Sterling Commerce
An IBM Company

Performance Management Guide

Release 7.5 SP1

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Contents

Preface

This document provides implementation, tuning and monitoring recommendations and guidelines for the Yantra 7x Release 7.5 SP1 application.

Intended Audience

This manual is intended for technical architects, performance engineers, application administrators, database administrators, and system administrators who have to implement, monitor and optimize Yantra 7x running in production.

Structure

This manual contains the following sections:

Chapter 1, "Introduction"

This chapter introduces this document.

Chapter 2, "Performance Recommendations Checklist"

As a quick reference, this chapter lists the recommendations found in this guide in a checklist format.

Chapter 3, "Computer System"

This chapter provides general performance recommendations for computer servers.

Chapter 4, "IBM AIX"
This chapter provides performance recommendations for AIX computer servers.

Chapter 5, "HP HP-UX11i"
This chapter provides performance recommendations for HP-UX computer servers.

Chapter 6, "Red Hat Enterprise Linux"
This chapter provides performance recommendations for Red Hat Enterprise Linux computer servers.

Chapter 7, "Sun Solaris"
This chapter provides performance recommendations for Solaris computer servers.

Chapter 8, "General JVM Recommendations"
This chapter provides general performance recommendation for Java Virtual Machines.

Chapter 9, "HotSpot JVM"
This chapter provides performance recommendations for SunSoft JVMs.

Chapter 10, "IBM JVM"
This chapter provides performance recommendations for IBM JVMs.

Chapter 11, "BEA JRockit"
This chapter provides performance recommendations for BEA JRockit JVMs.

Chapter 12, "BEA WebLogic"
This chapter provides tuning recommendations for BEA WebLogic application servers.

Chapter 13, "IBM WebSphere"
This chapter provides tuning recommendations for IBM WebSphere application servers.

Chapter 14, "Database Management System"

This chapter provides performance recommendations for database servers.

Chapter 15, "Oracle10g"

This chapter provides performance recommendations for Oracle10g.

Chapter 16, "IBM Universal Database (UDB)"

This chapter provides performance recommendations for IBM UDB.

Chapter 17, "Microsoft SQL Server"

This chapter provides performance recommendations for Microsoft SQL Server.

Chapter 18, "Advanced Database Topic - Oracle10g Real Application Cluster Database"

This chapter guides you through the planning and implementation of Oracle10g Real Application Cluster as a clustered database for scalability and availability.

Chapter 19, "Java Message Services"

This chapter provides a high level overview of how the Yantra 7x application uses JMS and general recommendations.

Chapter 20, "BEA WebLogic JMS"

This chapter provides recommendations on how to configure the BEA WebLogic JMS.

Chapter 21, "IBM WebSphere MQ"

This chapter provides recommendations on how to configure the IBM WebSphere MQ.

Chapter 22, "Yantra 7x - General"

This chapter provides general recommendations on how to configure Yantra 7x.

Chapter 23, "Yantra 7x - Distributed Order Management"

This chapter provides recommendations on how to configure Yantra 7x Distributed Order Management.

Chapter 24, "Yantra 7x Warehouse Management System"

This chapter provides recommendations on how to configure Yantra 7x Warehouse Management System.

Chapter 25, "References"

This chapter lists books, articles, and web sites referenced in this document.

Yantra 7x Documentation

For more information about the Yantra® 7x components, see the following manuals in the Yantra® 7x documentation set:

- *Yantra® 7x Release Notes*
- *Yantra® 7x Installation Guide*
- *Yantra® 7x Upgrade Guide*
- *Yantra® 7x Performance Management Guide*
- *Yantra® 7x High Availability Guide*
- *Yantra® 7x System Management Guide*
- *Yantra® 7x Localization Guide*
- *Yantra® 7x Customization Guide*
- *Yantra® 7x Integration Guide*
- *Yantra® 7x Product Concepts*
- *Yantra® 7x Warehouse Management System Concepts Guide*
- *Yantra® 7x Platform Configuration Guide*
- *Yantra® 7x Distributed Order Management Configuration Guide*
- *Yantra® 7x Supply Collaboration Configuration Guide*
- *Yantra® 7x Inventory Synchronization Configuration Guide*
- *Yantra® 7x Product Management Configuration Guide*

- *Yantra® 7x Logistics Management Configuration Guide*
- *Yantra® 7x Reverse Logistics Configuration Guide*
- *Yantra® 7x Warehouse Management System Configuration Guide*
- *Yantra® 7x Platform User Guide*
- *Yantra® 7x Distributed Order Management User Guide*
- *Yantra® 7x Supply Collaboration User Guide*
- *Yantra® 7x Inventory Synchronization User Guide*
- *Yantra® 7x Logistics Management User Guide*
- *Yantra® 7x Reverse Logistics User Guide*
- *Yantra® 7x Warehouse Management System User Guide*
- *Yantra® 7x Mobile Application User Guide*
- *Yantra® 7x Analytics Guide*
- *Yantra® 7x Javadocs*
- *Yantra® 7x Glossary*
- *Yantra® 7x Carrier Server Guide*
- *Yantra® 7x Application Server Installation Guide* (for optional component)

Conventions

The following conventions may be used in this manual:

Convention	**Meaning**
. . .	An ellipsis represents information that has been omitted.
< >	Angle brackets indicate user-supplied input.
`mono-spaced text`	Mono-spaced text indicates a file name, an API name, or a code example.
/ or \	Slashes and backslashes are file separators for Windows, UNIX and LINUX operating systems. The file separator for the Windows operating system is "\" and the file separator for Unix and Linux systems is "/". The Unix convention is used unless otherwise mentioned.

1 Introduction

This document is the Performance Management Guide for the Yantra 7x Release 7.5 SP1.

Performance Management is defined as all the activities one performs to ensure responsive service and processing throughput that meet the business needs at an acceptable cost.

1.1 Lifecycle

Performance Management activities occur throughout the project lifecycle. They could range from initial hardware sizing studies during the presales phase, architectural trade-off studies and risk mitigation studies during the design phase, load or system tests prior to implementation, to continual system monitoring and tuning in production.

1.2 System Components and Roles

Performance Management activities are wide-ranging and effect all aspects of the system ranging from computer nodes, network, disks, application servers, to Yantra 7x.

One person (or role) may be responsible for one, several or all of the components. Some typical roles include:

- Hardware Engineer
- System Administrator
- Local Area Network Engineer
- Wide Area Network Engineer
- WebLogic or WebSphere System Administrator

- Database Administrator
- Yantra 7x Administrator
- Capacity Planner
- Performance Analyst
- Architect/Planner

Given the diversity of interest and responsibilities, we have arranged this document into the following parts.

For example, the chapters in Part I, "Computer Systems" present the steps needed to configure the computer system nodes for Yantra 7x. This section should be of interest to the Hardware Engineers, System Administrators, Local Area Network Engineers, and Wide Area Network Engineers.

The chapters in Part II, "Java Virtual Machines" explain how to configure the Java Virtual Machine (JVM). The JVM is the operating environment for Java applications which includes the WebLogic and WebSphere application server, and the Yantra 7x Agent/Monitor Servers, and so forth. This chapter should be of interest to the WebLogic and WebSphere System Administrator and Yantra 7x Administrator.

The chapters in Part III, "Application Servers" presents the steps needed to configure the BEA WebLogic and IBM WebSphere application servers. This component provides the run time environment for Yantra 7x. This chapter should be of interest to the WebLogic or WebSphere System Administrators.

The chapters in Part IV, "Databases" discusses the key recommendations for the Oracle, UDB and SQL Server database servers.

Chapter 18, "Advanced Database Topic - Oracle10g Real Application Cluster Database" discusses recommendations for implementing Oracle10g Real Application Cluster for scalability and high availability.

Part VI, "Yantra Application" discusses how to configure Yantra 7x. This chapter should be of interest to Yantra 7x Administrator.

The Performance Analyst or the person who is responsible for monitoring the Yantra 7x system in production should read all chapters.

The Architect or Planner who is responsible for architecting and designing the entire system should read all chapters.

1.3 Principles

When performing the performance management activities, you should keep in mind the following principles.

1.3.1 Having Your Cake and Eating It Too

Performance and scalability are critical architectural attributes. In an ideal world, we would have the luxury of configuring systems with an infinite number of the latest and fastest system components. In reality, we have to construct systems that balance performance with other architectural attributes such as availability, affordability, security, maintainability, operability, interoperability, scalability, and many other words that end in "ility".

Take for example the following simple trade-off study between only three attributes - affordability, scalability and maintainability. If you want to configure a database with very fast I/O (maximize scalability) with a limited software budget (maximize affordability), you could implement your database files on raw devices which, to some, can be more difficult to manage. However, if you think that approach comes with unacceptable maintainability and operability burdens, you could implement the database files on the regular Unix file system. This approach would improve maintainability and operability at no additional cost but may not scale under high transaction volumes. If performance is important, you may opt to implement a specialized file system that provides raw-device performance and the maintainability of file systems. Here you would choose to maximize performance and maintainability at the expense of additional cost - you will have to purchase this specialized software.

The example above is a fairly simple trade-off study. Recognizing this reality, this document identifies major decision junctures, provides the context of how they fit within the overall system, provides rationale for our recommendations, and assists you in arriving at your own decision that is relevant to your organization's needs.

The planning sections are not recipe books. We will not provide a specific set of instructions that you can blindly follow to completion because we recognize that you may have unique business or operational requirements.

1.3.2 Keep It Simple Strategy

There are a large number of settings that can be tuned in a complex system. On HP-UX, there are over 100 TCP/IP, UDP and IP settings, over 50 HP-UX kernel parameters, close to 550 undocumented Oracle parameters, and over 250 documented Oracle parameters. The permutations and combinations of these settings are staggering. Some adjustments are beneficial - some not. Some may negate the benefit of others.

This Performance Management Principle proposes that systems be implemented with their default settings and that changes only be made when necessary.

This document will identify those adjustments that we believe are critical or beneficial. These include connection pooling, reusable SQL, Java heap settings. We will identify the parameters which we believe are optional and that you can set when there is a clear need.

1.3.3 Your Mileage May Vary

One day, an inquisitive little girl asked her mother why she trimmed the sides of the roast before putting it into the oven. The mother said that that was how her mother cooked. The little girl, still curious, asked the grandmother. After finishing laughing, the grandmother explained to the little girl that a long time ago, she had a tiny oven. She had to trim the side of the roast to prevent it from touching the side of the oven.

You should not take our recommendations (or recommendations from any book) as absolute truths. Recommendations may apply to most but not all systems. We will identify those recommendations that we believe are critical. We highly recommend that you understand the context and the implications of each recommendation. We also highly recommend that you test each recommendation prior to production.

1.3.4 Performance Recommendations Graveyard

Technology changes rapidly. Processors double in speed every eighteen months. There are major performance enhancements every software release. As a result, recommendations that were at one time critical to a particular release of Yantra 7x can become deprecated. In addition to applying the recommendations, you may at times have to remove obsoleted recommendations.

In conjunction with the Keep It Simple Strategy and the Your Mileage May Vary Principles, you should

- apply tuning optimization changes when needed but only after testing
- capture these changes in a formal change management system
- document the changes from the default settings and why they were deemed necessary
- question their applicability as the system evolves - for example, during upgrades, operating system changes, and so forth.

We present a list of deprecated recommendations in Section 2.2, "Performance Recommendations Graveyard".

1.3.5 System Test Before Going Live

We cannot over-emphasize the importance of system tests before going live. You will see this recommendation throughout this document. Your system is different from other Yantra 7x systems because it

- has its own unique set of external systems that it connects to,
- has groups of users performing work that is specific to your business, and so forth,
- is configured differently from other systems, and so forth.
- has different levels of customization
- may have some screens or processes that, although are optimized for general use, may not be optimal for your specific use

As a result, we strongly encourage all our customers to system test the entire system, which is made up of the Yantra 7x system and all the external systems, under anticipated peak transaction volumes prior to implementation into production.

1.3.6 Measure Thrice, Check Twice, Cut Once

An old adage in carpentry is to Measure Thrice, Check Twice and Cut Once.

In the heat of a performance problem, it is very tempting to try different tuning parameters without fully understanding the root-cause of the problem. Some changes or combination of changes can have a negative impact on the system. After trying many tuning changes, it is possible that some of the non-beneficial changes are not rolled back.

From past experiences, we found that system optimization is often more effective and efficient if the problem is correctly analyzed and the root cause clearly identified. An approach that we have adopted is as follows

- (measure) measure the system to establish the baseline performance and throughput
- (measure) measure the system when performance issues arise
- (check) given the symptoms, formulate theories as to the root-cause of the problem and the potential tuning changes
- (check) ensure you can explain why certain tuning recommendations can help alleviate the problem and to formulate the expected behavior if the tuning change is applied
- (cut) make one (or a few) tuning change at a time - in some cases, multiple changes could negate the benefit of other changes
- (measure) measure the system and see if the system gained the intended benefits

Measure Thrice, Check Twice, Cut Once.

1.3.7 Cascading Failure

A defense logistics officer, once gruffly reminded a group of young pilots that their new fighter jet was nothing more than 50,000 parts flying in tight formation.

This message has many parallels to any large computing systems. A large application system has many working components ranging from physical disk drives, operating systems, interfaces to external systems, application servers to database. All of these highly interconnected and dependent components must work well for the system to perform.

Lets assume that a Yantra 7x transaction calls out to an external system to check on item availability. If that external system is unable to scale or performs poorly, that Yantra 7x transaction will wait which will result in a thread being blocked. If there are many requests for that transaction, the system could become stalled when all the threads become blocked. As a result, a poorly tuned system could have a ripple effect on integrated systems.

This document will present some of these interdependencies along with approaches to monitoring them.

1.3.8 Only the Facts Jack

This document does not attempt to rewrite the vast body of tuning knowledge found in the public domain. This document also does not serve as a substitute for third party vendor training such as IBM, BEA and Oracle. Instead, this document provides recommendations that supplement or deviate from conventional recommendations or recommendations that are specific to Yantra 7x. We have liberally referenced many excellent sources of information - be they the web, books, magazine articles, and so forth - that we found useful. A list of these references are found in Chapter 25, "References".

2 Performance Recommendations Checklist

This chapter provides a list of some of the recommendations found in this document in a checklist format. We encourage you to fully understand the rationale behind these recommendations and their implications to the overall system.

2.1 Performance Checklist

In the following tables, the columns "Dev" and "Prod" indicate whether the recommendations are Recommended (R), Critical (C) or Not Applicable (NA) in a Development or Production environment respectively.

2.1.1 Planning Checklist

The following are long-lead time planning elements. For example, you need to ask for a server node sizing in order to know how much computer resources to acquire. Some configurations could have more than one month lead-time.

Table 2–1 Planning Recommendations

Recommendation	Section	Dev	Prod	Comments
Server Node Sizing	3.2.2.1 3.2.2.2	NA	C	You must ensure you have sufficient computing capacity to process peak transaction volumes.
Database Disk Sizing	3.2.2.3	NA	C	You must have sufficient disk space for database server

2.1.2 Architectural Checklist

The following recommendations are architectural or design related.

Table 2–2 Planning Recommendations

Recommendation	Section	Dev	Prod	Comments
Ensure user exit or event processing times are minimal when holding on to critical locks.	22.4.7.3	C	C	When defining or coding user exits or events, make sure you are aware of locks held and the amount of time you could spend in the exit or event.
Record Sorting Strategy to avoid deadlocks	22.4.12	C	C	Apply this recommendation to custom code or the manner in which records are locked to avoid deadlocks.

2.1.3 Computer Node Implementation Checklist

Table 2–3 Computer Server Node Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
OS Version and OS Kernel Parameters	3.2.1	C	C	Make sure you install the Yantra 7x system on certified OS versions and levels.
Network Speed and Duplex Negotiation	3.3.3.2	C	C	Make sure your network cards are operating at the highest speeds. The network interface card and the network switch can negotiate to lower speed and duplex. When that happens, performance will noticeably degrade even under low transaction volumes.
AIX Recommendations				

Table 2–3 Computer Server Node Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
Page Space Allocation	4.1.1	C	C	AIX's default page space allocation policy does not reserve swap space when processes allocate memory allocations. This could lead to swap space over-commitment which will force AIX to kill processes when it runs out of swap space. Either • ensure sufficient swap space or • set the environment variables PSALLOC=EARLY NODISCLAIM=TRUE
AIX/Oracle Recommendations				
asynchronous I/O parameters	4.1.3.1.1	NA	C	• The default asynchronous I/O parameters are set too low.
WebLogic / AIX Recommendations				
udp_sendspace	4.1.2.1.1	C	C	WebLogic's multicast packets are larger than AIX's udp_sendspace buffers. At the default level, you will get multicast errors. • set udp_sendspace to 32768

2.1.4 Java Virtual Machine Implementation Checklist

Table 2–4 JVM Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
JVM Version	8.2	C	C	Make sure you install the Yantra 7x system on certified JVM versions and levels.

Table 2–4 JVM Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
Add `-showversion` to the JVM command line	8.3.1.2	R	R	During the JVM startup, the JVM version and mode will be displayed. This simple step will help eliminate cases where the wrong JVM is used.
Verbose GC Statistics	8.3.1.4	NA	C	Enable verbose GC statistics collection. Understanding the "health" of GCs for each JVM is critical for performance.
Defer distributed garbage collection to a long interval by setting `-Dsun.rmi.dgc.server.gcInterval`	8.3.1.4	NA	C	The default distributed garbage collection setting unnecessarily forces expensive Full Garbage Collections every minute. The impact is noticeable especially for large heaps that are larger than 600MB. You should set this parameter on both the Yantra agents and the application servers.
Monitor for Paging	8.4.2	C	C	The JVM heap must be resident in memory. Performance will noticeably degrade if the OS has to page portions of the heap out to disk.
Monitor for OutOfMemory exceptions	8.4.3	C	C	OutOfMemory exceptions can cause unpredictable application behaviors. As a safety measure, Yantra 7x will stop the JVM when it catches an OutOfMemory exception.
For HotSpot JVMs				
JVM VM modes	9.1.1.1	C	C	For HotSpot JVMs, the `server` mode is more applicable for long running workloads.

Table 2–4 JVM Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
For HotSpot JVMs running WebLogic, set `-XX:MaxPermSize=128m`	9.1.1.2	C	C	The default permanent generation space setting is too small for Sun and HP JVMs. If you don't increase this setting, the JVM will fail and throw a cryptic java.lang.OutOfMemory exception.
For HP JVMs, ensure amount of free space in the Old Generation is larger than the combined size of the Eden plus the occupied space in the survivor space.	9.1.2.1.2	C	C	Sun and HP JVMs implement a conservative policy called the Young Generation Guarantee (see [21]) that states that the amount of free space in the Old must be larger than the eden and survivor space on the chance that every object is still alive after the GC. If the Old free is too small, the JVM will revert to Full GCs. Customers migrating from JDK 1.3.1 may have to increase their overall heap size or decrease the eden.
Heap Size	9.1.2.1.3	C	C	Configuring the JVM Heap correctly is not only critical for performance but also for availability. If the heap is sized too big, the GC pauses could be very long. If the heap is larger than physical memory, the system could "thrash". If the heap is too small, the JVM could experience outOfMemory exceptions.

2.1.5 Application Server Checklist

Table 2–5 Application Server Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
Connection Pool	12.1.1.4 13.1.1.2		C	Database connection establishments are very expensive operations. If connection pooling is not enabled in the application servers, transactions from application server will not scale. The Yantra 7x agents are automatically started with a connection pool that is implemented in the agent infrastructure.
Assign each Yantra 7x agent to its own JMS destination	19.2.2	NA	C	For production, dedicated JMS queues are critical for performance. They are also easier to monitor. For ease of configuration and deployment in development, you can continue to use the single DefaultAgentQueue for all agents.
Assign integration-based queues to a separate JMS server	19.1.2	NA	C	Put integration-based queues (e.g., queues used to receive orders from an external system) into a separate JMS server especially if the number of messages in that queue could grow to large numbers.
Precompile the JSPs	12.1.1.5 13.1.1.3	R	C	The application servers compile JSPs the first time they are used. The compilation phase can take over 30 seconds which could lead users to perceive poor user interface response times. Note: For WebLogic 8.1, we recommend the use of `weblogic.appc` over the use of `weblogic.jspc`.

2.1.6 Yantra 7x Checklist

Table 2–6 Yantra 7x Implementation Recommendations

Recommendation	Section	Dev	Prod	Comments
Reference Data Cache	22.4.4		C	Reference Data Caching is critical for scalability for customers who have high transaction volumes. Reference Data Caching is also critical for UI screen responsiveness. Starting in Yantra 5x 5.0 SP2, the reference data cache is enabled by default. For Development or non-production environments that are memory constrained, you can selectively enable Reference Data Caching. For example, for responsive UI, you need to, at a minimum, cache the `yfs_resource` and `yfs_resource_permissions` tables.
Agents and Messaging Configuration	22.3.1		C	For production, configure the optimum threading level, the assignment of agents to message queues or destinations, and the placement of message destinations on message servers.
Statistics	22.5.2	NA	R	Yantra 7x generates statistics for internal Yantra use. These statistics can be used to monitor throughput and to assist in performance diagnosis. We recommend leaving statistics generation on and regularly purging old statistics (e.g., greater than 3 weeks). Please be aware that the content and/or structure of the metrics can change without warning.

2.1.7 Yantra 7x WMS Application Checklist

Table 2–7 Yantra 7x WMS Application Checklist

Recommendation s	Section	Dev	Prod	Comments
Increase Java stack size for create wave and batch wave agents if you want to process waves with large number of shipments	24.4.1	NA	C	These agents need large stack sizes to perform wave optimization calculations.
Run WMS Task Purge on a daily basis	24.2.3	NA	C	Purge will move completed YFS_ TASK records to the YFS_TASK_H history table.

2.1.8 Database Checklist

Table 2–8 Database Checklist

Recommendation s	Section	Dev	Prod	Comments
Monitor and adjust indices	14.2.4	C	C	The Yantra 7x schema comes with a default set of indices for general use. In some cases, the indices may not apply to your operational environment. Regularly monitor the resource cost of frequently used queries. See if additional indices are needed. Also monitor if indices can be deleted.

2.1.9 Oracle Database Checklist

Table 2–9 Oracle Database Checklist

Recommendations	Section	Dev	Prod	Comments
Oracle: Check if histograms are needed	15.1.4.3	NA	C	As you start to populate the database, check to see if there are indexed columns that have skewed data distribution - for example, most rows have the same value (e.g., space). These could include fields like `derived_from_order_header_key`, `chained_from_order_header_key`, `derived_from_order_line_key`, chained_from_order_line_key. If there are skewed columns, add a histogram. The performance impact is very noticeable. One customer saw a query that took 30 seconds drop to sub-second.

2.1.10 UDB Database Checklist

Table 2–10 UDB Database Checklist

Recommendations	Section	Dev	Prod	Comments
Optimizer Statistics	16.1.4.2	NA	C	Regularly run runstats to keep table and index statistics up to date to ensure the UDB optimizer picks appropriate execution plans.
Parameters governing UDB locking strategy	16.1.1	C	C	Set DB2_EVALUNCOMMITTED, DB2_SKIPDELETED and DB2_SKIPINSERTED to reduce lock contention.
Volatile Table	16.1.3.2.1	NA	C	Mark tables that change significantly as volatile.

2.1.11 Monitoring Checklist

Table 2–11 Monitoring Recommendations

Recommendation	Section	Dev	Prod	Comments
Monitor CPU utilization		NA	C	Monitor CPU utilization to ensure there are no CPU contention.
Monitor Swap Usage		C	C	If there is not enough space left on the swap device (or paging file), the OS could prevent another process from starting or in some cases be forced to kill running processes. •
Monitor Paging	8.4.2	C	C	The Java Virtual Machines and Database Management Systems rely on large memory buffers or heaps and are sensitive to paging. Performance will noticeably degrade if there is not enough memory to keep the JVM heap in memory - even in Development. • Monitor paging levels using standard operating system or third party measurement tools. For example, n on Unix and Linux, you could use SAR. n On Windows, use System Monitor
Monitor Heap Garbage Collection Performance			C	Monitoring heap GC performance is critical for performance and availability. For example, if the amount of heap free after a GC is continually increasing and approaching the maximum heap size, the JVM could experience outOfMemory exceptions.

2.2 Performance Recommendations Graveyard

This section lists performance recommendations that were deprecated by this release.

Table 2–12 Deprecated Performance Recommendations

Deprecated In	Deprecated Recommendations	Comments
Yantra 7x 7.5 and Oracle10g RAC	In the past, we adhered to Oracle’s recommended setting for max_commit_propagation_delay of 700 centiseconds (or 7 seconds). Oracle has revised its recommendation to 0 effectively disabling the Lamport scheme.	For existing Oracle instances, reset max_commit_propagation_delay so that the default value is 0.

Part I
Computer Systems

This part of the book provides implementation, configuration, monitoring and tuning recommendations for computer systems which include the physical server nodes and the operating systems.

3

Computer System

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the operating system and the computer nodes.

3.1 Overview

Generally speaking, from a performance perspective, the server nodes for the Yantra application fit into two broad categories.

- database server node
- mid-tier server nodes that run the Yantra application such as the agents and application servers

3.2 Planning

The computer systems have long lead time planning elements such as developing the configuration specifications, soliciting bids, procuring the configuration. The lead time to delivery and set up could take up to a month.

The choice of hardware and vendors is typically dictated by your organization although that choice must conform to the Yantra certified technology stack.

3.2.1 Supported Configurations

Please refer to the *Yantra 7x Installation Guide* for a list of the support operating systems and computer servers.

3.2.2 Capacity Sizing/Resource Requirements

Yantra provides two tools to help you size your computer configuration.

3.2.2.1 Pre-Sales Server Sizing

Early in the sales phase, you can request a Yantra Server Sizing study to get an estimate of the processor, memory and network requirements for the standard/baseline Yantra 7x application.

3.2.2.2 Capacity Plan

Once you have fully developed the system, you can also engage Yantra Professional Services to conduct a capacity plan study of your system. This involves measuring your system and using the measurements to forecast resource requirements at anticipated peak periods.

The benefit of this approach is that the forecasting model is based on your system which includes all your customization, and your specific configuration.

3.2.2.3 Database Disk Sizing

The size of the database disk subsystem could range widely from a few hundred gigabytes to terabytes. The size will depend on the business order transaction volumes, the complexity of each order, the length of time you want to keep the orders in the active and the history database. The *Yantra 7x Installation Guide* has a section to help you estimate the space requirements for your database.

3.3 Implementation

3.3.1 Relevant Documents

3.3.1.1 BEA WebLogic

If you are going to install BEA WebLogic, please refer to the *BEA WebLogic Server Performance and Tuning* for detailed operation system kernel parameter recommendations. This document can be found at http://e-docs.bea.com/wls/docs81/pdf/perform.pdf.

3.3.1.2 IBM WebSphere

If you are supporting IBM WebSphere, you need to read the tuning recommendations found in the following URL

- http://www.redbooks.ibm.com/abstracts/sg246198.html

3.3.1.3 Oracle

Please refer to the Oracle Installation Guide for Unix for kernel recommendations. This document can be found in either http://metalink.oracle.com or http://otn.oracle.com.

3.3.1.4 UDB

Please refer to the IBM UDB Installation Guide for kernel recommendations.

3.3.2 Time Synchronization

Although this is not a performance recommendation, we strongly recommend that you keep the system time synchronized across all computer nodes using a time synchronization protocol. Keeping the system time synchronized will allow you to:

- correlate events in the database, Yantra 7x and the application server logs
- correlate workload arrival, as recorded in the application server's access.log, to system measurements (such as SAR, vmstat, and so forth.)

One approach is to use Network Time Protocol (NTP) (see [46]). A number of NTP-based implementations are available for Windows (see [47]).

With NTP, you designate one computer node to serve as the NTP Server (or time reference) and all the other nodes as the NTP Client.

3.3.3 Network Connectivity

3.3.3.1 Data Center Network

The performance of the Yantra 7x system is critically dependent on the performance of the data center network that sits between the application server nodes and the database node. Here are some considerations:

- the network latency between the application server, the agent/monitor server and the database nodes must be kept as low as possible. Therefore, for best performance, you should implement the nodes on high performance switches
- the network must have correctly negotiated to the highest bandwidth and with full duplex (see Section 3.3.3.2, "Auto-Negotiation")

3.3.3.2 Auto-Negotiation

By design, Ethernet network interface cards (NIC) automatically negotiate the best speed and duplex with the switch that it is connected to. Generally, auto-negotiation work. We have however seen cases where auto-negotiation drops the connection to sub-optimal levels (e.g., 10mps half-duplex) after a server boot.

If both the network interface card and the switch are capable of full-duplex 100mbps or 1000mbps, you can let then auto-negotiate. Alternatively, you can manually set the higher speed and duplex as described in the "Auto-negotiation" sections in the subsequent chapters.

3.3.3.2.1 Network Negotiation Test An easy way to check the NIC negotiation is to FTP, SCP or RCP a 256MB file from a test node to all other nodes.

From the database server node, create a 256MB file

```
dd if=/dev/zero of=/tmp/egg bs=16384 count=16384
```

Assuming that you have three nodes (applservernode1 to applservernode3) and you can rcp or scp into each node, issue the following

```
export ALLHOSTS="applservernode1 applservernode2 applservernode3"
for i in $ALLHOSTS
do
    time rcp /tmp/egg $i:/tmp/egg
    done
```

If you cannot rcp or scp, you can issue an FTP transfer.

The time to transfer the 256MB file should be around 20 seconds for 100mbps Fast Ethernet. If the times are much slower, you may have a network negotiation problem.

Please see the "Auto-Negotiation" sections for your computer system in the following chapters.

4

IBM AIX

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune an IBM AIX server node.

4.1 Implementation

4.1.1 Page Space Allocation Policy

AIX, by default, implements a *late page space allocation* policy. When a program asks for a large memory allocation, AIX will grant the virtual memory allocation but will not allocate the space on the backing store (or swap) until it is actually used. In contrast, *early page space allocation* will first allocate the space in swap before granting the virtual memory.

With *late page space allocation*, AIX could successfully start many processes. However, as these processes use their virtual memory, AIX could run low on swap. When this happens, AIX will choose the youngest process to kill. The following message on the application server's console indicates that it was killed.

```
./startManagedWebLogic.sh[216]: 13550 Killed
```

You will see the following error message in the AIX error log if your application server instance was killed because of *late page space allocation.*

```
Date/Time:       Thu May 30 17:35:37
Sequence Number: 39
Machine Id:      000F257F4C00
Node Id:         ibm04
Class:           S
Type:            PERM
```

```
Resource Name:   SYSVMM

Description
SOFTWARE PROGRAM ABNORMALLY TERMINATED

Probable Causes
SYSTEM RUNNING OUT OF PAGING SPACE

Failure Causes
INSUFFICIENT PAGING SPACE DEFINED FOR THE SYSTEM
PROGRAM USING EXCESSIVE AMOUNT OF PAGING SPACE

        Recommended Actions
        DEFINE ADDITIONAL PAGING SPACE
        REDUCE PAGING SPACE REQUIREMENTS OF PROGRAM(S)

Detail Data
PROGRAM
java
USER'S PROCESS ID:
       19194
PROGRAM'S PAGING SPACE USE IN 1KB BLOCKS
      295388
```

You can reduce the likelihood of a *late page space allocation* kill by increasing the amount of swap space. However, the recommended approach is to selectively turn on *early page space allocation* by exporting the following environment variables.

```
export PSALLOC=early
export NODISCLAIM=true
```

For Yantra 7x agents and BEA WebLogic application servers, you can issue the commands in the startup scripts. For IBM WebSphere, you can define the environment variables in the Environment dialog box in the administrative client.

If you make that change and not increase the swap space, you will get the following error message immediately on startup.

```
Unable to alloc heap of requested size, perhaps the maxdata value is too
small - see README.HTML for more information.
Unable to allocate an initial java heap of 1073741824 bytes.
**Out of memory, aborting**
```

```
*** panic: JVMST016: Cannot allocate memory for initial java heap
```

The exception above is actually the desired behavior because AIX is stating that it is unable to guarantee that there is enough swap space for all potential requirements.

