

Oracle PressTM

Oracle Database 12*c*The Complete Reference

Bob Bryla Kevin Loney



New York Chicago San Francisco Lisbon London Madrid Mexico City Milan New Delhi San Juan Seoul Singapore Sydney Toronto



Acknowledgments

	PART I Critical Database Concepts	
1	Oracle Database 12c Architecture Options Databases and Instances Inside the Database Storing the Data Guarding the Data Programmatic Structures Choosing Architectures and Options	
2	Installing Oracle Database 12c and Creating a Database Overview of Licensing and Installation Options Installing the Oracle Software Installing the Grid Infrastructure Installing the Database	1: 14 14
3	Upgrading to Oracle Database 12c Choosing an Upgrade Method Before Upgrading Upgrading the Grid Infrastructure and Database Grid Infrastructure Upgrade Database Upgrade After Upgrading	2: 2: 2: 2: 2:
4	Planning Oracle Applications—Approaches, Risks, and Standards The Cooperative Approach Everyone Has "Data" The Familiar Language of Oracle Tables of Information Structured Query Language	4! 4! 4!

Xii Oracle Database 12c: The Complete Reference

	A Simple Oracle Query	46
	Why It Is Called "Relational"	48
	Some Common, Everyday Examples	50
	What Are the Risks?	52
	The Importance of the New Vision	53
	Changing Environments	53
	Codes, Abbreviations, and Naming Standards	54
	How to Reduce the Confusion	55
	Normalization	55
	English Names for Tables and Columns	60
	English Words for the Data	62
	Capitalization in Names and Data	62
	Normalizing Names	63
	Good Design Has a Human Touch	63
	Understanding the Application Tasks	64
	Outline of Tasks	65
	Understanding the Data	67
	The Atomic Data Models	68
	The Atomic Business Model	69
	The Business Model	69
	Data Entry	69
	Query and Reporting	69
	Toward Object Name Normalization	70
	Level-Name Integrity	70
	Foreign Keys	71
	Singular Names	71
	Brevity	72
	Object Name Thesaurus	72
	Intelligent Keys and Column Values	73
	The Commandments	73
	PART II	
	SQL and SQL*Plus	
5	The Pagic Payte of Canach in COI	
3	The Basic Parts of Speech in SQL	
	Style	79
	Creating the NEWSPAPER Table	80
	Using SQL to Select Data from Tables	80
	SELECT, FROM, WHERE, and ORDER BY	84
	Logic and Value	86
	Single-Value Tests	87
	LIKE	90
	Simple Tests Against a List of Values	92
	Combining Logic	94

	Another Use for WHERE: Subqueries	95
	Single Values from a Subquery	96
	Lists of Values from a Subquery	97
	Combining Tables	98
	Creating a View	100
	Expanding the View	102
,		
6	•	105
	Building a Simple Report	
	REMARK	
	SET HEADSEP	
	TTITLE and BTITLE	
		112
	BREAK ON	113
	COMPUTE AVG	113
	SET LINESIZE	114
	SET PAGESIZE	115
	SET NEWPAGE	115
	SPOOL	116
	/* */	117
	Some Clarification on Column Headings	117
	Other Features	118
	Command Line Editor	118
	SET PAUSE	
	SAVE	
	Store	
	Editing	
	HOST	
	Adding SQL*Plus Commands	
	START	
	Checking the SQL*Plus Environment	
	Building Blocks	127
7	Getting Text Information and Changing It	129
	Datatypes	
	What Is a String?	
	Notation	
	Concatenation ()	133
	How to Cut and Paste Strings	134
	RPAD and LPAD	135
	LTRIM, RTRIM, and TRIM	136
	Combining Two Functions	137
	Using the TRIM Function	139
	Adding One More Function	140
	LOWER, UPPER, and INITCAP	140
	LENGTH	140

