Novell ZENworks® Orchestrator

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DEVELOPER GUIDE AND REFERENCE

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About This Guide

The Novell® ZENworks Orchestrator Job Development Guide is a component of the Novell ZENworks Orchestrator documentation library. While Orchestrator provides the broad framework and networking tools to manage complex virtual machines and high performance computing resources in a datacenter, this guide explains how to develop grid application jobs and polices that form the basis of Orchestrator functionality. This guide provides developer information to create and run custom Orchestrator jobs. It also helps provides the basis to build, debug, and maintain policies using Orchestrator.

This guide contains the following sections:

- Chapter 1, “Getting Started,” on page 15
- Chapter 2, “Job Development Concepts,” on page 19
- Chapter 3, “Setting Up a Development Grid,” on page 43
- Chapter 4, “Orchestrator Job Classifications,” on page 49
- Chapter 5, “Developing Policies,” on page 57
- Chapter 6, “Using the Orchestrator Client SDK,” on page 69
- Chapter 7, “Job Architecture,” on page 71
- Chapter 8, “Job Scheduling,” on page 87
- Chapter 9, “Virtual Machine Job Development,” on page 113
- Chapter 10, “Complete Job Examples,” on page 143
- Appendix B, “Orchestrator Job Classes and JDL Syntax,” on page 223
- Appendix A, “Orchestrator Client SDK,” on page 211
- Appendix C, “Orchestrator Job Scheduling DTD,” on page 313

Audience

This guide is intended for use by application developers and technically advanced datacenter technicians assigned to write Job Description Language (JDL) jobs to manage all resources in a Orchestrator-enabled environment. It assumes that users have the following background:

- Thorough understanding of concepts related to Novell ZENworks Orchestrator.
- Experience with the Python programming language.
- General understanding of network, operating environments, and systems architecture.
- Knowledge of basic UNIX* shell commands, Windows* command line tools, and text editors.
- An understanding of parallel computing and applications running on grid network infrastructures.

Documentation Updates

For the most recent version of this *Installation and Getting Started Guide*, visit the ZENworks Orchestrator 1.2 Web site (http://www.novell.com/documentation/zen_orchestrator12/).

Additional Documentation

For additional documentation that might assist you in developing Orchestrator jobs, see the following guides:

- *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*
- *Novell ZENworks Orchestrator 1.2 Job Management Guide*
- *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*

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Other typographical conventions used in this guide include the following:

Convention	Description
Italics	Indicates variables, new terms and concepts, and book titles. For example, a job is a piece of work that describes how an application can be run in Grid Management on multiple computers.
Boldface	Used for advisory terms such as Note, Tip, Important, Caution, and Warning.
Keycaps	Used to indicate keys on the keyboard that you press to implement an action. If you must press two or more keys simultaneously, keycaps are joined with a hyphen. For example, Ctrl-C. Indicates that you must press two or more keys to implement an action. Simultaneous keystrokes (in which you press down the first key while you type the second character) are joined with a hyphen; for example, press Stop-a. Consecutive keystrokes (in which you press down the first key, then type the second character) are joined with a plus sign; for example, press F4+q.

Convention	Description
Fixed-width	Used to indicate various types of items. These include: Commands that you enter directly, code examples, user type-ins in body text, and options. For example, cd mydir System.out.println("Hello World"); Enter abc123 in the Password box, then click Next. -keep option Jobs and policy keywords and identifiers. For example, <run> </run> File and directory names. For example, /usr/local/bin **Note:** UNIX path names are used throughout and are indicated with a forward slash (/). If you are using the Windows platform, substitute backslashes (\) for the forward slashes (/).
Fixed-width italic and <Fixed-width italic>	Indicates variables in commands and code. For example, zos login <servername> [--user=] [--passwd=] [--port=] **Note:** Angle brackets (< >) are used to indicate variables in directory paths and command options.
| (pipe)	Used as a separator in menu commands that you select in a graphical user interface (GUI), and to separate choices in a syntax line. For example, File|New {a|b|c} [a|b|c]
{ } (braces)	Indicates a set of required choices in a syntax line. For example, {a|b|c} means you must choose a, b, or c.
[ ] (brackets)	Indicates optional items in a syntax line. For example, [a|b|c] means you can choose a, b, c, or nothing.
< > (angle brackets)	Used for XML content elements and tags, and to indicate variables in directory paths and command options. For example, <template> <DIR> -class <class>

Convention	Description
. . . (horizontal ellipses)	Used to indicate that portions of a code example have been omitted to simplify the discussion, and to indicate that an argument can be repeated several times in a command line. For example, zosadmin [options|optfile.xmlc ...] docfile
plain text	Used for URLs, generic references to objects, and all items that do not require special typography. For example, http://www.novell.com/documentation/index.html The presentation object is in the presentation layer.
ALL CAPS	Used for SQL statements and HTML elements. For example, CREATE statement <INPUT>
lowercase	Used for XML elements. For example, <onevent> **Note:** XML is case-sensitive. If an existing XML element uses mixed-case or uppercase, it is shown in that case. Otherwise, XML elements are in lowercase.
Grid Management Server root directory	Where the ZENworks Orchestrator Server is installed. The GMStrexecutables and libraries are in a directory. This directory is referred to as the Grid Management Server root directory or <Grid Management Server_root>.
Paths	UNIX path names are used throughout and are indicated with a forward slash (/). If you are using the Windows platform, substitute backslashes (\) for the forward slashes (/). For example, UNIX: /usr/local/bin Windows: \usr\local\bin
URLs	URLs are indicated in plain text and are generally fully qualified. For example, http://www.novell.com/documentation/index.html
Screen shots	Most screen shots reflect the Microsoft Windows look and feel.

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Getting Started

1

This *Developer Guide* for Novell™ ZENworks™ Orchestrator 1.2 provides information on how to assemble, deploy, and manage grid applications—called "jobs"—on the ZENworks Orchestrator Server. This guide also explains how to build, debug, and maintain policies that manage jobs running on the Orchestrator Server.

This section includes the following information:

- Section 1.1, "What You Should Know," on page 15
- Section 1.2, "Orchestrator Documentation Set," on page 16
- Section 1.3, "Prerequisites for the Development Environment," on page 17

1.1 What You Should Know

This section includes the following information:

- Section 1.1.1, "Prerequisite Knowledge," on page 15
- Section 1.1.2, "Setting Up Your Development Environment," on page 16

1.1.1 Prerequisite Knowledge

This guide assumes you have the following background:

- Sound understanding of networks, operating environments, and system architectures.
- Familiarity with the Python development language. For more information, see the following online references:
  - **Python Development Environment (PyDEV):** The PyDEV plug-in (http://pydev.sourceforge.net/) enables developers to use Eclipse* for Python and Jython development. The plug-in makes Eclipse a more robust Python IDE and comes with tools such as code completion, syntax highlighting, syntax analysis, refactor, debug and many others.
  - **Python Reference Manual:** This reference (http://python.org/doc/2.2.3/ref/ref.html) describes the exact syntax and semantics but does not describe the Python Library Reference, (http://python.org/doc/2.2.3/lib/lib.html) which is distributed with the language and assists in development.
  - **Python Tutorial:** This online tutorial (http://python.org/doc/2.2.3/tut/tut.html)helps developers get started with Python.
  - **Extending and Embedding the Python Interpreter:** This resource (http://python.org/doc/2.2.3/ext/ext.html) describes how to add new extensions to Python and how to embed it in other applications.
- Sound understanding of the ZENworks Orchestrator Job Development Language (JDL).

  JDL integrates compact Python scripts to create jobs to manage nearly every aspect of the Orchestrator grid. For more information, see Appendix B, "Orchestrator Job Classes and JDL Syntax," on page 223.

- Knowledge of basic UNIX shell commands or the Windows command prompt, and text editors.
- An understanding of parallel computing and how applications are run on ZENworks Orchestrator infrastructure.
- Familiarity with on-line ZENworks Orchestrator API Javadoc as you build custom client applications. For more information see Appendix A, "Orchestrator Client SDK," on page 211.
- Developer must assume both Orchestrator administrative and end-user roles while testing and debugging jobs.

1.1.2 Setting Up Your Development Environment

To set up a development environment for creating jobs, we recommend the following procedure:

1. Initially set up a simple, easy-to-manage server, agent, and client on a single machine. Even on a single machine, you can simulate multiple servers by starting extra agents (see "Independent Installation of the Agent and Clients".
2. As you get closer to a production environment, your setup might evolve to handle more complex system demands, such as any of the the following:
   - A server deployed on one computer.
   - An agent installed on every managed server.
   - A client installed on your client machine.

     From your client machine you can build jobs/policies, and then remotely deploy them using *zosadmin Command Line* tool. You can then remotely modify the jobs and other grid object through the Orchestrator Console.
3. Use a version control system, such as Subversion*, to organize and track development changes.
4. Put the job version number inside the deployed file at make time. This will help you keep your job versions organized.
5. Create make or Ant controls for bundling and deploying your jobs.
6. After you are familiar with more simple jobs, you will want to move to more complex "meta jobs," which enable you to tie together several applications in a service. These jobs will include startup dependencies and other logic to enable one application job code with different parameters and policies to be used in more than one service.
7. To enhance the robustness of your jobs, we suggest you deploy all jobs to more than one site, with different policies activated at each site.
8. Ideally, to leverage the flexibility of the Orchestrator environment, you should not have to write jobs targeted specifically for one container technology (Xen, VMWare, etc.).

1.2 Orchestrator Documentation Set

Before developing, deploying, and managing the Orchestrator jobs explained in this document, you should have a thorough understanding of how to deploy and manage all product components. These administrative tasks are explained in the following documents in both PDF and HTML formats:

- Section 1.2.1, "Novell ZENworks Orchestrator Getting Started Guide," on page 17
- Section 1.2.2, "Novell ZENworks Orchestrator Administration Guide," on page 17
- Section 1.2.3, "Novell ZENworks Orchestrator Virtual Machine Management Guide," on page 17

- Section 1.2.4, “Novell ZENworks Orchestrator Job Management Guide,” on page 17

1.2.1 Novell ZENworks Orchestrator Getting Started Guide

The *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide* introduces ZENworks Orchestrator 1.2, including its basic administration environment, which is accessed either through the Orchestrator console or the zos command line. It provides an introductory overview of Orchestrator components and explains how to install, monitor, and manage applications running on the Orchestrator. The guide provides basic startup and management instructions for system administrators.

1.2.2 Novell ZENworks Orchestrator Administration Guide

The *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide* provides basic information on how to deploy and manage specific, basic jobs on the ZENworks Orchestrator Grid Management Server using the resources available in the data center. Job managers typically have limited rights and responsibilities and are not expected to know the intricacies of the Orchestrator or to understand how to create the jobs themselves.

1.2.3 Novell ZENworks Orchestrator Virtual Machine Management Guide

The *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide* introduces Novell ZENworks Virtual Machine Management, including its basic administration environment, which is accessed through an Eclipse interface console, and its interface for developers, which is accessed through the developer portal. The guide provides an introductory overview of virtual machine management (VMM), explains how to install, monitor, and manage VMs and coordinate their management with applications running on the Orchestrator.

1.2.4 Novell ZENworks Orchestrator Job Management Guide

The *Novell ZENworks Orchestrator 1.2 Job Management Guide* provides in-depth information on the ZENworks Orchestrator Console, a thin-client browser console, and the ZENworks Orchestrator user grid command-line management and deployment tool. It is anticipated that developers will typically develop jobs using the zos command line tool, while higher level system administrators will use the ZENworks GUI-based interfaces to submit, deploy and run jobs and manage network resources.

1.3 Prerequisites for the Development Environment

- Install the Java* Development Kit (https://sdlc3d.sun.com/ECom/EComActionServlet;jsessionid=DCA955A842E56492B469230CC680B2E1), version 1.5 or later, to create jobs and to compile a Java SDK client in the Orchestrator environment.The Orchestrator installer ships with a Java Runtime Environment (JRE) suitable for running Orchestrator jobs.

- **Components to write Python-based Job Description Language (JDL) scripts:**
  - Eclipse version 3.2.1 or later. (http://www.eclipse.org/) is the interface console accessed through the developer portal.
- **Product License:** To expose full product functionality and access to all job examples, you should be provisioned with a 90-day trial license SKU. If not, you need to add additional example jobs to customize your setup profile to mirror a fully enabled Novell ZENworks Server. If you need to customize setup profile, go to "Tested Platforms and Installation Methods for the Orchestrator Server, Agent, and Clients" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.
- **Development Environment:** Set up your environment according to the guidelines outlined in "Planning the Installation." In general, the deployed Orchestrator Server requires 2 (minimum for 100 or fewer managed resources) to 4 gigabytes (recommended for more than 100 managed resources) of RAM. By default, the Orchestrator Server is configured to use 1 gigabyte of memory.
- **Network Capabilities:** For Virtual Machine Management, you need a high-speed Gigabit Ethernet. For more information about network requirements, see "Installing the VM Management Interface".
- **Initial Configuration:** After you install and configure Orchestrator, start in the auto registration mode as described in "First Use of Basic ZENworks Orchestrator Components." As a first-time connection, the server creates an account for you as you set up a self-contained system.

IMPORTANT: Because auto registration mode does not provide high security, make sure you prevent unauthorized access to your network from your work station during development. As you migrate to a production environment, be certain that promiscuous mode is deactivated.

Job Development Concepts

2

This document is written for individuals who assume the role of Novell® ZENworks® Orchestrator job developers, rather than network administrators or system technicians who later deploy the jobs that developers create. This document discusses the tools and technology required to create discrete programming scripts—called "jobs"—that control nearly every aspect of the Orchestrator product.

As a job developer, you need your own self-contained, standalone system with full access to your network environment. At one point or another, you will assume all system roles: job creator, job deployer, system administrator, tester, etc. For more information about jobs, see "Jobs" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.

This section provides conceptual information to help you create your own Novell ZENworks Orchestrator jobs:

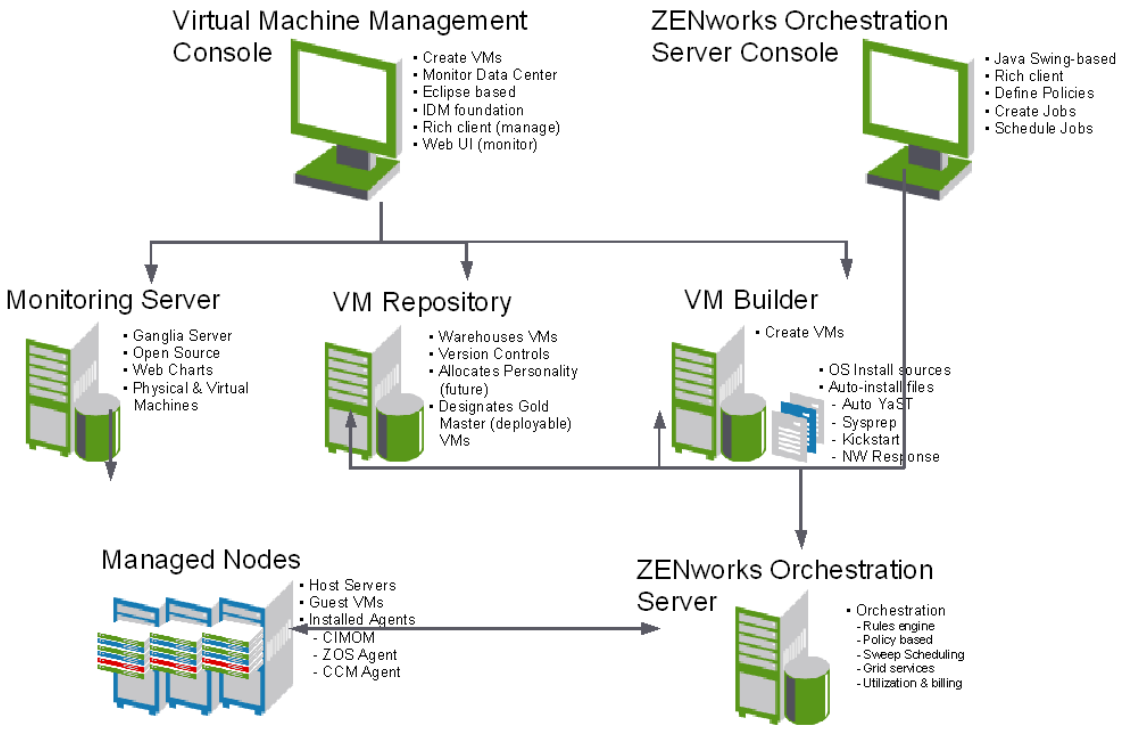
- Section 2.1, "Orchestrator Development Architecture," on page 19
- Section 2.2, "Understanding ZENworks Orchestrator Functionality," on page 30
- Section 2.3, "JDL Job Scripts," on page 37
- Section 2.4, "Understanding TLS Encryption," on page 39
- Section 2.5, "Understanding Job Examples," on page 40

2.1 Orchestrator Development Architecture

Novell ZENworks Orchestrator is an advanced datacenter management solution designed to manage all network resources. It provides the infrastructure that manages group of ten, one hundred, or thousands of of physical or virtual resources.

Orchestrator is equally apt at performing a number of distributed processing problems. From high performance computing, the breaking down of work into lots of small chucks that can be processed in parallel through distributed job scheduling. The following figure shows the product's high-level architecture:

Figure 2-1 *ZENworks Orchestrator*



2.1.1 Orchestrator Agents

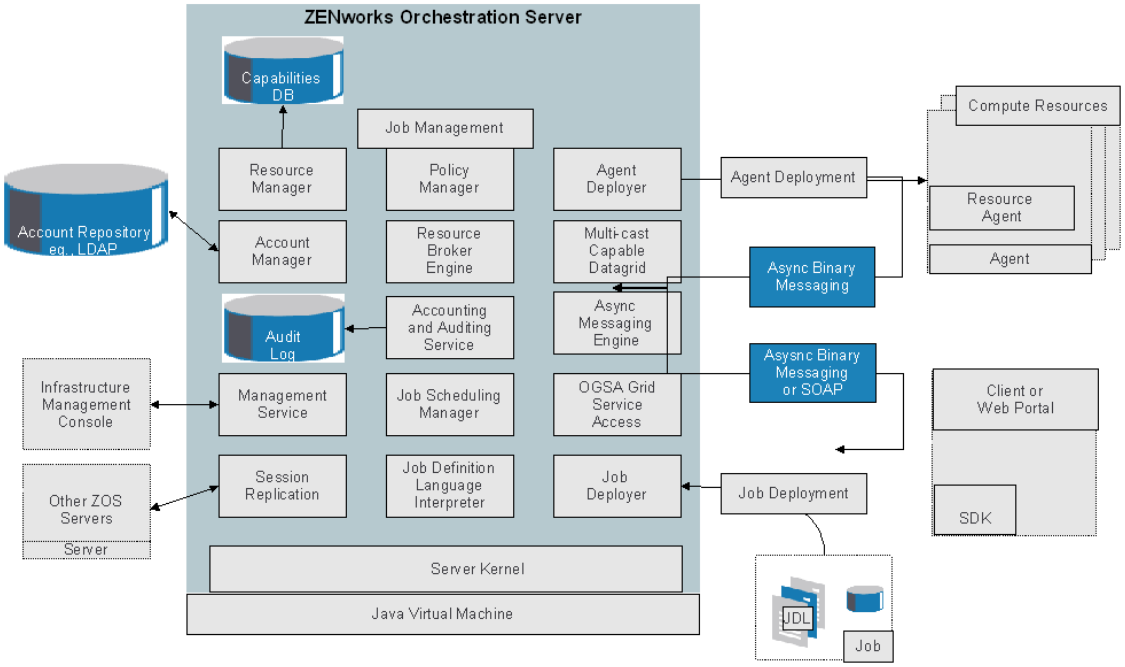
Agents are installed on all managed resources as part of the product deployment. For more detailed information about these components, see "Software Architecture" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.

The agent connects every managed resource to its configured server and advertises to the ZENworks Orchestrator Server that the resource is available for tasks. This persistent and auto-reestablishing connection is important because it provides a message bus for the distribution of work, collection of information about the resource, per-job messaging, health checks, and resource failover control.

After resources are enabled, Orchestrator can discover, access, and store detailed abstracted information—called "facts"—about every resource. Managed resources, referred to as "nodes," are addressable members of the of the Orchestrator Server "grid" (also sometimes called the "matrix"). When integrated into the grid, nodes can be deployed, monitored, and managed by the Orchestrator Server, as discussed in Section 2.2, "Understanding ZENworks Orchestrator Functionality," on page 30.

An overview of the Orchestrator grid architecture is illustrated in the figure below, much of which is explained in this developer's guide:

Figure 2-2 *Orchestrator Server Architecture*



For additional information about job architecture, see Chapter 7, “Job Architecture,” on page 71.

2.1.2 Orchestrator Resource Monitor

ZENworks Orchestrator enables you to monitor your system computing resources using the built-in Resource Monitor. To open the Resource Monitor in the console, see “Monitoring Server Resources” in the *ZENworks Orchestrator Administration Guide*.

2.1.3 Orchestrator Entity Types and Managers

The following entities are some of key components involved in the Orchestrator Server:

- “Resources” on page 22
- “Users” on page 22
- “Job Definitions” on page 22
- “Job Instances” on page 22
- “Policies” on page 22
- “Facts” on page 22
- “Constraints” on page 23
- “Groups” on page 24
- “VM: Hosts, Images, and Instances” on page 24
- “Templates” on page 24

Resources

All managed resources, which are called nodes, have an agent with a socket connection to the Orchestrator Server. All resource use is metered, controlled, and audited by the Orchestrator Server. Policies govern the use of resources.

Orchestrator allocates resources by reacting as load is increased on a resource. As soon as we go above a threshold that was set in a policy, a new resource is allocated and consequently the load on that resource drops to an acceptable rate.

You can also write and jobs that perform cost accounting to account for the cost of a resource up through the job hierarchy, periodically, about every 20 seconds. For more information, see Section 4.5, “Auditing and Accounting Jobs,” on page 56.

A collection of jobs, all under the same hierarchy, can cooperate with each other so that when one job offers to give up a resource it is reallocated to another similar priority job. Similarly, when a higher priority job becomes overloaded and is waiting on a resource, the system “steals” a resource from a lower priority job, thus increasing load on the low priority job and allocating it to the higher priority job. This process satisfies the policy, which specifies that a higher priority job must complete at the expense of a low priority job.

Users

Orchestrator users must authenticate to access the system. Access and use of system resources are governed by policies.

Job Definitions

A job definition is described in the embedded enhanced Python script that you create as a job developer. Each job instance runs a job that is defined by the Job Definition Lannguage (JDL). Job definitions might also contain usage policies. For more information, see the Job (page 265) class.

Job Instances

Jobs are instantiated at runtime from job definitions that inherit policies from the entire context of the job (such as users, job definitions, resources, or groups). For more information, see JobInfo (page 275).

Policies

Policies are XML documents that contain various constraints and static fact assignments that govern how jobs run in the Orchestrator environment.

Policies are used to enforce quotas, job queuing, resource restrictions, permissions, and other job parameters. Policies can be associated with any Orchestrator object. For more information, see Section 2.2.2, “Policy-Based Management,” on page 31.

Facts

Facts represent the state of any object in the Orchestrator grid. They can be discovered through a job or they can be explicitly set.

Facts control the behavior a job (or joblet) when it’s executing. Facts also detect and return information about that job in various UIs and server functions. For example, a job description that is

set through its policy and has a specified value might do absolutely nothing except return immediately after network latency.

There are three basic types of facts:

- **Static:** Facts that require you to set a value. For example, in a policy, you might set a value to be False. Static facts can be modified through policies.
- **Dynamic:** Facts produced by the Orchestrator system itself. Policies cannot override dynamic facts. They are read only and their value is determined by the orchestrator itself.
- **Computed:** Facts derived from a value, like that generated from the cell of a spreadsheet. Computed facts have some kind of logic behind them which derive their values.

  For example, you might have two numeric facts that you want expressed in another fact as an average of the two. You could compose a computed fact which averages two other facts and express it as an average value under a certain fact name. This enables you to create facts that represent other metrics on the system that aren't necessarily available in the default set, or are not static to anything that might impact other dynamic facts.

For more information about facts, see Section 5.1.2, "Facts," on page 57.

Constraints

In order for the Orchestrator to choose resources for a job, it uses resource constraints. A resource constraint is some Boolean logic that executes against facts in the system. Based upon this evaluation, it will only consider resources that match the criteria that have been set up by use of constraints.

For more detailed information, see Section 7.7, "Working with Facts and Constraints," on page 76 and the following JDL constraint definitions:

- AndConstraint() (page 229)
- BinaryConstraint (page 231)
- Constraint (page 239)
- ContainerConstraint (page 240)
- ContainsConstraint (page 241)
- DefinedConstraint (page 247)
- EqConstraint (page 248)
- GeConstraint (page 258)
- GtConstraint (page 263)
- LeConstraint (page 284)
- LtConstraint (page 285)
- NeConstraint (page 290)
- NotConstraint (page 291)
- OrConstraint (page 292)
- UndefinedConstraint (page 308)

Groups

Resources, users, job definitions and virtual machines (VM) are managed in groups with group policies that are inherited by members of the group. For more information, see ***see “Job Info/ Groups” in the *ZENworks Orchestrator Administration Guide*

VM: Hosts, Images, and Instances

A virtual machine host is a resource that is able to run guest operating systems. Attributes (facts) associated with the VM host control its limitations and functionality within the Orchestrator Server. A VM image is a resource image that can be cloned and/or provisioned. A VM instance represents a running copy of a VM image.

Templates

Templates are images that are meant to be cloned (copied) prior to provisioning the new copy. For more information, see “Building and Discovering and VMs” in the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

2.1.4 Jobs

The Orchestrator server manages all nodes by administering jobs (and the functional control of jobs at the resource level by using joblets), which control the properties (facts) associated with every resource. In other words, jobs are units of functionality that dispatch data center tasks to resources on the network such as management, migration, monitoring, load balancing, etc.

Orchestrator provides a unique job development, debugging, and deployment environment that expands with the demands of growing data centers.

As a job developer, your task is to develop jobs to perform a wide array of work that can be deployed and managed by ZENworks Orchestrator.

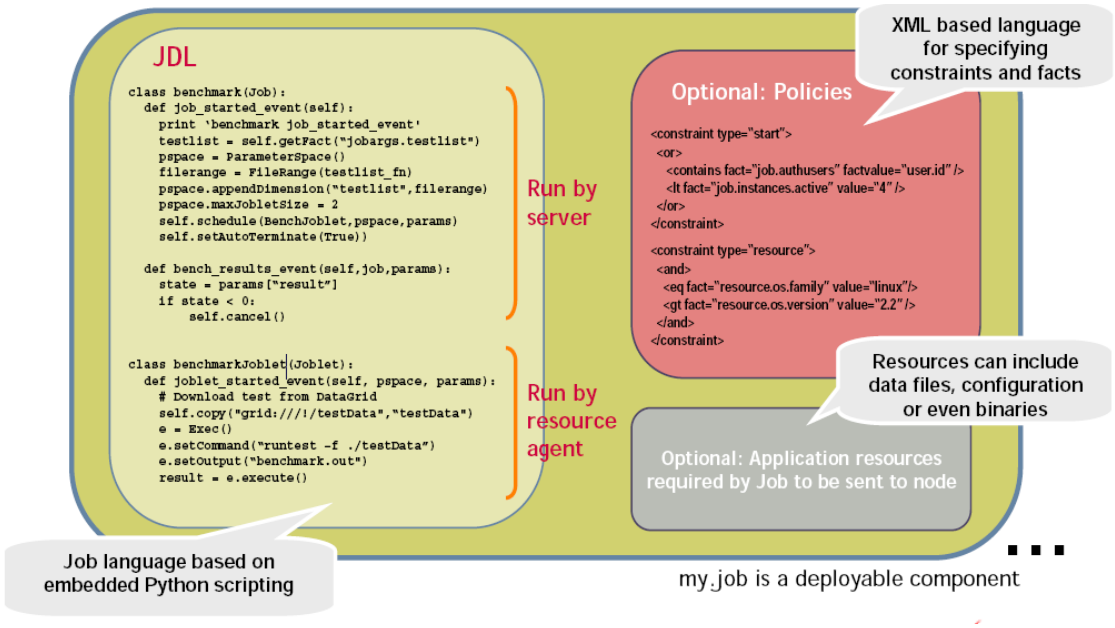
Jobs, which run on the Orchestrator server, can provide functions within the Orchestrator environment that might last from seconds to months. Job and joblet code exist in the same script file and are indentified by the `.jdl` extension. The Python script contains only one job definition and zero or rmore joblet definitions.

A job file also might have policies associated with it to define and control the job’s behavior and to define and to define certain constraints restricting its execution. A .jdl script that is accompanied by a policy file is typically packaged in a job archive file (.job). Because a .job file is physically equivalent to a Java archive file (.jar), you can use the JDK JAR tool to create the job archive.

Multiple job archives can be delivered as a management pack in a service archive file (SAR) identified with the .sar extension. Typically, a group of related files are delivered this way. For example, the xen30 management pack is a SAR.

As shown in the following illustration, jobs include all of the code, policy, and data elements necessary to execute specific, predetermined tasks administered either through the ZENworks Orchestrator console, or from the zos command line tool.

Figure 2-3 *Components of an Orchestrator Job (`my.job`)*



Because each job has specific, predefined elements, jobs can be scripted and delivered to any agent, which ultimately can lead to automating almost any datacenter task. Jobs provide the following functionality:

- "Controlling Process Flow" on page 25
- "Parallel Processing" on page 25
- "Managing the Cluster Life Cycle" on page 26
- "Discovery Jobs" on page 26
- "System Jobs" on page 26
- "Provisioning Jobs" on page 27

For more information, see Chapter 4, "Orchestrator Job Classifications," on page 49 and the JDL job class definitions:

- Job (page 265)
- JobInfo (page 275)

Controlling Process Flow

Jobs can written to control all operations and processes of managed resources. Through jobs, the Orchestrator Server manages resources to perform work. Automated jobs (written in JDL), are broken down into joblets, which are distributed among multiple resources.

Parallel Processing

By managing many small joblets, the Orchestrator server can enhance system performance and maximize resource use.

Managing the Cluster Life Cycle

Jobs can detect demand and monitor health of system resources, then modify clusters automatically to maximize system performance and provide failover services.

Discovery Jobs

Some jobs provide inspection of resources to more effectively management assets. These jobs enable all agents to periodically report basic resource facts and performance metrics. In essence, these metrics are stored as facts consisting of a key word and typed-value pairs like the following example:

```
resource.loadaverage=4.563, type=float
```

Jobs can poll resources and automatically trigger other jobs if resource performance values reach certain levels.

The system job scheduler is used to run resource discovery jobs to augment resource facts as demands change on resources. This can be done on a routine, scheduled basis or whenever new resources are provisioned, new software is installed, bandwidth changes occur, OS patches are deployed, or other events occur that might impact the system.

Consequently, resource facts form a capabilities database for the entire system. Jobs can be written that apply constraints to facts in policies, thus providing very granular control of all resources as required. All active resources are searchable and records are retained for all off-line resources.

The following `osInfo.job` example shows how a job sets operating system facts for specific resources:

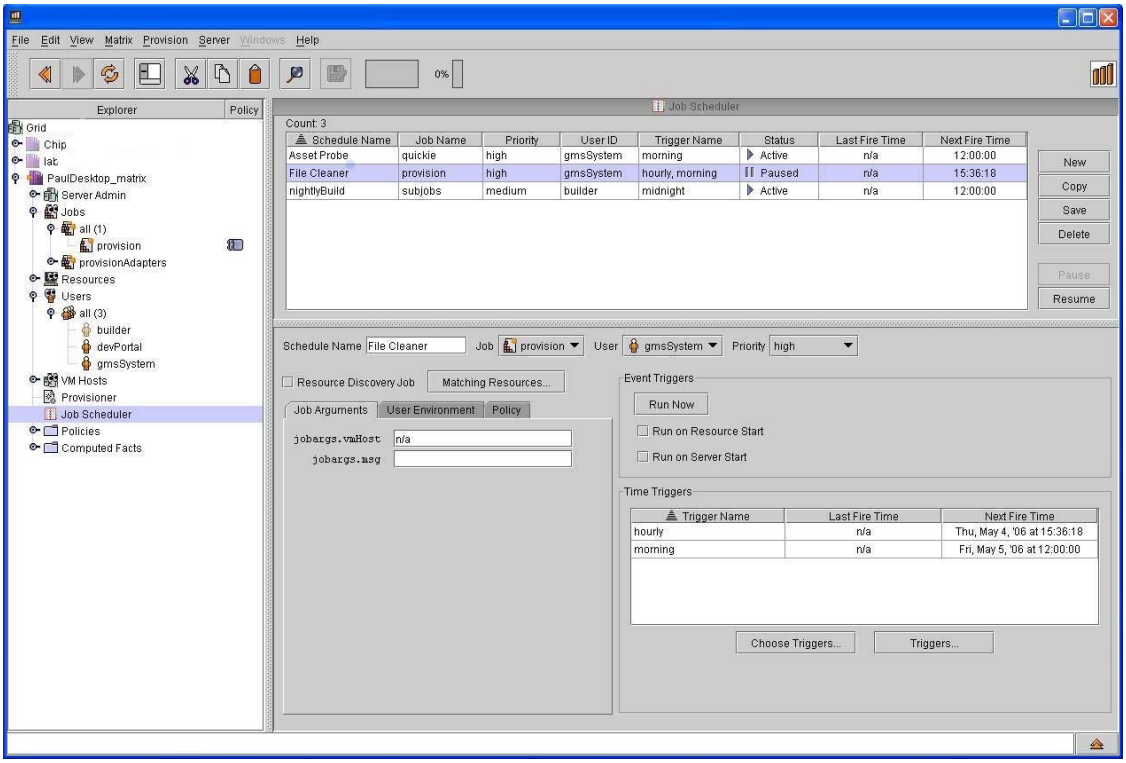
```
resource.cpu.mhz (integer) e.g., "800" (in Mhz)
    resource.cpy.vendor (string) e.g. "GenuineIntel"
    resource.cpu.model (string) e.g. "Pentium III"
    resource.cpu.family (string) e.g. "i686"
```

`osInfo.job` is packaged as a single cross-platform job and includes the Python-based JDL and a policy to set the timeout. It is run each time a new resource appears and once every 24 hours to ensure validity of the resources. For a more detailed review of this example, see osInfo.job (page 51).

