

Contents at a Glance

PART I

Database Architecture

1	Getting Started with the Oracle Architecture	3
2	Upgrading to Oracle Database 11g	49
3	Planning and Managing Tablespaces	61
4	Physical Database Layouts and Storage Management	75

PART II

Database Management

5	Developing and Implementing Applications	123
6	Monitoring Space Usage	163
7	Managing Transactions with Undo Tablespaces	207
8	Database Tuning	241
9	Database Security and Auditing	277

PART III

High Availability

10	Real Application Clusters	349
11	Backup and Recovery Options	391
12	Using Recovery Manager (RMAN)	417
13	Oracle Data Guard	475
14	Miscellaneous High Availability Features	495

PART IV
Networked Oracle

15	Oracle Net	511
16	Managing Large Databases	543
17	Managing Distributed Databases	599
	Appendix: Installation and Configuration	635
	Index	653

Contents

Acknowledgments	xix
Introduction	xxi

PART I

Database Architecture

1	Getting Started with the Oracle Architecture	3
	An Overview of Databases and Instances	4
	Databases	4
	Instances	5
	Oracle Logical Storage Structures	6
	Tablespaces	6
	Blocks	7
	Extents	7
	Segments	7
	Oracle Logical Database Structures	8
	Tables	8
	Constraints	15
	Indexes	17
	Views	19
	Users and Schemas	21
	Profiles	21
	Sequences	22
	Synonyms	22
	PL/SQL	22
	External File Access	23
	Database Links and Remote Databases	24
	Oracle Physical Storage Structures	24
	Datafiles	25
	Redo Log Files	26
	Control Files	26
	Archived Log Files	27
	Initialization Parameter Files	27

Alert and Trace Log Files	28
Backup Files	28
Oracle Managed Files	29
Password Files	29
Multiplexing Database Files	29
Automatic Storage Management	29
Manual Multiplexing	30
Oracle Memory Structures	32
System Global Area	32
Program Global Area	35
Software Code Area	35
Background Processes	35
Backup/Recovery Overview	38
Export/Import	38
Offline Backups	38
Online Backups	39
RMAN	39
Security Capabilities	39
Privileges and Roles	39
Auditing	40
Fine-grained Auditing	40
Virtual Private Database	41
Label Security	41
Real Application Clusters	41
Oracle Streams	42
Oracle Enterprise Manager	42
Oracle Initialization Parameters	43
Basic Initialization Parameters	43
Advanced Initialization Parameters	47
2 Upgrading to Oracle Database 11g	49
Choosing an Upgrade Method	51
Before Upgrading	52
Using the Database Upgrade Assistant	53
Performing a Manual Direct Upgrade	54
Using Export and Import	57
Export and Import Versions to Use	57
Performing the Upgrade	57
Using the Data-Copying Method	58
After Upgrading	59
3 Planning and Managing Tablespaces	61
Tablespace Architecture	62
Tablespace Types	62
Optimal Flexible Architecture	68
Oracle Installation Tablespaces	72
SYSTEM	72
SYSAUX	72

TEMP	72
UNDOTBS1	73
USERS	73
EXAMPLE	73
Segment Segregation	73
4 Physical Database Layouts and Storage Management	75
Traditional Disk Space Storage	76
Resizing Tablespaces and Datafiles	76
Moving Datafiles	92
Moving Online Redo Log Files	94
Moving Control Files	96
Automatic Storage Management	98
ASM Architecture	98
Creating an ASM Instance	99
ASM Instance Components	101
ASM Dynamic Performance Views	103
ASM Filename Formats	103
ASM File Types and Templates	105
Administering ASM Disk Groups	107

