic Server Environments*.

Tuning Execute Queues

Note: Execute Queues are deprecated in this release of WebLogic Server. BEA recommends migrating applications to use work managers.

In previous versions of WebLogic Server, processing was performed in multiple execute queues. Different classes of work were executed in different queues, based on priority and ordering

requirements, and to avoid deadlocks. See "Using the WebLogic 8.1 Thread Pool Model" on page B-1.

Understanding the Differences Between Work Managers and Execute Queues

The easiest way to conceptually visualize the difference between the execute queues of previous releases with work managers is to correlate execute queues (or rather, execute-queue managers) with work managers and decouple the one-to-one relationship between execute queues and thread-pools.

For releases prior to WebLogic Server 9.0, incoming requests are put into a default execute queue or a user-defined execute queue. Each execute queue has an associated execute queue manager that controls an exclusive, dedicated thread-pool with a fixed number of threads in it. Requests are added to the queue on a first-come-first-served basis. The execute-queue manager then picks the first request from the queue and an available thread from the associated thread-pool and dispatches the request to be executed by that thread.

For releases of WebLogic Server 9.0 and higher, there is a single priority-based execute queue in the server. Incoming requests are assigned an internal priority based on the configuration of work managers you create to manage the work performed by your applications. The server increases or decreases threads available for the execute queue depending on the demand from the various work-managers. The position of a request in the execute queue is determined by its internal priority:

- The higher the priority, closer it is placed to the head of the execute queue.

- The closer to the head of the queue, more quickly the request will be dispatched a thread to use.

Work managers provide you the ability to better control thread utilization (server performance) than execute-queues, primarily due to the many ways that you can specify scheduling guidelines for the priority-based thread pool. These scheduling guidelines can be set either as numeric values or as the capacity of a server-managed resource, like a JDBC connection pool.

Migrating from Previous Releases

If you upgrade application domains from prior releases that contain execute queues, the resulting 9.0 domain will contain execute queues.

- Migrating application domains from a previous release to WebLogic Server 9.0 does not automatically convert an execute queues to work manager.

- If execute queues are present in the upgraded application configuration, the server instance assigns work requests appropriately to the execute queue specified in the `dispatch-policy`.

- Requests without a `dispatch-policy` use the self-tuning thread pool.

For more information on migrating a domain, see Upgrading WebLogic Application Environments at `http://e-docs.bea.com/common/docs90/upgrade/intro.html`.

Tuning the Stuck Thread Detection Behavior

WebLogic Server automatically detects when a thread in an execute queue becomes "stuck." Because a stuck thread cannot complete its current work or accept new work, the server logs a message each time it diagnoses a stuck thread.

WebLogic Server diagnoses a thread as stuck if it is continually working (not idle) for a set period of time. You can tune a server's thread detection behavior by changing the length of time before a thread is diagnosed as stuck, and by changing the frequency with which the server checks for stuck threads. Although you can change the criteria WebLogic Server uses to determine whether a thread is stuck, you cannot change the default behavior of setting the "warning" and "critical" health states when all threads in a particular execute queue become stuck. For more information, see "Configuring WebLogic Server to Avoid Overload Conditions" in *Configuring WebLogic Server Environments*.

To configure thread detection behavior:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure thread detection behavior.

4. On the **Configuration > Tuning** tab, update as necessary:

- **Stuck Thread Max Time**—Amount of time, in seconds, that a thread must be continually working before a server instance diagnoses a thread as being stuck.

- >**Stuck Thread Timer Interval**—Amount of time, in seconds, after which a server instance periodically scans threads to see if they have been continually working for the configured Stuck Thread Max Time.

5. Click Save.

6. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

7. You must reboot the server to use the new thread detection behavior values.

Tuning Network I/O

The following sections provide information on network communication between clients and servers (including t3 and IIOP protocols, and their secure versions):

- "Tuning Muxers" on page 6-7

- "Which Platforms Have Performance Packs?" on page 6-8

- "Enabling Performance Packs" on page 6-9

- "Changing the Number of Available Socket Readers" on page 6-9

- "Network Channels" on page 6-9

- "Tuning Message Size" on page 6-10

- "Tune the Chunk Parameters" on page 6-10

- "Tuning Connection Backlog Buffering" on page 6-11

Tuning Muxers

WebLogic Server uses software modules called muxers to read incoming requests on the server and incoming responses on the client. These muxers are of two primary types: the Java muxer or native muxer.

A Java muxer has the following characteristics:

- Uses pure Java to read data from sockets.

- It is also the only muxer available for RMI clients.

- Blocks on reads until there is data to be read from a socket. This behavior does not scale well when there are a large number of sockets and/or when data arrives infrequently at

sockets. This is typically not an issue for clients, but it can create a huge bottleneck for a server.

Native muxers use platform-specific native binaries to read data from sockets. The majority of all platforms provide some mechanism to poll a socket for data. For example, Unix systems use the poll system and the Windows architecture uses completion ports. Native provide superior scalability because they implement a non-blocking thread model. When a native muxer is used, the server creates a fixed number of threads dedicated to reading incoming requests. BEA recommends using the default setting of selected for the `Enable Native IO` parameter which allows the server automatically selects the appropriate muxer for the server to use.

If the `Enable Native IO` parameter is not selected, the server instance exclusively uses the Java muxer. This maybe acceptable if there are a small number of clients and the rate at which requests arrive at the server is fairly high. Under these conditions, the Java muxer performs as well as a native muxer and eliminate Java Native Interface (JNI) overhead. Unlike native muxers, the number of threads used to read requests is not fixed and is tunable for Java muxers by configuring the `Percent Socket Readers` parameter setting in the Administration Console. See "Changing the Number of Available Socket Readers" on page 6-9. Ideally, you should configure this parameter so the number of threads roughly equals the number of remote concurrently connected clients up to 50% of the total thread pool size. Each thread waits for a fixed amount of time for data to become available at a socket. If no data arrives, the thread moves to the next socket.

Which Platforms Have Performance Packs?

Benchmarks show major performance improvements when you use native performance packs on machines that host WebLogic Server instances. Performance packs use a platform-optimized, native socket multiplexor to improve server performance. For example, the native socket reader multiplexor threads have their own execute queue and do not borrow threads from the default execute queue, which frees up default execute threads to do application work

To see which platforms currently have performance packs available:

1. Go to the Certifications Pages at `{PLATFORM}/index.html`.

2. Select your platform from the list of certified platforms.

3. Use your browser's Edit →Find to locate all instances of "Performance Pack" to verify whether it is included for the platform.

Enabling Performance Packs

The use of native performance packs are enabled by default in the configuration shipped with your distribution. You can use the Administration Console to verify that performance packs are enabled.

To enable native IO:

1. In the left pane of the console, expand **Environment > Servers**.

2. On the **Summary of Servers** page, select the server instance for which you will enable native IO.

3. Expand the **Configuration > Tuning** tab.

4. If the **Enable Native IO** check box is not selected, select the check box.

5. Click **Save**.

Changing the Number of Available Socket Readers

If you must use the pure-Java socket reader implementation for host machines, you can improve the performance of socket communication by configuring the proper number of socket reader threads for each server instance and client machine.

To change the percentage of execute threads used as socket readers:

1. In the left pane of the console, expand **Environment > Servers**.

2. On the **Summary of Servers** page, select the server instance for which you will configure the number of available socket readers.

3. Expand the **Configuration > Tuning** tab.

4. On the **Configuration > Tuning** tab, update `Socket Readers`. The value of this parameter is the percentage of execute threads from the self-tuning thread pool that can be used as socket readers. This value can not exceed 50% of the thread pool. The default value is 33.

5. Click **Save**.

Network Channels

Network channels, also called network access points, allow you to specify different quality of service (QOS) parameters for network communication. Each network channel is associated with its own exclusive socket using a unique IP address and port. By default, requests from a

multi-threaded client are multiplexed over the same remote connection and the server instance reads requests from the socket one at a time. If the request size is large, this becomes a bottleneck.

Although the primary role of a network channel is to control the network traffic for a server instance, you can leverage the ability to create multiple custom channels to allow a multi-threaded client to communicate with server instance over multiple connections, reducing the potential for a bottleneck. To configure custom multi-channel communication, use the following steps:

1. Configure multiple network channels using different IP and port settings. See "Configure custom network channels" in *Administration Console Online Help.*

2. In your client-side code, use a JNDI URL pattern similar to the pattern used in clustered environments. The following is an example for a client using two network channels:

   ```
   t3://<ip1>:<port1>,<ip2>:<port2>
   ```

See "Understanding Network Channels" in *Configuring WebLogic Server Environments.*

Tuning Message Size

WebLogic Server allows you to specify a maximum incoming request size to reduce the potential for Denial of Service (DoS) attacks by preventing a server from being bombarded by a series of large requests. You can set a global value or set specific values for different protocols and network channels. Although it does not directly impact performance, JMS applications that aggregate messages before sending to a destination may be refused if the aggregated size is greater than specified value. See "Servers: Protocols: General" in *Administration Console Online Help* and *"Tuning MessageMaximum" on page 12-16.*

Tune the Chunk Parameters

A chunk is a unit of memory that the WebLogic Server network layer, both on the client and server side, uses to read data from and write data to sockets. To reduce memory allocation costs, a server instance maintains a pool of these chunks. For applications that handle large amounts of data per request, increasing the value on both the client and server sides can boost performance. The default chunk size is about 4K. Use the following properties to tune the chunk size and the chunk pool size:

- `weblogic.Chunksize`—Sets the size of a chunk (in bytes). The primary situation in which this may need to be increased is if request sizes are large. It should be set to values that are multiples of the network's maximum transfer unit (MTU), after subtracting from

the value any Ethernet or TCP header sizes. Set this parameter to the same value on the client and server.

- `weblogic.utils.io.chunkpoolsize`—Sets the maximum size of the chunk pool. The default value is 2048. The value may need to be increased if the server starts to allocate and discard chunks in steady state. To determine if the value needs to be increased, monitor the CPU profile or use a memory/ heap profiler for call stacks invoking the constructor `weblogic.utils.io.Chunk`.

- `weblogic.PartitionSize`—Sets the number of pool partitions used (default is 4). The chunk pool can be a source of significant lock contention as each request to access to the pool must be synchronized. Partitioning the thread pool spreads the potential for contention over more than one partition.

Tuning Connection Backlog Buffering

You can tune the number of connection requests that a WebLogic Server instance will accept before refusing additional requests. The `Accept Backlog` parameter specifies how many Transmission Control Protocol (TCP) connections can be buffered in a wait queue. This fixed-size queue is populated with requests for connections that the TCP stack has received, but the application has not accepted yet.

You can tune the number of connection requests that a WebLogic Server instance will accept before refusing additional requests. For more information on TCP tuning, see "Basic OS Tuning Concepts" on page 4-1.

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure connection backlog buffering.

4. Expand the **Configuration > Tuning** tab.

5. Modify the **Accept Backlog** value as necessary to tune the number of TCP connections the server instance can buffer in the wait queue.

- If many connections are dropped or refused at the client, and no other error messages are on the server, the **Accept Backlog** value might be set too low.

- If you are getting "connection refused" messages when you try to access WebLogic Server, raise the **Accept Backlog** value from the default by 25 percent. Continue increasing the value by 25 percent until the messages cease to appear.

- The default value is 50 and the maximum value is operating system dependent.

6. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

Setting Your Compiler Options

You may improve performance by tuning your server's compiler options.

Compiling EJB Classes

Use the `weblogic.appc` utility to compile EJB 2.x and 1.1 container classes. If you compile `Jar` files for deployment into the EJB container, you must use `weblogic.appc` to generate the container classes. By default, ejbc uses the `javac` compiler. You may be able to improve performance by specifying a different compiler (such as `IBM Jikes`) using the `-compiler` flag or using the Administration console. For more information, see:

- "Implementing Enterprise Java Beans" in *Programming WebLogic EJB*

- Configure compiler options in *Administration Console Online Help.*

Setting JSP Compiler Options

WebLogic Server uses Javelin to compile JSPs. In the `weblogic.xml` file, the `jsp-descriptor` element defines parameter names and values for servlet JSPs. Use the `precompile` parameter to configure WebLogic Server to precompile your JSPs when WebLogic Server starts up. See the `jsp-descriptor` element at `{DOCROOT}/webapp/weblogic_xml.html#jsp-descriptor`.

If you receive the following error message received when compiling JSP files on a UNIX machine:

```
failed: java.io.IOException: Not enough space
```

Try any or all of the following solutions:

- Add more RAM if you have only 256 MB.

- Raise the file descriptor limit, for example:

```
set rlim_fd_max = 4096
```

```
set rlim_fd_cur = 1024
```

Using WebLogic Server Clusters to Improve Performance

A WebLogic Server cluster is a group of WebLogic Servers instances that together provide fail-over and replicated services to support scalable high-availability operations for clients within a domain. A cluster appears to its clients as a single server but is in fact a group of servers acting as one to provide increased scalability and reliability.

A domain can include multiple WebLogic Server clusters and non-clustered WebLogic Server instances. Clustered WebLogic Server instances within a domain behave similarly to non-clustered instances, except that they provide failover and load balancing. The Administration Server for the domain manages all the configuration parameters for the clustered and non-clustered instances.

For more information about clusters, see "Understanding WebLogic Server Clustering" at {DOCROOT}/cluster/overview.html.

Scalability and High Availability

Scalability is the ability of a system to grow in one or more dimensions as more resources are added to the system. Typically, these dimensions include (among other things), the number of concurrent users that can be supported and the number of transactions that can be processed in a given unit of time.

Given a well-designed application, it is entirely possible to increase performance by simply adding more resources. To increase the load handling capabilities of WebLogic Server, add another WebLogic Server instance to your cluster—without changing your application. Clusters provide two key benefits that are not provided by a single server: scalability and availability.

WebLogic Server clusters bring scalability and high-availability to J2EE applications in a way that is transparent to application developers. Scalability expands the capacity of the middle tier beyond that of a single WebLogic Server or a single computer. The only limitation on cluster membership is that all WebLogic Servers must be able to communicate by IP multicast. New WebLogic Servers can be added to a cluster dynamically to increase capacity.

A WebLogic Server cluster guarantees high-availability by using the redundancy of multiple servers to insulate clients from failures. The same service can be provided on multiple servers in a cluster. If one server fails, another can take over. The ability to have a functioning server take over from a failed server increases the availability of the application to clients.

Caution: Provided that you have resolved all application and environment bottleneck issues, adding additional servers to a cluster should provide linear scalability. When doing benchmark or initial configuration test runs, isolate issues in a single server environment before moving to a clustered environment.

Clustering in the Messaging Service is provided through distributed destinations; connection concentrators, and connection load-balancing (determined by connection factory targeting); and clustered Store-and-Forward (SAF). Client load-balancing with respect to distributed destinations is tunable on connection factories. Distributed destination Message Driven Beans (MDBs) that are targeted to the same cluster that hosts the distributed destination automatically deploy only on cluster servers that host the distributed destination members and only process messages from their local destination. Distributed queue MDBs that are targeted to a different server or cluster than the host of the distributed destination automatically create consumers for every distributed destination member. For example, each running MDB has a consumer for each distributed destination queue member.

How to Ensure Scalability for WebLogic Clusters

In general, any operation that requires communication between the servers in a cluster is a potential scalability hindrance. The following sections provide information on issues that impact the ability to linearly scale clustered WebLogic servers:

- "Database Bottlenecks" on page 6-14

- "Session Replication" on page 6-15

- "Invalidation of Entity EJBs" on page 6-15

- "Invalidation of HTTP sessions" on page 6-16

- "JNDI Binding, Unbinding and Rebinding" on page 6-16

Database Bottlenecks

In many cases where a cluster of WebLogic servers fails to scale, the database is the bottleneck. In such situations, the only solutions are to tune the database or reduce load on the database by exploring other options. See "DataBase Tuning" on page 8-1 and "Tuning JDBC Applications" on page 10-1.

Session Replication

User session data can be stored in two standard ways in a J2EE application: stateful session EJBs or HTTP sessions. By themselves, they are rarely a impact cluster scalability. However, when coupled with a session replication mechanism required to provide high-availability, bottlenecks are introduced. If a J2EE application has Web and EJB components, you should store user session data in HTTP sessions:

- HTTP session management provides more options for handling fail-over, such as replication, a shared DB or file.

- Superior scalability.

- Replication of the HTTP session state occurs outside of any transactions. Stateful session bean replication occurs in a transaction which is more resource intensive.

- The HTTP session replication mechanism is more sophisticated and provides optimizations a wider variety of situations than stateful session bean replication.

See "Session Management" on page 16-3.

Invalidation of Entity EJBs

This applies to entity EJBs that use a concurrency strategy of `Optimistic` or `ReadOnly` with a read-write pattern.

`Optimistic`—When an `Optimistic` concurrency bean is updated, the EJB container sends a multicast message to other cluster members to invalidate their local copies of the bean. This is done to avoid optimistic concurrency exceptions being thrown by the other servers and hence the need to retry transactions. If updates to the EJBs are frequent, the work done by the servers to invalidate each other's local caches become a serious bottleneck. A flag called `cluster-invalidation-disabled` (default false) is used to turn off such invalidations. This is set in the `rdbms` descriptor file.

`ReadOnly` with a read-write pattern—In this pattern, persistent data that would otherwise be represented by a single EJB are actually represented by two EJBs: one read-only and the other updateable. When the state of the updateable bean changes, the container automatically invalidates corresponding read-only EJB instance. If updates to the EJBs are frequent, the work done by the servers to invalidate the read-only EJBs becomes a serious bottleneck.

Invalidation of HTTP sessions

Similar to "Invalidation of Entity EJBs" on page 6-15, HTTP sessions can also be invalidated. This is not as expensive as entity EJB invalidation, since only the session data stored in the secondary server needs to be invalidated. BEA advises users to not invalidate sessions unless absolutely required.

JNDI Binding, Unbinding and Rebinding

In general, JNDI binds, unbinds and rebinds are expensive operations. However, these operations become a bigger bottleneck in clustered environments because JNDI tree changes have to be propagated to all members of a cluster. If such operations are performed too frequently, they can reduce cluster scalability significantly.

Performance Considerations When Running Multiple Server Instances on Multi-CPU Machines

With multi-processor machines, additional consideration must be given to the ratio of the number of available CPUs to clustered WebLogic Server instances. Because WebLogic Server has no built-in limit to the number of server instances that reside in a cluster, large, multi-processor servers, such as Sun Microsystems' Sun Enterprise 10000, can potentially host very large clusters or multiple clusters.