4.1.2 Application and Agent Nodes

4.1.2.1 BEA WebLogic

4.1.2.1.1 UDP_sendspace The default setting for udp_sendspace (9,216 bytes) is too small for some of BEA's multicast messages. You should increase the value to 32,767 (the maximum is 64K). The udp_ sendspace must be less than udp_recvspace. At the default setting, you may see the following errors in the WLS console log.

```
<Error> <Cluster> <Error sending multicast message: java.io.IOException: A
message for a socket data transfer is too long.
```

To set these two parameters, first issue the following command to find the initial settings.

```
$ no -a | grep udp_
                  udp_ttl = 30
            udp_sendspace = 9216
            udp_recvspace = 41920
        udp_pmtu_discover = 1
        udp_ephemeral_low = 32768
       udp_ephemeral_high = 65535
```

To set the udp_sendspace higher, issue the following command:

```
$ no -o udp_sendspace=32768
```

4.1.3 Database Server Nodes

4.1.3.1 Oracle

4.1.3.1.1 Asynchronous I/O AIX supports both kernelized asynchronous I/O to data files on raw or Veritas Quick I/O devices and threaded asynchronous I/O. With KAIO, the Oracle process queues I/O requests in the kernel and are notified of I/O completion by an interrupt. In contrast, Oracle implements threaded asynchronous I/O with multiple threads - each thread issues a synchronous I/O.

The default Asynchronous I/O Tunable Parameters may be set too low for Oracle Databases on large systems with 4 CPUs or more if you are using threaded asynchronous I/O.

The asynchronous I/O parameters are too low in your configuration if you find the following messages in the DBWR, CKPT, or LGWR files in the ORACLE_BASE/admin/<dbname>/bdump directory.

```
Warning: lio_listio returned EAGAIN
Performance degradation may be seen
```

The EAGAIN from the lio_listio function indicates that "the resources necessary to queue all the I/O requests were not available" (see lio_listio subroutine documentation in the AIX Technical Reference: Base Operating System and Extensions Volume 1).

You can find out the current asynchronous I/O settings by issuing the following command

```
> lsattr -El aio0
autoconfig available STATE to be configured at system restart True
fastpath   enable    State of fast path                        True
kprocprio  39        Server PRIORITY                           True
maxreqs    4096      Maximum number of REQUESTS                True
maxservers 10        MAXIMUM number of servers per cpu         True
minservers 1         MINIMUM number of servers                 True
```

You can change the asynchronous I/O parameters with the following command

```
chdev -l aio0 -a maxservers=NewValue
```

The change should be effective immediately and is permanent.

The following MetaLink Notes discusses the issue and provide recommendations for maxreqs, minservers and maxservers.

- 265491.1 - AIX: DBWR trace warning: LIO_LISTIO RETURNED EAGAIN
- 271444.1 - AIX Kernel Parameters - Required for Asynchronous I/O Tuning

4.1.4 Network Connectivity

4.1.4.1 Auto-Negotiation

On AIX, you can check the link using SMIT. In SMIT, go to Devices > Communication > Ethernet Adapter > Adapter > Change / Show Characteristics of an Ethernet Adapter. Select the network interface. The link speed and mode configuration will be displayed in the Media Speed field.

Alternatively, you can issue the following commands:

```
$ lsparent -C -k ent
ent0 Available 40-58 IBM 10/100 Mbps Ethernet PCI Adapter (23100020)

$ lsattr -E -l ent0 -a media_speed
media_speed Auto_Negotiation Media Speed True
```

To find out the actual negotiated speed and duplex, issue the following command:

```
$ netstat -v ent0 | grep Media
Media Speed Selected: Auto negotiation
Media Speed Running: 100 Mbps Full Duplex
```

If the auto-negotiation failed, you can set the NIC from SMIT or by issuing the following commands:

```
$ chdev  -l ent0 -a media_speed=100_Full_Duplex -P
ent0 changed

reboot
```

5

HP HP-UX11i

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune HP HP-UX11i server nodes running on HP PA-RISC processors.

5.1 Network Connectivity

5.1.1 Auto-Negotiation

On HP-UX, you can check the link by issuing the following commands:

```
$ lanscan
Hardware Station        Crd Hdw   Net-Interface  NM  MAC       HP-DLPI DLPI
Path     Address        In# State NamePPA        ID  Type      Support Mjr#
0/0/0/0  0x00306E09612B 0   UP    lan0 snap0     1   ETHER     Yes     119

$ lanadmin -x 0
Current Speed                   = 100 Full-Duplex Auto-Negotiation-ON
```

If the auto-negotiation failed, you can manually set the NIC by issuing the following commands:

```
$ lanadmin -X 100FD 0

WARNING: an incorrect setting could cause serious network problems!!!

Driver is attempting to set the new speed
Reset will take approximately 11 seconds
```

6

Red Hat Enterprise Linux

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune Red Hat Enterprise Linux (RHEL) 3 Advanced Server (AS) or Enterprise Server (ES) operating system running on Intel Xeon IA-32 or EM64T processors.

6.1 Overview

The Yantra 7x application is only certified to run with Red Hat Enterprise Linux 3 Advanced or Enterprise Servers both 32-bit and 64-bit versions.

6.1.1 32-bit versus 64-bit

You can run the RHEL 3 operating system on a number of processors including the 32-bit IA-32 and 64-bit EM64T/AMD64 processors. Given a choice, we would prefer procuring the 64-bit EM64T processors for the following reasons:

- for compatibility, the EM64T processors will allow you to run both the 32-bit or the 64-bit RHEL 3 operating system. If you purchase the 32-bit Xeon IA-32 processors, you will only be able to run the 32-bit RHEL operating systems.
- hardware vendors like IBM are primarily shipping servers based on EM64T-based processors. We believe the industry is past the point where more 64-bit Xeon based servers are being shipped than the 32-bit versions.
- with the 64-bit RHEL OS, you will face less 32-bit memory constrained issues - for example, running out of LOWMEM in the 32-bit OS. You will also be able to allocate and use more memory for applications like Oracle or UDB.

6.1.2 Network Connectivity

6.1.2.1 Auto-Negotiation

For Linux, you can check the link speed and duplex by issuing the following command. The "FD" in the output below denotes full-duplex.

```
$ mii-tool
eth0: negotiated 100baseTx-FD flow-control, link ok
eth1: no link
```

7

Sun Solaris

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune a Sun Solaris computer server.

7.1 Implementation

7.1.1 Network Connectivity

7.1.1.1 Auto-Negotiation

On Solaris, you can check a gigabit (GE), Quad-Fast Ethernet (QFE) and Fast-Ethernet (HME) links with the following process:

```
#ifconfig -a
lo0: flags=1000849<UP,LOOPBACK,RUNNING,MULTICAST,IPv4> mtu 8232 index 1
        inet 127.0.0.1 netmask ff000000
hme0: flags=1000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4> mtu 1500 index 2
        inet 10.10.10.10 netmask ffffff00 broadcast 10.10.10.255
```

In the example above, the server has a single HME interface. To query the HME settings, issue the following commands.

```
# ndd -get /dev/hme link_speed
1
# ndd -get /dev/hme link_mode
1
```

For QFE or GE, substitute in /dev/qfe or /dev/ge respectively.

The results of the commands above are as follows

Table 7–1 NDD Results

NDD Variable	Results
link_speed	0 = 10mps 1 = 100mps
link_mode	0 = half-duplex 1 = full-duplex

If the auto-negotiation failed, you can manually set the NIC by issuing the following commands:

```
# ndd -set /dev/hme instance 0
# ndd -set /dev/hme adv_100T4_cap 0     disables T4 cabling
# ndd -set /dev/hme adv_100fdx_cap 1    enables 100mps full duplex
# ndd -set /dev/hme adv_100hdx_cap 0    disables 100mps half duplex
# ndd -set /dev/hme adv_10fdx_cap 0     disables 10mps full duplex
# ndd -set /dev/hme adv_10hdx_cap 0     disables 10mps half duplex
# ndd -set /dev/hme adv_autoneg_cap 0   disables autonegotiation
```

You can preserve the commands above across reboot by adding the following commands to /etc/system:

```
set hme:hme_adv_autoneg_cap=0
set hme:hme_adv_100T4_cap=0
set hme:hme_adv_100fdx_cap=1
set hme:hme_adv_100hdx_cap=0
set hme:hme_adv_10fdx_cap=0
set hme:hme_adv_10hdx_cap=0
```

You also need to manually set the switch ports to 100mps full-duplex. Please see your switch documentation.

Part II

Java Virtual Machines

This part of the book provides information on how to implement, monitor and tune the Java Virtual Machine (JVM). The JVM is the core technology that provides the runtime environment that the Yantra application runs on.

Configuring and operating the JVM efficiently is critical for performance. Suboptimal JVM settings will cause poor application performance at best. It could cause application outages at worst.

The first chapter in this part, Chapter 8, "General JVM Recommendations", provides an overview of the JVM technology and general JVM recommendations. The subsequent chapters provide detailed JVM recommendations specific to the JVM families.

The subsequent chapters provide recommendations specific to a JVM family. The JVM families include:

- SunSoft HotSpot JVM
- IBM JVM
- BEA JRockit

The genesis of the JVM families is the Sun JavaSoft's Reference JVM Implementation. From that baseline, Sun SunSoft division produces a productionized JVM version called the SunSoft HotSpot JVM. This JVM technology is licensed to HP. As a result, the HP and SunSoft HotSpot JVM share a lot of the same command line options, performance characteristics and in some cases bugs. As a result, you should read Chapter 9, "HotSpot JVM" if you are planning to run the Yantra application

- on Solaris server nodes

- on HP-UX11i server nodes

You should read Chapter 10, "IBM JVM" if you plan to run the Yantra application with IBM WebSphere on

- IBM AIX server nodes or
- Linux on Intel Xeon processor based servers

You should read Chapter 11, "BEA JRockit" if you plan to run Yantra with BEA WebLogic on

- either Linux based or Windows based servers running on Intel Xeon processors

8

General JVM Recommendations

This chapter provides general recommendations on how to plan, implement, configure and tune Java Virtual Machines that is applicable to all the supported JVM families.

8.1 Overview

The Java language is designed to be "Written Once and Run Anywhere" (WORA). When you compile a Java source, you get an intermediate Java file called the Java class. The class file is made up of bytecodes representing abstract instruction codes. These codes are not directly executable by any computer processor. In contrast, languages like C compile their source code to native instructions for a specific processor.

To run a Java program, you start a JVM and pass the class file to the JVM. The JVM provides many services including loading the class file and interpreting (executing) the byte codes. The JVM is the core technology that provides the runtime environment in which a Java application runs in.

Each Java program or application runs in its own JVM. For example, if you configured an application server cluster with ten managed server instances that is controlled by one administrative instance, your configuration will run eleven JVM processes.

Since the JVM is the underlying engine for the Yantra application, it is critical that the JVMs are optimally configured and running efficiently. Incorrect JVM settings could cause poor application performance. At worse, it could lead to JVM outages.

8.2 Supported Configuration

Please see the *Yantra 7x Installation Guide* for the list of supported configurations.

To find out the JVM version, issue the following command

```
$JAVA_HOME/bin/java -version
```

Note: A common mistake is to verify the version for one JDK installation but accidentally use another JDK installation. Ensure that all startup scripts reference the correct java executable.

8.3 Implementation

This section provides general recommendations on how to implement, configure and run the JVMs. JVM family specific recommendations, such as Permanent Generation settings for SunSoft JVMs, are found in the subsequent chapters.

8.3.1 Recommended JVM Command Line Options

We recommend that you specify the following command line options on all JVMs.

- JVM identifier using the -D option
- -showversion
- -verbosegc
- set a high Distributed Garbage Collection interval

8.3.1.1 JVM Identifier

In any moderately complex Yantra configuration, you will have to manage many JVMs. To ease the management and monitoring of JVMs, we recommend you use the -D Java option to "tag" the Yantra application’s JVMs with an appropriate identifier. For example

```
java -Dyfsag=SCHEDULE ..... <class name>     and
java -Dyfsas=server01 ..... <class name>
```

The `-D` option lets you set a system property variable. In the examples above, we use the `-D` option to set a name/value pair to help identify the purpose of the JVM. The names, yfsag and yfsas, indicates the type of workload - in this case a Yantra 7x agent and an application server respectively. The values, SCHEDULE and server01, indicate the instance of the workload. If you issue the following command

```
ps -ef | grep java
```

you will see

```
   UID   PID  PPID  C    STIME  TTY     TIME CMD
user03  6420  6418  2 08:20:21 pts/29   0:04 java -Dyfsag=SCHEDULE -server
user03  6456  6443  2 08:23:32 pts/29   0:23 java -Dyfsas=server01 -server
```

If you follow this convention, you can easily list all the Yantra JVMs by issuing

```
ps -ef | grep Dyfs
```

The tagging and some simple scripting will allow you to automate a lot of management tasks. For example, to generate a thread dump on all the application servers, you could issue the following command

```
for i in ‘ps -ef | grep Dyfsas | awk ’{print $2}’‘
do
    kill -3 $i
    echo "Issued thread dump for pid=$i"
done
```

8.3.1.2 Java Version

A common but difficult problem to diagnose is one where the wrong JVM version or level was started. You can easily spot this problem if you start the JVM with the -showversion option. If you ran the following command on an IBM JVM on Linux,

```
> java -showversion <class name>
```

you will get the following output

```
java version "1.4.2"
Java(TM) 2 Runtime Environment, Standard Edition (build 1.4.2)
Classic VM (build 1.4.2, J2RE 1.4.2 IBM build cxia321420-20040626 (JIT
enabled: jitc))
```

We recommend setting the -showversion option for all JVMs in production. This simple and inexpensive step provides valuable information that can help ensure that the correct JVM version and mode are used.

8.3.1.3 Garbage Collection Statistics

Garbage collection statistics are critical and should be enabled in production. The statistics is the only window you have into the behavior of the JVM heap management and the efficiency of the JVM. Issue the following command line option to enable garbage collection statistics.

```
> java -verbosegc <class name>
```

For HP's HotSpot JVM, use the following command line option. The GC statistics will be sent to the specified filename.

```
> java -Xverbosegc:filename <class name>
```

8.3.1.4 Distributed Garbage Collection

When a Java client program creates a remote object on a server, the server leases out that object to the client for a fixed amount of time. The client is responsible for renewing the lease if it needs the remote object for a longer period of time. The client should notify the server if it no longer needs that remote object so that the server can collect that object.

If the lease is not renewed, the distributed garbage collector assumes the client no longer requires the remote object and will automatically mark that object as clean (and available for collection).

To ensure that unreachable remote objects are collected in a timely manner, the Distributed Garbage Collector by default issues a System.gc every 60 seconds.

The default interval is too short and will unnecessarily force GCs every minute regardless of the amount of free space in the heap. In internal testing, we have successfully lengthened the time between distributed garbage collection to 1 hour by adding the following directive

```
java -Dsun.rmi.dgc.server.gcInterval=3600000
```

We suggest you do not disable the JVM's ability to issue System.gc() by setting the `-XX:+DisableExplicitGC` flag. In some cases, you may (for example on application servers) want the flexibility to request the JVM to manually force a GC. If this flag is set, the JVM will ignore the GC request.

You can set the gcInterval to a high number to effectively disable explicit GCs.

```
-Dsun.rmi.dgc.server.gcInterval=0x7FFFFFFFFFFFFFF0
```

Note: As of December 2, 2004, Sun has acknowledged that the DGC timeout intervals were set too low and have set the timeout default values to 1 hour for JDK 5. (see http://bugs.sun.com/bugdatabase/view_bug.do?bug_id=6200091). For JDK 1.4.2 JVMs, you will still have to set the parameters to 1 hour as recommended above.

8.3.2 Optional JVM Command Line Settings

The following are optional settings that can be applied when needed.

8.3.2.1 Stack Size

Each time a method is called, a stack frame is created and pushed on to the thread's stack. The stack frame contains, at a minimum, the method's local variables and the method arguments. You can get a `java.lang.StackOverflowError` exception if you reach the maximum allowable stack limit of a thread. This can happen if

- the method call depth is very deep (for example, in the Create Wave agent, the wave optimizer call depth is roughly equal to the number of shipments assigned to a shipment group).
- the stack frame is very large

You can set the -Xss option to increase the maximum stack size per thread.

Please see related section Section 24.4.1, "Java Stack Size" if you are running Yantra 7x Warehouse Management System.

8.4 Monitoring

8.4.1 Hanging Threads / Deadlocks / Infinite Loops

In some rare exceptions, the JVM may have threads that are not progressing, possibly because of one of the following reasons:

- threads are deadlocked
- threads are in an infinite loop
- threads are waiting for an external event
- JVM bug

You can often find these offending threads by taking several successive thread dumps and seeing if there are any threads that seem "stuck" in the same processing point. On HP-UX and Solaris, issue the following command where pid is the process id of the JVM.

```
# kill -3 pid
```

If you have a hanging or deadlocked thread, in the best case, all they do is tie up a number of scarce worker (execute) threads. There currently isn't any way to kill hung or deadlock threads except to schedule a restart of the JVM.

In the worst case, these offending threads hold on to crucial shared resources (such as database record locks) and are blocking other threads in this or other JVMs. This situation could lead to a system-wide slowdown as more and more threads block behind these offending threads.

If you have infinite looping threads, at best, all they do is make the server node busier. In the worst case, they start to impact the performance of transaction running in that node or they hold critical resources needed by other threads.

Recommendations

If you suspect a JVM has a hung or looping thread,

- take three thread dumps for that JVM. Space the thread dumps a minute apart.

- look at the stacktrace for the Default Queue in the successive thread dumps - see if there are any threads that are active and in the same code path in each thread dump.

If you suspect transactions are slow across many JVMs,

- look in your database for blocking chains - specifically, what sessions are blocking whom. Find out what servers the root blockers are coming from, the types of locks that they are holding and what was the latest SQL executed
- identify the JVMs that have the root blockers. You may have to shutdown those JVMs if the blocking sessions are spreading to a system-wide shutdown.

Best Practice: Since thread dumps are invaluable diagnostic tools, you should be very comfortable taking thread dumps when the need arises. For example, you should occasionally take thread dumps from all JVMs (e.g., all application server instances, all agent/monitor servers) during non-peak processing periods. This will give you a chance to find out where the thread dumps are written to and how to read the thread dumps.

8.4.2 Memory and Paging

Important: The JVM will perform very badly, even in low transaction volume environments if the OS has to continually page the JVM heap to disk.

You must make sure paging levels are minimal. The JVM manages its heap with the assumption that the entire heap is in memory. If significant portions of the heap are on the swap devices, the node could find itself in a "thrashing" situation where it spends most of its time shuffling pages between real memory and swap. This situation could arise for many reasons including:

- starting a JVM with a heap size that is larger than physical memory

- starting too many JVMs and other workloads such that the combined working set size is larger than the physical memory

8.4.3 OutOfMemory Exceptions

Important: Yantra 7x will stop a JVM that throws an OutOfMemory exception.

JVMs throw OutOfMemory exceptions when they cannot find enough space for new object allocation request. This situation arises for two primary reasons:

- the JVM heap was sized too small to accommodate the day-to-day processing requirements of that JVM.
- the application running in that JVM has a memory leak

JVMs try to recover gracefully when OutOfMemory exceptions occur - unfortunately, the outcome of the recovery can be unpredictable. We have seen situations where threads have disappeared (they don't show up in the thread dumps), threads have gone into infinite loops, or database connections from failed threads remain opened and in some cases, hold on to record locks.

For these and many other reasons, Yantra 7x will deliberately stop JVMs that encounter OutOfMemory exceptions. When that occurs, you should see the following message in the application log.

```
java.lang.OutOfMemoryError
Yantra encountered Java Virtual Machine Error, verify your JVM settings ....
Halting the system................
```

This measure is preferable to potentially unpredictable application behaviors.

In production, you should periodically check for the occurrence of the message above in the Yantra 7x log and to take appropriate actions - this could include alerting the application administrator or restarting the JVM.

8.4.3.1 Diagnosing OutOfMemory Exceptions

An outOfMemory exception could be caused by a memory leak or a temporary abnormally high memory requirement (possibly for a very large order or wave). If you encounter an outOfMemroy exception, we recommend you perform the following

- restart the JVM with a much larger heap (for example, 1.5GB)
- monitor the amount of space used. For Sun and HP HotSpot JVMs, you need to look at the heap used after Full GCs. If you see this value steadily growing and never shrinking, you may likely have a memory leak. If the heap used increases by a large value (larger than your original heap setting) but eventually drops down to its original level, you may have encountered a large order or wave. You may want to investigate the nature of that order to see if the order was an anomaly or if it is going to be recurring. You can use the GC statistics to set you JVM heap sizes.

If you believe you have a memory leak, you can do the following

- for IBM JVMs, generate a heapdump and use the IBM Memory Dump Diagnostic tool to identify the memory leak. We have found this tool to be easy to use and easy to identify memory leaks. The IBM JVM will automatically generate the heapdump when it runs into an OutOfMemory exception. You can also request a heapdump using a Kill -3 by first setting the following environment variables

  ```
  export IBM_HEAPDUMP=true
  export IBM_HEAP_DUMP=true
  export IBM_HEAPDUMPDIR=<directory to store the heap dumps>
  ```

- for Sun and HP HotSpot, try generating the hprof memory dump - the IBM Memory Dump Diagnostic tool is capable of analyzing hprof dumps. Otherwise, you may have to resort to using a tool like Quest JProbe Memory Debugger
- for BEA JRockit, you may have to run Quest JProbe Memory Debugger to spot the memory leak.

9

HotSpot JVM

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the HotSpot Java Virtual Machines.

You will use the Sun HotSpot JVM when you deploy the Yantra 7x application with BEA WebLogic or the IBM WebSphere application servers on Sun Solaris operating system running on Sun UltraSPARC processor based servers.

You will use the HP HotSpot JVM when you deploy the Yantra 7x application with BEA WebLogic application servers on HP HP-UX11i operating system running on HP PA-RISC processor based servers.

Note: BEA no longer supports the use of the SunSoft JVM on Linux in production.

9.1 Implementation

It is a mixed blessing that HotSpot JVMs provide many tuning parameters because tuning the JVMs can appear to be part art and part guess work. There isn't a golden set of JVM settings that apply to all customers and conditions. The settings, especially memory settings (which we will discuss below) are highly dependent on the transaction mix, the amount of data cached, the complexity of the transactions, concurrency levels, and so forth.

Fortunately, the HotSpot JVMs provide good measurement feedback that will allow you to measure the effectiveness of the settings.

As a starting point, we recommend you configure your JVMs with the following initial values and to review and adjust the settings as you run the JVMs under representative workloads and traffic volumes.

9.1.1 Starting Recommendations

As a starting point, you should configure the JVMs as follows

- set the JVM mode to server mode
- set the permanent generation to 128MB

9.1.1.1 Virtual Machine Mode

The Java language is designed to be platform independent. When you compile a Java source, you get an intermediate Java class which is made up of bytecodes representing abstract instructions. In contrast, languages like C compile to native binary code that a specific hardware processor can run. To run the program, you start a JVM and pass the class file to the JVM. The JVM will load the class file and interpret (execute) the byte codes.

Interpretation and execution of bytecodes is much slower than the executing code that has been compiled to the native instruction set of the host processor.

For speed and performance, the HotSpot JVM will, on-the-fly or just-in-time (JIT), compile frequently used methods into native code (see [19] and [20] for more detail).

The HotSpot JVMs support two different compiler modes: ***-client*** and ***-server***. Each supports differing levels of optimization.

The **server** VM mode is designed to maximize performance of long running workloads by applying more aggressive optimizations. The **client** VM mode, in contrast, is designed to reduce application startup time and memory footprint. The client VM mode is typically better suited for applets running in browsers.

For optimal performance, you generally want to run long running workloads in server mode. In some cases, you may have to switch to client mode if there are issues with the server mode. This was the case in earlier versions of the JVM and less so today.

You should always check the platform recommendations for BEA WebLogic [33] and IBM WebSphere [38]. The following table lists Yantra's recommended VM modes

Table 9–1 Recommended VM Mode

Operating Environment	WebLogic	WebSphere	Yantra 7x Agents/Monitors
HP HP-UX11	server mode	not supported	server mode
SUN Solaris 2.9	server mode	server mode	server mode
Microsoft Windows 2000	server mode	not supported	server mode

To run the JVM in the server mode, you need to add the -server directive when starting up the JVM. For example, to start WebLogic in server mode, issue:

```
java -server weblogic.Server
```

To run WebLogic in the client mode, issue the following command:

```
java -client weblogic.Server
```

9.1.1.2 Permanent Generation

The HotSpot JVM sets aside an area, called permanent generation, to store the JVM's reflective data such as class and method objects. The size of this area is set to 64MB by default. Due to the number of classes used by application servers, you must set the permanent generation space setting to at least 128MB. If you use the default values, you will likely experience OutOfMemory exceptions during application server initialization.

To increase the permanent generation space, issue the following command

```
java -server -XX:MaxPermSize=128m java_class
```

This recommendation only applies to the application server JVM and not to the Yantra agents.

9.1.2 Heap Memory and Garbage Collection

The JVM run-time environment uses a large memory pool called the heap for object allocation. The JVM automatically invokes *garbage collections* in order to clean up the heap of unreferenced or dead objects. In contrast, memory management in legacy programming languages like C++ was left to the programmer.

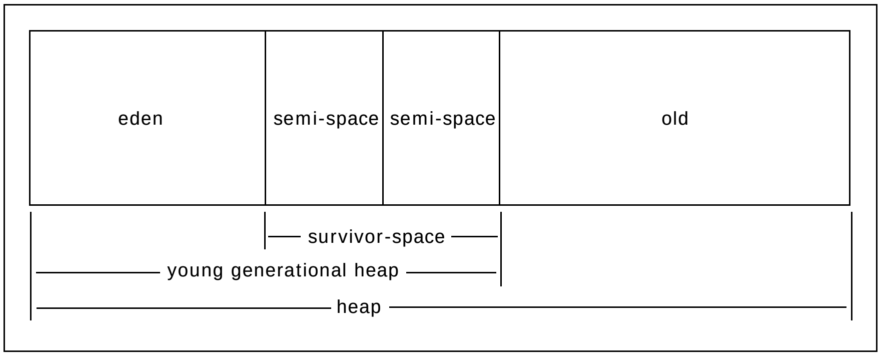
If the JVM heap settings are not set correctly, the garbage collection overhead can make the system appear unresponsive. In the worst case, your transactions or the JVM could abort due to outOfMemory exceptions (please see Section 8.4.3, "OutOfMemory Exceptions").

In the past, garbage collection overhead was quite substantial and the impact to end-user response times noticeable. Many garbage collection techniques have been proposed and implemented - all with their own strengths and weaknesses. Garbage collection techniques are constantly being improved. For example, the Sun JDK 1.3.1 JVM currently supports a mainly "stop-the-world" garbage collector - all transactions have to pause in a safe point for the entire duration of the garbage collection. In Sun JDK 1.4, the JVM supports a parallel concurrent collector where transactions can continue running during most of the collection.

9.1.2.1 Sun and HP-UX Generational Collectors

The Sun and HP JVM organized its heap into generations to improve the efficiency of its garbage collection, and to reduce the frequency and duration of user-perceivable garbage collection pauses. The premise behind generational collection is that memory is managed in *generations* or in pools of memory with different ages (see Figure 9–1, "Heap Layout").

Figure 9–1 Heap Layout



New objects are allocated in the *eden*. When the *eden* fills up, the JVM issues a *scavenge GC* or *minor collection* to move the surviving objects into one of the two survivor or semi spaces. The JVM does this by first identifying and moving all referenced objects in the eden to one of the survivor space. At the end of the scavenge GC, the *eden* will be empty (since all the referenced objects are now in the survivor space) and ready for object allocation.

The scavenge GC's efficiency depends on the amount of referenced objects it has to move to the survivor space and not on the size of the eden. The higher the amount of referenced objects, the slower the scavenge GC. Studies, however, have shown that most Java objects live a very short time. Since most objects live for a short time, one can typically create large edens.

Referenced objects in the survivor space bounce between the two survivor spaces at each scavenge GC until it either becomes unreferenced or the number of bounces has reached the *tenuring threshold*. If the tenuring threshold is reached, that object is migrated up to the old heap.

When the *old heap* fills up, the JVM issues a *Full GC* or *major collection*. In a Full GC, the JVM has to first identify all the referenced objects. When that is done, the JVM sweeps the entire heap to reclaim all free memory (for example, because the object is now dead). Finally, the JVM will then move referenced objects in order to defragment the old heap. The efficiency of the Full GC is dependent on the amount of referenced objects and the size of the heap. For more information see [19] and [21].

9.1.2.1.1 Heap Settings It is both a curse and a blessing that the SunSoft based JVMs provide many parameters to control the JVM heap configuration. Tuning the SunSoft generational collectors can be part art and part guess work. You may opt for the Keep It Simple Strategy Principle. In the following example, only specify the starting (-Xms) and maximum (-Xmx) heap size.

```
java -server -Xms358m -Xmx358m weblogic.Server
```

When choosing the JVM settings, you should keep the following in mind:

- set the initial and max heap size the same - this will eliminate the need of the JVM to decide when to expand or shrink the heap. This could also prevent a class of outOfMemory exceptions where there is not enough swap space when the JVM needs to expand the overall heap.

- by default, Yantra 7x caches reference data for performance. Depending on your data setup, you may have to increase the heap size or reduce the numbers of cached records. See Section 22.4.4, "Performance Feature - Reference Data Caching" for more information on the caching feature.
- ensure that the node has enough physical memory so that portions of the heap are not paged out

Note: Please make sure you test your JVM heap settings with representative workloads and data under anticipated peak processing rates. In addition, you should run these tests for a number of days. Depending on your processing mix, the JVM heap settings could be different for the JVMs running the agents, the application servers and the JMS servers.

When setting the young heap, keep the following recommendations in mind:

- set the initial and max eden size the same - this will eliminate the need of the JVM to decide when to expand or shrink the eden
- the cost of a scavenge GC is dependent on the amount of active objects that has to be moved to the survivor space and not on the size of the eden. Therefore, one can usually allocate a large eden.
- allocate the eden large enough so that the scavenge GCs are not occurring too frequently (e.g., less than once per minute) and the collection service time is reasonably short (e.g., less than 0.3 seconds).
- alternatively, create more JVMs to spread out the load. This will reduce the amount of active objects in a JVM which will reduce the frequency and the duration of the scavenge GC.

Keep in mind the following when configuring the survivor spaces:

- the survivor spaces must be large enough to store all the active objects coming from the eden as well as the sum of active objects that have an age that is less than the tenuring threshold.

Keep in mind the following when configuring the old heap:

- The amount of free space in the old heap must be larger than both the eden size plus one of the survivor space. If the free space is less, the JVM will resort to using Full GCs (see Section 9.1.2.1.2, "Young Generation Guarantee" below).
- The cost of a Full GC is dependent on the amount of active objects as well as the size of the old heap. A Full GC is typically a lot more noticeable to the end user than a scavenge GC. A Full GC on a 256MB old heap can take up to three seconds.
- Keep in mind that Yantra 7x provides the ability to cache records. If you activate this feature, you should monitor the occurrence of full GC to see if the *old generation* is large enough. See Section 22.4.4, "Performance Feature - Reference Data Caching" for more information on the caching feature.

Therefore, you should allocate the *old* heap large enough so that Full GCs are not occurring too frequently (e.g., more than once in 15 minutes) and the collection service time is less than 2 seconds

9.1.2.1.2 Young Generation Guarantee Starting in JDK 1.3.1_05, the Sun/HP JDKs implemented a conservative garbage collection policy called the Young Generation Guarantee. Before starting a GC, the JVM checks if the free space in the old heap (OLD FREE) is larger than the sum of the eden. The premise is that it is possible (though highly unlikely) that every object in the eden (remains alive and uncollected) the collection and has to be promoted to the old heap. If that ever happens, the Young Generation Guarantee will ensure that there is enough free space in the old heap for all the promoted objects.

Please see Sun's JDK 1.4.2 Garbage Collection document [20] for a detailed description of the Young Generation Guarantee.

9.1.2.1.3 Starting Recommendations We recommend that you try the default generational settings with a 384M and a 768M heap for your agents and application servers respectively.

```
java -server -Xms768m -Xmx768m \
     -XX:MaxPermSize=128m \
        weblogic.Server
```

Another approach is to set the overall heap to 1024MB with a 200MB young generation. For Solaris, you would issue the following command:

```
java -server -Xms1024m -Xmx1024m \
     -XX:NewSize=200m -XX:MaxNewSize=200m \
     -XX:MaxPermSize=128m \
     weblogic.Server
```

For HP-UX, you would issue the following command:

```
java -server -Xms1024m -Xmx1024m \
     -Xmn200m \
     -XX:MaxPermSize=128m \
     weblogic.Server
```

You have to regularly monitor the "health" of the garbage collection and adjust accordingly. For example,

- if you notice that the amount of heap free after a Full GC is approaching 500MB (the capacity of the old heap), you could eventually get java.lang.OutOfMemory exceptions. You should investigate why your JVM is keeping that many live objects. For example, with your data, you may have large reference data caches (see Section 22.4.4, "Performance Feature - Reference Data Caching").
- conversely, if the amount of heap free after a Full GC is much smaller than the old heap (and the load test is representative), you may consider reducing the old heap
- increase the overall heap size - however, make sure the Full GC takes less than 2 seconds
- you must ensure that the node has enough physical memory so that portions of the heap are not paged out

The optimum JVM heap setting depends on your workload characteristics, your workload concurrency levels, your workload complexity, and so forth. The JVM heap setting can be (and often is) different between the application servers and agents. In addition, the settings may be different between some agents. As a result, you will have to periodically check the effectiveness of each JVM’s heap setting.