PART II

Database Management

5 Developing and Implementing Applications	123
Tuning by Design: Best Practices	124
Do As Little As Possible	124
Do It As Simply As Possible	127
Tell the Database What It Needs to Know	129
Maximize the Throughput in the Environment	129
Divide and Conquer Your Data	130
Test Correctly	131
Standard Deliverables	133
Resource Management and Stored Outlines	136
Implementing the Database Resource Manager	136
Implementing Stored Outlines	140
Sizing Database Objects	143
Using Temporary Tables	149
Supporting Tables Based on Abstract Datatypes	150
Using Object Views	151
Security for Abstract Datatypes	154
Indexing Abstract Datatype Attributes	156
Quiescing and Suspending the Database	157
Supporting Iterative Development	158
Iterative Column Definitions	159
Forcing Cursor Sharing	159
Managing Package Development	160
Generating Diagrams	160

Space Requirements	160
Tuning Goals	161
Security Requirements	161
Data Requirements	161
Version Requirements	161
Execution Plans	161
Acceptance Test Procedures	162
The Testing Environment	162
6 Monitoring Space Usage	163
Common Space Management Problems	164
Running Out of Free Space in a Tablespace	165
Insufficient Space for Temporary Segments	165
Too Much or Too Little Undo Space Allocated	165
Fragmented Tablespaces and Segments	166
Oracle Segments, Extents, and Blocks	166
Data Blocks	167
Extents	169
Segments	170
Data Dictionary Views and Dynamic Performance Views	171
DBA_TABLESPACES	171
DBA_SEGMENTS	172
DBA_EXTENTS	172
DBA_FREE_SPACE	173
DBA_LMT_FREE_SPACE	173
DBA_THRESHOLDS	173
DBA_OUTSTANDING_ALERTS	174
DBA_ALERT_HISTORY	174
V\$ALERT_TYPES	174
V\$UNDOSTAT	175
V\$OBJECT_USAGE	175
V\$SORT_SEGMENT	175
V\$TEMPSEG_USAGE	175
Space Management Methodologies	175
Locally Managed Tablespaces	176
Using OMF to Manage Space	177
Bigfile Tablespaces	178
Automatic Storage Management	179
Undo Management Considerations	181
SYSAUX Monitoring and Usage	182
Archived Redo Log File Management	184
Built-in Space Management Tools	184
Segment Advisor	185
Undo Advisor and the Automatic Workload Repository	187
Index Usage	189
Space Usage Warning Levels	190
Resumable Space Allocation	192
Managing Alert and Trace Files with ADR	195
OS Space Management	197

Space Management Scripts	197
Segments That Cannot Allocate Additional Extents	197
Used and Free Space by Tablespace and Datafile	198
Automating and Streamlining the Notification Process	199
Using DBMS_SCHEDULER	199
OEM Job Control and Monitoring	200
7 Managing Transactions with Undo Tablespaces	207
Transaction Basics	208
Undo Basics	209
Rollback	209
Read Consistency	209
Database Recovery	210
Flashback Operations	210
Managing Undo Tablespaces	210
Creating Undo Tablespaces	210
Undo Tablespace Dynamic Performance Views	216
Undo Tablespace Initialization Parameters	216
Multiple Undo Tablespaces	217
Sizing and Monitoring the Undo Tablespace	220
Read Consistency vs. Successful DML	222
Flashback Features	223
Flashback Query	223
DBMS_FLASHBACK	225
Flashback Transaction Backout	227
Flashback Table	227
Flashback Version Query	232
Flashback Transaction Query	234
Flashback Data Archive	236
Flashback and LOBs	239
Migrating to Automatic Undo Management	239
8 Database Tuning	241
Tuning Application Design	243
Effective Table Design	243
Distribution of CPU Requirements	244
Effective Application Design	245
Tuning SQL	247
Impact of Order on Load Rates	248
Additional Indexing Options	249
Generating Explain Plans	250
Tuning Memory Usage	252
Specifying the Size of the SGA	255
Using the Cost-Based Optimizer	256
Implications of the COMPUTE STATISTICS Option	257
Tuning Data Access	257
Locally Managed Tablespaces	257
Identifying Chained Rows	258
Increasing the Oracle Block Size	259