System Jobs

Jobs can be scheduled to to periodically trigger specific system resources based on specific time constraints or events. As shown in the following figure, Orchestrator provides a built-in job scheduler that enables you or system administrators to flexibly deploy and run jobs.

Figure 2-4 *Orchestrator Job Scheduler*



For more information, see Section 4.2, “Dynamic Scheduling,” on page 51, Chapter 8, “Job Scheduling,” on page 87, and Job (page 265).

Provisioning Jobs

Jobs also drive provisioning for virtual machines and blade servers. Provisioning adapter jobs are deployed and organized into appropriate job groups for management convenience. Provisioning adapters are deployed as part of your VMM license. For more information, see Section 9.2.1, “VM Provisioning,” on page 115 and “Provisioning Adapter Jobs” in the *ZENworks Orchestrator Administration Guide*.

2.1.5 Constraint-Based Job Scheduling

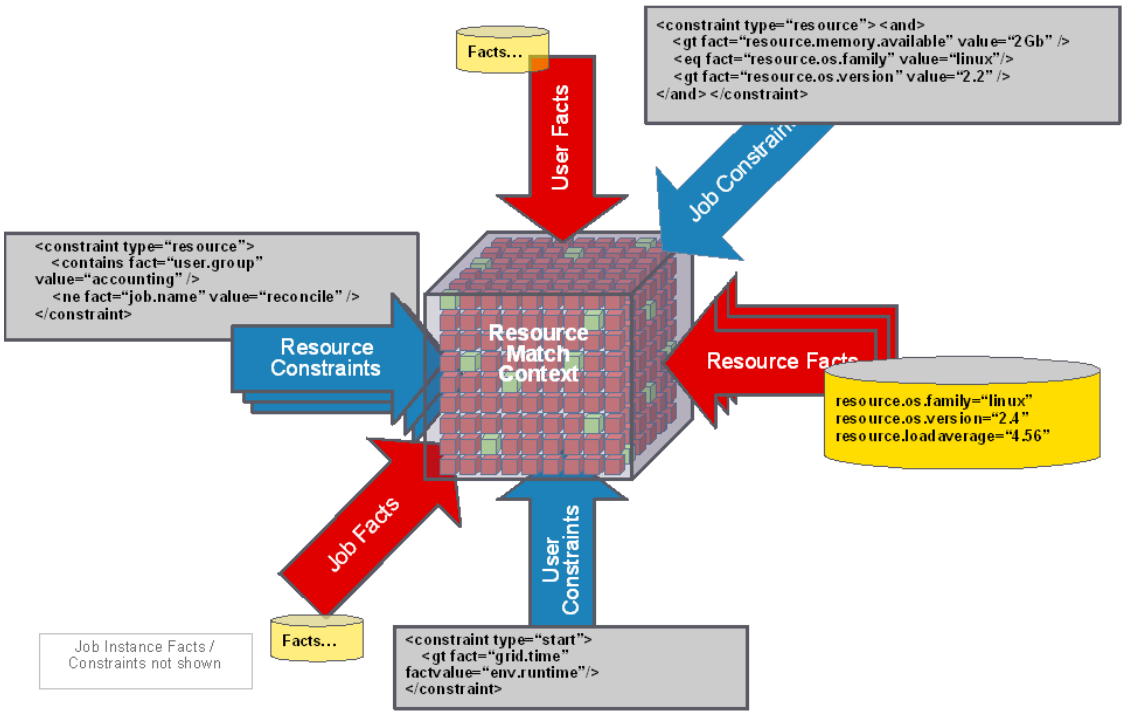
The Orchestrator Server is a “broker” that can distribute jobs to every “partner” agent on the grid. Based on assigned policies, jobs have priorities and are executed based on the following contexts:

- User Constraints
- User Facts
- Job Constraints
- Job Facts
- Job Instance
- Resource User Constraints
- Resource Facts

- Groups

Each object in a job context contains the following elements:

Figure 2-5 *Constraint-Based Resource Brokering*



For more information, see Section 7.7, "Working with Facts and Constraints," on page 76.

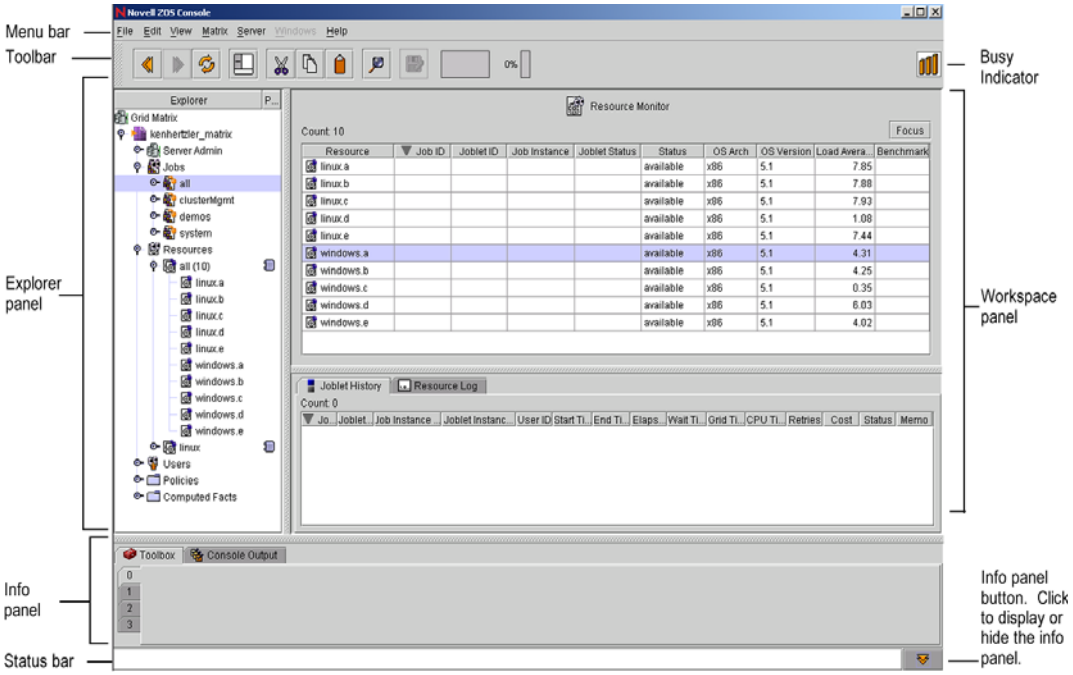
2.1.6 Understanding Orchestrator API Interfaces

There are three API interfaces available to the Orchestrator Server:

- **Orchestrator Server Management Interface:** The ZENworks Orchestrator server, written entirely in Java using the JMX (Java MBean) interface for management, leverages this API for the ZENworks Orchestrator Console. The console is a robust desktop GUI designed for administrators to apply, manage, and monitor usage-based policies on all infrastructure resources. The console also provides at-a-glance grid health and capacity checks.

  For more information, see "Using the ZENworks Orchestrator Console" in the *ZENworks Orchestrator Administration Guide.*

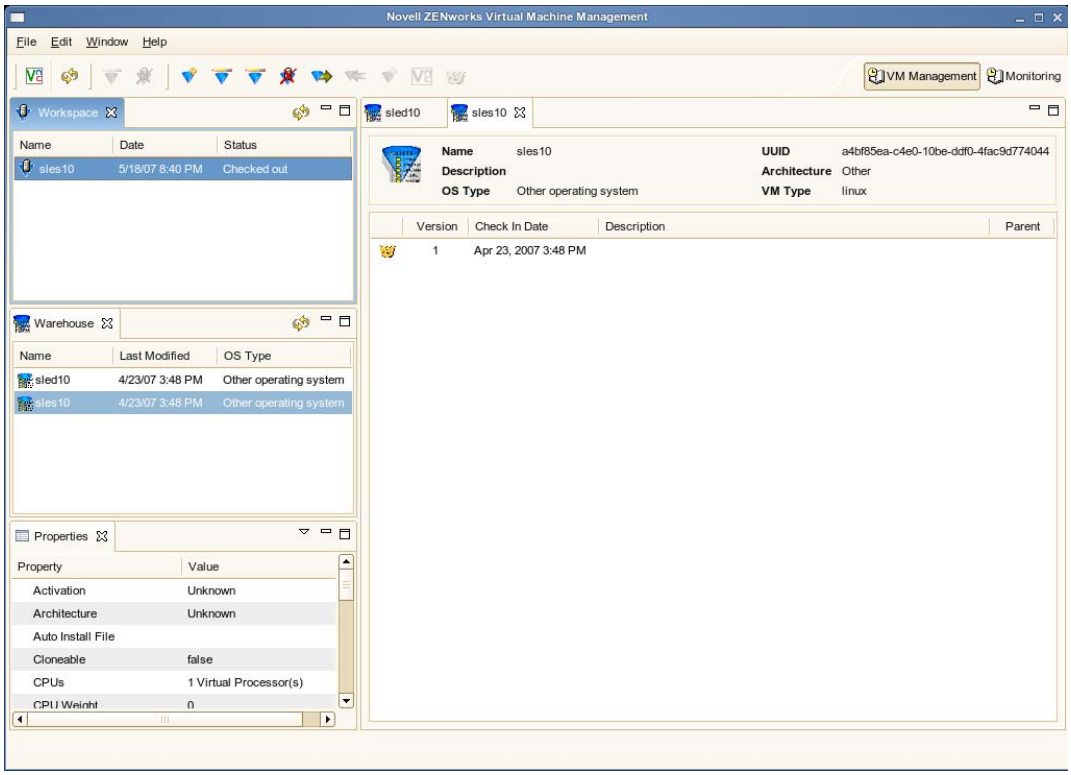
Figure 2-6 *Novell ZENworks Orchestrator Console*



- **Job Interface:** Includes a customizable/replaceable Web application and the zosadmin command line tool. The Web-based User Portal built with this API provides a universal job viewer from which job logs and progress can be monitored. The job interface is accessible via a Java API or CLI. A subset is also available as a Web Service. The default Orchestrator Developer Portal web application leverages this API. It can be customized or alternative J2EE* application can be written.
- **ZENworks Monitoring System:** Monitors all aspects of the data center through an open source, Eclipse*-based interrface.This interface operates in conjunction with the Orchestrator Server and monitors the following objects:
  - Deployed jobs that teach Orchestrator and provide the control logic that Orchestrator runs when performing its management tasks.
  - Users and Groups
  - Virtual Machines

  For more information, see the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

Figure 2-7 *Novell ZENworks Orchestrator Virtual Machine Manager interface.*



2.2 Understanding ZENworks Orchestrator Functionality

- Section 2.2.1, “Resource Virtualization,” on page 30
- Section 2.2.2, “Policy-Based Management,” on page 31
- Section 2.2.3, “Global Resource Visualization,” on page 32
- Section 2.2.4, “Understanding Job Semantics,” on page 34
- Section 2.2.5, “Distributed Messaging and Failover,” on page 35
- Section 2.2.6, “Web-Based User Interaction,” on page 36

2.2.1 Resource Virtualization

Host machines or test targets managed by the Orchestrator Server form nodes on the grid (sometimes referred to as the matrix). All resources are virtualized for access by maintaining a capabilities database containing extensive information (facts) for each managed resource.

This information is automatically polled and obtained from each resource periodically or when it first comes online. The extent of the resource information the system can gather is customizable and highly extensible, controlled by the jobs you create and deploy.

The ZENworks Virtual Machine Builder is a service of VM Management that allows you to build a VM to precise specifications required for your data center. You designate the parameters required: processor, memory, hard drive space, operating system, virtualization type, if it’s based of an auto-install file, and any additional parameters. When you lauch the build job, VM Builder sends the

build request to a machine that meets the hardware requirements of the defined VM and builds the VM there.

For more information, see “Building a Virtual Machine” in the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

2.2.2 Policy-Based Management

Policies are aggregations of facts and constraints that are used to enforce quotas, job queuing, resource restrictions, permissions, and other user and resource functions. Policies can be set on all objects and are inherited, which facilitates implementation within related resources.

Facts, which might be static, dynamic or computed for complex logic, are used when jobs or test scenarios require resources in order to select a resource that exactly matches the requirements of the test, and to control the access and assignment of resources to particular jobs, users, projects, etc. through policies. This abstraction keeps the infrastructure fluid and allows for easy resource substitution.

Of course, direct named access is also possible. An example of a policy that constrains the selection of a resource for a particular job or test is shown in the figure below. Although resource constraints can be applied at the policy level, they can also be described by the job itself or even dynamically composed at runtime.

Figure 2-8 *Resource Selection Policy Example*

```
<policy>
  <constraint type="resource">
    <and>
      <eq fact="resource.os.family" value="Linux" />
      <gt fact="resource.os.version" value="2.2" />
    <and>
  </constraint>
</policy>
```

An example of a policy that constrains the start of a job or test because too many tests are already in progress is shown in the following figure:

Figure 2-9 *Job/Test Start Policy Example*

```
<policy>
   <!-- Constrains the job to limit the number of running jobs to a
defined value but exempt certain users from this limit. All jobs
that attempt to exceed the limit are queued until the running jobs
count decreases and the constraint passes. -->

<constraint type="start" reason="Too busy">
      <or>
         <lt fact="job.instances.active" value="5" />
         <eq fact="user.name" value="canary" />
      </or>
   </constraint>
</policy>
```

See also:

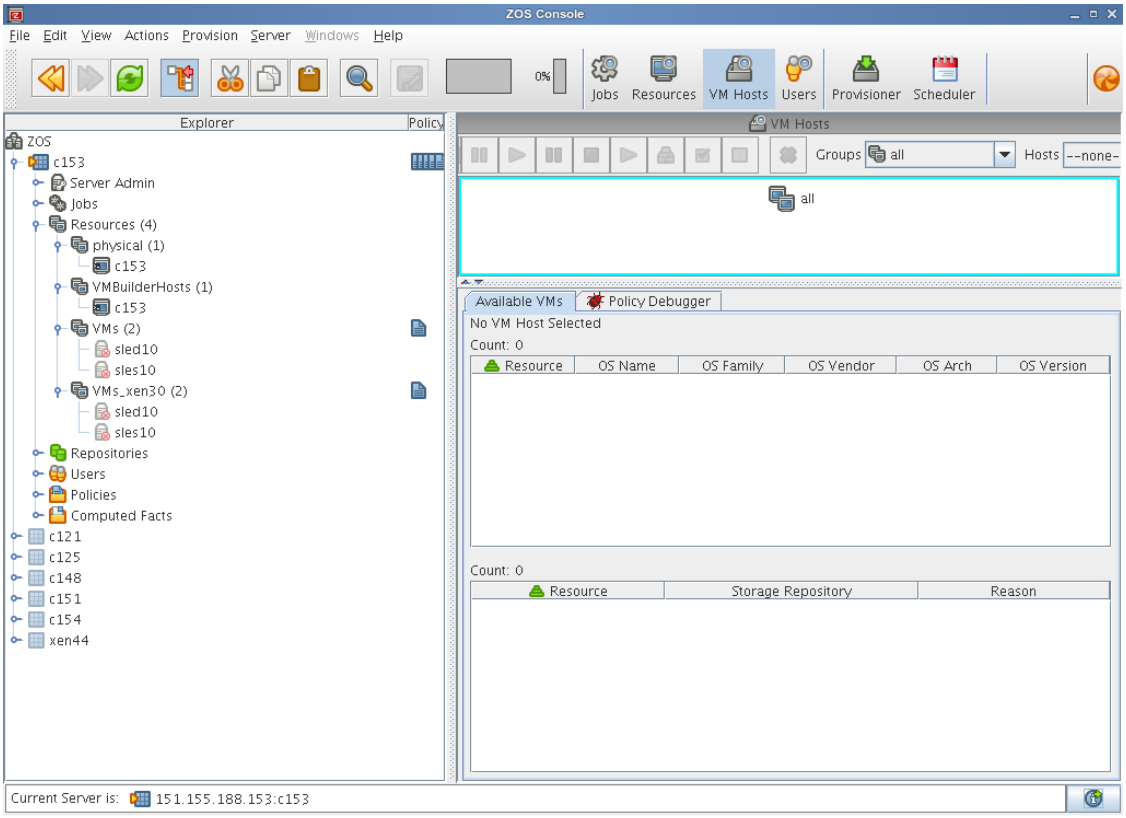
- Chapter 5, “Developing Policies,” on page 57.
- Chapter 7, “Job Architecture,” on page 71.

2.2.3 Global Resource Visualization

One of the greatest strengths of the Novell ZENworks Orchestrator solution is the ability to manage and visualize the entire grid. This is performed through the ZENworks Orchestrator Console and the ZENworks Monitoring System.

The desktop console is a Java application that has broad platform support and provides job, resource, and user views of activity as well as access to the historical audit database system, cost accounting, and other graphing features.

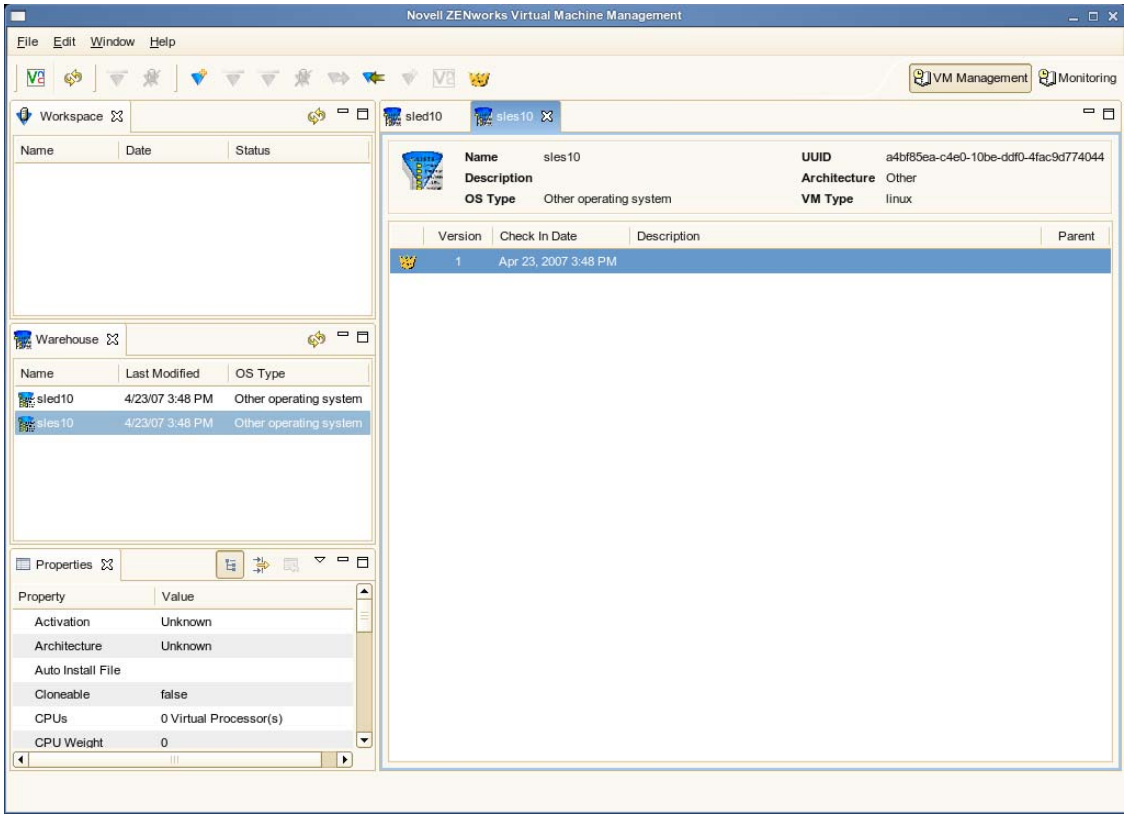
Figure 2-10 *The ZENworks Orchestrator Console with Virtual Machine Management Elements*



The console also applies policies that govern the use of shared infrastructure or simply create logical grouping of nodes on the grid. For more information about the ZENworks Orchestrator Console, see the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.

The ZENworks Monitoring System provides robust graphical monitoring of all managed virtual resources managed on the grid.

Figure 2-11 *The Eclipse ZENworks Monitoring System*

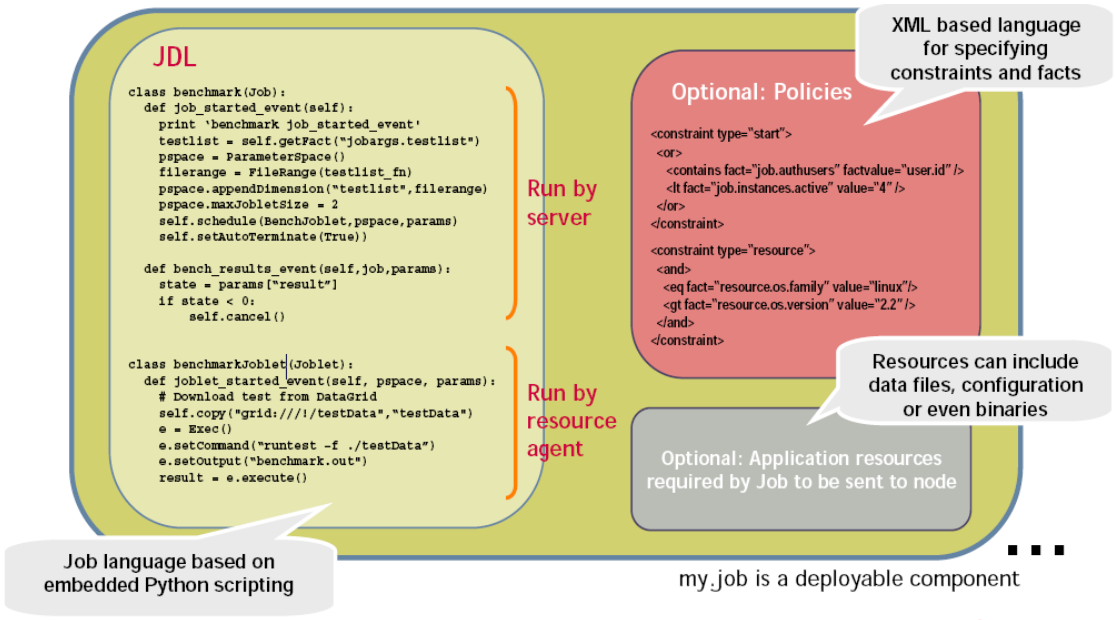


For more information, see the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

2.2.4 Understanding Job Semantics

As mentioned earlier, ZENworks Orchestrator runs jobs. A job is a container that can encapsulate several components including the Python-based logic for controlling the job life cycle (such as a test) through logic that accompanies any remote activity, task-related resources such as configuration files, binaries and any policies that should be associated with the job, as illustrated below.

Figure 2-12 *Components of an Orchestrator Job*



Workflows

Jobs can also invoke other jobs creating hierarchies. Because of the communication between the job client (either a user/user client application or another job) it is easy to create complex workflows composed of discrete and separately versioned components.

When a job is executed and an instance is created, the class that extends job is run on the server and as that logic requests resources, the class(es) that extend the joblet are automatically shipped to the requested resource to manage the remote task. The communication mechanism between these distributed components manifests itself as event method calls on the corresponding piece.

For more information, see Section 2.5.2, “Workflow Job Example,” on page 42, Section 7.3.1, “Job State Transition Events,” on page 73, and Section 7.10, “Communicating Through Job Events,” on page 80.

2.2.5 Distributed Messaging and Failover

A job has control over all aspects of its failover semantics, which can be specified separately for conditions such as the loss of a resource, failure of an individual joblet, or joblet timeout.

The failover/health check mechanisms leverage the same communications mechanism that is available to job and joblet logic. Specifically, when a job is started and resources are employed, a message interface is established among all the components as shown in Figure 2-13 on page 36.

Optionally, a communication channel can also be kept open to the initiating client. This client communication channel can be closed and reopened later based on jobid. Messages can be sent with the command

```
sendEvent(foo_event, params, ...)
```

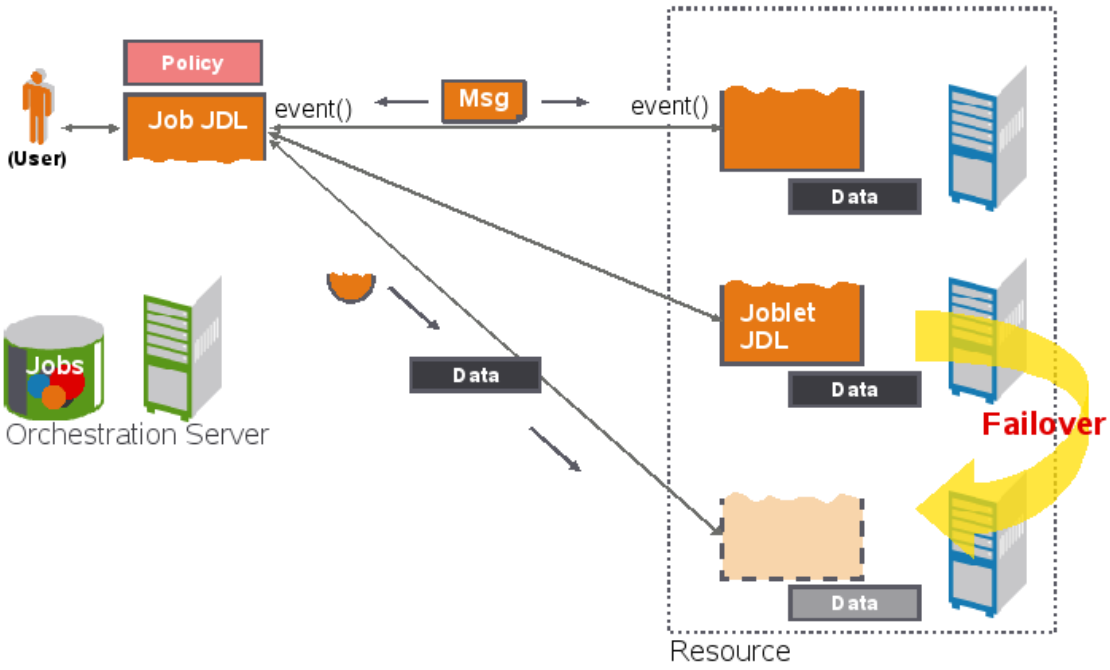
and received at the other end as a method invocation

```
def foo_event(self, params)
```

If a job allows it, a failure in any joblet causes the Orchestrator Server to automatically find an alternative resource, copy over the joblet JDL code, and reestablish the communication connection. A job also can listen for such conditions simply by defining a method for one of the internally generated events, such as def joblet_failure_event(...).

Such failover allows, for example, for a large set of regression tests to be run (perhaps in parallel) and for a resource to die in the middle of the tests without the test run being rendered invalid. The figure below shows how job logic is distributed and failover achieved:

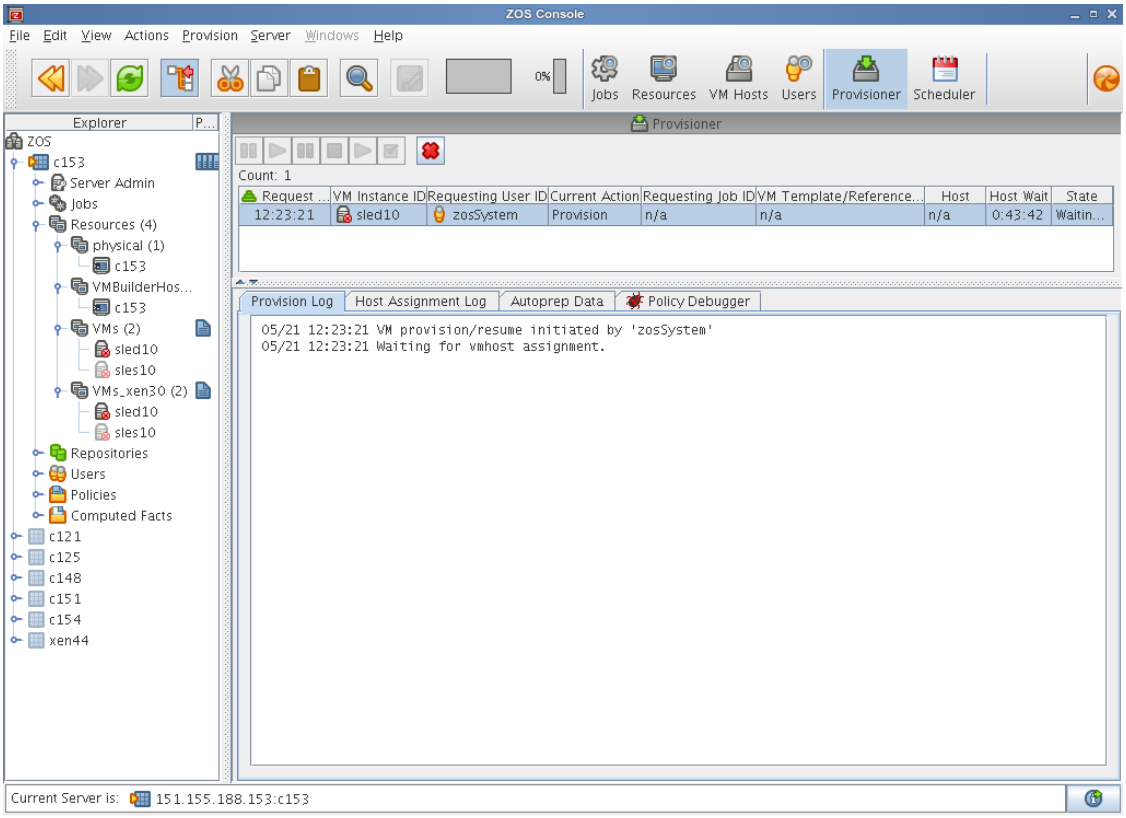
Figure 2-13 *A Job in Action*



2.2.6 Web-Based User Interaction

ZENworks Orchestrator ships a universal job monitoring and submission interface as a Web application that natively runs on the Orchestrator Server. This application is written to the Orchestrator job management API and can be customized or replaced with alternative rendering as required. The figure belows shows an example of the interface and more details are discussed in "The ZENworks Orchestrator Console."

Figure 2-14 *The ZENworks Orchestrator Console Management Interface*



2.3 JDL Job Scripts

The Orchestrator job definition language (JDL) is an extended and embedded implementation of Python. It is completely multi-threaded. The developer of the job has full access to the Python language and standard extensions, and the GMS system provides additional constructs to control and access the following:

- Interaction with the infrastructure under management (requesting resources, querying load, etc.)
- Distributed variable space with job, user and system-wide scoping
- Extensible event callbacks mechanism
- Job logging
- Datagrid for efficient and cached movement of files across the infrastructure.
- Automatic breakdown and distribution of parallel operations
- Failover logic

For more information about the Orchestrator JDL script editor, see “JDL Editor” in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*. See also Section 7.2, “JDL Package,” on page 72.

The JDL language allows for the scripted construction of test cases that can be driven by external parameters and constraints at the time the job instance is executed. In addition, the development of a

job with the JDL (Python) language is very straightforward. For a listing of the job, joblet, and utility classes, see Appendix B, “Orchestrator Job Classes and JDL Syntax,” on page 223.

A simple “hello world” Python script example that runs a given number of times (*numTests*) in parallel (subject to resource availability and policy) is shown below:

```
class exampleJob(Job):
    def job_started_event(self):
        print 'Hello world started: got job_started_event'
        # Launch the joblets
        numJoblets = self.getFact("jobargs.numTests")
        pspace = ParameterSpace()
        i = 1
        while i <= numJoblets:
            pspace.appendRow({'name':'test'+str(i)})
            i += 1
        self.schedule(exampleJoblet, pspace, {})

class exampleJoblet(Joblet):
    def joblet_started_event(self):
        print "Hello from resource%s" % self.getFact("resource.id")
```

This example script contains two sections:

- The class that extends the job and runs on the server.
- The class that extends the joblet that will run on any resource employed by this job.