In order to determine the optimal ratio of CPUs to WebLogic server instances, you must first ensure that an application is truly CPU-bound, rather than network or disk I/O-bound. Use the following steps to determine the optional ratio of CPUs to server instances:

1. Test your application to determine the *Network Requirements.*

   If you discover that an application is primarily network I/O-bound, consider measures to increase network throughput before increasing the number of available CPUs. For truly network I/O-bound applications, installing a faster network interface card (NIC) may increase performance more than additional CPUs, because most CPUs would remain idle while waiting to read available sockets.

2. Test your application to determine the *Disk I/O Requirements.*

   If you discover that an application is primarily disk I/O-bound, consider upgrading the number of disk spindles or individual disks and controllers before allocating additional CPUs.

3. Begin performance tests using a ratio of one WebLogic Server instance for every available CPU.

4. If CPU utilization is consistently at or near 100 percent, increase the ratio of CPUs to server instances by adding an additional CPU. Add additional CPUs until utilization reaches an acceptable level. Remember, always reserve some spare CPU cycles on your production systems to perform any administration tasks that may occur.

How to Monitor a WebLogic Server Domain

The following sections provide information on how to monitor WebLogic Server domains:

- "Using the Administration Console to Monitor WebLogic Server" on page 6-17

- "Using JMX to Monitor WebLogic Server" on page 6-17

- "Using WLST to Monitor WebLogic Server" on page 6-17

- "dev2dev Resources to Monitor WebLogic Server" on page 6-17

- "Third-Party Tools to Monitor WebLogic Server" on page 6-18

Using the Administration Console to Monitor WebLogic Server

The tool for monitoring the health and performance of your WebLogic Server domain is the Administration Console. See "Monitor servers" in *Administration Console Online Help*.

Using JMX to Monitor WebLogic Server

WebLogic Server® provides its own set of MBeans that you can use to configure, monitor, and manage WebLogic Server resources. See "*Developing Custom Management Utilities with JMX*".

Using WLST to Monitor WebLogic Server

The WebLogic Scripting Tool (WLST) is a command-line scripting interface that system administrators and operators use to monitor and manage WebLogic Server instances and domains. See "*WebLogic Scripting Tool*".

dev2dev Resources to Monitor WebLogic Server

dev2dev.bea.com provides product downloads, articles, sample code, product documentation, tutorials, white papers, news groups, and other key content for WebLogic Server.

Third-Party Tools to Monitor WebLogic Server

BEA partners with other companies that provide production monitoring and management tools. See "Production Performance Management" on page A-7.

Tuning the WebLogic Persistent Store

The following sections explain how to tune the persistent store, which provides a built-in, high-performance storage solution for WebLogic Server subsystems and services that require persistence.

Overview of Persistent Stores

The following sections provide information on using persistent stores.

Using the Default Persistent Store

Each server instance, including the administration server, has a default persistent store that requires no configuration. The default store is a file-based store that maintains its data in a group of files in a server instance's `data\store\default` directory. A directory for the default store is automatically created if one does not already exist. This default store is available to subsystems

that do not require explicit selection of a particular store and function best by using the system's default storage mechanism. For example, a JMS Server with no persistent store configured will use the default store for its Managed Server and will support persistent messaging. See:

- "Using the WebLogic Persistent Store" in *Configuring WebLogic Server Environments*.

- "Modify the Default Store Settings" in *Administration Console Online Help.*

Using Custom File Stores and JDBC Stores

In addition to using the default file store, you can also configure a file store or JDBC store to suit your specific needs. A custom file store, like the default file store, maintains its data in a group of files in a directory. However, you may want to create a custom file store so that the file store's data is persisted to a particular storage device. When configuring a file store directory, the directory must be accessible to the server instance on which the file store is located.

A JDBC store can be configured when a relational database is used for storage. A JDBC store enables you to store persistent messages in a standard JDBC-capable database, which is accessed through a designated JDBC data source. The data is stored in the JDBC store's database table, which has a logical name of WLStore. It is up to the database administrator to configure the database for high availability and performance. See:

- "When to Use a Custom Persistent Store" in *Configuring WebLogic Server Environments*.

- "Comparing File Stores and JDBC Stores" in *Configuring WebLogic Server Environments*.

- "Creating a Custom (User-Defined) File Store" in *Configuring WebLogic Server Environments*.

- "Creating a JDBC Store" in *Configuring WebLogic Server Environments*.

Using JMS Paging Stores

Each JMS server implicitly creates a file based paging store. When the WebLogic Server JVM runs low on memory, this store is used to page non-persistent messages as well as JDBC store persistent messages. Depending on the application, paging stores may generate heavy disk activity.

Note: File store persistent messages do not page using a paging store, such messages page directly into and out of their respective file stores.

JMS paging stores usually require no tuning. You can optionally change the directory location and the thresholds setting at which paging begins. See "Paging Out Messages To Free Up Memory" on page 12-6.

Best Practices When Using Persistent Stores

- For subsystems that share the same server instance, share one store between multiple subsystems rather than using a store per subsystem. Sharing a store is more efficient for the following reasons:

  – A single store batches concurrent requests into single I/Os which reduces overall disk usage.

  – Transactions in which only one resource participates are lightweight one-phase transactions. Conversely, transactions in which multiple stores participate become are heavier weight two-phase transactions.

  For example, configure all SAF agents and JMS servers that run on the same server instance so that they share the same store.

- Add a new store only when the old store(s) no longer scale.

Tuning JDBC Stores

The location of the JDBC store DDL that is used to initialize empty stores is now configurable. This simplifies the use of custom DDL for database table creation, which is sometimes used for database specific performance tuning. For information, see "Create JDBC stores" in *Administration Console Online Help* and "Using the WebLogic Persistent Store" in *Configuring WebLogic Server Environments*.

Tuning File Stores

The following section provides information on tuning File Stores:

- For basic (non-RAID) disk hardware, consider dedicating one disk per file store. A store can operate up to four to five times faster if it does not have to compete with any other store on the disk. Remember to consider the existence of the default file store in addition to each configured store and a JMS paging store for each JMS server.

- Use `Direct-Write` synchronous write policy.

– For releases of WebLogic Server 9.0 and higher, `Direct-Write` is the default write policy. In most applications `Direct-Write` provides better performance than the `Cache-Flush` write policy.

> **Note:** The `Direct-Write` write-policy (default) can be unsafe on Microsoft Windows. As with other vendors that use a direct write policy, MS-Windows system administrators must ensure that the Windows disk configuration doesn't cache direct-writes in memory instead of flushing them to disk. See getSynchronousWritePolicy.

– File stores in releases prior to Weblogic Server 9.0 default to the `Cache-Flush` write policy.

● The `Disabled` write-policy option can dramatically improve performance, especially at low client loads. However, it is unsafe because writes become asynchronous and data can be lost in the event of Operating System or power failure.

● When performing head-to-head vendor comparisons, make sure all the write policies for the persistent store are equivalent. Some non-WebLogic vendors default to the equivalent of the `Disabled`.

● If disk performance continues to be a bottleneck, consider purchasing disk or RAID controller hardware that has a built-in "write-back cache". These caches significantly improve performance by temporarily storing persistent data in volatile memory. Use a battery backed write-back caches to provide protection from power outages, host machine failure, and operating system failure.

DataBase Tuning

Your database can be a major enterprise-level bottleneck. Configure your database for optimal performance by following the tuning guidelines in this section and in the product documentation for the database you are using.

General Suggestions

This section provides general database tuning suggestions:

- Good database design — Distribute the database workload across multiple disks to avoid or reduce disk overloading. Good design also includes proper sizing and organization of tables, indexes, and logs.

- Disk I/O optimization — Disk I/O optimization is related directly to throughput and scalability. Access to even the fastest disk is orders of magnitude slower than memory access. Whenever possible, optimize the number of disk accesses. In general, selecting a larger block/buffer size for I/O reduces the number of disk accesses and might substantially increase throughput in a heavily loaded production environment.

- Checkpointing — This mechanism periodically flushes all dirty cache data to disk, which increases the I/O activity and system resource usage for the duration of the checkpoint. Although frequent checkpointing can increase the consistency of on-disk data, it can also slow database performance. Most database systems have checkpointing capability, but not all database systems provide user-level controls. Oracle, for example, allows administrators

to set the frequency of checkpoints while users have no control over SQLServer 7.x checkpoints. For recommended settings, see the product documentation for the database you are using.

● Disk and database overhead can sometimes be dramatically reduced by batching multiple operations together and/or increasing the number of operations that run in parallel (increasing concurrency). Examples:

– Increasing the value of the Message bridge `BatchSize` or the Store-and-Forward `WindowSize` can improve performance as larger batch sizes produce fewer but larger I/Os.

– Programmatically leveraging JDBC's batch APIs.

– Use the MDB transaction batching feature. .

– Increasing concurrency by increasing `max-beans-in-free-pool` and the thread pool size for MDBs (or decreasing it if batching can be leveraged).

Database-Specific Tuning

The following sections provide basic tuning suggestions for Oracle, SQL Server, and Sybase:

Note: Always check the tuning guidelines in your database-specific vendor documentation.

Oracle

This section describes performance tuning for Oracle.

● Number of processes — On most operating systems, each connection to the Oracle server spawns a shadow process to service the connection. Thus, the maximum number of processes allowed for the Oracle server must account for the number of simultaneous users, as well as the number of background processes used by the Oracle server. The default number is usually not big enough for a system that needs to support a large number of concurrent operations. For platform-specific issues, see your Oracle administrator's guide. The current setting of this parameter can be obtained with the following query:

```
SELECT name, value FROM v$parameter WHERE name = 'processes';
```

- Buffer pool size —The buffer pool usually is the largest part of the Oracle server system global area (SGA). This is the location where the Oracle server caches data that it has read from disk. For read-mostly applications, the single most important statistic that affects data base performance is the buffer cache hit ratio. The buffer pool should be large enough to provide upwards of a 95% cache hit ratio. Set the buffer pool size by changing the value, in data base blocks, of the `db_cache_size` parameter in the `init.ora` file.

- Shared pool size — The share pool in an important part of the Oracle server system global area (SGA). The SGA is a group of shared memory structures that contain data and control information for one Oracle database instance. If multiple users are concurrently connected to the same instance, the data in the instance's SGA is shared among the users. The shared pool portion of the SGA caches data for two major areas: the library cache and the dictionary cache. The library cache stores SQL-related information and control structures (for example, parsed SQL statement, locks). The dictionary cache stores operational metadata for SQL processing.

  For most applications, the shared pool size is critical to Oracle performance. If the shared pool is too small, the server must dedicate resources to managing the limited amount of available space. This consumes CPU resources and causes contention because Oracle imposes restrictions on the parallel management of the various caches. The more you use triggers and stored procedures, the larger the shared pool must be. The `SHARED_POOL_SIZE` initialization parameter specifies the size of the shared pool in bytes.

  The following query monitors the amount of free memory in the share pool:

  ```
  SELECT * FROM v$sgastat
  WHERE name = 'free memory' AND pool = 'shared pool';
  ```

- Maximum opened cursor — To prevent any single connection taking all the resources in the Oracle server, the `OPEN_CURSORS` initialization parameter allows administrators to limit the maximum number of opened cursors for each connection. Unfortunately, the default value for this parameter is too small for systems such as WebLogic Server. Cursor information can be monitored using the following query:

  ```
  SELECT name, value FROM v$sysstat
  WHERE name LIKE 'opened cursor%';
  ```

- Database block size — A block is Oracle's basic unit for storing data and the smallest unit of I/O. One data block corresponds to a specific number of bytes of physical database space on disk. This concept of a block is specific to Oracle RDBMS and should not be confused with the block size of the underlying operating system. Note that since the block size affects physical storage, this value can be set only during the creation of the database; it cannot be changed once the database has been created. The current setting of this parameter can be obtained with the following query:

```
SELECT name, value FROM v$parameter WHERE name = 'db_block_size';
```

- Sort area size — Increasing the sort area increases the performance of large sorts because it allows the sort to be performed in memory during query processing. This can be important, as there is only one sort area for each connection at any point in time. The default value of this `init.ora` parameter is usually the size of 6–8 data blocks. This value is usually sufficient for OLTP operations but should be increased for decision support operation, large bulk operations, or large index-related operations (for example, recreating an index). When performing these types of operations, you should tune the following `init.ora` parameters (which are currently set for 8K data blocks):

```
sort_area_size = 65536
sort_area_retained_size = 65536
```

Microsoft SQL Server

The following guidelines pertain to performance tuning parameters for Microsoft SQL Server databases. For more information about these parameters, see your Microsoft SQL Server documentation.

- Store `tempdb` on a fast I/O device.

- Increase the recovery interval if `perfmon` shows an increase in I/O.

- Use an I/O block size larger than 2 KB.

Sybase

The following guidelines pertain to performance tuning parameters for Sybase databases. For more information about these parameters, see your Sybase documentation.

- Lower recovery interval setting results in more frequent checkpoint operations, resulting in more I/O operations.

- Use an I/O block size larger than 2 KB.

- Sybase controls the number of engines in a symmetric multiprocessor (SMP) environment. They recommend configuring this setting to equal the number of CPUs minus 1.

Tuning WebLogic Server EJBs

The following sections describe how to tune WebLogic Server EJBs to match your application needs:

General EJB Tuning Tips

- Deployment descriptors are schema-based. Descriptors that are new in this release of WebLogic Server are not available as DTD-based descriptors.

- Avoid using the `RequiresNew` transaction parameter. Using `RequiresNew` causes the EJB container to start a new transaction after suspending any current transactions. This means additional resources, including a separate data base connection are allocated.

- Use local-interfaces or set call-by-reference to true to avoid the overhead of serialization when one EJB calls another or an EJB is called by a servlet/JSP in the same application. Note the following:

    – In release prior to WebLogic Server 8.1, call-by-reference is turned on by default. For releases of WebLogic Server 8.1 and higher, call-by-reference is turned off by default.

Older applications migrating to WebLogic Server 8.1 and higher that do not explicitly turn on call-by-reference may experience a drop in performance.

– This optimization does not apply to calls across different applications.

- Use Stateless session beans over Stateful session beans whenever possible. Stateless session beans scale better than stateful session beans because there is no state information to be maintained.

- WebLogic Server provides additional transaction performance benefits for EJBs that reside in a WebLogic Server cluster. When a single transaction uses multiple EJBs, WebLogic Server attempts to use EJB instances from a single WebLogic Server instance, rather than using EJBs from different servers. This approach minimizes network traffic for the transaction. In some cases, a transaction can use EJBs that reside on multiple WebLogic Server instances in a cluster. This can occur in heterogeneous clusters, where all EJBs have not been deployed to all WebLogic Server instances. In these cases, WebLogic Server uses a multitier connection to access the datastore, rather than multiple direct connections. This approach uses fewer resources, and yields better performance for the transaction. However, for best performance, the cluster should be homogeneous — all EJBs should reside on all available WebLogic Server instances.

Tuning EJB Caches

The following sections provide information on how to tune EJB caches:

Tuning the Stateful Session Bean Cache

The EJB Container caches stateful session beans in memory up to a count specified by the `max-beans-in-cache` parameter specified in `weblogic-ejb-jar.xml`. This parameter should be set equal to the number of concurrent users. This ensures minimum passivation of stateful session beans to disk and subsequent activation from disk which yields better performance.

Tuning the Entity Bean Cache

Entity beans are cached at two levels by the EJB container:

●

Transaction-Level Caching

Once an entity bean has been loaded from the database, it is always retrieved from the cache whenever it is requested when using the `findByPrimaryKey` or invoked from a cached reference in that transaction. Note that getting an entity bean using a non-primary key finder always retrieves the persistent state of the bean from the data base.

Caching between transactions

Entity bean instances are also cached between transactions. However, by default, the persistent state of the entity beans are not cached between transactions. To enable caching between transactions, set the value of the `cache-between-transactions` parameter to true.

Is it safe to cache the state? This depends on the concurrency-strategy for that bean. The entity-bean cache is really only useful when `cache-between-transactions` can be safely set to true. In cases where `ejbActivate()` and `ejbPassivate()` callbacks are expensive, it is still a good idea to ensure the entity-cache size is large enough. Even though the persistent state may be reloaded at least once per transaction, the beans in the cache are already activated. The value of the cache-size is set by the deployment descriptor parameter `max-beans-in-cache` and should be set to maximize cache-hits. In most situations, the value need not be larger than the product of the number of rows in the table associated with the entity bean and the number of threads expected to access the bean concurrently.

Tuning the Query Cache

Query Caching is a new feature in WebLogic Server 9.0 that allows read-only CMP entity beans to cache the results of arbitrary finders. Query Caching is supported for all finders except `prepared-query` finders. The query cache can be an application-level cache as well as a bean-level cache. The size of the cache is limited by the `weblogic-ejb-jar.xml` parameter `max-queries-in-cache`. The `finder-level` flag in the `weblogic-cmp-rdbms` descriptor file, `enable-query-caching` is used to specify whether the results of that finder are to be cached. A flag with the same name has the same purpose for internal relationship finders when applied to the `weblogic-relationship-role` element. Queries are evicted from the query-cache under the following circumstances:

● The query is least recently used and the `query-cache` has hit its size limit.

● At least one of the EJBs that satisfy the query has been evicted from the entity bean cache, regardless of the reason.

- The query corresponds to a finder that has `eager-relationship-caching` enabled and the query for the associated internal relationship finder has been evicted from the related bean's query cache.

It is possible to let the size of the entity-bean cache limit the size of the query-cache by setting the `max-queries-in-cache` parameter to 0, since queries are evicted from the cache when the corresponding EJB is evicted. This may avoid some lock contention in the query cache, but the performance gain may not be significant.

Tuning EJB Pools

The following section provides information on how to tune EJB pools:

Tuning the Stateless Session Bean Pool

The EJB container maintains a pool of stateless session beans to avoid creating and destroying instances. Though generally useful, this pooling is even more important for performance when the `ejbCreate()` and the `setSessionContext()` methods are expensive. The pool has a lower as well as an upper bound. The upper bound is the more important of the two.

- The upper bound is specified by the `max-beans-in-free-pool` parameter. It should be set equal to the number of threads expected to invoke the EJB concurrently. Using too small of a value impacts concurrency.

- The lower bound is specified by the `initial-beans-in-free-pool` parameter. Increasing the value of `initial-beans-in-free-pool` increases the time it takes to deploy the application containing the EJB and contributes to startup time for the server. The advantage is the cost of creating EJB instances is not incurred at run time. Setting this value too high wastes memory.

Tuning the MDB Pool

The lifecycle of MDBs is very similar to stateless session beans. The MDB pool has the same tuning parameters as stateless session beans and the same factors apply when tuning them. In general, most users will find that the default values are adequate for most applications.