Using Index-Organized Tables	260
Tuning Issues for Index-Organized Tables	261
Tuning Data Manipulation	262
Bulk Inserts: Using the SQL*Loader Direct Path Option	262
Bulk Data Moves: Using External Tables	263
Bulk Inserts: Common Traps and Successful Tricks	264
Bulk Deletes: The truncate Command	265
Using Partitions	266
Tuning Physical Storage	267
Using Raw Devices	267
Using Automatic Storage Management	267
Reducing Network Traffic	268
Replication of Data Using Materialized Views	268
Using Remote Procedure Calls	270
Using the Automatic Workload Repository	270
Managing Snapshots	271
Managing Baselines	271
Generating AWR Reports	272
Running the Automatic Database Diagnostic Monitor Reports	272
Using the Automatic SQL Tuning Advisor	272
Tuning Solutions	275
9 Database Security and Auditing	277
Non-Database Security	279
Database Authentication Methods	279
Database Authentication	280
Database Administrator Authentication	280
Operating System Authentication	283
Network Authentication	284
3-Tier Authentication	286
Client-Side Authentication	286
Oracle Identity Management	286
User Accounts	288
Database Authorization Methods	292
Profile Management	292
System Privileges	299
Object Privileges	302
Creating, Assigning, and Maintaining Roles	306
Using a VPD to Implement Application Security Policies	313
Auditing	331
Auditing Locations	331
Statement Auditing	332
Privilege Auditing	336
Schema Object Auditing	337
Fine-Grained Auditing	338
Auditing-Related Data Dictionary Views	339
Protecting the Audit Trail	340
Enabling Enhanced Auditing	340

Data Encryption Techniques	342
DBMS_CRYPTO Package	342
Transparent Data Encryption	342

PART III

High Availability

10 Real Application Clusters	349
Overview of Real Application Clusters	350
Hardware Configuration	351
Software Configuration	351
Network Configuration	351
Disk Storage	352
Installation and Setup	353
Operating System Configuration	354
Software Installation	360
RAC Characteristics	378
Server Parameter File Characteristics	379
RAC-related Initialization Parameters	380
Dynamic Performance Views	380
RAC Maintenance	382
Starting Up a RAC	382
Redo Logs in a RAC Environment	383
Undo Tablespace in a RAC Environment	383
Failover Scenarios and TAF	383
RAC Node Failure Scenario	385
Tuning a RAC Node	389
Tablespace Management	390
11 Backup and Recovery Options	391
Capabilities	392
Logical Backups	392
Physical Backups	393
Offline Backups	393
Online Backups	394
Using Data Pump Export and Import	395
Creating a Directory	395
Data Pump Export Options	396
Starting a Data Pump Export Job	399
Data Pump Import Options	403
Starting a Data Pump Import Job	406
Comparing Data Pump Export/Import to Export/Import	410
Implementing Offline Backups	411
Implementing Online Backups	411
Integration of Backup Procedures	414
Integration of Logical and Physical Backups	415
Integration of Database and Operating System Backups	416

12	Using Recovery Manager (RMAN)	417
	RMAN Features and Components	418
	RMAN Components	419
	RMAN vs. Traditional Backup Methods	420
	Backup Types	421
	Overview of RMAN Commands and Options	423
	Frequently Used Commands	423
	Setting Up a Repository	423
	Registering a Database	428
	Persisting RMAN Settings	428
	Initialization Parameters	432
	Data Dictionary and Dynamic Performance Views	433
	Backup Operations	434
	Full Database Backups	435
	Tablespace	439
	Datafiles	442
	Image Copies	442
	Control File, SPFILE Backup	444
	Archived Redo Logs	444
	Incremental Backups	445
	Incrementally Updated Backups	447
	Incremental Backup Block Change Tracking	450
	Backup Compression	451
	Using a Flash Recovery Area	452
	Validating Backups	453
	Recovery Operations	455
	Block Media Recovery	455
	Restoring a Control File	456
	Restoring a Tablespace	456
	Restoring a Datafile	459
	Restoring an Entire Database	461
	Validating Restore Operations	464
	Point in Time Recovery	465
	Data Recovery Advisor	465
	Miscellaneous Operations	470
	Cataloging Other Backups	470
	Catalog Maintenance	471
	REPORT and LIST	472
13	Oracle Data Guard	475
	Data Guard Architecture	476
	Physical vs. Logical Standby Databases	477
	Data Protection Modes	477
	LOG_ARCHIVE_DEST_n Parameter Attributes	478
	Creating the Standby Database Configuration	479
	Preparing the Primary Database	480
	Creating Logical Standby Databases	484
	Using Real-Time Apply	486
	Managing Gaps in Archive Log Sequences	486
	Managing Roles—Switchovers and Failovers	487
	Switchovers	487

