# Contents

#### 1 Introduction to Clusterware

**Objectives** 1-2 Cluster 1-3 Clusterware 1-4 Oracle Clusterware 1-5 Clusterware Architecture and Cluster Services 1-6 Goals for Oracle Clusterware 1-7 Oracle Clusterware Fencing 1-8 Cluster Time Synchronization 1-9 Network Resource Management 1-10 Oracle Clusterware Operating System Requirements 1-11 Oracle Clusterware Networking 1-12 IP Addresses for Public Networks 1-14 Private Network IPv6 Support 1-15 Grid Naming Service (GNS) 1-16 Grid Naming Service Configuration Options 1-17 Shared GNS Across Multiple Clusters 1-19 Highly Available Grid Naming Service 1-20 Configuring Highly Available GNS 1-22 Single-Client Access Name 1-23 Quiz 1-24 Summary 1-26

## 2 Oracle Clusterware Architecture

Objectives 2-2 Oracle Clusterware Technology Stack 2-3 Cluster Ready Services Technology Stack 2-4 OHAS Technology Stack 2-6 Clusterware Component Processes and Services 2-7 Oracle Clusterware Repository (OCR) 2-8 CSS Voting Disk Function 2-9 Voting Disk Considerations 2-10 Oracle Local Registry and High Availability 2-11 Oracle Clusterware Initialization 2-12 Clusterware Startup Details 2-14 Clusterware Startup: OHASD orarootagent 2-15 Clusterware Startup Details: CRSD orarootagent 2-16 Clusterware Startup Details: OHASD oraagent 2-18 Controlling Oracle Clusterware 2-19 Verifying the Status of Oracle Clusterware 2-20 Viewing the High Availability Services Stack 2-21 GPnP Architecture: Overview 2-22 How GPnP Works: Cluster Node Startup 2-24 Client Database Connections 2-25 Quiz 2-26 Summary 2-27 Practice 2: Overview 2-28

## 3 Cluster Configuration Options

Cluster Configuration Options 3-3 Oracle Standalone Clusters 3-4 Oracle Cluster Domain 3-5 Oracle Cluster Domain: Overview 3-6 Oracle Member Clusters 3-7 Oracle Member Cluster for Oracle Databases 3-8 Oracle Member Cluster for Applications 3-9 Member Cluster Manifest File for Member Clusters 3-10 Oracle Extended Clusters 3-12 Option 1: Configure an Oracle Extended Cluster 3-13 Assign Failure Groups to Sites 3-14 Option 2: Configure Oracle Extended Clusters 3-15 Assign Failure Groups to Sites Using ASMCA 3-17 Quiz 3-18 Summary 3-19

# 4 Grid Infrastructure: Preinstallation Tasks

Objectives 4-2 Shared Storage Planning for Grid Infrastructure and RAC 4-3 Using a Shared File System with Grid Infrastructure 4-4 Logical Volume Managers and Grid Infrastructure 4-5 Managing Voting Disks in ASM 4-6 Sizing Storage for Oracle Standalone Cluster 4-7 GIMR Configuration Details 4-8 Quiz 4-9 Oracle Grid Infrastructure Installation 4-10 General Server Minimum Requirements 4-11

Checking System Requirements 4-12 Enabling the Name Service Cache Daemon (nscd) 4-13 Setting the Disk I/O Scheduler on Linux 4-14 Cluster Name and SCAN Requirements 4-15 Checking Network Requirements 4-16 IP Address Requirements with GNS 4-17 IP Address Requirements for Static Configuration 4-18 Broadcast and Multicast Requirements 4-20 Private Interconnect Network Requirements 4-21 Interconnect NIC Guidelines 4-22 Private Interconnect Redundant Network Requirements 4-23 Interconnect Link Aggregation: Single Switch 4-24 Interconnect Link Aggregation: Multiswitch 4-26 Additional Interconnect Guidelines 4-27 Cluster Time Synchronization 4-28 Software Requirements (Kernel) 4-30 Software Requirements: Packages 4-31 Oracle Linux with the Unbreakable Enterprise Kernel 4-34 Zero-Downtime Kernel Updates with Ksplice 4-35 Oracle Preinstallation RPM 4-36 Installing the cyugdisk RPM for Linux 4-37 Creating Groups and Users 4-38 Creating Groups, Users, and Paths 4-39 Shell Settings for the Grid Infrastructure User 4-40 Determining Root Script Execution Plan 4-41 Quiz 4-42 Summary 4-43 Practice 4: Overview 4-44

#### 5 Grid Infrastructure Installation

Objectives 5-2 Installing Grid Infrastructure 5-3 Choosing a Cluster Configuration 5-4 Grid Plug and Play Support 5-5 Configuring Shared GNS 5-6 Cluster Node Information 5-7 Specify Network Interface Usage 5-8 Storage Option Information 5-9 Create ASM Disk Group 5-10 Create ASM Disk Group: Specify Failure Groups 5-11 Specify ASM Password 5-12