Tuning the Entity Bean Pool

The entity bean pool serves two purposes:

- A target objects for invocation of finders via reflection.

- A pool of bean instances the container can recruit if it cannot find an instance for a particular primary key in the cache.

The entity pool contains anonymous instances (instances that do not have a primary key). These beans are not yet active (meaning `ejbActivate()` has not been invoked on them yet), though the EJB context has been set. Entity bean instances evicted from the entity cache are passivated and put into the pool. The tunables are the `initial-beans-in-free-pool` and `max-beans-in-free-pool`. Unlike stateless session beans and MDBs, the `max-beans-in-free-pool` has no relation with the thread count. You should increase the value of `max-beans-in-free-pool` if the entity bean constructor or `setEnityContext()` methods are expensive.

CMP Entity Bean Tuning

The largest performance gains in entity beans are achieved by using caching to minimize the number of interactions with the data base. However, in most situations, it is not realistic to be able to cache entity beans beyond the scope of a transaction. The following sections provide information on WebLogic Server EJB container features, most of which are configurable, that you can use to minimize database interaction safely:

- "Use Eager Relationship Caching" on page 9-6

- "Use JDBC Batch Operations" on page 9-6

- "Tuned Updates" on page 9-6

- "Using Field Groups" on page 9-6

- "include-updates" on page 9-7

- "call-by-reference" on page 9-7

- "Bean-level Pessimistic Locking" on page 9-7

- "Concurrency Strategy" on page 9-8

Use Eager Relationship Caching

Using eager relationship caching allows the EJB container to load related entity beans using a single SQL join. Use only when the same transaction accesses related beans. See Relationship Caching in *Programming WebLogic Server Enterprise JavaBeans*.

Use JDBC Batch Operations

JDBC batch operations are turned on by default in the EJB container. The EJB container automatically re-orders and executes similar data base operations in a single batch which increases performance by eliminating the number of data base round trips. BEA recommends using batch operations.

Tuned Updates

When an entity EJB is updated, the EJB container automatically updates in the data base only those fields that have actually changed. As a result the update statements are simpler and if a bean has not been modified, no data base call is made. Because different transactions may modify different sets of fields, more than one form of update statements may be used to store the bean in the data base. It is important that you account for the types of update statements that may be used when setting the size of the prepared statement cache in the JDBC connection pool. See "Cache Prepared and Callable Statements" on page 10-3.

Using Field Groups

Field groups allow the user to segregate commonly used fields into a single group. If any of the fields in the group is accessed by application/bean code, the entire group is loaded using a single SQL statement. This group can also be associated with a finder. When the finder is invoked and `finders-load-bean` is true, it loads only those fields from the data base that are included in the field group. This means that if most transactions do not use a particular field that is slow to load, such as a BLOB, it can be excluded from a field-group. Similarly, if an entity bean has a lot of fields, but a transaction uses only a small number of them, the unused fields can be excluded.

Note: Be careful to ensure that fields that are accessed in the same transaction are not configured into separate field-groups. If that happens, multiple data base calls occur to load the same bean, when one would have been enough.

include-updates

This flag causes the EJB container to flush all modified entity beans to the data base before executing a finder. If the application modifies the same entity bean more than once and executes a non-pk finder in-between in the same transaction, multiple updates to the data base are issued. This flag is turned on by default to comply with the EJB specification.

If the application has transactions where two invocations of the same or different finders could return the same bean instance and that bean instance could have been modified between the finder invocations, it makes sense leaving include-updates turned on. If not, this flag may be safely turned off. This eliminates an unnecessary flush to the data base if the bean is modified again after executing the second finder. This flag is specified for each finder in the cmp-rdbms descriptor.

call-by-reference

When it is turned off, method parameters to an EJB are passed by value, which involves serialization. For mutable, complex types, this can be significantly expensive. Consider using for better performance when:

- The application does not require call-by-value semantics, such as method parameters are not modified by the EJB.

  or

- If modified by the EJB, the changes need not be invisible to the caller of the method.

This flag applies to all EJBs, not just entity EJBs. It also applies to EJB invocations between servlets/JSPs and EJBs in the same application. The flag is turned off by default to comply with the EJB specification. This flag is specified at the bean-level in the WebLogic-specific deployment descriptor.

Bean-level Pessimistic Locking

Bean-level pessimistic locking is implemented in the EJB container by acquiring a data base lock when loading the bean. When implemented, each entity bean can only be accessed by a single transaction in a single server at a time. All other transactions are blocked, waiting for the owning transaction to complete. This is a useful alternative to using a higher data base isolation level, which can be expensive at the RDBMS level. This flag is specified at the bean level in the cmp-rdbms deployment descriptor.

Note: If the lock is not exclusive lock, you man encounter deadlock conditions. If the data base lock is a shared lock, there is potential for deadlocks when using that RDBMS.

Concurrency Strategy

The `concurrency-strategy` deployment descriptor tells the EJB container how to handle concurrent access of the same entity bean by multiple threads in the same server instance. Set this parameter to one of four values:

- `Exclusive`—The EJB container ensures there is only one instance of an EJB for a given primary key and this instance is shared among all concurrent transactions in the server with the container serializing access to it. This concurrency setting generally does not provide good performance unless the EJB is used infrequently and chances of concurrent access is small.

- `Database`—This is the default value and most commonly used concurrency strategy. The EJB container defers concurrency control to the database. The container maintains multiple instances of an EJB for a given primary-key and each transaction gets it's own copy. In combination with this strategy, the database isolation-level and bean level pessimistic locking play a major role in determining if concurrent access to the persistent state should be allowed. Note that it is possible for multiple transactions to access the bean concurrently so long as it does not need to go to the database, as would happen when the value of `cache-between-transactions` is true. However, setting the value of `cache-between-transactions` to true unsafe and not recommended with the `Dababase` concurrency strategy.

- `Optimistic`—The goal of the optimistic concurrency strategy is to minimize locking at the data base and while continuing to provide data consistency. The basic assumption is that the persistent state of the EJB is changed very rarely. The container attempts to load the bean in a nested transaction so that the isolation-level settings of the outer transaction does not cause locks to be acquired at the data base. At commit-time, if the bean has been modified, a predicated update is used to ensure it's persistent state has not been changed by some other transaction. If so, an `OptimisticConcurrencyException` is thrown and must be handled by the application.

  Since EJBs that can use this concurrency strategy are rarely modified, using `cache-between-transactions` on can boost performance significantly. This strategy also allows commit-time verification of beans that have been read, but not changed. This is done by setting the `verify-rows` parameter to `Read` in the `cmp-rdbms` descriptor. This provides very high data-consistency while at the same time minimizing locks at the data base. However, it does slow performance somewhat. It is recommended that the optimistic verification be performed using a version column: it is faster, followed closely by timestamp, and more distantly by modified and read. The modified value does not apply if verify-rows is set to `Read`.

When an optimistic concurrency bean is modified in a server that is part of a cluster, the server attempts to invalidate all instances of that bean cluster-wide in the expectation that it will prevent `OptimisticConcurrencyExceptions`. In some cases, it may be more cost effective to simply let other servers throw an `OptimisticConcurrencyException`. in this case, turn off the cluster-wide invalidation by setting the `cluster-invalidation-disabled` flag in the `cmp-rdbms` descriptor.

- `ReadOnly`—The ReadOnly value is the most performant. When selected, the container assumes the EJB is non-transactional and automatically turns on `cache-between-transactions`. Bean states are updated from the data base at periodic, configurable intervals or when the bean has been programmatically invalidated. The interval between updates can cause the persistent state of the bean to become stale. This is the only concurrency-strategy for which `query-caching` can be used. See "Caching between transactions" on page 9-3.

Tuning In Response to Monitoring Statistics

The WebLogic Server Administration Console reports a wide variety of EJB runtime monitoring statistics, many of which are useful for tuning your EJBs. This section discusses how some of these statistics can help you tune the performance of EJBs.

To display the statistics in the Administration Console, see "Monitoring EJBs" in *Administration Console Online Help*. If you prefer to write a custom monitoring application, you can access the monitoring statistics using JMX or WLST by accessing the relevant runtime MBeans. See Runtime MBeans in the WebLogic Server® MBean Reference.

Cache Miss Ratio

The cache miss ratio is a ratio of the number of times a container cannot find a bean in the cache (cache miss) to the number of times it attempts to find a bean in the cache (cache access):

```
Cache Miss Ratio = (Cache Total Miss Count / Cache Total Access Count) * 100
```

A high cache miss ratio could be indicative of an improperly sized cache. If your application uses a certain subset of beans (read primary keys) more frequently than others, it would be ideal to size your cache large enough so that the commonly used beans can remain in the cache as less commonly used beans are cycled in and out upon demand. If this is the nature of your application, you may be able to decrease your cache miss ratio significantly by increasing the maximum size of your cache.

If your application doesn't necessarily use a subset of beans more frequently than others, increasing your maximum cache size may not affect your cache miss ratio. We recommend

testing your application with different maximum cache sizes to determine which give the lowest cache miss ratio. It is also important to keep in mind that your server has a finite amount of memory and therefore there is always a trade-off to increasing your cache size.

Lock Waiter Ratio

When using the `Exclusive` concurrency strategy, the lock waiter ratio is the ratio of the number of times a thread had to wait to obtain a lock on a bean to the total amount of lock requests issued:

```
Lock Waiter Ratio = (Current Waiter Count / Current Lock Entry Count) * 100
```

A high lock waiter ratio can indicate a suboptimal concurrency strategy for the bean. If acceptable for your application, a concurrency strategy of Database or Optimistic will allow for more parallelism than an Exclusive strategy and remove the need for locking at the EJB container level.

Because locks are generally held for the duration of a transaction, reducing the duration of your transactions will free up beans more quickly and may help reduce your lock waiter ratio. To reduce transaction duration, avoid grouping large amounts of work into a single transaction unless absolutely necessary.

Lock Timeout Ratio

When using the `Exclusive` concurrency strategy, the lock timeout ratio is the ratio of timeouts to accesses for the lock manager:

```
Lock Timeout Ratio =(Lock Manager Timeout Total Count / Lock Manager Total
Access Count) * 100
```

The lock timeout ratio is closely related to the lock waiter ratio. If you are concerned about the lock timeout ratio for your bean, first take a look at the lock waiter ratio and our recommendations for reducing it (including possibly changing your concurrency strategy). If you can reduce or eliminate the number of times a thread has to wait for a lock on a bean, you will also reduce or eliminate the amount of timeouts that occur while waiting.

A high lock timeout ratio may also be indicative of an improper transaction timeout value. The maximum amount of time a thread will wait for a lock is equal to the current transaction timeout value.

If the transaction timeout value is set too low, threads may not be waiting long enough to obtain access to a bean and timing out prematurely. If this is the case, increasing the trans-timeout-seconds value for the bean may help reduce the lock timeout ratio.

Take care when increasing the trans-timeout-seconds, however, because doing so can cause threads to wait longer for a bean and threads are a valuable server resource. Also, doing so may increase the request time, as a request ma wait longer before timing out.

Pool Miss Ratio

The pool miss ratio is a ratio of the number of times a request was made to get a bean from the pool when no beans were available, to the total number of requests for a bean made to the pool:

```
Pool Miss Ratio = (Pool Total Miss Count / Pool Total Access Count) * 100
```

If your pool miss ratio is high, you must determine what is happening to your bean instances. There are three things that can happen to your beans.

- They are in use.

- They were destroyed.

- They were removed.

Follow these steps to diagnose the problem:

1. Check your destroyed bean ratio to verify that bean instances are not being destroyed.

   Investigate the cause and try to remedy the situation.

2. Examine the demand for the EJB, perhaps over a period of time.

   One way to check this is via the Beans in Use Current Count and Idle Beans Count displayed in the Administration Console. If demand for your EJB spikes during a certain period of time, you may see a lot of pool misses as your pool is emptied and unable to fill additional requests.

   As the demand for the EJB drops and beans are returned to the pool, many of the beans created to satisfy requests may be unable to fit in the pool and are therefore removed. If this is the case, you may be able to reduce the number of pool misses by increasing the maximum size of your free pool. This may allow beans that were created to satisfy demand during peak periods to remain in the pool so they can be used again when demand once again increases.

Destroyed Bean Ratio

The destroyed bean ratio is a ratio of the number of beans destroyed to the total number of requests for a bean.

```
Destroyed Bean Ratio = (Total Destroyed Count / Total Access Count) * 100
```

To reduce the number of destroyed beans, BEA recommends against throwing non-application exceptions from your bean code except in cases where you want the bean instance to be destroyed. A non-application exception is an exception that is either a java.rmi.RemoteException (including exceptions that inherit from RemoteException) or is not defined in the throws clause of a method of an EJB's home or component interface.

In general, you should investigate which exceptions are causing your beans to be destroyed as they may be hurting performance and may indicate problem with the EJB or a resource used by the EJB.

Pool Timeout Ratio

The pool timeout ratio is a ratio of requests that have timed out waiting for a bean from the pool to the total number of requests made:

```
Pool Timeout Ratio = (Pool Total Timeout Count / Pool Total Access Count) *
100
```

A high pool timeout ratio could be indicative of an improperly sized free pool. Increasing the maximum size of your free pool via the `max-beans-in-free-pool` setting will increase the number of bean instances available to service requests and may reduce your pool timeout ratio.

Another factor affecting the number of pool timeouts is the configured transaction timeout for your bean. The maximum amount of time a thread will wait for a bean from the pool is equal to the default transaction timeout for the bean. Increasing the `trans-timeout-seconds` setting in your `weblogic-ejb-jar.xml` file will give threads more time to wait for a bean instance to become available.

Users should exercise caution when increasing this value, however, since doing so may cause threads to wait longer for a bean and threads are a valuable server resource. Also, request time might increase because a request will wait longer before timing out.

Transaction Rollback Ratio

The transaction rollback ratio is the ratio of transactions that have rolled back to the number of total transactions involving the EJB:

```
Transaction Rollback Ratio = (Transaction Total Rollback Count / Transaction
Total Count) * 100
```

Begin investigating a high transaction rollback ratio by examining the Transaction Timeout Ratio reported in the Administration Console. If the transaction timeout ratio is higher than you expect, try to address the timeout problem first.

An unexpectedly high transaction rollback ratio could be caused by a number of things. We recommend investigating the cause of transaction rollbacks to find potential problems with your application or a resource used by your application.

Transaction Timeout Ratio

The transaction timeout ratio is the ratio of transactions that have timed out to the total number of transactions involving an EJB:

```
Transaction Timeout Ratio = (Transaction Total Timeout Count / Transaction
Total Count) * 100
```

A high transaction timeout ratio could be caused by the wrong transaction timeout value. For example, if your transaction timeout is set too low, you may be timing out transactions before the thread is able to complete the necessary work. Increasing your transaction timeout value may reduce the number of transaction timeouts.

You should exercise caution when increasing this value, however, since doing so can cause threads to wait longer for a resource before timing out. Also, request time might increase because a request will wait longer before timing out.

A high transaction timeout ratio could be caused by a number of things such as a bottleneck for a server resource. We recommend tracing through your transactions to investigate what is causing the timeouts so the problem can be addressed.

Tuning JDBC Applications

The following sections provide tips on how to get the best performance from JDBC applications:

Tune the Number of Database Connections

A straightforward and easy way to boost performance of JDBC in WebLogic Server applications is to set the value of Initial Capacity equal to the value for Maximum Capacity when configuring connection pools in your data source.

Creating a database connection is a relatively expensive process in any environment. Typically, a connection pool starts with a small number of connections. As client demand for more connections grow, there may not be enough in the pool to satisfy the requests. WebLogic Server creates additional connections and adds them to the pool until the maximum pool size is reached.

One way to avoid connection creation delays for clients using the server is to initialize all connections at server startup, rather than on-demand as clients need them. Set the initial number of connections equal to the maximum number of connections in the Connection Pool tab of your data source configuration. See "JDBC Data Source: Configuration: Connection Pool" in the

Administration Console Online Help. You will still need to determine the optimal value for the `Maximum Capacity` as part of your pre-production performance testing.

Waste Not

Another simple way to boost JDBC application performance avoid wasting resources. Here are some situations where you can avoid wasting JDBC related resources:

- JNDI lookups are relatively expensive, so caching an object that required a looked-up in client code or application code avoids incurring this performance hit more than once.

- Once client or application code has a connection, maximize the reuse of this connection rather than closing and reacquiring a new connection. While acquiring and returning an existing creation is much less expensive than creating a new one, excessive acquisitions and returns to pools creates contention in the connection pool and degrades application performance.

- Don't hold connections any longer than is necessary to achieve the work needed. Getting a connection once, completing all necessary work, and returning it as soon as possible provides the best balance for overall performance.

Use Test Connections on Reserve with Care

When `Test Connections on Reserve` is enabled, the server instance checks a database connection prior to returning the connection to a client. This helps reduce the risk of passing invalid connections to clients.

However, it is a fairly expensive operation. Typically, a server instance performs the test by executing a full-fledged SQL query with each connection prior to returning it. If the SQL query fails, the connection is destroyed and a new one is created in its place. A new and optional performance tunable has been provided in WLS 9.0 within this "test connection on reserve" feature. The new optional performance tunable in 9.0 allows WLS to skip this SQL-query test within a configured time window of a prior successful client use (default is 10 seconds). When a connection is returned to the pool by a client, the connection is timestamped by WLS. WLS will then skip the SQL-query test if this particular connection is returned to a client within the time window. Once the time window expires, WLS will execute the SQL-query test. This feature can provide significant performance boosts for busy systems using "test connection on reserve".

Cache Prepared and Callable Statements

When you use a prepared statement or callable statement in an application or EJB, there is considerable processing overhead for the communication between the application server and the database server and on the database server itself. To minimize the processing costs, WebLogic Server can cache prepared and callable statements used in your applications. When an application or EJB calls any of the statements stored in the cache, WebLogic Server reuses the statement stored in the cache. Reusing prepared and callable statements reduces CPU usage on the database server, improving performance for the current statement and leaving CPU cycles for other tasks. For more details, see "Increasing Performance with the Statement Cache" in *Configuring and Managing WebLogic JDBC*.

Using the statement cache can dramatically increase performance, but you must consider its limitations before you decide to use it. For more details, see "Usage Restrictions for the Statement Cache" in *Configuring and Managing WebLogic JDBC*.

Use Best Design Practices

Most performance gains or losses in a database application is not determined by the application language, but by how the application is designed. The number and location of clients, size and structure of DBMS tables and indexes, and the number and types of queries all affect application performance. For Detailed information on how to design a database application, see "Designing Your Application for Best Performance" in *Programming WebLogic JDBC*.