9.1.2.1.4 Garbage Collection Statistics We recommend that you continuously collect garbage collection statistics for all JVMs even in production. The collection overhead is minor compared to the benefit. With the statistics, you will be able to tell if:

- a JVM has or is about to run into a memory leak
- the garbage collection is efficient
- your JVM heap settings are optimal

For a Sun JVM, you will get the following statistics if you enable `-XX:+PrintGCDetails`, `-XX:+PrintGCTimeStamps`, and `-Xloggc`.

```
0.000: [GC 0.001: [DefNew: 32192K->511K(33152K), 0.0383176 secs]
32192K->511K(101440K), 0.0385223 secs]
1.109: [GC 1.110: [DefNew: 32703K->198K(33152K), 0.0344874 secs]
32703K->697K(101440K), 0.0346844 secs]
```

Please see [21] for a detailed explanation of the statistics.

For an HP JVM, you will get the following statistics if you enable `-Xverbosegc:file`.

```
<GC: 1 0 13848.360276 8 16400 31 429520056 0 429522944 0 2328104 53673984
100687544 100687544 536870912 69787968 69787968 69992448 0.162748 >
<GC: 1 0 73541.610471 9 48 31 429522944 0 429522944 2328104 9051392 53673984
100687544 100687544 536870912 70708000 70708000 70778880 0.249739 >
```

Best Practice: Create the GC log file name with the name of the workload and the starting time. In the example below the `-XX:+PrintGCTimeStamps` directive provides relative times of the GC from the time the JVMs started for the WebLogic server. The starting time in the file name will allow you to determine when the GCs occurred.

```
WORKLOAD=SCHEDULE
gclog_file=${WORKLOAD}_‘date +%Y%m%d-%H%M%S‘
java -verbosegc -XX:+PrintGCTimeStamps -Xloggc:${gclog_file} weblogic.Server
```

9.2 Monitoring

9.2.1 Garbage Collection Statistics

In our opinion, garbage collection statistics are critical and should be enabled in production. The statistics is the only window you have into the behavior of the JVM heap management and the efficiency of the JVM.

This section describes three types of garbage collection statistics.

- The first is a comprehensive set from HP's JVM.
- The second is a terse statistics from both the HP and Sun JVM.

9.2.1.1 Comprehensive HP GC Logs

At every garbage collection, the HP JVM prints out a statistic record with 20 fields in the following format:

```
At every garbage collection, the following 20 fields are printed:
<GC: %1 %2 %3 %4 %5 %6 %7 %8 %9 %10 %11 %12 %13 %14 %15 %16 %17 %18 %19 %20
>

  %1:  Indicates the type of the garbage collection.
        1: represents a Scavenge (GC of New Generation only)
           %2: indicates if this is a parallel scavenge.
                0: non-parallel scavenge
                n(>0): parallel scavenge, n represents the number of
parallel GC threads

        2: represents an Old Generation GC or a Full GC
           %2: indicates the GC reason:
                1: Allocation failure, followed by a failed scavenge,
leading to a Full GC
                2: Call to System.gc
                3: Tenured Generation full
                4: Permanent Generation full
                5: Scavenge followed by a Train collection
                6: CMS Generation full
                7: Old generation expanded on last scavenge
                8: Old generation too full to scavenge
                9: FullGCAlot
               10: Allocation profiler triggered
```

```
      3: represents a complete background CMS GC
         %2:  indicates the GC reason:
              1: Occupancy > initiatingOccupancy
              2: Expanded recently
              3: Incremental collection will fail
              4: Linear allocation will fail
              5: Anticipated promotion

      4: represents an incomplete background CMS GC
            (exited after yielding to foreground GC)
         %2:  n.m
              n indicates the GC reason:
                1: Occupancy > initiatingOccupancy
                2: Expanded recently
                3: Incremental collection will fail
                4: Linear allocation will fail
                5: Anticipated promotion
                6: Incremental CMS
              m indicates the background CMS state when yielding:
                0: Resetting
                1: Idling
                2: InitialMarking
                3: Marking
                4: FinalMarking
                5: Precleaning
                6: Sweeping

%3:  Program time at the beginning of the collection, in seconds

%4:  Garbage collection invocation. Counts of background CMS GCs
      and other GCs are maintained separately

%5:  Size of the object allocation request that forced the GC,
      in bytes

%6:  Tenuring threshold - determines how long the new born object
      remains in the New Generation

The report includes the size of each space:
   Occupied before garbage collection (Before)
   Occupied after garbage collection (After)
   Current capacity (Capacity)
All values are in bytes

Eden Sub-space (within the New Generation)
```

```
    %7:  Before
    %8:  After
    %9:  Capacity

  Survivor Sub-space (within the New Generation)
    %10:  Before
    %11:  After
    %12:  Capacity

  Old Generation
    %13:  Before
    %14:  After
    %15:  Capacity

  Permanent Generation (Storage of Reflective Objects)
    %16:  Before
    %17:  After
    %18:  Capacity

    %19:  The total stop-the-world duration, in seconds.

    %20:  The total time used in collection, in seconds.
```

HP provides a graphical tool called HPjtune to help you visualize the HP JVM garbage collection activities. This tool is free and can be downloaded from [24].

The following are additional recommendations that add on to HP's excellent documentation.

9.2.1.1.1 Capacity When the JVM is in steady state, check %9 (Eden Capacity), %12 (Survivor Sub-space Capacity), %15 (Old Generation Capacity), and %18 (Permanent Generation Capacity) to make sure you have allocated the JVM heap correctly.

9.2.1.1.2 Things to Monitor In a healthy heap,

- during steady state, you should see mostly Scavenge GCs (%1=1) and the occasional Full GC caused by allocation failures (%1=2, %2=1).
- the sum of the GC times (%19 and %20) should not exceed 3% of the measurement interval - for example, in a 1-hour measurement

interval, the time taken for all GCs should not be more than 108 seconds.

- if you see Full GCs due to System.gc (%1=2, %2=2), you may need to set or adjust the -Dsun.rmi.dgc.server.gcInterval parameter (see Section 8.3.1.4, "Distributed Garbage Collection").
- if you see continuous Full GCs (%2=1), check to see if the free space in the old heap (%15 - %13) is less than the sum of %7 and %10. If it is, the JVM uses Full GCs even though there may be lots of free space in the heap (see Section 9.1.2.1.2, "Young Generation Guarantee"). This could be due to the amount of long-lived objects in the heap (see %14 after Full GCs), the old space (%15) is too small for the amount of long-lived objects or the eden (%9) is too big.
- if the amount of long-lived objects (%14 after Full GCs) is large (e.g., greater than 350MB) and has been steadily growing, you may have a memory leak. If %14 continues to grow, that JVM will eventually fail with an outOfMemory exception (see Section 8.4.3, "OutOfMemory Exceptions").

9.2.2 SUN

When the following flags are set

```
-verbose:gc -XX:+PrintGCTimeStamps -XX:+PrintGCDetails -Xloggc:filename
```

the Sun JVM produces the following garbage collection statistics

```
0.000: [GC 0.001: [DefNew: 32192K->511K(33152K), 0.0383176 secs]
32192K->511K(101440K), 0.0385223 secs]
1.109: [GC 1.110: [DefNew: 32703K->198K(33152K), 0.0344874 secs]
32703K->697K(101440K), 0.0346844 secs]
2.408: [GC 2.409: [DefNew: 32390K->403K(33152K), 0.0227843 secs]
32889K->902K(101440K), 0.0231518 secs]
```

Please see [21] for a description of the statistics. See [22] for examples of how to diagnose GC problems.

9.2.2.1 Potential Memory Leak

After running the JVM for a while, check the amount of objects remaining after a Full GC to see if there are potential memory leaks (please see Section 8.4.3, "OutOfMemory Exceptions").

9.2.2.1.1 Old Heap Too Small If you see successive Full GCs and the "heap after GC" number is consistently larger than the size of the Old Generation, the amount of live objects is larger than the Old Generation.

9.2.2.1.2 GC Times Watch for GC times that take over 2-5 seconds. Recall that all threads are paused for the duration of the GC. A transaction that normally takes 1 second will grow to 3-6 seconds. More importantly, blocked threads that are holding on to database locks could start to block other threads in other JVMs.

9.2.2.1.3 PrintGCStats Script Sun has developed a script, PrintGCStats, to interpret the results from the output file generated by "-Xloggc:*filename".* The PrintGCStats script can be downloaded from http://java.sun.com/developer/technicalArticles/Programming/turbo/.

Note: The PrintGCStats script can only produce meaningful results of the -Xloggc:filename output if the JVM is started with the "-verbose:gc -XX:+PrintGCTimeStamps -XX:+PrintGCDetails" flags.

An example output of the script is as follows:

```
what          count      total      mean      max   stddev
gen0(s)           9      0.591   0.06563    0.297   0.0870
gen0t(s)          9      0.600   0.06665    0.305   0.0895
gen1t(s)          9      7.890   0.87667    1.637   0.4381
GC(s)            18      8.490   0.47166    1.637   0.5175
alloc(MB)         9    721.889  80.20985   80.312   0.3079
promo(MB)         9      0.000   0.00000    0.000   0.0000

alloc/elapsed_time    =    721.889 MB /   4045.460 s  =   0.178 MB/s
alloc/tot_cpu_time    =    721.889 MB /  32363.680 s  =   0.022 MB/s
alloc/mut_cpu_time    =    721.889 MB /  32295.761 s  =   0.022 MB/s
promo/elapsed_time    =      0.000 MB /   4045.460 s  =   0.000 MB/s
promo/gc0_time        =      0.000 MB /      0.600 s  =   0.000 MB/s
gc_seq_load           =     67.919 s  /  32363.680 s  =   0.210%
gc_conc_load          =      0.000 s  /  32363.680 s  =   0.000%
gc_tot_load           =     67.919 s  /  32363.680 s  =   0.210%
```

The following table describes what each of the tags in the above excerpt means.

Table 9–2 PrintGCStats Output Statistics

Item Name	Description
gen0(s)	Young generation collection time in seconds
cmsIM(s)	CMS initial mark pause in seconds
cmsRM(s)	CMS remark pause in seconds
GC(s)	All stop-the-world GC pauses in seconds
cmsCM(s)	CMS concurrent mark phase in seconds
cmsCS(s)	CMS concurrent sweep phase in seconds
alloc(MB)	Object allocation in young generation in MB
promo(MB)	Object promotion to old generation in MB
elapsed_time(s)	Total wall clock elapsed time for the application run in seconds
tot_cpu_time(s)	Total CPU time = no. of CPUs * elapsed_time
mut_cpu_time(s)	Total time that was available to the application in seconds
gc0_time(s)	Total time used by GC during young generation pauses
alloc/elapsed_time(MB/s)	Allocation rate per unit of elapsed time in MB/seconds
alloc/tot_cpu_time(MB/s)	Allocation rate per unit of total CPU time in MB/seconds
alloc/mut_cpu_time(MB/s)	Allocation rate per unit of total application time in MB/seconds
promo/gc0_time(MB/s)	Promotion rate per unit of GC time in MB/seconds
gc_seq_load(%)	Percentage of total time spent in stop-the-world GCs
gc_conc_load(%)	Percentage of total time spent in concurrent GCs
gc_tot_load(%)	Total percentage of GC time (sequential and concurrent)

There are two statistics generated by this script that are very useful in tuning the JVM. The statistic *gc_seq_load* generates the total stop the world GC time as a percent of total application time. The statistic *gc_tot_ load* is the total GC time for both full and scavenge GCs as a percentage of total application time. When making changes to the JVM this script should be run before and after to see if there is a positive change in these numbers. It is important to note that by lowering the gc_tot_load, and increasing the gc_seq_load, there would be a degradation in performance of the application overall. The reason for this is that the gc_ seq_load is the total time the application spends in "Stop the World" GCs during which all threads are stopped.

10

IBM JVM

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the IBM Java Virtual Machine.

You will use the IBM JVM when you deploy the Yantra 7x application with IBM WebSphere application servers on

- IBM AIX operating system on POWER4 or POWER5 based servers or
- Red Hat Enterprise Linux operating system on Intel processor based systems

10.1 Implementation

10.1.1 Starting Recommendations

As a starting pint, you should configure the IBM JVM as follows

- set JIT and MMI on (by default)
- set PSALLOC=EARLY and NODISCLAIM=TRUE (IBM AIX only)

10.1.1.1 JIT and MMI

The Java language is designed to be platform independent. When you compile a Java source, you get an intermediate Java class which is made up of bytecodes representing abstract instructions. In contrast, languages like C compile to native binary code that a specific hardware processor can run. To run the program, you start a JVM and pass the class file to the JVM. The JVM will load the class file and interpret (execute) the byte codes.

Interpretation and execution of bytecodes is much slower than the executing code that has been compiled to the native instruction set of the host processor. At the same time, compiling every bytecode to native instructions will slow down the JVM startup.

As a result, the IBM JVM uses mixed-mode interpretation (MMI) where initially bytecodes are interpreted. When the MMI detects that bytecodes have been interpreted multiple times, it will invoke a just-in-time (JIT) compiler to compile those bytecodes to native instructions.

For performance, you should ensure the JIT and MMI are enabled. The JVM performance will degrade significantly if JIT is disabled. Some third party vendors may recommend disabling certain portions of the JIT compiler. In those specific situations, we recommend you run controlled performance tests with and without that specific JIT option to understand the impact to performance.

The JDK 1.4.2 Diagnostic Guide [27] provides an excellent description of the JIT compiler and the MMI.

10.1.1.2 PSALLOC and NODISCLAIM (AIX only)

IBM AIX implements a late page allocation policy. When you start a JVM with a large heap, AIX does not guarantee that there is sufficient page space to back the heap. AIX will only allocate space on the page device when you use the heap. In some cases, AIX may have to kill JVMs when it is low on free space on the page devices.

To prevent this, we recommend setting the following environment variables prior to starting the JVM

```
PSALLOC=EARLY
NODISCLAIM=TRUE
```

Please see Section 4.1.1, "Page Space Allocation Policy" for more information.

10.1.2 Heap Memory and Garbage Collection

The JVM run-time environment uses a large memory pool called the heap for object allocation. The JVM automatically invokes *garbage collections* in order to clean up the heap of unreferenced or dead objects. In contrast, memory management in legacy programming languages like C++ was left to the programmer.

If the JVM heap settings are not set correctly, the garbage collection overhead can make the system appear unresponsive. In the worst case, your transactions or the JVM could abort due to outOfMemory exceptions (please see Section 8.4.3, "OutOfMemory Exceptions").

When choosing the JVM settings, you should keep the following in mind:

- set the initial and max heap size the same - this will eliminate the need of the JVM to decide when to expand or shrink the heap. This could also prevent a class of outOfMemory exceptions where there is not enough swap space when the JVM needs to expand the overall heap.
- by default, Yantra 7x caches reference data for performance. Depending on your data setup, you may have to increase the heap size or reduce the numbers of cached records. See Section 22.4.4, "Performance Feature - Reference Data Caching" for more information on the caching feature.
- ensure that the node has enough physical memory so that portions of the heap are not paged out

10.1.2.1 IBM JVMs

IBM chose not to implement generational copying garbage collectors (as described above) but to instead focus on optimizing the three collection phases. These three phases are

- marking live objects,
- sweeping the heap to look for large free chunks, and
- compacting the heap to reduce fragmentation

[25], Part 2 provides a very good description of collection phases. The JDK 1.4.1 Diagnostic Guide [27] provides an outstanding description of the IBM JVM garbage collector and guidance on how to interpret the garbage collection statistics.

The JVM is the foundation or engine which Yantra 7x and the BEA WebLogic or IBM WebSphere application server runs on. If the JVM settings are not implemented correctly, the system can appear sluggish or unresponsive. In the worst case, the JVM will crash.

There isn’t a golden set of JVM settings that apply to all customers and conditions. The settings, especially memory settings (which we will discuss below) are highly dependent on the transaction mix, the amount of data cached, the complexity of the transactions, concurrency levels, and so forth.

10.1.2.1.1 Heap Settings The default heap settings are appropriate for small applications. By default, the heap on AIX starts at 4MB and can grow to 64MB. You must adjust the heap settings for your environment.

Fortunately, the IBM JVM was designed to work with most scenarios with less parameter tuning as compared to the HotSpot generational collectors. From past experiences, we generally only set the initial and maximum heap size. As a result, the IBM JVMs are easier to configure. The IBM JVM also provides good statistics to help monitor and tune the JVMs. See [26] for an excellent article on recommendations on setting the heap parameters and both [25] and [27] on monitoring the JVM performance.

10.1.2.2 Starting Recommendations

We recommend you configure the IBM JVMs with the following starting recommendations and test the JVMs under representative workloads and traffic volumes prior to going live in production.

As a starting point, you should configure the JVMs running the Yantra 7x agents and the application servers with a 384M and a 512-768M heap respectively. The following are two sample configurations to start the Yantra 7x Schedule agent and a WebLogic application server.

```
export PSALLOC=EARLY          # AIX Only
export NODISCLAIM=TRUE        # AIX Only

java -Xms384m -Xmx384m \
    -Dsun.rmi.dgc.server.gcInterval=3600000 \
    -verbosegc \
    com.yantra.integration.adapter.IntegrationAdapter

java -Xms768m -Xmx768m \
    -Dsun.rmi.dgc.server.gcInterval=3600000 \
    -verbosegc \
    weblogic.Server
```

10.1.2.2.1 Heap Settings The -Xms and -Xmx sets the initial and maximum heap size. When setting these values, keep the following guidelines in mind.

- set the initial (-Xms) and maximum (-Xmx) heap size the same - this will eliminate the need of the JVM to decide when to expand or shrink the heap. This could also prevent the situation where there is not enough swap space when the JVM needs to expand the overall heap.
- you must ensure that the node has enough physical memory so that portions of the heap are not paged out
- you must ensure there is enough swap space to back the virtual address space requirement for all concurrently running JVMs or, if you are on AIX, ensure the JVMs are started with `PSALLOC=EARLY` and `NODISCLAIM=TRUE` (see Chapter 4.1.1, "Page Space Allocation Policy")

10.1.2.2.2 Garbage Collection Statistics We recommend that you continuously collect garbage collection statistics for all JVMs even in production. The collection overhead is minor compared to the benefit. With the statistics, you will be able to tell if:

- a JVM has or is about to run into a memory leak
- the garbage collection is efficient
- your JVM heap settings are optimal

To enable GC statistics, set the -verbosegc option. The JDK 1.4.1 Diagnostic Guide [27] provides very good guidance on how to interpret the garbage collection statistics.

10.2 Monitoring

10.2.1 Garbage Collection Statistics

In our opinion, garbage collection statistics are critical and should be enabled in production. The statistics is the only window you have into the behavior of the JVM heap management and the efficiency of the JVM.

This section describes the garbage collection statistics.

IBM provides excellent documentation on their garbage collector and how to interpret their GC statistics (see [25], [26], [27]).

Here is a sample of the GC log.

```
<AF[4655]: Allocation Failure. need 32784 bytes, 14343 ms since last AF>
```

```
<AF[4655]: managing allocation failure, action=1 (173688/265222656)
(3145728/314
5728)>
<GC(4657): GC cycle started Thu Jan 30 11:31:56 2003
<GC(4657): freed 233284808 bytes, 88% free (236604224/268368384), in 179 ms>
  <GC(4657): mark: 146 ms, sweep: 33 ms, compact: 0 ms>
  <GC(4657): refs: soft 0 (age >= 32), weak 6, final 14, phantom 3>
<AF[4655]: completed in 181 ms>
```

In the example above, <AF[4655]> indicates that this is the 4,655th time an attempt to allocate memory failed and as a result, a GC was initiated. An allocation failure is not an error in the system or code. When there is not enough free space in the heap, the JVM will initiate a garbage collection. The last time an allocation failure occurred was 14,343 ms ago (or 14.343 seconds).

The lines with <GC(4657)> provides information on the collection process. In the example above, the mark, sweep and compact phases completed in 0.181 seconds and was able to free up 233,284,808 bytes. As a result, the heap has 236,604,224 bytes free out of a total of 268,368,384.

10.2.1.1 Frequency of GC Health Check

You should check how often GCs are occurring by looking at the time between allocation failures.

10.2.1.2 GC Times

Monitor the time to complete the GC. You should try to keep the GCs close to sub-second. Recall that all threads are paused for the duration of the GC. Blocked threads that are holding on to database locks could start to block other threads in other JVMs.

10.2.1.3 Potential Memory Leak

If the JVM is running for a while and the percentage free is continually decreasing with each successive GC, that JVM could be heading to an outOfMemory condition. This could indicate that either the Java application is keeping a lot of active objects (e.g., reference data caching) or there is a memory leak.

10.2.2 Heapdump

The IBM JVM heapdump contains information about all the live objects in its heap. The JVM will automatically create a heapdump when the JVM runs into an outOfMemory (OOM) exception. You can also instruct the IBM JVM to generate a heapdump with the kill -3 command if you had started the JVM with the IBM_HEAPDUMP=true environment variable.

The IBM Memory Dump Diagnostic is an excellent tool for analyzing the heapdump. You can download the Memory Dump Diagnostic from http://www-128.ibm.com/developerworks/websphere/downloads/memory_dump.html.

You need an IBM JVM 1.4.2 to run the Memory Dump Diagnostic tool. That JDK is available in the same download page.

You can read up on IBM heapdumps (and a lot more) in the IBM JDK 1.4.2 Diagnostic Guide - see http://www-128.ibm.com/developerworks/java/jdk/diagnosis/

The presentation at http://www-1.ibm.com/support/docview.wss?uid=swg27006624&aid=1 discusses how to use the older Heapanalyzer. The techniques and screens are similar and applicable to the Memory Dump Diagnostic tool.

11

BEA JRockit

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the BEA JRockit Java Virtual Machine.

You will use the JRockit JVM when you deploy the Yantra 7x application with BEA WebLogic application servers on either the Red Hat Enterprise Linux or Windows operating system on Intel processor based systems.

11.1 Implementation

The BEA JRockit was designed for server-side applications. One distinguishing feature of JRockit is its adaptability. During the life of the JVM, JRockit could change the type of garbage collector used or the size of the heap.

11.1.1 Starting Recommendations

To exploit the adaptiveness of the JRockit JVM, we recommend the simple starting JVM settings

```
java -Xms384m -Xmx384m \
    -Dsun.rmi.dgc.server.gcInterval=3600000 \
    -Xverbosetimestamp -verbosegc \
    com.yantra.integration.adapter.IntegrationAdapter

java -Xms768m -Xmx768m \
    -Dsun.rmi.dgc.server.gcInterval=3600000 \
    -Xverbosetimestamp -verbosegc \
    weblogic.Server
```

11.1.1.1 Heap Settings

The `-Xms` and `-Xmx` sets the initial and maximum heap size. When setting these values, keep the following guidelines in mind.

- set the initial (-Xms) and maximum (-Xmx) heap size the same - this will eliminate the need of the JVM to decide when to expand or shrink the heap. This could also prevent the situation where there is not enough swap space when the JVM needs to expand the overall heap.
- by default, Yantra 7x caches reference data for performance. Depending on your data setup, you may have to increase the heap size or reduce the numbers of cached records. See Section 22.4.4, "Performance Feature - Reference Data Caching" for more information on the caching feature.
- you must ensure that the node has enough physical memory so that portions of the heap are not paged out

11.1.1.2 Garbage Collection Statistics

We recommend that you continuously collect garbage collection statistics for all JVMs even in production. The collection overhead is minor compared to the benefit. With the statistics, you will be able to tell if:

- a JVM has or is about to run into a memory leak
- the garbage collection is efficient
- your JVM heap settings are optimal

To enable GC statistics, set the `-verbosegc` option.

Part III
Application Servers

This part of the book provides information on how to implement, monitor and tune application servers. The application server is the core technology that provides the runtime environment that the Yantra application runs on.

Configuring and operating the application server efficiently is critical for performance. Suboptimal application server settings will cause poor application performance at best. It could cause application outages at worst.

The following chapters are included in this Part

12

BEA WebLogic

This chapter provides guidelines on the planning, implementation, configuration, monitoring, and tuning of the BEA WebLogic application servers.

12.1 Implementation

12.1.1 WebLogic Tuning

This section assumes that you:

- are familiar with and have installed BEA WebLogic application server in a clustered mode
- have read BEA's performance tuning guide [28]

This section elaborates on the recommendations found in [28].

12.1.1.1 Server Tuning

12.1.1.1.1 Execute Thread Count Yantra 7x workloads run in the WebLogic application server's default processing queue, `weblogic.kernel.Default`. This queue is initially set to 15 threads. You can check the current setting in the WebLogic console at Server > *Server Name*. Right click the Server Name and select "View Execute Queues". Look at the Thread Count setting for `weblogic.kernel.Default`.

Typically, you can scale better by configuring additional WebLogic Server instances than by increasing the thread count beyond its default value.

12.1.1.2 Application Server Instances

Please keep in mind the following when determining the number of WebLogic instances:

- configure at most one WebLogic Server instance per processor - if you have a 4-way node (4 processors), then configure at most 4 WebLogic Server instances on that node.
- plan for a single WebLogic Server instance to be able to use at most 4 (preferably 2) processors. If you have an 8-way node, you should not implement one WebLogic Server instance and expect it to effectively use all processors. With this rule, to fully utilize the node, you should plan for two to four WebLogic Server instances.

12.1.1.3 Server Tuning Parameters

You may want to set the following Server Tuning Parameters - all others can be left to their default settings. In the left pane of the WebLogic Console, click on Server > *Server Name*. In the right pane, click on the Tuning tab.

Table 12–1 Server - Tuning Settings

Attribute	Value
Stuck Threads Max Time	set to a lower number to proactively identify long running transactions. You could set this value to 60 seconds and adjust as needed.
Accept Backlog	This determines how many transactions are queued in the backlog queue when all Execute Threads are busy. The default of 50 may be too small to handle occasional surges in transaction volumes. Recommend setting the backlog queue to 100 and adjust as needed.

Stuck Threads Max Time

You will get a similar message in the WebLogic log when a transaction has been actively working for more than the Stuck Thread Max Time setting.

```
<Feb 19, 2004 2:10:08 PM EST> <Warning> <WebLogicServer> <BEA-000337>
<ExecuteThread: '12' for queue: 'weblogic.kernel.Default' has been busy for
"41" seconds working on the request "Http Request:
```

```
/yantra/console/wave.detail", which is more than the configured time
(StuckThreadMaxTime) of "30" seconds.>
```

12.1.1.4 WebLogic Connection Pool

Creating database connections are very expensive operations (see [34]). For performance, Yantra 7x takes advantage of the WebLogic connection pool.

To enable connection pooling, you need to

- define a data source to Yantra 7x
- define a connection pool in WebLogic
- define a data source in WebLogic that ties the data source in Yantra 7x to the connection pool in WebLogic

12.1.1.4.1 Define Data Source in Yantra 7x To define the data source name to Yantra 7x, add the following parameter into Yantra 7x properties file - `yfs.properties` (see Section 22.4.10, "Property Files").

```
yfs.dblogin.datasource.name=yfsdbsourceperf
```

At initialization, Yantra 7x uses the datasource name to find the connection pool in WebLogic. In the example above, the datasource name is `yfsdbsourceperf`.

12.1.1.4.2 Define a Connection Pool in WebLogic In the WebLogic admin console, in Services > JDBC > Connection Pools, create a new connection pool. The following is a valid connection pool definition.

In Services > JDBC > Connection Pools > General, set the following attributes.

Table 12–2 Connection Pool - General Settings

Attribute	Value
Name	connection pool name - e.g., yfsconnpool

Table 12–2 Connection Pool - General Settings

Attribute	Value
URL	database URL - e.g., jdbc:oracle:thin:@<hostname>:1521:<sid> where <hostname> is your database server hostname or IP address <sid> is your database system id
Driver Classname	oracle.jdbc.OracleDriver
Properties	user = <yantra appl user> password = <yantra user's password>

In Services > JDBC > Connection Pools > Connections, set the following attributes.

Table 12–3 Connection Pool - Connection Settings

Attribute	Value
Initial Capacity	Initial number of connections to create for the connection pool. If the pool is allowed to shrink, it will not shrink below this number. See below for recommendations.
Maximum Capacity	Maximum number of connections that can be created for this pool. See below for recommendations.
Capacity Increment	The increment by which the pool grows. Recommend 1.
Statement Cache Type	Set to LRU if you want the Least recently used algorithm, or fixed if you want to use the First In algorithm
Statement Cache Size	Recommend 40.
Login Delay	The amount of delay between connection pool establishment. Recommend 1 second.
Allow Shrinking	Determines whether WebLogic will release connections that have been inactive for a specified length of time (see Shrink Period below). Recommend setting this attribute to allow shrinking.
Shrink Frequency	Recommend leaving setting at default of 900 seconds.
Enable Connection Leak Profiling	Recommend leaving setting at default setting of "not enabled". Only set when needed to detect connection leaks.

Table 12–3 Connection Pool - Connection Settings

Attribute	Value
Refresh Period	The interval when free connections in the pool are tested. Recommend 5 minutes.
Supports Local Transaction	This attribute applies to XA connection pools only. Recommend not setting this value.

Note: If you are deploying Oracle10g Real Application Cluster, please see Section 18.2.5.1, "WebLogic Connection Pool Properties" for additional connection pool recommendations.

Yantra recommends that you benchmark your application prior to migration to production to ensure that these values are set optimally. Yantra also recommends that you continually monitor the connection pool usage levels to ensure that these parameters are set optimally.

Initial Capacity

Bear in mind the following guidelines when setting the initial capacity attribute

- You should set the initial capacity to satisfy your daily average connection requirements. This level can be derived by monitoring your actual pool usage levels.
- You may want to set the initial capacity to a higher number if your system experiences frequent traffic bursts.
- You may not want to set initial capacity to a very high number because both WebLogic and database server will have to maintain a high number of connections. For example, assume you have 8 managed server instances, each with 15 execute threads. If you set initial and maximum connection at 17, WebLogic will create and maintain 136 database connections.

BEA [28] suggest considering setting Initial Capacity equal to Maximum Capacity.

Maximum Capacity

This attribute sets the maximum number of connections your pool can grow to within a single WebLogic Server instance. If you set this value to 27 and you have eight WebLogic Server instances, in theory, WebLogic could create up to 216 database connections.

Bear in mind the following guidelines when setting the maximum capacity attribute

- Generally, each Yantra 7x transaction requires one connection. If you set ThreadCount (see Section 12.1.1.1.1, "Execute Thread Count") to 15, there can be at most 15 concurrently running transactions. Therefore, at most you should only require 15 connections. As a result, one could set the maximum capacity to 15. In practice, we set maximum capacity to be around Thread Count plus a small number (e.g., 2 or 5) for a safety buffer. Therefore, you can set the maximum capacity to 17 or 20.
- Monitor your application in production to confirm that the ratio of connection usage is roughly equal to the number of active execute threads.
- Benchmark your application to see if custom code, user exits, and so forth require additional connections.

Capacity Increment and Login Delay Seconds

Recall that database connection establishment process is very resource intensive. Internal benchmarks shows that Oracle connections can take from 400 to 800ms and are serially processed.

This attribute pair is useful in throttling back the number of connection requests.

Allow Shrinking and Shrink Frequency

This attribute pair informs WebLogic to release inactive connections if they have been idle for the period as specified by "shrink frequency". This has the advantage of releasing resources both at the WebLogic and database server end.

Prepared Statement Cache Size

This attribute tells WebLogic to create a cache for each database connection that can store prepared statements up to the value specified.

Prepared statements are precompiled SQL statements that can be repeatedly invoked with different parameter values. Prepared statements will reduce the need to compile the SQL statements.

To disable prepared statement caching, set the prepared statement cache size to 0. To use the cache, you can set a value up to 300.

In Services > JDBC > Connection Pools > Testing, set the following attributes.