Because the resources are not requested explicitly, they are allocated based on the resource constraints associated with this job (or user and relevant groups). If none are specified, all resources match. The `exampleJoblet` class would typically execute some process or test based on unique parameters.

Finally, the `ParameterSpace` object accesses the built in “grid” ability of the Orchestrator Server, which is the way to describe the parallel inherent in a problem. In this example, the simple addition of `appendRows()` indicates that each joblet can run in parallel. This guide provides information to create much more sophisticated constructs.

2.3.1 Principles of Job Operation

Whenever a job is run on the Orchestrator system it undergoes state transition, as illustrated in Figure 2-15 on page 39. In all, there are 11 states. The following four states are important in understanding how constraints are applied on a job’s life cycle through policies:

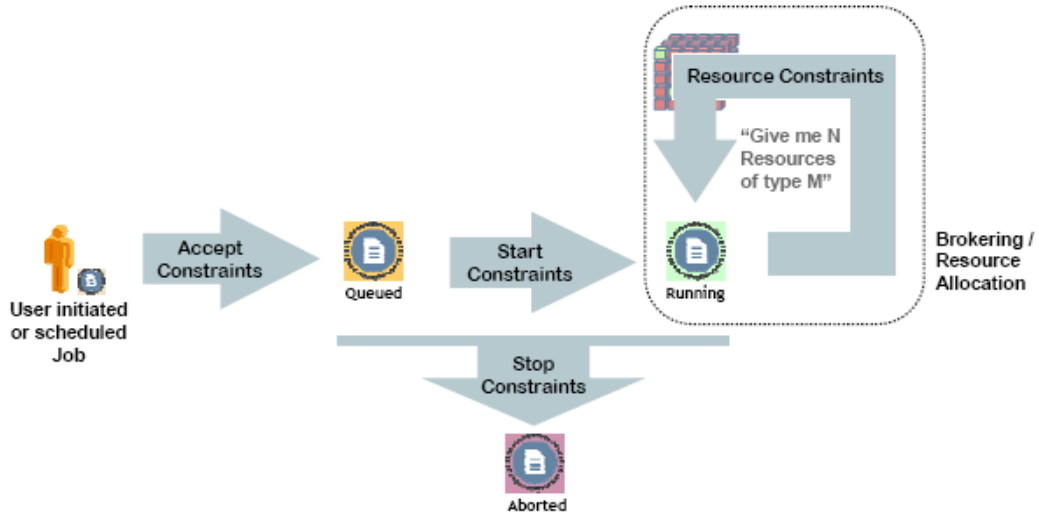
Accept: Used to prevent work from starting; enforces a hard quota on the jobs.

Start: Used to queue up work requests; limits the quantity of jobs or the load on a resource.

Resource: Used to select specific resources.

Stop: Used to abort jobs; provides special timeout or overrun conditions.

Figure 2-15 *Constraint-Based Job State Transition*



For more information about job life cycle, see Section 7.3.1, "Job State Transition Events," on page 73.

2.4 Understanding TLS Encryption

Understanding Transport Layer Security (TLS) encryption is particularly important if you reinstall the server and have an old server certificate in either your agent or client user profile. It's kind of loke "ssh." If you have an old certificate, you need to either manually replace it or delete it and allow the client or agent to download the new one from the server using one of the following procedures:

- **For the Agent:** The TLS certificate is in `<agentdir>/tls/server.pem`. Deleting this certificate will cause the agent, by default, to log a minor warning message and download the new one the next time it tries to connect to the server. This is technically not secure, since the server could be an impersonator. If security is required for this small window of time, then the real server's `<serverdir>/<instancedir>/tls/cert.pem` can be copied to the above server.pem file.
- **For the Client:** The easiest way to update the certificate from the command line tools is to simply answer "yes" both times when prompted about the out-of date certificate. This is, again, not 100% secure, but is suitable for most situations. For absolute security, hand copy the server's cert.pem (see above) to `~/.novell/zos/client/tls/<serverIPAddr:Port>.pem`.
- **For Java SDK clients:** Follow the manual copy technique above to replace the certificate. If the local network is fairly trustworty, you can also delete the above `~/.novell/.../*.pem` files, which will cause the client to auto-download the new certificate on a once-only basis.

2.5 Understanding Job Examples

The following preliminary examples demonstrate how you can use JDL scripting to manage specific functionality:

- Section 2.5.1, “provisionBuildTestResource.job,” on page 40
- Section 2.5.2, “Workflow Job Example,” on page 42

For additional job examples, see Chapter 10, “Complete Job Examples,” on page 143.

2.5.1 provisionBuildTestResource.job

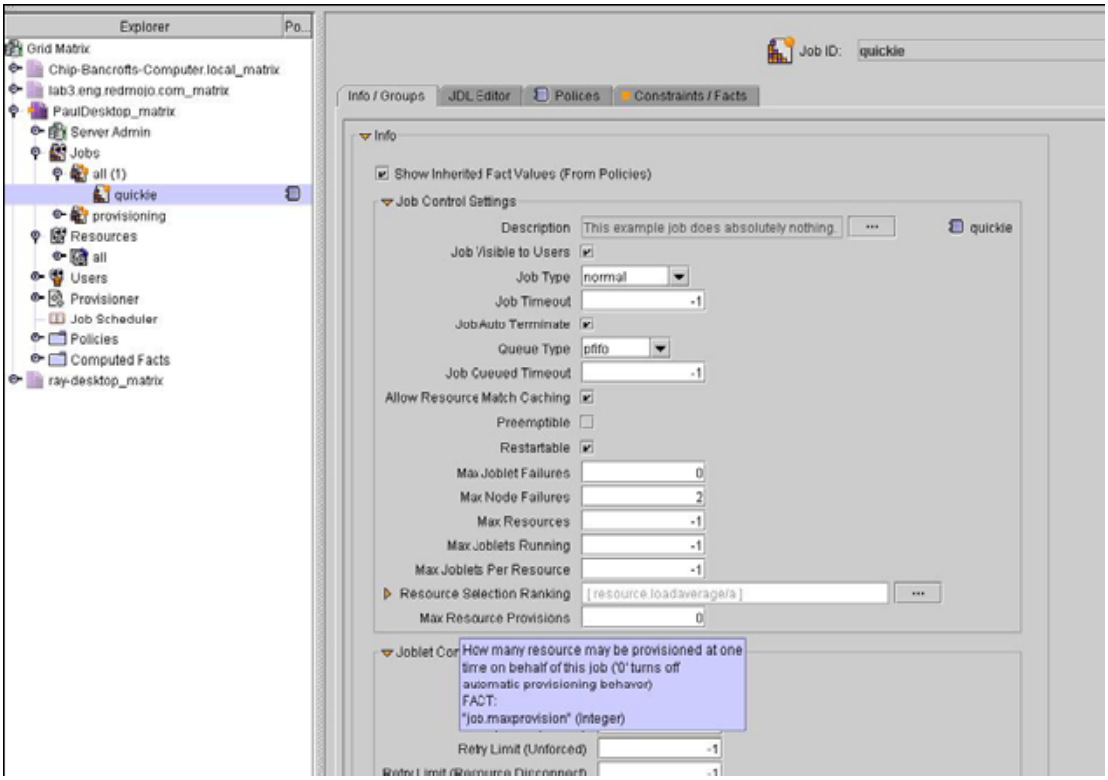
The following job example illustrates simple scripting to ensure that each of the desired OS platforms are available in the grid and, if not, it tries to provision them. The resource Constraint object is created programmatically, so there is no need for external policies.

```
1  class provisionBuildTestResource(Job):
2
3      def job_started_event(self):
4          oslist = ["Windows XP", "Windows 2000", "Windows 2003
Server"]
5          for os in oslist:
6              constraint = EqConstraint()
7              constraint.setFact("resource.os.name")
8              constraint.setValue(os)
9              resources =
getMatrix().getGridObjects("resource",constraint)
10             if len(resources) == 0:
11                 print "No resources were found to match constraint.
12 os:%s" % (os)
13             else:
14               #
15              # Find an offline vm instance or template.
16               #
17               instance = None
18               for resource in resources:
19               if resource.getFact("resource.type") != "Fixed
Physical" and \
20                 resource.getFact("resource.online") == False:
21                 # Found a vm or template. provision it for job.
22                 print "Submitting provisioning request for vm %s."
% (resource)
23                 instance = resource.provision()
24                 print "Provisioning successfully submitted."
25                   break
26               if instance == None:
27             print "No offline vms or templates found for os: %s" %
(os)p
```

It is not necessary to always script resource provisioning. Automatic resource provisioning on demand is one of the built-in functions of the Orchestrator Server. For example, a job requiring a Windows 2003 Server resource that cannot be satisfied with online resources only needs to have the

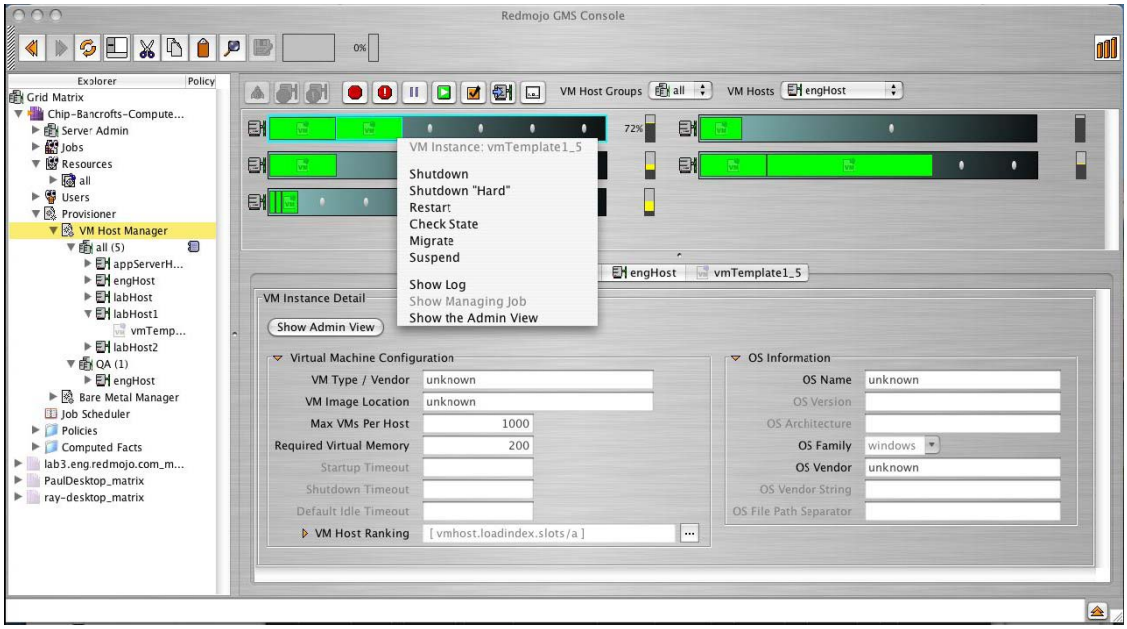
appropriate facts set in the Orchestrator console; that is, job.maxprovision is enabled as shown in the following figure.

Figure 2-16 *Example of a Job to Provision Resources Automatically*



This fact could also be set through deployment of a policy. If it is set up this way, GMS detects that a job is in need of a resource and automatically takes the necessary provisioning steps, including reservation of the provisioned resource.

Figure 2-17 *The ZENworks Orchestrator Console Showing Virtual Machine Management*



All provisioned virtual machines and the status of the various hosts are visible in this example of the Orchestrator console.

2.5.2 Workflow Job Example

This brief example illustrates a job that does not require resources but simply acts as a coordinator (workflow) for the buildTest and provision jobs discussed in Section 5.2, “BuildTest Job Examples,” on page 59.

```
1 class Workflow(Job):
2    def job_started_event(self):
3       self.runJob("provisionBuildTestResource", {})
4       self.runJob("buildTest", { "testlist" : "/QA/testlists/
production",
5 "buildId": "2006-updateQ1" } )
```

The job starts in line 1 with the job_started_event, which initiates provisionBuildTestResource.job (page 40) to ensure all the necessary resources are available, and then starts the buildTest.jdl Example (page 61). This workflow job does not complete until the two subjobs are complete, as defined in lines 3 and 4.

If necessary, this workflow could monitor the progress of subjobs by simply defining new event methods (usually by convention using the _event suffix). The system defines many standard events, but custom events are simply the methods names custom_event. Every message received by the job executes the corresponding event handler method and can also contain a payload (Python dictionary).

Setting Up a Development Grid

3

This section explains concepts related to the Novell® ZENworks® Orchestrator Server data grid and specifies many of the objects and facts that are managed in the grid environment:

- Section 3.1, “Defining the Datagrid,” on page 43
- Section 3.2, “Datagrid Communications,” on page 45
- Section 3.3, “datagrid.copy Example,” on page 47

3.1 Defining the Datagrid

Within the Orchestrator environment, the datagrid has three primary functions:

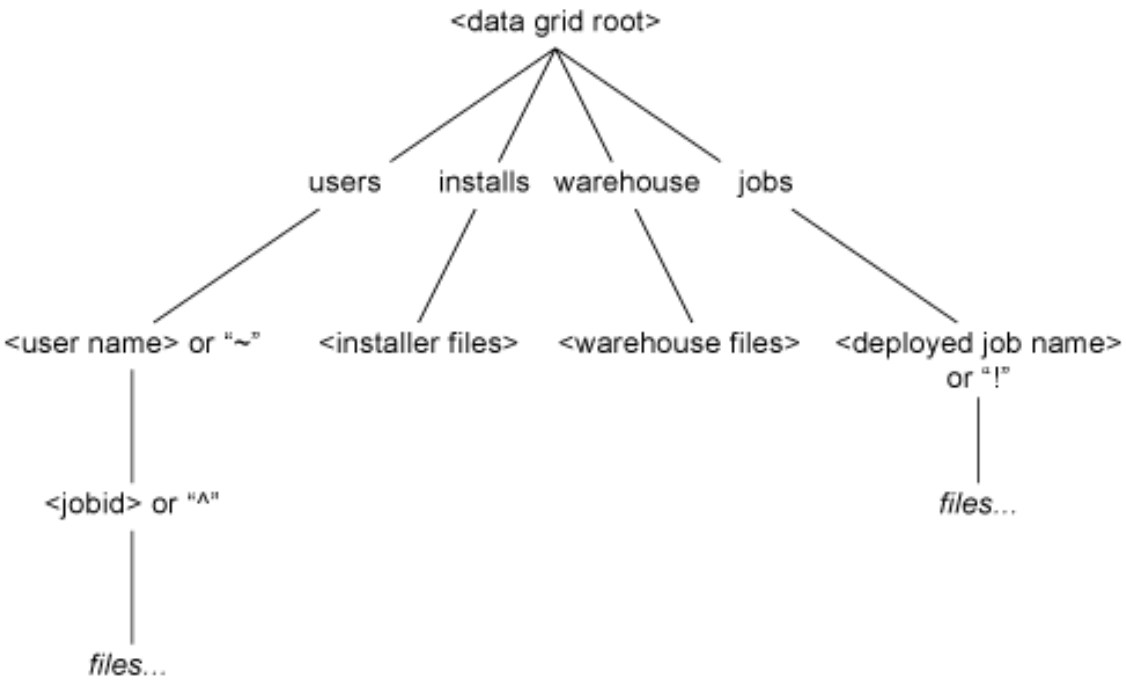
- Section 3.1.1, “Naming Orchestrator Job Files,” on page 43
- Section 3.1.2, “Distributing Files,” on page 44
- Section 3.1.3, “Simultaneous Multicasting to Multiple Receivers,” on page 45

3.1.1 Naming Orchestrator Job Files

The Orchestrator datagrid provides a file naming convention that is used by the job JDL code and by the Orchestrator CLI for accessing files created by the grid job. The naming convention is in the form of a URL. For more information, see Section 2.1.4, “Jobs,” on page 24.

The datagrid server defines the root of the namespace, with further divisions under the root as illustrated in the figure below:

Figure 3-1 *File Structure of Data Nodes in a Datagrid*



The grid URL naming convention is the form `grid://<gridID>/<file path>`. Including the gridID is optional and its absence means the host default grid.

When writing jobs and configuring a datagrid, entering the symbol ^ can be used as a shortcut to the *<jobid>* directory either standalone, indicating the current job, or followed by the jobid number to identify a particular job.

Likewise, the symbol ! can be used as a shortcut to the deployed jobs' home directory either standalone, indicating the current jobs' type, or followed by the deployed jobs' name.

The symbol ~ is also a shortcut to the user's home directory in the datagrid, either by itself, indicating the current user, or followed by the desired user ID to identify a particular user.

The following examples show address locations in the datagrid using the ZOS command line tool. These examples assume you have logged in using "zos login" to the Orchestrator Server Server you are using:

- "Directory Listing of the Datagrid Root Example" on page 44
- "Directory Listing of the Jobs Subdirectory Example" on page 44

Directory Listing of the Datagrid Root Example

```
$ zos dir grid:///
     <DIR>          Jun-26-2007 9:42 installs
     <DIR>          Jun-26-2007 9:42 jobs
     <DIR>          Jun-26-2007 14:26 users
     <DIR>          Jun-26-2007 9:42 vms
     <DIR>          Jun-26-2007 10:09 warehouse
```

Directory Listing of the Jobs Subdirectory Example

This example displays all the jobs that are deployed with the Virtual Machine Management (VMM) pack. The jobs listing is different in the High performance Computing (HPC) pack.

```
$ zos dir grid:///jobs
     <DIR>          Jun-26-2007 9:42 cpuInfo
     <DIR>          Jun-26-2007 9:42 findApps
     <DIR>          Jun-26-2007 9:42 osInfo
     <DIR>          Jun-26-2007 9:42 vcenter
     <DIR>          Jun-26-2007 9:42 vmHostVncConfig
     <DIR>          Jun-26-2007 9:42 vmprep
     <DIR>          Jun-26-2007 9:42 vmserver
     <DIR>          Jun-26-2007 9:42 vmserverDiscovery
     <DIR>          Jun-26-2007 9:42 xen30
     <DIR>          Jun-26-2007 9:42 xenDiscovery
     <DIR>          Jun-26-2007 9:42 xenVerifier
```

3.1.2 Distributing Files

The Orchestrator datagrid provides a way to distribute files in the absence of a distributed file system. This is an integrated service of the Orchestrator that performs system-wide file delivery and management.

3.1.3 Simultaneous Multicasting to Multiple Receivers

The datagrid provides a multicast distribution mechanism that can efficiently distribute large files simultaneously to multiple receivers. This is useful even when a distributed file system is present. For more information, see Section 3.2, “Datagrid Communications,” on page 45.

3.1.4 Orchestrator Data Grid Commands

The following data grid commands can be used when creating job files. To see where these commands are applied in the Novell Orchestrator console, see “Typical Use of the Grid”.

Command	Description
`cat`	Displays the contents of a datagrid file.
`copy`	Copies files and directories to and from the data grid.
`delete`	Deletes files and directories in the data grid.
`dir`	Lists files and directories in the data grid.
`head`	Displays the first of a data grid file.
`log`	Displays the log for the specified job.
`mkdir`	Makes a new directory in the data grid.
`move`	Moves files and directories in the data grid.
`tail`	Displays the end of a data grid file.

3.2 Datagrid Communications

There is no set limit to the number of receivers (nodes) that can participate in the datagrid or in a multicast operation. Indeed, multicast is rarely more efficient when the number of receivers is small. Any type of file or file hierarchy can be distributed via the datagrid.

The datagrid uses both a TCP/IP and IP multicast protocols for file transfer. Unicast transfers (the default) are reliable because of the use of the reliable TCP protocol. Unicast file transfers use the same server/node communication socket that is used for other job coordination datagrid packets are simply wrapped in a generic DataGrid message. Multicast transfers use the persistent socket connection to setup a new multicast port for each transfer.

After the multicast port is opened, data packets are received directly. The socket communication is then used to coordinate packet resends.Typically, a receiver will loose intermittent packets (because of the use of IP multicast, data collisions, etc.). After the file is transferred, all receivers will respond with a bit map of missed packets. The logically ANDing of this mask is used to initiate a resend of commonly missed packets. This process will repeat a few times (with less data to resend on each iteration). Finally, any receiver will still have incomplete data until all the missing pieces are sent in a reliable unicast fashion.

The data transmission for a multicast datagrid transmission is always initiated by the Orchestrator Server. Currently this is the same server that is running the grid.

With the exception of multicast file transfers, all Data Grid traffic goes over the existing connection between the agent/client and the server. This is done transparently to the end user or developer. As

long as the agent is connected and/or the user is logged in to the grid, the Data Grid operations function.

3.2.1 Multicast Example

Multicast transfers are currently only supported through JDL code on the agents. Doing it via the command line client interface Um, would be far too messy. In JDL, after you get the "datagrid" object, you can enable and configure multicasting like this:

```
dg.setMulticast(true)
```

Additional multicast tuneables can be set on the object as well, such as the following example:

```
dg.setMulticastRate(20000000)
```

This would set the maximum data rate on the transfer to 20 million bytes/sec. There are a number of other options as well. Refer to the JDL reference for complete information.

The actual multicast copy is initiated when a sufficient number of JDL joblets on different nodes issue the JDL command:

```
dg.copy(...)
```

to actually copy the requested file locally. See the 'setMulticastMin' and 'setMulticastQuorum' options to change the minimum receiver count and other thresholds for multicasting.

For example, to set up a multicast from a joblet, where the data rate is 30 million bytes/sec, and a minumum of five receivers must request multicast within 30 seconds, but if 30 receivers connect, then start right away, use the following script:

```
dg = DataGrid()
dg.setMulticast(true)
dg.setMulticastRate(30000000)
dg.setMulticastMin(5)
dg.setMulticastQuorum(30)
dg.setMulticastWait(30000)
dg.copy('grid:///vms/huge-image.dsk', 'image.dsk')
```

In the above example, if at least five agents running the joblet request the file within the same 30 second period, then a multicast is started to all agents that have requested multicast before the transfer is started. Agents requesting after the cutoff have to wait for the next round. Also, if fewer than 5 agents request the file, then each agent will simply fall back to plain old unicast file copy.

Furthermore, if more than 30 agents connect before 30 seconds is up, then the transfer begins immediately after the 30th request. This is useful for situations where you know how many agents will request the file and want to start as soon as all of them are ready.

3.2.2 Grid Performance Factors

The multicast system performance is dependent on the following factors:

- **Network Load:** As the load increases, there is more packet loss, which results in more retries.
- **Number of Nodes:** The more nodes (receivers) there are, the greater the efficiency of the multicast system.
- **File Size:** The larger the file size, the better. Unless there are a large number of nodes, files less than 2 Mb are probably too small.

- **Tuning:** The datagrid facility has the ability to throttle network bandwidth. Best performance has been found at about maximum bandwidth divided by 2. Using more bandwidth leads to more collisions. Also the number of simultaneous multicasts can be limited. Finally the minimum receiver size, receiver wait time and quorum receiver size can all be tuned.

Access to the datagrid is typically performed via the CLI tool or JDL code within a job. There is also a Java API in the Client SDK (on which the CLI is implemented). See "ClientAgent" on page 212.

3.2.3 Plan for Datagrid Expansion

When planning your datagrid, you need to consider where you want the Orchestrator Server to store its data. Much of the server data is the contents of the datagrid, including ever-expanding job logs. Every job log can become quite large and quickly exceed its storage constraints.

In addiion, every deployed job with its job package—JDL scripts, policy information, and all other associated executables and binary files—is stored in the datagrid. Consequently, if your datagrid is going to grow very large, store it in a directory other than `/opt`.

3.3 datagrid.copy Example

This example fetches the specified source file to the destination. A recursive copy is then attempted if `setRecursive(True)` is set. The default is a single file copy. A multicast also is attempted if `setMulticast(True)` is set. The default is to do a unicast copy.

The following example copies a file from the data grid to a resource, then read the lines of the file:

```
1       datagrid = DataGrid()
2       datagrid.copy("grid:///images/myFile","myLocalFile")
3       text = open("myLocalFile").readlines()
```

This is an example to recursively copy a directory and its sub directories from the data grid to a resource:

```
4       datagrid = DataGrid()
5       datagrid.setRecursive(True)
6       datagrid.copy("grid:///testStore/testFiles","/home/tester/
myLocalFiles")
```

Here's an example to copy down a file from the job deployment area to a resource and then read the lines of the file:

```
7      datagrid = DataGrid()
8      datagrid.copy("grid:///!myJob/myFile","myLocalFile")
9     text = open("myLocalFile").readlines()
```

Here are the same examples without using the shortcut characters. This shows the job "myJob" is under the "jobs" directory under the Datagrid root:

```
10      datagrid = DataGrid()
11      datagrid.copy("grid:///jobs/myJob/myFile","myLocalFile")
12      text = open("myLocalFile").readlines()
```

Orchestrator Job Classifications

4

This section discusses the core job classifications that can be run by the Novell® ZENworks Orchestrator Server® on grid objects:

- Section 4.1, “Resource Discovery,” on page 49
- Section 4.2, “Dynamic Scheduling,” on page 51
- Section 4.3, “Workload Management,” on page 53
- Section 4.4, “Policy Management,” on page 54
- Section 4.5, “Auditing and Accounting Jobs,” on page 56

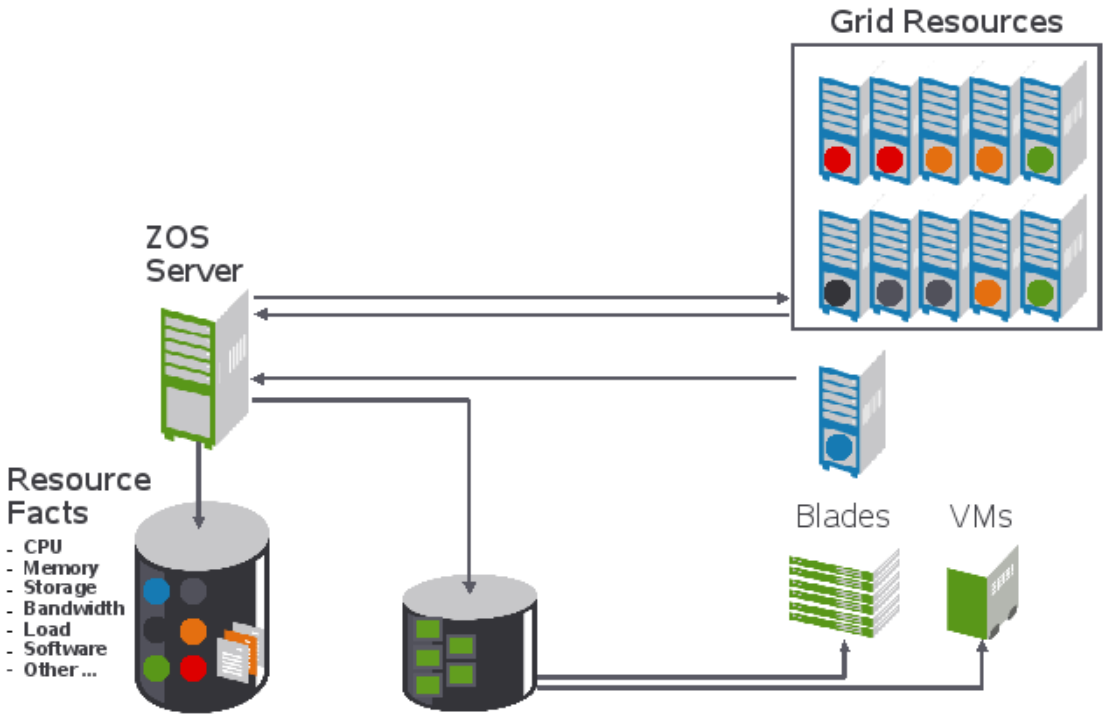
For more information, see Section 2.1, “Orchestrator Development Architecture,” on page 19.

4.1 Resource Discovery

Resource discovery jobs introspect a resource’s environment to set resource facts stored with the resource grid object.

As shown in the following figure, resource discovery jobs automatically discover the resource attributes (fully extensible facts relating to CPU, memory, storage, bandwidth, load, software inventory, and so forth) of the resources being managed by the ZENworks Orchestrator server. This enables the Orchestrator Server to automatically detect new resources and to integrate resource provisioning of on-line resources. The server can also keep account of these facts for managed resources that are off line.

Figure 4-1 *Resource Discovery Overview*



For more information, see "Walkthrough: Observe Discovery Jobs Run" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*, and "Discovering Virtual Machines" in the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

4.1.1 Provisioning Jobs

Provisioning jobs are included in the Orchestrator VM Management Pack and are used for interacting with a VM Technology for VM life cycle management and for cloning, moving VMs, and other management tasks.These type of jobs are called Provisionng Adapters and are members of the job group called "provisionAdapters."

For more information, see Section 9.2, "Virtual Machine Management," on page 114 and "Provisioning Adapters" in the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

4.1.2 Resource Targeting

Resource targeting jobs typically match constraints on the client and server, then test for conditions required by specific grid resources.

4.1.3 Resource Discovery Jobs

Some of the commonly used resource discovery jobs include:

- "auditCleaner.job" on page 51
- "cpuInfo.job" on page 51

- “demoInfo.job” on page 51
- “findApps.job” on page 51
- “logRotator.job” on page 51
- “osInfo.job” on page 51

auditCleaner.job

Cleans up the audit database, which frequently becomes cluttered because of massive audit files.

cpuInfo.job

Gets CPU information of a resource.

demoInfo.job

Generates the CPU, operating system, and application information for testing.

findApps.job

Finds and reports what applications are installed on the data grid.

logRotator.job

Rotates server logs.

osInfo.job

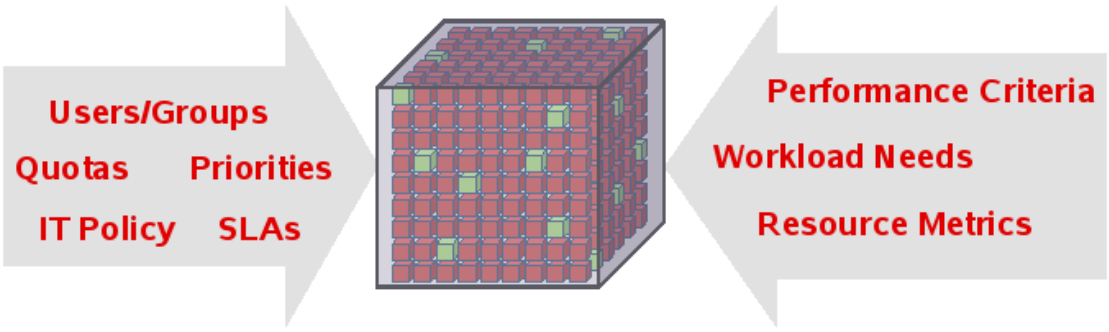
Gets the operating system of a grid resource. On Linux, it reads the /proc/cpuinfo; on Windows, it reads the registry; on UNIX, it executes `uname`.

```
resource.cpu.mhz (integer) e.g., "800" (in Mhz)
resource.cpy.vendor (string) e.g. "GenuineIntel"
resource.cpu.model (string) e.g. "Pentium III"
resource.cpu.family (string) e.g. "i686"
```

4.2 Dynamic Scheduling

ZENworks Orchestrator enables you to create jobs that meet the infrastructure scheduling and resource management requirements of your data center, as illustrated in the following figure.

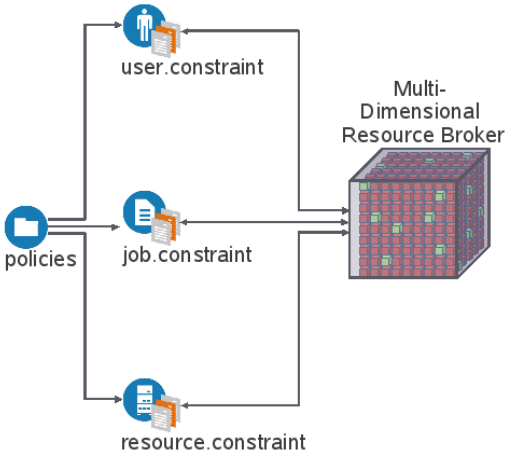
Figure 4-2 *Multi-Demensional Resource Scheduling Broker*



Notice that there are many combinations of constraints and scheduling demands on the system that can be managed by the highly flexible Orchestrator resource broker.