XVi Oracle Database 12c: The Complete Reference

	Outer Joins	
	Pre-Oracle9i Syntax for Outer Joins	
	Current Syntax for Outer Joins	249
	Replacing NOT IN with an Outer Join	
	Replacing NOT IN with NOT EXISTS	
	Natural and Inner Joins	253
	UNION, INTERSECT, and MINUS	254
	IN Subqueries	257
	Restrictions on UNION, INTERSECT, and MINUS	258
14	Some Complex Possibilities	259
	Complex Groupings	
	Using Temporary Tables	
	Using ROLLUP, GROUPING, and CUBE	
	Family Trees and CONNECT BY	
	Excluding Individuals and Branches	
	Traveling Toward the Roots	
	Finding the Leaves	
	The Basic Rules	
15	Changing Data: INSERT, DELETE, UPDATE, and MERGE	275
13	INSERT	
	Inserting a Time	
	INSERT with SELECT	
	Using the APPEND Hint to Improve INSERT Performance	
	ROLLBACK, COMMIT, and AUTOCOMMIT	
	Using SAVEPOINTs	
	Implicit COMMIT	
	Auto ROLLBACK	
	Multitable INSERTs	
	DELETE	
	UPDATE	
	UPDATE with Embedded SELECT	
	UPDATE with NULL	
	MERGE	
	Handling Errors	292
16	DECODE and CASE: IF, THEN, and ELSE in SQL	295
	IF, THEN, ELSE	
	Replacing Values via DECODE	
	DECODE Within DECODE	300
	Greater Than and Less Than in DECODE	303
	Using CASE	305
	Using PIVOT	308

17	Creating and Managing Tables, Views, Indexes, Clusters, and Sequences	311
	Creating a Table	312
	Character Width and NUMBER Precision	313
	Rounding During Insertion	315
	Defining Constraints within CREATE TABLE	316
	Designating Index Tablespaces	318
	Naming Constraints	319
	Dropping Tables	
	Altering Tables	320
	The Rules for Adding or Modifying a Column	
	Creating Read-Only Tables	
	Altering Actively Used Tables	
	Creating Virtual Columns	
	Dropping a Column	
	Creating a Table from a Table	
	Creating an Index-Organized Table	
	Creating a View	
	View Stability	
	Using ORDER BY in Views	
	Creating a Read-Only View	
	Indexes	
	Creating an Index	
	Enforcing Uniqueness	
	Creating a Unique Index	
	Creating a Bitmap Index	
	When to Create an Index	
	Creating Invisible Indexes	
	Variety in Indexed Columns	
	How Many Indexes to Use on a Table	
	Placing an Index in the Database	
	Rebuilding an Index	
	Function-Based Indexes	
	Clusters	
	Sequences	340
18	Partitioning	343
	Creating a Partitioned Table	
	List Partitioning	
	Creating Subpartitions	347
	Creating Reference and Interval Partitions	
	Reference Partitioning	
	Interval Partitioning	
	Indexing Partitions	
	Managing Partitioned Tables	350

XVIII Oracle Database 12c: The Complete Reference

19	Basic Oracle Security	351
	Users, Roles, and Privileges	352
	Creating a User	352
	Password Management	353
	Standard Roles	357
	Format for the GRANT Command	
	Revoking Privileges	
	What Users Can Grant	
	Moving to Another User with CONNECT	
	CREATE SYNONYM	
	Using Ungranted Privileges	
	Passing Privileges	364
	Creating a Role	
	Granting Privileges to a Role	
	Granting a Role to Another Role	367
	Granting a Role to Users	367
	Adding a Password to a Role	
	Removing a Password from a Role	
	Enabling and Disabling Roles	369
	Revoking Privileges from a Role	370
	Dropping a Role	370
	Granting UPDATE to Specific Columns	370
	Revoking Object Privileges	
	Defining Security by User	371
	Granting Access to the Public	372
	Granting Access to Limited Resources	373
	PART III	
	Beyond the Basics	
20	Advanced Security—Virtual Private Databases	377
	Initial Configuration	
	Create an Application Context	380
	Create a Logon Trigger	381
	Create a Security Policy	382
	Apply the Security Policy to Tables	383
	Test the VPD Security Policy	
	How to Implement Column-Level VPD	385
	How to Disable VPD	386
	How to Use Policy Groups	387
21	Advanced Security—Transparent Data Encryption	389
	Transparent Data Encryption for Columns	
	Setting Up TDE for Columns	
	Additional Setup for RAC Databases	391