Table 12–4 Connection Pool - Testing Settings

Attribute	Value
Test Table Name	Oracle: dual SQL Server: an empty table UDB: sysibm.sysdummy1
Test Reserved Connections	disable
Test Reserved Connections	disable

Note: If you are deploying Oracle10g Real Application Cluster, please see Section 18.2.5.1, "WebLogic Connection Pool Properties" for additional connection pool/testing recommendations.

12.1.1.4.3 Define Data Source After creating the connection pool, you then need to define the data source. In Services > Data Sources > Configuration, set the following attributes.

Table 12–5 Data Source - Configuration Settings

Attribute	Value
Name	Data source name. This value must be the same as the one you specified in the yfs.properties. In the example above, the data source name was set to **yfsdbsourceperf**
JNDI Name	Sets the name which the data source name is bound to JNDI. Recommend setting this to the same as the data source name.
Pool Name	Sets the name of the connection pool that was created above (e.g., **yfsconnpool**)
Row Prefetch Enabled, Row Prefetch Size	Enables resultset prefetching for external clients that process JDBC through WebLogic. Recommend not setting this feature since it is not required.
Stream Chunk Size	Enables resultset prefetching for external clients that process JDBC through WebLogic. Recommend not setting this feature since it is not required.

12.1.1.5 JSP Pre-Compilation

When users call up a JSP page the first time, WebLogic will automatically translate the JSP file into a servlet and then compile that servlet. This process can over 30 seconds, which could lead to user dissatisfaction. Further, this process is performed serially even on a multiprocessor node - if you have multiple users hitting five different pages, WebLogic will compile these pages one at a time.

As a result, we strongly recommend precompiling the JSP pages and saving the compiled JSPs prior to deployment into production.

12.1.1.5.1 Precompiling the Yantra EAR To precompile to the enterprise archive file (yantra.ear), you first need to build the EAR. Please see *Yantra 7x Installation Guide*.

When you have the ear, issue the following

```
DB_DRIVER=$YFS_HOME/lib/ojdbc14.jar

WLS_JARS=${JAVA_HOME}/lib/tools.jar:\
    ${WL_HOME}/lib/weblogic.jar:\
    ${JAVA_HOME}/jre/lib/rt.jar:\
    ${WL_HOME}/lib/webservices.jar:

APPC_CLASSPATH=${WL_HOME}/lib/weblogic.jar:${JAVA_HOME}/lib/tools.jar

for i in $YFS_HOME/lib/*.jar
do
    YANTRA_JARS=$YANTRA_JARS:$i
done

YANTRA_CLASSPATH="${YANTRA_JARS}:${PATCHES}:${WLS_JARS}:${CLASSPATH}"

APPC_CLASSPATH=${WL_HOME}/lib/weblogic.jar:${JAVA_HOME}/lib/tools.jar

YANTRA_CLASSPATH=$YANTRA_CLASSPATH:$APPC_CLASSPATH

java weblogic.appc \
    -output ${YFS_HOME}/drop/yantra.ear \
    -forceGeneration \
    -O \
    -verbose
    -classpath ${YANTRA_CLASSPATH} \
    ${YFS_HOME}/drop/yantra.ear
```

The precompiled JSPs will be stored back into the `yantra.ear` file.

12.1.1.5.2 Precompiling for Exploded Archives For convenience, you can deploy the web component of the Yantra application as an "exploded" archive. For example, with an exploded archive, you can modify or add a JSP and have that new JSP take effect immediately. This could be very useful in development environments.

Note: The preferred method of deployment in production is the EAR mode.

To precompile the web component of the exploded archive, issue the following command against the JSPs found in $YFS_HOME/webpages.

```
java weblogic.appc \
    -output /tmp/precompile \
    -forceGeneration \
    -O \
    -verbose
    -classpath ${YANTRA_CLASSPATH} \
    ${YFS_HOME}/webpages
```

In the example above, the compiled pages will be stored in /tmp/precompile. For example, the shipment_receipt_details.jsp page will be compiled into /tmp/ precompile/WEB-INF/classes/jsp_servlet/_ om/_shipment/_detail/__shipment_receipt_details.java.

```
[jspc] parsing /om/shipment/detail/shipment_receipt_details.jsp:
[jspc] parsed /app2/q81lin3x/jsp/om/shipment/detail/shipment_receipt_details.jsp
in 190 ms.
[jspc] generated java file /tmp/precompile/WEB-INF/classes/jsp_servlet/_om/_
shipment/_detail/__shipment_receipt_details.java
```

When the precompile step is finished, copy the classes folder to the $YFS_HOME/webpages/WEB-INF folder.

12.1.1.6 WebLogic Server Cluster

For operational simplicity, you could implement the WebLogic Server as a single (non-clustered) instance. However, for availability and performance, many installations implement a WebLogic cluster over separate physical nodes. When creating the cluster, consider the following:

- For performance, multiple WebLogic instances in a cluster generally out-perform a single WebLogic instance on a large SMP node.
- For availability, multiple WebLogic instances spread over multiple physical nodes reduce the impact of losing a node.
- For performance, multiple WebLogic instances spread over multiple physical nodes reduce the impact of garbage collection on response times to users.
- For maintainability, set aside a bank of consecutive IP addresses for the cluster so that you can multi-home the network cards. Each WebLogic instance requires a unique IP address.

12.1.2 HTTP Load-Balancing

The Yantra HTTP screens are stateful in the sense that a screen preserves state information for subsequent screens. As a result, you have to set up proxy servers or load-balancers to load-balance HTTP requests with a “sticky” load-balancing policy. This ensures HTTP requests go back to the server that have the session states.

Load-balancing can improve performance for large number of HTTP users because the user population is serviced by multiple application servers that are managed as a cluster. Load-balancing can be implemented with a variety of technologies ranging from the Apache proxy servers to hardware-based load balancers.

12.1.2.1 HTTP Session Replication

Yantra 7x supports HTTP in-memory session replication on the following configuration.

- BEA WebLogic
- Apache 2.0.44 with the WebLogic plug-in as the proxy server with idempotent set to 'OFF'

Please see the *Yantra 7x Installation Guide* for instructions on how to set up WebLogic in-memory session replication.

Note: The Apache or load-balancer idempotent flag must be set to OFF. In rare cases, for example, when a transaction completes and commits but was unable to post the response to the proxy server, the proxy server could retransmit the transaction. For some update transactions, this could result in duplicate update entries.

12.2 Monitoring

You should monitor the following on a regular basis

- Execute Thread Count
    - Track the average and maximum number of active execute threads through third-party tools or custom-developed JMX-based programs.
    - Correlate that number to the workload level issued to the application servers.
    - Either using mathematical projections or system tests, estimate the number of concurrent threads expected during your peak operational periods. As a general rule, you should plan to keep the average active threads to 15 or less.
- Garbage Collection

  - Monitor the frequency and health of the JVM’s heap management. Please see the chapter relevant to your JVM in Part II, "Java Virtual Machines".
- Connection Pool Usage
  - Check if Connection High is equal to the JDBC pool size - the Connection High is the highest number of connections ever reached. Recall, the JDBC pool to be equal to the maximum possible transaction concurrency level plus a safety buffer of two. The Connection High should not be the same as the JDBC pool size.

13

IBM WebSphere

This chapter provides guidelines on the planning, implementation, configuration, monitoring, and tuning of the BEA WebLogic application servers.

13.1 Implementation

13.1.1 WebSphere Tuning

This section assumes that you:

- are familiar with and have installed IBM WebSphere application server in a network deployment
- have read the IBM WebSphere performance tuning guide [36]

This section elaborates on the recommendations found in [36].

13.1.1.1 WebSphere Queuing Network

In [36], IBM describes transactions to WebSphere as being processed in a network of interconnected queues that includes the network, Web Server, Web Container, EJB container, data source, connection pool, and the database sessions.

IBM then recommends that the queues closest to the client be large (e.g, the network) and that downstream queues (e.g., EJB container, data source) grow progressively smaller as it gets further from the client. One of the reasons offered is that an application that spends 90% of its time in a complex servlet and only 10% of its time making short JDBC queries would require a significantly smaller database connection queue than the Web Container queue.

We agree with the first statement that the network queue can be large because it is preferable to queue in the network and not in the application server. However, from our experience, the downstream queues should be set to the same size if not larger.

In database intensive applications, such as Yantra 7x, when a transaction enters the Web Container, the APIs will almost always require a database connection. If one were to allow 20 concurrent transactions (by setting `Maximum Thread Size` in the Web Container Services) to run against a connection pool of 12, there will be a possibility that at peak processing periods, 8 transactions would either be forced to wait for a connection or throw an exception because it can’t get a connection.

Using the same argument, the database instance should be able to create more sessions than the sum of all the connections possible from all the WebSphere instances combined. You will also need additional database sessions for standalone Java applications that need database services (e.g., the Yantra 7x agents or monitors), real-time performance monitors, database utilities and so forth

13.1.1.2 WebSphere Connection Pool

Creating database connections are very expensive operations. For performance, Yantra 7x takes advantage of the WebSphere connection pool.

To enable connection pooling, you need to

- define a data source to Yantra 7x
- define a connection pool in WebSphere and then associate the connection pool to the data source name in Yantra 7x

13.1.1.2.1 Define Data Source in Yantra 7x To define the data source name to Yantra 7x, add the following parameter into Yantra 7x properties file - `yfs.properties` (see Section 22.4.10, "Property Files").

```
yfs.dblogin.datasource.name=yfsdbsourceperf
```

At initialization, Yantra 7x uses the datasource name to find the connection pool in WebSphere. In the example above, the datasource name is `yfsdbsourceperf`.

13.1.1.2.2 Define a Connection Pool in WebSphere In the WebSphere administrative console, in Resources > JDBC Provider, create a new connection pool. The following is a valid connection pool definition.

Next, in Resources > JDBC Provider > *pool name*, create the data source. In the data source dialog box, set the following in the Connection Pool tab.

Table 13–1 Connection Pool - Connection Settings

Attribute	Value
Minimum pool size	Initial number of connections to create for the connection pool. If the pool is allowed to shrink, it will not shrink below this number. See below for recommendations.
Maximum pool size	Maximum number of connections that can be created for this pool. See below for recommendations.
Statement cache size	The maximum number of prepared statements to cache for the data source.

Yantra recommends that you benchmark your application prior to migration to production to ensure that these values are set optimally. Yantra also recommends that you continually monitor the connection pool usage levels to ensure that these parameters are set optimally.

Minimum Pool Size

Bear in mind the following guidelines when setting the minimum pool size attribute

- You should set the minimum pool size to satisfy your daily average connection requirements. This level can be derived by monitoring your actual pool usage levels.
- You may want to set the minimum pool size to a higher number if your system experiences frequent traffic bursts.

- You may not want to set minimum pool size to a very high number because both WebSphere and the database server will have to maintain a high number of connections.

Maximum Pool Size

This attribute sets the maximum number of connections the pool can grow to within a single WebSphere instance. If you set this value to 20 and you have ten WebSphere instances, in theory, WebSphere could create 200 database connections.

Bear in mind the following guidelines when setting the maximum pool size attribute

- Generally, each Yantra 7x transaction requires one connection. If you we set maximum pool size to be around the maximum concurrency level at peak period plus a small safety buffer (e.g., 2 or 5). For example, if you expect the concurrency level to never grow higher than 15, you should set the maximum pool size to 17 or 20.
- Monitor your application in production to confirm that the ratio of connection usage is roughly equal to the concurrency levels.
- Benchmark your application to see if custom code, user exits, and so forth require additional connections.

Statement Cache Size

This attribute tells WebSphere to create a cache at the data source level to store prepared statements up to the value specified.

Prepared statements are precompiled SQL statements that can be repeatedly invoked with different parameter values. Prepared statements will reduce the need to compile the SQL statements.

To disable prepared statement caching, set the prepared statement cache size to 0. To use the cache, you can set a value to a higher value.

13.1.1.3 JSP Pre-Compilation

When users call a JSP page the first time, WebSphere will automatically compile that JSP. JSP compilations, however, can take a long time which could lead to the perception that the system is slow. Some JSPs can take over a minute to compile. You can avoid this problem by precompiling the JSPs after deployment. To do this, issue the following `JspBatchCompiler` script from *was_root*/bin from each WebSphere node

```
./JspBatchCompiler.sh  \
    -enterpriseapp.name ${appName} \
    -webmodule.name yantra.war \
    -cell.name <customer cell name> \
    -node.name <customer node name> \
    -server.name <customer server name> \
    -keepgenerated true
```

The `webmodule.name` must be set to `yantra.war`.

13.1.2 HTTP Load-Balancing

The Yantra HTTP screens are stateful in the sense that a screen preserves state information for subsequent screens. As a result, you have to set up proxy servers or load-balancers to load-balance HTTP requests with a “sticky” load-balancing policy. This ensures HTTP requests go back to the server that have the session states.

Load-balancing can improve performance for large number of HTTP users because the user population is serviced by multiple application servers that are managed as a cluster. Load-balancing can be implemented with a variety of technologies ranging from the Apache proxy servers to hardware-based load balancers.

13.2 Monitoring

You should monitor the following on a regular basis

- Execute Thread Count
    - Track the average and maximum number of active execute threads through third-party tools or custom-developed JMX-based programs.
    - Correlate that number to the workload level issued to the application servers.
    - Either using mathematical projections or system tests, estimate the number of concurrent threads expected during your peak operational periods. As a general rule, you should plan to keep the average active threads to 15 or less.

- Garbage Collection
  - Monitor the frequency and health of the JVM’s heap management. Please see the chapter relevant to your JVM in Part II, "Java Virtual Machines".
- Connection Pool Usage
  - Check if Connection High is equal to the JDBC pool size - the Connection High is the highest number of connections ever reached. Recall, the JDBC pool to be equal to the maximum possible transaction concurrency level plus a safety buffer of two. The Connection High should not be the same as the JDBC pool size.

Part IV
Databases

The part of the book provides information on how to implement, monitor and tune the database management systems (DBMS).

14

Database Management System

This chapter provides guidelines on the implementation, configuration and tuning of database management systems in general.

14.1 Overview

Yantra 7x uses a database server as a repository for the transactional, reference and history data generated and used by the Yantra 7x application.

14.2 Planning

This section provides planning elements that have to be completed prior to the implementation phase. The key planning tasks include, at a minimum,

- selecting a certified database management server software and version.
- determining the size and configuration of the database server node
- determining the size and configuration of the database disk subsystem
- determining the disk technology

14.2.1 Supported Configuration

Please see the *Yantra 7x Installation Guide* for a list of the supported configurations.

14.2.2 Server Sizing

At appropriate times in the project lifecycle, you can request a Server Sizing study from your Professional Services Project Manager or Yantra Sales Executive. This study starts with the Yantra Server Sizing Questionnaire. Yantra Performance Engineering will create a sizing document that will provide an estimated processor, memory and network requirement for the standard/baseline Yantra 7x application. You need to factor in additional requirements such as other workloads on the same node (for example, additional third party software, customization, performance monitors, and so forth).

14.2.3 Disk Subsystem

14.2.3.1 Disk Technology

Your disk capacity requirement is a very important input to the disk configuration planning process. This is not a simple process that involves many other factors including

- survivability -
  - configure the disks with the ability to survive single or multiple disk failures (e.g., RAID-1 or RAID-10)
  - configure the disk array with multiple I/O paths to the server to survive I/O path failures
  - configure the disks to be accessible from multiple server nodes to tolerate a single node failure
- manageability -
  - if you have very short time windows to backup the database, select disk arrays that allow you to take logical backups (e.g., array snapshots)
- scalability/performance
  - configure the disk array with many small disks instead of a few large disks so that you can increase the number of I/O paths
  - configure the disk array with large NVRAM cache to improve read and write performance
  - configure the disks with stripping (e.g., RAID-0 or RAID-10)

Let’s take for example that you need 900GB and you have disk arrays or storage area networks (SAN) that are made up of 93GB disks. The following table summarizes the trade-off choices for the common disk organizations. Let’s further assume that the database is implemented over ninety 10GB data files.

Table 14–1 Disk Organization - Trade-Off

Tech	Scalability	Survivability	Maintainability	Num Disks
JBOD	Poor - Subject to throughput of individual disks	Poor - Single disk failure will create outage and require database recovery	Poor - High disk utilization skew	10
RAID-0	Excellent - Striping N disks provides read/write throughput at N times a single disk	Poor - Single disk failure will create outage and require database recovery	Excellent - expect near uniform disk utilization within a logical unit. Potential LUN utilization skew.	10
RAID-1	Poor - similar performance to JBOD	Better - Could survive multiple disk failures in different mirrored sets	Poor - High disk utilization skew	20
RAID-5	Excellent for read - similar to RAID-0. Potentially poor for write performance.	Better - Able to survive a single disk failure. Multiple disk failures will create an outage and require database recovery.	Excellent - low disk util skew. Possible LUN utilization skew.	11
RAID-01	Excellent read/write performance.	Could tolerate up to two disk failures as long as both failures are not in the same mirrored set.	Excellent - low disk util skew. Possible LUN utilization skew.	20

Table 14–1 Disk Organization - Trade-Off

Tech	Scalability	Survivability	Maintainability	Num Disks
RAID-10	Excellent read/write performance.	Could tolerate up to N disk failures as long as there isn't two failures in a mirrored set	Excellent - low disk util skew. Possible LUN utilization skew.	20

14.2.4 Yantra 7x Schema

The *Yantra 7x Installation Guide* provides directions on how to create the Yantra 7x database, the Yantra 7x tables and their associated indices.

These DDL statements are intended to allow you to create a simple schema that is suitable for general use. You need to review and possibly modify these statements for production. Specifically

- The DDL statements create a minimal set of indices for general Yantra 7x use. You may need to create additional or modify existing indices for your business practice.
- The DDL statements create a single tablespace with a large data file. You may want to create additional tablespaces for manageability as well as additional data files for I/O load balancing.

14.2.4.1 Indices

Most customers use a subset of the broad functionality in the Yantra 7x application. As a result, the base Yantra 7x database schema with the default or starting set of indices may have to be adjusted for your specific use. Therefore, you should validate the starting index set to see if they support your workloads.

As a suggestion, prior to production, you should conduct a system test where all the key screens, agents and APIs run against a copy of the production database. During this test, you can check if additional indices are required and if there are any unused indices you can disable or drop.

Please see the following sections on how to enable index monitoring

- for Oracle10g - see Section 15.1.4.1, "Oracle Index Monitoring and Tuning"

- for IBM UDB - see Section 16.1.4.1, "UDB Index Monitoring and Tuning"
- for MS SQL Server - see Section 17.1.2, "SQL Server Index Monitoring and Tuning"

14.2.4.1.1 Custom Indices Please follow the following convention when you create a new index.

First, make sure the index name does not end with the following suffix:

- "_PK" - this suffix is reserved for indices that are the primary key for the underlying table. For example, the index, `yfs_order_header_pk`, is the primary key index for the `yfs_order_header` table
- "_I*nn*" where *nn* is an integer value from 0 to 99 - this suffix is reserved for secondary or alternate indices for the underlying table. For example, the index, `yfs_order_header_i1`, is a secondary index for the `yfs_order_header` table

The convention above will prevent situations where new base Yantra indices has the same name as one of your custom index.

Secondly, to further differentiate custom indices from the base, the custom index should start with EXTN_ as a prefix and X*nn* in the index name. For example, if you add two indices to the YFS_ORDER_HEADER table, the index names should be EXTN_ORDER_HEADER_X1 and EXTN_ORDER_HEADER_X2.

15 Oracle10g

This chapter provides guidelines on the implementation, configuration and tuning of Oracle10g.

15.1 Implementation

This section assumes that you have read the Oracle installation guide that is applicable to your platform.

15.1.1 Recommended Oracle Parameters

The following table summarizes the recommended choices.

Table 15–1 init.ora Parameters

Parameters	Oracle10g
db_block_size	8KB
processes	must be greater than the number of connections needed by the (a) application servers, (b) the agents/monitors and (c) operational management tools.
compatible	10.1.0.4 (or the appropriate Oracle10g Rel 1 level)
shared_pool_size	200MB to 500MB
cursor_sharing	FORCE
timed_statistics	true
optimizer_mode	choose
hpux_sched_noage	178 (only for HP-UX)

Table 15–1 init.ora Parameters

Parameters	Oracle10g
open_cursors	default (higher if prepared statement caching used)
query_rewrite_enabled	true (if using the **WMS** application)
query_rewrite_integrity	trusted (if using the **WMS** application)

15.1.1.1 processes

This parameter sets the limit on the number of database connections. You have to pick a reasonably high enough number so that the combined connection requirements from the application servers, agents, and so forth do not exceed the connection limit during peak processing periods. If you do, you will have to restart the Oracle instance to increase this limit.

Fortunately, with the use of connection pooling in application servers, the number of database connections will be less than the number of users logged into Yantra 7x. Depending on your anticipated peak workload traffic, this parameter could range from a small number like 25 to a large number in the thousands.

You must regularly monitor the number of concurrent connections in production (and especially during peak periods) to ensure that it does not reach the maximum. When the maximum session is reached, Oracle will refuse to establish new connection requests.

See WebLogic connection pooling discussions in Section 12.1.1.4, "WebLogic Connection Pool".

See WebSphere connection pooling discussions in Section 13.1.1.2, "WebSphere Connection Pool".

Guidelines for Estimating Number of Connections.

You can roughly estimate the number of concurrent users required by Yantra 7x with the following formula:

$$\text{concurrentOracleConnections} = A + B + C + D$$

where

- A = maximum number of agents transaction threads that will run concurrently (see Section 22.3.1, "Agent Thread Levels".

- B = maximum application server connection pool size times the number of application server instances. See Maximum Capacity
- C = any additional connections that are opened by customized code or user exits that do not go through the application server connection pool. This connection requirement is specific to your implementation.
- D = number of asynchronous adapters (Service Definition Framework) times the number of connections per adapter

Yantra 7x agents and monitors are long running Java applications that open and use one Oracle connection per thread.

Example: Lets assume that you plan to configure a system with the following characteristics:

- six application server instances where each application server instance can run up to a maximum of twenty-five (25) transactions concurrently.
- twelve agent threads
- four asynchronous adapters where each could have up to four threads
- maximum ten connections for operational tools such as Oracle OEM or Quest SpotLight

Lets further assume that each transaction in the application server will only requires one database connection. Specifically, user exits do not open their own database connection. As a result, for the example above, you will need:

- in the worst case, 25 x 6 or 150 database connections from the application servers during the peak period if there is a possibility that all application server threads become active. This of course would not be a desirable state - if there ever is such a possibility, you should configure more application server instances.
- 12 database connections for the agents/monitors
- 4 x 4 or 16 database connections from the asynchronous adapters
- 10 database connections from your operational monitors

As a result, you should plan for at least 150 + 12 + 16 + 10 or 188 database connections.

As always, we strongly recommend that you benchmark your system to validate these assumptions and estimates prior to a production implementation. During the test, you should monitor the connection pool usage levels in each of the WebLogic Server instances, the number of agents that you need to run in order to meet your processing and service levels and the actual Oracle connections established.

15.1.1.2 compatible

You should set the `compatible` parameter to the four level release number that your Oracle software is running at in order to take advantage of the latest optimizer features. An example of the release number is 10.1.0.4.

15.1.1.3 share_pool_size

This value sets aside an area in the SGA for sharable SQL and PL/SQL. A high level of reuse is critical for performance. Generally, Yantra 7x requires a shared pool of around 300MB but can grow to 1GB.

15.1.1.4 cursor_sharing

With cursor_sharing enabled, Oracle converts dynamic (non-reusable) SQL into reusable SQL by changing literal values into bind variables. Enabling cursor sharing will significantly reduce shared pool and library cache contention.

For optimal performance, you must set `cursor_sharing=SIMILAR`.

15.1.1.5 hpux_sched_noage

(only applicable to HP-UX)

This parameter instructs Oracle to run the database processes at a fixed priority. The benefit is that this parameter reduces the likelihood of processes that are holding on to critical data locks or system latches but are unable to run because their dispatch priority was lowered.

This parameter is useful when you have a very large number of active database processes relative to the number of processors.

15.1.1.6 open_cursors

This parameter sets the maximum cursors (active SQL statements) per Oracle session. Generally, the default is sufficient unless you set a high prepared statement cache size (see Prepared Statement Cache Size in Section 12.1.1.4.2, "Define a Connection Pool in WebLogic").

To find out the number of cursors opened by sessions, issue the following query

```
select sid, count(*)
from v$open_cursor
group by sid
```

If you suspect a cursor leak, issue the following query

```
select sid,substr(sql_text,1,40),count(*)
from v$open_cursor
group by sid,substr(sql_text,1,40)
having count(*) > 10
```

That query will identify SQL statements that potentially have more than 10 open cursors in a given session.

15.1.1.7 query_rewrite_enabled and query_rewrite_integrity

If you are using the **Yantra 7x WMS** application, you have to create at least one function-based index as part of the application installation. As a result, Yantra 7x schema must have QUERY REWRITE privilege. In addition, in order for Oracle to use the function-based indexes in queries, you have to set the Oracle parameters

- QUERY_REWRITE_ENABLED to true and
- QUERY_REWRITE_INTEGRITY to trusted.

15.1.2 Redo Logs

Redo logs are critical for database and instance recovery. Proper redo log configuration is also critical for performance. Some recommendations for redo logs configuration include:

- implement redo logs on raw devices
- if you prefer file systems, you should implement redo logs on file systems that are configured to perform I/O in small data blocks to avoid partial block writes.

  Redo log buffers are typically small. If redo logs are implemented on file systems that are configured as 8KB blocks, some redo log writes will require the file system to read in the block, append the log buffer to that block and then write out the block to disk.

If you are using a file system on Solaris or AIX, the redo log file system should be configured for 512 byte blocks. For HP-UX, the file system block size should be 1024 bytes. See http://www.ixora.com.au/tips/use_raw_log_files.htm or [9].

- If the redo logs are placed on file systems, enable direct I/O - specifically avoid the situation where the writes are buffered in the file system cache before written out to disk.
- consider implementing redo logs on dedicated disk devices.
- consider implementing redo log group log files on alternating disks

15.1.2.1 Redo File Size

Your choice of redo file size depends on your trade-off between performance and availability, specifically the time needed to recover the Oracle instance in the event of a failure. For performance, some installations opt to create large redo logs to reduce the frequency of log switches. However, doing so means that there are potentially more transactions in the redo logs that have to be replayed during recovery. The general rule for sizing redo log files is to look at the time it takes to switch log files. By issuing the following query you can see how often the redo log files are changing. As a general rule the logs should not be switching more that once every twenty to thirty minutes.

```
select * from v$loghist
order by first_time desc
```

The following is an example of the output:

```
THREAD#   SEQUENCE#   FIRST_CHANGE#               FIRST_TIME   SWITCH_CHANGE#
      1          97         7132082   10/20/2003 11:47:53 PM          7155874
      1          96         7086715   10/20/2003 11:32:04 PM          7132082
      1          95         7043684   10/20/2003 11:15:07 PM          7086715
      1          94         6998984   10/20/2003 11:00:57 PM          7043684
      1          93         6950799   10/20/2003 10:48:03 PM          6998984
```

In the example above, the logs switched every fifteen minutes.

15.1.3 Server Mode

You should create Oracle to use dedicated servers (instead of shared servers). Shared servers can be useful in two-tier client/server configurations where a large number of users need to access the database directly.

In Yantra 7x, the WebLogic or WebSphere Application Server serves as a transaction manager to multiplex large number of users into a finite number of connections to the Oracle instance. Long running processes such as Agent Servers, by design, maintain a single dedicated connection to Oracle. As a result, in both cases, dedicated servers are recommended.

15.1.4 Yantra 7x Schema

15.1.4.1 Oracle Index Monitoring and Tuning

As we mentioned in Section 14.2.4.1, "Indices", you may have to adjust the base starting index set to suit your operational environment. You can find out what indices are used (and by corollary, which ones are not used) through index monitoring. To enable index monitoring, issue the following commands, one for each index.

```
...
alter index yfs_order_header_pk monitoring usage;
alter index yfs_order_header_i1 monitoring usage;
alter index yfs_order_header_i2 monitoring usage;
...
```

You can generate the command above by issuing the following query

```
select 'alter index ' || index_name || ' monitoring usage;'
from user_indexes;
```

Periodically, as you run your functionality and system test, you can run the following query to see if which indices have been used and which have not yet been used.

```
select index_name, monitoring, used, start_monitoring
from v$object_usage;

INDEX_NAME           MONITORING  USED  START_MONITORING
-------------------  ----------  ----  -------------------
YFS_ORDER_HEADER_I1  YES         YES   01/29/2003 01:23:03
```

To turn off index monitoring, issue the following command:

```
alter index yfs_order_header_i1 nomonitoring usage;
```

15.1.4.2 Tablespaces

Prior to production, you should plan the overall storage strategy.

Since there are strong preferences, the DDLs to create temporary tablespaces and data tablespaces are left to the discretion of the customer.

We instead provide the following recommendations for your consideration.

- You should consider creating one or more tablespaces that only store data tables and another set of tablespaces for indices.
- You should implement these tablespaces as locally managed tablespaces (LMTs)You do this by specifying `extent management local` when creating the tablespace.
- You should implement tablespaces with automatic space management by specifying `segment space management auto`.
- With LMTs, you may want to consider creating tablespaces that store small reference tables with the `autoallocate` extent allocation model.

```
create tablespace yt1
    datafile '/u03/dbs/pyantradb/yt1_001.dbf' size 2047m
    extent management local autoallocate
    segment space management auto;
```

- If you have very large tables, you may want to consider putting those tables into their own tablespace and to use the `uniform` extent allocation model.

```
create tablespace yfs_order_header_t1
    datafile '/u03/dbs/pyantradb/y_order_header_t1_001.dbf' size 2002m
    extent management local uniform size 1000m
    segment space management auto;
```

- you should create your temporary tablespace as a temporary data file (temp files) [9]. Temp files are used to store intermediate results (e.g., from large sort operations). Changes to temp files are not recorded in the redo logs.

```
create temporary tablespace yfs_temp
    tempfile '/u03/dbs/pyantradb/yfs_temp_01.dbf' size 1024m
    extent management local
    uniform size 1m;
```

15.1.4.2.1 Tables After creating the tablespaces, you can modify and use the DDL script file, $YFS_HOME/database/oracle/scripts/yfs_tables.sql, to create the tables. At a minimum, you may want to modify the table to tablespace mapping.

15.1.4.3 Index and Table Statistics

The database optimizers rely on up-to-date accurate table and index statistics to generate optimal access plans.

In addition, columns, such as `enterprise_key` in the `yfs_order_header`, can exhibit high skew - for example, there could be many orders for one enterprise and a few orders for another enterprise. Columns such as `derived_from_order_header_key` in the `yfs_order_header` table could have very high skew, which will result in low cardinality because they only contain spaces. This can happen when customers have small numbers of derived orders.

Queries, such as the one below, against columns with high skew and/or low cardinality

```
select *
from yfs_order_header
where derived_from_order_header_key = '2003012412213801928344';
```

can result in table scans even if the columns are indexed. The example above was from an actual case (see below).

Case Study: Customer reported that the Order Detail screen took over 4 minutes. The query that checks if the order is a derived order resulted in a table scan of the YFS_ORDER_HEADER table. When customer ran dbms_stats to create histograms, Order Detail screen dropped to 1 second.

From the optimizer's perspective, the queries against these columns either will return a small or a very large result set. To err on the side of caution, the optimizer will generally choose a table scan over an index range scan.

You can get the optimizer to choose a more optimal access plan by providing additional statistics in the form of histograms.

15.1.4.3.1 Oracle Issue the following command to create histograms in Oracle,

```
exec dbms_stats.gather_schema_stats (ownname => 'YANTRA', -
estimate_percent => dbms_stats.auto_sample_size, -
method_opt=>'for all indexed columns size skewonly', -
cascade=>true);
```

In the example above, the `method_opt` with the `auto` parameter lets Oracle decide whether histograms are to be created based on the column's data distribution <u>and</u> the way the columns are being used by the application. Alternatively, you can specify `skewonly` if you want Oracle to create histogram based solely on data distribution.

16

IBM Universal Database (UDB)

This chapter provides guidelines on the implementation, configuration and tuning of IBM UDB 8.2.

16.1 Implementation

This section assumes that you have read the IBM UDB *Administration Guide: Planning* [16], *Administration Guide: Implementation* [17] and *Administration Guide: Performance* [18] guides.

16.1.1 Recommended UDB dbset Registry Variables

UDB exposes close to 200 db2set registry variables. Of that, we have found the following variables to be critical for performance. These parameters are described in [18].