Failure Isolation Support with IPMI 5-13 Specify Management Options 5-14 Privileged Operating System Groups 5-15 Specify Installation Location 5-16 Create Inventory 5-17 Root Script Execution Configuration 5-18 Perform Prerequisite Checks 5-19 Install Product 5-20 Verifying the Grid Infrastructure Installation 5-21 Understanding Offline Processes 5-22 Check ASM Function for Oracle Clusterware Files 5-23 Create a Fast Recovery Area Disk Group 5-24 Modifying Oracle Clusterware Binaries After Installation 5-25 Unconfiguring Oracle Clusterware Without Removing Binaries 5-26 Quiz 5-27 Summary 5-28 Practice 5: Overview 5-29

## 6 Managing Cluster Nodes

Objectives 6-2 Adding a Cluster Node 6-3 Prerequisite Steps for Adding a Node 6-4 Adding a Node Using gridSetup.sh 6-6 Using gridSetup.sh to Add a Node 6-7 Adding a Node to a Cluster on Windows Systems 6-8 Using Fleet Patching and Provisioning to Add a Node 6-9 Deleting a Node from the Cluster 6-10 Deleting a Node from a Windows-Based Cluster 6-14 Additional Methods to Delete a Node from a Ccluster 6-15 Summary 6-16 Practice 6: Overview 6-17

## 7 Traditional Clusterware Management

Objectives 7-2 Managing Oracle Clusterware 7-3 Role-Separated Management 7-4 Configuring Horizontal Role Separation 7-6 Controlling Oracle Clusterware 7-7 Verifying the Status of Oracle Clusterware 7-8 Determining the Location of Oracle Clusterware Configuration Files 7-9 Checking the Integrity of Oracle Clusterware Configuration Files 7-10

Locating the OCR Automatic Backups 7-11 Changing the Automatic OCR Backup Location 7-12 Adding, Replacing, and Repairing OCR Locations 7-13 Removing an Oracle Cluster Registry Location 7-14 Migrating OCR Locations to ASM 7-15 Migrating OCR from ASM to Other Shared Storage 7-16 Performing Manual OCR Backups 7-17 Restoring the OCR on Linux or UNIX Systems 7-18 Backing Up and Recovering the Voting Disk 7-22 Adding, Deleting, or Migrating Voting Disks 7-23 Restoring Voting Disks 7-24 Oracle Local Registry 7-27 Oracle Interface Configuration Tool: oifcfg 7-29 Determining the Current Network Settings 7-30 Configuring Redundant Interconnect Usage Using OIFCFG 7-31 Changing the Virtual IP Addresses Using SRVCTL 7-32 Changing the Interconnect Adapter Using OIFCFG 7-34 Managing SCAN VIP and SCAN Listener Resources 7-36 SCAN Listeners and Valid Node Checking 7-40 What-If Command Evaluation 7-41 Performing What-If Command Evaluation on Application Resources with CRSCTL 7-42 Performing What-If Command Evaluation on Oracle Clusterware Resources with CRSCTL 7-43 Formatting the Output for What-If Command Evaluation on Oracle Clusterware Resources 7-44 Performing What-If Command Evaluation with SRVCTL 7-45 Evaluating Failure Consequences with SRVCTL 7-46 Reasoned Command Evaluation (Why-If) 7-47 Why-If: Managing Servers, Server Pools, and Policies 7-48 Quiz 7-50 Summary 7-53 Practice 7: Overview 7-54

## 8 Policy-Based Cluster and Capacity Management

Objectives 8-2 Policy-Based Cluster Management Enhancements: Overview 8-3 Server Pools 8-4 Server Pools and Policy-Based Management 8-5 Server Pool Attributes 8-6 Server Pool Attribute Considerations 8-8

GENERIC and FREE Server Pools 8-10 Assignment of Servers to Server Pools 8-12 Creating Server Pools with crsctl and srvctl 8-13 Managing Server Pools with srvctl and crsctl 8-14 Moving Servers Between Server Pools 8-15 Managing Server Pools Using Default Attributes 8-16 Server State Attributes 8-17 Server Categorization: Overview 8-19 Server Categorization 8-20 Administering Server Categorization: Server Attributes 8-21 Administering Server Categorization: Server Categories 8-22 Administering Server Categorization: Server Pools 8-24 Policy Set: Overview 8-25 Policy-Based Cluster Management and QoS Management 8-27 Viewing the Policy Set 8-28 Configuring a User-Defined Policy Set: Method 1 8-29 Configuring a User-Defined Policy Set: Method 2 8-30 Modifying a User-Defined Policy Set 8-31 Activating a User-Defined Policy 8-32 Load-Aware Resource Placement 8-33 Server Weight-Based Node Eviction 8-34 Assigning Weight to Servers and Resources 8-35 Quiz 8-36 Summary 8-39 Practice 8 Overview: Using Policy-Based Cluster Management 8-40

