



ORACLE PRESS™ — EXCLUSIVELY FROM MCGRAW-HILL/OSBORNE

ORACLE DATABASE 10g Linux Administration

Deploy and Optimize Oracle Database 10g in a Linux Environment



ORIGINAL • AUTHENTIC

Oracle Press™

ONLY FROM OSBORNE

EDWARD WHALEN

Founder and Chief Technologist of
Performance Tuning Corporation

OSBORN HILL COMPANIES
FOR DONATION ONLY
NOT FOR RESALE
12ASA07
FOR DONATION ONLY
NOT FOR RESALE

JOIN THE **ORACLE PRESS** COMMUNITY TODAY!

Get these member benefits:

- Get "sneak peeks" at Oracle Press titles - not yet published
- Receive special promotional offers
- Read "New Book Alerts" to learn about the latest Oracle Press releases
- Hear from the editor as to what's coming and why

GIF

Q

A FOUNDATION

AND MUCH MORE!

Y CHÂU Á
BÁN LẠ

JOIN TODAY AT WWW.ORACLEPRESSBOOKS.COM



ORIGINAL • AUTHENTIC

Oracle Press

ONLY FROM OSBORNE

ORACLE®

Oracle Press™

Oracle Database 10g Linux Administration

Edward Whalen



**GIFT OF THE ASIA FOUNDATION
NOT FOR RE-SALE**

**QUÀ TẶNG CỦA QUỸ CHÂU Á
KHÔNG ĐƯỢC BÁN LẠI**

McGraw-Hill/Osborne

New York Chicago San Francisco

Lisbon London Madrid Mexico City Milan

New Delhi San Juan Seoul Singapore Sydney Toronto

McGraw-Hill/Osborne
2100 Powell Street, 10th Floor
Emeryville, California 94608
U.S.A.

To arrange bulk purchase discounts for sales promotions, premiums, or fund-raisers, please contact **McGraw-Hill/Osborne** at the above address.

Oracle Database 10g Linux Administration

Copyright © 2005 by The McGraw-Hill Companies, Inc. (Publisher). All rights reserved. Printed in the United States of America. Except as permitted under the Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of Publisher.

Oracle is a registered trademark of Oracle Corporation and/or its affiliates. Screen displays of copyrighted Oracle software programs have been reproduced herein with the permission of Oracle Corporation and/or its affiliates.

1234567890 FGR FGR 0198765

ISBN 0-07-223053-3

Acquisitions Editor
Lisa McClain

Project Editor
Carolyn Welch

Contributing Authors
Robert Bryan Thomas
Fraser Talbot
Dan Hotka

Technical Editors
Michael New
James Petts
Greg Marsden
Joel Becker

Copy Editor
Bob Campbell

Proofreader
Susie Elkind

Indexer
Claire Splan

Composition
Apollo Publishing Services

Cover Series Design
Damore Johann Design, Inc.

Series Design
Jani Beckwith, Peter F. Hancik

This book was composed with Corel VENTURA™ Publisher.

Information has been obtained by Publisher from sources believed to be reliable. However, because of the possibility of human or mechanical error by our sources, Publisher, or others, Publisher does not guarantee to the accuracy, adequacy, or completeness of any information included in this work and is not responsible for any errors or omissions or the results obtained from the use of such information.

Oracle Corporation does not make any representations or warranties as to the accuracy, adequacy, or completeness of any information contained in this Work, and is not responsible for any errors or omissions.

About the Author

Edward Whalen is the founder of Performance Tuning Corporation (www.perftuning.com), a consulting company specializing in database performance, administration, and backup/recovery solutions. Prior to starting Performance Tuning Corp., Mr. Whalen worked at Compaq Computer Corporation as an OS developer, and then as a database performance engineer. He has extensive experience in database system design and tuning for optimal performance. His career has consisted of hardware, OS, and database development projects for many different companies. Mr. Whalen has written three other books on the Oracle RDBMS and four books on MS SQL Server. He has also worked on numerous benchmarks and performance tuning projects with both Oracle and MS SQL Server. Mr. Whalen is recognized as a leader in database performance tuning and optimization. In addition to his experience in Oracle on many different OS platforms, such as Solaris, AIX, HP-UX, and Windows, he has recently spent significant time working with Oracle on Linux, including the deployment of some of the first RAC clusters on Linux. He works closely with both Red Hat and Novell/SUSE with many different flavors of Linux.