Tuning Logging Last Resource

The following sections provide background and tuning information for Last Logging Resource transaction optimization (LLR):

- "What is LLR?" on page 11-1
- "LLR Tuning Guidelines" on page 11-2

What is LLR?

The Logging Last Resource (LLR) transaction optimization through JDBC data sources safely reduces the overhead of two-phase transactions involving database inserts, updates, and deletes. Two phase transactions occur when two different resources participate in the same global transaction (global transactions are often referred to as "XA" or "JTA" transactions). Consider the following:

- Typical two-phase transactions in JMS applications usually involve both a JMS server and a database server. The LLR option can as much as double performance compared to XA.

- The safety of the JDBC LLR option contrasts with well known but less-safe XA optimizations such as "last-agent", "last-participant", and "emulate-two-phase-commit" that are available from other vendors as well as BEA WebLogic.

- JDBC LLR works by storing two-phase transaction records in a database table rather than in the transaction manager log (the TLOG).

See "Logging Last Resource Transaction Optimization" in *Programming WebLogic JTA*.

LLR Tuning Guidelines

The following section provides tuning guidelines for LLR:

Note: BEA recommends that you read and understand "Logging Last Resource Transaction Optimization" in *Programming WebLogic JTA* and "Transaction Options" in *Configuring and Managing WebLogic JDBC*. LLR has a number of important administration and design implications.

- JJDBC LLR generally improves performance of two-phase transactions that involve SQL updates, deletes, or inserts.

- LLR generally reduces the performance of two-phase transactions where all SQL operations are read-only (just selects).

- JDBC LLR pools provide no performance benefit to WebLogic JDBC stores. WebLogic JDBC stores are fully transactional but do not use JTA (XA) transactions on their internal JDBC connections.

- Consider using LLR instead of the less safe "last-agent" optimization for connectors, and the less safe "emulate-two-phase-commit" option for JDBC connection pools (formerly known as the "enable two-phase commit" option for pools that use non-XA drivers).

- On Oracle databases, heavily used LLR tables may become fragmented over time, which can lead to unused extents. This is likely due to the highly transient nature of the LLR table's data. To help avoid the issue, set `PCT_FREE` to 5 and `PCT_USED` to 95 on the LLR table. Also periodically defragment using the `ALTER TABLESPACE [`*`tablespace-name`*`]` `COALESCE` command.

Tuning WebLogic JMS

The following sections explain how to get the most out of your applications by implementing the administrative performance tuning features available with WebLogic JMS:

Defining Quota

In prior releases, there were multiple levels of quotas: destinations had their own quotas and would also have to compete for quota within a JMS server. In this release, there is only one level of quota: destinations can have their own private quota or they can compete with other destinations using a shared quota.

In addition, a destination that defines its own quota no longer also shares space in the JMS server's quota. Although JMS servers still allow the direct configuration of message and byte quotas, these options are only used to provide quota for destinations that do not refer to a quota resource.

Quota Resources

A quota is a named configurable JMS module resource. It defines a maximum number of messages and bytes, and is then associated with one or more destinations and is responsible for enforcing the defined maximums. Multiple destinations referring to the same quota share available quota according to the sharing policy for that quota resource.

Quota resources include the following configuration parameters:

Table 12-1 Quota Parameters

Attribute	Description
Bytes Maximum and Messages Maximum	The Messages Maximum/Bytes Maximum parameters for a quota resource defines the maximum number of messages and/or bytes allowed for that quota resource. No consideration is given to messages that are pending; that is, messages that are in-flight, delayed, or otherwise inhibited from delivery still count against the message and/or bytes quota.
Quota Sharing	The Shared parameter for a quota resource defines whether multiple destinations referring to the same quota resource compete for resources with each other.
Quota Policy	The Policy parameter defines how individual clients compete for quota when no quota is available. It affects the order in which send requests are unblocked when the Send Timeout feature is enabled on the connection factory, as described in "Defining a Send Timeout on Connection Factories" on page 12-4.

For more information about quota configuration parameters, see QuotaBean in the *WebLogic Server MBean Reference.* For instructions on configuring a quota resource using the Administration Console, see "Create a quota for destinations" in the *Administration Console Online Help*.

Destination-Level Quota

Destinations no longer define byte and messages maximums for quota, but can use a quota resource that defines these values, along with quota policies on sharing and competition.

The Quota parameter of a destination defines which quota resource is used to enforce quota for the destination. This value is dynamic, so it can be changed at any time. However, if there are

unsatisfied requests for quota when the quota resource is changed, then those requests will fail with a `javax.jms.ResourceAllocationException`.

Note: Outstanding requests for quota will fail at such time that the quota resource is changed. This does not mean changes to the message and byte attributes for the quota resource, but when a destination switches to a different quota.

JMS Server-Level Quota

In some cases, there will be destinations that do not configure quotas. JMS Server quotas allow JMS servers to limit the resources used by these "quota-less" destinations. All destinations that do not explicitly set a value for the Quota attribute share the quota of the JMS server where they are deployed. The behavior is exactly the same as if there were a special Quota resource defined for each JMS server with the Shared parameter enabled.

The interfaces for the JMS server quota are unchanged from prior releases. The JMS server quota is entirely controlled using methods on the JMSServerMBean. The quota policy for the JMS server quota is set by the Blocking Send Policy parameter on a JMS server, as explained in "Specifying a Blocking Send Policy on JMS Servers" on page 12-3. It behaves just like the Policy setting of any other quota.

Specifying a Blocking Send Policy on JMS Servers

The Blocking Send policies enable you to define the JMS server's blocking behavior on whether to deliver smaller messages before larger ones when multiple message producers are competing for space on a destination that has exceeded its message quota.

To use the Administration Console to define how a JMS server will block message requests when its destinations are at maximum quota.

1. Follow the directions for navigating to the JMS Server: Configuration: Thresholds and Quotas page of the Administration Console in "Configure JMS server thresholds and quota" in the *Administration Console Online Help*.

2. From the Blocking Send Policy list box, select one of the following options:

   – FIFO — All send requests for the same destination are queued up one behind the other until space is available. No send request is permitted to complete when there another send request is waiting for space before it.

   – Preemptive — A send operation can preempt other blocking send operations if space is available. That is, if there is sufficient space for the current request, then that space is used even if there are previous requests waiting for space.

For more information about the Blocking Send Policy field, see "JMS Server: Configuration: Thresholds and Quota" in the *Administration Console Online Help*.

3. Click Save.

Defining a Send Timeout on Connection Factories

The Send Timeout feature provides more control over message send operations by giving message produces the option of waiting a specified length of time until space becomes available on a destination. For example, if a producer makes a request and there is insufficient space, then the producer is blocked until space becomes available, or the operation times out.

To use the Administration Console to define how long a JMS connection factory will block message requests when a destination exceeds its maximum quota.

1. Follow the directions for navigating to the JMS Connection Factory: Configuration: Flow Control page in "Configure message flow control" in the *Administration Console Online Help*.

2. In the Send Timeout field, enter the amount of time, in milliseconds, a sender will block messages when there is insufficient space on the message destination. Once the specified waiting period ends, one of the following results will occur:

    – If sufficient space becomes available before the timeout period ends, the operation continues.

    – If sufficient space does not become available before the timeout period ends, you receive a "resource allocation" exception.

    If you choose not to enable the blocking send policy by setting this value to 0, then you will receive a "resource allocation" exception whenever sufficient space is not available on the destination.

    For more information about the Send Timeout field, see "JMS Connection Factory: Configuration: Flow Control" in the *Administration Console Online Help*.

3. Click Save.

Compressing Messages

To improve the performance of sending messages traveling across JVM boundaries and help conserve disk space, you can specify the automatic compression of any messages that exceed a user-specified threshold size. Message compression can help reduce network bottlenecks by automatically reducing the size of messages sent across network wires. Compressing messages can also conserve disk space when storing persistent messages in file stores or databases.

Note: Compressed messages may actually inadvertently affect destination quotas since some message types actually grow larger when compressed.

A message compression threshold can be set programmatically using a JMS API extension to the `WLMessageProducer` interface, or administratively by either specifying a Default Compression Threshold value on a connection factory or on a JMS SAF remote context.

For instructions on configuring default compression thresholds using the Administration Console, see:

- Connection factories — "Configure default delivery parameters" in the *Administration Console Online Help*.

- Store-and-Forward (SAF) remote contexts — "Configure SAF remote contexts" in the *Administration Console Online Help*.

Once configured, message compression is triggered on producers for client sends, on connection factories for message receives and message browsing, or through SAF forwarding. Messages are compressed using GZIP. Compression only occurs when message producers and consumers are located on separate server instances where messages must cross a JVM boundary, typically across a network connection when WebLogic domains reside on different machines. Decompression automatically occurs on the client side and only when the message content is accessed, except for the following situations:

- Using message selectors on compressed XML messages can cause decompression, since the message body must be accessed in order to filter them. For more information on defining XML message selectors, see "Filtering Messages" in *Programming WebLogic JMS*.

- Interoperating with earlier versions of WebLogic Server can cause decompression. For example, when using the Messaging Bridge, messages are decompressed when sent from the current release of WebLogic Server to a receiving side that is an earlier version of WebLogic Server.

On the server side, messages always remains compressed, even when they are written to disk.

Paging Out Messages To Free Up Memory

With the *message paging* feature, JMS servers automatically attempt to free up virtual memory during peak message load periods. This feature can greatly benefit applications with large message spaces. Message paging is always enabled on JMS servers, and so a message paging directory is automatically created without having to configure one. You can, however, specify a directory using the Paging Directory option, then paged-out messages are written to files in this directory.

JMS message paging saves memory for persistent messages, as even persistent messages cache their data in memory. If a JMS server is associated with a file store (either user-defined or the server's default store), paged persistent messages are generally written to that file store, while non-persistent messages are always written to the JMS server's paging directory. If a JMS server is associated with a JDBC store, then both paged persistent and non-persistent messages are always written to the JMS server's paging directory. See "Best Practices When Using Persistent Stores" on page 7-3.

However, a paged-out message does not free all of the memory that it consumes, since the message header with the exception of any user properties, which are paged out along with the message body, remains in memory for use with searching, sorting, and filtering. Queuing applications that use selectors to select paged messages may show severely degraded performance as the paged out messages must be paged back in. This does not apply to topics or to applications that select based only on message header fields (such as `CorrelationID`).

Specifying a Message Paging Directory

If a paging directory is not specified, then paged-out message bodies are written to the default `\tmp` directory inside the *servername* subdirectory of a domain's root directory. For example, if no directory name is specified for the default paging directory, it defaults to:

`bea_home\user_projects\domains\domainname\servers\servername\tmp`

where `domainname` is the root directory of your domain, typically `c:\bea\user_projects\domains\domainname`, which is parallel to the directory in which WebLogic Server program files are stored, typically `c:\bea\weblogic90`.

Tuning the Message Buffer Size Option

The Message Buffer Size option specifies the amount of memory that will be used to store message bodies in memory before they are paged out to disk. The default value of Message Buffer Size is approximately one-third of the maximum heap size for the JVM, or a maximum of 512

megabytes. The larger this parameter is set, the more memory JMS will consume when many messages are waiting on queues or topics. Once this threshold is crossed, JMS may write message bodies to the directory specified by the Paging Directory option in an effort to reduce memory usage below this threshold.

It is important to note that this parameter is not a quota. If the number of messages on the server passes the threshold, the server will write messages to disk and evict them from memory as fast as it can to reduce memory usage, but it will not stop accepting new messages. It is still possible to run out of memory if messages are arriving faster than they can be paged out. Users with high messaging loads who wish to support the highest possible availability should consider setting a quota, or setting a threshold and enabling flow control to reduce memory usage on the server.

Controlling the Flow of Messages on JMS Servers and Destinations

With the Flow Control feature, you can direct a JMS server or destination to slow down message producers when it determines that it is becoming overloaded.

The following sections describe how flow control feature works and how to configure flow control on a connection factory.

- "How Flow Control Works" on page 12-7
- "Configuring Flow Control" on page 12-8
- "Flow Control Thresholds" on page 12-9

How Flow Control Works

Specifically, when either a JMS server or it's destinations exceeds its specified byte or message threshold, it becomes *armed* and instructs producers to limit their message flow (messages per second).

Producers will limit their production rate based on a set of flow control attributes configured for producers via the JMS connection factory. Starting at a specified *flow maximum* number of messages, a producer evaluates whether the server/destination is still armed at prescribed intervals (for example, every 10 seconds for 60 seconds). If at each interval, the server/destination is still armed, then the producer continues to move its rate down to its prescribed *flow minimum* amount.

As producers slow themselves down, the threshold condition gradually corrects itself until the server/destination is *unarmed*. At this point, a producer is allowed to increase its production rate,

but not necessarily to the maximum possible rate. In fact, its message flow continues to be controlled (even though the server/destination is no longer armed) until it reaches its prescribed *flow maximum*, at which point it is no longer flow controlled.

Configuring Flow Control

Producers receive a set of flow control attributes from their session, which receives the attributes from the connection, and which receives the attributes from the connection factory. These attributes allow the producer to adjust its message flow.

Specifically, the producer receives attributes that limit its flow within a minimum and maximum range. As conditions worsen, the producer moves toward the minimum; as conditions improve; the producer moves toward the maximum. Movement toward the minimum and maximum are defined by two additional attributes that specify the rate of movement toward the minimum and maximum. Also, the need for movement toward the minimum and maximum is evaluated at a configured interval.

Flow Control options are described in following table:

Table 12-2 Flow Control Parameters

Attribute	Description
Flow Control Enabled	Determines whether a producer can be flow controlled by the JMS server.
Flow Maximum	The maximum number of messages per second for a producer that is experiencing a threshold condition.
	If a producer is not currently limiting its flow when a threshold condition is reached, the initial flow limit for that producer is set to Flow Maximum. If a producer is already limiting its flow when a threshold condition is reached (the flow limit is less than Flow Maximum), then the producer will continue at its current flow limit until the next time the flow is evaluated.
	Once a threshold condition has subsided, the producer is not permitted to ignore its flow limit. If its flow limit is less than the Flow Maximum, then the producer must gradually increase its flow to the Flow Maximum each time the flow is evaluated. When the producer finally reaches the Flow Maximum, it can then ignore its flow limit and send without limiting its flow.

Table 12-2 Flow Control Parameters

Attribute	Description
Flow Minimum	The minimum number of messages per second for a producer that is experiencing a threshold condition. This is the lower boundary of a producer's flow limit. That is, WebLogic JMS will not further slow down a producer whose message flow limit is at its Flow Minimum.
Flow Interval	An adjustment period of time, defined in seconds, when a producer adjusts its flow from the Flow Maximum number of messages to the Flow Minimum amount, or vice versa.
Flow Steps	The number of steps used when a producer is adjusting its flow from the Flow Minimum amount of messages to the Flow Maximum amount, or vice versa. Specifically, the Flow Interval adjustment period is divided into the number of Flow Steps (for example, 60 seconds divided by 6 steps is 10 seconds per step).
	Also, the movement (that is, the rate of adjustment) is calculated by dividing the difference between the Flow Maximum and the Flow Minimum into steps. At each Flow Step, the flow is adjusted upward or downward, as necessary, based on the current conditions, as follows:
	• The downward movement (the decay) is geometric over the specified period of time (Flow Interval) and according to the specified number of Flow Steps. (For example, 100, 50, 25, 12.5).
	• The movement upward is linear. The difference is simply divided by the number of Flow Steps.

For more information about the flow control fields, and the valid and default values for them, see "JMS Connection Factory: Configuration: Flow Control" in the *Administration Console Online Help*.

Flow Control Thresholds

The attributes used for configuring bytes/messages thresholds are defined as part of the JMS server and/or its destination. Table 12-3 defines how the upper and lower thresholds start and stop flow control on a JMS server and/or JMS destination.

Table 12-3 Flow Control Threshold Parameters

Attribute	Description
Bytes/Messages Threshold High	When the number of bytes/messages exceeds this threshold, the JMS server/destination becomes armed and instructs producers to limit their message flow.
Bytes/Messages Threshold Low	When the number of bytes/messages falls below this threshold, the JMS server/destination becomes unarmed and instructs producers to begin increasing their message flow.
	Flow control is still in effect for producers that are below their message flow maximum. Producers can move their rate upward until they reach their flow maximum, at which point they are no longer flow controlled.

For detailed information about other JMS server and destination threshold and quota fields, and the valid and default values for them, see the following pages in the *Administration Console Online Help*:

- JMS Server: Configuration: Thresholds and Quotas

- JMS Queue: Configuration: Thresholds and Quotas

- JMS Topic: Configuration: Thresholds and Quotas

Handling Expired Messages

The following sections describe two message expiration features, the message Expiration Policy and the Active Expiration of message, which provide more control over how the system searches for expired messages and how it handles them when they are encountered.

Active message expiration ensures that expired messages are cleaned up immediately. Moreover, expired message auditing gives you the option of tracking expired messages, either by logging when a message expires or by redirecting expired messages to a defined "error" destination.

- "Defining a Message Expiration Policy" on page 12-11
- "Enabling Active Message Expiration" on page 12-16

Defining a Message Expiration Policy

Use the message Expiration Policy feature to define an alternate action to take when messages expire. Using the Expiration Policy attribute on the Destinations node, an expiration policy can be set on a per destination basis. The Expiration Policy attribute defines the action that a destination should take when an expired message is encountered: discard the message, discard the message and log its removal, or redirect the message to an error destination.

Also, if you use JMS templates to configure multiple destinations, you can use the Expiration Policy field to quickly configure an expiration policy on all your destinations. To override a template's expiration policy for specific destinations, you can modify the expiration policy on any destination.

For instructions on configuring the Expiration Policy, click one of the following links:

- "Configuring an Expiration Policy on Topics" on page 12-11
- "Configuring an Expiration Policy on Queues" on page 12-12
- "Configuring an Expiration Policy on Templates" on page 12-13
- "Defining an Expiration Logging Policy" on page 12-14

Configuring an Expiration Policy on Topics

Follow these directions if you are configuring an expiration policy on topics without using a JMS template. Expiration policies that are set on specific topics will override the settings defined on a JMS template.

1. Follow the directions for navigating to the JMS Topic: Configuration: Delivery Failure page in "Configure message delivery failure options" in the *Administration Console Online Help*.

2. From the Expiration Policy list box, select an expiration policy option.

   – Discard — Expired messages are removed from the system. The removal is not logged and the message is not redirected to another location.

   – Log — Removes expired messages and writes an entry to the server log file indicating that the messages were removed from the system. You define the actual information that will be logged in the Expiration Logging Policy field in next step.