## 9 Upgrading and Patching Grid Infrastructure

Objectives 9-2 Clusterware Upgrading and Patching: Overview 9-3 Oracle Grid Infrastructure Upgrade 9-4 Options for Oracle Grid Infrastructure Upgrades 9-5 Pre-Upgrade Tasks 9-6 Moving Oracle Clusterware Files to Oracle ASM 9-7 Using CVU to Validate Readiness for Clusterware Upgrades 9-8 Understanding Rolling Upgrades Using Batches 9-9 Dry-run Upgrade 9-10 Performing a Rolling Upgrade from an Earlier Release 9-11 Completing a Clusterware Upgrade When Nodes Become Unreachable 9-14 Deinstalling the Old Oracle Clusterware Installation 9-15 Patching: Overview 9-16 Types of Patches 9-17 RU and RUR Download Assistant 9-18 Apply Patches during an Oracle Grid Infrastructure Installation or Upgrade 9-19 Grid Infrastructure Patching with OPatch 9-20 Rolling Patches 9-21 Checking Software Versions 9-22 OPatch: Overview 9-23 OPatch: General Usage 9-24 Before Patching with OPatch 9-25 Installing a Patch Manually Using OPatch 9-26 OPatch Automation 9-28 Installing a Patch Automatically Using OPatchAuto 9-29 OPatch Log and Trace Files 9-30 Queryable Patch Inventory 9-31 Quiz 9-32 Summary 9-34

#### 10 Monitoring and Troubleshooting Oracle Clusterware

**Objectives** 10-2 "Golden Rule" in Debugging Oracle Clusterware 10-3 Oracle Autonomous Health Framework 10-4 Cluster Verify Utility (CVU) 10-5 Clusterware resource (ora.cvu) 10-6 CVU Heath Check Report: Example 10-8 Cluster Verify Components 10-9 Cluster Verify Output: Example 10-11 Cluster Health Monitor (CHM) 10-12 oclumon Utility 10-13 clumon dumpnodeview Command 10-14 oclumon dumpnodeview Command 10-15 oclumon manage Command 10-16 Oclumon dumpnodeview 10-17 Oclumon Version / debug 10-18 Cluster Health Advisor (CHA) 10-19 Cluster Health Advisor: Overview 10-20 Oracle Cluster Health Advisor Architecture 10-21 Using the CHA Command Line Interface chactl 10-22 Managing the CHA Models: Defining "normal" 10-23 CHA Key Performance and Workload Indicators 10-24 Using chactl guery to View Problems and Diagnosis 10-25 Managing the CHA Repository 10-26 Trace File Analyzer (TFA) Collector 10-29

TFA Collector Utility 10-30 TFA Collector Analysis 10-31 TFA Collector Repository 10-32 Managing ADR Logs by Using tfactl managelogs 10-33 Oracle Autonomous Health Framework Components 10-34 Lesson Agenda 10-35 Cluster Resource Activity Log (CALOG) 10-36 Querying and Managing the CALOG 10-37 Lesson Agenda 10-38 ADR Directory Structure 10-39 Files in the Trace Directory 10-40 Clusterware Trace Files 10-41 The Oracle Clusterware Alert Log 10-42 Incident Trace Files 10-43 Other Diagnostic Data 10-44 Lesson Agenda 10-45 Node Eviction: Overview 10-46 Rebootless Node Eviction: Example 10-47 Processes Roles For Node Reboots 10-48 Reboot Advisory in clusterware alert.log 10-49 Other Log & Trace Files to Review 10-52 Possible Troubleshooting Scenario: Example 10-54 Quiz 10-55 Summary 10-58 Practice 10: Overview 10-59

#### 11 Making Applications Highly Available with Oracle Clusterware

Objectives 11-2 Oracle Clusterware High Availability (HA) 11-3 Oracle Clusterware HA Components 11-4 Clusterware Resource Modeling 11-5 Agents 11-6 Action Scripts 11-7 Resource Types 11-7 Resource Types 11-10 Adding a Resource Type with EM 11-11 Using Clusterware to Enable High Availability 11-12 Resource Attributes 11-14 Resource States 11-19 Resource Dependencies 11-20 Start Dependencies 11-21

Stop Dependencies 11-24 Creating a Clusterware Managed Application VIP 11-25 Creating an Application VIP Using EM 11-27 Deciding on a Deployment Scheme 11-28 Registering a Resource 11-29 Registering a Resource: Example 11-30 Adding Resources with EM 11-32 Managing Resources with crsctl 11-35 Managing Clusterware Resources with EM 11-37 Clusterware Resource Groups 11-38 Resource Group: Overview 11-39 Automatic Resource Groups 11-40 Resource Group Privileges 11-41 Resource Group Dependencies 11-42 Resource Group Dependency Types and Modifiers 11-43 Failure and Recovery of Critical Resources 11-44 Failure and Recovery of Non-Critical Resources 11-45 Resource Group Types 11-46 Using Resource Groups 11-47 HA Events: ONS and FAN 11-49 Managing Oracle Notification Server with srvctl 11-50 Quiz 11-51 Summary 11-54 Practice 11: Overview 11-55