About the Contributing Authors

Robert Bryan Thomas is a Senior Performance Consultant at Performance Tuning Corporation. He has a diverse background in database performance, Oracle RAC, data warehousing, and SAN storage. He currently specializes in Oracle10g RAC on multiple OS platforms. Robert Thomas graduated from Texas A&M University with a degree in Computer Science.

Fraser Talbot is a Senior Performance Consultant at Performance Tuning Corporation. His background includes several years of database administration, exclusively Oracle and Oracle E-Business Suite. He and his wife, Virginia, and three daughters, Margaret, Susan, and Elizabeth, reside in Houston, Texas.

Dan Hotka is a Training Specialist, who has over 27 years of experience in the computer industry and over 22 years of experience with Oracle products. He is an internationally recognized Oracle expert with Oracle experience dating back to the Oracle V4.0 days. He is also the author of *Oracle9i Development by Example* and *Oracle8i from Scratch* by Que and has co-authored six other popular books. He is frequently published in Oracle trade journals, and speaks regularly at Oracle conferences and user groups around the world. Visit his website at www.DanHotka.com. Dan can also be reached at dhotka@earthlink.net.



Contents

ACKNOWLEDGMENTS	xv
INTRODUCTION	xvii

PART I

Oracle on Linux Overview

1 Linux Architecture	3
Operating System Overview	5
The Monolithic Kernel	5
The Microkernel	6
The Hybrid Kernel	7
Linux Overview	8
The Linux Directory Structure	8
Linux Utilities and Directories	9
The Development Environment	13
The Linux User Interface	17
X Windows	17
GUI Environments	18
Linux Web Server Utilities	19
The Apache Web Server	19
CGI Programming in Linux	19
The Linux Boot Process	20
Linux Source Code	20
Rebuilding the Linux Kernel	21
Processes and Threads	23
What Is a Process?	23
Oracle's Use of Processes	23
What Is a Thread?	23
Devices	24
Character Devices	24

Block Devices	24
Logical Volume Managers	25
Automatic Storage Management	25
Filesystems	26
ext3	26
OCFS	26
Raw Devices	27
Summary	29
2 Oracle Architecture	30
The Oracle Database Server	31
The Oracle Database	31
Physical Data Structures	35
Logical Data Structures	54
The Oracle Instance	54
The Instance Defined	54
Components of the Instance	58
User Processes	59
Server Processes	59
PGA Memory	59
MTS vs. Dedicated Server Processes	60
Oracle 10g New Features	60
Performance and Scalability Features	61
Clustering	61
Availability	61
Manageability	62
Business Intelligence	62
Application Development	63
Linux 64-Bit Support	63
Grid Computing	63
Summary	63
3 Transaction Management and the Oracle Schema Objects	65
Oracle Functionality	66
Reading from the Database	66
Concurrency	67
Writing to the Database	67
Locking	67
Read Consistency	68
Data Integrity	68
The Redo Log	69
Undo	76
Introduction to Transaction Management	79
Transactions	79

Introduction to the Oracle Schema Objects	83
Tables	84
Indexes	85
Views	86
Sequences	87
Clusters	87
Synonyms	87
Summary	87

PART II

Deploying Oracle 10g on Linux

4 Sizing Oracle 10g on Linux Systems	91
An Introduction to Sizing	92
Sizing for Peak Utilization and Steady-State Utilization	92
Service-Level Agreements	93
System Resources, Capacity, and Queuing	95
CPU Performance and Queuing	96
I/O Performance and Queuing	97
Network Performance	98
Memory	98
Metrics	99
Oracle Sizing	101
Limitation Parameters	101
Resource Parameters	102
Hardware Sizing	104
CPU Sizing	104
Memory Sizing	104
I/O Subsystem Sizing	105
RAID Disk Subsystems	114
Hardware vs. Software RAID	114
Striping	115
Parity Overview	120
Capacity Planning	123
Summary	124
5 Configuring the Linux System for Oracle	125
Preinstallation Procedures for Linux	126
Minimum Requirements	126
Configuring the Filesystems	127
Choosing Linux Components	128
Post-Installation Procedures for Linux	131
Configuring Kernel Parameters	131