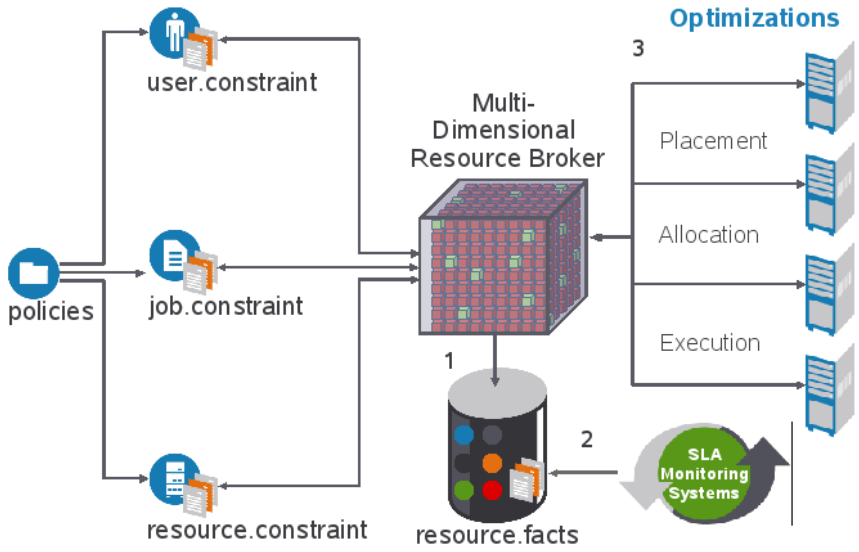
Policies govern how how jobs are dynamically scheduled based on the various job constraints that are shown in the following figure. Policies are XML files that specify the requirement for all constraints.

Figure 4-3 *Policy-Based Resource Management Relying on Various Constraints*



Every resource has abstracted attributes, called facts, that define its operational characteristics.

Figure 4-4 *Policy-Based Job Management*



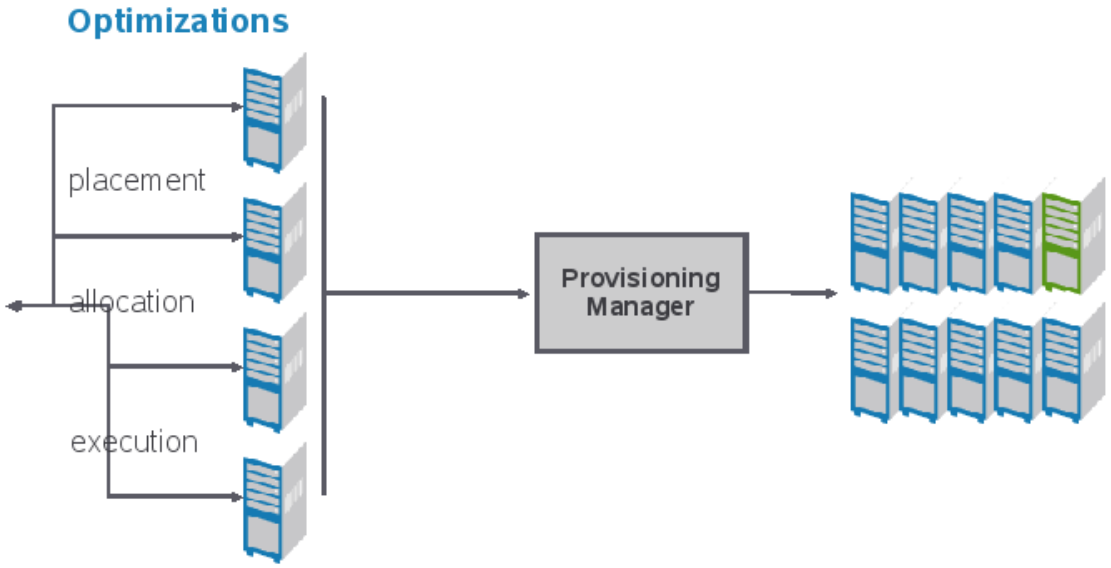
Resources that are discovered by the Orchestrator Server (resource broker) are defined by a resource.facts file (1), which are monitored by service level agreement systems on the broker (2).

See Chapter 8, “Job Scheduling,” on page 87 for examples of scheduling jobs. See also Section 7.7, “Working with Facts and Constraints,” on page 76.

4.3 Workload Management

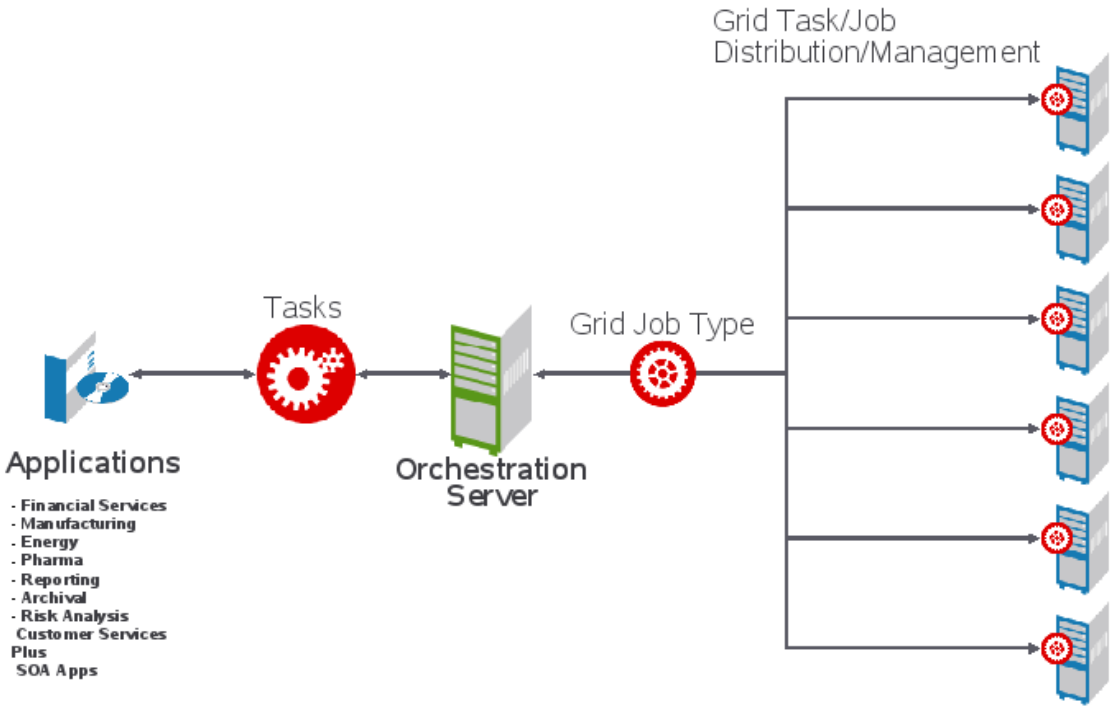
The Orchestrator Server uses a provisioning manager to initiate and monitor changes for both online and offline resources, and also supports physical and virtual servers. It also manages preemption and stealing (reassignment) of resources by monitoring the system and submitting workload management jobs as needed.

Figure 4-5 *Workload Management*



Depending on the tasks that applications might require, the Orchestrator Server submits the required jobs to one or more of the connected services to perform the specific tasks as shown in the figure below.

Figure 4-6 *Grid Scheduling*



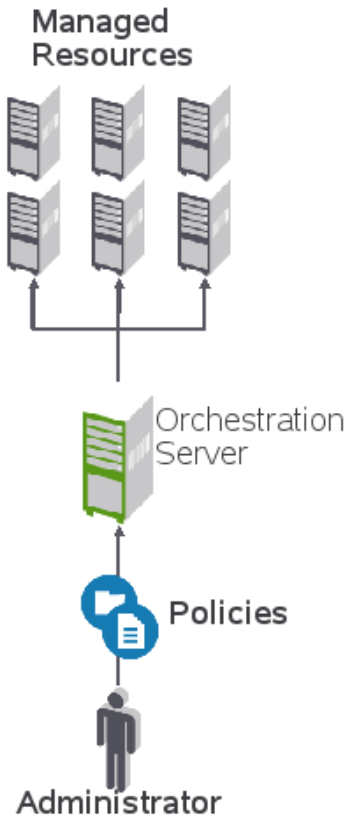
For more information about how grid sceduling works, see the following sections:

- Chapter 8, “Job Scheduling,” on page 87
- Section 9.5, “Automatically Provisioning a VM Server,” on page 121
- Examples: dgtest.job (page 157) and factJunction.job (page 194).

4.4 Policy Management

Policies are the core control system across the Orchestrator Server. Jobs can be written to change the configuration and behavior of policies, such as pooling of dynamic and virtual resources, managing system loads, monitoring and controlling user quotas, controlling priorities of resources, scheduling jobs and resources, controling failover operations, and other functions.

Figure 4-7 *Managing Policies*



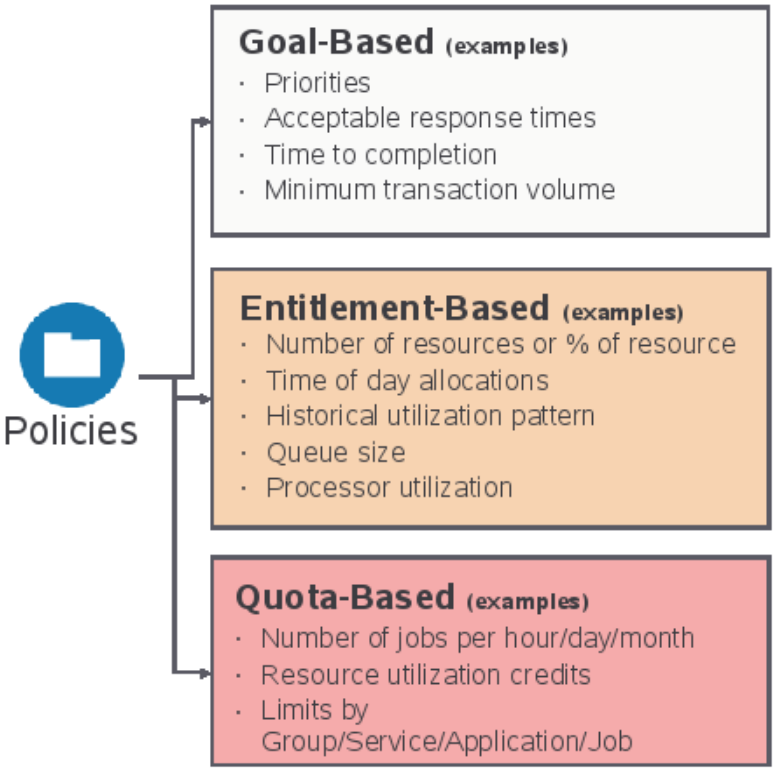
Policies are XML-based files that aggregate resource facts and constraints used to control resources. This provides an extensible and highly flexible system that can covers a wide range of user and resource demands.

Policies are used to enforce quotas, job queuing, resource restrictions, permissions, etc. They can be set on all objects. The policy example below constrains a job to limit the number of running jobs to a defined value, but exempts certain users from this limit. All of the jobs that attempt to exceed the limit are queued until the running jobs count decreases and the constraint passes:

```
<policy>
    <constraint type="start" reason="too busy">
        <or>
            <lt fact="job.instances.active" value="5" />
            <eq fact="user.name" value="canary" />
        </or>
    </constraint>
</policy>
```

As illustrated in the following figure, policies can be based on goals, entitlements, quotas, and other factors, all of which are controlled by jobs.

Figure 4-8 *Policy Types and Examples*



For more information about policies, see Section 2.2.2, “Policy-Based Management,” on page 31. See also Section 7.7, “Working with Facts and Constraints,” on page 76.

4.5 Auditing and Accounting Jobs

Jobs also can be created to control reporting, auditing, and costing. All activity is logged to an ADBMS database and is available for reporting. Your jobs can aggregate cost accounting for assigned resources and perform resource audit trails.

For more detailed information about the structure of jobs, see “auditCleaner.job” on page 51 and Chapter 8, “Job Scheduling,” on page 87.

Developing Policies

5

This section explains policy concepts required when developing Novell® ZENworks® Orchestrator jobs:

- Section 5.1, “Policy Elements,” on page 57
- Section 5.2, “BuildTest Job Examples,” on page 59

5.1 Policy Elements

XML is the representation for Orchestrator Policy elements. A policy can be deployed to the server and associated with any grid object. The policy element is the root element for policies. Policies contain constraints and fact definitions for grid objects:

- Section 5.1.1, “Constraints,” on page 57
- Section 5.1.2, “Facts,” on page 57
- Section 5.1.3, “Computed Facts,” on page 58

5.1.1 Constraints

The constraint element defines the selection of grid objects such as resources. The required type attribute defines the selection type. Supported types are:

- Resource
- Provision
- Allocation
- Accept
- Start
- Continue
- vmhost
- Repository

Constraints can also be constructed in JDL and in the Java Client SDK. A JDL constructed constraint can be used for grid search and for scheduling. A Java Client SDK constructed constraint can only be used for grid object search. See also Section 7.7, “Working with Facts and Constraints,” on page 76.

5.1.2 Facts

The XML fact element defines a fact to be stored in the grid object's fact namespace. The name, type and value of the fact are specified as attributes. For list or array fact types, the element tag defines list or array members. For dictionary fact types, the dict tag defines dictionary members.

See the examples in the directory, `/allTypes.policy`. This example policy has an XML representation for all the fact types.

Facts can also be created and modified in JDL and in the Java Client SDK.

5.1.3 Computed Facts

Computed facts are used when you want to run JDL to generate the value for a fact. Although computed facts are not jobs, they use the same JDL syntax.

To create a new computed fact, you subclass the `ComputedFact` class with the .cfact extension. An implementation uses the `ComputedFactContext` to get the evaluation context. For more information, see the job structure from the following examples:

- ComputedFact (page 235)
- ComputedFactContext (page 237)

After the new computed fact is created, you deploy it using the same procedures required for jobs (using either the zosadmin command line tool or the Orchestrator console).

The following example shows a computed fact that returns the number of active job instances for a specific job for the current job instance. This fact can be used in an accept or start constraint to limit how many jobs a user can run in the system. The constraint is added to the job policy in which to have the limit. In this example, the start constraint uses this fact to limit the number of active jobs for a user to one:

```
"""
    <constraint type="start" >
        <lt fact="cfact.activejobs"
            value="1"
            reason="You are only allowed to have 1 job running at a
time" />
     </constraint>

Change JOB_TO_CHECK to define which job is to be limited.
"""
JOB_TO_CHECK="quickie"

class activejobs(ComputedFact):

   def compute(self):

          j = self.getContext()
          if j == None:
               # This means computed Fact is executed in a non running

               # job context.  e.g., the MMC fact browser
               print "no job instance"
               return 0
          else:
               # Computed fact is executing in a job context
               user = j.getFact("user.id")
               activejobs = self.getMatrix().getActiveJobs()
               count = 0
               for j in activejobs:
                    jobname = j.getFact("job.id")
```

```
                    # Don't include queued in count !
                    state = j.getFact("jobinstance.state.string")
                    if jobname == JOB_TO_CHECK \
                              and j.getFact("user.id") == user \
                              and (state == "Running" or state ==
"Starting"):
                         count+=1

               jobid = j.getFact("jobinstance.id")
               print "jobid=%s count=%d" % (jobid,count)
               return count
```

For another computed fact example, see activejobs.cfact (located in the `examples/activejobs.cfact` directory).

5.2 BuildTest Job Examples

There are many available facts that you can use in creating your jobs. If you find that you need specific kinds of information about a resource or a job, such as the load average of a user or the ID of a job or joblet, chances are that it is already available.

If a fact is not listed, you can create your own facts by by creating a `<fact>` element in the job's policy. In addition, you can create a fact directly in the JDL job code. The fact doesn't need to be an argument; you can simply create the fact and write it to the fact database for use in specifying parameters for other objects as well.

If you want to remember something from one loop to the next or make something available to other objects in the grid, you can set a fact with your own self-defined names.

This section explains a relatively simple working job that performs a set (100) regression tests on three different platform types. A number of assumptions have been made to simplify this example:

- Each regression test is atomic and has no dependencies.
- Every resource is preconfigured to run the tests. Typically, the configuration setup is included as part of the job.
- The tests are expressed as line entries in a file. Orchestrator has multiple methods to specify parameters. This is just one example (/QA/testlists/nightly.dat):

  ```
  dir c:/windows
  dir c:/windows/system32
  dir c:/notexist
  dir c:/tmp
  dir c:/cygwin
  ```

To demonstrate the possible functionality for this example, we have invented some policies that might apply to this example:

- Only users running tests are able to use resources owned by their group.
- To conserve resources, we want to terminate the test after 50 failures.
- Because the system under test requires a license, we will prevent more than three of these regression tests from running at one time.
- To prevent a job backlog, the system limits the number of queued jobs.

- To allow the regression test run to tolerate resource failures (for example, unexpected network disconnections, unexpected reboots, etc.), we enable automatic failover without affecting the regression run.

5.2.1 buildTest.policy Example

Policies are typically spread over different objects, entities, and groups on the system. However, to simplify the concept, we have combined all policies into this one example that is directly associated with the job.

The arguments available to the job are specified in the in the <jobargs> section (lines 1-11). When the job is run, job arguments are made available as facts to the job instance. The default values of these arguments can be overridden when the job is invoked.

```
1 <policy>
2    <jobargs>
3        <fact name="buildId"
4            type="String"
5            value="02-24-06 1705"
6            description="Build Id to show in memo field" />
7        <fact name="testlist"
8            type="String"
9            value="/QA/testlists/nightly.dat"
10           description="Path to testlist to use in tests" />
11    </jobargs>
```

The <job> section (lines 12-25) defines facts that are associated with the job. These facts are used in other policies or by the JDL logic itself. Typically, these facts are aggregated from inherited policies.

```
12    <job>
13        <fact name="max_queue_size"
14            type="Integer"
15            value="10"
16            description="Limit of queued jobs. Any above this limit
are not accepted." />
17        <fact name="max_licenses"
18            type="Integer"
19            value="5"
20           description="License count to limit number of jobs to run
simultaneously. Any above this limit are queued." />
21        <fact name="max_test_failures"
22            type="Integer"
23            value="50"
24            description="To decide to end the job if the number of
failures exceeds a limit" />
25    </job>
```

The <accept> (line 26), <start> (line 31), and <continue> (line 40) constraints control the job life cycle and implement the policy outlined in the example. In addition, allowances are made for “privileged users” (lines 28 and 33) to bypass the accept and start constraints.

```
26    <constraint type="accept" reason="Maximum number of queued jobs
has been reached">
27        <or>
28            <defined fact="user.privileged_user" />
28            <lt fact="job.instances.queued"
factvalue="job.max_queue_size" />
29        </or>
30    </constraint>
31    <constraint type="start">
32        <or>
33            <defined fact="user.privileged_user" />
34            <lt fact="job.instances.active"
factvalue="job.max_licenses" />
35        </or>
36    </constraint>
```

The <resource> constraint (lines 37 and 38) ensures that only resources that are members of the buildtest group are used by this job. As noted earlier, this is normally associated with the user or user group.

```
37    <constraint type="resource">
38       <contains fact="resource.groups" value="buildtest" reason="No
resources are in the buildtest group" />
39    </constraint>
40    <constraint type="continue" >
41        <lt fact="jobinstance.test_failures"
factvalue="job.max_test_failures" reason="Reached test failure limit"
/>
42    </constraint>
</policy>
```

NOTE: Typically, resource usage restrictions are specified on the user or user group and not on the job.

5.2.2 buildTest.jdl Example

The following example shows how additional resource constraints representing the three test platform types are specified in XML format. These also could have been specified in ZENworks Orchestrator Console.

Setting Resource Constraints

The annotated JDL code represents the job definition, consisting of base Python v2.1 (and libraries) as well as a large number of added Orchestrator operations that allow interaction with the Orchestrator Server:

```
1  import sys,os,time

2  winxp_platform = "<eq fact=\"resource.os.name\" value=\"Windows
XP\" />"
3  win2k_platform = "<eq fact=\"resource.os.name\" value=\"Windows
2000\" />"
```

```
4  win2003_platform = "<eq fact=\"resource.os.name\" value=\"Windows
2003 Server\" />"
```

Lines 2-4 specify the resource constraints representing the three test platform types (Windows XP, Windows 2000, and Windows 2003) in XML format. Alternatively, these constraints could be set programmatically as options in the Orchestrator console.

The `job_started_event` in line 6 is the first event delivered to the job on the server.The logic in this method performs some setup and defines the parameter space used to iterate over the tests.

```
5 class BuildTest(Job):

6    def job_started_event(self):
7       self.total_counts = {"failed":0,"passed":0,"run":0}
8       self.setFact("jobinstance.test_failures",0)

9       self.testlist_fn = self.getFact("jobargs.testlist")
10      self.buildId = self.getFact("jobargs.buildId")
11      self.form_memo(self.total_counts)

12      # Form range of tests based on a testlist file
13      filerange = FileRange(self.testlist_fn)
```

Parameter spaces (lines 14-16) can be multidimensional but, in this example, they schedule three units of work (joblets), one for each platform type, each with a parameter space of the range of lines in the (optionally) supplied test file (lines 21, 24 and 27).

```
14      # Form ParameterSpace defining Joblet Splitting
15      pspace = ParameterSpace()
16      pspace.appendDimension("cmd",filerange)

17      # Form JobletSet defining execution on resources
18      jobletset = JobletSet()
19      jobletset.setCount(1)
20      jobletset.setJobletClass(BuildTestJoblet)
```

Within each platform test, a joblet is scheduled for each test line item on each different platform. After they are deployed, these joblets can be viewed individually in various Orchestrator UI portals.

```
21      # Launch tests on Windows XP
22      jobletset.setConstraint(winxp_platform)
23      self.schedule(jobletset)

24      # Launch tests on Windows 2000
25      jobletset.setConstraint(win2k_platform)
26      self.schedule(jobletset)

27      # Launch tests on Windows 2003
28      jobletset.setConstraint(win2003_platform)
29      self.schedule(jobletset)
```

The `test_results_event` in line 32 is a message handler that is called whenever the joblets send test results.

```
30 # Event invoked when a Joblet has completed running tests.
31 #
32 def test_results_event(self,params):
33      self.form_memo(params)
```

Creating a Memo Field

In line 37, the `form_memo` method is called to form an informational string to display the running totals for this test. These totals are displayed in the memo field for the job (visible in all portal, MMC, command line, SDK, and Web interface tools). The memo field is accessed through setting the String fact `jobinstance.memo` in line 55.

```
34 #
35 # Update the totals and write totals to memo field.
36 #
37 def form_memo(self,params):
38     # total_counts will be empty at start
39     m = "Build Test BuildId %s " % (self.buildId)
40     i = 0
41     for key in self.total_counts.keys():
42     if params.has_key(key):
43         total = self.total_counts[key]
44         count = params[key]
45         total += count
46         printable_key = str(key).capitalize()
47        if i > 0:
48            m += ", "
48        else:
49            if len(m) > 0:
50        m+= ", "
51        m += printable_key + ": %d" % (total)
52        i += 1
53        self.total_counts[key] = total
54
self.setFact("jobinstance.test_failures",self.total_counts["failed"])
55     self.setFact("jobinstance.memo",m)
```

Joblet Definition

As previously discussed, a joblet is the logic that is automatically shipped to any resource employed by this job, as defined in lines 56-80. The `joblet_started_event` in line 60 mirrors the `job_started_event` (line 6) but, of course, runs on a different resource than the server.

The portion of the parameter space allocated to this joblet in line 65-66 represents some portion of the total test (parameter) space. The exact breakdown of this is under full control of the administrator/job. Essentially, the size of the “work chunk” in line 67 is a compromise between overhead and retry convenience.

In this example, each element of the parameter space (a test) in line 76 is executed locally and the exit code is used to determine pass or failure. (The exit code is often insufficient and additional logic must be added to analyze generated files, copy results, or to perform other tasks.) A message is then

sent back to the server prior to completion with the result counts.

```
56 #
57 # Define test execution on a resource.
58 #
59 class BuildTestJoblet(Joblet):
60    def joblet_started_event(self):
61        passed = 0
62        failed = 0
63        run = 0
64        # Iterate over parameter space assigned to this Joblet
65        pspace = self.getParameterSpace()
66        while pspace.hasNext():
67            chunk = pspace.next()
68            cmd = chunk["cmd"].strip()
69            rslt = self.run_cmd(cmd)
70            print "rslt=%d cmd=%s" % (rslt,cmd)
71            if rslt == 0:
72                passed +=1
73            else:
74                failed +=1
75            run += 1
76
self.sendEvent("test_results_event",{"passed":passed,"failed":failed,"
run":run})
77         def run_cmd(self,cmd):
78            e = Exec()
79            e.setCommand(cmd)
80            return e.execute()
```

5.2.3 Packaging Job Files

A job package might consist of the following elements:

- Job description language (JDL) code (the Python-based script containing the bits to control jobs).
- An optional policy XML file, which applies constraints and other job facts to control jobs. Constraints and facts are discussed Constraints (page 57) and Facts (page 57).
- Any other associated executables or data files that the job requires.

Section 7.2, “JDL Package,” on page 72 provides more information about job elements.

5.2.4 Deploying Packaged Job Files

After jobs are created, you deploy `.jdl` or multi-element `.job` files to the Orchestrator Server by using any of the following methods:

- Copy job files into the “hot” Orchestrator Server deployment directory. See “Deploying a Sample System Job”.
- Drag and drop job files using the Orchestrator management console. You can drag browser attributes and job files to the Orchestrator Toolbox. This serves as a shortcut to its browser

viewin the workspace panel. When you double-click a component in th eToolbox, the console displays that component's view in the workspace panel.

- Use the Orchestrator command line (CLI) tools. This process is discussed in "The ZOS Command Line Tool" in the *Novell ZENworks Orchestrator 1.2 Job Management Guide* and in "The Zosadmin Command Line Tool" in the *Novell ZENworks Orchestrator 1.2 Administration Guide*.

5.2.5 Running Your Jobs

After your jobs are deployed, you can execute them by using the following methods:

- **Command Line Interface:** Nearly all Orchestrator functionality, including deploying and running jobs, can be performed using the command line tool, as shown in the following example:

```
>zos run buildTest [testlist=myList]
JobID: paul.buildTest.14
```

  More detailed ZOS CLI information is available in the zos command line tool.

- **Web Portal interface:** After Orchestrator is installed, the management console is available online to edit, deploy, and run all jobs you create. This process is discussed in "Using the Orchestrator Portal to Run VM Jobs"*** in the *Virtual Machine Management Guide*.
- **Custom Client:** The Orchestrator toolkit provides an SDK that provides a custom client that can invoke your custom jobs. This process is discussed in Appendix A, "Orchestrator Client SDK," on page 211.
- **Built-in Job Scheduler:** The Orchestrator Server uses a built-in job scheduler to run deployed jobs. This process is discussed in Chapter 8, "Job Scheduling," on page 87.
- **From Other Jobs:** As part of a job workflow, jobs can be invoked from within other jobs. You integrate these processes within your job scripts as described in the Chapter 8, "Job Scheduling," on page 87.

5.2.6 Monitoring Job Results

ZENworks Orchestrator enables you to monitor jobs by using the same methods outlined in Section 5.2.5, "Running Your Jobs," on page 65. The following figure shows examples of the status of the job ray.buildtest.18 using different monitoring interfaces:

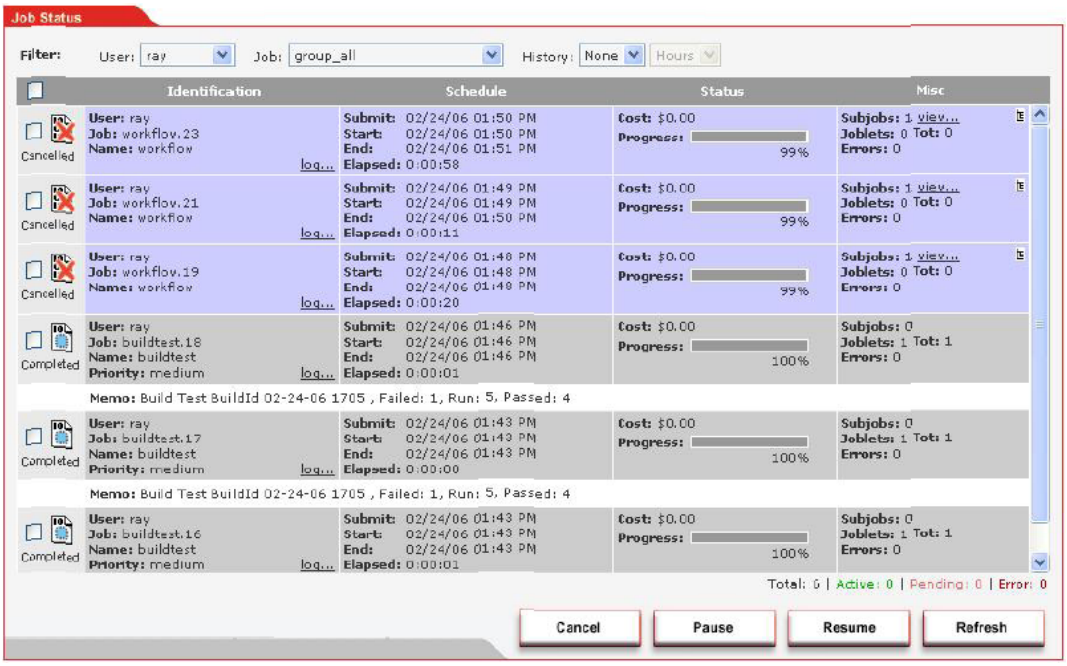
CLI Job Monitoring

Figure 5-1 *CLI Job Monitoring Example*

```
> zos status -e ray.buildertest.18
Job Status for ray.buildtest.18
------------------------------
             State: Completed
    Resource Count: 0              (0 this job)
  Percent Complete: 100%
         Queue Pos: 1 of 1 (initial pos=1)
   Child Job Count: 0              (0 this job)


     Instance Name: buildtest
          Job Type: buildtest
              Memo: Build Test BuildId 02-24-06 1705 , Failed: 1, Run: 5,
                    Passed: 4
          Priority: medium
         Arguments: <none>

       Submit Time: 02/24/2006 01:46:12
     Delayed Start: n/a
        Start Time: 02/24/2006 01:46:12
          End Time: 02/24/2006 01:46:14
      Elapsed Time: 0:00:01
        Queue Time: 0:00:00
        Pause Time: 0:00:00

    Total CPU Time: 0:00:00        (0:00:00 this job)
     Total GCycles: 0:00:00        (0:00:00 this job)
        Total Cost: $0.0002        ($0.0002 this job)
         Burn Rate: $0.0003/hr     ($0.0003/hr this job)
```

Notice in the bottom section that job costing metrics also can be monitored, which are quite minimal in this example. More sophisiticated job monitoring is possible. For more information, see "Verification at the Command Line" and "Verification at the Jobs Monitor" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.

Figure 5-2 *Developer Portal Job Monitoring Example*

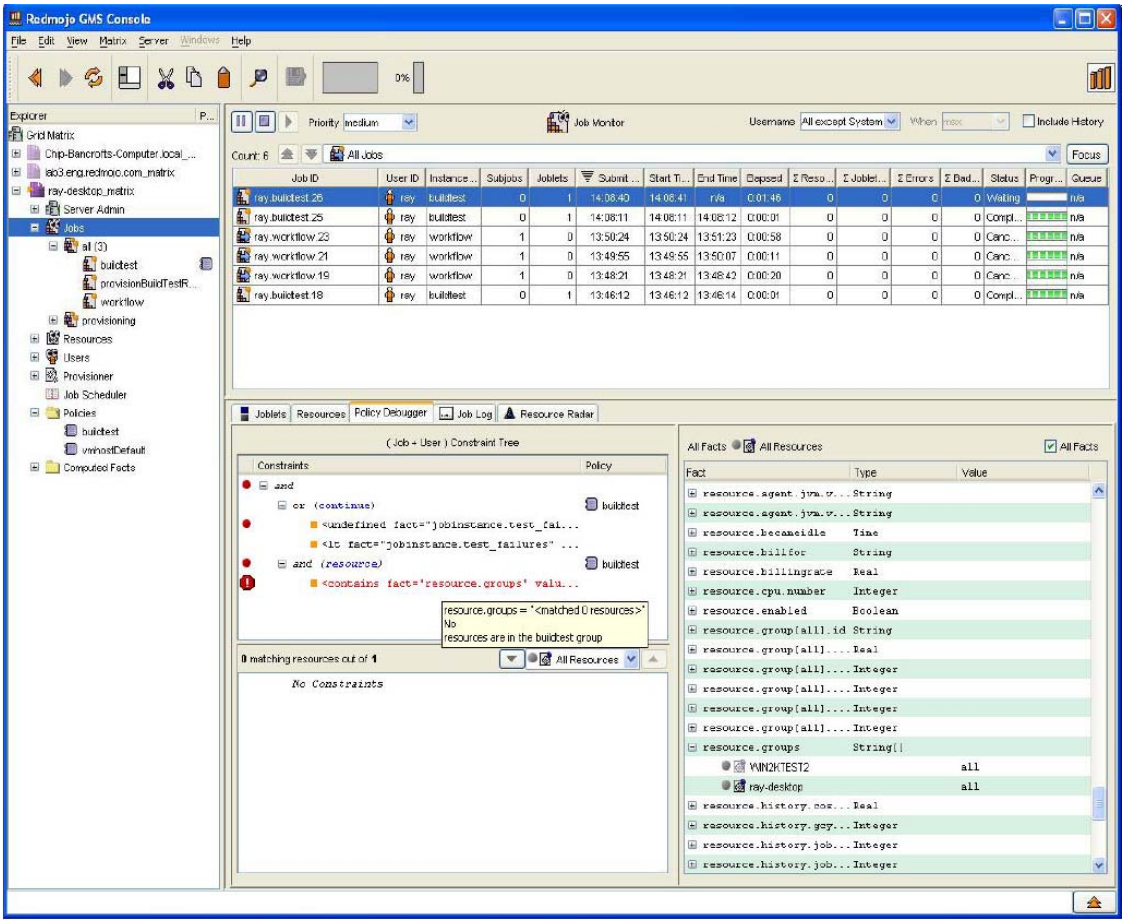


In this example, the job memo field is displayed. <For more Developer Portal information, see link to specific doc sections>.