	Opening and Closing the Wallet	392
	Encrypting and Decrypting Columns	392
	Transparent Data Encryption for Tablespaces	394
	Setting Up TDE on Tablespaces	394
	Creating an Encrypted Tablespace	395
22	Working with Tablespaces	397
	Tablespaces and the Structure of the Database	
	Tablespace Contents	
	RECYCLEBIN Space in Tablespaces	
	Read-Only Tablespaces	
	NOLOGGING Tablespaces	
	Temporary Tablespaces	
	Tablespaces for System-Managed Undo	
	BIGFILE Tablespaces	
	Encrypted Tablespaces	
	Supporting the FLASHBACK DATABASE Command	
	Transporting Tablespaces	
	Planning Your Tablespace Usage	405
	Separate Active and Static Tables	405
	Separate Indexes and Tables	405
	Separate Large and Small Objects	
	Separate Application Tables from Core Objects	405
23	Using SQL*Loader to Load Data	407
23	Using SQL*Loader to Load Data	
23	The Control File	408 409
23	The Control File Loading Variable-Length Data Starting the Load	408 409 410
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records	408 409 410 413
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes	408 409 410 413 415
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads	408 409 410 413 415 416
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads	408 409 410 413 415 416 417
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads	408 409 410 413 415 416 417 418
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading	408 409 410 413 415 416 417 418 419
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode	408 409 410 413 415 416 417 418 419 421
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading	408 409 410 413 415 416 417 418 419 421
23	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import	408 409 410 413 415 416 417 418 419 421 422 423
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory	408 409 410 413 415 416 417 418 419 421 422 423
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Options	408 409 410 413 415 416 417 418 419 421 422 423 424 424
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Options Starting a Data Pump Export Job	408 409 410 413 415 416 417 418 419 421 422 423 424 424 427
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Job Storping and Restarting Running Jobs	408 409 410 413 415 416 417 418 419 421 422 423 424 424 427 428
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Job Starting a Data Pump Export Job Stopping and Restarting Running Jobs Exporting from Another Database	408 409 410 413 415 416 417 418 419 421 422 423 424 424 427 428 429
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Options Starting a Data Pump Export Job Stopping and Restarting Running Jobs Exporting from Another Database Using EXCLUDE, INCLUDE, and QUERY	408 409 410 413 415 416 417 418 421 422 423 424 424 427 428 429 430
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Options Starting a Data Pump Export Job Stopping and Restarting Running Jobs Exporting from Another Database Using EXCLUDE, INCLUDE, and QUERY Data Pump Import Options	408 409 410 413 415 416 417 418 421 422 423 424 424 427 428 429 430 431
	The Control File Loading Variable-Length Data Starting the Load Logical and Physical Records Control File Syntax Notes Managing Data Loads Repeating Data Loads Tuning Data Loads Direct Path Loading SQL*Loader Express Mode Additional Features Using Data Pump Export and Import Creating a Directory Data Pump Export Options Starting a Data Pump Export Job Stopping and Restarting Running Jobs Exporting from Another Database Using EXCLUDE, INCLUDE, and QUERY	408 409 410 413 415 416 417 418 421 422 423 424 427 428 429 430 431 435

XX Oracle Database 12c: The Complete Reference

	EXCLUDE, INCLUDE, and QUERY	
	Generating SQL	437
25	Accessing Remote Data	
	Database Links	442
	How a Database Link Works	442
	Using a Database Link for Remote Queries	443
	Using a Database Link for Synonyms and Views	444
	Using a Database Link for Remote Updates	
	Syntax for Database Links	446
	Using Synonyms for Location Transparency	449
	Using the USER Pseudo-Column in Views	450
26	Using Materialized Views	453
	Functionality	
	Required System Privileges	454
	Required Table Privileges	455
	Read-Only vs. Updatable	455
	CREATE MATERIALIZED VIEW Syntax	456
	Types of Materialized Views	460
	ROWID vs. Primary Key-Based Materialized Views	460
	Using Prebuilt Tables	460
	Indexing Materialized View Tables	461
	Using Materialized Views to Alter Query Execution Paths	461
	Using DBMS_ADVISOR	463
	Refreshing Materialized Views	465
	What Kind of Refreshes Can Be Performed?	466
	FAST Refresh with CONSIDER FRESH	469
	Automatic Refreshes	469
	Manual Refreshes	470
	CREATE MATERIALIZED VIEW Log Syntax	472
	Altering Materialized Views and Logs	473
	Dropping Materialized Views and Logs	473
27		
27	Using Oracle Text for Text Searches	475
	Adding Text to the Database	476
	Text Queries and Text Indexes	477
	Text Queries	478
	Available Text Query Expressions	479
	Searching for an Exact Match of a Word	479
	Searching for an Exact Match of Multiple Words	480
	Searching for an Exact Match of a Phrase	484
	Searching for Words That Are Near Each Other	485
	Using Wildcards During Searches	485
	Searching for Words That Share the Same Stem	486
	Searching for Fuzzy Matches	487