   – Redirect — Moves expired messages from their current location into the Error Destination defined for the topic.

   For more information about the Expiration Policy options for a topic, see "JMS Topic: Configuration: Delivery Failure" in the *Administration Console Online Help*.

3. If you selected the Log expiration policy in previous step, use the Expiration Logging Policy field to define what information about the message is logged.

   For more information about valid Expiration Logging Policy values, see "Defining an Expiration Logging Policy" on page 12-14.

4. Click Save.

Configuring an Expiration Policy on Queues

Follow these directions if you are configuring an expiration policy on queues without using a JMS template. Expiration policies that are set on specific queues will override the settings defined on a JMS template.

1. Follow the directions for navigating to the JMS Queue: Configuration: Delivery Failure page in "Configure message delivery failure options" in the *Administration Console Online Help*.

2. From the Expiration Policy list box, select an expiration policy option.

   – Discard — Expired messages are removed from the system. The removal is not logged and the message is not redirected to another location.

   – Log — Removes expired messages from the queue and writes an entry to the server log file indicating that the messages were removed from the system. You define the actual information that will be logged in the Expiration Logging Policy field described in the next step.

   – Redirect — Moves expired messages from the queue and into the Error Destination defined for the queue.

For more information about the Expiration Policy options for a queue, see "Configure queue message delivery failure options" in the *Administration Console Online Help*.

3. If you selected the Log expiration policy in the previous step, use the Expiration Logging Policy field to define what information about the message is logged.

   For more information about valid Expiration Logging Policy values, see "Defining an Expiration Logging Policy" on page 12-14.

4. Click Save

5. Repeat steps 3–7 to configure an expiration policy for additional queues.

Configuring an Expiration Policy on Templates

Since JMS templates provide an efficient way to define multiple destinations (topics or queues) with similar attribute settings, you can configure a message expiration policy on an existing template (or templates) for your destinations.

1. Follow the directions for navigating to the JMS Template: Configuration: Delivery Failure page in "Configure message delivery failure options" in the *Administration Console Online Help*.

2. In the Expiration Policy list box, select an expiration policy option.

   – Discard — Expired messages are removed from the messaging system. The removal is not logged and the message is not redirected to another location.

   – Log — Removes expired messages and writes an entry to the server log file indicating that the messages were removed from the system. The actual information that is logged is defined by the Expiration Logging Policy field described in the next step.

   – Redirect — Moves expired messages from their current location into the Error Destination defined for the destination.

   For more information about the Expiration Policy options for a template, see "JMS Template: Configuration: Delivery Failure" in the *Administration Console Online Help*.

3. If you selected the Log expiration policy in Step 4, use the Expiration Logging Policy field to define what information about the message is logged.

   For more information about valid Expiration Logging Policy values, see "Defining an Expiration Logging Policy" on page 12-14.

4. Click Save.

5. Repeat steps 2–6 to configure an expiration policy for additional JMS templates.

Defining an Expiration Logging Policy

Note: The Expiration Logging Policy parameter has been deprecated in this release of WebLogic Server. In its place, BEA recommends using the Message Life Cycle Logging feature, which provide a more comprehensive view of the basic events that JMS messages will traverse through once they are accepted by a JMS server, including detailed message expiration data. For more information about message life cycle logging options, see Message Life Cycle Logging in *Configuring and Managing WebLogic JMS*.

Note: When the Expiration Policy is set to Log, the Expiration Logging Policy defines what information about the message is logged. Valid values for Expiration Logging Policy properties include `%header%`, `%properties%`, JMS header properties as defined in the JMS specification, the WebLogic JMS-specific extended header fields `JMSDeliveryTime` and `JMSRedeliveryLimit`, and any user-defined property. Each property must be separated by a comma.

The `%header%` value indicates that all header fields should be logged. The `%properties%` value indicates that all user properties should be logged. Neither values are case sensitive. However, the enumeration of individual JMS header fields and user properties are case sensitive.

For example, you could specify one of the following values:

- `JMSPriority, Name, Address, City, State, Zip`

- `%header%, Name, Address, City, State, Zip`

- `JMSCorrelationID, %properties%`

The `JMSMessageID` field is always logged and cannot be turned off. Therefore, if the Expiration Policy is not defined (that is, none) or is defined as an empty string, then the output to the log file contains only the `JMSMessageID` of the message.

Expiration Log Output Format

When an expired message is logged, the text portion of the message (not including timestamps, severity, thread information, security identity, etc.) conforms to the following format:

```
<ExpiredJMSMessage JMSMessageId='$MESSAGEID' >
    <HeaderFields Field1='Value1' [Field2='Value2'] … ] />
    <UserProperties Property1='Value1' [Property='Value2'] … ] />
</ExpiredJMSMessage>
```

where $MESSAGEID is the exact string returned by `Message.getJMSMessageID()`.

For example:

```
<ExpiredJMSMessage JMSMessageID='ID:P<851839.1022176920343.0' >
    <HeaderFields JMSPriority='7' JMSRedelivered='false' />
    <UserProperties Make='Honda' Model='Civic' Color='White'
     Weight='2680' />
</ExpiredJMSMessage>
```

If no header fields are displayed, the line for header fields is not be displayed. If no user properties are displayed, that line is not be displayed. If there are no header fields and no properties, the closing `</ExpiredJMSMessage>` tag is not necessary as the opening tag can be terminated with a closing bracket (`/>`).

For example:

```
<ExpiredJMSMessage JMSMessageID='ID:N<223476.1022177121567.1' />
```

All values are delimited with double quotes. All string values are limited to 32 characters in length. Requested fields and/or properties that do not exist are not displayed. Requested fields and/or properties that exist but have no value (a null value) are displayed as null (without single quotes). Requested fields and/or properties that are empty strings are displayed as a pair of single quotes with no space between them.

For example:

```
<ExpiredJMSMessage JMSMessageID='ID:N<851839.1022176920344.0' >
    <UserProperties  First='Any string longer than 32 char ...'
     Second=null Third='' />
</ExpiredJMSMessage>
```

Enabling Active Message Expiration

Use the Active Expiration feature to define the timeliness in which expired messages are removed from the destination to which they were sent or published. Messages are not necessarily removed from the system at their expiration time, but they are removed within a user-defined number of seconds. The smaller the window, the closer the message removal is to the actual expiration time.

Configuring a JMS Server to Actively Scan Destinations for Expired Messages

Follow these directions to define how often a JMS server will actively scan its destinations for expired messages. The default value is 30 seconds, which means the JMS server waits 30 seconds between each scan interval.

1. Follow the directions for navigating to the JMS Server: Configuration: General page of the Administration Console in "Configure general JMS server properties" in the *Administration Console Online Help*.

2. In the Scan Expiration Interval field, enter the amount of time, in seconds, that you want the JMS server to pause between its cycles of scanning its destinations for expired messages to process.

   To disable active scanning, enter a value of 0 seconds. Expired messages are passively removed from the system as they are discovered.

   For more information about the Expiration Scan Interval attribute, see "JMS Server: Configuration: General" in the *Administration Console Online Help*.

3. Click Save.

There are a number of design choices that impact performance of JMS applications. Some others include reliability, scalability, manageability, monitoring, user transactions, message driven bean support, and integration with an application server. In addition, there are WebLogic JMS extensions and features have a direct impact on performance.

Tuning MessageMaximum

WebLogic JMS pipelines messages are delivered to asynchronous consumers, otherwise known as message listeners. This action aids performance because messages are aggregated when they are internally pushed from the server to the client. The messages backlog (the size of the pipeline) between the JMS server and the client is tunable by configuring the `MessagesMaximum` setting on the connection factory. See "Asynchronous Message Pipeline" in *Programming WebLogic JMS*.

In some circumstances, tuning the `MessagesMaximum` parameter may improve performance dramatically, such as when the JMS application defers acknowledges or commits. In this case, BEA suggests setting the `MessagesMaximum` value to:

```
2 * (ack or commit interval) + 1
```

For example:

If the JMS application acknowledges 50 messages at a time, set the `MessagesMaximum` value to 101.

Tuning the `MessagesMaximum` value too high can cause:

- Increased memory usage on the client.

- Affinity to an existing client as its pipeline fills with messages. For example: If `MessagesMaximum` has a value of 10,000,000, the first consumer client to connect will get all messages that have already arrived at the destination. This condition leaves other consumers without any messages and creates an unnecessary backlog of messages in the first consumer that may cause the system to run out of memory.

Setting Maximum Message Size on a Client

You may need to configure WebLogic clients in addition to the server, when sending and receiving large messages. To set the maximum message size on a client, use the following command line property:

```
-Dweblogic.MaxMessageSize
```

Tuning Applications Using Unit-of-Order

Message Unit-of-Order is a WebLogic Server value-added feature that enables a stand-alone message producer, or a group of producers acting as one, to group messages into a single unit with respect to the processing order (a sub-ordering). This single unit is called a Unit-of-Order and requires that all messages from that unit be processed sequentially in the order they were created. UOO replaces the following complex design patterns:

- A dedicated consumer with a unique selector per each sub-ordering

- A new destination per sub-ordering, one consumer per destination.

See "Using Message Unit-of-Order" in *Programming WebLogic JMS*.

Best Practices

The following sections provide best practice information when using UOO:

- Ideal for applications that have strict message ordering requirements. UOO simplifies administration and application design, and in most applications improves performance.

- Use MDB batching to:
  - Speed-up processing of the messages within a single sub-ordering.
  - Consume multiple messages at a time under the same transaction.

  See TBD.

- You can configure a default UOO for the destination. Only one consumer on the destination processes messages for the default UOO at a time.

Using UOO and Distributed Destinations,

To ensure strict ordering when using distributed destinations, each different UOO is pinned to a specific physical destination instance. There are two options for automatically determining the correct physical destination for a given UOO:

- Hashing—Is generally faster and the UOO setting. Hashing works by using a hash function on the UOO name to determine the physical destination. It has the following drawbacks:
  - It doesn't correctly handle the administrative deleting or adding physical destinations to a distributed destination.
  - If a UOO hashes to an unavailable destination, the message send fails.

- Path Service—Is a single server UOO directory service that maps the physical destination for each UOO. The Path Service is generally slower than hashing if there are many differently named UOO created per second. In this situation, each new UOO name implicitly forces a check of the path service before sending the message. If the number of UOOs created per second is limited, Path Service performance is not an issue as the UOO paths are cached throughout the cluster.

Migrating Old Applications to Use UOO

For releases prior to WebLogic Server 9.0, applications that had strict message ordering requirements were required to do the following:

- Use a single physical destination with a single consumer

● Ensure the maximum asynchronous consumer message backlog (The `MessagesMaximum` parameter on the connection factory) was set to a value of 1.

UOO relaxes these requirements significantly as it allows for multiple consumers and allows for a asynchronous consumer message backlog of any size. To migrate older applications to take advantage of UOO, simply configure a default UOO name on the physical destination. See "Configure connection factory unit-of-order parameters" in *Administration Console Online Help*.

Tuning WebLogic JMS Store-and-Forward

For WebLogic Server releases 9.0 and higher, JMS provides advanced store-and-forward capability for high-performance message forwarding from a local server instance to a remote JMS destination. See "Understanding the Store-and-Forward Service" in *Configuring and Managing WebLogic Store-and-Forward.*

The following sections provide information on how to get the best performance from Store-and-Forward (SAF) applications:

Best Practices

- Avoid using SAF if remote destinations are already highly available. JMS clients can send directly to remote destinations. Use SAF in situations where remote destinations are not highly available, such as an unreliable network or different maintenance schedules.

- Use the better performing JMS SAF feature instead of using a Messaging Bridge when forwarding messages to remote destinations. In general, a JMS SAF agent is significantly faster than a Messaging Bridge. One exception is a configuration when sending messages in a non-persistent exactly-one mode.

  Note: A Messaging Bridge is still required to store-and-forward messages to foreign destinations and destinations from releases prior to WebLogic 9.0.

- Configure separate SAF Agents for JMS SAF and Web Services Reliable Messaging Agents (WS-RM) to simplify administration and tuning.

- Sharing the same WebLogic Store between subsystems provides increased performance for subsystems requiring persistence. For example, transactions that include SAF and JMS operations, transactions that include multiple SAF destinations, and transactions that include SAF and EJBs. See "Tuning the WebLogic Persistent Store" on page 7-1.

Tuning Tips

- Target imported destinations to multiple SAF agents to load balance message sends among available SAF agents.

- Increase the JMS SAF `Window Size` for applications that handle small messages. By default, a JMS SAF agent forwards messages in batches that contain up to 10 messages. For small messages size, it is possible to double or triple performance by increasing the number of messages in each batch to be forwarded. A more appropriate initial value for `Window Size` for small messages is 100. You can then optimize this value for your environment.

  Note: Changing the `Window Size` for applications handling large message sizes is not likely to increase performance and is not recommended. `Window Size` also tunes WS-RM SAF behavior, so it may not be appropriate to tune this parameter for SAF Agents of type `Both`.

- Increase the JMS SAF `Window Interval`. By default, a JMS SAF agent has a `Window Interval` value of 0 which forwards messages as soon as they arrive. This can lower performance as it can make the effective `Window size` much smaller than the configured value. A more appropriate initial value for `Window Interval` value is 500 milliseconds. You can then optimize this value for your environment. In this context, small messages are less than a few K, while large messages are on the order of tens of K.

  Note: Changing the `Window Interval` improves performance only in cases where the forwarder is already able to forward messages as fast as they arrive. In this case, instead of immediately forwarding newly arrived messages, the forwarder pauses to accumulate more messages and forward them as a batch. The resulting larger batch size improves forwarding throughput and reduces overall system disk and CPU usage at the expense of increasing latency.

- Set the `Non-Persistent QOS` value to `At-Least-Once` for imported destinations if your application can tolerate duplicate messages.

Tuning WebLogic Message Bridge

The following sections provide information on various methods to improve message bridge performance:

Best Practices

- Avoid using a Messaging Bridge if remote destinations are already highly available. JMS clients can send directly to remote destinations. Use messaging bridge in situations where remote destinations are not highly available, such as an unreliable network or different maintenance schedules.

- Use the better performing JMS SAF feature instead of using a Messaging Bridge when forwarding messages to remote destinations. In general, a JMS SAF agent is significantly faster than a Messaging Bridge. One exception is a configuration when sending messages in a non-persistent exactly-one mode.

  Note: A Messaging Bridge is still required to store-and-forward messages to foreign destinations and destinations from releases prior to WebLogic 9.0.

Changing the Batch Size

When the `Asynchronous Mode Enabled` attribute is set to false and the quality of service is `Exactly-once`, the `Batch Size` attribute can be used to reduce the number of transaction commits by increasing the number of messages per transaction (batch). The best batch size for a bridge instance depends on the combination of JMS providers used, the hardware, operating system, and other factors in the application environment. See "Configure transaction properties" in *Administration Console Online Help.*

Changing the Batch Interval

When the `Asynchronous Mode Enabled` attribute is set to false and the quality of service is `Exactly-once`, the `BatchInterval` attribute is used to adjust the amount of time the bridge waits for each batch to fill before forwarding batched messages. The best batch interval for a bridge instance depends on the combination of JMS providers used, the hardware, operating system, and other factors in the application environment. For example, if the queue is not very busy, the bridge may frequently stop forwarding in order to wait batches to fill, indicating the need to reduce the value of the `BatchInterval` attribute. See "Configure transaction properties" in *Administration Console Online Help.*

Changing the Quality of Service

An `Exactly-once` quality of service may perform significantly better or worse than `At-most-once` and `Duplicate-okay`.

When the `Exactly-once` quality of service is used, the bridge must undergo a two-phase commit with both JMS servers in order to ensure the transaction semantics and this operation can be very expensive. However, unlike the other qualities of service, the bridge can batch multiple operations together using `Exactly-once` service.

You may need to experiment with this parameter to get the best possible performance. For example, if the queue is not very busy or if non-persistent messages are used, `Exactly-once`

batching may be of little benefit. See "Configure messaging bridge instances" in *Administration Console Online Help.*

Using Multiple Bridge Instances

If message ordering is not required, consider deploying multiple bridges.

Multiple instances of the bridge may be deployed using the same destinations. When this is done, each instance of the bridge runs in parallel and message throughput may improve. If multiple bridge instances are used, messages will not be forwarded in the same order they had in the source destination. See "Create messaging bridge instances" in *Administration Console Online Help.*

Consider the following factors when deciding whether to use multiple bridges:

● Some JMS products do not seem to benefit much from using multiple bridges

● WebLogic JMS messaging performance typically improves significantly, especially when handling persistent messages.

● If the CPU or disk storage is already saturated, increasing the number of bridge instances may decrease throughput.

Changing the Thread Pool Size

A general bridge configuration rule is to provide a thread for each bridge instance targeted to a server instance. Use one of the following options to ensure that an adequate number of threads is available for your environment:

● Use the common thread pool—A server instance changes its thread pool size automatically to maximize throughput, including compensating for the number of bridge instances configured. See Understanding How WebLogic Server Uses Thread Pools in *Designing and Configuring WebLogic Server Environments.*

● Configure a work manager for the `weblogic.jms.MessagingBridge` class. See Understanding Work Managers in *Designing and Configuring WebLogic Server Environments.*

● Use the Administration console to set the `Thread Pool Size` property in the Messaging Bridge Configuration section on the **Configuration: Services** page for a server instance. To avoid competing with the default execute thread pool in the server, messaging bridges share a separate thread pool. This thread pool is used only in synchronous mode (`Asynchronous Mode Enabled` is not set). In asynchronous mode the bridge runs in a

thread created by the JMS provider for the source destination. Deprecated in WebLogic
Server 9.0.

Avoiding Durable Subscriptions

If the bridge is listening on a topic and it is acceptable that messages are lost when the bridge is
not forwarding messages, disable the `Durability Enabled` flag to ensure undeliverable
messages do not accumulate in the source server's store. Disabling the flag also makes the
messages non-persistent. See "Configure messaging bridge instances" in *Administration Console
Online Help.*

Co-locating Bridges with Their Source or Target Destination

If a messaging bridge source or target is a WebLogic destination, deploy the bridge to the same
WebLogic server as the destination. Targeting a messaging bridge with one of its destinations
eliminates associated network and serialization overhead. Such overhead can be significant in
high-throughput applications, particularly if the messages are non-persistent.