Adding Users and Groups	133
Configuring Shell Limits for the Oracle User	134
Creating Directory Structures	135
Setting Up the Oracle Environment	136
Installation Checklists	137
Installation Checklist for Oracle 10g R1	138
Installation Checklist for Oracle 10g R2	140
Summary	141
6 Installing Oracle 10g on Linux	142
Preinstallation Steps	142
Kernel Configuration Parameters	142
Storage Requirements	146
Device Names Might Change	149
Configuring the ASM Library Driver	150
Setting Up ASM Drives	154
The Installation Process	154
Staging the Install	155
Running the Installer	158
Postinstallation Steps	158
Downloading and Installing Patches	159
Configuration Steps	162
Testing and Validating	162
Additional Miscellaneous Configuration Steps	162
Summary	162

PART III

Oracle RAC on Linux

7 Oracle Real Application Cluster Concepts	165
What Is Clustering?	167
Cluster Terminology	167
Cluster Definition	169
RAC (Real Application Clusters)	171
Overview of RAC	171
Oracle RAC 10g Components	174
RAC Database Components	178
Oracle 10g RAC's Use of Shared Storage	181
Using NAS as Shared Storage	183
Summary	184
8 Deploying Oracle Real Application Clusters on Linux	185
Planning the RAC System	186
The RAC Components	186
Sizing the RAC System	189

Configuring Linux	190
Verifying Hardware	191
Verifying Network Requirements	192
Setting Up the Linux Kernel	193
Setting Up the Linux System	196
Configuring Linux Modules/Programs	198
Oracle Directories	198
Setting Environment Variables	200
Networking	200
Configuring RAC	203
Configuring the Cluster Ready Services (CRS)	204
Configuring the Interconnect	205
Configuring the Shared Disk	206
Testing and Managing the RAC	208
Oracle 10g RAC Help	213
Summary	213
9 Administering Oracle and RAC on Linux	215
Configuring the Linux Kernel	216
Configuring Shared Memory	216
Configuring Semaphores and Other Kernel Parameters	216
Monitoring and Changing Linux Configuration Parameters	217
Configuring the Network	218
Monitoring Linux	218
sar	219
vmstat	220
top	220
iostat	221
Upgrading the Linux Operating System	222
Starting Up the Instance	222
Database Startup	223
Database Mounted	224
Database Opened	224
Starting Up from the Enterprise Manager Database Control	225
Oracle Database 10g and CSSD	227
User Authentication	227
Database Authentication	227
Operating System Authentication	227
Network Authentication	227
Remote Authentication	228
Mid-Tier Authentication	228
Authentication by SSL	228
User Authorization	229
User Profiles	229
Privileges	231

Adding a User Account	233
Summary	234
10 Tuning Oracle and RAC on Linux	235
Performance Tuning Methodology	237
Step 1: Initial Assessment	237
Step 2: Monitor the System	238
Step 3: Analyze Results	239
Step 4: Create a Hypothesis	239
Step 5: Propose a Solution	240
Step 6: Implementation of Solution	241
Step 7: Test and Monitor	241
Further Analysis and Testing	242
Tuning Oracle on Linux	243
Application Tuning	243
Instance Tuning Basics	246
Monitoring the Oracle Instance	253
Tuning for Wait Events	253
Hardware Tuning	254
Monitoring the Linux System	255
Monitoring Linux with ps	257
Monitoring Linux Using vmstat	257
Monitoring Linux Using iostat	258
Monitoring Linux Using sar	259
Monitoring Linux Using Top	260
Using Large Memory Models	260
Configuring Linux for > 1.7GB (and <= 2.7GB) of SGA	261
Configuring Oracle for > 2.7GB SGA	262
Using Load Testing for Performance Validation	263
Why Is the System Being Tested?	264
Load-Testing Batch Jobs	265
Load-Testing Loading	265
Load-Testing OLTP Applications	267
Performance Metrics	267
Load Testing Tips	268
Summary	269