	Searching for Words That Sound Like Other Words	488
	Nesting Search Operators	488
	Summarizing the Search Options	489
	Using the ABOUT Operator	490
	Index Synchronization	490
	Index Sets	491
28	Using External Tables	493
20	Accessing the External Data	
	Creating an External Table	
	External Table Creation Options	
	Loading External Tables on Creation	
	Altering External Tables	
	ACCESS PARAMETERS	
	ADD COLUMN	
	DEFAULT DIRECTORY	
	DROP COLUMN	
	LOCATION	
	MODIFY COLUMN	
	PARALLEL	
	PROJECT COLUMN	
	REJECT LIMIT	
	RENAME TO	
	Limitations, Benefits, and Potential Uses of External Tables	
20	Limitations, Benefits, and Potential Uses of External Tables	508
29	Limitations, Benefits, and Potential Uses of External Tables	508 511
29	Limitations, Benefits, and Potential Uses of External Tables	508 511 512
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data	508 511 512 513
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example	508 511 512 513 514
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails?	508 511 512 513 514 516
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row?	508 511 512 513 514 516 516
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries	508 511 512 513 514 516 516 518
29	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks	508 511 512 513 514 516 516 518 521
29 30	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases	508 511 512 513 514 516 516 518 521
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command	508 511 512 513 514 516 516 518 521 523 524
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required	508 511 512 513 514 516 516 518 521 523 524 524
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables	508 511 512 513 514 516 516 518 521 523 524 524 524
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin	508 511 512 513 514 516 516 518 521 523 524 524
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp	508 511 512 513 514 516 516 518 521 523 524 524 524 524 526 526
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp Indexes and Statistics	508 511 512 513 514 516 516 518 521 523 524 524 524 526 526 528
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp	508 511 512 513 514 516 516 518 521 523 524 524 524 524 526 526
30	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp Indexes and Statistics The FLASHBACK DATABASE Command	508 511 512 513 514 516 516 518 521 523 524 524 524 526 526 528 528
	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp Indexes and Statistics The FLASHBACK DATABASE Command	508 511 512 513 514 516 518 521 523 524 524 524 526 528 528 528 533
30	Limitations, Benefits, and Potential Uses of External Tables Using Flashback Queries Time-Based Flashback Example Saving the Data SCN-Based Flashback Example What If the Flashback Query Fails? What SCN Is Associated with Each Row? Flashback Version Queries Planning for Flashbacks Flashback—Tables and Databases The FLASHBACK TABLE Command Privileges Required Recovering Dropped Tables Enabling and Disabling the Recycle Bin Flashing Back to SCN or Timestamp Indexes and Statistics The FLASHBACK DATABASE Command	508 511 512 513 514 516 516 518 521 523 524 524 524 526 526 528 528

XXII Oracle Database 12c: The Complete Reference

	Capturing the Workload	
	Defining Filters	
	Starting the Capture	
	Stopping the Capture	538
	Exporting AWR Data	538
	Processing the Workload	538
	Replaying the Workload	539
	Controlling and Starting the Replay Clients	539
	Initializing and Running the Replay	
	Exporting AWR Data	542
	PART IV	
	PL/SQL	
32	An Introduction to PL/SQL	545
	PL/SQL Overview	546
	Declarations Section	546
	Executable Commands Section	550
	Conditional Logic	551
	Loops	
	CASE Statements	
	Exception Handling Section	
33	Online Application Upgrades	567
	Highly Available Databases	
	Oracle Data Guard Architecture	
	Creating the Standby Database Configuration	
	Managing Roles—Switchovers and Failovers	
	Making Low-Impact DDL Changes	
	Creating Virtual Columns	
	Altering Actively Used Tables	
	Adding NOT NULL Columns	
	Online Object Reorganizations	
	Dropping a Column	
34	Triggers	
	Required System Privileges	
	Required Table Privileges	582
	Types of Triggers	582
	Row-Level Triggers	583
	Statement-Level Triggers	583
	BEFORE and AFTER Triggers	583
	INSTEAD OF Triggers	583
	Schema Triggers	584
	Database-Level Triggers	584
	Compound Triggers	584