5.2.7 Debugging Jobs

As a brief introduction to the built-in debugging capabilities of ZENworks Orchestrator, the following figure shows how to find that the buildTest job was not able to find or match any resources, because resources were not added to the buildtest group as required by the policy.

Figure 5-3 *Debugging Jobs Using the Orchestrator Console*



The policy debugger shows the blocking constraint, and the tooltip gives the reason why. Dragging and dropping the resources to the required group allows the job to quickly continue and no restart was necessary.

Using the Orchestrator Client SDK

6

Novell® ZENworks® Orchestrator includes a Java* Client SDK in which you can write Java applications to remotely manage jobs. The ZOS command line tool is written using the Client SDK, as described in Appendix A, "Orchestrator Client SDK," on page 211. This SDK application can perform the following operations:

- Login and logout to an Orchestrator Server.
- Manage the life cycle of a job (run/cancel).
- Monitor running jobs (get job status).
- Communicate to a runing job using events.
- Receive events from a running job.
- Search for grid objects using constraints.
- Retrieve and mondify grid object facts.
- Datagrid operations (such as copying files to the server and downloading files from the server).

6.1 SDK Requirements

Before you can run the Orchestrator Client SDK, you must perform the following tasks:

1. Install the Orchestrator Client package. For instructions, see "Installing the Agent and Clients by Using the Product ISO" and "Walkthrough: Launch the ZENworks Orchestrator Console" in the *Novell ZENworks Orchestrator 1.2 Installation and Getting Started Guide*.
2. Install JDK 1.4.2 (http://java.sun.com/j2se/1.4.2/download.html).
3. Examine the two example Orchestrator SDK client applications that are included in the examples directory:
   - **extranetDemo:** Provides a sophisticated example of lauching multiple jobs and listening and sending events to running jobs.
   - **cracker:** Demonstrates a simple example how to launch a job and listen for events sent from the job to the client application. .

6.2 Creating an SDK Client

Use the following procedure to create an SDK client in conjunction with the sample Java code (see Section A.1.2, "ClientAgent," on page 212):

1 create ClientAgent instance:

```
// example zos server host is "myserver"

ClientAgent clientAgent =
ClientAgentFactory.newClientAgent("myserver");
```

2 Use the following user and password example to log in to the Orchestrator Server (see "Walkthrough: Log in to the ZENworks Orchestrator Server") :

```
  Credential credential =
CredentialFactory.newPasswordCredential(username,password);

  clientAgent.login(credential);
```

3 Run the server operations; in this case, it is the quickie.jbl example job (which must have been previously deployed) with no job arguments:

```
  String jobID = clientAgent.runJob("quickie",null)
```

4 (Optional) Listen for server events using the AgentListener interface:

```
  clientAgent.addAgentListener(this);
```

4a Register with the Orchestrator Server to receive job events for the job you started.

```
  clientAgent.getMessages(jobID);
```

5 Log out of the server:

```
  clientAgent.logout()
```

Job Architecture

7

The ZENworks® Orchestrator job scheduling manager is a sophisticated scheduling engine that maintains high performance network efficiency and quality user service when running jobs on the grid. Such efficiencies are managed through a set of grid component facts that operate in conjunction with job constraints. Facts and constraints operate together like a filter system to maintain both the administrator's goal of high quality of service and the user's goal to run fast, inexpensive jobs.

This section explains the following job architectural concepts:

- Section 7.1, "Understanding JDL," on page 71
- Section 7.2, "JDL Package," on page 72
- Section 7.3, "Job Class," on page 73
- Section 7.4, "Job Invocation," on page 75
- Section 7.5, "Deploying Jobs," on page 75
- Section 7.6, "Starting Orchestrator Jobs," on page 76
- Section 7.7, "Working with Facts and Constraints," on page 76
- Section 7.8, "Using Facts in Job Scripts," on page 79
- Section 7.9, "Using Other Grid Objects," on page 79
- Section 7.10, "Communicating Through Job Events," on page 80
- Section 7.11, "Executing Local Programs," on page 81
- Section 7.12, "Logging and Debugging," on page 83
- Section 7.13, "Improving Job and Joblet Robustness," on page 84

7.1 Understanding JDL

The Orchestrator Grid Management system uses an embedded Python-based language for describing jobs (called the Job Definition Language or JDL). This scripting language is used to control the job flow, request resources, handle events and generally interact with the Grid server as jobs proceed.

Jobs run in an environment that expects facts (information) to exist about available resources. These facts are either set up manually through configuration or automatically discovered via discovery jobs. Both the end-user jobs and the discovery jobs have the same structure and language. The only difference is in how they are scheduled.

The job JDL controls the complete life cycle of the job. JDL is a scripting language, so it does not provide compile-time type checking. There are no checks for infinite loops, although various precautions are available to protect against runaway jobs, including job and joblet timeouts, maximum resource consumption, quotas, and limited low-priority JDL thread execution.

As noted, the JDL language is based on the industry standard Python language, which was chosen because of its widespread use for test script writing in QA departments, its performance, its readability of code, and ease to learn.

The Python language has all the familiar looping and conditional operations as well as some powerful operations. There are various books on the language including O'Reilly's *Python in a Nutshell* and *Learning Python*. Online resources are available at http://www.python.org (http://www.python.org)

Within the Orchestrator Server and grid jobs, JDL not only adds a suite of new commands but also provides an event-oriented programming environment. A job is notified of every state change or activity by calling an appropriately named event handler method.

A job only defines handlers for events it is interested in. In addition to built-in events (such as, `joblet_started_event`, `job_completed_event`, `job_cancelled_event`, and `job_started_event`) it can define handlers for custom events caused by incoming messages. For example, if a job (Job (page 265) class) defines a method as follows:

```
def my_custom_event(self, job, params):
  print \u201cGot a my_custom event carrying ", params)
```

And the joblet (Joblet (page 276) class) sends an event/message as follows:

```
self.sendEvent("my_custom", {"arg1":"one"})
```

The following line is added to the job log:

```
Got a my_custom event carrying arg1="one"
```

JDL can also define timer events (periodic and one-time) with similar event handlers.

Each event handler can run in a separate thread for parallel execution or can be synchronized to a single thread. A separate thread results in better performance, but also incurs the development expense of ensuring that shared data structures are thread safe.

7.2 JDL Package

The job package consists of the following elements:

- Job Description Language (JDL) code, consisting of a Python-based script containing the bits to control jobs.
- An optional policy XML file, which applies constraints and other job facts to control jobs.
- Any other associated executables or data files that the job requires.

The `cracker.jdl` sample job, for example, includes a set of Java code that discovers the user password in every configured agent before the Java class is run. Or, many discovery jobs, which measure performance of Web servers or monitor any other applications, might include resource discovery utilities that enable resource discovery.

Jobs include all of the code, policy, and data elements necessary to execute specific, predetermined tasks administered either through the ZENworks Orchestrator Console user interface or from the command line. Because each job has specific, predefined elements, jobs can be scripted and delivered to any agent, which ultimately can lead to automating almost any datacenter task.

7.2.1 `.sched` Files

Job packages also can contain optional XML `.sched` files that describe the scheduling requirements for any job. This file defines when the job is run.

For example, jobs might be run whenever an agent starts up, which is defined in the `.shed` file. The discovery job "osInfo.job" on page 51 has a schedule XML file that specifies to always run a specified job whenever a specific resource is started and becomes available.

7.3 Job Class

The Job class is a representation of a running job instance. This class defines functions for interacting with the server, including handling notification of job state transitions, child job submission, managing joblets and for receiving and sending events from resources and from clients. A job writer defines a subclass of the job class and uses the methods available on the job class for scheduling joblets and event processing.

For more information about the methods this class uses, see Section 7.3.1, "Job State Transition Events," on page 73.

The following example demonstrates a job that schedules a single joblet to run on one resource:

```
class Simple(Job):
     def job_started_event(self):
         self.schedule(SimpleJoblet)

class SimpleJoblet(Joblet):
     def joblet_started_event(self):
         print "Hello from Joblet"
```

For the above example, the class `Simple` is instantiated on the server when a job is run either by client tools or by the job scheduler. When a job transitions to the started state, the method job_started_event is invoked. Here the job_started_event invokes the base class method `schedule()` to create a single joblet and schedule the joblet to run on a resource. The `SimpleJoblet` class is instantiated and run on a resource.

7.3.1 Job State Transition Events

Each job has a set of events that are invoked at the state transistions of a job. On the starting state of a job, the job_started_event is always invoked.

The following is a list of job events that are invoked upon job state transitions:

```
job_started_event
job_completed_event
job_cancelled_event
job_failed_event
job_paused_event
job_resumed_event
```

The following is a list of job events that are invoked upon child job state transitions:

```
child_job_started_event
child_job_completed_event
child_job_cancelled_event
child_job_failed_event
```

The following is a list of provisioner events that are invoked upon provisioner state transitions:

```
provisioner_completed_event
provisioner_cancelled_event
provisioner_failed_event
```

The following is a list of joblet events that are invoked as the joblet state transitions:

```
joblet_started_event
joblet_completed_event
joblet_failed_event
joblet_cancelled_event
joblet_retry_event
```

NOTE: *Only the job_started_event is required; other events are optional.

7.3.2 Handling Custom Events

A job writer can also handle and invoke custom events within a job. Events can come from clients, other jobs, and from joblets.

The folowing example defines an event handler named mycustom_event in a job:

```
class Simple(Job):
    def job_started_event(self):
        ...

    def mycustom_event(self,params):
        dir = params["directory_to_list"]
        self.schedule(MyJoblet,{ "dir" : dir } )
```

In this example, the event retrieves a element from the params dictionary that is supplied to every custom event. The dictionary is optionally filled by the caller of the event.

The following example invokes the custom event named mycustom_event from the Orchestrator client command line tool:

```
zos event mycustom_event directory_to_list="/tmp"
```

In this example, a message is sent from the client tool to the job running on the server.

The following example invokes the same custom event from a joblet:

```
class SimpleJoblet(Joblet):
    def joblet_started_event(self):
        ...
        self.sendEvent("mycustom_event", { ... } )
```

In this example, a message is sent from the joblet running on a resource to the job running on the server. The running job has access to a factset which is the aggregation of the job instance factset (jobinstance.*), the deployed job factset (job.*, jobargs.*), the User factset (user.*), the Matrix factset (matrix.*) and any jobargs or policy facts supplied at the time the job is started.

Fact values are retrieved using the GridObjectInfo (page 259) functions that the job class inherits.

The following example retrieves the value of the job instance fact state.string from the jobinstance namespace:

```
class Simple(Job):
    def job_started_event(self):
        jobstate = self.getFact("jobinstance.state.string")
        print "job state=%s" % (jobstate)
```

7.4 Job Invocation

Jobs can be started using either the `zos` command line tool, scheduling through a `.shed` file, or manually through the ZENworks® Orchestrator Console. Internally, when a job is invoked, an XML file is created. It can be deployed immediately or it can be scheduled for later deployment, depending upon the requirements of the job.

Jobs also can be started within a job. For example, you might have a job that contains JDL code to run a secondary job. Jobs also can be started through the Web portal.

Rather than running jobs immediately, there are many benefits to using the Job Scheduling Manager:

- Higher priority jobs can be run first and jump ahead in the scheduling priority band.
- Jobs can be run on the least costly node resources when accelerated performance is not as critical.
- Jobs can be run on specific types of hardware.
- User classes can be defined to indicate different priority levels for running jobs.

7.5 Deploying Jobs

A job must be deployed to the Orchestrator Server before it can be run. Deployment to the server is done in either of the following ways:

- Section 7.5.1, "Using the Orchestrator Console," on page 75
- Section 7.5.2, "Using the ZOSADMIN Command Line Tool," on page 75

7.5.1 Using the Orchestrator Console

1. In the *Actions* menu, click *Deploy Job*.
2. For additional deployment details, see "Walkthrough: Deploy a Sample Job".

7.5.2 Using the ZOSADMIN Command Line Tool

From the CLI, you can deploy a component file (`.job`, `.jdl`, `.sar`) or refer to a directory containing job components.

`.job` files are Java jar archives containing `.jdl`, `.policy`, `.sched` and any other files required by your job. A `.sar` file is a Java jar archive for containing multiple jobs and policies.

1. To deploy a `.job` file from the command line, enter the following command:

   ```
   >zosadmin deploy <myjob>.job
   ```

2. To deploy a job from a directory where the directory /jobs/myjob contains `.jdl`, `.policy`, `.sched`, and any other files required by your job, enter the following command:

   ```
   >zosadmin deploy /jobs/myjob
   ```

   Deploying from a directory is useful if you want to explode an existing job or `.sar` file and redeploy the job components without putting the job back together as a `.job` or `.sar` file.

3. Copy the job file into the "hot" deploy directory by entering the following command:

   ```
   >cp <install dir>/examples/whoami.job <install dir>/deploy
   ```

As part of an iterative process, you can re-deploy a job from a file or a directory again after specified local changes are made to the job file. You can also undeploy a job out of the system if you are done with it. Use `zosadmin redeploy` and `zosadmin undeploy` to re-deploy and undeploy jobs, respectively.

A typical approach to designing, deploying, and running a job is as follows:

1. Identify and outline the job tasks you want the Orchestrator Server to perform.
2. Use the preconfigured JDL files for specific tasks listed in Appendix B, "Orchestrator Job Classes and JDL Syntax," on page 223.
3. To configure jobs, edit the JDL file with an external text editor.
4. Repackage the job as a `.jar` file.
5. Run the ZOS administration tool to redeploy the packaged job into the Orchestrator Server.
6. Run the job using the `zos` command line tool.
7. Monitor the results of the job in the ZENworks Orchestrator Console.

Another method to deploy jobs is to edit JDL files through the Orchestrator console. The console has a text editor that enables you to make changes directly in the JDL file as it is stored on the server ready to deploy. After changes are made and the file is saved using the Orchestrator console, you simply re-run the job without redeploying it. The procedure is useful when you need to fix typos in the JDL file or have minor changes to make in the job functionality.

NOTE: Redeploying a job overwrites any job that has been previously saved on the Orchestrator Server. The Orchestrator console has a *Save File* menu option if you want to preserve JDL modifications you made using ZOC.

7.6 Starting Orchestrator Jobs

Jobs can be started by using any of the following options:

- Running jobs from the ZOS command line (see "The Zosadmin Command Line Tool").
- Running jobs from the Orchestrator scheduler (see "Understanding the Orchestrator Job Scheduler").
- Running jobs from Web applications (see "Using the ZENworks Orchestrator User Portal").
- Running jobs from within jobs (see "Using Facts in Job Scripts" on page 79).

7.7 Working with Facts and Constraints

You can incorporate facts and constraints into the custom jobs you create to manage your data center resources using Orchestrator. You should already be familiar with the concepts related to controlling jobs using job facts and constraints. For more information, see the following JDL links:

- Job (page 265)
- Joblet (page 276)

This section contains the following topics:

- Section 7.7.1, "Grid Objects and Facts," on page 77
- Section 7.7.2, "Defining Job Elements," on page 77

- Section 7.7.3, "Job Arguments and Parameter Lists," on page 78

7.7.1 Grid Objects and Facts

Every resource and service discovered in an Orchestrator-enabled network is identified and abstracted as an object. Within the Orchestrator management framework, objects are stored within an addressable database called a grid. Every grid object has an associated set of facts and constraints that define the properties and characteristics of either physical or virtual resources. In essence, by building, deploying, and running jobs on the Orchestrator Server, you can individually change the functionality of any and all system resources by managing an object's facts and constraints.

The components that have facts include resources, users, jobs, repositories, and vmhosts. The grid server assigns default values to each of the component facts, although they can be changed at anytime by the administrator unless they are read-only.

However, the developer desires certain constraints to be used for a job and might specify these in the policy. These comprise a set of logical clauses and operators that are compared with the respective component's fact values when the job is run by the Job Scheduling Manager.

Remember, all properties appear in the job context, which is an environment where constraints are evaluated. These constraints provide a multilevel filter for a job in order to ensure the best quality of service the grid can provide.

7.7.2 Defining Job Elements

When you deploy a job, you can include an XML policy file that defines constraints and facts. Because every job is a grid object with its own associated set of facts (job.id, etc.), it already has a set of predefined facts, so jobs can also be controlled by changing job arguments at run time.

As a job writer, you define the set of job arguments in the job `args` fact space. Your goal in writing a job is to define the specific elements a job user is permitted to change. These job argument facts are defined in the job XML policy for every given job.

The job argument fact values are passed to a job when the job is run. Consequently, the Orchestrator Server `run` command passes in the job arguments. Similarly, for the job scheduler, you can define which job arguments you want to schedule or run a job. You can also specify job arguments for the Web portal.

For example, in the following `quickie.job` example, the number of joblets allowed to run and the amount of sleep time between running joblets are set by the arguments `numJoblets` and `sleeptime` as defined in the policy file for the job. If no job arguments are defined, the client cannot affect the job:

```
...
          # Launch the joblets
          numJoblets = self.getFact("jobargs.numJoblets")
          print 'Launching ', numJoblets, ' joblets'

          self.schedule(quickieJoblet, numJoblets)

class quickieJoblet(Joblet):
```

```
def joblet_started_event(self):
     sleeptime = self.getFact("jobargs.sleeptime")
     time.sleep(sleeptime)
```

To view the complete example, see quickie.job (page 153).

As noted, when running a job, you can pass in a policy file, which is another method the client can use to control job behavior. Policy files can pass in additional constraints to the job, such as how a resource might be selected or how the job runs. The policy file is an XML file defined with the `.policy` extension.

For example, as shown below, you can pass in a policy for the job named `quickie`, with an additional constraint to limit the chosen resources to those with a Linux OS. Suppose a policy file name `linux.policy` in the directory named `/mypolicies` with this content:

```
<constraint type=?resource?>
    <eq fact="resource.os.family" value="linux" />
</constraint>
```

To start the `quickie` job using the additional policy, you would enter the following command:

```
>zos run quickie --policyfile=/mypolicies/linux.policy
```

7.7.3 Job Arguments and Parameter Lists

Part of a job's static definition might include job arguments. A job argument defines what values can be passed in when a job is invoked. This allows the developer to statically define and control how a job behaves, while the administrator can modify policy values.

You define job arguments in an XML policy file named with the same base name as the job. The example job `cracker.jdl`, for example, has an associated policy file named `cracker.policy`. The `cracker.policy` file contains entries for the <*jobargs*> namespace, as shown in the following partial example from `cracker.policy`.

```
<jobargs>
     <fact name="cryptpw"
      type="String"
      description="Password of abc"
      value="4B3lzcNG/Yx7E"
      />
   <fact name="joblets"
      type="Integer"
      description="joblets to run"
      value="100"
      />
</jobargs>
```

The above policy defines two facts in the `jobargs` namespace for the cracker job. One is a String fact named `cryptpw` with a default value. The second `jobargs` fact is an integer named `joblets`. Both of these facts have default values so they do not require been set on job invocation. If the default value was omitted, then job would require that the two facts be set on job invocation. The job will not start unless all required job argument facts are supplied at job invocation. The default values of job argument facts can be overridden at job invocation.

Job arguments are passed to a job when the job is invoked. This is done in one of the following ways:

- From the ZOS `run` command from the CLI, as shown in the following example:
  ```
  >zos run cracker cryptpw="dkslsl"
  ```
- From within a JDL job script when invoking a child job, as shown in the following job JDL fragment:
  ```
  self.runjob("cracker", { "cryptpw" : "asdfa" } )
  ```
- From the Orchestrator scheduler, either with the Orchestrator console or by a `.sched` file.

7.8 Using Facts in Job Scripts

Facts can be retrieved, compared against, and written to (if not read-only) from within jobs. Every grid object has a set of accessor and setter JDL functions. For example, to retrieve the `cryptpw` job argument fact in the job example listed in "Job Arguments and Parameter Lists" on page 78, you would write the following JDL code:

```
1  def job_started_event(self):
2      pw = self.getFact("jobargs.cryptpw")
```

In line 2, the function `getFact()` retrieves the value of the job argument fact. `getFact()` is invoked on the job instance grid object.

The following set of JDL grid object functions retrieve facts:

```
getFact()
factExists()
getFactLastModified()
getFactNames()
```

The following set of JDL grid object functions modify fact values (if they are not read-only) and remove facts (if they are not deleteable):

```
setFact
setDateFact
setTimeFact
setArrayFact
setBooleanArrayFact
setDateArrayFact
setIntegerArrayFact
setTimeArrayFact
setStringArrayFact
deleteFact
```

For more complete information on these fact values, see GridObjectInfo (page 259).

7.9 Using Other Grid Objects

Grid objects can be retrieved using jobs. This is done when facts from other objects are needed for job decision processing, or when joblets are executed on a resource.

The MatrixInfo (page 286) grid object represents the system and from the MatrixInfo object, you can retrieve other grid objects in the system. For example, to retrieve the resource grid object named `webserver` and a fact named `resource.id` from this object, you would enter the following JDL code:

```
webserver = getMatrix().getGridObject(TYPE_RESOURCE,"webserver")
id = webserver.getFact("resource.id")
```

The MatrixInfo grid object also provides functions for creating other grid objects. For more complete information about these functions, see MatrixInfo (page 286).

7.10 Communicating Through Job Events

JDL events are how the server communicates job state transitions to your job. The required `job_started_event` is always invoked when the job transitions to the `starting` state.

Likewise, all the other state transitions have JDL equivalents that can be optionally implemented in your job. For example, the `joblet_completed_event` is invoked when a joblet has transistioned to completed. You could implement `joblet_completed_event` to launch another job or joblet or send a custom event to a Client, another job, or another joblet.

You can also use your own custom events for communicating between Client, job, child jobs and joblets.

Every partition of a job (client, job, joblet, child jobs) can communicate with each other using Events. Events are messages that are communicated to each of the job partitions. For example, a joblet running on a resource can send an event to the job portion running on the server to communicate the completion of a stage of operation.

A job can send an event to a Java Client signalling a stage completion or just to send a log message to display in a client GUI.

Every event carries a dictionary as a payload. You can put any key/values you want to fulfill the requirements of your communication. The dictionary can be empty.

For more information about events are invoked at the state transitions of a job, see Job (page 265) and Section B.7, “Joblet State Values,” on page 226.

7.10.1 Sending and Receiving Events

To send an event from a joblet to a job running on a server, you would input the following:

1. The portion in the joblet JDL to send the event:
   ```
   self.sendEvent("myevent", { "message": "hello from joblet" } )
   ```
2. The portion in job JDL to receive the event:
   ```
   def myevent(self,params):
       print "hello from myevent. params=",params
   ```

To send an event from a job running on the server to a client, you would input the following:

```
self.sendClientEvent("notifyClient", { "log" : "Web server
installation completed" } )
```

In your Java client, you must implement AgentListener and check for an Event message.

For testing, you can use the `zos run ... --listen` option to print events from the server.

For additional details about the `sendEvent()` and `sendClientEvent()` methods in the Job (page 265) and Joblet (page 276) documentation.

7.10.2 Synchronization

By default, no synchronization occurs on job events. However, synchronization is necessary when you update the same grid objects from multiple events.

In that case, you must put a synchronization wrapper around the critical section you want to protect. The following JDL script is how this is done:

```
1  import synchronize
2  def objects_discovered_event(self, params):
3      print "hello"
4  objects_discovered_event =
synchronize.make_synchronized(objects_discovered_event)
```

Line 1 specifies to use the synchronization wrapper, which requires you to import the synchronize package.

Lines 2 and 3 provide the normal definition to an event in your job, while line 4 wraps the function definition with a synchronized wrapper.

7.11 Executing Local Programs

Running local programs is one of the main reasons for scheduling joblets on resources. Although you are not allowed to run local programs on the server side job portion of JDL, there are two ways to run local programs in a joblet:

1. Use the built-in `system()` function.

   This function is used for simple executions requiring no output or process handling. It simply runs the supplied string as a shell command on the resource and writes `stdout` and `stderr` to the job log.

2. Use the `Exec` JDL class.

   The Exec class provides flexibility in how to invoke executables, to process the output, and to manage the process once running. There is provision for controlling `stdin`, `stdout`, and `stderr` values. `stdout` and `stderr` can be redirected to a file, to the job log, or to a stream object.

   Exec provides control of how the local program is run. You can choose to run as the agent user or the job user. The default is to run as the job user, but fallback to agent user if the job user does not exist on the resource.

   For more information, see Exec (page 249).

7.11.1 Output Handling

The Exec (page 249) function provides controls for specifying how to handle `stdout` out `stderr`. By default, Exec discards the output.

The following example runs a program that directs `stdout` and `stderr` to the job log:

```
e = Exec()
e.setShellCommand(cmd)
e.writeStdoutToLog()
e.writeStderrToLog()
e.execute()
```

The following example runs a program that directs `stdout` and `stderr` to files and opens the `stdout` file if there is no error in execution:

```
e = Exec()
e.setCommand("ps -aef")
e.setStdoutFile("/tmp/ps.out")
e.setStderrFile("/tmp/ps.err")
result = e.execute()
if result == 0:
    output = open("/tmp/ps.out").read()
    print output
```

7.11.2 Local Users

You can choose to run local programs and have file operations done as the agent user or the job user. The default is to run as the job user, but fallback to agent user if the job user does not exist on the resource. These controls are specified on the job. The job.joblet.runtype fact specifies how file and executable operations run in the joblet in behalf of the job user, or not.

The choices for `job.joblet.runtype` are defined in the following table:

Table 7-1 *Job Run Type Values*

Option	Description
RunAsJobUserFallingBackToNodeUser	Default. This means if the job user exists as a user on the resource, then executable and file operations is done on behalf of that user. By falling back, this means that if the job user does not exist, the agent will still execute the joblet executable and file operation as the agent user. If the executable or file operation still has a permission failure, then the agent user is not allowed to run the local program or do the file operation.
RunOnlyAsJobUser	This means resource can only run the executable or file operation as the job user and will fail immediately if the job user does not exist on the resource. You want to use this mode of operation if you wish to strictly enforce execution and file ownership. You must have your resource setup with NIS or other naming scheme so that your users will exist on the resource.
RunOnlyAsNodeUser	This means the resource will only run executables and do file operations as the agent user.

There is also a fact on the resource grid object that can override the `job.joblet.runtype` fact. The fact `resource.agent.config.exec.asagentuseronly` on the resource grid object can overwrite the `job.joblet.runtype` fact.

This ability to run as the job user is supported by the `enhanced exec` feature of the Orchestrator agent. A resource might not support the Orchestrator enhanced execution of running as job users. If the capability is not supported, the fact `resource.agent.config.exec.enhancedused` is False. This fact is provided so you can create a resource or allocation constraint to exclude such a resource if your grid mixes resource with/without the enhanced exec support and your job requires enhanced exec capabilities.

7.11.3 Safety and Failure Handling

An exception in JDL will fail the job. By default, an exception in the joblet will fail the joblet. The `job.joblet.*` facts provide controls on how many times a failure will fail the joblet. For more information, see Section 7.13, “Improving Job and Joblet Robustness,” on page 84.

```
try :
  < JDL >
except:
    exc_type, exc_value, exc_traceback = sys.exc_info()
    print "Exception:", exc_type, exc_value
```

JDL also provides the `fail()` function on the Job and Joblet class for failing a job and joblet. The `fail()` function takes an optional reason message.

You would use `fail()` when you detect an error condition and wish to end the job or joblet immediately. Usage of the joblet `fail()` fails the currently running instance of the joblet. The actual `failed` state of the joblet occurs when the maximum number of retries has been reached.

7.12 Logging and Debugging

The following sections show some examples how jobs can be logged and debugged:

- Section 7.12.1, “Creating a Job Memo,” on page 83
- Section 7.12.2, “Tracing,” on page 84

7.12.1 Creating a Job Memo

This job example shows how to set a brief memo visible in the Orchestrator console.

In the job section of this example (lines 4-8), the fact name (jobinstance.memo) is set by job instance.

```
1  JOB:
2  fact name "jobinstance.memo"
3
4  class MyJob(Job):
5     def job_started_event(self):
6         numJoblets = 2
7         self.setFact("jobinstance.memo", "Running MyJob Scheduling +
" + numJoblets + " joblets")
8         self.schedule(MyJoblet,numJoblets)
```

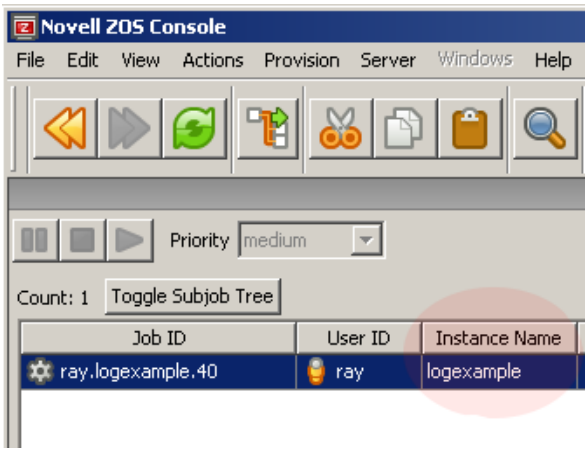
In the `joblet` section of this example, the face name (`joblet.memo`, line 10), is set by the joblet instance and consists of a brief memo for each joblet. This typically is used for providing detailed explanations, such as what executable is being run.

```
9  JOBLET:
10 fact name "joblet.memo"  (Set by joblet instance)
11
```

In lines 12-19, the name of the joblet is specified. This is typically a simple word, which is displayed in the console joblet column view.

```
12 fact name "joblet.instancename"
13
14
15 class MyJoblet(Joblet):
16    def joblet_started_event(self):
17         self.setFact("joblet.memo", "Running MyJoblet on " +
self.getFact("resource.id"))
18
19         self.setFact("joblet.instancename", "webserver")
```

Figure 7-1 *Example of How a 'logexample' Name Appears in the Orchestrator Console*



7.12.2 Tracing

There are two facts on the job grid object to turn on /off tracing. The tracing fact writes a message to the job log when a job and/or joblet event is entered and exited.

The facts are `job.tracing` and `job.joblet.tracing`. You can turn these on via the Orchestrator console or from the `zos run` command tool.

7.13 Improving Job and Joblet Robustness

The job and joblet grid objects provide several facts for controlling the robustness of job and joblet operation.

The default setting of these facts is to fail the job on first error, since failures are typical during the development phase. Depending on your job requirements, you adjust the retry maximum on the fact to enable your joblets either to failover or to retry.

The fact `job.joblet.maxretry` defaults to 0, which means the joblet is not retried. On first failure, the joblet is considered failed. This, in turn, fails the job. However, after you have written and tested your job, you should introduce fault tolerance to the joblet.

For example, suppose you know that your resource application might occasionally timeout due to network or other resource problems. Therefore, you might want to introduce the following behavior by setting facts appropriately:

- On timeout of 60 seconds, retry the joblet.
- Retry a maximum of two times. This may cause a retry on another resource matching your resource and allocation constraints.
- On the third third timeout, fail the joblet.

To configure this setup, you use the following facts in either the job policy (using the Orchestrator console to edit the facts directly) or within the job itself:

```
job.joblet.timeout set to 60
job.joblet.maxretry set to 2
```

In addition to timeout, there are different kinds of joblet failures for which you can set the maximum retry. There are forced (job errors) and unforced connection errors. For example, an error condition detected by the JDL code (forced) might require more retries than a network error, which might cause resource disconnections. In the connection failure case, you might want to lower the retry limit because you probably do not want a badly setup resource with connection problems to keep retrying and getting work.