PART IV

Administering and Tuning Oracle Database 10g on Linux

11 Backup and Recovery	273
Backup Overview	274
Backup and Recovery Concepts	275
Instance Recovery	275
Data Recovery or Media Recovery	276

Online and Archived Redo Log File Recovery	276
How Transactions Work	278
RDBMS Functionality	279
Introduction to Backup	283
Archivelog Backup	283
Controlfile Backup	285
Full Backup	285
Tablespace and Datafile Backups	286
Incremental Backups	287
How to Back Up the Database	288
Recovery Manager (RMAN)	289
Automatic Disk-Based Backup and Recovery (Flash Recovery Area)	294
OS Facilities: Online Backup	295
Export and Data Pump	297
Commercially Available Backup Utilities	300
Backup Strategies	300
When and What to Back Up	301
Examples of Backup Strategies	303
Summary	304
12 Restore	305
Recovering the Database	306
Recovery vs. Restoration	306
How to Recover Your Database	307
Instance Recovery	307
Media Recovery	308
Log File Recovery	309
Point-in-Time Recovery	310
Using the Flashback Features of Oracle 10g	311
Developing a Recovery Strategy	318
Planning for Instance Recovery	318
Planning for Media Recovery	319
Planning for Operator Error Recovery	320
Summary	320
13 Oracle Data Guard on Linux	323
Data Guard Concepts	324
Data Guard Services	326
Physical Standby Database	329
Logical Standby Database	330
Configuring and Managing Oracle Data Guard	332
Physical Standby Database Configuration	332
Logical Standby Database Configuration	338
Summary	340

14 Oracle Advanced Replication on Linux	341
Introduction to Oracle Replication	343
Multimaster Replication	345
Materialized View Replication	345
Hybrid Replication	345
Oracle Replication on Linux	346
I/O Capacity	346
Database Layout	346
Sufficient Network Capacity	349
Summary	351
15 Configuring the Hardware for Linux and Oracle	351
Hardware Tuning Fundamentals	352
Choosing the Right Hardware	352
Tuning Hardware for Linux	359
Network Tuning on Linux	365
Choosing the Right Network	366
Tuning Linux for Network Performance	366
Summary	367
16 Tuning SQL	369
Examining the Execution Plan	370
Plan Table Review	370
Viewing the Execution Plan	374
Understanding the Explain Plan	377
Understanding the Optimizer Decision Process	380
A Working Example	382
Controlling the Optimizer Decisions	385
SQL Tuning Tips	388
Summary	401
17 Indexes and Partitioning	403
Introduction to Oracle 10g Indexing Options	404
Oracle 10g Index Options	406
The Index Clustering Factor	415
Oracle 10g Partitioning	417
Index Partitioning Options	421
IOT Partitioning Options	423
Using Partitioned Indexes for Performance	423
Summary	424

PART V

Oracle Products on Linux

18 Oracle Application Server 10g on Linux	427
What Components Make Up Oracle Application Server 10g?	428
Java 2 Enterprise Edition	429

Management and Security	429
Portals	430
Wireless	430
Business Intelligence	430
E-Business Integration	430
Using Oracle Application Server 10g	431
Installing and Configuring Oracle Application Server 10g on Linux	438
Installation	438
Configuration	438
Summary	442
19 The Oracle E-Business Suite on Linux	443
Overview of the Oracle E-Business Suite on Linux	444
What Is the Oracle E-Business Suite?	445
E-Business Suite Architecture	445
What Modules Are Available on Linux	448
Using the Oracle E-Business Suite on Linux	448
The E-Business Suite in a RAC Environment	448
Installing and Configuring the E-Business Suite on Linux	449
Installation	449
Migrating to the E-Business Suite on Linux	451
Migrating the Application Tier	452
Migrating the Database Tier	453
Converting the Database Tier to RAC	454
Testing	455
Summary	455
Index	457