	Trigger Syntax	584
	Combining DML Trigger Types	586
	Setting Inserted Values	588
	Maintaining Duplicated Data	589
	Customizing Error Conditions	590
	Calling Procedures Within Triggers	592
	Naming Triggers	593
	Creating DDL Event Triggers	593
	Creating Database Event Triggers	598
	Creating Compound Triggers	598
	Enabling and Disabling Triggers	600
	Replacing Triggers	601
	Dropping Triggers	601
35	Procedures, Functions, and Packages	603
	Required System Privileges	604
	Required Table Privileges	606
	Procedures vs. Functions	606
	Procedures vs. Packages	606
	CREATE PROCEDURE Syntax	607
	CREATE FUNCTION Syntax	609
	Referencing Remote Tables in Procedures	611
	Debugging Procedures	611
	Creating Your Own Functions	613
	Customizing Error Conditions	614
	Naming Procedures and Functions	616
	CREATE PACKAGE Syntax	616
	Viewing Source Code for Procedural Objects	619
	Compiling Procedures, Functions, and Packages	620
	Replacing Procedures, Functions, and Packages	621
	Dropping Procedures, Functions, and Packages	621
36	Using Native Dynamic SQL and DBMS_SQL	
	Using EXECUTE IMMEDIATE	
	Using Bind Variables	
	Using DBMS_SQL	
	OPEN_CURSOR	
	PARSE*	
	BIND_VARIABLE and BIND_ARRAY	
	EXECUTE	629
	DEFINE_COLUMN	
	FETCH_ROWS, EXECUTE_AND_FETCH, and COLUMN_VALUE	629
	CLOSE_CURSOR	630
37	PL/SQL Tuning	631
	Tune the SOI	632

XXIV Oracle Database 12c: The Complete Reference

	Steps for Tuning the PL/SQL	632
	Use PL/SQL Within SQL Statements	633
	Use DBMS_PROFILER to Identify Problems	635
	Use PL/SQL Features for Bulk Operations	640
	FORALL	640
	BULK COLLECT	642
	PART V	
	Object-Relational Databases	
38	Implementing Object Types, Object Views, and Methods	647
	Working with Object Types	648
	Security for Object Types	648
	Indexing Object Type Attributes	651
	Implementing Object Views	653
	Manipulating Data via Object Views	656
	Using INSTEAD OF Triggers	656
	Methods	659
	Syntax for Creating Methods	659
	Managing Methods	661
39	Collectors (Nested Tables and Varying Arrays)	663
	Varying Arrays	664
	Creating a Varying Array	664
	Describing the Varying Array	665
	Inserting Rows into the Varying Array	666
	Selecting Data from Varying Arrays	667
	Nested Tables	670
	Specifying Tablespaces for Nested Tables	671
	Inserting Rows into a Nested Table	672
	Working with Nested Tables	6/3
	Additional Functions for Nested Tables and Varying Arrays	6/5
	Management Issues for Nested Tables and Varying Arrays	6/5
	Variability in Collectors	
	Location of the Data	
40	Using Large Objects	679
	Available Datatypes	680
	Specifying Storage for LOB Data	681
	Manipulating and Selecting LOB Values	683
	Initializing Values	685
	Using INSERT with Subqueries	
	Updating LOB Values	688
	Using String Functions to Manipulate LOB Values	688
	Using DBMS_LOB to Manipulate LOB Values	689
	Deleting LOBs	/05