Changing the Asynchronous Mode Enabled Attribute

The `Asynchronous Mode Enabled` attribute determines whether the messaging bridge receives
messages asynchronously using the JMS `MessageListener interface`, or whether the bridge
receives messages using the synchronous JMS APIs. In most situations, the `Asynchronous
Enabled` attributes value is dependent on the QOS required for the application environment as
shown in Table 14-1:

Table 14-1 Asynchronous Mode Enabled Values for QOS Level

QOS	Asynchronous Mode Enabled Attribute value
`Exactly-once`[1]	false
`At-least-once`	true
`At-most-once`	true

1. If the source destination is a non-WebLogic JMS provider and the QOS is
Exactly-once, then the Asynchronous Mode Enabled attribute is disabled and the
messages are processed in synchronous mode.

See "Configure messaging bridge instances" in *Administration Console Online Help.*

A quality of service of `Exactly-once` has a significant effect on bridge performance. The bridge starts a new transaction for each message and performs a two-phase commit across both JMS servers involved in the transaction. Since the two-phase commit is usually the most expensive part of the bridge transaction, as the number of messages being processed increases, the bridge performance tends to decrease.

Tuning WebLogic Message Bridge

Tuning Resource Adapters

This appendix describes some best practices for resource adapter developers.

Classloading Optimizations for Resource Adapters

You can package resource adapter classes in one or more JAR files, and then place the JAR files in the RAR file. These are called nested JARs. When you nest JAR files in the RAR file, and classes need to be loaded by the classloader, the JARs within the RAR file must be opened and closed and iterated through for each class that must be loaded.

If there are very few JARs in the RAR file and if the JARs are relatively small in size, there will be no significant performance impact. On the other hand, if there are many JARs and the JARs are large in size, the performance impact can be great.

To avoid such performance issues, you can either:

1. Deploy the resource adapter in an exploded format. This eliminates the nesting of JARs and hence reduces the performance hit involved in looking for classes.

2. If deploying the resource adapter in exploded format is not an option, the JARs can be exploded within the RAR file. This also eliminates the nesting of JARs and thus improves the performance of classloading significantly.

Connection Optimizations

BEA recommends that resource adapters implement the optional enhancements described in sections 7.14.2 and 7.14.2 of the J2CA 1.5 Specification. Implementing these interfaces allows WebLogic Server to provide several features that will not be available without them.

Lazy Connection Association, as described in section 7.14.1, allows the server to automatically clean up unused connections and prevent applications from hogging resources. Lazy Transaction Enlistment, as described in 7.14.2, allows applications to start a transaction after a connection is already opened.

Thread Management

Resource adapter implementations should use the `WorkManager` (as described in Chapter 10, "Work Management" in the J2CA 1.5 Specification) to launch operations that need to run in a new thread, rather than creating new threads directly. This allows WebLogic Server to manage and monitor these threads.

InteractionSpec Interface

WebLogic Server supports the Common Client Interface (CCI) for EIS access, as defined in Chapter 15, "Common Client Interface" in the J 2CA 1.5 Specification. The CCI defines a

standard client API for application components that enables application components and EAI frameworks to drive interactions across heterogeneous EISes.

As a best practice, you should not store the `InteractionSpec` class that the CCI resource adapter is required to implement in the RAR file. Instead, you should package it in a separate JAR file outside of the RAR file, so that the client can access it without having to put the `InteractionSpec` interface class in the generic CLASSPATH.

With respect to the `InteractionSpec` interface, it is important to note that when all application components (EJBs, resource adapters, Web applications) are packaged in an EAR file, all common classes can be placed in the `APP-INF/lib` directory. This is the easiest possible scenario.

This is not the case for standalone resource adapters (packaged as RAR files). If the interface is serializable (as is the case with `InteractionSpec`), then both the client and the resource adapter need access to the `InteractionSpec` interface as well as the implementation classes. However, if the interface extends `java.io.Remote`, then the client only needs access to the interface class.

Tuning Web Applications

The following sections contain BEA best practices for tuning Web applications and managing sessions:

Best Practices

Disable Page Checks

You can improve performance by disabling servlet and JDP page checks. Set each of the following parameters to -1:

- `pageCheckSeconds`

- `servlet-reload-check-secs`

- `Servlet Reload Check`

These are default values for production mode.

Use Custom JSP Tags

BEA provides three specialized JSP tags that you can use in your JSP pages: cache, repeat, and process. These tags are packaged in a tag library jar file called `weblogic-tags.jar`. This jar file contains classes for the tags and a tag library descriptor (TLD). To use these tags, you copy this jar file to the Web application that contains your JSPs and reference the tag library in your JSP. See "Using Custom WebLogic JSP Tags (cache, process, repeat)" in *Developing Web Applications, Servlets, and JSPs for WebLogic Server.*

Precompile JSPs

You can configure WebLogic Server to precompile your JSPs when a Web Application is deployed or re-deployed or when WebLogic Server starts up by setting the precompile parameter to true in the `jsp-descriptor` element of the `weblogic.xml` deployment descriptor. To avoid recompiling your JSPs each time the server restarts and when you target additional servers, precompile them using `weblogic.jspc` and place them in the WEB-INF/classes folder and archive them in a `.war` file. Keeping your source files in a separate directory from the archived `.war` file eliminates the possibility of errors caused by a JSP having a dependency on one of the class files. For a complete explanation on how to avoid JSP recompilation, see Avoiding Unnecessary JSP Compilation.

Use Service Level Agreements

You should assign servlets and JSPs to work managers based on the service level agreements required by your applications. See "Thread Management" on page 6-3.

Related Reading

- "Servlet Best Practices" in *Developing Web Applications, Servlets, and JSPs for WebLogic Server.*

- "Servlet and JSP performance tuning", by Rahul Chaudhary, JavaWorld, June 2004.

Session Management

As a general rule, you should optimize your application so that it does as little work as possible when handling session persistence and sessions. The following sections provide information on how to design a session management strategy that suits your environment and application:

- "Managing Session Persistence" on page 16-3

- "Minimizing Sessions" on page 16-4

- "Aggregating Session Data" on page 16-4

Managing Session Persistence

Weblogic Server offers five session persistence mechanisms that cater to the differing requirements of your application. The session persistence mechanisms are configurable at the Web application layer. Which session management strategy you choose for your application depends on real-world factors like HTTP session size, session life cycle, reliability, and session failover requirements. For example, a Web application with no failover requirements could be maintained as a single memory-based session; whereas, a Web application with session fail-over capability could be maintained as replicated sessions or JDBC-based sessions, based on their life cycle and object size.

In terms of pure performance, in-memory session persistence is a better overall choice when compared to JDBC-based persistence for session state. According to the authors of *Session Persistence Performance in BEA WebLogic Server 7.0*: "While all session persistence mechanisms have to deal with the overhead of data serialization and deserialization, the additional overhead of the database interaction impacts the performance of the JDBC-based session persistence and causes it to under-perform compared with the in-memory replication." However, in-memory-based session persistence requires the use of WebLogic clustering, so it isn't an option in a single-server environment.

On the other hand, an environment using JDBC-based persistence does not require the use of WebLogic clusters and can maintain the session state for longer periods of time in the database. One way to improve JDBC-based session persistence is to optimize your code so that it has as high a granularity for session state persistence as possible. Other factors that can improve the overall performance of JDBC-based session persistence are: the choice of database, proper database server configuration, JDBC driver, and the JDBC connection pool configuration.

For more information on managing session persistence, see:

- "Session Persistence Performance in BEA WebLogic Server 7.0" in the *BEA WebLogic Developers Journal* provides in-depth comparisons of the five session persistence mechanisms supported by WebLogic Server, at
  `http://wldj.sys-con.com/read/42784.htm`.

- "Configuring Session Persistence" in *Assembling and Configuring Web Applications*, at
  `{DOCROOT}/webapp/sessions.html#session-persistence`

- "HTTP Session State Replication" in *Using WebLogic Sever Clusters*, at
  `http://{DOCROOT}/cluster/failover.html#httpstaterep`

- "Using a Database for Persistent Storage (JDBC Persistence)" in *Assembling and Configuring Web Applications*, at
  `{DOCROOT}/webapp/sessions.html#jdbc_persistence`

Minimizing Sessions

Configuring how WebLogic Server manages sessions is a key part of tuning your application for best performance. Consider the following:

- Use of sessions involves a scalability trade-off.

- Use sessions sparingly. In other words, use sessions only for state that cannot realistically be kept on the client or if URL rewriting support is required. For example, keep simple bits of state, such as a user's name, directly in cookies. You can also write a wrapper class to "get" and "set" these cookies, in order to simplify the work of servlet developers working on the same project.

- Keep frequently used values in local variables.

For more information, see "Setting Up Session Management" in *Assembling and Configuring Web Applications*, at `{DOCROOT}/webapp/sessions.html#session-management`.

Aggregating Session Data

This section provides best practices on how to aggregate session data. WebLogic Server tracks and replicates changes in the session by attribute so you should:

- Aggregate session data that changes in tandem into a single session attribute.

- Aggregate session data that changes frequently and read-only session data into separate session attributes

For example: If you use a a single large attribute that contains all the session data and only 10% of that data changes, the entire attribute has to be replicated. This causes unnecessary serialization/deserialization and network overhead. You should move the 10% of the session data that changes into a separate attribute.

Tuning WebLogic Tuxedo Connector

The WebLogic Tuxedo Connector (WTC) provides interoperability between WebLogic Server applications and Tuxedo services. WTC allows WebLogic Server clients to invoke Tuxedo services and Tuxedo clients to invoke WebLogic Server Enterprise Java Beans (EJBs) in response to a service request. See BEA WebLogic Tuxedo Connector.

The following sections provide information on how to get the best performance from WTC applications:

- "Configuration Guidelines" on page 17-1
- "Best Practices" on page 17-2

Configuration Guidelines

Use the following guidelines when configuring WebLogic Tuxedo Connector:

- You may have more than one WTC Service in your configuration.
- You can only target one WTC Service to a server instance.
- WTC does not support connection pooling. WTC multiplexes requests though a single physical connection.
- Configuration changes implemented as follows:
  - Changing the session/connection configuration (local APs, remote APs, Passwords, and Resources) before a connection/session is established:

    The changes are accepted and are implemented in the new session/connection.

– Changing the session/connection configuration (local APs, remote APs, Passwords, and Resources) after a connection/session is established:

The changes accepted but are not implemented in the existing connection/session until the connection is disconnected and reconnected. See "Assign a WTC Service to a Server" in *Administration Console Online Help*.

– Changing the Imported and Exported services configuration:

The changes are accepted and are implemented in the next inbound or outbound request. BEA does not recommend this practice as it can leave in-flight requests in an unknown state.

– Changing the tBridge configuration:

Any change in a deployed WTC service causes an exception. You must untarget the WTC service before making any tBridge configuration changes. After untargetting and making configuraton changes, you must target the WTC service to implement the changes.

Best Practices

The following section provides best practices when using WTC:

- When configuring the connection policy, use ON_STARTUP and INCOMING_ONLY.

  ON_STARTUP and INCOMING_ONLY always paired. For example: If a WTC remote access point is configured with ON_STARTUP, the DM_TDOMAIN section of the Tuxedo domain configuration must be configured with the remote access point as INCOMING_ONLY. In this case, WTC always acts as the session initiator. See "Configuring the Connections Between Access Points" in the *WebLogic Tuxedo Connector Administration Guide*.

- Avoid using connection policy ON_DEMAND. The preferred connection policy is ON_STARTUP and INCOMING_ONLY. This reduces the chance of service request failure due to the routing semantics of ON_DEMAND. See "Configuring the Connections Between Access Points" in the *WebLogic Tuxedo Connector Administration Guide*.

- Consider using the following WTC features: Link Level Failover, Service Level failover and load balancing when designing your application. See "Configuring Failover and Failback" in the *WebLogic Tuxedo Connector Administration Guide*.

- Consider using WebLogic Server clusters to provide additional load balancing and failover. To use WTC in a WebLogic Server cluster:

  – Configure a WTC instance on all the nodes of the WebLogic Server cluster.

– Each WTC instance in each cluster node must have the same configuration.

See "How to Manage WebLogic Tuxedo Connector in a Clustered Environment" in the *WebLogic Tuxedo Connector Administration Guide.*

- If your WTC to Tuxedo connection uses the internet, use the following security settings:

  – Set the value of `Security` to `DM_PW`. See "Authentication of Remote Access Points" in the *WebLogic Tuxedo Connector Administration Guide.*

  – Enable Link-level encryption and set the `min-encrypt-bits` parameter to 40 and the `max-encrypt-bits` to 128. See "Link-Level Encryption" in the *WebLogic Tuxedo Connector Administration Guide.*

- Your application logic should provide mechanisms to manage and interpret error conditions in your applications.

  – See "Application Error Management" in the *WebLogic Tuxedo Connector Programmer's Guide.*

  – See "System Level Debug Settings" in the *WebLogic Tuxedo Connector Administration Guide.*

- Avoid using embedded `TypedFML32` buffers inside `TypedFML32` buffers. See "Using FML with WebLogic Tuxedo Connector" in the *WebLogic Tuxedo Connector Programmer's Guide*.

- If your application handles heavy loads, consider configuring more remote Tuxedo access points and let WTC load balance the work load among the access points. See "Configuring Failover and Failback" in the *WebLogic Tuxedo Connector Administration Guide.*

- When using transactional applications, try to make the remote services involved in the same transaction available from the same remote access point. See "WebLogic Tuxedo Connector JATMI Transactions" in the *WebLogic Tuxedo Connector Programmer's Guide*.

- The number of client threads available when dispatching services from the gateway may limit the number of concurrent services running. There is no WebLogic Tuxedo Connector attribute to increase the number of available threads. Use a reasonable thread model when invoking service. See "Thread Management" on page 6-3 and Using Work Managers to Optimize Scheduled Work in *Configuring WebLogic Server Environments*.

Related Reading: Performance Tools and Information

The following sections provide an extensive performance-related reading list:

- "Java Database Connectivity (JDBC) Information" on page A-9

- "General Performance Information" on page A-10

BEA Systems, Inc. Information

- For general information about BEA Systems, see the BEA Web site

  See `http://www.bea.com`

- BEA WebLogic Server Documentation page

  See `{DOCROOT}`

- BEA's dev2dev Web site

  See `http://dev2dev.bea.com/index.jsp`

- BEA WebLogic Server Evaluation White Papers (for example, "J2EE Design Considerations for WebLogic Server" and "Distributed Computing with BEA WebLogic Server")

  See
  `http://www.bea.com/framework.jsp?CNT=papers.htm&FP=/content/products/server/evaluate/`

- *Professional J2EE Programming with BEA WebLogic Server* by Paco Gomez and Peter Zadrozny, 2000

- *BEA WebLogic Server Bible* by Joe Zuffoletto, et al, 2002

- J2EE Performance Testing with BEA WebLogic Server by Peter Zadrozny, Philip Aston, and Ted Osborne, 2002

- Mastering BEA WebLogic Server: Best Practices for Building and Deploying J2EE Applications by Gregory Nyberg, Robert Patrick, Paul Bauerschmidt, Jeff McDaniel, and Raja Mukherjee, 2003

Sun Microsystems Information

- For general information about Sun Microsystems, see Sun's Web site at `http://www.sun.com`

- Sun Microsystems Performance Information

  See `http://java.sun.com/docs/performance/index.html`

- Java Standard Edition Platform Documentation

  See `http://java.sun.com/docs/index.html`

- Java 2 SDK, Standard Edition Documentation

  See `http://java.sun.com/j2se/1.5.0/docs`

- *Solaris Tunable Parameters Reference Manual*

  See `http://docs.sun.com/app/docs/doc/819-2724?`

- For BEA WebLogic Server and Solaris-specific details, see the SPARC Solaris links on the Supported Configurations pages at `{PLATFORM}/index.html`.

- For more about Solaris configuration, check the Solaris FAQ

  See `http://www.science.uva.nl/pub/solaris/solaris2/index.html`

- *Sun Performance and Tuning: Java and the Internet* by Adrian Cockcroft, et al, 1998

- *Solaris 7 Performance Administration Tools* by Frank Cervone, 2000

Linux OS Information

- For general information about the Linux operating system, see Linux Online at `http://www.linux.org/`

- For information about the Linux Documentation Project, see LDP at `http://www.tldp.org/`

- For information about Redhat Enterprise Linux, see Redhat at `http://www.redhat.com/software/rehel/`

- For information about SuSE Linux Enterprise Server, see SuSE Linux at `http://www.novell.com/products/linuxenterpriseserver/`

- Linux Performance Tuning and Capacity Planning, by Jason R. Find, et al, 1997, Sams 2001

- Ipsysctl Tutorial 1.0.4, at `http://ipsysctl-tutorial.frozentux.net/ipsysctl-tutorial.html,` describes the IP options provided by Linux

- The Linux Cookbook: Tips and Techniques for Everyday Use, by Michael Stutz at `http://www.amazon.com/exec/obidos/tg/detail/-/1886411484/104-4452937-4644719?v=glance`

Hewlett-Packard Company Information

- General Hewlett-Packard information

  See `http://www.thenewhp.com.`

- For BEA WebLogic Server and HP-UX-specific details, see Hewlett-Packard HP/9000 with HP-UX 11.0 and 11i on the BEA Certifications Pages

  See `{PLATFORM}/hp9000.html`

- Java Performance Tuning on HP-UX

  See
  `http://h21007.www2.hp.com/dspp/tech/tech_TechDocumentDetailPage_IDX/1,1 701,1602,00.html`

- Hewlett Packard JMeter, a tool for analyzing profiling information

  See `http://www.hp.com/products1/unix/java/hpjmeter/`

- GlancePlus system performance diagnostic tool

  See `http://www.managementsoftware.hp.com/products/gplus/index.html`

- HPjconfig Java system configuration tool

  See `http://www.hp.com/products1/unix/java/java2/hpjconfig/index.html`

Microsoft Information

- General Microsoft information

  See `http://www.microsoft.com/ms.htm`

- Windows 2000 Performance Tuning White Paper

  See
  `http://www.microsoft.com/technet/prodtechnol/windows2000serv/maintain/o ptimize/perftune.mspx`

- *Windows 2000 Performance Guide*, by Mark Friedman and Odysseas Pentakalos, 2002, O'Reilly

  See
  `http://www.amazon.com/exec/obidos/ASIN/1565924665/qid%3D1055443647/sr%3 D11-1/ref%3Dsr%5F11%5F1/104-9412286-0155141`

- SQL-Server-Performance.Com, Microsoft SQL Server Performance Tuning and Optimization

  See `http://www.sql-server-performance.com/`

- *Microsoft SQL Server 2000 Performance Optimization and Tuning Handbook*, by Ken England, 2001, Digital Press

  See
  `http://www.sql-server-performance.com/sql_server_2000_perform_optimizat`
  `ion_review.asp`

Web Performance Tuning Information

- Apache Performance Notes

  See `http://httpd.apache.org/docs/misc/perf-tuning.html`

- iPlanet Web Server 4.0 Performance Tuning, Sizing, and Scaling

  See `http://docs.sun.com/db/doc/816-5663-10`

- *The Art and Science of Web Server Tuning with Internet Information Services 5.0*

  See
  `http://www.microsoft.com/windows2000/techinfo/administration/web/tuning`
  `.asp`

- *Web Performance Tuning: Speeding Up the Web*, by Patrick Killelea, Linda Mui (Editor), O'Reilly Nutshell, 1998

- *Capacity Planning for Web Performance: Metrics, Models, and Methods*, by Daniel A. Menasce, Virgilio A. F. Almeida, Prentice Hall PTR, 1998

- *Scaling for E-Business: Technologies, Models, Performance, and Capacity Planning*, by Daniel A. Menasce, Virgilio A. F. Almeida, Prentice Hall PTR, 2000

Network Performance Tools

- TracePlus/Ethernet, a network packet analysis tool for Windows 95/98/ME, NT 4.x, Windows 2000/XP

  See `http://www.sstinc.com/home.html`

Load Testing Tools

- LoadRunner, a tool that predicts enterprise-level system behavior and performance by emulating thousands of users and employs performance monitors to identify and isolate problems.