Table 16–1   db2set registry variables

db2set registry variables	UDB 8.2
DB2_EVALUNCOMMITTED	ON
DB2_SKIPDELETED	ON
DB2_SKIPINSERTED	ON
DB2_PARALLEL_IO	see below for recommendations
DB2_SELECTIVITY	ALL

DB2_EVALUNCOMMITTED

Enabling this variable can reduce the amount of unneeded lock contention from read share and next-key share. By default, UDB requests share locks on the index or record before it checks if the record satisfies the query predicate. Queries that scan a set of records in tables with high frequency of inserts or updates can unnecessarily block on records that do not belong to its result set.

When you set `DB2_EVALUNCOMMITTED=ON`, UDB will perform an uncommitted read on the record to perform the predicate check. If the record satisfies the predicate, UDB will then request a share lock on that record.

DB2_SKIPDELETED

Enabling this variable allows index-range or table-scan queries to skip over records that are in an uncommitted delete state. This reduces the amount of lock contention from read share and next-key share locks from range queries in tables with a high frequency of deletes.

When enabled, will allow, where possible, table or index access scans to defer or avoid row locking until a data record is known to satisfy predicate evaluation. With this variable enabled, predicate evaluation may occur on uncommitted data.

It is applicable only to statements using either Cursor Stability or Read Stability isolation levels. For index scans, the index must be a type-2 index. Furthermore, deleted rows are skipped unconditionally on table scan access while deleted keys are not skipped for type-2 index scans unless the registry variable DB2_SKIPDELETED is also set.

DB2_SKIPINSERTED

Enabling this parameter allows SELECTs with cursor stability or read stability isolation levels to skip over uncommitted inserted rows. This parameter setting can reduce record lock contention on tables with heavy insert rates.

DB2_PARALLEL_IO

Enabling this variable changes the way in which UDB calculates I/O parallelism to the tablespace. By default, UDB sets I/O parallelism to a tablespace to be the number of containers in that tablespace. For example, if the tablespace has four containers, prefetches to that tablespace will be performed as four extent-sized prefetch requests.

You should set the DB2_PARALLEL_IO variable if you implement containers on stripped devices (e.g., RAID-5, RAID-10 or RAID-01).

If you set DB2_PARALLEL_IO=ON or DB2_PARALLEL_IO=*, UDB will assume that containers are implemented on a RAID 5 (6+1) configuration - six data disks plus 1 parity disk. Using the example above, prefetches to the four-container tablespace above will be performed in 24 extent-sized prefetch requests.

You should monitor the unread_prefetch_pages and prefetch_wait_time monitor element from the snapshot_database monitor to assess the effectiveness of your prefetch parallel I/O settings. The unread_prefetch_pages monitor element tracks the number of prefetch pages that were evicted from the buffer pool before it was used. A continually growing number could indicate that the prefetch requests are too large either because the prefetch size is larger than the pages needed or that the prefetch activities are bringing in too many pages for the capacity of the buffer pool. In either case, you may want to consider reducing the prefetch size.

The application could be waiting for pages if you have high prefetch_wait_time values.

DB2_SELECTIVITY

Enabling this variable allows the selectivity clause to be used in the where clause. Without setting DB2_SELECTIVITY=ALL, UDB will only allow the selectivity clause to be used for User Defined Functions (UDFs).

16.1.2 Recommended DBM CFG Parameters

Table 16–2 dbm cfg parameters

dbm cfg parameters	**UDB 8.2**
INTRA_PARALLEL	SYSTEM
DFT_MON_BUFPOOL	ON
DFT_MON_LOCK	ON
DFT_MON_SORT	ON
DFT_MON_STMT	ON
DFT_MON_TABLE	ON
DFT_MON_TIMESTAMP	ON
DFT_MON_UOW	ON
MON_HEAP_SZ	16384

Table 16–2 dbm cfg parameters

dbm cfg parameters	UDB 8.2
MAXAGENTS	must be greater than the number of connections needed by the (a) application servers, (b) the agents/monitors and (c) operational management tools.

INTRA_PARALLEL

In general, we do not recommend using intra-partition parallelism in an online transactional application.

However, parallelism, can benefit infrequent but long running, resource-intensive operations such as creating indices.

As a result, we recommend setting INTRA_PARALLEL=SYSTEM along with the default degree of parallelism to none (DFT_DEGREE=1). Please see Section 16.1.3, "Recommended DB CFG Parameters".

You can enable parallelism at the connection (application) level by setting the following command

```
db2 set current degree = '8'
```

In the example above, UDB will be allowed to use parallelism up to degree 8.

DFT_MON_BUFPOOL
DFT_MON_LOCK
DFT_MON_SORT
DFT_MON_STMT
DFT_MON_TABLE
DFT_MON_TIMESTAMP
DFT_MON_UOW

We recommend enabling the monitor switches above in production.

MAXAGENTS

This parameter sets the limit on the number of database manager agents (both coordinator or subagents) that can be concurrently running at any given time. You have to pick a reasonably high enough number so that the combined connection requirements from the application servers, agents, monitoring tools, and so forth do not exceed the MAXAGENTS limit during peak processing periods. If you do, you will have to restart the UDB instance to increase this limit.

Fortunately, with the use of connection pooling in application servers, the number of database connections will be less than the number of users logged into Yantra 7x. Depending on your anticipated peak workload traffic, this parameter could range from a small number like 25 to a large number in the thousands.

You must regularly monitor the number of concurrent connections in production (and especially during peak periods) to ensure that it does not reach the maximum. When the MAXAGENTS limit is reached, UDB will refuse to establish new connection requests.

See WebLogic connection pooling discussions in Section 12.1.1.4, "WebLogic Connection Pool".

See WebSphere connection pooling discussions in Section 13.1.1.2, "WebSphere Connection Pool"

Guidelines for Estimating Number of Connections.

You can roughly estimate the number of concurrent users required by Yantra 7x with the following formula:

$$\text{concurrent(UDB)Connections} = A + B + C + D$$

where

- A = maximum number of agents transaction threads that will run concurrently (see Section 22.3.1, "Agent Thread Levels".
- B = maximum application server connection pool size times the number of application server instances. See Maximum Capacity
- C = any additional connections that are opened by customized code or user exits that do not go through the application server connection pool. This connection requirement is specific to your implementation.
- D = number of asynchronous adapters (Service Definition Framework) times the number of connections per adapter

Yantra 7x agents and monitors are long running Java applications that open and use one database connection per thread.

Example: Lets assume that you plan to configure a system with the following characteristics:

- six application server instances where each application server instance can run up to a maximum of twenty-five (25) transactions concurrently.
- twelve agent threads
- four asynchronous adapters where each could have up to four threads
- maximum ten connections for operational tools such as Oracle OEM or Quest SpotLight

Lets further assume that each transaction in the application server will only requires one database connection. Specifically, user exits do not open their own database connection. As a result, for the example above, you will need:

- in the worst case, 25 x 6 or 150 database connections from the application servers during the peak period if there is a possibility that all application server threads become active. This of course would not be a desirable state - if there ever is such a possibility, you should configure more application server instances.
- 12 database connections for the agents/monitors
- 4 x 4 or 16 database connections from the asynchronous adapters
- 10 database connections from your operational monitors

As a result, you should plan for at least 150 + 12 + 16 + 10 or 188 database connections.

As always, we strongly recommend that you benchmark your system to validate these assumptions and estimates prior to a production implementation. During the test, you should monitor the connection pool usage levels in each of the application server instances, the number of agents that you need to run in order to meet your processing and service levels and the actual UDB database connections established.

16.1.3 Recommended DB CFG Parameters

Table 16–3 db cfg Parameters

db cfg parameters	UDB 8.2
DBHEAP	5,000 or higher

Table 16–3 db cfg Parameters

db cfg parameters	UDB 8.2
LOCKLIST	5,000 to 10,000 (DOM) 10,000 or more (WMS)
LOGFILSIZ	262144
LOGPRIMARY	5 to 10 or more
LOGSECOND	3
NUM_LOG_SPAN	LOGPRIMARY - safety buffer
DFT_DEGREE	1
PCKCACHESZ	131072

DBHEAP

The default DBHEAP is too small. You should set it anywhere from 5,000 or higher depending on the amount of memory available and the traffic volume.

LOCKLIST

The DOM application is predominantly an online transaction processing (OLTP) application characterized by high volume of short transactions. A lock list of around 5,000 to 10,000 4K-pages should be sufficient. The WMS application has a combination of OLTP transactions as well as long-running transactions that update many records. This application should have a locklist of around 10,000 or more 4K-pages.

UDB could escalate row level locks to table locks if the locklist is too small. You should track the following monitor elements:

- `lock_list_in_use` to see how of the locklist allocation is used
- `lock_escals` to see if UDB had to escalate row level locks to table locks
- `x_lock_escals` to see UDB had to escalate row level locks to exclusive table locks

The performance of any OLTP system can suffer when table locks are obtained.

LOGFILSIZ, LOGPRIMARY, LOGSECOND

At a minimum, you should configure four transaction logs (LOGPRIMARY=4) of 1GB (LOGFILSIZ=262144 4K-pages) for DOM and ten transaction logs (LOGPRIMARY=10) for WMS.

As an additional precaution, you should configure at least three secondary transaction logs (LOGSECOND=3). UDB will allocate secondary logs when it cannot reuse any of the primary logs because of active transactions.

You should adjust these settings as needed.

You should track the following monitor elements to assess the effectiveness of these settings.

- `total_log_used` and `tot_log_used_top` to see how much of the logs are used. You should investigate which workloads are consuming or holding the transaction logs when this value approaches the total primary log capacity. If needed, you may have to adjust the LOGPRIMARY higher.
- `sec_log_used_top` and `sec_logs_allocated` to see if secondary transaction logs are used. You should investigate how often logging spills over to the secondary logs, what workloads are running during the spill. In some cases, you may have to increase LOGPRIMARY to prevent the log spills.

NUM_LOG_SPAN

Setting this parameter limits the number of logs a transaction can span, which will prevent situations where UDB cannot switch transaction logs because all transaction logs are active. For example,

- somebody could update a record in Control Center but forget to commit the change
- there could be software bug that updates one or more database records but not commit the work

This parameter should be set to at least 3 so that valid long running transactions (e.g., WMS Create Wave agent) are not prematurely forced. This parameter should be set to at most `LOGPRIMARY` minus a safety buffer (e.g., 2). For example, if you have set `LOGPRIMARY=10`, then set `NUM_LOG_SPAN=8`.

DFT_DEGREE

This parameter sets the default degree of parallelism for intra-partition parallelism. In general, online transactional applications, like Yantra, typically experiences high volume of short queries that do not benefit from parallel queries. As a result, we recommend setting DFT_ DEGREE=1 which will disable intra-partition parallelism.

Parallelism can benefit long running, resource-intensive operations such as creating indices on a large table. To enable parallelism, you need to

- enable INTRA_PARALLEL (see Section 16.1.2, "Recommended DBM CFG Parameters").
- override the default degree of parallelism in the application (connection) prior to performing the operation. For example, issue the following command to set the degree of parallelism to 8

```
db2 set current degree = '8'
```

PCKCACHESZ

The package cache is used to store the SQL statements and execution plans. We recommend setting the package size to 131072 4K pages or 512MB.

16.1.3.1 UDB Event Monitors

The Yantra application is written to minimize the occurrence of deadlocks. For example, critical database records such as inventory records are always obtained in the same order. However, deadlocks can still happen for many reasons including

- custom code may obtain records in a different order
- UDB may choose an access plan that retrieves records in a different order

To help diagnose deadlocks, we recommend setting the following event monitor.

```
MON=<monitor name - e.g., DLMON>
OUTDIR=<directory to store deadlock information>

db2 -v create event monitor $MON for deadlocks with details \
          write to file $OUTDIR buffersize 64 nonblocked
db2 -v set event monitor $MON state = 1
```

When a deadlock occurs, issue the following.

```
db2 flush event monitor $MON
db2evmon -path $OUTDIR
```

The flush will ensure deadlock records in the buffers are written out. The db2evmon will format the deadlock information.

16.1.3.2 Table and Index Statistics

UDB relies on good up-to-date table and index statistics in order to generate optimal access plans. Inaccurate statistics could lead to sub-optimal access plans; in the worst case, it could lead to deadlocks.

To generate the statistics, we recommend running the following command for each table in the Yantra schema.

```
db2 runstats on table <table name> on key columns with distribution on key
columns and sampled detailed indexes all allow read access
```

The frequency at which you collect statistics depends on many factors. You should run runstats more frequently (e.g., once per day) when the table is growing rapidly - e.g., more than 10% each day. You can decrease the frequency (e.g., once per week or every two weeks) if the table has reached a sufficiently large size (e.g., greater than 1 to 5 million records).

16.1.3.2.1 Volatile Tables

In some cases, the content of tables (e.g., YFS_INVENTORY_SUPPLY_ADDNL and YFS_INVENTORY_DEMAND_ADDNL) can fluctuate significantly during the day. Therefore, the representativeness of the statistics can depend on when the statistics were gathered.

In some cases, UDB may choose to table scan a table with a large number of records if the statistics were generated when the table was empty. The volatility of the data makes reliance on statistics, which represents the table at a single point in time, unreliable. In those situations, you can mark the table as volatile with the following command.

```
alter table <table name> volatile cardinality
```

At a minimum, we recommend setting the volatile flag on the following tables

- YFS_EXPORT
- YFS_IMPORT
- YFS_INVENTORY_SUPPLY_ADDNL
- YFS_INVENTORY_DEMAND_ADDNL
- YFS_TASK_Q

You may also have to mark small tables as volatile during their initial growth phase. In some cases, UDB may choose to use a full table scan when the table is small. These table scans can deadlock with other queries. You should mark these tables as non-volatile when the table has grown to a sufficiently large size. At that time, you want the optimizer to choose plan based on statistics.

16.1.3.3 CLI Packages

If you configure a service as a string of API calls, all performing under a single transaction commit boundary, that service may fail with a SQL0805N error with a package NULLID.SYSLN203.

This happens when the number of cursors opened by a given SQL statement goes beyond the capacity defined for the small and large CLI packages (which are used by JDBC). In such a case, you should first check to see if there was a cursor leak. If you are certain there isn't a cursor leak, you can then either break up the service into smaller chunks or increase the number of packages bound.

The syntax for adding extra packages is

db2 bind ../sqllib/bnd/db2clipk.bnd clipkg 10

The number of packages required can differ depending on individual situations. You should test your application under expected peak concurrency levels and transaction rates to ensure you have sufficient packages.

16.1.4 Yantra 7x Schema

16.1.4.1 UDB Index Monitoring and Tuning

As we mentioned in Section 14.2.4.1, "Indices", you may have to adjust the base starting index set to suit your operational environment. You can find out what indices are used (and by corollary, which ones are not used) You can use UDB's Design Advisor to monitor index usage. The Design Advisor will recommend additional indices as well as indices that are not used.

16.1.4.2 Index and Table Statistics

The database optimizers rely on up-to-date accurate table and index statistics to generate optimal access plans.

In addition, columns, such as `enterprise_key` in the `yfs_order_header`, can exhibit high skew - for example, there could be many orders for one enterprise and a few orders for another enterprise. Columns such as `derived_from_order_header_key` in the `yfs_order_header` table could have very high skew, which will result in low cardinality because they only contain spaces. This can happen when customers have small numbers of derived orders.

Queries, such as the one below, against columns with high skew and/or low cardinality

```
select *
from yfs_order_header
where derived_from_order_header_key = '2003012412213801928344';
```

can result in table scans even if the columns are indexed. The example above was from an actual case (see below).

From the optimizer's perspective, the queries against these columns either will return a small or a very large result set. To err on the side of caution, the optimizer will generally choose a table scan over an index range scan.

You can get the optimizer to choose a more optimal access plan by providing additional statistics in the form of histograms.

Issue the following command to create histograms in UDB,

```
db2 runstats on table <table name> on key columns with distribution on key
columns and sampled detailed indexes all allow read access
```

17

Microsoft SQL Server

This chapter provides guidelines on the implementation, configuration and tuning for Microsoft SQL Server 2000.

17.1 Implementation

17.1.1 Parameters

Microsoft has designed SQL Server to be easy to install and manage. The SQL Server installation is straight-forward with little up-front choices. The only mandatory decision points is the following collation settings which is needed by the Yantra 7x application to support case-insensitive sorts:

Table 17–1 SQL Server Installation Decision Points

Description	Recommendation
Collation Settings	SQL Collation: Dictionary order, case-insensitive, for use with 1252 Character Set

17.1.2 SQL Server Index Monitoring and Tuning

Prior to production, you should conduct a system test where all the key screens, agents and APIs are run against a copy of the production database. This will be your opportunity to see if additional indices are required.

When you add your own indices, choose a naming convention for the indices so that the index name does not end with the following suffix:

- "_PK" - this suffix is reserved for indices that are the primary key for the underlying table. For example, the index, `yfs_order_header_pk`, is the primary key index for the `yfs_order_header` table
- "_I*nn*" where *nn* is an integer value from 0 to 99 - this suffix is reserved for secondary or alternate indices for the underlying table. For example, the index, `yfs_order_header_i1`, is a secondary index for the `yfs_order_header` table

In addition, you should enable index monitoring to see if there are any unused indices you can disable or drop.

In SQL Server, you can use the Index Tuning Wizard to recommend new indices as well as indices that are not used.

17.1.3 Statistics

By default, SQL Server will automatically create statistics on indexed fields when the index is created. If deemed beneficial, SQL Server will also create statistics on non-indexed fields that are used in joins or filter criteria. The information on the column's data distribution could help the Query Optimizer choose the optimum execution plan. Although this feature can be disabled, we recommend leaving it on. To check if automatic statistics creation is enabled, issue the following query.

```
select databasepropertyex('ywinss01','IsAutoCreateStatistics')
```

The result is 1 if enabled and 0 if disabled.

SQL Server will also automatically manage the statistics based on the amount of changes to the table. When the number of changes exceed a threshold, SQL Server will automatically generate new statistics. Although this feature can be disabled, we recommend leaving it on. To check if automatic statistics update is enabled, issue the following query.

select databasepropertyex('ywinss01','IsAutoUpdateStatistics')

The result is 1 if enabled and 0 if disabled.

18

Advanced Database Topic - Oracle10g Real Application Cluster Database

This chapter provides limited guidelines on implementing, configuring and tuning Oracle10g Real Application Cluster (RAC). RAC is a powerful technology offered by Oracle. This chapter will only present information specific or applicable to the Yantra application. Installation and tuning RAC in general is beyond the scope of this document.

Please consult Oracle documentation, technical support and training for all questions pertaining to RAC and the associated technologies such as HP ServiceGuard that are integral to the RAC solution.

18.1 Overview

Oracle10g RAC is a technology that allows you to cluster multiple Oracle instances to acts as one Oracle instance.

18.2 Planning

18.2.1 Supported DB Platforms

Yantra 7x Release 7.5 SP1 has been tested with Oracle10g RAC on the following database server platforms.

- HP HP-UX11i running on HP PA-RISC processors[1]
- Sun Solaris 2.9 running on Sun UltraSPARC IV or IV+ processors

[1] We have not yet tested Oracle RAC running on the HP Integrity servers which uses the Intel Itanium processors

- Red Hat Enterprise Linux 3.0 Advanced Server running on Intel Xeon IA-32 (32-bit) or EM64T/AMD64 (64-bit) processors

18.2.2 Supported Filesystems

The Oracle10g RAC database data files can be implemented on clustered filesystems or raw devices.

The filesystem is an important operating system component that is critical for both performance and data integrity. Yantra requires that the Yantra 7x application be configured and deployed only on filesystems that are approved and certified for use with RAC by the Oracle Corporation.

The Yantra 7x application has been tested with Oracle RAC running with

- raw devices
- Oracle Cluster File System (running on Red Hat Enterprise Linux).

Yantra will not support systems that run on non-Oracle RAC supported filesystems such as the Sistina GFS.

18.2.3 Oracle RAC Support Limitations

There are practical limits to any technology. One should not expect every technology to scale infinitely. At this time, Yantra will support up to 3-node RAC configurations.

Yantra has, to date, been either tested or deployed on 2-node (HP RP7410 eight-way processors each for a total of 16 processors) and 3-node Intel servers running Red Hat Enterprise Linux 3.0.

Please call Yantra Technical Support if you have questions.

18.2.3.1 OLTP Applications and Oracle RAC Concerns

For OLTP applications, including Yantra, one common concern is high insertion rates and the effect on index maintenance. In high volume OLTP applications, index leaf blocks have to be maintained and passed among the multiple nodes to keep them all in sync. Generally, when new records, like orders, are being indexed, they are being written to the right most part of the index. In very high transaction volumes, concurrent insertions could wait while a similar request is handled by a different node. The index leaf block for the right most part of the index cannot be released to another node until the request is completed. This forces more sequenced rather than simultaneous processing and is likely to drag significantly on performance.

Another example is the frequency with which inventory records are being accessed and updated.

Research suggests that other OLTP app vendors are generally aware of these issues — some only certifying for a maximum number of nodes and other articles suggesting optimal node / CPU configurations for Oracle RAC.

Some industry literature suggest using hash partition or reverse indices to reduce or eliminate contention to enable OLTP applications for RAC. What isn't stated is that these techniques can negatively affect application performance which could slow down query response times. At this time, Yantra has not tested, nor will we support, the use of reverse indices or hash partitions for Oracle RAC enablement. Please check with Yantra Technical Support for the latest information.

18.2.4 Recommendations

18.2.4.1 Sequence Numbers

Yantra 7x uses Oracle sequence numbers to quickly generate unique numbers. If you are upgrading from pre Yantra 5x 5.0 SP2 versions, ensure the `seq_yfs_task_key` sequence is created with the NOORDER parameter. If the ORDER option is enabled, RAC will disable the CACHE option.

The SQL command to create sequence is as follows

```
create sequence seq_yfs_table_key
increment by 1 start with 1
maxvalue 9999999999
minvalue 1
cycle
cache 500 noorder ;
```

In the example above, the CACHE option pre-allocates and stores 500 sequence numbers in the instance's SGA for fast access. When those sequence numbers are used up, Oracle will preallocate another group of sequence numbers. The CACHE option should be set to a value so that sequence requests for one to two seconds during the peak period can be satisfied in memory is critical for performance (see [12] and [13]).

For example, if the sequence cache is set to 500, the last_sequence_number in user_sequences table should not grow by more than 500 every two seconds or 30,000 every minute. You should monitor this value periodically during the peak hour.

The NOORDER option allows each RAC instance to preallocate its own group of sequence numbers. The NOORDER option is enabled by default. If the NOORDER option is disabled (or if the ORDER option is selected), Oracle will disable the CACHE option.

Enabling the CACHE option with a sufficiently high value and the NOORDER option are critical for Oracle10g RAC performance.

You can issue the following command to check whether the ORDER option is disabled.

```
select sequence_name, order_flag, cache_size,last_number
from user_sequences
where sequence_name = 'SEQ_YFS_TABLE_KEY'
```

If the ORDER_FLAG is set to "N", the NOORDER option is enabled.

```
SEQUENCE_NAME                  ORDER_FLAG CACHE_SIZE LAST_NUMBER
------------------------------ ---------- ---------- -----------
SEQ_YFS_TABLE_KEY                       N        500   422838694
```

18.2.5 High Availability

Please refer to the *Yantra 7x High Availability Guide* document for more detailed instructions.

From a performance perspective, you need to configure the Yantra 7x system so that it can quickly discover the Oracle failure and to quickly recover the connections.

The Yantra 7x system is made up of client programs that connect to the Oracle instance. These include:

- WebLogic or WebSphere application servers
- Yantra 7x agents or monitors

18.2.5.1 WebLogic Connection Pool Properties

In WebLogic, we recommend setting the following Connection Pool properties so that WebLogic can detect stale or dead connections faster.

Table 18–1 WebLogic Connection Pool Properties

Parameter	Value
Test Frequency	120
Test Table Name	SQL SELECT 1 FROM DUAL
Test Reserved Connections	enable
Initial Capacity	3
Maximum Capacity	see Section 12.1.1.4.2, "Define a Connection Pool in WebLogic"
Shrink Frequency	leave at the default of 900 seconds

With the settings above, the WebLogic connection pool manager will test idle connections every `Test Frequency` seconds by issuing a Select statement to `Test Table Name`. Connections that do not pass the test will be closed and a new connection reestablished. This setting will help the connection pool manager to get rid of dead or stale connections.

Additionally, when you set `Test Connections On Reserve` to true, the connection pool manager will test connections before the pool manager gives the connection to transactions. This test adds a small delay to each connection request.

You must set `Test Table Name`. The settings above are invalid without the `Test Table Name` setting.

The `Initial Capacity` and `Maximum Capacity` settings should be set to your operational requirements (see Section 12.1.1.4.2, "Define a Connection Pool in WebLogic"). You should not set `Initial Capacity` to zero - when WebLogic shrinks the connection pool (at every ShrinkPeriodMinutes minutes), it will aggressively shrink all currently unused connections, even connections that were recently active.

You may not want to set `Test Created Connections` and `Test Released Connection` especially if you already have enabled `Test Connections On Reserve`. The probability that a connection has died after it was created or after it was released should be very low.

18.2.5.2 TCP/IP

The default time for a connection request to an unavailable node to timeout is deliberately set to a high value. This value allows connection requests (e.g., telnet connections) the opportunity to find the node on the Internet. This setting is less applicable in a high-speed switched network.

On Solaris 2.8, a telnet to a non-existent node will take about 2.75 minutes to timeout. On HPUX11, the timeout is around 75 seconds.

The connection timeout value can be tuned down by issuing the following ndd commands.

```
ndd -set /dev/tcp tcp_ip_abort_cinterval 1000
ndd -set /dev/tcp tcp_rexmit_interval_initial 200
ndd -set /dev/tcp tcp_rexmit_interval_max 5000
```

This known phenomenon is described in the following SunSolve article found in [23]. The settings are applicable to both Solaris and HP-UX.

18.2.5.3 Fast Application Notification Support

Fast Application Notification (FAN) provides RAC the ability to inform the client programs the status of the cluster. With FAN, the client programs, especially those with connection pools, can drop stale connections to failed nodes.

The Yantra 7x application does not support FAN because neither the BEA WebLogic or the IBM WebSphere application servers are aware of or are capable of exploiting FAN notifications.

Part V

Java Message Services

This part of the book provides information on how to implement, monitor and tune Java Message Services (JMS).

Configuring and operating the JMS queues efficiently is critical for performance. Suboptimal JMS queue settings will cause poor application performance at best. It could cause application outages at worst.

The Yantra 7x application is certified to run with the following message queueing systems.

- Chapter 20, "BEA WebLogic JMS"
- Chapter 21, "IBM WebSphere MQ"

19

Java Message Services

This chapter provides guidelines on implementing, configuring and tuning for Java Message Services (JMS) in general.

19.1 Overview

The Yantra 7x application uses JMS extensively. For example

- the Yantra 7x agents use JMS as a source of work
- the Yantra 7x integration servers use JMS as a means to communicate with external systems

19.1.1 Agent Queues

The Yantra 7x agents are designed to issue a "getter" to look for work that needs to be processed and to create the appropriate messages into a queue. For example, the Schedule agent on start up will check the Schedule JMS queue. If that queue is empty, it will automatically fire a "getter" query against the YFS_TASK_Q table looking for tasks that need to be processed by the Schedule transaction. A JMS message is created for each eligible task. Similarly, the Yantra 7x order or inventory monitors fire "getters" to look for orders or inventory items in a particular state (for which they are being monitored for). As above, the appropriate messages are put into the JMS queue.

By default, the getter will create up to 5,000 messages even when there are more eligible work. The default is generally sufficient. You can change the limit if you find that the agent is spending more time retrieving work and creating the messages than in processing. This could happen if you have a high number of processing threads or if the retrieval cost is high. You can change the limit by changing the "Number of Records to Buffer" in the agent’s Transaction Detail (in Platform > Process Modeling) > Agent Criteria Definition > Agent Criteria Details > Criteria Parameter. Please see *Yantra 7x Platform Configuration Guide* for more information.

19.1.2 Integration Queues

In contrast, integration queues are used for external communication. For example, one could architect the system where multiple sales channels capture orders. These orders are passed to the Yantra 7x application through an integration queue.

Similarly, the Yantra 7x application could pass messages to external systems on when transactions are processed.

19.2 Implementation

19.2.1 Persistence

You can define queues as being persistent or non-persistent. Messages in non-persistent queues are lost after the queue is restarted. For example, if you have 100 messages in the queue, all those messages are lost when the WebLogic JMS server or the WebSphere MQ queue manager is restarted. In contrast, messages in persistent queues are preserved after a restart. Using the same example from above, the same 100 messages will be in the queue after a restart.

In general, the following recommendations apply

- all queues used by the Yantra 7x agent should be defined as non-persistent. As we described above, the agents can easily recreate the messages if lost.
- all integration queues used for external communications, either for messages coming from external systems to the Yantra 7x application or for messages going from the Yantra 7x application to external systems, must be defined as persistent. In most cases, recreating integration messages can be difficult especially when the information in two or more systems have to be re-synchronized.

19.2.2 Dedicated Queues

We strongly recommend you define a dedicated queue for each agent and service that uses JMS for work because of

- performance
- monitoring

For both the WebLogic JMS and WebSphere MQ, the cost of pulling up a message is proportional to the number of messages the JMS server or queue managers have to interrogate.

In the current WebLogic JMS implementation, a request for a message with a certain selector results in a sequential search through the JMS queue until a message with the specified selector is found. The JMS manager could use a lot of CPU searching for messages if there are lots of messages in the queue. Putting high volume messages into a separate JMS destination eliminates the search - the JMS manager will either find that there are no messages in that destination or it will find the message immediately.

Similarly, in the current IBM MQSeries JMS implementation, the consumer (client) uses the supplied mq.jar to connect to the MQSeries queue manager. When the client asks for a message, the client code in com.ibm.mq.jar retrieves messages from the queue and checks whether the message has the specific selector. The mq.jar will continue to do this until it has found the appropriate message or there are no more messages in the queue. When there are no more messages, the mq.jar sleeps for 5 seconds and repeats the polling cycle. Putting messages into its own JMS destination means that the mq.jar will either find the message immediately or sleep for 5 seconds.

In some extreme cases, the performance and cost is very noticeable. Take the case of a queue with messages for multiple agents and 100,000 integration messages. When a message for the Schedule transaction is created, that message is added after the existing 100,000 messages. When the Schedule transaction getter runs, the getter will have to walk through the entire queue looking for Schedule messages.

An exception to the above is development and possibly test environments. In those cases, to ease configuration and management overhead, it may be acceptable to put all the JMS destinations into a single JMS queue.

19.2.3 Queue File Placement

19.2.3.1 Performance

The WebSphere MQ logs and files and the BEA WebLogic JMS file and paging stores can be implemented on an internal disk. Message queues on a single internal disk should be able to provide from 150K to 200K messages per hour. Obviously, many factors can affect the message throughput including the size of the message content, the burstiness of the traffic, and so forth).

For high transaction systems, for example, a nightly upload of inventory synchronization messages or the import of point-of-sales orders, you should consider placing the WebSphere MQ logs and files and the BEA WebLogic JMS file and paging stores on a SAN RAID-10 LUN, possibly with a large NVRAM cache. The striping component in the RAID-10 will spread the message I/Os over multiple disks. The NVRAM cache could reduce the number of physical disk I/Os.

In extremely high transaction volume scenarios, you may have to consider implementing multiple WebLogic JMS servers or MQ queue managers. This is applicable to solutions where the message order is not important.

19.2.3.2 Availability

For failover and high availability, you should consider placing the WebSphere MQ logs and files and the BEA WebLogic JMS file stores for persistent queues on an external SAN. In the event of a node failure, a standby node could attach to the SAN to access the files. In addition, you could replicate the content of the SAN to prevent message loss in the event of a data center disaster. Please see the *Yantra 7x High Availability Guide* for more information.

19.2.4 Parameters

Please see the following chapters for specific recommendations.

Chapter 20, "BEA WebLogic JMS"

Chapter 21, "IBM WebSphere MQ"

20

BEA WebLogic JMS

This chapter provides guidelines on implementing, configuring and tuning the BEA WebLogic JMS.

20.1 WebLogic JMS Recommendations

20.1.1 Dedicated JMS Server

You should consider running the JMS server on one or more dedicated WebLogic servers that is outside of the Yantra 7x WebLogic cluster. These server instance should only provide JMS services. The benefits of isolating the JMS server on its own server include:

- easier to monitor and manage
- easier to diagnose issues - issues that arise, such as OutOfMemory exceptions, must be related to JMS services or JMS messages

20.1.1.1 Integration Queues

In addition, you should consider putting integration queues into their own dedicated WebLogic JMS servers running on separate JVMs especially if these queues can grow unbounded or at a fast rate.