41	Advanced Object-Oriented Concepts	70 7
	Row Objects vs. Column Objects	708
	Object Tables and OIDs	708
	Inserting Rows into Object Tables	709
	Selecting Values from Object Tables	710
	Updating and Deleting from Object Tables	711
	Using the REF Function	711
	Using the DEREF Function	712
	Using the VALUE Function	
	Invalid References	716
	Object Views with REFs	716
	A Quick Review of Object Views	
	Object Views Involving References	717
	Object PL/SQL	
	Objects in the Database	722
	PART VI	
	Java in Oracle	
42	An Introduction to Java	725
	Java vs. PL/SQL: An Overview	726
	Getting Started	727
	Declarations	
	Executable Commands	728
	Conditional Logic	729
	Loops	
	Exception Handling	
	Reserved Words	736
	Classes	736
43	JDBC Programming	741
	Using the JDBC Classes	742
	Using JDBC for Data Manipulation	746
44	Java Stored Procedures	751
	Loading the Class into the Database	
	How to Access the Class	
	Calling Java Stored Procedures Directly	
	Where to Perform Commands	
	PART VII	
	Hitchhiker's Guides	
45	The Hitchhiker's Guide to the Oracle Data Dictionary	765
73	A Note about Nomenclature	
	New Views Introduced in Oracle Database 12c	

xxvi Oracle Database 12c: The Complete Reference

New Views Introduced in Oracle Database 11g	773
The Boad Maps: DICTIONARY (DICT) and DICT COLUMNS	//8
Things You Select From: Tables (and Columns), Views, Synonyms, and Sequences	700
Catalog: USER_CATALOG (CAT)	700
Objects: LISER OBJECTS (OBJ)	780
Tables: LISER_TABLES (TABS)	701
Columns: USER_TAB_COLUMNS (COLS)	/83
Views: USER VIEWS	/ 84
Synonyms: USER_SYNONYMS (SYN)	787
Sequences: USFR_SEQUENCES (SEQ)	788
Recycle Bin: USER_RECYCLEBIN and DBA_RECYCLEBIN	788
Constraints and Comments	788
Constraints: USER CONSTRAINTS	789
Constraint Columns: USER_CONS_COLUMNS	790
Constraint Exceptions: EXCEPTIONS	791
Table Comments: USER_TAB_COMMENTS	792
Column Comments: USER_COL_COMMENTS	793
Indexes and Clusters	793
Indexes: USER_INDEXES (IND)	793
Indexed Columns: USER_IND_COLUMNS	796
Clusters: USER_CLUSTERS (CLU)	796
Cluster Columns: USER_CLU_COLUMNS	. 797
Abstract Datatypes and LOBs	. 790
Abstract Datatypes and Love	, /90
LOBs: USER_LOBS	. 800
Database Links and Materialized Views	. 800
Database Links: USER_DB_LINKS	. 801
Materialized Views	. 001
Materialized View Logs: USER_MVIEW_LOGS	. 803
Triggers, Procedures, Functions, and Packages	. 003
Triggers: USER_TRIGGERS	. 804
Procedures, Functions, and Packages: USER_SOURCE	. 004
Dimensions	. 000
Space Allocation and Usage, Including Partitions and Subpartitions	. 007
Tablespaces: USER_TABLESPACES	. 007
Space Quotas: USER_TS_QUOTAS	. 000
Segments and Extents: USER_SEGMENTS and USER_EXTENTS	. 000
Partitions and Subpartitions	. 005
Free Space: USER_FREE_SPACE	. 012
Users and Privileges	. 012
Users: USER_USERS	. 012
Resource Limits: USER_RESOURCE_LIMITS	. Ölz
Table Privileges: USER_TAB_PRIVS	, 813
Column Privileges: USER_COL_PRIVS	. 81.
System Privileges: USER_SYS_PRIVS	. 81.