  See `http://www-heva.mercuryinteractive.com/products/loadrunner/`

- e-Load, a fast and accurate way to perform load testing, scalability testing, stress testing of enterprise Web applications.

  See
  `http://www.empirix.com/Empirix/Web+Test+Monitoring/testing+solutions/we b+application+load+testing.html`

- The Grinder, a pure Java load-testing framework.

  See `http://sourceforge.net/projects/grinder/`

Performance Analysis Tools

A profiler is a performance analysis tool that allows you to reveal hot spots in the application that result in either high CPU utilization or high contention for shared resources. Some common profilers are:

- OptimizeIt Java Performance Profiler from Borland, a performance debugging tool for Solaris and Windows

  See `http://borland.com/optimizeit/optimizeit_profiler/index.html`

- JProbe Profiler with Memory Debugger, a family of products that provide the capability to detect performance bottlenecks, perform code coverage and other metrics

  See `http://www.sitraka.com/software/jprobe`

- Hewlett Packard JMeter, a tool for analyzing profiling information

  See `http://www.hp.com/products1/unix/java/hpjmeter/`

- Topaz, Mercury Interactive's application performance management solution

  See `http://www-svca.mercuryinteractive.com/products/topaz/`

- VTune Performance Analyzer a tool to identify and locate performance bottlenecks in your code

  See `http://www.intel.com/software/products/vtune/`

- PerformaSure a tool to detect, diagnose, and resolve performance problems in multi-tier J2EE applications

    See `http://http:java.quest.com/performasure/performasure.shtml`

Production Performance Management

- Acsera provides comprehensive, enterprise class, fully integrated application production monitoring and diagnostic solutions for J2EE Infrastructures.

    See `http://www.acsera.com`

- Veritas i3 for Web-J2EE is a monitoring, analysis, and tuning tool for Web-based J2EE Applications.

    See `http://www.veritas.com/Products/www?c=product&refId=316)`

- Wily Technology, Inc. provides management solutions for large-scale, real-time production Web applications, applications servers, portal solutions and integration middleware.

    See `http://partners.bea.com/search.portal?partnerId=192`

Benchmarking Information

- SPECjbb2000, a software benchmark product developed by the Standard Performance Evaluation Corporation (SPEC). SPECjbb2000 is designed to measure a system's ability to run Java server applications.

    See `http://www.spec.org/osg/jbb2000/docs/whitepaper.html`

- SPECjAppServer2004 (Java Application Server), a client/server benchmark for measuring the performance of Java Enterprise Application Servers using a subset of J2EE API's in a complete end-to-end web application.

    See `http://www.spec.org/osg/jAppServer2004/`

Java Virtual Machine (JVM) Information

- BEA JRockit JDK Documentation

    See `http://e-docs.bea.com/wljrockit/docs50/index.html`

- BEA JRockit Memory Leak Detector

    See `http://dev2dev.bea.com/jrockit/tools.html`

- BEA JRockit Runtime Analyzer

  See `http://dev2dev.bea.com/jrockit/tools.html`

- JVM Corner at artima.com

  See `http://www.artima.com/java/index.html`

- Performance Tuning for HP-UX Systems

  See http://www.presentationselect.com/hpinvent/archivec.asp?ctg=PFT.

- Sun Microsystems FAQ about Java HotSpot technology and about performance in general

  See `http://java.sun.com/docs/hotspot/PerformanceFAQ.html`

- Performance Documentation for the Java HotSpot Virtual Machine

  See `http://java.sun.com/docs/hotspot/index.html`

- Java HotSpot VM Options, a Sun Microsystems document provides information on the command-line options and environment variables that can affect the performance characteristics of the HotSpot JVM.

  See `http://java.sun.com/docs/hotspot/VMOptions.html`

- Improving Java Application Performance and Scalability by Reducing Garbage Collection Times and Sizing Memory Using JDK 1.4.1, a Sun Microsystem document on how to reduce garbage collection times with JDK 1.4.1.

  See
  `http://developers.sun.com/techtopics/mobility/midp/articles/garbagecollection2/index.html`

- The Java Virtual Machines for J2SE 1.5.0

  See `http://java.sun.com/j2se/1.5.0/docs/guide/vm/index.html`

- Which Java VM scales best? From JavaWorld, results of a VolanoMark 2.0 server benchmark show how 12 virtual machines stack up.

  See `http://www.javaworld.com/jw-08-1998/jw-08-volanomark.html`

- *Garbage Collection: Algorithms for Automatic Dynamic Memory Management* by Richard Jones, Rafael D Lins, John Wiley & Sons, 1999

  See
  `http://www.amazon.com/exec/obidos/ASIN/0471941484/richardjones/002-1748120-9756040`

Enterprise JavaBeans Information

- *Programming WebLogic Enterprise JavaBeans*

  See `{DOCROOT}/ejb/index.html`

- *Enterprise JavaBeans, Second Edition*, by Richard Monson-Haefel, Mike Loukides (Editor), 2000

- *Mastering Enterprise JavaBeans and the Java 2 Platform, Enterprise Edition*, by Ed Roman, 1999

- TheServerSide.com, a free online community dedicated to Enterprise JavaBeans (EJBs) and J2EE.

  See `http://www.theserverside.com/home/index.jsp`

- *Seven Rules for Optimizing Entity Beans*, by Akara Sucharitakul, Java Developer Connection, 2001

  See
  `http://developer.java.sun.com/developer/technicalArticles/ebeans/sevenr ules/`

WebLogic Store Information

Using the WebLogic Persistent Store in *Configuring WebLogic Server Environments*.

Java Message Service (JMS) Information

- *Messaging (JMS) for BEA WebLogic Server*

- JMS Specification

  See `http://java.sun.com/products/jms/docs.html`

Java Database Connectivity (JDBC) Information

- *Performance Tuning Your JDBC Application*

  See `{DOCROOT}/jdbc/performance.html`

General Performance Information

- Jack Shirazi's Java Performance Tuning Web site

  See `http://www.javaperformancetuning.com`

- The Software Testing and Quality Engineering Magazine, Web Application Scalability, "Avoiding Scalability Shock" by Bill Shea, May/June 2000

  See
  `http://www.stqemagazine.com/index.asp?frame=CORE&content=BACKISSUE&stamp=417165320)`

- High-Performance Java Platform Computing™ by Thomas W. Christopher,   George K. Thiruvathukal, 2000

  See `http://www.toolsofcomputing.com/JavaThreads`

- *Performance and Idiom Guide* by Craig Larman and Rhett Guthrie, 1999

Using the WebLogic 8.1 Thread Pool Model

If you have been using execute queues to improve performance prior to this release, you may continue to use them after you upgrade your application domains to WebLogic Server 9.0.

Note: BEA recommends migrating from execute queues to using the self-tuning execute queue with work managers. See Using Work Managers to Optimize Scheduled Work in *Configuring WebLogic Server Environments*.

- "How to Enable the WebLogic 8.1 Thread Pool Model" on page B-1

- "Tuning the Default Execute Queue" on page B-2

- "Using Execute Queues to Control Thread Usage" on page B-4

- "Monitoring Execute Threads" on page B-10

- "Allocating Execute Threads to Act as Socket Readers" on page B-11

- "Tuning the Stuck Thread Detection Behavior" on page B-12

How to Enable the WebLogic 8.1 Thread Pool Model

BEA provides a flag that enables you to disable the self-tuning execute pool and provide backward compatibility for upgraded applications to continue to use user-defined execute queues.

- To use user-defined execute queues in a WebLogic Server 9.0 domain, you need to include the `use81-style-execute-queues` sub-element of the `server` element in the `config.xml` file and reboot the server.

Note: To run WebLogic Server in the 81-style-execute-queues mode to tune the thread count, you need to create the `weblogic.kernel.Default` execute queue after you set the `use81-style-execute-queues` element to `true` in the configuration file. Create this execute queue from the Administration Console and reboot the server.

The following example code allows an instance of `myserver` to use execute queues.

Listing B-1   Using the use81-style-execute-queues Element

```
.
.
.
<server>
    <name>myserver</name>
    <use81-style-execute-queues>true</use81-style-execute-queues>
.

.

.

</server>
.
.
.
```

● Configured work managers are converted to execute queues at runtime by the server instance.

Tuning the Default Execute Queue

The value of the `ThreadCount` attribute of an `ExecuteQueue` element in the `config.xml` file equals the number of simultaneous operations that can be performed by applications that use the execute queue. As work enters an instance of WebLogic Server, it is placed in an execute queue. This work is then assigned to a thread that does the work on it. Threads consume resources, so handle this attribute with care—you can degrade performance by increasing the value unnecessarily. WebLogic Server uses different default values for the thread count of the default execute queue depending on the startup mode of the server instance. See Specify a startup mode in *Administration Console Online Help*.

Table B-1 Default Thread Count for Startup Modes

Server Mode . . .	Default Thread Count . . .
Development	15 threads
Production	25 threads

Unless you configure additional execute queues, and assign applications to them, the server instance assigns requests to the default execute queue.

Note: If native performance packs are not being used for your platform, you may need to tune the default number of execute queue threads *and* the percentage of threads that act as socket readers to achieve optimal performance. For more information, see "Allocating Execute Threads to Act as Socket Readers" on page B-11.

Should You Modify the Default Thread Count?

Adding more threads to the default execute queue does not necessarily imply that you can process more work. Even if you add more threads, you are still limited by the power of your processor. You can degrade performance by increasing the value of the ThreadCount attribute unnecessarily. A high execute thread count causes more memory to be used and may increases context switching, which can degrade performance.

The value of the ThreadCount attribute depends very much on the type of work your application does. For example, if your client application is thin and does a lot of its work through remote invocation, that client application will spend more time connected — and thus will require a higher thread count — than a client application that does a lot of client-side processing.

If you do not need to use more than 15 threads (the development default) or 25 threads (the production default) for your work, do not change the value of this attribute. As a general rule, if your application makes database calls that take a long time to return, you will need more execute threads than an application that makes calls that are short and turn over very rapidly. For the latter case, using a smaller number of execute threads could improve performance.

To determine the ideal thread count for an execute queue, monitor the queue's throughput while all applications in the queue are operating at maximum load. Increase the number of threads in the queue and repeat the load test until you reach the optimal throughput for the queue. (At some point, increasing the number of threads will lead to enough context switching that the throughput for the queue begins to decrease.)

Note: The WebLogic Server Administration Console displays the cumulative throughput for all of a server's execute queues. To access this throughput value, follow steps 1-6 in "Using Execute Queues to Control Thread Usage" on page B-4.

Table B-2 shows default scenarios for adjusting available threads in relation to the number of CPUs available in the WebLogic Server domain. These scenarios also assume that WebLogic Server is running under maximum load, and that all thread requests are satisfied by using the default execute queue. If you configure additional execute queues and assign applications to specific queues, monitor results on a pool-by-pool basis.

Table B-2 Scenarios for Modifying the Default Thread Count

When...	And you see...	Do This:
Thread Count < number of CPUs	CPUs are under utilized, but there is work that could be done.	Increase the thread count.
Thread Count = number of CPUs	CPUs are under utilized, but there is work that could be done.	Increase the thread count.
Thread Count > number of CPUs (by a moderate number of threads)	CPUs have high utilization, with a moderate amount of context switching.	Tune the moderate number of threads and compare performance results.
Thread Count > number of CPUs (by a large number of threads)	Too much context switching.	Reduce the number of threads.

Using Execute Queues to Control Thread Usage

You can fine-tune an application's access to execute threads (and thereby optimize or throttle its performance) by using user-defined execute queues in WebLogic Server. However, keep in mind that unused threads represent significant wasted resources in a WebLogic Server system. You may find that available threads in configured execute queues go unused, while tasks in other queues sit idle waiting for threads to become available. In such a situation, the division of threads into multiple queues may yield poorer overall performance than having a single, default execute queue.

Default WebLogic Server installations are configured with a default execute queue which is used by all applications running on the server instance. You may want to configure additional queues to:

- **Optimize the performance of critical applications.** For example, you can assign a single, mission-critical application to a particular execute queue, guaranteeing a fixed number of execute threads. During peak server loads, nonessential applications may compete for threads in the default execute queue, but the mission-critical application has access to the same number of threads at all times.

- **Throttle the performance of nonessential applications.** For an application that can potentially consume large amounts of memory, assigning it to a dedicated execute queue effectively limits the amount of memory it can consume. Although the application can potentially use all threads available in its assigned execute queue, it cannot affect thread usage in any other queue.

- **Remedy deadlocked thread usage.** With certain application designs, deadlocks can occur when all execute threads are currently utilized. For example, consider a servlet that reads messages from a designated JMS queue. If all execute threads in a server are used to process the servlet requests, then no threads are available to deliver messages from the JMS queue. A deadlock condition exists, and no work can progress. Assigning the servlet to a separate execute queue avoids potential deadlocks, because the servlet and JMS queue do not compete for thread resources.

Be sure to monitor each execute queue to ensure proper thread usage in the system as a whole. See "Should You Modify the Default Thread Count?" on page B-3 for general information about optimizing the number of threads.

Creating Execute Queues

An execute queue represents a named collection of execute threads that are available to one or more designated servlets, JSPs, EJBs, or RMI objects.

To configure a new execute queue using the Administration Console:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure an execute queue.

4. Select the **Configuration > Queues** tab and click **New**.

5. Name the execute queue and click **OK**.

6. On the **User-Defined Execute Queues** page, select the execute queue you just created.

7. On the execute queue **Configuration** tab, modify the following attributes or accept the system defaults:

- `Queue Length`—Always leave the Queue Length at the default value of 65536 entries. The Queue Length specifies the maximum number of simultaneous requests that the server can hold in the queue. The default of 65536 requests represents a very large number of requests; outstanding requests in the queue should rarely, if ever reach this maximum value.

  If the maximum Queue Length is reached, WebLogic Server automatically doubles the size of the queue to account for the additional work. Note, however, that exceeding 65536 requests in the queue indicates a problem with the threads in the queue, rather than the length of the queue itself; check for stuck threads or an insufficient thread count in the execute queue.

- `Queue Length Threshold Percent`—The percentage (from 1–99) of the Queue Length size that can be reached before the server indicates an overflow condition for the queue. All actual queue length sizes below the threshold percentage are considered normal; sizes above the threshold percentage indicate an overflow. When an overflow condition is reached, WebLogic Server logs an error message and increases the number of threads in the queue by the value of the Threads Increase attribute to help reduce the workload.

  By default, the Queue Length Threshold Percent value is 90 percent. In most situations, you should leave the value at or near 90 percent, to account for any potential condition where additional threads may be needed to handle an unexpected spike in work requests. Keep in mind that Queue Length Threshold Percent must not be used as an automatic tuning parameter—the threshold should never trigger an increase in thread count under normal operating conditions.

- `Thread Count`—The number of threads assigned to this queue. If you do not need to use more than 15 threads (the default) for your work, do not change the value of this attribute. (For more information, see "Should You Modify the Default Thread Count?" on page B-3.)

- `Threads Increase`—The number of threads WebLogic Server should add to this execute queue when it detects an overflow condition. If you specify zero threads (the default), the server changes its health state to "warning" in response to an overflow condition in the thread, but it does not allocate additional threads to reduce the workload.

  Note: If WebLogic Server increases the number of threads in response to an overflow condition, the additional threads remain in the execute queue until the server is

rebooted. Monitor the error log to determine the cause of overflow conditions, and reconfigure the thread count as necessary to prevent similar conditions in the future. Do not use the combination of Threads Increase and Queue Length Threshold Percent as an automatic tuning tool; doing so generally results in the execute queue allocating more threads than necessary and suffering from poor performance due to context switching.

- **Threads Minimum**—The minimum number of threads that WebLogic Server should maintain in this execute queue to prevent unnecessary overflow conditions. By default, the Threads Minimum is set to 5.

- **Threads Maximum**—The maximum number of threads that this execute queue can have; this value prevents WebLogic Server from creating an overly high thread count in the queue in response to continual overflow conditions. By default, the Threads Maximum is set to 400.

8. Click **Save**.

9. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

10. You must reboot the server to use the new thread detection behavior values.

Modifying the Thread Count

To modify the default execute queue thread count using the Administration Console:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure thread detection behavior.

4. On the **Configuration > Queues** tab, select the execute queue for which you will modify the default thread count.

    Note: You can only modify the default execute queue for the server or a user-defined execute queue.

5. Locate the Thread Count value and increase or decrease it, as appropriate.

6. Click **Save**.

7. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

8. You must reboot the server to use the new thread detection behavior values.

Tuning Execute Queues for Overflow Conditions

You can configure WebLogic Server to detect and optionally address potential overflow conditions in the default execute queue or any user-defined execute queue. WebLogic Server considers a queue to have a possible overflow condition when its current size reaches a user-defined percentage of its maximum size. When this threshold is reached, the server changes its health state to "warning" and can optionally allocate additional threads to perform the outstanding work in the queue, thereby reducing the queue length.

To automatically detect and address overflow conditions in a queue, you can configure the following items:

- The threshold at which the server indicates an overflow condition. This value is set as a percentage of the configured size of the execute queue (the `QueueLength` value).

- The number of threads to add to the execute queue when an overflow condition is detected. These additional threads work to reduce the size of the queue and reduce the size of the queue to its normal operating size.

- The minimum and maximum number of threads available to the queue. In particular, setting the maximum number of threads prevents the server from assigning an overly high thread count in response to overload conditions.

To tune an execute queue using the WebLogic Server Administration Console:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure overflow conditions behavior.