Job Scheduling

8

Novell® ZENworks® Orchestrator schedules jobs either manually using the Job Scheduler or programatically using the Job Description Language (JDL). This section contains the following topics:

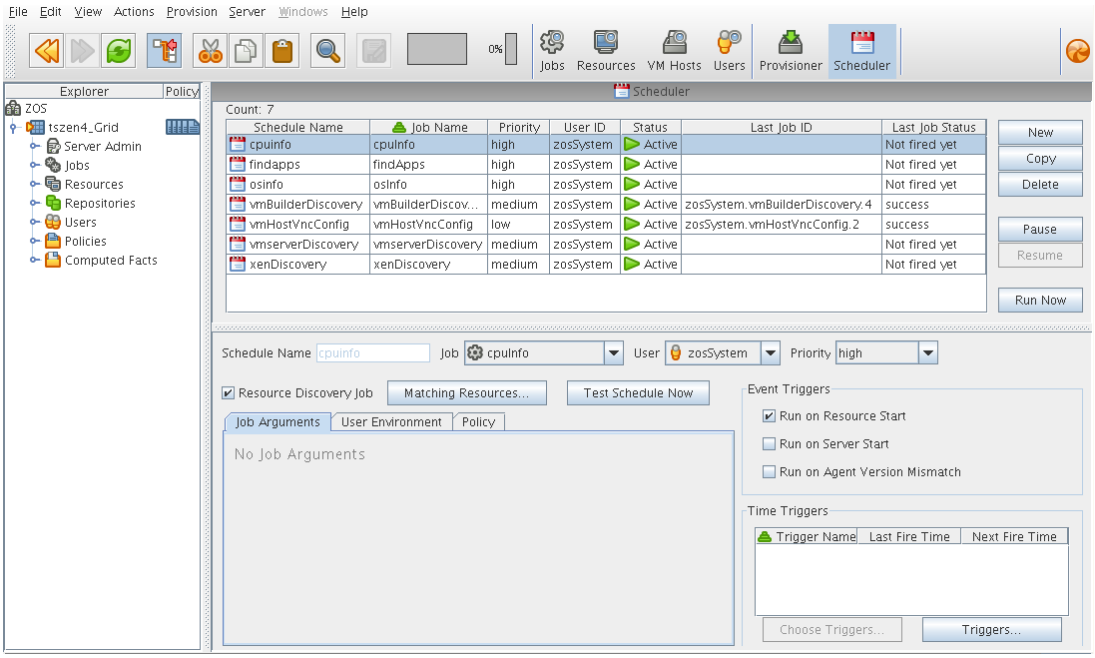
- Section 8.1, “Job Scheduler GUI,” on page 87
- Section 8.2, “Schedule Files,” on page 88
- Section 8.3, “Job Scheduling DTD Commands and Events,” on page 89
- Section 8.4, “Scheduling with Constraints,” on page 109

8.1 Job Scheduler GUI

After ZENworks Orchestrator is enabled with a license, users have access to a built-in job Scheduler. This GUI interface allows jobs to be started periodically based upon user scheduling or when various system events occur.

The following figure illustrates the job Scheduler, with seven jobs staged in the main Scheduler panel.

Figure 8-1 *The ZENworks Orchestrator Scheduler GUI*



Jobs are individually submitted and managed using the Job Scheduler as discussed in “Understanding the Orchestrator Job Scheduler” in the *Novell ZENworks Orchestrator 1.2 Administration Guide* and in “Using the ZENworks Orchestrator User Portal” in the *Novell ZENworks Orchestrator 1.2 Job Management Guide*.

8.2 Schedule Files

In addition to using the Job Scheduler GUI, developers can also write XML files to schedule jobs to run when triggered by specific events.These files are designated using the `.sched` extension and can be included as part of the job archive file.

Everything that you do manually in the Job Scheduler can be automated by creating a `.sched` XML script as part of a job. The XML file enables you to package system and job scheduling logic without using the GUI. This includes setting up cron triggers (for example, running a job at specified intervals) and other triggers that respond to system events, such as startup (login).

For example, the `osInfo` discovery job, which probes a resource for its operating system information, is packaged with a schedule file, as shown in the "osInfo.sched Example" on page 88. See also Section 8.2.2, "Cron Trigger Example," on page 89.

8.2.1 osInfo.sched Example

A schedule file can be packaged with a job in a .job file or independently deployed to a Orchestrator server. Because the XML file defines the job Schedule programatically outside of the Orchestrator console, packaging these scripts into jobs is typically a developer task.

The `osinfo.sched` file is packaged with the osInfo discovery job, which is deployed as part of the base server. Its purpose is to trigger a run of the osInfo job on a resource when the resource comes on line as it logs into the server.

The following shows the syntax of the schedule file that wraps the job:

```
1<schedule>
2     <job name="osinfo" job="osInfo" user="zosSystem" priority="high"
>
3         <resourcediscovery/>
4         <active/>
5         <runonresourcestart/>
6         <runoneachresource/>
7     </job>
8 </schedule>
```

NOTE: The XML descriptor, which is written against the schedule DTD, is documented in Appendix C, "Orchestrator Job Scheduling DTD," on page 313.

Line 1: Starts the new schedule definition.

Line 2: Defines a new schedule named *osinfo*, which is used to schedule a run of the job `osInfo`. If the job (in this case, `osinfo`) is not deployed, the deployment returns a "Job is not deployed" error. The *user* parameter identifies what user to run the `osinfo` job, while *priority* specifies a priorty at which to run the job.

Line 3: Instructs the schedule to run the job as a resource discovery job.

Line 4: Activates the job after it is deployed. The schedule default is not active.

Line 5: Runs `osInfo` job when the resource logs into the server.

Line 6: Specifies to run a single joblet on each resource.

8.2.2 Cron Trigger Example

The following example shows the syntax of a schedule file that has two cron triggers for scheduling a job:

```
1<schedule>
2    <trigger name="NightlyReportTrigger" description="CRON fire at 4
am every day">
       <cron value="0 0 4 * * ?" />
    </trigger>
3    <trigger name="DailyReportTrigger" description="CRON fire at 4 pm
every day">
       <cron value="0 0 16 * * ?" />
    </trigger>
4    <job name="Report" job="ReportJob" user="manager">
5        <jobargs>
            <fact name="fullreport" type="Boolean" value="false" />
         </jobargs>
6        <active/>
7        <triggers value="NightlyReportTrigger" />
8        <triggers value="DailyReportTrigger" />
9    </job>
10 </schedule>
```

Line 1: Starts the new schedule definition..

Lines 2-3: Defines two new triggers to fire at 4 a.m. and 4 p.m. every day.

Line 4: Defines a new scheduled task named *Report* that is used to schedule a run of the job `ReportJob`.

Line 5: Specifies the job parameters for the scheduled job.

Line 6: Activates the job after it is deployed. The schedule default is not active.

Lines 7-8: Defines that the schedule uses the two specified triggers.

A schedule file can be packaged either within a `.job` archive alongside the `.jdl` file or independently deployed using the zosadmin command line utility.

8.3 Job Scheduling DTD Commands and Events

The following XML DTD commands and events explain many of the Orchestrator's job scheduling functions.

- "<active>" on page 91
- "<cron>" on page 92
- "<dict>" on page 93
- "<element>" on page 94
- "<fact>" on page 95
- "<interval>" on page 96
- "<job>" on page 97
- "<jobargs>" on page 99

- "<passuserenv>" on page 100
- "<repeat>" on page 101
- "<resourcediscovery>" on page 102
- "<runoneachresource>" on page 103
- "<runonresourcestart>" on page 104
- "<runonserverstart>" on page 105
- "<schedule>" on page 106
- "<startin>" on page 107
- "<triggers>" on page 108
- "<trigger>" on page 109

To see a full implementation of the DTD, see Appendix C, "Orchestrator Job Scheduling DTD," on page 313.

<active>

Indicates this schedule is activated upon deployment.

Definition

```
<!ELEMENT active (#PCDATA)>
```

Parent

Job

<cron>

Defines a cron string.

Definition

```
<!ELEMENT cron (#PCDATA)>
<!ATTLIST cron
          value     CDATA     #REQUIRED
>
```

Attributes

value

Parent

Job

<dict>

Defines a member of a dictionary fact.

Description

The required key, type, and value attributes define a dictionary member.

Definition

```
<!ELEMENT dict (#PCDATA)>
<!ATTLIST dict
          key     CDATA     #REQUIRED
          type    CDATA     #IMPLIED
          value   CDATA     #REQUIRED >
```

Attributes

key

type

Specifies the attribute type.

value

Specifies the value associated with the dict fact.

<element>

Defines a member of a list or array fact.

Definition

```
<!ELEMENT element (#PCDATA)>
<!ATTLIST element
          type     CDATA     #IMPLIED
          value    CDATA     #REQUIRED >
```

Attributes

type

Specifies if the element is an array or a list.

value

Defines the required attribute of a member of the list or array.

<fact>

Defines which jobarg fact is being assigned.

Description

The name, type and value of the fact are specified as attributes. The jobarg fact must be defined in the jobargs namespace for the job.

Definition

```
<!ELEMENT fact (element*,dict*)>
<!ATTLIST fact
          name     CDATA     #REQUIRED
          type     CDATA     #REQUIRED
          value    CDATA     #IMPLIED >
```

Attributes of <nds>

name

Specifies the attribute name.

type

For list or array fact types, the element tag defines a list or array members. For dictionary fact types, the dict tag defines dictionary members.

value

Specifies the value associated with this fact.

Elements

<element>

<dict>

Parent

Job

<interval>

Defines the number of minutes to wait between scheduled jobs.

Definition

```
<!ELEMENT interval (#PCDATA)>
<!ATTLIST interval
          value     CDATA     #REQUIRED >
```

Attributes

value

Specifies the waiting time in minutes between scheduled jobs.

Parent

Job

<job>

Defines the root element for job scheduling.

Description

A job contains parameters for jobargs, scheduling options, and which triggers to use..

Definition

```
<!ELEMENT job
(jobargs?,resourcediscovery?,active?,passuserenv?,runonresourcestart?,
runonserverstart?,runoneachresource?,triggers*)>
<!ATTLIST job
          name     CDATA     #REQUIRED
          job      CDATA     #REQUIRED
          user     CDATA     #IMPLIED
          priority CDATA     #IMPLIED >
```

Attributes

name

Specifies the unique schedule name.

job

Defines the unique name of the job associated with the schedule.

user

priority

Sets the priority in which the job runs.

Elements

<jobargs>

Allows specifying values for jabargs facts on job submission.

<resourcdiscovery>

Enables the job to discover facts on a resource.

<active>

Designates the schedule is activated when it is deployed.

<passuseerenv>

Indicates the user's environment factset, if available, is availabe when the job is executed.

<runonresourcestart>

Specifies the job is run when a resource has logged in.

<runonserverstart>

Specifies the job is run after the server has started.

<runoneachresource>

Specifies the job is run on every resource..

<triggers>

Defines what triggers, if any, are used for this scheduled job.

Parent

None

<jobargs>

Allows specifying values for jobargs facts when the job is submitted.

Definition

```
<!ELEMENT jobargs (fact)*>
```

Element

<fact>

Defines which jobarg fact is being assigned.

Parent

Job

<passuserenv>

Indicates that the user's environment factset, if available, is available when the job is executed.

Definition

```
<!ELEMENT passuserenv (#PCDATA)>
```

Parent

Job

<repeat>

Defines the number of iterations to run a scheduled job.

Definition

```
<!ELEMENT repeat (#PCDATA)>
<!ATTLIST repeat
          value     CDATA     #REQUIRED >
```

Attributes

value

Specifies the number of interations to run a scheduled job.

Parent

Job

<resourcediscovery>

Specifies that this job is run to discover facts on a specified resource.

Definition

```
<!ELEMENT resourcediscovery (#PCDATA)>
```

Parent

Job

<runoneachresource>

Indicates the job is to be run on every resource, subject to the job's policies.

Definition

```
<!ELEMENT runoneachresource (#PCDATA)
```

Parent

Job

<runonresourcestart>

Indicates the job is run after a resource has logged in.

Definition

```
<!ELEMENT runonresourcestart (#PCDATA)>
```

Parent

Job

<runonserverstart>

Indicates the job is run after the server has started.

Definition

```
<!ELEMENT runonserverstart (#PCDATA)>
```

Parent

Job

<schedule>

Defines the root element for job scheduling and triggers.

Description

A schedule contains job schedules and triggers.

Definition

```
<!ELEMENT schedule (job|trigger)* >
```

Elements

<job>

The job scheduled to run.

<trigger>

Defines an event trigger for starting a scheduled job. The name attribute is required for uniquely identifying the trigger..

Parent

Top element

<startin>

Defines the number of minutes to delay until starting a scheduled job.

Definition

```
<!ELEMENT startin  (#PCDATA)>
<!ATTLIST startin
          value     CDATA     #REQUIRED >
```

Attributes

value

Specifies the number of minutes to delay a scheduled job.

Parent

Job

<triggers>

Defines what triggers, if any, that are used for this scheduled job.

Description

The triggers listed here must either be defined in this file or already exist.

Definition

```
<!ELEMENT triggers (#PCDATA)>
<!ATTLIST triggers
          value     CDATA     #REQUIRED >
```

Attribute

value

The values specified for the job triggers.

Parent

Job

<trigger>

The trigger element is the root element for trigger definition.

Description

The trigger element defines an event trigger for starting a scheduled job. The name attribute is required to uniquely identify the trigger.

Definition

```
<!ELEMENT trigger (cron?,startin?,interval?,repeat?)>
<!ATTLIST   trigger
            name        CDATA     #REQUIRED
            description CDATA     #REQUIRED >
```

Attributes

name

Specifies the required name to uniquely identify the trigger.

description

Describes the functionality of the trigger.

Elements

<cron>

The cron string.

<startin>

Specifies the number of minutes to delay until starting a scheduled job..

<interval>

Specifies the waiting time in minutes between scheduled jobs.

<repeat>

Defines the number of iterations to run a scheduled job.

Parent

Job

8.4 Scheduling with Constraints

The constraint specification of the policies is comprised of a set of logical clauses and operators that compare property names and values. The grid server defines most of these properties, but they can also be arbitrarily extended by the user/developer.

All properties appear in the job context, which is an environment where constraints are evaluated. Compound clauses can be created by logical concatenation of earlier clauses. A rich set of constraints can thus be written in the policies to describe the needs of a particular job. However, this is only part of the picture.

Constraints can also be set by an administrator via deployed policies, and additional constraints can be specified by jobs to further restrict a particular job instance. The figure below shows the complete process employed by the Orchestrator Server to constrain and schedule jobs.

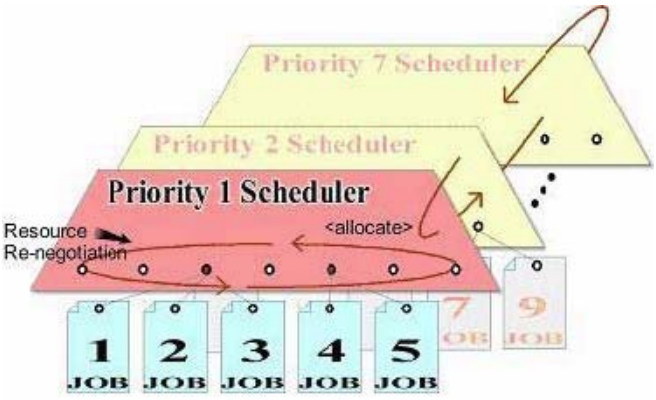
When a user issues a work request, the user facts (user.* facts) and job facts (job.* facts) are added to the job context. The server also makes all available resource facts (resource.* facts) visible by reference. This set of properties creates an environment in which constraints can be executed. The scheduler applies a logic ANDing of job constraints (specified in the policies), grid policy constraints (set on the server), optionally additional user defined constraints specified on job submission, and optional constraints specified by the resources.

This procedure results in a list of matching resources. The Orchestrator solution returns three lists:

- Available resources
- Preemptable resources (nodes running lower priority jobs that could be suspended)
- Resources that could be “stolen” (nodes running lower-priority jobs that could be killed)

These lists are then passed to the resource allocation logic where, given the possible resources, the ordered list of desired resources is returned together with information on the minimum acceptable allocation. The scheduler uses this information to appropriate resources for all jobs within the same priority group. Because the scheduler is continually re-evaluating the allocation of resources, the job policies forms part of the schedulers real-time algorithm, thus providing an extremely versatile and powerful scheduling mechanism.

Figure 8-2 *Job Scheduling Priority*



Although job scheduling might appear complex, it is very easy to use for an end user. For example, a job developer might write just a few lines of policy code to describe a job to require a node with a x86 machine, greater than 512 MB of memory, and a resource allocation strategy of minimizing execution time. Below is an example.

```
<constraint type=”resource”>
  <and>
    <eq fact="cpu.architecture" value="x86" />
    <gt fact="memory.physical.total" value="512" />
```

```
  </and>
</constraint>
```

Virtual Machine Job Development 9

This section explains the following concepts related to developing virtual machine (VM) management jobs:

- Section 9.1, “VM Job Best Practices,” on page 113
- Section 9.2, “Virtual Machine Management,” on page 114
- Section 9.3, “VM Life Cycle Management,” on page 116
- Section 9.4, “Manual Management,” on page 119
- Section 9.5, “Automatically Provisioning a VM Server,” on page 121
- Section 9.6, “Defining Values for Grid Objects,” on page 122

9.1 VM Job Best Practices

This section discusses some of VM job architecture best practices to help you understand and get started developing VM jobs:

- Section 9.1.1, “Plan Robust Application Starts and Stops,” on page 113
- Section 9.1.2, “Managing VM Systems,” on page 113
- Section 9.1.3, “Managing VM Images,” on page 114
- Section 9.1.4, “Managing VM Hypervisors,” on page 114
- Section 9.1.5, “VM Job Considerations,” on page 114

9.1.1 Plan Robust Application Starts and Stops

An application is required for a service, and a VM is provisioned on its behalf. As part of the provisioning process, the VM’s OS typically must be prepared for specific work; for example, NAS mounts, configuration, and other tasks. The application might also need customizing, such as configuring file transfer profiles, client/server relationships, and other tasks.

Then, the application is started and its “identity” (IP address, instance name, and other identifying characteristics) might need to be transferred to other application instances in the service, or a load balancer).

If the Orchestrator Server loses the job/joblet communication state machine, such as when a server failover or job timeout occurs, all of the state information must be able to be recovered from “facts” that are associated with the server. This kind of job should also work in a disaster recovery mode, so it should be implemented in jobs regularly when relevant services from Data Center A must be started in Data Center B in a DR case. These jobs require special precautions.

9.1.2 Managing VM Systems

A series of VMs must typically be provisioned in order to run systemwide maintenance tasks. Because there might not be enough resources to bring up every VM simultaneously, you might

consider running discovery jobs to limit how many resources (RAM, cores, etc.) that can be used at any given time. Then, you should consider running a task that writes a consolidated audit trail.

9.1.3 Managing VM Images

Similar to how the job `instagent` searches for virtual machine grid objects using specified Constraints and runs a VM operation (installAgent) on the VMs that are returned, an Orchestrator image must be checked out of the warehouse and mounted, modified, and checked in again. Preferably, this should occur without having to provision the VM itself.

9.1.4 Managing VM Hypervisors

The management engine ("hypervisor") underlying the the host server must be "managed" while a VM is running. For example, VM memory or CPU parameters must be adjusted on behalf of a monitoring job or a management console action.

9.1.5 VM Job Considerations

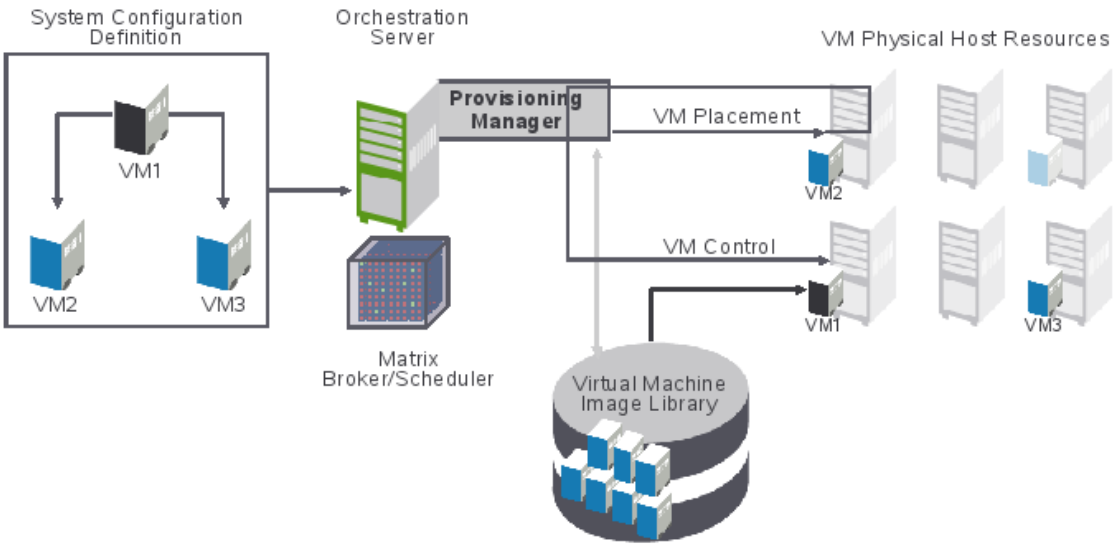
In some instances, some managed resources might host VMs that do not contain an Orchestrator agent. Such VMs can only be controlled by administrators interacting directly with them.

Long-running VMs can be modified or migrated while the job managing the VM is not actively interacting with it. If you have one joblet running on the container and one inside the VM, that relationship might have to be re-established.

9.2 Virtual Machine Management

The Orchestrator provisioning manager provides the ability to manage the life cycle of virtual machines, as shown in the following figure.

Figure 9-1 *VM Lifecycle Management*



For more information about managing virtual machines, see the *Novell ZENworks Orchestrator 1.2 Virtual Machine Management Guide*.

While Orchestrator enables you you manage many aspects of your virtual environment, as a developer, you can create custom jobs that do the following tasks:

- **Create and clone VMs:** These jobs Creates virtual machine images to be stored or deployed. They also create templates for building images to be stored or deployed (see "VM Instance" on page 115 and "VM Template" on page 116).
- **Discover resources that can be used as VM hosts.**
- **Provision, migrate, and move VMs:** Virtual machine images can be moved from one physical machine to another.
- **Check in VMs that have the proper versions and system configurations.**
- **Provide checkpoints, restoration, and resynchronization of VMs:** Snapshots of the virtual machine imge can be taken and used to restore the environment if needed.
- **Retire, delete, and destroy VMs:** Jobs can decommission and retire deployed images.
- **Monitor VM operations:** Jobs can start, shut down, suspend and restart VMs.
- **Manage on, off, suspend, and restart operations.**

9.2.1 VM Provisioning

VM provisioning adapters run just like regular jobs on the Orchestrator. The system can detect a local store on each VM host and if a local disk might contain VM images. The provisioner puts in a request for a VM host. However, before a VM is brought to life, the system pre-reserves that VM for exclusive use.

That reservation prevents a VM from being stolen by any other job that's waiting for a resource that might match this particular VM. The constraints specified to find a suitable host evaluates machine architectures, CPA, bit width, available virtual memory, or other administrator configured constraints, such as the number of virtual machine slots.

This process provides heterogeneous virtual machine management using the following virtual machine adapters:

- **Xen Adapter:** For more information, see XenSource* (http://www.xensource.com/).
- **VMWware Server 1.0 and GSX 3.2:** For more information, see VMWare (http://www.vmware.com).
- **VMWare* ESX 2.5 and 3.0, GSX 3.2 thru Virtual Center 1.3.1 API:** For more information, see VMWare (http://www.vmware.com).

There are two types of VMs:

- "VM Instance" on page 115
- "VM Template" on page 116

VM Instance

A VM instance is a VM that is "state-full." This means there can only ever be one VM that can be provisioned, moved around the infrastructure, and then shut down, yet maintains its state.

VM Template

A VM template represents an image that can be clonable. After it is finished its services, it is shut down and destroyed.

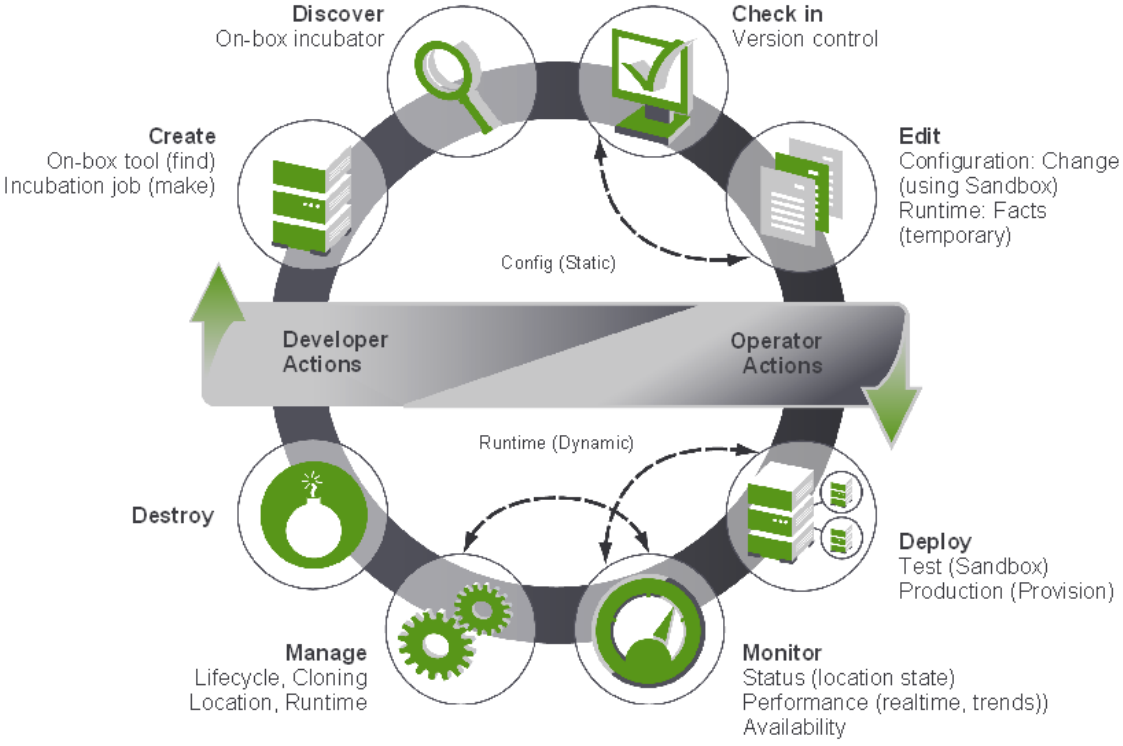
It can be thought of as a “golden master.” The number of times a golden master or template can be provisioned or cloned is controlled though constraints that you specify when you create a provisioning job.

9.3 VM Life Cycle Management

The Novell ZENworks Orchestrator maintains a library of VM images, hosts, and instances. Like physical resources, VMs can be grouped and they have facts that describe their attributes.

ZENworks orchestrator provides a JDL management API for the following tasks you can use jobs to perform on VMs, as illustrated in the following figure:

Figure 9-2 *VM Lifecycle Management*



- Provision (schedule or manually provision a set of VMs at a certain time of day).
- Move
- Clone (clone a VM, an online VM, or a template)
- Migrate
- Create a VM template from a physical machine
- Create a VM from a physical machine
- Destroy
- Restart

- Check status
- Create a template to instance
- Create an instance to template
- Affiliate with a host
- Make it a stand-alone VM
- Create checkpoints
- Restore
- Delete
- Cancel Action.

You might want to provision a set of VMs at a certain time of day before the need arises. You also might create a job to shut down all VMs or a constrained group of VMs. You can perform these tasks programatically (using a job), manually (through the management console), or automatically on demand.

When performing tasks automatically, a job might make a request for an unavailable resource, which triggers a job to look for a suitable VM image and host. If located, the image is provisioned and the instance is initially reserved for calling a job to invoke the required logic to select, place, and use the newly provisioned resource.

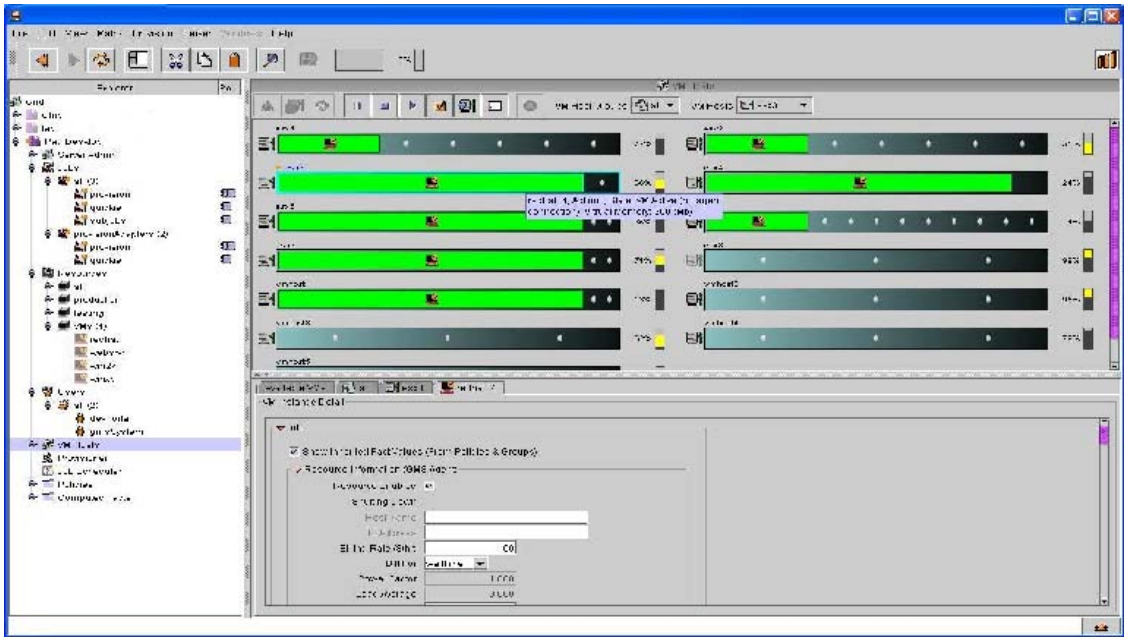
For an example of this job, see sweeper.job (page 183).

VM operations are available on the ResourceInfo (page 298) grid object, and VmHost operations are available on the VMHostInfo (page 310) grid object. In addtion, as shown in Section 9.3.2, “Provisioning Example,” on page 119, three provisioner events are fired when a provision action has completed, failed, or cancelled.

The API is equivalent to the actions available within the Orchestrator management console. The selection and placement of the VM host is governed by policies, priorities, queues, and ranking, similar to the processes used selecting resources.

Provisioning adapters on the Orchestrator Server abstract the VM. These adapters are special provisioning jobs that perform operations for each integration with different VM technologies. The following figure shows the VM host management interface that is using the Orchestrator console.

Figure 9-3 *VM Host Management*



9.3.1 VM Placement Policy

To provision virtual machines, a suitable host must be found. The following shows an example of a VM placement policy:

```
<policy>
  <constraint type="vmhost">
    <and>
      <eq fact="vmhost.enabled" value="true"
          reason="VmHost is not enabled" />
      <eq fact="vmhost.online" value="true"
          reason="VmHost is not online" />
      <eq fact="vmhost.shuttingdown" value="false"
          reason="VmHost is shutting down" />
      <lt fact="vmhost.vm.count" factvalue="vmhost.maxvmslots"
          reason="VmHost has reached maximum vmslots" />
     <ge fact="vmhost.virtualmemory.available"
         factvalue="resource.vmimage.virtualmemory"
        reason="VmHost has insufficient virtual memory for guest VM" /
>
      <contains fact="vmhost.vm.availableids"
                factvalue="resource.id"
                reason="VmImage is not available on this VmHost" />
    </and>
  </constraint>
</policy>
```

9.3.2 Provisioning Example

This job example provisions a virtual machine and monitors whether provisioning completed successfully. The VM name is “webserver” and the job requires a VM to be discovered before it is run. After the provision has started, one of the three provisioner events is called.

```
1  class provision(Job):
2
3      def job_started_event(self):
4          vm = getMatrix().getGridObject(TYPE_RESOURCE,"webserver")
5          vm.provision()
6          self.setFact("job.autoterminate",False)
7
8      def provisioner_completed_event(self,params):
9          print "provision completed successfully"
10         self.setFact("job.autoterminate",True)
11
12     def provisioner_failed_event(self,params):
13         print "provision failed"
14         self.setFact("job.autoterminate",True)
15
16     def provisioner_cancelled_event(self,params):
17         print "provision cancelled"
18         self.setFact("job.autoterminate",True)
```

See additional provisioning examples in Section 9.4, “Manual Management,” on page 119 and Section 9.5, “Automatically Provisioning a VM Server,” on page 121.

9.4 Manual Management

The example provided in this section is a general purpose job that only provisions a resource.

You might use a job like this, for example, each day at 5:00 p.m. when your accounting department requires extra SAP servers to be available. As a developer, you would create a job that provisions the required VMs, then use the Orchestrator Scheduler to schedule the job to run every day at the time specified.

In this example, the `provision` job retrieves the members of a resource group (which are VMs) and invokes the provision action on the VM objects.

To setup to create the `provision.job`, use the following procedure:

1. Create your VMs and follow the discovery process in the Orchestrator console so the VMs are in the Orchestrator inventory.
2. In Orchestrator console, create a Resource Group called `sap` and add the required VMs as members of the group.
3. Given the `.jdl` and `.policy` below you would create a `.job` file (jar them):
   `>jar cvf provision.job provision.jdl provision.policy`
4. Deploy the `provision.job` file to the Orchestrator Server using either the Orchestrator console or the `zosadmin` command line.