	Roles	
	Auditing	
	Auditing Privileges, DML, and Authentication	
	Monitoring Object Usage	
	Miscellaneous	
	Monitoring: The V\$ Dynamic Performance Tables	817
	CHAINED_ROWS	
	PLAN_TABLE	
	Interdependencies: USER_DEPENDENCIES and IDEPTREE	
	DBA-Only Views	
	Oracle Label Security	
	SQL*Loader Direct Load Views	
	Globalization Support Views	819
	Libraries	
	Heterogeneous Services	819
	Indextypes and Operators	819
	Outlines	820
	Advisors	820
	Schedulers	820
46	The Hitchhiker's Guide to Tuning Applications and SQL	Ω21
	An Overview of Oracle Database Tuning Features	822
	Tuning—Best Practices	
	Do as Little as Possible	
	Do It as Simply as Possible	
	Tell the Database What It Needs to Know	
	Maximize the Throughput in the Environment	
	Maximize the Throughput in the Environment Divide and Conquer Your Data	829
	Divide and Conquer Your Data	829 830
	Divide and Conquer Your Data Test Correctly	829 830 831
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans	829 830 831 833
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON	829 830 831 833 833
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN	829 830 831 833 833 838
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans	829 830 831 833 833 838 839
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL	829 830 831 833 833 838 839
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID	829 830 831 833 838 839 839 839
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints	829 830 831 833 838 839 839 840
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes	829 830 831 833 838 839 839 840 840
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes When Indexes Are Used	829 830 831 833 838 839 839 840 840 842
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes When Indexes Are Used Operations That Manipulate Data Sets	829 830 831 833 838 839 839 840 840 842 847
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes When Indexes Are Used Operations That Manipulate Data Sets Operations That Perform Joins	829 830 831 833 838 839 839 840 840 842 847 854
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes When Indexes Are Used Operations That Manipulate Data Sets Operations That Perform Joins How Oracle Handles Joins of More Than Two Tables	829 830 831 833 838 839 839 840 840 842 854 855
	Divide and Conquer Your Data Test Correctly Generating and Reading Explain Plans Using SET AUTOTRACE ON Using EXPLAIN PLAN Major Operations Within Explain Plans TABLE ACCESS FULL TABLE ACCESS BY INDEX ROWID Related Hints Operations That Use Indexes When Indexes Are Used Operations That Manipulate Data Sets Operations That Perform Joins	829 830 831 833 838 839 839 840 840 842 847 854 855 861

XXVIII Oracle Database 12c: The Complete Reference

4/	Database Parameter Settings for SQL Result Cache	
	The DBMS_RESULT_CACHE Package	
	Dictionary Views for the SQL Result Cache	. 873
	Additional Details for SQL Result Cache	
	Oracle Call Interface (OCI) Client Query Cache	
	Oracle Call Interface (OCI) Client Query Cache Restrictions	. 875
48	Case Studies in Tuning	
	Case Study 1: Waits, Waits, and More Waits	
	Case Study 2: Application-Killing Queries	
	Using the 10053 Trace Event	
	Case Study 3: Long-Running Batch Jobs	. 885
49	The Hitchhiker's Guide to Pluggable Databases	
	Pluggable Database Concepts	
	Container Database Components	
	CDB User Accounts	
	Prerequisites	
	Creating the Container Database	
	Creating a Pluggable Database	
	Managing Pluggable Databases	
	Unplugging a Pluggable Database	
	Dropping a Pluggable Database	. 898
	Plugging In a Pluggable Database	. 898
	Monitoring Pluggable Databases	. 898
50	The Hitchhiker's Guide to Oracle Real Application Clusters	901
	Preinstallation Steps	. 902
	Installing RAC	
	Storage	
	Initialization Parameters	
	Starting and Stopping RAC Instances	
	Transparent Application Failover	
51	The Hitchhiker's Guide to Database Administration	
	Creating a Database	
	Using the Oracle Enterprise Manager	
	Starting and Stopping the Database	
	The Initialization Parameter File	
	Allocating and Managing Space for the Objects	
	Implications of the STORAGE Clause	
	Table Segments	

	About the CD-ROM	1391
	Alphabetical Reference	
	PART VIII	
	Other Features	951
	Using XMLType	
	Customizing the Query Process	
	XSU and Java	
	Insert, Update, and Delete Processing with XSU	
	Using XSU to Select, Insert, Update, and Delete XML Values	
	XML Schema	941
	Document Type Definitions, Elements, and Attributes	
?	The Hitchhiker's Guide to XML in Oracle	937
	Where to Go from Here	936
	Recovery Manager	
	Online Backups	
	Offline Backups	
	Data Pump Export and Import	
	Performing Backups	930
	Plugging in the Transportable Tablespace Set	
	Generating a Transportable Tablespace Set	929
	Transporting Tablespaces	
	Segment Space Management	
	Configuring ASM	
	Automating Storage Management	
	Monitoring an Undo Tablespace	
	Free Space	
	Temporary Segments	
	System-Managed Undo	927