	Switchovers to Physical Standby Databases	487
	Switchovers to Logical Standby Databases	489
	Failovers to Physical Standby Databases	490
	Failovers to Logical Standby Databases	490
	Administering the Databases	491
	Startup and Shutdown of Physical Standby Databases	491
	Opening Physical Standby Databases in Read-Only Mode	491
	Managing Datafiles in Data Guard Environments	492
	Performing DDL on a Logical Standby Database	492
14	Miscellaneous High Availability Features	495
	Recovering Dropped Tables Using Flashback Drop	496
	The Flashback Database Command	498
	Using LogMiner	500
	How LogMiner Works	500
	Extracting the Data Dictionary	501
	Analyzing One or More Redo Log Files	502
	LogMiner Features Introduced in Oracle Database 10g	504
	LogMiner Features Introduced in Oracle Database 11g	505
	Online Object Reorganization	506
	Creating Indexes Online	506
	Rebuilding Indexes Online	506
	Coalescing Indexes Online	506
	Rebuilding Index-Organized Tables Online	506
	Redefining Tables Online	507
PART IV		
Networked Oracle		
15	Oracle Net	511
	Overview of Oracle Net	512
	Connect Descriptors	515
	Net Service Names	516
	Replacing tnsnames.ora with Oracle Internet Directory	517
	Listeners	517
	Using the Oracle Net Configuration Assistant	520
	Configuring the Listener	521
	Using the Oracle Net Manager	525
	Starting the Listener Server Process	527
	Controlling the Listener Server Process	528
	The Oracle Connection Manager	531
	Using Connection Manager	531
	Directory Naming with Oracle Internet Directory	534
	Using Easy Connect Naming	537
	Using Database Links	538
	Tuning Oracle Net	540
	Limiting Resource Usage	541
	Debugging Connection Problems	541
16	Managing Large Databases	543
	Creating Tablespace in a VLDB Environment	545
	Bigfile Tablespace Basics	545

Creating and Modifying Bigfile Tablespaces	546
Bigfile Tablespace ROWID Format	546
DBMS_ROWID and Bigfile Tablespaces	547
Using DBVERIFY with Bigfile Tablespaces	550
Bigfile Tablespace Initialization Parameter Considerations	551
Bigfile Tablespace Data Dictionary Changes	552
Advanced Oracle Table Types	552
Index-Organized Tables	553
Global Temporary Tables	553
External Tables	555
Partitioned Tables	557
Materialized Views	589
Using Bitmap Indexes	589
Understanding Bitmap Indexes	589
Using Bitmap Indexes	590
Using Bitmap Join Indexes	590
Oracle Data Pump	591
Data Pump Export	592
Data Pump Import	592
Using Transportable Tablespaces	593
17 Managing Distributed Databases	599
Remote Queries	601
Remote Data Manipulation: Two-Phase Commit	602
Dynamic Data Replication	603
Managing Distributed Data	604
The Infrastructure: Enforcing Location Transparency	604
Managing Database Links	609
Managing Database Triggers	610
Managing Materialized Views	612
Using DBMS_MVIEW and DBMS_ADVISOR	616
What Kind of Refreshes Can Be Performed?	625
Using Materialized Views to Alter Query Execution Paths	629
Managing Distributed Transactions	630
Resolving In-Doubt Transactions	631
Commit Point Strength	631
Monitoring Distributed Databases	632
Tuning Distributed Databases	632
Appendix: Installation and Configuration	635
Software Installation	636
Overview of Licensing and Installation Options	637
Using OUI to Install the Oracle Software	638
Using the DBCA to Create a Database	638
Manually Creating a Database	649
Index	653