To run the job, use either of the following procedures:

Manually Using the ZOS Command Line:

1. At the command line, enter:

```
>zos login <zos server>
>zos run provision VmGroup="sap"
```

For more complete details about entering CLI commands, see "The ZOS Command Line Tool" in the *Novell ZENworks Orchestrator 1.2 Job Management Guide*.

Automatically Using the Orchestrator Console Job Scheduler:

1. Create a *New* schedule.
2. Fill in the job name (`provision`), user, priority.
3. For the jobarg `VmGroup`, enter `sap`.
4. Create a Trigger for the time you want this job to run.
5. Save the Schedule and enable it by clicking *Resume*.

You can manually force scheduling by clicking *Test Schedule Now*.

For more complete details about using the ZOS Control Scheduler. See also Section 9.5, "Automatically Provisioning a VM Server," on page 121.

9.4.1 Provision Job JDL

```
"""
Job that retrieves the members of a supplied resource group and invokes
the provision action on all members. For more details about this class,
see Job (page 265). See also ProvisionSpec (page 295).

The members must be VMs.

"""
class provision(Job):

    def job_started_event(self):

        # Retrieves the value of a job argument supplied in
        # the 'zos run' or scheduled run.
        VmGroup = self.getFact("jobargs.VmGroup")

        #
        # Retrieves the resource group grid object of the supplied
name.
        # The job Fails if the group name does not exist.
        #
        group = getMatrix().getGroup(TYPE_RESOURCE,VmGroup)
        if group == None:
            self.fail("No such group '%s'." % (VmGroup))

        #
        # Gets a list of group members and invokes a provision action
on each one.
```

```
        #
        members = group.getMembers()
        for vm in members:
           vm.provision()
           print "Provision action requested for VM '%s'" %
(vm.getFact("resource.id"))


Job Policy:
<!--
    The policy definition for the provision example job.

    This specifies the job argument VmGroup' which is required
-->
<policy>

    <jobargs>

        <fact name="VmGroup"
              type="String"
              description="Name of a VM resource group whose members
will be provisioned"
              />

    </jobargs>

</policy>
```

9.5 Automatically Provisioning a VM Server

If you write jobs to automatically provision virtual machines, you set the following facts in the job policy:

```
resoure.provision.maxcount
resource.provision.maxpending
resource.provision.hostselection
resource.provision.maxnodefailures
resource.provision.rankby
```

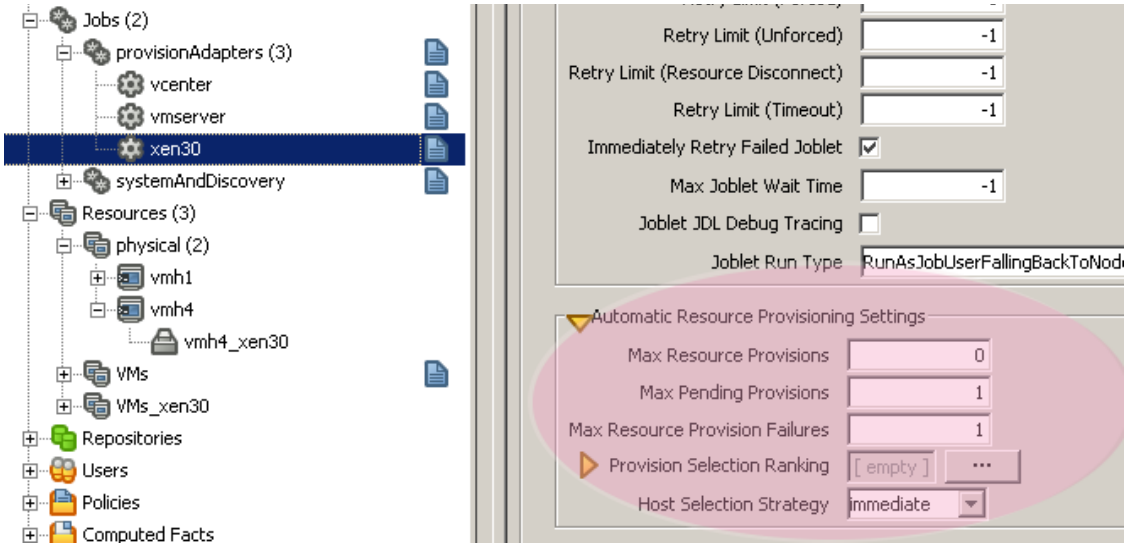
These are the job facts to enable and configure the usage of virtual machines for resource allocation. These facts can be set in a job's policy.

For example, setting the provision.maxcount to greater than 0 allows for virtual machines to be included in resource allocation.

```
<job>
    <fact name="provision.maxcount" type="Integer" value="1" />
    <fact name="provision.maxpending" type="Integer" value="1" />
</job>
```

The following figure shows the job Orchestrator console settings to use VMs:

Figure 9-4 *Job Settings for VM Provisioning*



9.5.1 Specifying Reservations

When using automatic provisioning, the provisioned resource is reserved for the job requesting the resource. This prevents another job requiring reesources from obtaining the provisioned resource.

When the job that reserved the resource has finished its work (joblet has completed) on the provisioned resoruce, then the reservation is relaxed allowing other jobs ot use the provisioned resource.

Using JDL, the reservation can be specified to reserve by JobID and also user. This is done using the ProvisionSpec (page 295) class.

9.6 Defining Values for Grid Objects

The following sections describe the ZENworks Orchestrator Server grid objects and facts that are required for provisioning of Orchestrator resource objects: This section highlights the facts that are expected to be set from a virtual machine discovery.

- Section 9.6.1, “Orchestrator Grid Objects,” on page 122
- Section 9.6.2, “Repository Objects and Facts,” on page 123
- Section 9.6.3, “VmHost Objects and Facts,” on page 130
- Section 9.6.4, “VM Resource Objects and Other Base Resource Facts,” on page 134
- Section 9.6.5, “Physical Resource Objects and Additional Facts,” on page 141

9.6.1 Orchestrator Grid Objects

The following table explains the abbreviated codes used to define the Orchestrator grid objects and facts listed in the following sections:

Table 9-1 *Orchestrator Gride Object Definitions*

Value	Description
Automatic	The fact should be automatically set after the successful discovery of virtual resources (VmHosts and VMs).
Boolean	The fact is a Boolean value.
Default	The specified default value of the fact is set.
Dictionary	The fact is selected from a specified dictionary listing.
Dynamic	The fact is dynamically generated.
Enumerate	The fact is a specified enumerated value.
Example	When available, provides an example how a fact might be applied to an object.
Integer	The fact is an integer value.
Real	The fact is a real number.
String	The fact is a string value.
Datagrid	Facts relate to datagrid object types.
Local	Facts relate to local object types.
NAS	Facts relate to Network Attached Storage (NAS) object types.
SAN	Facts relate to Storage Area Network (SAN) object types.
Virtual	Facts relate to virtual object types.
Warehouse	Facts relate to warehouse object types.

9.6.2 Repository Objects and Facts

Facts marked with an X designate that they should be automatically set after the successful discovery of virtual resources (VmHosts and VMs). Unless marked with the ° symbol, all of the following repository objects and facts must be set for the particular provisioning adapter to function. Facts marked with °° indicate the fact is required under certain conditions.

Table 9-2 *Reposiotory Objects and Facts*

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.capacity	The maximum amount of storage space available to virtual machines (in megabytes). The value -1 means unlimited.	Integer	**Local:** Note: Not auto discovered, but set to a default value of -1 (unlimited size). The Administrator should alter this value. This fact is not currently applicable to SAN because you cannot move file-based disks into a SAN. **SAN:** Note: Not auto discovered, but set to a default value of -1 (unlimited size). The Administrator should alter this value. **nas:** Note: Not auto discovered, but set to a default value of -1 (unlimited size). The Administrator should alter this value. **Warehouse:** Note: Not autodiscovered, but set to a default value of -1' (unlimited size). The Administrator should alter this value. **datagrid:** Note: Not auto discovered, but set to a default value of -1 (unlimited size). The Administrator should alter this value. **virtual:** Note: Not auto discovered, but set to a default value of -1 (unlimited size). The Administrator should alter this value.
repository.searchpath	The relative path from the location to search for VM configuration files, which implicitly includes repository.image. preferredpath.	String []	**Local:** X. [etc/xen/vm, myimages] **NOTE:** The path is relative to repository.location or the leading '/' is ignored. **SAN:** °. **nas:** X. [“my_vms”, “saved_vms”] or [""] Specifiesto search the whole mount. **NOTE:** The path is either relative to repository.location; the leading '/' ignored. **Warehouse:** N/A **datagrid:** N/A **virtual:** N/A

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.description	The description of the repository.	String	**Local:** ° Default empty. **SAN:** °. **nas:** °. **Warehouse:** ° Default empty. **datagrid:** ° Default empty. **virtual:** ° Default empty.
repository.efficency	The efficiency coefficient used to calculate the cost of moving VM disk images to and from the repository. This value is multiplied by the disk image size in Mb to determine a score. Thus, thus 0 means no cost and is very efficient).	Real	**Local:** Defaults to 1, which normalizes the transfer efficiency for moving VM disks. **SAN:** °Defaults to 1, which normalizes the transfer efficiency for moving VM disks. Not currently applicable because file-based disks cannot be moved into a SAN. **nas:** Defaults to 1, which normalizes the transfer efficiency for moving VM disks. **Warehouse:** Defaults to 1, which normalizes the transfer efficiency for moving VM disks. **datagrid:** Defaults to 1, which normalizes the transfer efficiency for moving VM disks. **virtual:** Defaults to 1, which normalizes the transfer efficiency for moving VM disks.
repository.enabled	True if the Repository is enabled, meaning that new VM instances can be provisioned.	Boolean	**Local:** Defaults to true. **SAN:** Defaults to true. **nas:** Defaults to true. **Warehouse:** Defaults to true. **datagrid:** Defaults to true. **virtual:** Defaults to true.

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.freespace	The amount of storage space available to new virtual machines (in megabytes). The value -1 means unlimited.	Integer	**Local:** Dynamic: (capacity—used space) or -1 if capacity is unlimited. **SAN:** Dynamic: (capacity—used space) or -1 if capacity is unlimited. **nas:** Dynamic: (capacity—used space) or -1 if capacity is unlimited. **Warehouse:** Dynamic: (capacity—used space) or -1 if capacity is unlimited. **datagrid:** Dynamic: (capacity—used space) or -1 if capacity is unlimited. **virtual:** Dynamic: (capacity—used space) or -1 if capacity is unlimited.
repository.groups	The groups this Repository is a member of.	String[]	**Local:** X **SAN:** X **nas:** X **Warehouse:** X **virtual:** X
repository.id	The repository's unique name.	String	**Local:** X **SAN:** X **nas:** X **Warehouse:** X. This fact is autocreated as warehouse, but could add others manually. **datagrid:** X. Currently one one datagrid repository is supported. **virtual:** X

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.preferredpath	The relative path from the location to search and place VM files for movement and cloning.	String	**Local:** X. "var/lib/xen/images" **NOTE:** The path is relative to repository.location; the leading '/' is ignored. **SAN:** **nas:** X. "my_vms" **NOTE:** The path is relative to repository.location; the leading '/' is ignored. **Warehouse:** N/A **datagrid:** N/A **virtual:** N/A
repository.location	The Repository's physical location.	String	**Local:** X. "/" or /var/xen/images. **SAN:** °. **nas:** X. /u or /mnt/myshareddisk. **NOTE:** This is the “mount point,” which is assumed to be the same mount point on every host that has a connection to this NAS. **Warehouse:** X. grid:///warehouse **datagrid:** °X. grid:///vms **virtual:** N/A
repository.provisioner.jobs	The names of the provisioning adapter jobs that can manage VMs on this repository.	String []	**Local:** X. ["xen30"] **SAN:** **nas:** X. ["xen30"] **Warehouse:** X. ["xen30"] **datagrid:** X. ["xen30"] **virtual:** X. ["vcenter"]

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.san.type	The type of SAN (Adapter specific, “iscsi”, or “fiberchannel” or '' if not applicable.	String (enum)	**Local:** N/A, empty. **SAN:** Administrator must set to “iqn”, “npiv“, or “emc.” **nas:** N/A, empty. **Warehouse:** N/A, empty. **datagrid:** N/A, empty. **virtual:** N/A, empty.
repository.san.vendor	The vendor of the SAN. Controls which storage bind logic to run (e.g. LUN masking, etc).	String	**Local:** N/A, empty. **SAN:** Administrator must set to “iscsi” or “fiberchannel.” **nas:** N/A, empty. **Warehouse:** N/A, empty. **datagrid:** N/A, empty. **virtual:** N/A, empty.
repository.type	The type of repository: ◆ Local; e.g. a local disk. ◆ nas; e.g. a NFS mount. ◆ san , datagrid: A Orchestrator built in datagrid backed store. ◆ warehouse: A ZENworks managed storage. ◆ virtual: An externally managed VM; e.g. VMWare Virtual Center.	String (enum)	**Local:** X. Local **SAN:** **nas:** **Warehouse:** X. Warehouse **datagrid:** X. Datagrid **virtual:** X. Virtual

Fact Name	Description	Fact Type	Type: X = automatically set ° = Not necessary to be set °° = Required under certain conditions
repository.usedspace	The amount of storage space used for virtual machines.	Integer	**Local:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions). **SAN:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions). Not currently applicable to SAN because you cannot move file-based disks into SAN. **nas:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions). **Warehouse:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions). **datagrid:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions). **virtual:** Dynamic: Sum of disk space used by contained VMs. Only includes disks that are stored as local files (not partitions).
repository.vmhosts	The list of VM hosts capable of using this repository (aggregated from the individual VM host fact).	String []	**Local:** X **SAN:** **nas:** X **Warehouse:** X **datagrid:** X **virtual:** X
repository.vmimages	The list of VM images stored in this repository (aggregated from individual VM fact).	String []	**Local:** X **SAN:** **nas:** X **Warehouse:** X **datagrid:** X **virtual:** X

9.6.3 VmHost Objects and Facts

Unless marked with a “°” symbol, all of the following VmHost objects and facts must be set for the particular provisioning adapter to function.The “X”mark designates that the fact should be automatically set after the successful discovery of virtual resources (VmHosts and VMs).

Table 9-3 *VmHost Objects and Facts*

Fact Name	Description	Fact Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
vmhost.accountinggroup	The default vmhost (resource) group which is adjusted for VM statistics.	String	**xen30:** X. All. **vmserver:** X. All. **vcenter:** X. All.
vmhost.enabled	True if the VM host is enabled, which enables new VM instances to be provisioned.	Boolean	**xen30:** X. True. **vmserver:** X. True. **vcenter:** X. True.
vmhost.groups	The groups this VM host is a member of. Alias for 'vmhost.resource.group.	String []	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.id	The VM host's unique name.	String	**xen30:** X. <physical host id>_xen30 **vmserver:** X. <physical host id>_vmserver **vcenter:** X. <physical host id>_vcenter
vmhost.loadindex.slots	The loading index; the ratio of active hosted VMs to the specified maximum.	Dynamic Real	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.loadindex.virtual memory	The loading index; the ratio of consumed memory to the specifed maximum.	Dynamic Real	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.location	The VM host's physical location.	String	**xen30:** °Defaults to empty string. **vmserver:** °Defaults to empty string. **vcenter:** X. Virtual center's 'locator' to the Vmhost; e.g., "/vcenter/eng/esx1".

Fact Name	Description	Fact Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
vmhost.maxvmslots	The maximum number of hosted VM instances.	Integer	**xen30:** Defaults to 3. Should be reset by Adminstrator. **vmserver:** Defaults to 3. Should be reset by Adminstrator. **vcenter:** Defaults to 3. Should be reset by Adminstrator.
vmhost.memory.available	The amount of memory available to new virtual machines.	Dynamic Integer	**xen30:** X. Calculated to be 'vmhost.memory.max; the memory consumed by running VMs. **vmserver:** X. Calculated to be 'vmhost.memory.max; the memory consumed by running VMs. **vcenter:** X. Calculated to be 'vmhost.memory.max; the memory consumed by running VMs.
vmhost.memory.max	The maximum amount of memory available to virtual machines (in megabytes).	Integer	**xen30:** X. Discovered. **vmserver:** X. Discovered. **vcenter:** X. Discovered.
vmhost.migration	True if the VM host can support VM migration; also subject to provision adapter cababilities.	Boolean	**xen30:** X. Defaults to false. Not discovered. Adminstrator should enable as appropriate to indicate that the VmHost supports migration. **vmserver:** X. Defaults to false. Not discovered. Should not be set to true since vmserver/gsx does not support migration. **vcenter:** X. Discovered.
vmhost.provisioner.job	The name of the provisioning adapter job that manages VM discovery on this host.	String	**xen30:** X. xen30. **vmserver:** X. vmserver. **vcenter:** X. vcenter.
vmhost.provisioner.password	The password required for provisioning on the VM host. This fact is used by the provisioning adapter.	String	**xen30:** °. **vmserver:** °. If set, this fact is passed to the vmserver CLI tools to authenticate. Not necessary if Orchestrator agent is run as root. **vcenter:** °.

Fact Name	Description	Fact Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
vmhost.provisioner.username	The username required for provisioning on the VM host. This fact is used by the provisioning adapter.	String	**xen30:** °. **vmserver:** If set, is passed to vmserver CLI tools to authenticate. Not necessary if Orchestrator agent is run as root. **vcenter:** °.
vmhost.repositories	This list of repositories (VM disk stores) is visible to this VM host.	String []	**xen30:** X. Discovery only adds the local repository, the datagrid and the warehouse on the first creation of the vmhost. Adminstrator is required to add SAN/NAS repositories or remove local if desired. **vmserver:** X. Discovery only adds the local repository, the datagrid and the warehouse onthe first creation of the vmhost. Adminstrator is required to add SAN/NAS repositories or remove local if desired. **vcenter:** X. Automatically set to `VirtualCenter`. **NOTE:** This is the only sensible setting.
vmhost.resource	The name of the resource that houses this VM host container.		**xen30:** °. **vmserver:** X. **vcenter:** X.
vmhost.shuttingdown	True if the VM host is attempting to shut down and does not need to be provisioned.	Dynamic Boolean	**xen30:** Initially False, then set to True when the adminstrator specifies to shut down a host. **vmserver:** Initially False, then set to True when the adminstrator specifies to shut down a host. **vcenter:** Initially False, then set to True when the adminstrator specifies to shut down a host.

Fact Name	Description	Fact Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
vmhost.vm.available.groups	The list of resource groups containing VMs that are allowed to run on this host.	String []	**xen30:** X. Automatically set to VMs_<provisioning_adapter>; e.g., any VM of compatible type can be provisioned. The VMs_<provisioning_adapter> group is automatically created by discovery. The administrator can refine this by creating new groups and editing if further restrictions are required. **vmserver:** X. Automatically set to VMs_<provisioning_adapter>; e.g., any VM of compatible type can be provisioned. The VMs_<provisioning_adapter> group is automatically created by discovery. The administrator can refine this by creating new groups and editing if further restrictions are required. **vcenter:** X. Discovery attempts to map Virtual Center grouping to Orchestrator resources groups and sets this fact accordingly. This also includes a special "template_vcenter" group to map to Virtual Center 1.3.x "templates".
vmhost.vm.count	The current number of active VM instances.	Dynamic Integer	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.vm.instanceids	The list of active VM instances.	Dynamic String[]	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.vm.templatecounts	A dictionary of running instance counts for each running VM template.	Dynamic Dictionary	**xen30:** X. **vmserver:** X. **vcenter:** X.
vmhost.xen.bits	xen30 only. Legal values are 32 and 64.	Integer	**xen30:** X. 64. **vmserver:** °Not defined. **vcenter:** °Not defined.
vmhost.xen.hvm	xen30 only.	Boolean	**xen30:** X. True. **vmserver:** °Not defined. **vcenter:** °Not defined.

Fact Name	Description	Fact Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
vmhost.xen.version	xen30 only: Major.Minor version of the Xen hypervisor.	Real	**xen30:** X. 3.00 **vmserver:** °Not defined. **vcenter:** °Not defined.
vmhost.vcenter.hostname	vcenter only. The hostname of the resource containing this VM container. **NOTE:** Deprecated. Use 'vmhost.resource.hostname instead.	String	**xen30:** °Not defined. **vmserver:** °Not defined. **vcenter:** X. esx1.
vmhost.vcenter.networks	vcenter only. List of network interfaces on the physical host.	List	**xen30:** °Not defined. **vmserver:** °Not defined. **vcenter:** VM network.
vmhost.vcenter.grouppath	vcenter only: Part of the Virtual Center “locator” URL.	List	**xen30:** °Not defined. **vmserver:** °Not defined. **vcenter:** X. /vcenter/eng1.

9.6.4 VM Resource Objects and Other Base Resource Facts

The following virtual machine resource objects and additional base resource facts marked with the “•” symbol must be set for the particular provisioning adapter to function. Facts marked with “••” indicate the fact is required under certain conditions. The “X” character designates that the fact should be automatically set after the successful discovery of virtual resources (VmHosts and VMs).

Table 9-4 *Resource Objects (VM only) and Additional Facts to Base Resource Facts resource.provisioner.warehouse.guidresource.provisioner.warehouse.guid*

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.provision.automatic	Signifies that this resource was cloned/ provisioned automatically and thus is shut down/destroyed automatically as well.	Dynamic Boolean	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.provision.autoprep.*	Fact namespace used to convey configuration information actually used to "personalize" this VM instance.	<various>	**xen30:** ° X. Can be set when rediscovering the state or as a result of a migration or provision action. **vmserver:** ° X. Can be set when rediscovering the state or as a result of a migration or provision action. **vcenter:** ° X. Can be set when rediscovering the state or as a result of a migration or provision action.
resource.provision.currentaction	The current management action in progress on this provisionable resource.c.	Dynamic String	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.hostwait	The time (seconds) this resource has been waiting / waited for a suitable host.	Dynamic Integer	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.jobid	The current or last job ID that performed a provisioning action on this resource. Useful for viewing the job log.	Dynamic String	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.resync	Specifies that the provisioned resource's state needs to be resynced with the underlying provisioning technology at the next opportunity.	Dynamic Boolean	**xen30:** °X. Can be set on discovery when the Orchestrator state machine mismatches the VM state. This initiates a future VM state recovery action ("Check Status"). May be set for delayed re-discovery by administrator or JDL logic. **vmserver:** °X. Can be set on discovery when the Orchestrator state machine mismatches the VM state. This initiates a future VM state recovery action ("Check Status"). May be set for delayed re-discovery by administrator or JDL logic. **vcenter:** °X. Can be set on discovery when the Orchestrator state machine mismatches the VM state. This initiates a future VM state recovery action ("Check Status"). May be set for delayed re-discovery by administrator or JDL logic.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.provision.state	The current state of this provisioned instance (down, suspended, up, paused) or unknown if an admin action is currently being performed.	Dynamic String (enum)	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.status	The current descriptive status of the provisioned resource.	Dynamic String	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.template	The ID of the template resource that this instance was created from (if applicable).	Dynamic String	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.time.request	The time when the last provision (or other administrative action) request was made.	Dynamic Date	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.time.shutdown	The time when the resource was last shut down.	Dynamic Date	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.time.start	The time when the resource was last successfully provisioned.	Dynamic Date	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provision.vmhost	The ID of the host currently housing this provisioned resource.	Dynamic String	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provisionable	True if the resources is a provisionable type.	Dynamic Boolean	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.provisioner.autoprep.*	Fact namespace used to convey configuration information actually used to "personalize" this VM instance.	<various>	**xen30:** ° X (only if set in warehouse). **vmserver:** ° . **vcenter:** ° .

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.provisioner.count	The total count of operational instances and provisions in progress"	Dynamic Integer	**xen30:** o . **vmserver:** o . **vcenter:** o .
resource.provisioner.debug	Controls the debug log level in the provisioner.	Boolean	**xen30:** o . **vmserver:** o . **vcenter:** o .
resource.provisioner.host.maxwait	The maximum time to wait for a suitable host before timing out (in seconds, '<0' to wait indefinitely).	Integer	**xen30:** o . **vmserver:** o . **vcenter:** o .
resource.provisioner.host.preferredwait	The time after which some VMhost constraints is lifted to increase the available pool by, for example, considering moving the disk image (in seconds, <0 to wait indefinitely).	Integer	**xen30:** o . **vmserver:** o . **vcenter:** o .
resource.provisioner.instances	The list of id's of the instances of this template resource (if applicable).	String[]	**xen30:** o . **vmserver:** o . **vcenter:** o .
resource.provisioner.job	The name of the provisioning job that manages the life cycle of this resource.	String	**xen30:** X. xen30 **vmserver:** X. vmserver **vcenter:** X. vcenter
resource.provisioner.maxinstances	The maximum allowed number of instances of this provisionable resource (applicable only to templates).	Integer	**xen30:** X. Defaults to 1. Administrator should reset for VM templates to allow multiple clones. **vmserver:** X. Defaults to 1. Administrator should reset for VM templates to allow multiple clones. **vcenter:** X. Defaults to 1. Administrator should reset for VM templates to allow multiple clones.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.provisioner.recommendedhost	The host on which the image for this resource is associated; e.g., was suspended or is the preferred host for quick startup.	String	**xen30:** ° X. **vmserver:** ° X. **vcenter:** ° X.
resource.provisioner.warehouse.guid	The warehouse ID of this VM.	String	**xen30:** °° X. Required only if resource.provisioner.repository is 'warehouse' (guid from warehouse). **vmserver:** N/A **vcenter:** N/A.
resource.provisioner.warehouse.version	The warehouse version number of this VM.	Integer	**xen30:** °° X. Required only if resource.provisioner.repository is 'warehouse' {version from warehouse}. **vmserver:** N/A. **vcenter:** N/A.
resource.vcenter.grouppath	Locator for the Virtual Center group that the VM resides in.	String	**xen30:** ° Not defined. **vmserver:** ° Not defined. **vcenter:** X. /vcenter/eng
resource.vcenter.guest OS	VMWare's name for the guest OS.	String	**xen30:** ° Not defined. **vmserver:** ° Not defined. **vcenter:** X. winNetEnterprise.
resource.vcenter.imagepath	Locator for the VM in Virtual Center.	String	**xen30:** ° Not defined. **vmserver:** ° Not defined. **vcenter:** X. /vcenter/eng/windows2003ent.
resource.vm.basepath	The filesystem location of the VM files either absolute or relative to the 'repository.location' fact.	String	**xen30:** X. Example: "var/lib/xen/images/sles10". **vmserver:** X. For example, "/var/lib/vmware/Virtual-Machines/sles9". Location in the repository of the directory containing VM disks, configuration file and other related files. **vcenter:** ° N/A.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.vm.configfile	The location of the VM's configuration file inside of the default repository (resource.provisioner.repository).	String	**xen30:** X. /etc/xen/vm/sles10. **vmserver:** ° Not currently used. **vcenter:** ° N/A.
resource.vm.cpu.architecture	The required cpu architecture e.g. x86, x86_64, sparc.	String	**xen30:** ° X (only if set in warehouse). **vmserver:** ° . **vcenter:** ° .
resource.vm.cpu.weight	The CPU weight for this VM. A value of '1.0' represents normal weighting; setting another VM to a weight of '2.0' would mean it would get twice as much cpu as this VM.	Real	**xen30:** ° . **vmserver:** ° . **vcenter:** ° .
resource.vm.files	Files that make up this VM. The dictionary key (String) represents the file type (adapter specific), the value is the file path either absolute or relative to 'repository.location' of the 'resource.vm.repository'.	Dictionary	**xen30:** X. { "mof": /var/lib/xen/images/sles10/mof" , "suspendcheckpoint": "/var/lib/xend/domain/checkpoint", "config": "/var/lib/xen/images/sles10/config.xen' }. **vmserver:** ° X { "config": "/var/lib/vmware/Virtual Machines/sles10/sles10.vmx' }. **vcenter:** ° N/A.
resource.vm.maxinstancespervmhost	The maximum allowed number of instances of this VM image per vmhost.	Integer	**xen30:** Defaults to 1. Administrator should increase if more than one instance of the same VM template is allowed to be run on one host.
resource.vm.memory	The configured virtual memory requirement of this VM image (megabytes).	Integer	**xen30:** X. **vmserver:** X. **vcenter:** X.
resource.vm.preventmove	Set by the administrator to prevent relocation of a VM (disk moves) even if possible.	Boolean Default: False	
resource.vm.type	The required system type of a virtual machine ('full' or 'para').	String	**xen30:** X. **vmserver:** X. **vcenter:** X.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.vm.uuid	The UUID of a virtual machine (vendor/ adapter specific).	String	**xen30:** X. {vm uuid} **vmserver:** Not currently used. **vcenter:** Not currently used.
resource.vm.vcpu.number	The number of virtual CPUs for this VM.	Integer	**xen30:** ° X. **vmserver:** ° . **vcenter:** ° .
resource.vm.vdisks	The specification of virtual disks that make up this VM. The dictionary keys are name (String), repository (String), location (String), size (Integer), fixed (Boolean).	List of Dictionaries	**xen30:** X. [{ "location":"/var/lib/xen/images/sles10/disk1", "moveable":True,"repository":"vmhost1" ... }]. **vmserver:** ° Not currently used. **vcenter:** ° N/A.
resource.vm.vdisksize	The total size of all the moveable virtual desks for this VM image (megabytes).	Integer	**xen30:** X. **vmserver:** X. **vcenter:** X.
resource.vm.vendor	The vendor of a virtual machine.	String	**xen30:** ° X. **vmserver:** ° X. **vcenter:** ° X.
resource.vm.version	The version number for this VM.	Integer	**xen30:** X (only if set in warehouse). Required only if resource.provisioner.repository is 'warehouse. **vmserver:** ° N/A. **vcenter:** ° N/A.
resource.vm.vmhost.rankby	The ranking specification used to select suitable vm hosts. Element syntax is <fact>/<order> where order is either a (ascending) or d (descending).	String[]	**xen30:** Defaults to vmhost.vm.placement.score/a, vmhost.loadindex.slots/a. **vmserver:** Defaults to vmhost.vm.placement.score/a, vmhost.loadindex.slots/a. **vcenter:** Defaults to vmhost.vm.placement.score/a, vmhost.loadindex.slots/a.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.vnc.ip	The host ip address for a vnc session running on the resource. **NOTE:** Technically, this fact is available on all resources both VMs and physical.	String	**xen30:** ° X. 192.168.0.4 **vmserver:** Not used. **vcenter:** ° .
resource.vnc.port	The port number for a vnc session running on the resource. **NOTE:** Technically, this fact is available on all resources both VMs and physical.	Integer	**xen30:** ° X. 5900 **vmserver:** Not used. **vcenter:** ° .

9.6.5 Physical Resource Objects and Additional Facts

The following physical resource objects and additional base resource facts marked with the "•" symbol must be set for the particular provisioning adapter to function. The physical resources have the potential of creating VmHost containers.

Facts marked with "••" indicate the fact is required under certain conditions. The "X" character designates that the fact should be automatically set after the successful discovery of virtual resources (VmHosts and VMs).

Table 9-5 *Resource Object (Physical that have the potential for VmHost containers) / Additional Facts (additional to base resource set) resource.provisioner.warehouse.guid*

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.vcenter.client	vcenter only: Marks resources and Virtual Center web services client capable. .	Boolean	**xen30:** ° Not defined. **vmserver:** ° Not defined. **vcenter:** Administrator must set through association of 'vcenter_client.policy' with approriate resources.

Fact Name	Description	Type	Provision Adapter X = automatically set ° = Not necessary to be set °° = Required under certain conditions
resource.vmserver.cmdpath	vmserver only: Path to VMWare CLI tools.	String	**xen30:** ° Not defined. **vmserver: X.** For example, "/usr/bin/vmware-cmd" **vcenter:** ° Not defined.
resource.vmserver.localrepositories	vmserver only: Paths to VM storage directories.	List	**xen30:** ° Not defined. **vmserver:** For example, "/var/lib/vmware/virtual machines" **vcenter:** ° Not defined.
resource.vmserver.vmrunpath	vmserver only: Full path to vmrun CLI tool.	String	**xen30:** ° Not defined. **vmserver:** X. For example, "/usr/bin/vmrun". **vcenter:** ° Not defined.
resource.xen	xen30 only: Xen enabled.	Boolean	**xen30:** X. True. **vmserver:** ° Not defined. **vcenter:** ° Not defined.
resource.xen.bits	xen30 only: (legal values are 32 and 64)	String	**xen30:** X. 64 bit. **vmserver:** ° Not defined. **vcenter:** ° Not defined.
resource.xen.hvm	xen30 only:	Boolean	**xen30:** X. True. **vmserver:** ° Not defined. **vcenter:** ° Not defined.
resource.xen.version	xen30 only: Major.Minor version of the Xen hypervisor. .	Real	**xen30:** X. 3.00. **vmserver:** ° Not defined. **vcenter:** ° Not defined.