4. Select the **Configuration > Queues** tab, select the execute queue for which you will configure overflow conditions behavior.

5. Specify how the server instance should detect an overflow condition for the selected queue by modifying the following attributes:

- **`Queue Length`**—Specifies the maximum number of simultaneous requests that the server can hold in the queue. The default of 65536 requests represents a very large number of requests; outstanding requests in the queue should rarely, if ever reach this maximum value. Always leave the Queue Length at the default value of 65536 entries.

- **`Queue Length Threshold Percent`**—The percentage (from 1–99) of the Queue Length size that can be reached before the server indicates an overflow condition for the queue. All actual queue length sizes below the threshold percentage are considered normal; sizes above the threshold percentage indicate an overflow. By default, the Queue Length Threshold Percent is set to 90 percent.

6. To specify how this server should address an overflow condition for the selected queue, modify the following attribute:

- **`Threads Increase`**—The number of threads WebLogic Server should add to this execute queue when it detects an overflow condition. If you specify zero threads (the default), the server changes its health state to "warning" in response to an overflow condition in the execute queue, but it does not allocate additional threads to reduce the workload.

7. To fine-tune the variable thread count of this execute queue, modify the following attributes:

- **`Threads Minimum`**—The minimum number of threads that WebLogic Server should maintain in this execute queue to prevent unnecessary overflow conditions. By default, the Threads Minimum is set to 5.

- **`Threads Maximum`**—The maximum number of threads that this execute queue can have; this value prevents WebLogic Server from creating an overly high thread count in the queue in response to continual overflow conditions. By default, the Threads Maximum is set to 400.

8. Click **Save**.

9. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

10. You must reboot the server to use the new thread detection behavior values.

Assigning Servlets and JSPs to Execute Queues

You can assign a servlet or JSP to a configured execute queue by identifying the execute queue name in the initialization parameters. Initialization parameters appear within the `init-param` element of the servlet's or JSP's deployment descriptor file, `web.xml`. To assign an execute

queue, enter the queue name as the value of the `wl-dispatch-policy` parameter, as in the example:

```
<servlet>
   <servlet-name>MainServlet</servlet-name>
   <jsp-file>/myapplication/critical.jsp</jsp-file>
   <init-param>
      <param-name>wl-dispatch-policy</param-name>
      <param-value>CriticalAppQueue</param-value>
   </init-param>
</servlet>
```

See Creating and Configuring Servlets in *Developing Web Applications, Servlets, and JSPs for WebLogic Server* for more information about specifying initialization parameters in `web.xml`.

Assigning EJBs and RMI Objects to Execute Queues

To assign an EJB object to a configured execute queue, use the new `dispatch-policy` element in `weblogic-ejb-jar.xml`. For more information, see the weblogic-ejb-jar.xml Deployment Descriptor, at `{DOCROOT}/ejb/reference.html#dispatch_policy`.

While you can also set the dispatch policy through the `appc` compiler `-dispatchPolicy` flag, BEA strongly recommends you use the deployment descriptor element instead. This way, if the EJB is recompiled, during deployment for example, the setting will not be lost.

To assign an RMI object to a configured execute queue, use the `-dispatchPolicy` option to the `rmic` compiler. For example:

```
java weblogic.rmic -dispatchPolicy CriticalAppQueue ...
```

Monitoring Execute Threads

To use the Administration Console to monitor the status of execute threads:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure thread detection behavior.

4. Select the **Monitoring > Threads** tab.

5. A table of the execute queues available on this server instance is displayed.

6. Select an execute queue for which you would like to view thread information.

7. A table of execute threads for the selected execute queue is displayed.

Allocating Execute Threads to Act as Socket Readers

For best performance, BEA recommends that you use the native socket reader implementation, rather than the pure-Java implementation, on machines that host WebLogic Server instances (see "Thread Management" on page 6-3). However, if you must use the pure-Java socket reader implementation for host machines, you can still improve the performance of socket communication by configuring the proper number of execute threads to act as socket reader threads for each server instance.

The `ThreadPoolPercentSocketReaders` attribute sets the maximum percentage of execute threads that are set to read messages from a socket. The optimal value for this attribute is application-specific. The default value is 33, and the valid range is 1–99.

Allocating execute threads to act as socket reader threads increases the speed and the ability of the server to accept client requests. It is essential to balance the number of execute threads that are devoted to reading messages from a socket and those threads that perform the actual execution of tasks in the server.

Setting the Number of Socket Reader Threads For a Server Instance

To use the Administration Console to set the maximum percentage of execute threads that read messages from a socket:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure thread detection behavior.

4. Select the **Configuration > Tuning** tab.

5. Specify the percentage of Java reader threads in the `Socket Readers` field. The number of Java socket readers is computed as a percentage of the number of total execute threads (as shown in the Thread Count field for the Execute Queue).

6. Click **Save**.

7. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**.

Setting the Number of Socket Reader Threads on Client Machines

On client machines, you can configure the number of available socket reader threads in the JVM that runs the client. Specify the socket readers by defining the following parameters in the `java` command line for the client:

```
-Dweblogic.ThreadPoolSize=value
-Dweblogic.ThreadPoolPercentSocketReaders=value
```

Tuning the Stuck Thread Detection Behavior

WebLogic Server automatically detects when a thread in an execute queue becomes "stuck." Because a stuck thread cannot complete its current work or accept new work, the server logs a message each time it diagnoses a stuck thread.

WebLogic Server diagnoses a thread as stuck if it is continually working (not idle) for a set period of time. You can tune a server's thread detection behavior by changing the length of time before a thread is diagnosed as stuck, and by changing the frequency with which the server checks for stuck threads. Although you can change the criteria WebLogic Server uses to determine whether a thread is stuck, you cannot change the default behavior of setting the "warning" and "critical" health states when all threads in a particular execute queue become stuck. For more information, see Understanding WebLogic Logging Services in *Configuring Log Files and Filtering Log Messages*.

To configure stuck thread detection behavior:

1. If you have not already done so, in the Change Center of the Administration Console, click **Lock & Edit**.

2. In the left pane of the console, expand **Environment > Servers**.

3. On the **Summary of Servers** page, select the server instance for which you will configure thread detection behavior.

4. On the **Configuration > Tuning** tab, update as necessary:

- **Stuck Thread Max Time**—Amount of time, in seconds, that a thread must be continually working before a server instance diagnoses a thread as being stuck.

- >**Stuck Thread Timer Interval**—Amount of time, in seconds, after which a server instance periodically scans threads to see if they have been continually working for the configured Stuck Thread Max Time.

5. Click `Save`.

6. To activate these changes, in the Change Center of the Administration Console, click **Activate Changes**. Not all changes take effect immediately—some require a restart.

7. You must reboot the server to use the new thread detection behavior values.

Capacity Planning

The process of determining what type of hardware and software configuration is required to meet application needs adequately is called capacity planning. Capacity planning is not an exact science. Every application is different and every user behavior is different. The following sections provide an introduction to capacity planning:

- "Capacity Planning Factors" on page C-1
- "Assessing Your Application Performance Objectives" on page C-6
- "Hardware Tuning" on page C-6
- "Network Performance" on page C-7
- "Related Information" on page C-8

Capacity Planning Factors

A number of factors influence how much capacity a given hardware configuration will need in order to support a WebLogic Server instance and a given application. The hardware capacity required to support your application depends on the specifics of the application and configuration. You should consider how each of these factors applies to your configuration and application.

The following sections discuss several of these factors. Understanding these factors and considering the requirements of your application will aid you in generating server hardware requirements for your configuration. Consider the capacity planning questions in Table C-1.

Table C-1 Capacity Planning Factors and Information Reference

Capacity Planning Questions	For Information, See:
Is WebLogic Server well-tuned?	"Assessing Your Application Performance Objectives" on page C-6
How well-designed is the user application?	"Database Server Capacity and User Storage Requirements" on page C-4
Is there enough bandwidth?	"Network Load" on page C-5
How many transactions need to run simultaneously?	"Concurrent Sessions" on page C-4
Is the database a limiting factor? Are there additional user storage requirements?	"Database Server Capacity and User Storage Requirements" on page C-4
What is running on the machine in addition to WebLogic Server?	"Network Load" on page C-5
Do clients use SSL to connect to WebLogic Server?	"SSL Connections and Performance" on page C-3
What types of traffic do the clients generate?	"RMI and Server Traffic" on page C-3
What types of clients connect to the WebLogic Server application?	"Programmatic and Web-based Clients" on page C-2
Is your deployment configured for a cluster?	"Clustered Configurations" on page C-5

Programmatic and Web-based Clients

Primarily, two types of clients can connect to WebLogic Server:

- Web-based clients, such as Web browsers and HTTP proxies, use the HTTP or HTTPS (secure) protocol to obtain HTML or servlet output.

- Programmatic clients, such as Java applications and applets, can connect through the T3 protocol and use RMI to connect to the server.

The stateless nature of HTTP requires that the server handle more overhead than is the case with programmatic clients. However, the benefits of HTTP clients are numerous, such as the availability of browsers and firewall compatibility, and are usually worth the performance costs.

Programmatic clients are generally more efficient than HTTP clients because T3 does more of the presentation work on the client side. Programmatic clients typically call directly into EJBs while Web clients usually go through servlets. This eliminates the work the server must do for presentation. The T3 protocol operates using sockets and has a long-standing connection to the server.

A WebLogic Server installation that relies only on programmatic clients should be able to handle more concurrent clients than an HTTP proxy that is serving installations. If you are tunneling T3 over HTTP, you should not expect this performance benefit. In fact, performance of T3 over HTTP is generally 15 percent worse than typical HTTP and similarly reduces the optimum capacity of your WebLogic Server installation.

RMI and Server Traffic

What types of server traffic do the clients generate? If you are using T3 clients, most interaction with the server involves Remote Method Invocation (RMI.) Clients using RMI do not generate heavy traffic to the server because there is only one sender and one listener.

RMI can use HTTP tunneling to allow RMI calls to traverse a firewall. RMI tunneled through HTTP often does not deliver the higher degree of performance provided by non-tunneled RMI.

SSL Connections and Performance

Secure sockets layer (SSL) is a standard for secure Internet communications. WebLogic Server security services support X.509 digital certificates and access control lists (ACLs) to authenticate participants and manage access to network services. For example, SSL can protect JSP pages listing employee salaries, blocking access to confidential information.

SSL involves intensive computing operations. When supporting the cryptography operations in the SSL protocol, WebLogic Server can not handle as many simultaneous connections.

Note the number of SSL connections required out of the total number of clients required. Typically, for every SSL connection that the server can handle, it can handle three non-SSL connections. SSL substantially reduces the capacity of the server depending upon the strength of encryption used in the SSL connections. Also, the amount of overhead SSL imposes is related to how many client interactions have SSL enabled. WebLogic Server includes native performance packs for SSL operations.

WebLogic Server Process Load

What is running on the machine in addition to a WebLogic Server? The machine may be processing much more than presentation and business logic. For example, it could be running a Web server or maintaining a remote information feed, such as a stock information feed from a quote service.

Consider how much of your WebLogic Server machine's processing power is consumed by processes unrelated to WebLogic Server. In the case in which WebLogic Server (or the machine on which it resides) is doing substantial additional work, you need to determine how much processing power will be drained by other processes. When a Web server proxy is running on the same machine as WebLogic Server, expect anywhere from 25 to 50 percent of the computing capacity.

Database Server Capacity and User Storage Requirements

Is the database a bottleneck? Are there additional user storage requirements? Often the database server runs out of capacity much sooner that WebLogic Server does. Plan for a database that is sufficiently robust to handle the application. Typically, a good application's database requires hardware three to four times more powerful than the application server hardware. It is good practice to use a separate machine for your database server.

Generally, you can tell if your database is the bottleneck if you are unable to maintain WebLogic Server CPU usage in the 85 to 95 percent range. This indicates that WebLogic Server is often idle and waiting for the database to return results. With load balancing in a cluster, the CPU utilization across the nodes should be about even.

Some database vendors are beginning to provide capacity planning information for application servers. Frequently this is a response to the three-tier model for applications.

An application might require user storage for operations that do not interact with a database. For example, in a secure system disk and memory are required to store security information for each user. You should calculate the size required to store one user's information, and multiply by the maximum number of expected users.

Concurrent Sessions

How many transactions must run concurrently? Determine the maximum number of concurrent sessions WebLogic Server will be called upon to handle. For each session, you will need to add more RAM for efficiency. BEA Systems recommends that you install a *minimum* of 256 MB of memory for each WebLogic Server installation that will be handling more than minimal capacity.

Next, research the maximum number of clients that will make requests at the same time, and how frequently each client will be making a request. The number of user interactions per second with WebLogic Server represents the total number of interactions that should be handled per second by a given WebLogic Server deployment. Typically for Web deployments, user interactions access JSP pages or servlets. User interactions in application deployments typically access EJBs.

Consider also the maximum number of transactions in a given period to handle spikes in demand. For example, in a stock report application, plan for a surge after the stock market opens and before it closes. If your company is broadcasting a Web site as part of an advertisement during the World Series or World Cup Soccer playoffs, you should expect spikes in demand.

Network Load

Is the bandwidth sufficient? WebLogic Server requires enough bandwidth to handle all connections from clients. In the case of programmatic clients, each client JVM will have a single socket to the server. Each socket requires bandwidth. A WebLogic Server handling programmatic clients should have 125 to 150 percent the bandwidth that a server with Web-based clients would handle. If you are interested in the bandwidth required to run a web server, you can assume that each 56kbps (kilobits per second) of bandwidth can handle between seven and ten simultaneous requests depending upon the size of the content that you are delivering. If you are handling only HTTP clients, expect a similar bandwidth requirement as a Web server serving static pages.

The primary factor affecting the requirements for a LAN infrastructure is the use of in-memory replication of session information for servlets and stateful session EJBs. In a cluster, in-memory replication of session information is the biggest consumer of LAN bandwidth. Consider whether your application will require the replication of session information for servlets and EJBs.

To determine whether you have enough bandwidth in a given deployment, look at the network tools provided by your network operating system vendor. In most cases, including Windows NT, Windows 2000, and Solaris, you can inspect the load on the network system. If the load is very high, bandwidth may be a bottleneck for your system.

Clustered Configurations

Clusters greatly improve efficiency and failover. Customers using clustering should not see any noticeable performance degradation. A number of WebLogic Server deployments in production involve placing a cluster of WebLogic Server instances on a single multiprocessor server.

Large clusters performing in-memory replication of session data for Enterprise JavaBeans (EJBs) or servlets require more bandwidth than smaller clusters. Consider the size of session data and the size of the cluster.

Application Design

How well-designed is the application? WebLogic Server is a platform for user applications. Badly designed or unoptimized user applications can drastically slow down the performance of a given configuration from 10 to 50 percent. The prudent course is to assume that every application that is developed for WebLogic Server will not be optimal and will not perform as well as benchmark applications. Increase the maximum capacity that you calculate or expect. See "Tune Your Application" on page 2-4.

Assessing Your Application Performance Objectives

At this stage in capacity planning, you gather information about the level of activity expected on your server, the anticipated number of users, the number of requests, acceptable response time, and preferred hardware configuration. Capacity planning for server hardware should focus on maximum performance requirements and set measurable objectives for capacity.

The numbers that you calculate from using one of our sample applications are of course just a rough approximation of what you may see with your application. There is no substitute for benchmarking with the actual production application using production hardware. In particular, your application may reveal subtle contention or other issues not captured by our test applications.

Hardware Tuning

When you examine performance, a number of factors influence how much capacity a given hardware configuration will need in order to support WebLogic Server and a given application. The hardware capacity required to support your application depends on the specifics of the application and configuration. You should consider how each factor applies to your configuration and application.

Benchmarks for Evaluating Performance

The Standard Performance Evaluation Corporation, at `www.spec.org,` provides a set of standardized benchmarks and metrics for evaluating computer system performance.

Supported Platforms

The information on the Supported Configurations pages, at `{PLATFORM}/index.html`, contains the latest certification information on the hardware/operating system platforms that are supported for each release of WebLogic Server.

Network Performance

Network performance is affected when the supply of resources is unable to keep up with the demand for resources. Today's enterprise-level networks are very fast and are now rarely the direct cause of performance in well-designed applications. However, if you find that you have a problem with one or more network components (hardware or software), work with your network administrator to isolate and eliminate the problem. You should also verify that you have an appropriate amount of network bandwidth available for WebLogic Server and the connections it makes to other tiers in your architecture, such as client and database connections. Therefore, it is important to continually monitor your network performance to troubleshoot potential performance bottlenecks.

Determining Network Bandwidth

A common definition of bandwidth is "the rate of the data communications transmission, usually measured in bits-per-second, which is the capacity of the link to send and receive communications." A machine running WebLogic Server requires enough network bandwidth to handle all WebLogic Server client connections. In the case of programmatic clients, each client JVM has a single socket to the server, and each socket requires dedicated bandwidth. A WebLogic Server instance handling programmatic clients should have 125–150 percent of the bandwidth that a similar Web server would handle. If you are handling only HTTP clients, expect a bandwidth requirement similar to a Web server serving static pages.

To determine whether you have enough bandwidth in a given deployment, you can use the network monitoring tools provided by your network operating system vendor to see what the load is on the network system. You can also use common operating system tools, such as the `netstat` command for Solaris or the System Monitor (`perfmon`) for Windows, to monitor your network utilization. If the load is very high, bandwidth may be a bottleneck for your system.

Also monitor the amount of data being transferred across the your network by checking the data transferred between the application and the application server, and between the application server and the database server. This amount should not exceed your network bandwidth; otherwise, your network becomes the bottleneck. To verify this, monitor the network statistics for retransmission and duplicate packets, as follows:

```
netstat -s -P tcp
```

For instructions on viewing other TCP parameters using the `netstat -s -P` command, see

Related Information

The BEA corporate Web site provides all documentation for WebLogic Server. Information related to capacity planning is available in "Preparing to Install WebLogic Server: System Requirements" in the *BEA WebLogic Server Installation Guide*.

Information on topics related to capacity planning is available from numerous third-party software sources, including the following:

- Capacity Planning for Web Performance: Metrics, Models, and Methods. Prentice Hall, 1998, ISBN 0-13-693822-1 at http://www.cs.gmu.edu/~menasce/webbook/index.html.

- Configuration and Capacity Planning for Solaris Servers, by Brian Wong.

- J2EE Applications and BEA WebLogic Server. Prentice Hall, 2001, ISBN 0-13-091111-9 at http://www.phptr.com.

- Web portal focusing on capacity-planning issues for enterprise application deployments at http://www.capacityplanning.com/.