These integration queues should be configured as persistent so that messages can be recovered after JMS failures. Recovering integration messages can be difficult especially if they involve reconciling when there are many systems or applications involved in processing the messages.

You should consider implementing controls so that producers cannot significantly create messages faster than consumers can process messages. In extreme cases, high number of messages in the queue could consume most of the JMS servers's JVM heap resulting in degraded or loss of service.

The benefits of implementing dedicated JMS servers for integration queues include

- isolating integration-based message queues that could grow unbounded from the more predicable queues used by the Yantra 7x agents
- the ability to configure, manage and monitor the queues to the expected message traffic - for example, you may want to create JVMs with 1GB heap for integration-based JMS servers and smaller heaps for the Yantra 7x agents

20.2 Message and Byte Paging

For WebLogic JMS, you should enable message and/or byte paging on JMS queues that could grow unbounded (for example, integration-based queues. With this facility, the message bodies (not the message headers) are paged out of the JVM memory on to the local file system when the paging thresholds are exceeded. This can reduce the amount of JVM heap space used, which could prevent service degradation or loss.

Note: In extreme cases, excessively high number of message headers can still lead to outOfMemory exceptions.

21

IBM WebSphere MQ

This chapter provides specific guidelines on implementing, configuring and tuning IBM WebSphere MQ.

21.1 WebSphere MQ Parameters

Depending on your processing volumes and the number of MQ queue consumers and producers you expect to start, you may have to change the log and channel parameters in the qm.ini or mqs.ini file.

21.1.1 Channel

Each thread started that reads from or writes to the MQ queues requires a channel. If you were to start 20 JVMs with 5 threads each, you will need at least 100 channels (which is the default). You may also have to increase the number of channels if you have workloads that open and close the JMS connections rapidly.

If you experience messages indicating that the max channels have been reached, do the following

- check to see if there is a connection or channel leak. Run the following command to see how many active channels are used

  ```
  echo "dis chs(*)" | runmqsc | grep RUNNING | wc -l
  ```

- You may have to run each workload at peak production loads in your test environment to diagnose channel leaks
- If you suspect that channels are not getting reclaimed fast enough or if your TCP/IP connection is not reliable, you should set the following parameters. The KeepAlive parameter tells the queue manager to check the existence of the client. If the client is not there, the queue

manager will reclaim the channel. The MaxChannels defaults to 100. In production settings, that parameter could grow to a much higher number like 300 or 500.

```
TCP:
   KeepAlive=YES

Channels:
   MaxChannels=300
   MaxActiveChannels=100
```

21.1.2 Log Files

MQ uses log files to maintain message integrity in the event of a queue manager restart or a media failure.

The number of log files depends on your configuration, the size of the messages, the logging type, and the message volumes. You should performance test your application at or above peak production loads to see if the default MQ log settings are sufficient. If you are using CIRCULAR logging, the following may be reasonable starting values

```
Log:
   LogPrimaryFiles=4
   LogSecondaryFiles=1
   LogFilePages=65536
   LogType=CIRCULAR
   LogBufferPages=0
```

If you use LINEAR logging (for example, to be able to survive media failure), you will have to set LogPrimaryFiles higher.

21.2 Placement of MQ Log and Data Files

If your system has to be able to process a high message rate, you may should consider placing your MQ log and data files on a fast SAN, preferably configured with a large NVRAM and RAID-10. A single internal disk should have sufficient capacity to allow up to 150K to 200K messages per second. Files on a RAID-10 LUN should be able to get up to around 1.5M to 2.0M messages per hour. Beyond that message rate, you may want to consider implementing multiple queue managers with separate data and log files.

Part VI

Yantra Application

This part of the book provides information on how to implement, monitor and tune the Yantra 7x application.

This part includes the following chapters.

22

Yantra 7x - General

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the Yantra 7x application in general that transcends both the Yantra 7x Distributed Order Management and the Yantra 7x Warehouse Management System applications.

Yantra 7x with the default factory (data) settings provides a simple configuration that is suitable for development, training or product familiarization. That configuration is not suitable for production except for customer with very low transaction volumes. This chapter will guide you through the components that you have to configure for higher transaction volumes.

This chapter assumes that you

- are familiar with the installation of Yantra 7x
- are familiar with the basic functionality of Yantra 7x
- have read and followed all the instructions found in the *Yantra 7x Installation Guide*
- have read the *Yantra 7x Release Notes*

22.1 Planning

22.1.1 Scalability Requirements

An important aspect of planning the implementation and configuration of your Yantra 7x system for production is determining your workload and business processing characteristics, and your performance requirements. This includes (at a minimum) the following

- identifying the key or high transaction volume use case scenarios - for example, in retail environments, you will likely have an order capture, order returns, order modification and order authorization use case scenarios. For each use case scenario, you should determine:
  - the workloads (both custom-developed and Yantra supplied) that are executed
  - the forecasted peak transaction volumes
  - when the peak processing periods occur during the year
  - the external systems that the Yantra 7x system will be integrated with
  - the groups of users, their location, and their network connectivity to Yantra 7x.

When choosing use case scenarios, you should include

- workloads with anticipated high transaction volumes
- workloads that are complex (for example, orders with large number of order lines)
- workloads/transactions that have to traverse long network distances (for example, user and data center in different continents)
- high volume transactions that are integrated with external systems.

For each use case scenario, you should:

- perform load testing to at least the anticipated peak workload volumes
- measure the computing resource cost at different workload traffic volumes
- estimate the computing cost per unit work
- identify and tune expensive workloads - this could include ensuring all SQL are supported by appropriate indices (Section 14.2.4.1, "Indices"), custom code, and so forth
- incorporate the cost per unit work into a resource capacity forecasting or planning model
- project out the resource requirements for the peak periods

If you have remote users, you have to test use case scenarios that involve screens or network based transactions across a real or simulated wide-area network. These could include

- the use of Yantra 7x screens (for example, to enter or modify orders)
- RF transactions (for example, users at a warehouse in Asia interacting with the WMS application in North America)

The answers to the questions above are critical to how you configure Yantra 7x.

22.1.2 System Test

We strongly advise that you schedule time and resources to test the Yantra 7x system (including all custom code, integrated external systems, and so forth) prior to implementation. Yantra tests Yantra 7x to common or general usage patterns. Your configuration could differ greatly.

- custom code - need to ensure your custom code scales and does not have longevity issues. These are issues that show up after running the system for many days - for example, memory or connection leaks.
- integration to external systems - need to ensure that external systems can scale along with Yantra 7x. In the right conditions, slow external systems could tie up Yantra 7x resource and could lead to a system slow down.
- configuration - need to test the Yantra 7x system with representative data. For example, your configuration may have much larger catalogs and ship nodes than most customers.
- user locations - need to ensure users get responsive service. For example, you may have large customer groups located in a different continent from Yantra 7x. You may also have customers who dial in to access Yantra 7x. You need to ensure that all users get appropriate screen response times.

22.2 Yantra User Interface

The user interface provides the means for users to interact with the Yantra 7x application to view, create, modify and delete information.

22.2.1 HTML User Interface

Yantra 7x allows you to create or customize the UI screens. You may want to do so for the following reasons.

- you want to reduce processing or the screen size - from the usage scenario studies above, you may find that your users need a subset of a *detail* screen (e.g., order detail). Further, you expect a very large number of users to be located at a remote call center in a different continent. To reduce server processing and the amount of bytes send across the network, you can create a new screen that only has the information needed.
- in conjunction with simplifying the screens, you can also customize an APIs output XML using templates. This will not only reduce the number of bytes returned but can also reduce server and database processing. See Section 22.4.7.1, "API Output XML Files".
- you may want to control the types of searches that the general users can issue. The default search facility allows users to build up searches by picking different criteria. For example, the order search allows users to look for orders based on many criteria including status, enterprise code, and so forth. Some permutation of criteria can result in queries that require a lot of resources. You can create a search screen for general use that has a list of searches that you and the DBA have tested and have deemed to be "safe" for general use. You can further develop a screen with greater search capabilities for supervisors or application administrators. This search screen could mandate entering the enterprise code and a date range for the search to limit the number of records returned. Additionally, you may want to remove certain searches such as looking for orders in a particular status.

Please see the *Yantra 7x Customization Guide* for more information on how to extend or customize screens.

22.2.1.1 HTML Compression

If you use the Yantra Console UI in offices that are connected by either high latency or low bandwidth network links to the data center that house Yantra 7x and the Yantra Console HTML pages are large (for example, over 100KB), you may want to consider using HTML compression to reduce the number of bytes and the number of network round trips. Currently, we have tested the use of an F5 Big-IP v9 as an off-board HTML compression engine. In general, we have found that we could compress up to 85% of HTML pages.

If you were to use a Big-IP, you should be aware of the following Big-IP specific configuration requirements in the HTTP Profile configuration tab

- you need to set the **response chunking** parameter to **rechunk**. The default is **preserve**. The reason is that the Yantra application does not set the content length in the HTTP headers when sending out the response. With the default setting of preserve, the Big-IP will not attempt to compress HTML pages that do not have content lengths set. With the **rechunk** setting, Big-IP will compress the response chunks as they are received. More importantly, the Big-IP can forward along the compressed chunks without waiting for the entire HTML page to be compressed.
- Big-IP allows you to specify the amount of compression processing that it will attempt. The setting can range from Level 1 which tries a minimal compression in favor of processing speed to Level 9 which tries to find the most compression. We found that Level 1 compression was able to get up to 85% compression and that the benefits from Level 9 undetectable. As a result, we defaulted to testing with Level 1 compression.
- we set the compression buffer size to 128KB instead of the default of 4KB. The general thought is that the buffer size should be able to store the entire compressed response in order to set the content header length. In our testing, we didn’t see any appreciable differences between 4KB and 128KB. This may be due to the fact that we had already set response chunking to rechunk - as a result, the Big-IP does not have to set the content length on the compressed response. However, we were advised to set the buffer size to at least 128KB.

We recognize that there are other HTML compression technologies available including Apache deflate module and Juniper DX application acceleration devices. Please keep in mind that we have, to date, only tested against the F5 Big-IP v9.

Please also keep in mind that the compression is only certified for the Yantra Console. The Yantra Configurator and Yantra System Management Console do not support compression. The nWMS radio frequency and VT220 terminal screens are small and should not require compression.

22.2.1.2 Temporary Internet Files

You can reduce the number of hits against the application servers for static content by enabling temporary Internet file cache in Microsoft Internet Explorer. This will improve your UI response times. To enable the cache

- Go to the Internet Options dialog box
- In Microsoft Internet Explorer, go to Tools > Internet Option
  - Click on the Settings button in the Temporary Internet Files panel
  - Enable the “Check for newer version of stored pages” radio button to Automatically
  - Make sure there is sufficient disk space to store temporary Internet files (e.g., 500MB or higher).

22.2.1.3 SSL Acceleration

If you have many users and are planning on encrypting the Yantra 7x screens with SSL, you should consider the use of off-board hardware-based SSL accelerators. SSL encryption/decryption are expensive operations and can reduce application server throughput by over 30%.

Currently, we have tested the use of an F5 Big-IP v9 as an off-board SSL acceleration engine as an SSL Proxy. As an SSL Proxy, all page requests going to the F5 are sent as HTTPS. The Big-IP performs all the SSL processing and forwards all the requests to the applications servers in the "clear".

If you plan to use a Big-IP, you should be aware of the following Big-IP specific configuration requirements in the HTTP Profile configuration tab

- if you use BEA WebLogic application servers, you have to set the **header insert** parameter to **WL-Proxy-SSL: true**. This header directive informs BEA WebLogic that there is an SSL Proxy sitting in front of the application server.

- if you use IBM WebSphere application servers, you need to configure the **redirect rewrite** parameter to **ALL**.

We recognize that there are other SSL acceleration technologies available. Please keep in mind that we have, to date, only tested against the F5 Big-IP v9.

Please also keep in mind that the SSL acceleration was targeted towards the Yantra Console. The Yantra Configurator and Yantra System Management Console do not require SSL.

22.2.1.4 Search Screens

Yantra 7x provides a flexible search facility that allows users to look for orders, shipments and audit records with a wide range of criteria. Some search combinations are more expensive than others.

We recommend that you work with the user community to identify search combinations that are likely to be used in production. Each search combination should be tested to ensure they are optimized and acceptable in a production setting. When testing these searches, you need to make sure the tables searched are sufficiently large (e.g., over 1 million records). Inefficient queries may not be evident in small databases. In addition, ensure the tables are populated with an appropriate data mix. For example, if the query is looking for orders with certain attributes in the closed state, you should ensure that these attributes and the number of closed orders are representative. Database optimizers picks search paths that it believe are optimal for the data distribution.

It is likely that some search combinations will require indices to be created (see Section 14.2.4.1, "Indices").

22.2.1.4.1 Case-insensitive Search The Yantra search facility supports case-insensitive searches against the YFS_PERSON_INFO table on the following columns:

- FIRST_NAME
- LAST_NAME
- EMAILID

- ADDRESS_LINE1
- ADDRESS_LINE2
- CITY
- STATE
- ZIP_CODE
- COUNTRY

The data will continue to be stored in the database in mixed-case (mixture of upper and lower case).

Oracle

To support case-insensitive searches in Oracle, you will have to add function-based indices on the searched columns. To create an function-based index that supports case-insensitive searches on the emailid column, issue the following

```
create index yfs_person_info_cust1 on yfs_person_info(upper(emailid))
```

UDB

For UDB, you have to add a generated column for each searched column and an index on that generated column. For example, as in the example above, you need to perform the following

```
set integrity for yfs_person_info off

alter table yfs_person_info
   add column emailid_up generated always as (upper(emailid))

set integrity for yfs_person_info
   immediate checked force generated

create index extn_per_info_i1
   on yfs_person_info(emailid_up)

select *
from yfs_person_info
where upper(emailid) = 'SMITH'
```

In the example above, a generated column (emailid_up) was defined as a generated column and indexed.

SQL Server

In SQL Server, searches are case-insensitive by default so there are no changes needed.

22.2.1.5 JSP Pre-compilation

Precompiling the JSPs when you "build" the application is very important for user interface response times. If the JSPs are not precompiled, the application servers will compile the JSP on-the-fly the first time it is used. These compiles can take up to 30 seconds or more and could lead to the perceptions of a badly performing system.

Please see Section 12.1.1.5, "JSP Pre-Compilation" on precompiling JSPs in BEA WebLogic application servers.

Please see Section 13.1.1.3, "JSP Pre-Compilation" on precompiling JSPs in IBM WebSphere application servers.

22.2.1.6 HTML Limitations

The view screens (for example, the Order Detail and Shipment Detail screens) present the order or shipment entity and related records in their entirety. The HTML page for large orders or shipments can be very large and could take a long time to display especially over a wide area network. For example, the view screen for a 200 line order could be up to 500KB. Displaying this screen over a 128kbps line could take 30 seconds or more.

If your enterprise regularly process large orders, you may want to consider the following

- as we mentioned above, consider customizing the screens to only return the data needed, implementing HTML/HTTP compression, using output templates to reduce the size of the output, and so forth

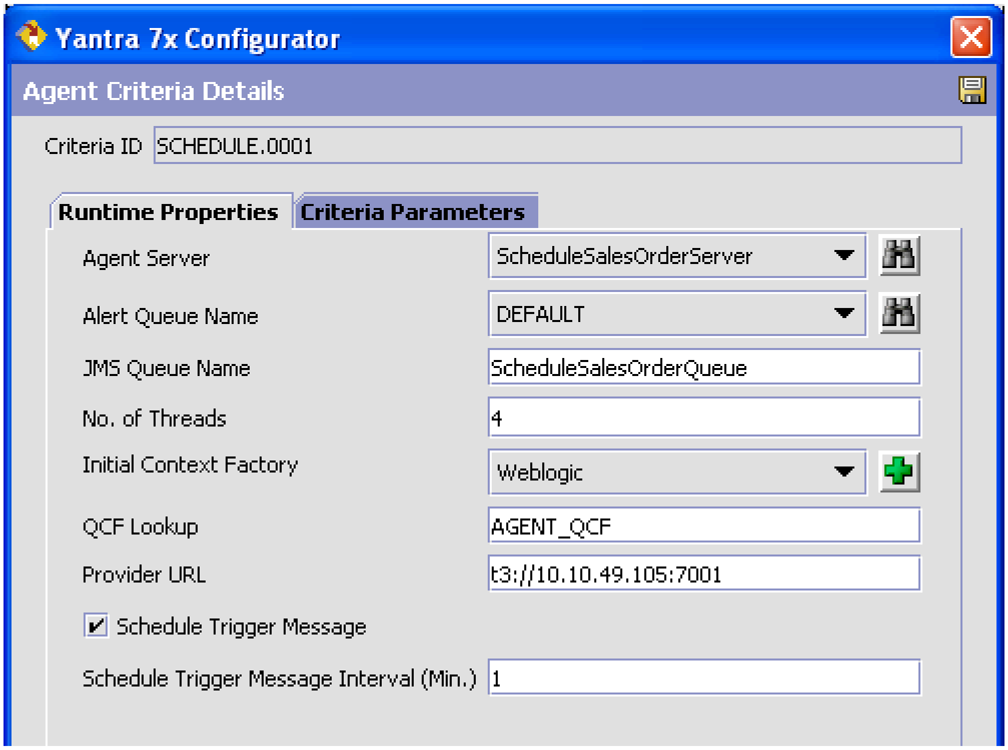
22.2.1.7 Yantra Configurator

The Yantra 7x Configurator is a Java applet that is used to configure the Yantra 7x rules. You may have to start the applet with more memory if you are modifying a large or complex configuration. You can change the memory settings in the JVM/JRE plug-in control panel in Microsoft Windows. Go to Start > Control Panel > Java Plug-In > Advanced. In the

Java Runtime Properties, put in "-mx356m". In this example, the JRE's heap will be allowed to grow to 356MB.

22.3 Integration Adapters/Yantra 7x Agents

Agent Servers or Integration Adapters are Java applications that run time-triggered (agent) transactions (see *Yantra 7x Distributed Order Management Configuration Guide*). Transactions process orders or shipments such as moving orders from one state to another. Out of the box, all time-triggered (agent) transactions are configured to run in a single Agent Server (called the DefaultAgent). This simple setup is convenient for training, development or product demos. You will need to configure the Agent Servers to your expected transaction volumes.



Criteria ID	SCHEDULE.0001
Agent Server	ScheduleSalesOrderServer
Alert Queue Name	DEFAULT
JMS Queue Name	ScheduleSalesOrderQueue
No. of Threads	4
Initial Context Factory	Weblogic
QCF Lookup	AGENT_QCF
Provider URL	t3://10.10.49.105:7001
Schedule Trigger Message	✓
Schedule Trigger Message Interval (Min.)	1

The example above defines the agent criteria for the Schedule time-triggered (agent) transaction. The Schedule transactions run in an

Agent Server which we have called the `ScheduleSalesOrderServer` server. When you start an Agent Server with the Criteria ID of SCHEDULE.0001, that server will be instructed to run four threads of the Schedule transaction. If you need more processing threads, you can run more instances of this Agent Server.

Best Practice: You should load test your agents with varying threading levels to determine the optimum throughput for your specific agent. It is advisable to run these tests for a sufficiently long enough time so that the JVM heap has reached a steady state (in terms of heap occupancy). By plotting the throughput over the threading level, you should be able to find the optimum configuration. As a general recommendation, you should start with four or six threads per JVM.

All time-triggered (agent) transactions are driven by tasks in their message queue. Currently, both BEA WebLogic JMS and IBM MQSeries are supported. A queue may serve one or more transactions. You may however want to configure one queue for each high volume transaction. In this example, the Release time-triggered (agent) transaction get their work from the `ReleaseAgentQueue` messaging queue. This queue name must corresponds to a configured JMS destination.

Work tasks are placed into the messaging queue by a *getter*. A getter's job is to put qualified orders (in this example, orders that are in the Scheduled state) into the `ScheduleSalesOrderQueue` queue. You can specify how many orders the getter picks up each time it runs. By default, the getter will pick up 5,000 orders.

Like the time-triggered (agent) transactions, a getter is also driven by work tasks in the queue - in this case, by a *getter work task* instead of a transaction work task. The getter work task is created by a trigger server.

You should consider the following recommendations when configuring the Agent Servers:

- agent thread levels
- getters that can accept enterprise code as an additional parameter
- for JMS Servers
    - dedicated JMS Servers
    - excessive agent scheduling
    - dedicated JMS Destinations

- running JMS servers in client VM mode
- enabling message and byte paging

22.3.1 Agent Thread Levels

You should derive the optimum number of Agent Servers to run and the number of transaction threads for each Agent Server. The Agent Server's throughput depends on many factors such as the amount of customization or user exits, the amount of data contention, the size and capacity of the agent servers, and so forth.

One approach you can use to derive your agent's effective throughput is:

- allow work to queue up. Make sure there are at least one to two hours worth of work queued up.
- run a single transaction thread and record the total (running) elapse time
- determine the total amount of work performed by the transaction thread for sample monitoring scripts)
- calculate the effective throughput of that agent thread by dividing total amount of work by elapse time. The throughput rate will be specified in terms of work per unit time (e.g., order lines per hour or order lines per minute)

During the test, you should make sure there are no significant system bottlenecks impeding the Agent Server's performance. Some of the performance indicators you should watch for include:

- excessive JVM garbage collection activities (especially Full GCs)
- excessive database waits (e.g., I/O, latches, and so forth)
- inefficient queries (e.g., missing indices)
- data lock contention
- excessive thread synchronization

Make sure the Agent Server is running optimally before calculating its potential throughput rate.

You can schedule multiple agent threads if your average processing level is greater than the effective throughput for a single agent thread. For the reasons mentioned above, more threads (beyond a reasonable level) does not always mean higher throughput.

22.3.1.1 Excessive Agent Scheduling

You should not over-aggressively schedule the time-triggered (agent) transactions - for example, configuring a time-triggered transaction to run on many Agent Servers with high threading levels when you expect to a low traffic volume for that transaction. If you schedule the agents too aggressively, you could end up with a situation where the agents (consumers) are outpacing the producers. As a result, the queue will typically have a few transactions which are quickly processed. When processed, the Agent Server will schedule another getter -- the frequent getter tasks could cause unnecessary overheads as it looks for work to do.

In this case, "more does not necessarily mean more".

22.4 Java Message Service

The Yantra 7x application uses JMS extensively. For example

- the Yantra 7x agents use JMS as a source of work
- the Yantra 7x integration servers use JMS as a means to communicate with external systems

22.4.1 Integration Queues

Integration-based queues are queues for inbound external messages (such as orders from external partners or inventory adjustments from external warehouse management systems) or outbound external messages (such as alert messages to an e-mail system).

You should consider putting these queues into one or more dedicated JMS servers especially if these queues can grow unbounded. In addition, these JMS destinations should be configured as persistent so that messages can be recovered after JMS failures.

You should consider implementing controls so that producers cannot significantly create messages faster than consumers can process messages. In extreme cases, high number of messages in the queue could consume most of the JMS servers’s JVM heap resulting in degraded or loss of service.

The benefits of implementing dedicated JMS servers for integration queues include

- isolating integration-based message queues that could grow unbounded from the more predicable queues used by the Yantra 7x agents
- the ability to configure, manage and monitor the queues to the expected message traffic - for example, you may want to create JVMs with 1GB heap for integration-based JMS servers and smaller heaps for the Yantra 7x agents

22.4.2 Dedicated JMS Destination

You should configure a dedicated JMS Destination for each time-triggered (agent) transaction for the following reasons

- ease of monitoring - with dedicated destinations, it is easier to see the number of messages coming into a destination, the number of messages that require processing, the maximum number of messages that ever existed in that destination. With that information, you can also calculate the messaging inflow and outflow rates.
- performance - with dedicated JMS destinations, the selector will be able to quickly find the message with the specified selector/filter.

In a common JMS destination with lots of messages (e.g., greater than 20K messages), the selector could take several seconds to find the appropriate message.

22.4.3 JMS Persistence

Many of the Yantra agents find work to process from message queues. These work requests are kept in non-persistent message queues. These messages are recreated, either when an external or internal agent trigger is issued.

Integration messages (e.g., createOrder messages from external systems) must be kept in persistent message queues. JMS will read the messages back into memory from the persistent store when the JMS server is restarted.

You should implement persistent JMS queues on a RAID-10 or RAID-5 disk array for performance and availability. These RAID disk arrays, especially for RAID-5, should be supported by a non-volatile cache to ensure fast I/O write operations. For high persistent message volumes, local disk queues can become an I/O bottleneck.

22.4.4 Performance Feature - Reference Data Caching

In controlled tests, reference data caching can increase application throughput by 25% or more and can reduce contention for database resources.

Starting in Yantra 5x 5.0 SP2, caching is enabled by default. The cached records are stored in the JVM heap. As a result, with caching enabled, you should monitor the health of the JVM heap garbage collections. For memory constrained environments, you may want to enable caching on specific tables.

The Yantra 7x reference data caching is implemented by a *local*, *simple*, *lazy-loading*, *asynchronous-refresh* cache manager. The cache manager is a *lazy-loader* in the sense that it does not read in the cacheable reference tables at start up but would instead only cache records as they are being read. The benefit of the lazy-loading strategy is that data is only cached where they are needed.

The cache manager implements a *simple* cache management policy. Data that is cached will remain in the cache until the cache manager is instructed to flush the cache. This could happen because the cache has reached a certain size limit or a reference data record was changed from a standard Yantra 7x API. The cache manager does not implement cache management policies, such as record flushing using a least recently used algorithm, in order to avoid cache management overheads. In our controlled test, this *simple* cache manager provides significant performance benefits with little management overhead.

In keeping with the simple cache strategy, when a reference data record is changed by a Yantra 7x API, the local cache manager will notify all the other cache managers to flush the reference data table. There is a small time-lag between when the reference data is changed to when the last cache manager is notified.

When the cache managers receive the change notification, the cache managers will flush all the cached entries for the affected table. As a result, you should cache tables that are infrequently changed. More importantly, this notification comes from Yantra 7x APIs. As a result, you should ensure that reference data are never changed via database tools like SQL*Plus.

Recommendations

- you should enable reference data caching when you need the extra performance boost
- you should ensure that the reference data is not subject to frequent updates

22.4.4.1 Caching Strategies

As we stated above, with caching, you introduce the possibility of data consistency issues. This data inconsistency may occur when an API changes a reference data record in one JVM while another transaction is using another copy of that reference data in another JVM.

That said, caching is a widely used technique that favors scalability, performance and affordability against possibly maintainability, data consistency, and accuracy.

In this section, we will describe strategies you can use to mitigate the data consistency issues.

Strategy 1 - Trade-off Performance and Affordability against Data Consistency

In this strategy, you may ask yourself the question. First, does the possibility of data consistency exist? Since the refreshes are done asynchronously, the answer is yes. The next question is, what is the probability of a data consistency? One of the factors that this answer depends on is the transaction volume. There may be more. For example, if you were to make the reference data changes at night when transaction volumes are low, you may decide that the probability of data consistency is potentially low. The last question you need to ask is, what is the impact of an inconsistent data? If you determine that the impact is insignificant, then you may decide to go with this strategy. The decision is yours to make.

Strategy 2 - Trade-off Performance and Affordability against Maintainability while keeping Data Consistency

In this strategy, you control updates against the cacheable reference data to eliminate any possibility of data consistency. One approach is to place the cacheable reference tables into a separate tablespace.

In addition, with Oracle, using the following command, you alter the tablespace to only allow reads.

```
alter tablespace <tablespace name> read only;
```

Oracle will ensure that these tables are not modified without your knowledge. To modify the cached reference data, you then alter the tablespace back to read/write and modify the reference data through the Yantra 7x Configurator. To be safe, you would probably do this when there is very little transactional activity o the system. When you are done, you can then mark that tablespace as read only with the following command.

```
alter tablespace <tablespace name> read write;
```

22.4.4.1.1 Automatically Refreshing Data Cache When a record of a cached table is modified by a Yantra 7x API, the local cache manager sends change notification messages to all the other cache managers in the Yantra 7x system. These messages are sent sequentially - going from one cache manager to the next. The time to notify all cache managers is dependent on the number of cache managers - the more managers, the longer the notification process. The list of cache managers are dynamically maintained in the Yantra 7x Java Naming and Directory Interface (JNDI) tree. The JNDI tree is updated when Yantra 7x application servers, integration servers or agents are started or terminated. At any time, the JNDI tree will have a record for every running Yantra 7x application server instances and integration server/agents.

Yantra 7x servers, integration servers and agents update the Yantra 7x JNDI tree that is pointed to by parameters found in the $YFS_ HOME/resources/ `management.properties` file.

If your JNDI tree is kept in WebLogic, enable the following parameters in the management.properties file.

```
#for WebLogic,
yfsjndi.jmx.java.naming.provider.url=
      t3://<ip address of WLS where the JNDI tree resides>:<port number>
yfsjndi.jmx.java.naming.factory.initial=
      weblogic.jndi.WLInitialContextFactory
```

For WebSphere, enable the following parameters.

```
#for WebSphere
yfsjndi.jmx.java.naming.provider.url=corbaloc::<ipAddress>:<port>
yfsjndi.jmx.java.naming.factory.initial=
      com.ibm.websphere.naming.WsnInitialContextFactory
```

The "Cache Clear Count" column in the System Management Console > Table Level Cache List screen provides statistics on the number of times the cache was cleared at the table level.

22.4.4.1.2 Manually Refreshing Data Cache You can manually refresh the Yantra 7x cache from the System Management Console. Go to the Details page for each application server or Yantra agent instance and press the "Clear Cache" icon.

22.4.4.2 Enabling Reference Data Caching

By default, Yantra 7x enables reference data caching for

- the application server instances
- the Yantra 7x agents and monitors

The caching feature is enabled using the `yfs.dbcache.classes` parameter in the `yfs.properties` file. In the following example, the yfs_item, yfs_item_alias and yfs_item_exclusion tables are cached.

```
yfs.dbcache.classes=com.yantra.yfs.dbclasses.YFS_ItemDBCacheHome, \
     com.yantra.yfs.dbclasses.YFS_Item_AliasDBCacheHome, \
     com.yantra.yfs.dbclasses.YFS_Item_ExclusionDBCacheHome
```

Currently, there are about 250 reference tables that are cacheable. The complete list is found in your `yfs.properties.sample` file.

The System Management Console allows you to confirm that tables are cached.

22.4.4.3 Limiting the Number of Records Cached

By default, Yantra 7x caches up to 10,000 records per table. You can change this limit at the table level by setting the following parameter in the `yfs.properties` file.

```
yfs.dbcache.com.yantra.yfs.dbclasses.YFS_QueryDBCacheHome=limit.rows=15000
```

In the example above, Yantra 7x will cache up to 15,000 YFS_QUERY records. You can also set a global limit for all cached table with the following parameter

```
yfs.dbcache.defaults=limit.rows=15000,enabled=true
```

In the example above, up to 15,000 records will be cached for each table that has been selected for caching.

The "Objects Cached" column in the System Management Console > Table Level Cache List provides the number of records cached for each table.

Please keep the following in mind if you change the default settings,

- Each cached record occupies space in the JVM heap. If you increase the number of records cached, you must ensure garbage collections are still effective and "healthy".
- Conversely, do not set the cache limit too low such that the Yantra 7x cache has to continually flush the cached tables

The UI login process will take over 20 seconds if you set the cache limit for the YFS_RESOURCE and YFS_RESOURCE_PERMISSION tables too low (e.g., 1,000). These two tables have over 3 thousand records which are read as part of the UI login process. By setting a low cache limit (less than the number of records in these two tables), the Yantra 7x cache will have to flush out earlier cache records when the cache fills up. As a result, the next login will have to read the records again.

To minimize the amount of cache management overhead, the caching mechanism implements a simple space management strategy - when the number of cached records for a table hits the limit specified above, the cache manager will initialize (or refresh) that table’s cache to being empty.

The amount of memory used by caching can be estimated with the following formula

$$\text{memory(MB)} = \frac{\text{rows} \times \text{DBRowSize(bytes)}}{1,000,000} \times 5$$

For example, for YFS_Query, if you expect to keep 10,000 records in the cache and if the average record length is 380 bytes, the YFS_Query cache will consume about 19MB of memory in the heap.

22.4.4.4 Caching for the Application Servers

To enable reference data caching for application servers,

- set the `yfs.dbcache.classes` parameter in the `yfs.properties` file that the application servers reference.
- restart the application servers

22.4.4.5 Caching for Yantra 7x Agents and Monitors

If you only want to enable caching to agents only, you must change the `agentrunner.sh` shell script to reference an agent-specific cache-enabled copy of the `yfs.properties` file. You should:

1. Copy the existing properties file (`yfs.properties`) to a new directory.
2. Add the caching feature attributes (see above) to the new properties file.
3. Change the `agentrunner.sh` shell script to use this new properties file.

22.4.4.5.1 Creating an Agent-Specific Properties File Yantra 7x looks for its property file by looking for a file called `yfs.properties` in a `resources` directory under each directory listed in the CLASSPATH environment variable. For example, if the CLASSPATH is set to:

```
/u01/prod:/u01/prod/yfs:/u01/prod/yfs/lib
```

Yantra 7x will try to find the properties file in the following sequence:

```
/u01/prod/resources/yfs.properties
/u01/prod/yfs/resources/yfs.properties
/u01/prod/yfs/lib/resources/yfs.properties
```

You need a new directory so that the application servers and the agents can reference their own distinct `yfs.properties` file. As a suggestion, if the current properties file is found in

```
u01/prod/yfs/resources/yfs.properties
```

you can create an agent specific properties file in

```
/u01/prod/yfsagents/resources/yfs.properties.
```

In the above example, you should modify the CLASSPATH in the `agentrunner.sh` to put /u01/prod/yfsagents ahead of the existing directories. For example,

```
/u01/prod/yfsagents:/u01/prod:/u01/prod/yfs:/u01/prod/yfs/lib
```

22.4.4.6 Strategies for Enabling Reference Data Caching

The following are some suggestions to consider if you decide to cache some or all of the reference tables.

- enable reference data caching if you need the extra performance boost
- move the tables you want to cache into a separate tablespace and monitor the read/write activities to that tablespace. That tablespace should exhibit high read activities and almost no write activities.
- cache tables that have a high read and almost no write or update activities.
- use the `limit.rows` parameter to limit the number of rows that can be cached if you have very large reference tables
- if you use the `limit.rows` parameter, monitor the frequency at which the cache tables hit the limit and are refreshed - you should ensure that the refresh frequency is kept low.
- monitor heap garbage collection - make sure that major collection are not occurring too frequently. If you have high frequency of major collections, you may want to experiment with either increasing the old generation space (using the `-Xms` and `-Xmx` parameters), decreasing the young generation (using the `-XX:MaxNewSize` and -XX:NewSize parameters), or using the `limit.row` parameter.
- when you decide to cache tables, put the cached tables into a read-only tablespace so that you can control the manner and frequency in which these tables are written to or updated.

22.4.4.7 Monitoring Cache

The number of records a JVM caches depend on many factors including the type of transaction, the data that it retrieves, the breadth of functionality used, and possibly seasonality.

For example, an agent that is configured to Schedule Orders will only cache records that is used by the Schedule transaction. An application server, in contrast, serves a broad range of transactions and will typically require more memory for the cache. An application server that services both DOM and WMS will likely cache more records than one that only services DOM.

You can monitor cache usage from the Yantra 7x System Management Console. Go to the Detail page for an application server or Yantra agent. Press the "Table Level Cache" button. The following is an approach to monitoring the cache.

- Monitor the cache usage on a regular basis
- Identify the table that has most of the cached records (for example, any table with more than 100 cached records). Typically, a small set of tables will account for most of the cached records.
- For each large cache table, record or plot the number of cached records
  - a table may be a good candidate for caching if the number of cached records climbs and remain at a plateau.
  - a table may be a good candidate if it has high logical and low physical read counts.
  - a table may also be a good candidate for caching if the time between cache drops is long (e.g., over an hour)
  - a table may not be a good candidate for caching or the cache is too small if the time between cache drops is very short (e.g., cache drops every minute).

22.4.4.7.1 Cache Drop Messages In addition, you can monitor when cached tables are flushed.

```
2004-02-11 13:10:44,753:WARN   :main: Clearing cache. Number
    cached=7787,Lists cached=2,Singletons cached=2: YFS_ResourceDBCacheHome
```

Look for tables that are frequently flushed. It could indicate that the cache is too small or that table is being updated. You may want to remove a table from the cache list if it is being flushed too often.

22.4.5 JNDI

The Yantra application uses JNDI to record an entry for each application server and each Yantra 7x server that starts up. These entries enable Yantra 7x to manage servers and to broadcast cached data updates to them. When a Yantra 7x server is shut down normally, the corresponding entry in the JNDI registry is removed.

When a Yantra 7x server ends abnormally (or whenever an application server ends) the corresponding entry remains in the JNDI registry, even though it no longer points to a valid running server. These pointers to servers that are no longer running are known as "stale entries." Stale entries may cause significant slowdown when managing servers through the System Administration Console and when broadcasting cache updates of configuration changes from the Yantra 7x Configurator.

To eliminate stale entries from the JNDI tree, Yantra 7x automatically tries to remove them during the initialization phase of any server start up. On WebLogic BEA WebLogic 8.1 SP5, this process can remove active entries as well as stale entries. This behavior may result in conditions ranging from benign (such as an inability to see a server in the System Administration Console) to potentially serious data integrity issues resulting from failed cache updates.

Yantra 7x supplies a script that enables you to maintain an accurate JNDI registry, using the following procedure. This script is extremely lightweight and does not require significant resources or separate sizing estimates.

Please see the *Yantra 7x Installation Guide* for instructions on how to run the JNDI cleanup script.

22.4.6 Yantra 7x Services

Yantra 7x provides certain standard out-of-the-box services, which could be used on actions configured from events. These services have been provided in synchronous mode. Some of these services like Receipt Closure, may require to be changed to asynchronous mode to maximize performance.

To make them asynchronous, you would need to copy the current supplied service to another service flow, and change the starting point to one of the asynchronous transports like WebLogic JMS, MQ, and so forth.

In events where the originally supplied service flows are configured to call synchronously, you would need to create a custom service which would publish the Input XML to an asynchronous transport component like WebLogic JMS, MSMQ, and so forth.

For more information on defining service definitions, see *Yantra 7x Platform Configuration Guide*.

22.4.7 Yantra 7x APIs

Yantra 7x provides an extensive list of APIs that client programs can invoke. Here are some recommendations for you to consider.

22.4.7.1 API Output XML Files

The Yantra 7x APIs, such as *getOrderDetails*, return data based on the specification of the following two XMLs files

- output XML file
- template XML file

The output XML file defines all the possible elements and attributes that the API is capable of returning. The template XML file allows you to specify a subset of the elements and attributes that the API will return.

For performance, especially for high volume APIs, you should optimize the template XML file. Please refer to the *Yantra 7x Customization Guide* for recommendations.

22.4.7.2 List APIs

List APIs allow you to retrieve sets of data from the Yantra 7x database. These APIs are typically labeled getXXXList - for example, getItemList, getLocationList, and getOrganizationList. In some cases, the list API could "find" a large number of records which would cause the API to return a very large output XML. If unchecked, the output XML could consume a large portion of the Java heap.

Developers can, and should, limit the number of records returned by setting the attribute `MaximumRecords` in the list XML. For example, the following input XML will return at most 2 records.

```
<Item MaximumRecords="2" />
```

You can also enforce a system-wide limit by setting `yantra.app.maxrecords` (see Section 22.4.10.5, "API Control").

22.4.7.3 User Exits and Events

APIs give you the ability to add your own custom code in user exits or events at well-defined points in the processing. The user exits and events are defined in the Yantra 7x API Javadocs and in the *Yantra 7x Customization Guide*.

When using user exits and events, keep the following in mind

- ensure the processing time in the exit and events are short. Long exit or event processing times will increase transaction response time which could result in lowered throughput.
- ensure that call-out (requests) to external systems can scale beyond anticipated peak processing rates. Unscaleable or degraded call-outs can significantly elongate user exit or event processing times.
- ensure that you do not hold critical record locks during the call out. Critical record locks are defined as those records, such as the YFS_ INVENTORY_ITEM, YFS_LOCATION, YFS_LOCATION_INVENTORY, YFS_ORDER_HEADER, and so forth that are potentially needed by other transactions. Please see below.

You need to be aware of whether you are holding record locks when invoking user exits or events, especially exits or events that could take a long time to process. For example, if your transaction is holding YFS_ INVENTORY_ITEM locks and your exit takes a minute to process, you could potentially block other inventory processing transactions that requires that lock.

You can find out whether you are holding on to locks during a call out by review VERBOSE traces. Look for any SELECT... FOR UPDATE statements issued prior to the call out.

Calling a user exit while holding on to locks may not be an issue if you are certain the user exit or event will complete quickly (e.g., less than 100ms). For example, you may have coded a user exit to publish an ON_

SUCCESS message to a message queue. The call out response time is less certain if your exit calls out to an external system. We have seen many cases at customer sites where external systems call outs either failed to return or have taken over two minutes.

22.4.8 Wildcard Characters

Oracle, UDB and SQL Server use the underscore character ("_") as a single character wildcard and the percent character ("%") as a wildcard character that can match zero or more characters. If possible, you should avoid using these two characters in indexed fields. Take for example the case where you have a record with ORDER_NO equal to E1_DIV01_03215466.

The following query will be fast because only records with 'E1_DIV01_03215466' qualifies.

```
select order_header_key
from yfs_order_header
where order_no = 'E1_DIV01_03215466';
```

But the following query can be very slow, especially if you have millions of records that start with "E1%".

```
select order_header_key
from yfs_order_header
where order_no like 'E1_DIV01_0321546%';
```

In the example above, records with ORDER_NO equal to E11DIV0110321546, E11DIV01A0321546 and so on qualifies. As a result, the database server has to find every qualifying record with ORDER_NOs ranging from E1<*low value*>DIV01<*low value*>0321546% to E1<*high value*>DIV01<*high value*>0321546%.

If you use wildcards as part of the column value, you can escape the wildcards as shown in the following example.

```
select order_header_key
from yfs_order_header
where order_no like 'E1\_DIV01\_0321546%'
escape '\';
```

22.4.9 log4j Logging

The *Yantra 7x Installation Guide* provides more detail on how to configure log4j. Logs are important because they provide information to help you detect

- application problems - for example, application errors during development
- order processing exceptions - for example, the inventory levels of an item are low and is causing orders to backorder

22.4.9.1 Logging Level

The Yantra 7x implementation of logging provides the following four application logging levels

- ERRORDTL
- ERROR
- WARN
- INFO

and the following four diagnostic logging levels

- TIMER
- SQLDEBUG
- DEBUG
- VERBOSE

You can turn on all or a combination of some of these levels. You can also designate different log destinations.

For production, you should enable either the INFO or WARN logging level. The application logging levels are cumulative. If you enable INFO, you will get all four levels from INFO to ERRORDTL. If you enable WARN, you will get three levels from WARN to ERRORDTL.

When needed, you can enable diagnostic logging levels for short periods of time in production. The DEBUG and VERBOSE consume large amount of computing resource and generate large amount of log entries. Enabling VERBOSE logging will also enable all diagnostic logging levels from VERBOSE to TIMER as well as all application logging from INFO to

ERRORDTL. VERBOSE logs prints out lots of information including the input, intermediate and resulting XMLs, debug information, and so forth.

The TIMER logging level produces a one-line trace entry to record when certain processing sections are entered and exited. This diagnostic logging level is useful for identifying areas for tuning.

The SQLDEBUG diagnostic logging level produces log entries for each SQL statement processed. In addition, SQLDEBUG will also enable the TIMER logging level. This logging level is useful if you suspect that there are slow SQL statements.

You control the log4j logging levels in the `log4jconfig.xml` file.

22.4.9.2 Log Destinations

By default, the `log4jconfig.xml.sample` file defines a `ROLLINGFILE_APPENDER` with a hard coded destination of `/application_path/log/yantra_application.log`. If you were to start multiple JVMs (e.g., multiple agents and/or application servers), they will all write to the same file. In some cases, the log messages from multiple JVMs could be interleaved.

To avoid this, you can use a parameter to define a separate log file for each JVM. This can be accomplished as follows

- in the log4jconfig.xml, set the ROLLINGFILE_APPENDER as follow

  ```
  <appender name="ROLLINGFILE_APPENDER"
  class="org.apache.log4j.RollingFileAppender">
      <param name="MaxFileSize" value="2048KB" />
      <param name="MaxBackupIndex" value="2" />
      <param name="File" value="${LOGFILE}" />
      <layout class="org.apache.log4j.PatternLayout">
       <param name="ConversionPattern" value="%d:%-7p:%t: %-60m: %-25c{1}%n"/>
      </layout>
  </appender>
  ```

- pass in the LOGFILE parameter when starting up the JVM. In the following example, the log file will have the agent or application server name followed by the node name and a date and time.

  ```
  AGENT_LOGFILE=${LOG_DIR}/${AGENT_NAME}_{$HOSTNAME}-`date +%Y%m%d%-H%M%S`.log
  java -DLOGFILE=${AGENT_LOGFILE} \
      com.yantra.integration.adapter.IntegrationAdapter
  ```

22.4.10 Property Files

Yantra 7x uses the following two property files to govern how it initializes and operates.

- yfs.properties
- yifclient.properties

These property files must be stored in a folder called resources. Yantra 7x looks for the property files by checking each directory or folder in the CLASSPATH environment variable that has a resources folder and the property file. For example, if you have the following property files

```
/u01/prod/yfs/resources/yfs.properties
/u01/prod/yfsagents/resources/yfs.properties
/u01/prod/yfsspecial/resources/yfs.properties
/u01/test/yfsagents/resources/yfs.properties
```

and your CLASSPATH is

```
CLASSPATH=/u01/prod/yfs/lib/yfs.jar:/u01/prod/yfsagents
```

the application will pick up `/u01/prod/yfsagents/resources/yfs.properties`. This technique gives you the flexibility to configure one property file for the entire application or to have a property file specific to a workload.

Table 22–1 yfs.properties

Parameters	Application Server	Integration/Agent Server
Application Server Connection Pool	Mandatory	Not Applicable
yfs.dblogin.datasource.name		
Integration/Agent Server Connection Pool	Not Applicable	Mandatory
yfs.dblogin.dbtype		
yfs.dblogin.driverclass		
yfs.dblogin.jdbcurl		
yfs.dblogin.userid		
yfs.dblogin.password		
yfs.context.timeout		
yfs.context.reaptime		

Table 22–1 yfs.properties

Parameters	Application Server	Integration/Agent Server
Reference Data Cache		
yfs.dbcache.classes	Recommended	
yfs.dbcache.com.yantra.yfs. dbclasses.*tablename.* DBCacheHome=limit.rows		
User Interface Control		
yfs.ui.MaxRecords	Optional	Not Applicable
yfs.ui.queryTimeout	default=120	Not Applicable
API Control		
yantra.app.maxrecords	default=5000	
Statistics		
yantra.statistics.collect	Recommended	
yantra.statistics.persist.interval		
Inventory Locking		
Hot SKU Feature	Recommended	
please see Section 22.4.11.4, "Hot SKU Feature"		
yfs.inventory.sortandlock	Please see note below	

22.4.10.1 Application Server Connection Pool Parameters

Yantra 7x components (e.g., EJB, servlets) that run in the application servers use the Application Server Connection Pool parameters to find the connection pool. Please refer to Section 12.1.1.4, "WebLogic Connection Pool"WebLogic Connection Pool if you are using BEA WebLogic or Section 13.1.1.2, "WebSphere Connection Pool" if you are using IBM WebSphere for more detail.

The Application Server Connection Pool parameters are not applicable to agents and the asynchronous adapters because they do not run in the application server.

Note 1: If Yantra 7x running in an application server cannot get a connection through the connection pool, it will try to establish a connection through the Direct Connection parameters. If you do not like this behavior, you can comment out the Direct Connection parameters in the application server-specific `yfs.properties` file. The application server transactions that cannot get a connection will abort with an exception.

22.4.10.2 Integration/Agent Server Connection Parameters

The agent and integration servers implement their own connection pool that is controlled by the following Direct Connection parameters.

```
yfs.context.timeout=600
yfs.context.reaptime=900
```

To detect and close down idle connections, the adapter's connection pool implemented a *Reaper* process. The *Reaper* wakes up periodically to see if connections have been idle for a specific period. The former is specified by `yfs.context.reaptime` which currently defaults to ten minutes. The later is specified by `yfs.context.timeout` which currently also defaults to ten minutes. In the example above, the Reaper will wake up every 600 seconds and close connections that have been idle for 900 seconds.

22.4.10.3 Reference Data Cache Parameters

Reference data caching is critical for performance and scalability. By default, the cache is enabled. Please see Section 22.4.4, "Performance Feature - Reference Data Caching" for more detail, recommendations and strategies.

The yfs.dbcache.classes parameter lets you specify the list of cacheable reference tables. Not all tables can be cached - only those listed in the yfs.properties.sample. For example

```
yfs.dbcache.classes=com.yantra.shared.dbclasses.YFS_ActionDBCacheHome, \
com.yantra.shared.dbclasses.YFS_Activity_ConstraintDBCacheHome, \
com.yantra.shared.dbclasses.YFS_AdapterDBCacheHome, \
...
com.yantra.shared.dbclasses.YFS_Routing_Guide_AttrDBCacheHome, \
com.yantra.shared.dbclasses.YFS_Routing_Guide_DetailDBCacheHome, \
com.yantra.shared.dbclasses.YFS_Ship_ConstraintsDBCacheHome
```

The yfs.dbcache.defaults parameter sets a global limit on the number of records cached for each cacheable table. For example, if you set the following parameter

```
yfs.dbcache.defaults=limit.rows=10000,enabled=true
```

the cache manager will cache at most 10,000 records per table.

22.4.10.4 User Interface Control

The UI Control parameters are only applicable to the screen workloads (e.g., JSPs) running in the application servers. They provide system level controls to the application administrators.

yfs.ui.maxRecords

The `yfs.ui.MaxRecords` parameter sets the maximum number of records that can be displayed in the list screens on a system-wide basis. Some of these list screens include Order Lists, Alert Lists and Item Lists. This parameter is currently defaults to 200. In addition to this control, the List screens have a Maximum Record field which is currently defaults to 30. Therefore, out-of-the-box, if the user issues a search that has 1,000 records, only 30 will be displayed. The user can, at their discretion, change the value of Maximum Record up to the value specified by `yfs.ui.MaxRecords`.

There are some important points that you need to be aware of:

- The `yfs.ui.MaxRecords` only controls the number of records (e.g., orders or items) that can be displayed in a list. It does not control the amount of work the database has to perform to get those records. For example, a user can issue a very inefficient query by asking for all orders that "contains" the letter "Z" in the order number or in the customer’s e-mail id. Those queries will typically result in a full table scan of potentially large tables.
- This control was put in place to limit users from trying to display a large number of records in a list. A large list increases the number of active objects in the JVM heap which can force more garbage collections which could cause transaction response times to climb. You should test the order list transactions under concurrent loads if you are going to increase this value.

yfs.ui.queryTimeout

The `yfs.ui.queryTimeout` parameter sets the maximum amount of time a query in a UI transaction can take. By default, this parameter is set to 120 seconds. If a query takes more than 120 seconds, the query is canceled, the transaction aborted and rolled back and an information screen is displayed to the user.

22.4.10.5 API Control

yantra.app.maxrecords

This parameter serves as a safe guard to limit records returned by LIST APIs to 5,000 records. Please see Section 22.4.7.2, "List APIs".

22.4.10.6 Statistics

By default, Yantra 7x generates application-level statistics every 10 minutes. The statistics generation is governed by the following parameters.

```
yantra.statistics.collect=y
yantra.statistics.persist.interval=10m
```

In the example above, statistics are persisted (or written out) every 10 minutes. These statistics are intended for internal Yantra use for throughput monitoring and performance problem diagnosis. You can disable statistics by setting `yantra.statistics.collect=n`. We, however, recommend customers leave statistics enabled. The Yantra 7x System Management Console (see Section 22.5.1, "System Management Console and Health Monitor Agent") relies on these statistics.

Please see Section 22.5.2, "Yantra 7x Statistics" for more information.

22.4.10.7 Inventory Locking

22.4.10.7.1 Hot SKU Feature Please see Section 22.4.11.7, "Hot SKU Controls" for information on the Hot SKU control parameters.

22.4.10.7.2 yfs.inventory.sortandlock To prevent deadlocks, the Yantra application sorts the order or shipment lines by the items at the line level (see Section 22.4.12, "Sort Order and Deadlocks") prior to processing. As the application processes the line, it locks the YFS_INVENTORY_ITEM record. For example, given the following four line order where

- line 1, item A
- line 2, item G

- line 3, item F
- line 4, item E

the Yantra application will lock the items and process the lines in the following sequence

- lock item A, process line 1
- lock item E, process line 4
- lock item F, process line 3
- lock item G, process line 2

Transactions that follow this convention reduces the likelihood of deadlocks. The exception is when orders has kits. Using the example above, assume that item G in line 2 is a kit that is made up of the following kit items D, B, and C. Since the application sorts the item at the line level, the application will still process lines 1, 4, 3, and 2 as above. However, when the transaction processes item G, it will potentially lock the kit items out of sequence. Using the example above, the locking sequence will be as follows

- lock item A, process line 1
- lock item E, process line 4
- lock item F, process line 3
- lock items B, C, and D, process line 2

If you are processing kits and are experiencing deadlocks, you can set the `yfs.inventory.sortandlock` parameter to Y. With the parameter enabled, the application will first sort and lock all the line item and kit items prior to processing the transaction. Using the example above, if you enable `yfs.inventory.sortandlock`, the application will perform the following.

- lock item A, B, C, D, E and F first
- process line 1
- process line 4
- process line 3
- process line 2

Note: Setting the `yfs.inventory.sortandlock` will increase the amount of time the YFS_INVENTORY_ITEM locks are held. That increase may not be noticeable in small orders (for example, five line orders). However, that increase could be noticeable if the number of lines is large (for example, over 100 or 200 lines).

Warning: You should not set this parameter if you do not process kits. Setting this parameter will not add any value to non-kit orders.

See Related Sections

- Section 22.4.12, "Sort Order and Deadlocks"

22.4.11 Performance Feature - Hot SKU

The Yantra application locks the inventory item record for an item before manipulating that item’s supply or demand information. That inventory item lock is held until the transaction is finished.

22.4.11.1 Determining The Amount Of Inventory Lock Contention

Transactions that hold inventory item record locks can block other transactions that need the same record. A certain amount of lock contention is acceptable especially if transactions are blocked infrequently or for short periods of time and if there is no material impact on processing throughput or end-user response times.

22.4.11.1.1 Determining Level of Lock Contention in Oracle You can determine the level of inventory lock contention with the following techniques. In Oracle,

- use STATSPACK to calculate the amount of lock contention
- in Oracle, query the v$session table to understand the extent of the lock contention

STATSPACK reports provide a measure of the total amount of time (in seconds) all transactions waited for record locks. This metric is found in the "Wait Events for DB" section (page 2) of a STATSPACK report. In the following example, transactions waited for enqueues for a total of 741 seconds in that 30-minute measurement interval.

```
Wait Events for DB: YRAC05  Instance: YRAC051  Snaps: 15202 -15203
```

```
                                                                   Avg
                                                     Total Wait   wait     Waits
Event                               Waits   Timeouts   Time (s)   (ms)      /txn
---------------------------- ------------ ---------- ---------- ------ --------
db file sequential read           903,826          0      6,246      7       3.0
db file scattered read            879,659          0      4,281      5       2.9
enqueue                             3,542          6        741    209       0.0
library cache pin                     375        231        719   1918       0.0
buffer busy waits                 116,687          0        449      4       0.4
log file sync                     129,571          0        134      1       0.4
```

Dividing that number of enqueue wait times (741 seconds) by the measurement interval (30 minutes) shows that the enqueue contention was on average 0.41 blocked seconds per second. From a statistical point of view, one transaction was blocked 41% of the time every second. If you have ten concurrently running transactions, at one extreme, this statistic could be interpreted as all transaction was blocked 4.1%. At the other extreme, one transaction could have been completely blocked for 719 seconds.

In the example above, the lock contention is minimal. As a guideline, high lock contention situations are characterized as

- enqueue wait seconds per second is greater than 5 second per second or
- enqueue wait is the top wait

If enqueue wait times are significant, run the following query to identify the sessions that are blocked, the amount of time that they were blocked for, and the objects they are blocked on.

```
select sid,last_call_et, sql_text
from v$session vs, v$sqlarea sa
where last_call_et > 0 and
  vs.sql_hash_value = sa.hash_value and
  vs.lockwait > ' '
order by last_call_et desc;

SID   LAST_CALL_ET    SQL_TEXT
13               1    SELECT  /*YANTRA*/   YFS_ORDER_HEADER.*
                      FROM YFS_ORDER_HEADER YFS_ORDER_HEADER
                      WHERE ENTERPRISE_KEY =:"SYS_B_0" AND
                            ORDER_NO = :"SYS_B_1"  FOR UPDATE
```

In the example above, session (SID=31) blocked for 1 second while trying to lock a YFS_ORDER_HEADER record.

We suggest you look at the following

- determine the objects that transactions are blocked on (e.g., are transactions blocked on YFS_INVENTORY_ITEM or some other table)
- determine the amount of time these transactions block for - if the blocks are for a few seconds (e.g., 1-2 seconds) and the number of order lines per order are small, the level of contention may be acceptable.

This query, along with the contention level derived from STATSPACK, lets you determine the extent of the lock contention.

22.4.11.1.2 Determining the Level of Lock Contention in UDB For UDB, check the following monitor elements

- `lock_wait_time` to determine the amount of lock contention. If you divide this number by the measurement interval, you will get the average lock wait (in milliseconds) per second.
- check the `table_name` monitor element in the `snapshot_lockwait` monitor to see where most of the lock contention are coming from
- for each blocked agent, check the `stmt_text` and `uow_lock_wait_time` monitor elements in the snapshot_statement monitor.

We suggest you look at the following

- determine the objects that transactions are blocked on (e.g., are transactions blocked on YFS_INVENTORY_ITEM or some other table)
- determine the amount of time these transactions block for - if the blocks are for a few seconds (e.g., 1-2 seconds) and the number of order lines per order are small, the level of contention may be acceptable.

22.4.11.2 Conditions For Inventory Lock Contention

The following three conditions must exist together for high inventory lock contention.

- sufficiently high number of concurrent transactions that require inventory locks
- sufficiently long inventory lock-holding times

- presence of a few common inventory (SKU) in the orders of the concurrently running transactions

If the transaction volume is low and only one transaction is running, this transaction will not experience any inventory lock contention. The likelihood of inventory lock contention grows as the number of concurrently running inventory processing transactions (e.g., createOrder, schedule, release, and so forth) increases.

The impact of lock contention may be minimal if the lock-holding times are very short. Blocked transactions eventually get and lock the inventory item they need to process.

If there are no common SKUs, all the concurrently running transactions will be able to process without blocking.

22.4.11.3 Optimization

If the inventory lock contention level is high, relative to your processing concurrency levels, or if you feel that your processing throughput or end-user response times are impacted, we suggest the following course of action.

Look at the lock-holding times. Run each inventory processing transaction with SQLDEBUG traces or possibly VERBOSE traces. VERBOSE traces provides more data but can be more intrusive than SQLDEBUG.

- See how long, on average, the transactions take.
- See when the first inventory locks are obtained (and as a result, how long they are held) within that transaction boundary. The goal is to keep lock-holding times short.
- See if there are places in the transaction that take a long time to process and the processing occurs when inventory item locks are held. For example,
    - the transaction may have a user-exit that calls out to external systems. If that external system slows down or is unable to scale, the user-exit time will increase. This will correspondingly elongate the lock-holding times.
    - there may be SQL statements that run for a long time and can be optimized with better database statistics or an additional index

- look at the GC logs - make sure the transaction is not slowed down by long costly garbage collection pauses

Reducing lock-holding times can have compounding effects - as lock-holding times decreases, transactions finish faster and, as a result, lower concurrency levels.

22.4.11.4 Hot SKU Feature

If inventory lock contention is still unacceptably high after you have applied the optimization from above, you can enable a feature that was simultaneously introduced in Yantra Release 5.5-SP1 and in 5.0 SP4 to alleviate Hot SKU contention.

In a nutshell, the Hot SKU feature tracks the time to lock inventory item records. If a lock request for an item (called SKUA) is longer than a specified threshold, the Hot SKU feature increments the number of "abnormal" lock attempts for SKUA. If the number of "abnormal" attempts in a monitoring window is more than another threshold, the Hot SKU feature will consider SKUA a Hot SKU.

Hot SKU detection and enablement occurs at each JVM. For example, a sudden high burst of demand for a single SKU could result in the createOrder adapter to consider that SKU hot. Later, as the downstream agents process those orders, they will independently detect and enable those SKUs as Hot SKUs if they encounter sufficient number of "abnormal" locks.

When an inventory item is upgraded to Hot SKU status, transactions will not lock that inventory item before manipulating its demand or supply information. Instead, the transactions will insert the demand or supply information into two new tables, YFS_INVENTORY_DEMAND_ADDNL or YFS_INVENTORY_SUPPLY_ADDNL respectively. As a result, demand or supply information can be recorded in a non-blocking manner because inserts will not block other transactions from proceeding. Transactions will continue in this mode until the inventory items have been downgraded to the normal status.

Inventory demand queries automatically check both the YFS_ INVENTORY_DEMAND and YFS_INVENTORY_DEMAND_ADDNL tables. Similarly, inventory supply queries checks the YFS_INVENTORY_SUPPLY and YFS_INVENTORY_SUPPLY_ADDNL tables.

The quantities in the inventory additional records are consolidated back to their base inventory tables by the Consolidate Additional Inventory agent.

22.4.11.5 Consolidate Additional Inventory Agent

If you enable the Hot SKU feature, you must run the Consolidate Additional Inventory agent (see *Yantra 7x Platform Configuration Guide*). This agent will consolidate the quantity in the demand and supply additional records back into the base YFS_INVENTORY_DEMAND or YFS_INVENTORY_SUPPLY tables. The additional demand and supply records are deleted after the quantities are consolidated.

Typically, you should configure this agent to run continuously with one thread. You don't need to overly aggressively schedule this agent - if you do, the agent will consolidate a small number of additional records. At the same time, you do not want to run for long periods without this agent - if you do, you could accumulate a large number of inventory additional records which can slow down inventory queries.

If you are using the UDB database server, you need to set the parameter DB2_SKIPINSERTED to ON and mark the YFS_INVENTORY_SUPPLY_ADDNL and YFS_INVENTORY_DEMAND_ADDNL tables as volatile. These settings will reduce lock contention. Please see the following sections for more information.

- Section 16.1.1, "Recommended UDB dbset Registry Variables"
- Section 16.1.3.2.1, "Volatile Tables"

22.4.11.6 Hot SKU Activity Monitoring

The following messages are logged by the Hot SKU feature.

```
Thread-8:2004-06-02 13:50:06,336:INFO   : Turning/retaining Item:
[Acme:SKUA:EACH:A] into a hot sku as abnormal lock count has increased now
to:4: YFSAvailHotSKUItem

Thread-7:2004-06-02 16:14:44,871:INFO   : Turning Item: [Acme:SKUA:EACH:A]
into a cold SKU as total requests in last 2 windows were :2 and 2:
YFSAvailHotSKUItem
```

In the example above, the inventory item, SKUA, for the Acme organization, with UOM EACH and product class A, was upgraded to Hot SKU status because the Hot SKU feature encountered four abnormal lock attempts in a monitoring period. Later, SKUA was downgraded to normal status when there was only 2 lock requests in the last two monitoring windows.

If you see multiple "turning hot" messages for a particular SKU (for example SKUA in the following example), you ran into a situation where multiple threads tried to lock an inventory item, which was at that time not considered a hot SKU, and was blocked. When those threads eventually get the lock, it will print the message indicating that it encountered an "abnormal" lock and has decided to turn that item hot.

```
Thread-8:2004-06-02 13:50:06,336:INFO   : Turning/retaining Item:
[Acme:SKUA:EACH:A] into a hot sku as abnormal lock count has increased now
to:4: YFSAvailHotSKUItem
Thread-10:2004-06-02 13:50:06,417:INFO   : Turning/retaining Item:
[Acme:SKUA:EACH:A] into a hot sku as abnormal lock count has increased now
to:5: YFSAvailHotSKUItem
Thread-7:2004-06-02 13:50:06,423:INFO   : Turning/retaining Item:
[Acme:SKUA:EACH:A] into a hot sku as abnormal lock count has increased now
to:6: YFSAvailHotSKUItem
```

That item was likely successfully converted to a hot SKU if you do not see any more subsequent "turning hot" messages for that item.

On the other hand, if you continue to see "turning hot" messages for the same SKU in the same window, you may have a "Hot" SKU that has low inventory. When a SKU’s inventory level is below a safety level, the Hot SKU feature will continue to lock that inventory item to calculate the items availability (see Section 22.4.11.9, "Limitations" below).

22.4.11.7 Hot SKU Controls

Warning: The Hot SKU component is a very powerful feature that you can deploy if your organization is experiencing true high Hot SKU contention. These parameters may cause performance problems if set incorrectly. Read this document carefully. Verify that you have true Hot SKU contention before enabling this feature or changing any settings. If in doubt, call Yantra Support.

The Hot SKU feature is controlled by the following parameters that are found in the `yfs.properties` file.

Table 22–2 Hot SKU Control

Parameter	Description
yfs.hotsku.useHotSKUFeature	Control used to enable/disable the Hot SKU feature. By default, this parameter is set to "N".
yfs.hotsku.secondsToClassifyAsAbnormalTime	Threshold used to determine when a lock request is "abnormal". If a lock request exceeded this threshold, that lock request is counted as an "abnormal" lock request. Defaults to 0.5 seconds.
yfs.hotsku.windowTimeInMinutes	Interval of one tracking window during which "abnormal" lock requests are tracked. A subsequent window begins once the first window ends. Default interval is 10 minutes.
yfs.hotsku.numberOfAbnormalLocksForSwitchToHotSKU	Threshold used to determine when to promote an inventory item to Hot SKU status. If the number of "abnormal" lock requests for an item exceeds this value within the tracking window, that item is promoted to Hot SKU status. see Section 22.4.11.8, "Three Usage Scenarios" for recommended settings.
yfs.hotsku.numRequestsInTrackingWindowToKeepAsHotSku	Minimum number of requests needed within the tracking window to keep the item in Hot SKU status.

Table 22–2 Hot SKU Control

Parameter	Description
yfs.hotsku.showExtraMessagesAsInfo	Enables extra messages to be displayed at info logging level. Default value is "N".
For Yantra Internal Use Only	
yfs.hotsku.qtyMultiplier	Defaults to 30. Do not modify without Yantra guidance.
yfs.hotsku.highRequestQuantityMultiplier	Defaults to 2. Do not modify without Yantra guidance.
yfs.hotsku.maxItemMapSizeInMemory	Defaults to 1000. Do not modify without Yantra guidance.

22.4.11.8 Three Usage Scenarios

Currently we envisage three scenarios for the Hot SKU feature.

Table 22–3 Hot SKU Usage Scenarios

Scenario	Description	Parameters
Not Enabled	Inventory lock contention is minimal. The Hot SKU feature is not needed.	`yfs.hotsku.useHotSKUFeature=N`

Small Orders	Inventory lock contention is sufficiently high and is caused by a high volume of small orders (around 1-5 order lines per order)	`yfs.hotsku.useHotSKUFeature=Y`
		`yfs.hotsku.numberOfAbnormalLocksForSwitchToHotSKU=3`

Large Orders	Inventory lock contention is sufficiently high and is caused by a high volume of large orders (more than 50 order lines per order)	`yfs.hotsku.useHotSKUFeature=Y`
		`yfs.hotsku.numberOfAbnormalLocksForSwitchToHotSKU=1`

22.4.11.9 Limitations

There are four situations where the Yantra application will continue to lock the YFS_INVENTORY_ITEM records even when the item is considered a Hot SKU.

First, the following APIs will always lock the YFS_INVENTORY_ITEM records during supply adjustment

- updateFutureInventory
- getInventoryMismatch
- adjustInventory

Second, the Yantra application will always lock YFS_INVENTORY_ITEM records for tag-controlled items, if the request is for specific tag criteria.

Third, the Yantra application will lock the YFS_INVENTORY_ITEM records for an item that is currently a Hot SKU in order to calculate availability if the inventory for that item is below a safety level.

Fourth, if the 'Summarize and Maintain Total Supply and Demand Values For Tag Controlled Items' Installation Rule is enabled, the Hot SKU logic is not used, and the values of the TotalOnhandSupply, TotalOtherSupply and TotalDemand fields are updated accordingly. For more information on defining additional inventory rules, refer to the *Yantra 7x Inventory Synchronization Configuration Guide*.

22.4.12 Sort Order and Deadlocks

Deadlocks occur when two or more sessions mutually block each other to the point where neither session can progress. As a result, these sessions will continue to block until the database management system kills one of the deadlocked sessions in order for the others to continue.

Deadlocks occur when two or more sessions obtain resource locks in an arbitrary fashion. For example, the following is a classic example

```
Txn 1                              Txn 2
Locks Record A                     Locks Record B
Tries to Lock Record B (blocked)   Tries to Lock Record A (blocked)
```

In the example above, Txn 1 holds the lock for Record A and Txn 2 holds the lock for Record B. When Txn 1 tries to lock Record B, it becomes blocked. When Txn 2 tries to lock Record A, it also becomes blocked. Now, neither session can progress unless one of the transaction is killed.

If the resource locks were obtained in a consistent order, the deadlock will not occur. For example, all transactions agree to lock the records in ascending order (Record A then Record B).

Replaying the example above, we now have

```
Txn 1                                  Txn 2
Locks Record A                         Tries to Lock Record A (blocked)
Locks Record B
commits
                                       Locks Record A
                                       Locks Record B
                                       commits
```

In the example above, Txn 2 is delayed but not deadlocked. Both transactions eventually complete.

22.4.12.1 Sort Order

When you develop custom code, you should be aware that the Yantra application obtains YFS_INVENTORY_ITEM locks in the following sort order

Item ID, Product Class and UOM

If you adopt this sort order, you should greatly minimize the chance of deadlocks.

22.4.13 Application Servers

The Yantra 7x UI is made up Java Server Pages (JSPs). When users call up a JSP the first time, the application server will automatically translate and compile the JSP file. This process can over 30 seconds, which could lead to the perception of an unresponsive system. Further, this process is performed serially even on a multiprocessor node - if you have multiple users hitting five different pages, WebLogic will compile these pages one at a time. As a result, we strongly recommend precompiling the JSP pages prior to deployment into production.

You should ensure your application server administrator precompiles the JSPs as part of the application deployment.

Please see Section 12.1.1.5, "JSP Pre-Compilation" on precompiling JSPs in BEA WebLogic application servers.

Please see Section 13.1.1.3, "JSP Pre-Compilation" on precompiling JSPs in IBM WebSphere application servers.

22.4.14 MS Internet Explorer

22.4.14.1 Temporary Internet Files

You can reduce the number of hits against the application servers for static content by enabling temporary Internet file cache in Microsoft Internet Explorer. This will improve your UI response times. To enable the cache

- Go to the Internet Options dialog box
- In Microsoft Internet Explorer, go to Tools > Internet Option
    - Click on the Settings button in the Temporary Internet Files panel
    - Enable the “Check for newer version of stored pages” radio button to Automatically
    - Make sure there is sufficient disk space to store temporary Internet files (e.g., 500MB or higher).

22.5 Monitoring

You can monitor the status and progress of Yantra 7x with the following tools or techniques

- System Management Console
- Throughput Queries
- Yantra 7x Statistics
- YFS_INBOX
- Application Logs

22.5.1 System Management Console and Health Monitor Agent

The System Management Console is an application monitor. Some of the areas you can monitor include:

- the processing throughput, response time, the amount of pending work, and the number of errors generated at the API and agent level

- the status of the application servers
- the number of messages in JMS queues

In addition, the System Management Console allows you to

- shutdown, suspend, or resume agent and integration servers.
- clear reference data cache for a single or all cached tables
- enable/disable API, agents, user exits, services, and the application consoles application traces.

The companion Health Monitor agent can be configured to alert system administrators when problems occur such as when an application server crashes or agent servers are not processing tasks.

The System Management Console's functionality, screens and related tasks are documented in detail in the *Yantra 7x System Management Guide*.

22.5.2 Yantra 7x Statistics

The System Management Console gets most of its measurements from data found in the YFS_STATISTICS_DETAIL table. These statistics are described in the *Yantra 7x Platform Configuration Guide*.

Yantra 7x Statistics records, by default, are generated every 10 minutes for each active API and transaction running in each application server or Integration Adapter. For example, if the Schedule transaction was active in 3 Integration Adapters, you will have 3 sets of statistics for each measurement interval.

Time-triggered transactions, at a minimum, generate the following four metrics.

- The `GetJobsProcessed` metric indicates how many times Get Jobs were issued to look for work for this transaction.
- The `ExecuteMessageCreated` metric indicates how many records were selected for processing
- The `ExecuteMessageSuccess` metric indicates how many messages were successfully processed
- The `ExecuteMessageFailure` metric conversely indicates how many messages were not successfully processed

With these four metrics, you could

- track ExecuteMessageSuccess to see how much work the application is processing throughout the day.
- track the ratio of ExecuteMessageSuccess divided by ExecuteMessageCreated to get an idea of the effectiveness. For example, a ratio of 0.8 means that only 80% of the orders are successfully processed. If the effectiveness ratio is consistently low, it could indicate that the application is encountering a large number of work (or orders) that repeatedly fail. This could lead to extra processing overhead.
- calculate the resource cost per unit work processed by correlating the number of worked processed against the CPU consumed. You could track this to see if the cost per unit work is changing. This metric is useful for identifying areas to optimize. It is also the basis for computing resource capacity forecasting or planning.

In addition, some transactions produce transaction specific statistics. For example, some of the metrics the Schedule transaction generates includes NumOrdersBackordered, NumWorkOrdersCreated, and so forth.

22.5.3 Inbox

You should monitor the number of active alerts in the YFS_INBOX table. Yantra 7x alerts come from the following source:

- transactions that are configured to raise alerts
- monitor (such as the order monitor)

Users subscribed to queues with large number of open alerts can experience slow logins. Very large YFS_INBOX tables can impact login times for all users.

You can find out the number of active and non-active alerts by issuing the following query:

```
select active_flag,count(*)
from yfs_inbox
group by active_flag
```

You can find out the distribution of alerts by queue name and inbox type by issuing the following query:

```
select queue_name, inbox_type, active_flag, count(*)
from yfs_inbox inb,yfs_queue q
where inb.queue_key = q.queue_key
group by queue_name, inbox_type, active_flag
```

You can find out the hourly rate of alert creation for July 4, 2004 by issuing the following query:

```
select substr(inbox_key,1,10),count(*)
from yfs_inbox
where inbox_key > '20040704000000' and
      inbox_key < '20040704999999'
group by substr(inbox_key,1,10);
```

22.5.4 Application Logs

You should regularly monitor the Yantra 7x and application server logs for, at a minimum, the following.

- application errors or business exception conditions - for example, invalid input XML to APIs, and so forth.
- system errors - e.g., Java OutOfMemory or NullPointer exceptions

23

Yantra 7x - Distributed Order Management

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the Yantra 7x Distributed Order Management system.

Yantra 7x Distributed Order Management with the default factory (data) settings provides a simple configuration that is suitable for development, training or product familiarization. That configuration is not suitable for production except for customer with very low transaction volumes. This chapter will guide you through the components that you have to configure for higher transaction volumes.

This chapter assumes that you

- are familiar with the basic functionality of Yantra 7x Distributed Order Management
- have read the common Yantra 7x performance concepts in Chapter 22, "Yantra 7x - General"
- have read and followed all the instructions found in the *Yantra 7x Installation Guide*
- have read the *Yantra 7x Release Notes*

23.1 Yantra 7x Distributed Order Management Agents

23.1.1 Schedule Agent for Backorder Efficiency

If you have a large number of backordered orders and the backorders can last a few days, you should consider creating a Schedule agent to process new orders and another Schedule agent to process the backorders.

The benefit of this approach is you can reduce the frequency when you trigger the backorder Schedule agent. For example, instead of once every minute, you could relax the triggers to once a day or immediately after inventory supply updates.

23.1.2 Real-Time Inventory Availability Monitor for ATP Efficiency

The Real-Time Inventory Availability Monitor is used to alert external systems when inventory availability crosses pre-defined thresholds. When items are flagged for real-time availability monitoring, a record is inserted into the YFS_INVENTORY_ACTIVITY table by inventory transactions that update supply or demand information.

This monitor checks inventory availability based on information in the YFS_INVENTORY_ACTIVITY table. The activity records associated with an item are deleted after the inventory check.

If you plan to use the real-time inventory availability monitor, we suggest you start with 5 threads and monitor the number of records in the YFS_INVENTORY_ACTIVITY table. It is highly recommended that you aggressively monitor the YFS_INVENTORY_ACTIVITY table. Additionally, we also recommend that you set this agent to be auto triggered with an interval of 5 minutes.

The following query can be used to monitor build up in the YFS_INVENTORY_ACTIVITY table. This query will tell you the oldest activity record in the table.

```
select sysdate, min(inventory_activity_key) "Min Datetime"
from yfs_inventory_activity

SYSDATE                    Min Datetime
```

```
    12/22/2004 3:57:57 PM       20041222155659187360102
```

In the example above, the query was issued at 15:57:57 and the oldest inventory activity record was created at 15:56:59. Therefore, the monitor is keeping up by about 1 minute.

If the time gap between the current time and the oldest record keeps increasing over time, we recommend starting additional JVMs of this agent.

Note: Although described as 'real-time', availability changes may not be triggered immediately as inventory changes occur if the agent has a backlog of messages to process. Furthermore, this monitor exists as a time-triggered transaction, and thus monitors availability of inventory items only when the monitor is triggered based on the configured runtime properties.

23.1.3 Getters with Enterprise Code

The getters for the following time-triggered (agent) transactions can take enterprise code as an additional parameter:

- order monitor
- shipment monitor
- negotiation monitor
- payment collection.

When the Agent Server processes a default getter task (a getter task that will pick up work for any enterprise), the server will turn around and create a getter message for each enterprise. Each of these getters will by default pick up their own 5,000 orders. Therefore, if you have four defined enterprises, the first getter message will result in the creation of four enterprise-specific getter messages. Those four getter messages could potentially create up to 20,000 task messages. If you have many enterprises, you may want to consider

- lowering the number of orders a getter puts into the message queue or
- explicitly scheduling getters with enterprise codes (instead of using the default getter which gets orders for all enterprises).

23.1.4 Sort Order and Deadlocks

Deadlocks occur when two or more sessions mutually block each other to the point where neither session can progress. As a result, these sessions will continue to block until the database management system kills one of the deadlocked sessions in order for the others to continue.

Deadlocks occur when two or more sessions obtain resource locks in an arbitrary fashion. For example, the following is a classic example

```
Txn 1                               Txn 2
Locks Record A                      Locks Record B
Tries to Lock Record B (blocked)    Tries to Lock Record A (blocked)
```

In the example above, Txn 1 holds the lock for Record A and Txn 2 holds the lock for Record B. When Txn 1 tries to lock Record B, it becomes blocked. When Txn 2 tries to lock Record A, it also becomes blocked. Now, neither session can progress unless one of the transaction is killed.

If the resource locks were obtained in a consistent order, the deadlock will not occur. For example, all transactions agree to lock the records in ascending order (Record A then Record B).

Replaying the example above, we now have

```
Txn 1                               Txn 2
Locks Record A                      Tries to Lock Record A (blocked)
Locks Record B
commits
                                    Locks Record A
                                    Locks Record B
                                    commits
```

In the example above, Txn 2 is delayed but not deadlocked. Both transactions eventually complete.

23.1.4.1 Sort Order

When you develop custom code, you should be aware that the Yantra application obtains YFS_INVENTORY_ITEM locks in the following sort order

Item ID, Product Class and UOM

If you adopt this sort order, you should greatly minimize the chance of deadlocks.

23.1.5 Agent Throughput

In addition to the data provided by the System Management Console and Yantra 7x Statistics, you can also get application processing statistics by data mining the Yantra 7x database. This technique takes advantage of the following application characteristics

- a record is created in yfs_order_header for every new order
- a record is created in yfs_order_line for every order line
- a record is created in yfs_order_release_status each time the order line moves through the various states in its lifecycle
- an audit record is created in yfs_order_audit each time an order or order line is modified
- an audit record is created in yfs_inventory_audit each time an inventory item is modified.
- each record has a primary key whose value is made up of two parts
    - a date/time component in the form of year, month, date, hours, minutes, and seconds. For example, a record that was created on September 21, 2003 at 4:20:14 pm will have 20030921162014 as the first part of the key).
    - a monotonically-increasing sequence number.

23.1.5.1 Order Creation Throughput

For example, in Oracle, to calculate the rate at which orders were created on a specific date (e.g., July 4, 2004), you can issue the following query:

```
select substr(order_header_key,1,10) time, count(*) as count
from yfs_order_header
where order_header_key > ’20040704000000’ and
      order_header_key < ’20040704999999’
group by substr(order_header_key,1,10);
```

This query produces a listing like this:

```
TIME                         COUNT
------------------------ ----------
2004070406                    3333
2004070407                    3366
2004070408                    3333
```

Note: For UDB, you should issue throughput queries as uncommitted reads. By default, queries run at the cursor stability level. As a result, UDB has to obtain a read share lock on the record it is reading. Queries against tables with high insert or update activities will block behind records with update or exclusive locks.

For UDB, to issue the query above at the uncommitted read lock level, issue the query with the "WITH UR" option.

```
select substr(order_header_key,1,10) time, count(*) as count
from yfs_order_header
where order_header_key > ’20040704000000’ and
      order_header_key < ’20040704999999’
group by substr(order_header_key,1,10)
with UR;
```

In SQL Server, issue the following

```
-- number of order headers
select substring(order_header_key,1,12) "Orders", count(*) "Meas. Minute
Rate"
from yfs_order_header
where order_header_key like '20040704%'
group by substring(order_header_key,1,12);

-- number of order lines created
select substring(order_line_key,1,12) "Order Lines", count(*) "Meas. Minute
Rate"
from yfs_order_line
where order_line_key like '20040704%'
group by substring(order_line_key,1,12);
```

23.1.5.2 Order LifeCycle Throughput

Similarly, you can calculate the throughput of orders going through its various lifecycle states with the following example:

```
select pipeline_key, status, substr(order_release_status_key,1,10) time,
       count(*) count
from yantra.yfs_order_release_status
```

```
where order_release_status_key > '20040704000000' and
      order_release_status_key < '20040704999999'
group by pipeline_key,
       status,
       substr(order_release_status_key,1,10);

PIPELINE_KEY             STATUS          TIME                          COUNT
------------------------ --------------- ------------------------ ----------
2004070409425525425230   1100            2003102906                    13333
2004070409425525425230   1100            2003102907                    13464
2004070409425525425230   1100            2003102908                    13333
2004070409425525425230   1300            2003102906                       50
2004070409425525425230   1300            2003102907                       23
2004070409425525425230   1300            2003102908                       50
2004070409425525425230   3200            2003102906                    13234
2004070409425525425230   3200            2003102907                    13477
2004070409425525425230   3200            2003102908                    13290
```

The definition of the STATUS is found in YFS_STATUS and PIPELINE_KEY in YFS_PIPELINE. For example, status of 1100 indicates order lines being created. In the example above, there were 13,333 order lines created for one pipeline and another 4,333 order lines created in another pipeline.

Best Practice: You should baseline the throughput of individual agents and key APIs to get an idea of the potential throughput. You should then monitor the agents in production against the baseline. This continual monitoring may reveal issues - e.g., a credit authorization agency providing slower response times, issues with the database, and so forth.

Best Practice: You can monitor the flow of the orders on an hourly basis by pivoting the data so that STATUS is in the column and TIME is in the row. For example, the data above can be displayed as follows.

```
Time              1100       1300       3200
2004070406       13333         50      13234
2004070407       13464         23      13447
2004070408       13333         50      13290
```

In the pivot example above, 13,333 order lines were created on 2003/07/04 at 06am. At that same time period, 50 order lines went to Backorder and 13,234 were Released. More importantly, one may conclude that the flow of the orders through the pipeline is good because order releases are keeping pace with order creation.

There are many ways to create pivot tables including Microsoft Excel (use Data > PivotTable and PivotChart Report...).

23.1.5.3 Order Kit Line Creation Throughput

To calculate Kit Line creation, issue the following example:

```
select substr(order_kit_line_key,1,10) time,
       count(*) count
from yfs_order_kit_line
where order_kit_line_key > '20040704000000' and
      order_kit_line_key < '20040704999999'
group by substr(order_kit_line_key,1,10);
```

This query produces a listing like this:

```
TIME                          COUNT
------------------------ ----------
2004070406                     3333
2004070407                     3366
2004070408                     3333
```

23.1.5.4 Throughput Query Limitations

As we discussed above, the throughput queries provides processing rates by counting the number of records created. If you run the throughput query against the YFS_ORDER_RELEASE_STATUS table, you will get rates at which order lines move through the pipeline statuses.

23.1.5.4.1 Reprocessing The throughput queries do not report "unsuccessful" work and as a result can appear skewed if you have a lot of order reprocessing. You can, however, augment these throughput queries with data from Yantra Statistics (see Section 22.5.2, "Yantra 7x Statistics").

For example, assume there are 10,000 orders available for scheduling. When the Schedule agent processes the 10,000 orders, it finds that 9,000 orders cannot be scheduled because they are either awaiting authorization or items are backordered. The throughput query will report that the Schedule agent successfully scheduled 1,000 orders but will not indicate that it tried to but was unable to schedule the other 9,000 orders. In these extreme cases, the Schedule agents will appear to consume a lot of computing resources for the amount of work (as reported by the throughput query) performed.

In addition to tracking the order flow, you should also track the number of exceptions using the exception query below (see Section 22.5.3, "Inbox").

23.1.5.4.2 Maximum Potential Throughput The throughput query reports actual work done within each measurement or reporting period. The rates can be less than the maximum throughput when there are idle agent threads during the reporting period - for example, when there is not enough work for the agents to process.

To calculate your agent configuration’s maximum throughput, you need to create a queue of work so that all agent threads are busy the entire reporting period and the amount of reprocessing is normal or representative of your peak day.

24

Yantra 7x Warehouse Management System

This chapter provides recommendations on how to plan, implement, configure, monitor, and tune the Yantra 7x Warehouse Management System. Yantra 7x WMS's default factory (data) settings provide a simple configuration that is suitable for development, training or product familiarization. That configuration is not suitable for production except for customer with very low transaction volumes. This chapter will guide you through the components that you have to configure for higher transaction volumes.

This chapter assumes that you

- are familiar with the basic functionality of Yantra 7x WMS
- have read the common Yantra 7x performance concepts in Chapter 22, "Yantra 7x - General"
- have read and followed all the instructions found in the *Yantra 7x Installation Guide*
- have read the *Yantra 7x Release Notes*

24.1 Property Files

The following parameters are used to influence the Yantra 7x WMS processing.

Table 24–1 yfs.properties

Parameters	Value
yfs.solver.iterations.wavecreate	1

Table 24–1 yfs.properties

Parameters	**Value**
yfs.containerization.maxshipmentsinoneround	75

The Create Wave transaction uses an efficient constraint-based optimization engine to assign shipments to waves. This engine will iteratively assign shipments to waves and recalculate cost. Suboptimal wave assignments are discarded and another solution set attempted. You can limit the number of iterations by specifying the following in the yfs.properties

- yfs.solver.iterations.wavecreate=< number of iterations >

We recommend testing the Create Wave transaction for your warehouse at the default iteration level (1) and at a higher level (e.g., iteration of 5) to see if there is an appreciable difference in processing times and shipment wave assignment. In some cases, setting `yfs.solver.iterations.wavecreate` to a lower number results in marginal differences in the wave assignment but a significant reduction in processing times.

One way to test the efficacy of the `yfs.solver.iterations.wavecreate` setting is to run controlled tests in your QA environment. For example, an approach is to

- create a reasonable number of shipments that are ready for the Create Wave processing
- take a backup so that you can repeat the test
- run the Create Wave with increasing values and assess the resulting waves
- restore the database and repeat above

The `yfs.containerization.maxshipmentsinoneround` parameter sets the number of shipments considered for containerization per iteration. The default is 75. With that setting, 75 shipments at a time are containerized and committed. This process reduces the number of record locks held.

24.2 WMS Agents

This section describes the run-time or performance characteristics of the Yantra 7x WMS agents or transactions.

24.2.1 Scheduling Using Agent Criteria Group

Yantra 7x WMS customers with a large number of small warehouses that require wave planning may want to use the "agent criteria group" wave scheduling feature. By default, the wave processing agents (e.g., Create Wave, Release Wave) are triggered individually for each node.

You could use utilities such as CRON on Unix to automatically trigger each of the nodes at some interval. However, if you have a 100 nodes and you would like to issue the triggers every hour, you would need to set up CRON for the 100 nodes for each agent.

An alternative is to use agent criteria groups. This can be accomplished in the following steps

- first define an agent criteria group in the Platform > System Administration > Agent Criteria Groups.
- Next, assign one or more nodes to the appropriate agent criteria group in the Platform > Participant Modeling. For each node, go to the Organization Details > Roles & Participation dialog box. Select the appropriate agent criteria group.
- Next, in the Platform > Process Modeling > Wave > Outbound Picking process model, select Transaction on the left screen. Select the appropriate transaction (e.g., Create Wave, Release Wave, and so forth).
- Create a new Agent Criteria Definition. In that Agent Criteria Details > Criteria Parameter, assign the agent criteria group to the appropriate parameter.

When you start the agent and trigger for this agent criteria, you will start the transaction for the agent criteria group. This will in turn start the transaction for each of the nodes assigned to that agent criteria group.

For example, you may define a node group by time zones or regional groups.

You may want to continue scheduling the wave agents for large warehouse nodes (those with high shipment volumes) individually.

Putting large nodes in node groups causes nodes could result in nodes waiting for the large nodes to complete their processing.

Please see the *Yantra 7x Platform Configuration Guide* for more information.

24.2.2 Processing Concurrency

For scalability, the Yantra 7x agents are designed to run in multiple parallel threads. Some of the Yantra 7x Warehouse Management System agents, by design, run single threaded for a given warehouse node. These agents include the

- Create Wave
- Release Wave

24.2.2.1 Create Wave

The Create Wave agent assigns eligible shipments and shipment lines for a warehouse node into optimum waves. By design, only one Create Wave transaction can concurrently run for a warehouse node.

You can, however, run multiple Create Wave transactions concurrently if you have multiple warehouse nodes - provided, as stated above, only one Create Wave transaction is running per warehouse node. This restriction is enforced by the application.

You can specify the number of threads in the Configurator (see Section 22.3, "Integration Adapters/Yantra 7x Agents").

24.2.2.2 Release Wave

The Release Wave transaction creates pick tasks from shipment lines in a wave. As part of the processing, this transaction serializes access to inventory item records for that node by locking YFS_TRANSACTION_LOCK records to prevent concurrent updates to inventory items during Release Wave processing. There is a YFS_TRANSACTION_LOCK record for each inventory item/node combination.

As a result, you should only run one Release Wave thread per warehouse node.

24.2.2.2.1 Allocate Task Agent You may want to use the Allocate Task agent if you process large waves (for example, over 500 line waves). The Release Wave acquires locks on the YFS_LOCATION_INVENTORY record before managing the inventory at those locations. For large waves, the locks held by the Release Wave agent could impact other transactions, such as picks, moves, etc, that also need YFS_LOCATION_INVENTORY record locks.

You can direct the Release Wave agent to defer inventory location updates. This will allow the Release Wave agent to complete its processing without acquiring these locks. A subsequent agent, the Allocate Task, will acquire the YFS_LOCATION_INVENTORY record locks and update the inventory at the location on a task basis. The amount of time that the record lock is held is much shorter (essentially for the duration of processing that task).

For more information about AllocateTask agent, refer to the *Yantra 7x Warehouse Management System Configuration Guide*.

24.2.2.3 Agents Between Create Wave to Release Wave

In general, all the agents from Create Wave through to Release Wave inclusive, including all custom agents, should be run in a single threaded fashion for each agent criteria group (see Section 24.2.1, "Scheduling Using Agent Criteria Group")or for each node if you want to ensure the waves are released in the order that they are created.

For example, assume you have 10 nodes - N01 to N10. Assume also that

- nodes N01 to N03 are assigned to agent criteria group 1
- nodes N04 to N08 are assigned to agent criteria group 2
- N09 and N10 are scheduled individually.

Then for a given agent (say 'Assign Lane') you should run 4 JVMs (one for each agent criteria group and one each for nodes N09 and N10). Each of these JVMs have to be configured to run with only one thread per transaction. These agents and transactions can run in parallel.

As we mentioned above, this is only necessary if you need your waves to be released in the order in which the waves were created. If the ordering is unnecessary, you can run these transactions in parallel.

24.2.3 Purge

We strongly recommend running the WMS Task Purge agent on a daily basis. This agent is used to keep the YFS_TASK table small by moving completed YFS_TASK records to the YFS_TASK_H history table. YFS_TASK table that grows unchecked could affect the performance of WMS task-based transactions, such as next task suggestion.

24.3 Database

24.3.1 Long Running Transactions in UDB

The WMS application is made of both short and long running transactions. Short transactions are characterized by a small number of database records read and possibly updated within a short processing time under a single unit of work. At the end of the processing (or unit of work), the workload commits the transaction. Database locks are released.

In contrast, some workloads, by their nature, are long running transactions. For example, the Create Wave transaction groups eligible shipments and shipment lines into optimum waves based on customer-specified wave constraints. The length of the processing time depends on many factors such as the number of shipments, the complexity of the optimization, the wave constraints, and so forth.

You should consider the following when configuring a UDB database

- monitor the amount of transaction log usage - specifically monitor `TOTAL_LOG_USED`, `TOTAL_LOG_USED_TOP`, `SEC_LOG_USED_TOP`, and `SEC_LOGS_ALLOCATED` monitor elements. You should ensure that the amount of log used does not approach the capacity of the primary logs and that UDB is not spilling over to secondary logs.
- monitor the `APPL_ID_OLDEST_XACT` monitor element - see which transaction holds the oldest transaction log entry.
- enable `NUM_LOG_SPAN` parameter to safeguard against a long running transaction holding too many logs that could result in a situation where all the transaction logs are full. Please see `NUM_LOG_SPAN` discussion in Section 16.1.3, "Recommended DB CFG Parameters"

24.4 JVM Settings

24.4.1 Java Stack Size

You have to increase the Java stack size if you plan to create waves or batch waves with more than 4,000 shipment lines that are assigned to a single shipment group. You can use the following table as a guideline.

Table 24–2 Stack Size Recommendations for Create Wave/Batch Wave

Shipment Lines per Shipment Group	Stack Size
4,000	2MB
10,000	4MB
15,000	6MB
20,000	8MB
25,000	10MB

Please see Section 8.3.2.1, "Stack Size" for instructions on how to set the Java thread stack size.

24.5 User Interfaces

24.5.1 Yantra 7x UI Console

24.5.1.1 Asynchronous Manifest Closure

Yantra 7x WMS allows you to close manifests from the Yantra UI synchronously or asynchronously. By default, in the synchronous mode, the user has to wait for the request to complete. Depending on the number of shipments in a manifest, the manifest close operation can take a long time and may result in users believing the UI is "locked up".

Yantra 7x WMS allows you to configure the system so that manifests are closed asynchronously. In this mode, the request from the UI creates a message for the CLOSE_MANIFEST agent. The screen is released to the user after the message is created. To change to the asynchronous manifest close mode, set the following property in the `yfs.properties` file.

```
yfs.closemanifest.online=N
```

If this property is set, the user will need to configure the CLOSE_MANIFEST agent for processing manifest closures requests. The users will also have to check for alerts/errors in the Alert Console. The manifest status "Closure Failed" indicates occurrence of errors while closing a manifest.

24.5.2 Asynchronous Batch Confirmation

Yantra 7x WMS allows you to confirm batch sheets from the Yantra UI synchronously or asynchronously. By default, in the synchronous mode, you have to wait for the request to complete. Depending on the number of tasks in the batch, the batch confirmation operation can take a long time and may result in users believing the UI is "locked up".

Yantra 7x WMS allows you to configure the system so that batch are confirmed asynchronously. In this mode, the request from the UI creates a message for the REQ_BATCH_COMPLETION agent. The screen is released to the user after the message is created. To change to the asynchronous confirm batch mode, set the following property in the `yfs.properties` file.

```
yfs.confirmbatch.online=N
```

If this property is set, the user will need to configure the REQ_BATCH_COMPLETION agent for processing the batch confirmation requests. The users will also have to check for alerts/errors in the Alert Console. The batch status "Completion Failed" indicates occurrence of errors while confirming a batch.

24.5.3 Mobile Devices

The Yantra 7x WMS application supports two mobile device displays - a VT100 character based display and a Microsoft PocketPC Graphical UI display. The PocketPC display interacts with the Yantra 7x WMS with HTML. The VT100 display sends VT100 characters.

You may want to consider using the VT100 RF display if you have limited network bandwidth.

25
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