Complete Job Examples

10

This section describes specific Job examples that can be deployed using Novell® ZENworks Orchestrator Server. The following sections demonstrate some practical ways to use Orchestrator and should help you better understand how to write your own jobs:

- Section 10.1, “Accessing Job Examples,” on page 143
- Section 10.2, “Installation and Getting Started,” on page 143
- Section 10.3, “ZOS Sample Job Summary,” on page 144
- Section 10.4, “Parallel Computing Examples,” on page 145
- Section 10.5, “General Purpose Jobs,” on page 156
- Section 10.6, “Miscellaneous Code-Only Jobs,” on page 193

10.1 Accessing Job Examples

The basic examples delivered with Novell® ZENworks® Orchestrator are located in either of two possible installation directories depending on the type of installation. For server installations, look here:

```
/opt/novell/zenworks/zos/server/examples/
```

For client installation, look here:

```
/opt/novell/zenworks/zos/client/examples/
```

When you unjar or unzip examples from the from the `<path>/examples/<example>.job` file or view jobs using the details panel and the JDL and Policy tabs in ZENworks Orchestrator Console (zoc), you should see the component `.jdl` and `.policy` files.

Policy files specify how the job arguments and static attributes are defined. Or, you can use the `zos jobinfo` command to simply display job arguments and their default values.

All of the examples can be opened and modified using a standard code editor, then redeployed and examined using the procedure explained in “Walkthrough: Deploy a Sample Job” in the *ZENworks Orchestrator Getting Started Guide*.

10.2 Installation and Getting Started

To run the ZENworks Orchestrator described in this section, use the following guidelines:

- Install and configure ZENworks Orchestrator properly (see “Installing and Configuring ZENworks Orchestrator Components” in the *ZENworks Orchestrator Getting Started Guide*.
- Unless otherwise indicated, install at least one agent on a managed resource and have it running (see “Installing the ZENworks Orchestrator Agent on VM Hosts and VMs” in the *ZENworks Orchestrator Getting Started Guide*).
- Before running `zosadmin` or `zos` commands, you must log into the Orchestrator Server.
  - For an explanation of the zosadmin commands, see “The Zosadmin Command Line Tool”.

```
> zosadmin login --user zosadmin
Login to server: skate
```

```
Please enter current password for 'zosadmin':
Logged into grid on server 'skate'
```

- For an explanation of zos commands, see "The Zosadmin Command Line Tool".

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
Logged into grid as vmmanager
```

You could create a user (see "Walkthrough: Create a User Account") but `zos login --user=vmmanger` works with the account created by default during installation.

10.3 ZOS Sample Job Summary

The following table provides a high-level explanation of the Orchestrator job examples delivered with Orchestrator and the job developer concepts you might want to understand:

Table 10-1 *ZENworks Orchestrator Job Development Examples*

Example Name	Job Function Capabilities
demoIterator.job (page 146)	• Using policy constraints and job arguments to restrict joblet execution to specific resources. • Scheduling joblets using a ParameterSpace.
dgtest.job (page 157)	• Downloading files stored on grid management servers to networked nodes.
factJunction.job (page 194)	• Retrieving information about objects in the grid relative to another object.
failover.job (page 167)	• Managing how joblets failover to enhance the robutsness of your jobs.
instclients.job (page 173)	• Installing a ZOS client on multiple machines.
jobargs.job (page 202)	• Understanding the various argument types that jobs can accept (integer, real, Boolean, string, time, date, list, dictionary, and array, which can contain the types integer, real, Boolean, time, date, and String).
notepad.job (page 179)	• Understanding how to launch specific applications on specified resources.
quickie.job (page 153)	• Understanding how jobs can start multiple instances of a joblet on one or more resources.
sweeper.job (page 183)	• Understanding how poll all resources on the grid.
whoami.job (page 189)	• Sending a command to the operating system's default command interpreter. On Microsoft Windows, this is `cmd.exe`. On POSIX systems, this is `/bin/sh`.

10.4 Parallel Computing Examples

The following examples demonstrate high performance or parallel computing concepts:

- “demoIterator.job” on page 146
- “quickie.job” on page 153

demoIterator.job

Reference implementation for a simple test iterator. A couple of concepts are demonstrated:
1) Using policy constraints and job arguments to restrict joblet execution to a specific resource, and
2) Scheduling joblets using a ParameterSpace.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
Logged into grid as vmmanager

> zos jobinfo --detail demoIterator
Jobname/Parameters    Attributes
------------------    ----------
demoIterator       Desc: This example job is a reference for a simple
test
                         iterator. It is useful for demonstrating how
policies
                        and job args can be used to target the job to a
                         particular resource.

    numJoblets     Desc: joblets to run
                   Type: Integer
                Default: 100

    cmd            Desc: Simple command to execute
                   Type: String
                Default:

    os             Desc: Regular expression match for Operating System
                   Type: String
                Default: .*

    cpu            Desc: Regular expression match for CPU architecture
                   Type: String
                Default: .*
```

Description

The files that make up the DemoIterator job include:

```
demoIterator                                # Total: 129 lines
|-- demoIterator.jdl                        #   68 lines
`-- demoIterator.policy                     #   61 lines
```

demoIterator.jdl

```
 1  import time, random
 2
 3  #
 4  # Add to the 'examples' group on deployment
 5  #
```

```
 6  if __mode__ == "deploy":
 7      try:
 8          jobgroupname = "examples"
 9          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
10          if jobgroup == None:
11              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
12          jobgroup.addMember(__jobname__)
13      except:
14          exc_type, exc_value, exc_traceback = sys.exc_info()
15          print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
16
17  class demoIteratorJob(Job):
18
19      def job_started_event(self):
20          print 'job_started_event'
21          self.completed = 0
22
23          # Launch the joblets
24          numJoblets = self.getFact("jobargs.numJoblets")
25          print 'Launching ', numJoblets, ' joblets'
26
27          pspace = ParameterSpace()
28          i = 1
29          while i <= numJoblets:
30              pspace.appendRow({'name':'joblet'+str(i)})
31              i += 1
32          pspace.maxJobletSize = 1
33          self.schedule(demoIteratorJoblet,pspace,{})
34
35      def joblet_completed_event(self, jobletnumber, node):
36          self.completed += 1
37          self.setFact("jobinstance.memo", "Tests run: %s" %
(self.completed))
38
39  class demoIteratorJoblet(Joblet):
40
41      def joblet_started_event(self):
42          print "Hi from joblet ", self.getFact("joblet.number")
43          time.sleep(random.random() * 15)
44
45          cmd = self.getFact("jobargs.cmd")
46          if len(cmd) > 0:
47              system(cmd)
48
49              # Example on more sophisticated exec
50              # e.g.  e.signal("SIGUSR1")
51              """
52              e = Exec()
53              e.setCommand(cmd)
54              #e.setStdoutFile("cmd.out")
55              e.writeStdoutToLog()
56              e.writeStderrtoLog()
```

```
57              #try:
58              e.execute()
59              #except:
60                  #raise RetryElsewhere, "example error"
61              """
```

demoIterator.policy

```
 1  <policy>
 2     <constraint type="accept" reason="Too busy for more work. Try
again later!">
 3        <or>
 4           <lt fact="job.instances.queued" value="4" />
 5           <contains fact="user.groups" value="superuser" />
 6        </or>
 7     </constraint>
 8
 9     <constraint type="start" reason="Waiting on queue">
10        <or>
11           <lt fact="job.instances.active" value="2" />
12           <contains fact="user.groups" value="superuser" />
13        </or>
14     </constraint>
15
16     <jobargs>
17        <fact name="numJoblets"
18              type="Integer"
19              description="joblets to run"
20              value="100"
21              visible="true" />
22
23        <fact name="cmd"
24              type="String"
25              description="Simple command to execute"
26              value="" />
27
28        <fact name="os"
29              type="String"
30              description="Regular expression match for Operating
System"
31              value=".*" />
32
33        <fact name="cpu"
34              type="String"
35              description="Regular expression match for CPU
architecture"
36              value=".*" />
37     </jobargs>
38
39     <constraint type="resource" reason="Does not match">
40        <and>
41           <eq fact="resource.os.family" factvalue="jobargs.os"
match="regexp" />
42           <eq fact="resource.cpu.architecture"
```

```
factvalue="jobargs.cpu" match="regexp"/>
43
44           <or>
45              <and>
46                 <defined fact="env.VENDOR" />
47                <eq fact="resource.os.vendor" factvalue="env.VENDOR"
match="regexp" />
48              </and>
49              <undefined fact="env.VENDOR" />
50           </or>
51        </and>
52     </constraint>
53
54     <job>
55        <fact name="description"
56              type="String"
57            value="This example job is a reference for a simple test
iterator. It is useful for demonstrating how policies and job args can
be used to target the job to a particular resource." />
58     </job>
59  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Exec

Used to manage command line execution on resources.

ParameterSpace

Defines a parameter space to be used by the scheduler to create a Joblet set. A parameter space might consist of rows of columns or a list of columns that is expanded and can be turned into a cross product.

Job Details

The following sections describe the DemoIterator job:

- “zosadmin deploy” on page 150
- “job_started_event” on page 150
- “joblet_started_event” on page 150

zosadmin deploy

The deployment for the DemoIterator job is performed by lines 3-15 of demoIterator.jdl (page 146). When jobs are deployed into the grid, they can optionally be organized into and easy reference. In this case, the demoIterator job will be added to the group named examples, and will show up in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples
```

For a general overview of how jobs are added to groups during deployment, see “Walkthrough: Deploy a Sample Job”.

job_started_event

When the DemoIterator job receives a job_started_event, it creates a ParameterSpace object, and adds the number of rows as indicated by the value of the argument `numJoblets` (see lines 27-31 in demoIterator.jdl (page 146)). A ParameterSpace object is like a spreadsheet, containing rows and columns of information that might all be given to one joblet or sliced up across many joblets at schedule time. In this case, the ParameterSpace is told that maxJobletSize is 1 (see line 32), meaning a joblet instance is created for each row in the ParameterSpace during job scheduling (see line 33).

Not shown in this example is the fact that a joblet can get access to this “spreadsheet” of information by calling `self.getParameterSpace()`, and calling `hasNext()` and `next()` to enumerate through each row of information. To learn more about putting information in a ParameterSpace object from a job and obtaining that information from the JobletParameterSpace object from a joblet, see ParameterSpace (page 293).

The resource that runs the joblet is determined from the resource constraint specified in lines 2-14 and 39-52 of demoIterator.policy (page 148), and from the values specified for the parameters `os` and `cpu` supplied on the command line. If these parameters are not specified on the command line, the default value for both is the regular expression `.*`, which means to include everything.

The constraints at lines 2-14 in demoIterator.policy (page 148) define the work load for the resources. In this case, resources do not accept jobs if there are already four jobs queued up, and are not to run jobs if there are two or more jobs currently in progress.

To learn more about setting `start`, `resource`, or `accept` constraints in a policy file, see “Defining Job Elements” on page 77.

joblet_started_event

As the DemoIterator joblet is executed on a particular resource, it receives a joblet_started_event. When this happens, the DemoIterator joblet simply sleeps for a random amount of time to stagger the execution of the joblets, and then sends a command to the operating system, if one was supplied as a job argument. The command is executed on the target operating system using the built-in function `system()`, which is an alternative to using the more feature-rich class Exec.

For more information on sending commands to the operating system using the Exec class, see Exec .

After the joblet is finished running, a joblet_completed_event is sent to demoIteratorJob, which increments the variable `completed`, and posts the updated value to the job fact `jobinstance.memo` (see lines 35-37 in demoIterator.jdl (page 146)). You can see the text for the memo displayed on the Job Log tab in the list of running jobs in the ZENworks Orchestrator Console.

For more information, see "Starting and Stopping the ZENworks Orchestrator Console".

Configure and Run

Execute the following commands to deploy and run `demoIterator.job`:

1. Deploy `demoIterator.job` into the grid:
   ```
   > zosadmin deploy demoIterator.job
   ```
2. Display the list of deployed jobs:
   ```
   > zos joblist
   ```
   demoIterator should appear in this list.
3. Run the job on the first available resource without regard to OS or CPU, and use the default value for number of joblets, which is 100:
   ```
   > zos run demoIterator
   ```
4. Run 10 joblets on Intel Windows resources, and launch the Notepad* application on each one:
   ```
   > zos run demoIterator numJoblets=10 cmd=notepad os=Windows
   cpu=i386
   ```

Here is another example:

```
> zos run demoIterator numJoblets=3 cmd=pwd os=linux
JobID: vmmanager.demoIterator.417

zos log vmmanager.demoIterator.417
job_started_event
Launching  3  joblets
[freeze] Hi from joblet  1
[freeze] /var/opt/novell/zenworks/zos/agent/node.default/freeze/
vmmanager.demoIterator.417.1
[skate] Hi from joblet  0
[skate] /var/opt/novell/zenworks/zos/agent/node.default/skate/
vmmanager.demoIterator.417.0
[melt] Hi from joblet  2
[melt] /var/opt/novell/zenworks/zos/agent/node.default/melt/
vmmanager.demoIterator.417.2
```

See Also

- Setting Constraints Using Policies (see Section 4.4, "Policy Management," on page 54 and Chapter 5, "Developing Policies," on page 57).
- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).

- quickie.job (page 153) demonstrates how a job starts up multiple instances of a joblet on one or more resources. The Joblet class defines how a joblet is executed on a resource.
- Setting default parameter values using policies
- Configuring constraints in a policy file
- Naming conventions for policy facts (see Section 3.1.1, “Naming Orchestrator Job Files,” on page 43)
- Facts provided by the ZENworks Orchestrator system that can be referenced within a JDL file
- Using zos
- Running commands using the Exec class

quickie.job

Demonstrates a job starting up multiple instances of a joblet on one or more resources. Because this job simply launches and returns immediately, it can also be useful for testing network latency.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
Logged into grid as vmmanager

> zos jobinfo --detail quickie
Jobname/Parameters    Attributes
------------------    ----------
quickie            Desc: This example job does absolutely nothing. It
just
                         returns immediately. For testing network
latency.

    sleeptime      Desc: time to sleep (in seconds)
                   Type: Integer
                Default: 0

    numJoblets     Desc: joblets to run
                   Type: Integer
                Default: 100
```

Description

The files that make up the Quickie job include:

```
quickie                                    # Total: 56 lines
|-- quickie.jdl                            #   33 lines
`-- quickie.policy                         #   23 lines
```

quickie.jdl

```
 1  import time
 2
 3  #
 4  # Add to the 'examples' group on deployment
 5  #
 6  if __mode__ == "deploy":
 7      try:
 8          jobgroupname = "examples"
 9          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
10          if jobgroup == None:
11              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
12          jobgroup.addMember(__jobname__)
13      except:
14          exc_type, exc_value, exc_traceback = sys.exc_info()
15          print "Error adding %s to %s group: %s %s" % (__jobname__,
```

```
jobgroupname, exc_type, exc_value)
16
17  class quickieJob(Job):
18
19      def job_started_event(self):
20
21          # Launch the joblets
22          numJoblets = self.getFact("jobargs.numJoblets")
23          print 'Launching ', numJoblets, ' joblets'
24
25          self.schedule(quickieJoblet, numJoblets)
26
27  class quickieJoblet(Joblet):
28
29      def joblet_started_event(self):
30          sleeptime = self.getFact("jobargs.sleeptime")
31          time.sleep(sleeptime)
```

quickie.policy

```
 1  <policy>
 2      <jobargs>
 3          <fact name="numJoblets"
 4                type="Integer"
 5                description="joblets to run"
 6                value="100"
 7                visible="true" />
 8
 9          <fact name="sleeptime"
10                type="Integer"
11                description="time to sleep (in seconds)"
12                value="0"
13                visible="true" />
14      </jobargs>
15
16      <job>
17          <fact name="description"
18                type="String"
19                value="This example job does absolutely nothing. It
just returns immediately. For testing network latency." />
20      </job>
21  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Job Details

The Quickie job can be broken down into the following separate operations:

- "zosadmin deploy" on page 155
- "job_started_event" on page 155
- "joblet_started_event" on page 155

zosadmin deploy

The job is first deployed into the grid, as shown in lines 2-14 of quickie.jdl (page 153). When jobs are deployed into the grid, they can optionally be organized into groups for easy reference. In this example, the Quickie job is added to the group named `examples` and displays in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples
```

job_started_event

As shown in line 25 of quickie.jdl (page 153), scheduling one or more instances of the Quickie joblet to run immediately is the second operation performed by the Quickie job. When the Quickie job class receives a `job_started_event()` notification, it schedules the number of QuickieJoblet instances as indicated by the value of the setting `numJoblets`, whose value might have been supplied on the command line or from the quickie.policy file (see line 3 in quickie.policy (page 154)).

joblet_started_event

The final operation performed by the Quickie job is for the joblet to sleep an amount of time as specified by the value of the setting `sleeptime` (see line 31 in quickie.jdl (page 153)), and then exit.

Configure and Run

1. Deploy quickie.job into the grid:

   ```
   > zosadmin deploy quickie.job
   ```

2. Display the list of deployed jobs:

```
> zos joblist
```

quickie should appear in this list.

3 Run the job on one or more resources using the default values for numJoblets and sleeptime:

```
> zos run quickie
```

4 Run the job on one or more resources using supplied values for `numJoblets` and `sleeptime`:

```
> zos run quickie numJoblets=10 sleeptime=3
JobID: vmmanager.quickie.418

> zos status vmmanager.quickie.418
Completed

> zos log vmmanager.quickie.418
Launching  10  joblets
```

Ten joblets will be run simultaneously, depending on the number of resources available in the grid and how many simultaneous jobs each resource is configured to run. After the job runs, each quickie joblet instance simply starts up, sleeps for 3 seconds, and then exits.

See Also

- Setting Constraints Using Policies (Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57).
- Adding jobs to groups during deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Scheduling multiple instances of a joblet

10.5 General Purpose Jobs

The following examples demonstrate general purpose job concepts:

dgtest.job

This job demonstrates downloading a file from the datagrid.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
Logged into grid as vmmanager

> zos jobinfo --detail dgtest
Jobname/Parameters    Attributes
------------------    ----------
dgtest                Desc: This job demonstrates downloading from the
Datagrid

    multicast         Desc: Whether to download using multicast or
unicast
                      Type: Boolean
                   Default: false

    filename          Desc: The filename to download from the Datagrid
                      Type: String
                  Default: None! Value must be specified
```

Description

Demonstrates usage of the datagrid to download a file stored on the Grid Management Server (GMS) to a node. For additional background information, see Section 3.1, “Defining the Datagrid,” on page 43.

Because it typically grows quite large, the physical location of the GMS root directory is important. Use the following procedure to determine the location of the datagrid in the Orchestrator server console:

1. Select the grid id on the left in the Orchestrator Explorer window >
2. Click the *Constraints/Facts* tab.

   The read-only fact name (`matrix.datagrid.root`) is located here by default:
   `/var/opt/novell/zenworks/zos/server`

   The top level directory name is dataGrid.

   Contents of the GMS can be seen with the Console command:

   ```
   > zos dir grid:///
        <DIR>         Dec-6-2007 6:55 installs
        <DIR>         Dec-6-2007 6:55 jobs
        <DIR>         Dec-6-2007 22:01 users
        <DIR>         Dec-6-2007 6:55 vms
        <DIR>         Dec-6-2007 6:56 warehouse
   ```

Job Files

The files that make up the Dgtest job include:

```
dgtest                                                  # Total: 208 lines
|-- dgtest.jdl                                          #  158 lines
`-- dgtest.policy                                       #   50 lines
```

dgtest.jdl

```
  1  """
  2  Example usage of DataGrid to download a file stored on the GMS
Server to a node.
  3
  4  Setup:
  5     Before running the job, you must:
  6        (1) Create a dgtest resource group using the management
console.
  7        (2) Copy a suitable file into the GMS Server datagrid
  8        (3) Modify the dgtest policy with the filename to download
  9                (to not use the default test file).
 10
 11     For example, use the following matrix command to copy the file
'suse-9-flat.vmdk'
 12     into the deployment area for the job 'dgtest'
 13        >matrix mkdir grid:///images
 14
 15        >matrix copy suse-9-flat.vmdk grid:///images/
 16
 17     To verify the file is there:
 18        >matrix dir grid:///images
 19
 20
 21  To start job, after the above setup steps are complete:
 22        >matrix run dgtest filename=suse-9-flat.vmdk
 23
 24  """
 25  import os,time
 26
 27  #
 28  # Add to the 'examples' group on deployment
 29  #
 30  if __mode__ == "deploy":
 31     try:
 32        jobgroupname = "examples"
 33        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
 34        if jobgroup == None:
 35           jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
 36        jobgroup.addMember(__jobname__)
 37     except:
 38        exc_type, exc_value, exc_traceback = sys.exc_info()
 39        print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
 40
```

```
 41
 42  class test(Job):
 43
 44     def job_started_event(self):
 45        filename = self.getFact("jobargs.filename")
 46        print "Starting Datagrid Test Job."
 47        print "Filename: %s" % (filename)
 48
 49        rg = None
 50        try:
 51           rg = getMatrix().getGroup("resource","dgtest")
 52        except:
 53           # no such group
 54           pass
 55
 56        if rg == None:
 57          self.fail("The resource group 'dgtest' was not found. It
is required for this job.")
 58           return
 59
 60        members = rg.getMembers()
 61        count = 0
 62        for resource in members:
 63           if resource.getFact("resource.online") == True and \
 64              resource.getFact("resource.enabled") == True:
 65              count += 1
 66
 67        memo = "Scheduling Datagrid Test on %d Joblets" % (count)
 68        self.setFact("jobinstance.memo",memo)
 69        print memo
 70        self.schedule(testnode,count)
 71
 72
 73  class testnode(Joblet):
 74
 75     def joblet_started_event(self):
 76        jobletnum = self.getFact("joblet.number")
 77        print "Running datagrid test joblet #%d" % (jobletnum)
 78        filename = self.getFact("jobargs.filename")
 79        multicast = self.getFact("jobargs.multicast")
 80
 81        # Test download a file from server job directory
 82        dg_url = "grid:///images/" + filename
 83
 84        # Create an intance of the JDL DataGrid object
 85        # This object is used to manage DataGrid operations
 86        dg = DataGrid()
 87
 88        # Set to always force a download.
 89        dg.setCache(False)
 90
 91        # Set whether to use multicast or unicast
 92        # If set to True, then the following  4 multicast
 93        # options are applicable
```

```
 94        dg.setMulticast(multicast)
 95
 96        # how long to wait for a quorom (milliseconds)
 97        #dg.setMulticastWait( 10000 )
 98
 99        # Number of receivers that constitute a quorum
100        #dg.setMulticastQuorum(4)
101
102        # Requested data rate in bytes per second. 0 means use
default
103        #dg.setMulticastRate(0)
104
105        # Min number of receivers
106        #dg.setMulticastMin(1)
107
108        if multicast:
109           mode = "multicast"
110        else:
111           mode = "unicast"
112
113        memo = "Starting %s download of file: %s" % (mode,dg_url)
114        self.setFact("joblet.memo",memo)
115        print memo
116
117        # Destination defaults to Node's Joblet dir.
118        # Change this path to go to any other local filesystem.
119        # e.g. to store in /tmp:
120        #    dest = "/tmp/" + filename
121        dest = filename
122        try:
123           dg.copy(dg_url,dest)
124        except:
125           exc_type, exc_value, exc_traceback = sys.exc_info()
126           retryUnicast = False
127           if multicast == True:
128              # If node's OS, NIC does not fully support multicast,
129              # then the node will timeout waiting for broadcasts.
130              # Note the error and fallback to unicast
131              if exc_type != None and len(str(exc_type)) > 0:
132                 msg = str(exc_type)
133                 index = msg.find("Multicast receive timed out")
134                 retryUnicast = index != -1
135
136           if retryUnicast:
137              memo = "Multicast timeout. Fallback to unicast"
138              self.setFact("joblet.memo",memo)
139              print memo
140              dg.setMulticast(False)
141              dg.copy(dg_url,dest)
142           else:
143              raise exc_type,exc_value
144
145        if os.path.exists(dest):
146           print dg_url + " downloaded successfully."
```

```
147
148           # Show directory listing of downloaded file to job log
149           if self.getFact("resource.os.family") == "windows":
150              cmd = "dir %s" % (dest)
151           else:
152              cmd = "ls -lsart %s" % (dest)
153
154           system(cmd)
155        else:
156           raise RuntimeError, "Datagrid copy() failed"
157
158        print "Datagrid test completed"
```

dgtest.policy

```
 1  <policy>
 2
 3     <jobargs>
 4
 5        <!--
 6           Name of file that is stored in the Datagrid area to
 7           download to the resource.
 8
 9           A value for this fact the 'zos run' is assigned when
10           using the 'zos run' command.
11        -->
12        <fact name="filename"
13              type="String"
14              description="The filename to download from the
Datagrid"
15              />
16
17        <fact name="multicast"
18              type="Boolean"
19              description="Whether to download using multicast or
unicast"
20              value="false" />
21
22     </jobargs>
23
24     <job>
25        <fact name="description"
26              type="String"
27              value="This job demonstrates downloading from the
Datagrid" />
28
29        <!-- limit to one per host -->
30        <fact name="joblet.maxperresource"
31              type="Integer"
32              value="1" />
33     </job>
34
35
36     <!--
```

```
 37       This job will only run on resources in the "dgtest" resource
group.
 38
 39        You must create a Resource Group named 'dgtest' using the
management
 40        console and populate the new group with resources that you
wish to have
 41        participate in the datagrid test.
 42     -->
 43     <constraint type="resource" reason="No resources are in the
dgtest group" >
 44
 45        <contains fact="resource.groups" value="dgtest"
 46           reason="Resource is not in the dgtest group" />
 47
 48     </constraint>
 49
 50  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

test

Class test (line 42 in dgtest.jdl (page 158) is derived from the Job class.

testnode

Class testnode (line 73 in dgtest.jdl (page 158) is derived from the Joblet (page 276) class.

Job Details

dgtest.job can be broken down into the following parts:

- "Policy" on page 163

- "zosadmin deploy" on page 163
- "job_started_event" on page 163
- "joblet_started_event" on page 164

Policy

In addition to describing the `filename` and `multicast` jobargs and the default settings for `multicast` (lines 3-22) in the dgtest.policy (page 161) file, there is the <job/> section (lines 24-33), which describes static facts (Section 5.1.2, "Facts," on page 57).

You must assign the `filename` argument when executing this example. This is only the name of the file in the "images" area of the GMS. For example, for `grid:///images/disk.img`, just assign `disk.img` to the argument. This file must be in the GMS file system for fetching and delivering to remote nodes used in this example.

To populate the GMS use the zos copy command. For example, for a file named `suse-9-flat.vmd` in the current directory, use the following command:

```
> zos mkdir grid:///images
> zos copy suse-9-flat.vmd grid:///images/
```

The `multicast` jobarg is a Boolean, defaulted to `false` so that unicast is used for transport. Set this value to `true` to use multicast transport for delivery of the file.

The policy in the <job/> section also describes a `resource.groups` constraint. (For more information, see "Constraints" on page 23). This requires a resource group named `dgtest` (lines 30-39 in dgtest.policy (page 161)) and that group should have member nodes. Consequently, you must create this resource group using the Orchestrator server console and assign it some nodes to run this example successfully.

zosadmin deploy

When the Orchestrator server deploys a job for the first time (see Section 7.5, "Deploying Jobs," on page 75), the job JDL files are executed in a special deploy mode. Looking at dgtest.jdl (page 158), you might notice that when the job is deployed (line 30), either via the Orchestrator console or the zosadmin deploy command, that it attempts to find the `examples` jobgroup (lines 32-33), create it if missing (lines 34-45), and add the dgtest job to the group (line 36).

If this deployment fails for some reason, an exception is thrown (line 37), which prints (line 39) the job name, group name, exception type, and value.

job_started_event

In dgtest.jdl (page 158), the `test` class (line 42) defines only the required job_started_event (line 44) method. This method runs on the Orchestration server when the job is run to launch the joblets.

When `job_started_event` is executed, it gets the name of the file assigned to the `jobargs.filename` variable and prints useful tracing information (lines 45-47). It then tries to find the resource group named `dgtest`. If the resource group doesn't exist, the member `fail` string is set to inform the user and returns without scheduling the joblet(s) (lines 49-58).

After finding the `dgtest` group, the job gets the member list and determines how many nodes are online and enabled. The total `count` is stored in lines 60-65. After setting the memo line in the Console (67-69), the job schedules `count` number of `testnode` joblets (line 70).

joblet_started_event

In dgtest.jdl (page 158), the `testnode` class (line 73) defines only the required joblet_started_event (line 75) method. This method runs on the Orchestrator agent nodes when scheduled by a Job (page 265) class.

The joblet_started_event prints some trace information (lines 76-77), gets the name of the file to transfer (line 78) and the mode of transfer (line 79), and creates the grid URL for the file (line 82).

A DataGrid (page 243) is instantiated (line 86), set not to cache (line 89), and set to use the multicast jobarg (line 94). The next four settings control multicast behavior are commented out (lines 97, 100, 103, and 106). See setMulticastWait(int mcastWait),setMulticastQuorum(int mcastQuorum), setMulticastRate(int mcastRate), and setMulticastMin(int mcastMin).

The joblet prints a memo line for the Orchestrator console (lines 108-115), sets the location for the file on the local node (line 121), and tries to transfer the file from the datagrid (line 123).

If the datagrid copy at line 123 fails for some reason, we have a retry mechanism in the exception handler (lines 125-143). The information for why the exception occurred is fetched (line125).

The variable `retryUnicast` (line 126) is set `False` and will only be set `True` if the failed download attempt was using multicast transport and the exception type has the string "Multicast receive timed out" (lines 125-134). If the `timed out` string is not found, the triad assigns the `retryUnicast` a value of `-1`. With this logic, either multicast timeout or not, a unicast attempt is made if multicast fails.

If you get to line 136 from a failed multicast copy, a memo for the Orchestrator console is set and printed to the log (137-138), `setMulticast` is set to `false` (140), and another copy from the datagrid is attempted.

If we get to line 136 from a failed unicast copy, an exception is raised (line 143) and we're done.

Configure and Run

```
> zos run dgtest filename=suse-9-flat.vmd
JobID: vmmanager.dgtest.323
```

Looks like it ran successfully; let's see what the log says:

```
> zos log vmmanager.dgtest.323
Starting Datagrid Test Job.
Filename: suse-9-flat.vmd
Job 'vmmanager.dgtest.323' terminated because of failure. Reason: The
resource group 'dgtest' was not found. It is required for this job.
```

There is no resource group. Using the Orchestration Console create the resource group `dgtest`:

```
> zos run dgtest filename=suse-9-flat.vmd
JobID: vmmanager.dgtest.324

> zos log vmmanager.dgtest.324
Starting Datagrid Test Job.
Filename: suse-9-flat.vmd
Scheduling Datagrid Test on 0 Joblets
```

NOTE: No joblets were scheduled because we have no active nodes in the group.

Using the Orchestration Console populate the `dgtest` group with nodes that are both online and anabled:

```
> zos run dgtest filename=suse-9-flat.vmd
JobID: vmmanager.dgtest.325

> zos log vmmanager.dgtest.325
Starting Datagrid Test Job.
Filename: suse-9-flat.vmd
Scheduling Datagrid Test on 2 Joblets
[freeze] Running datagrid test joblet #0
[freeze] Starting unicast download of file: grid:///images/suse-9-
flat.vmd
[freeze] Traceback (innermost last):
[freeze]   File "dgtest.jdl", line 143, in joblet_started_event
[freeze] copy() failed: DataGrid file "/images/suse-9-flat.vmd" does
not exist.
Job 'vmmanager.dgtest.325' terminated because of failure. Reason: Job
failed because of too many joblet failures (job.joblet.maxfailures =
0)
[melt] Running datagrid test joblet #1
[melt] Starting unicast download of file: grid:///images/suse-9-
flat.vmd
[melt] Traceback (innermost last):
[melt]   File "dgtest.jdl", line 143, in joblet_started_event
[melt] copy() failed: DataGrid file "/images/suse-9-flat.vmd" does not
exist.
```

Because the path and the file in the DataGrid are missing, we need to create and populate them:

```
> zos mkdir grid:///images
Directory created.

> zos copy suse-9-flat.vmd grid:///images/
suse-9-flat.vmd copied.

> zos run dgtest filename=suse-9-flat.vmd
JobID: vmmanager.dgtest.326

> zos log vmmanager.dgtest.326
Starting Datagrid Test Job.
Filename: suse-9-flat.vmd
Scheduling Datagrid Test on 2 Joblets
[melt] Running datagrid test joblet #1
[melt] Starting unicast download of file: grid:///images/suse-9-
flat.vmd
[melt] grid:///images/suse-9-flat.vmd downloaded successfully.
[melt] 16732 -rw-r--r-- 1 root root 17108462 Dec 21 21:32 suse-9-
flat.vmd
[melt] Datagrid test completed
[freeze] Running datagrid test joblet #0
[freeze] Starting unicast download of file: grid:///images/suse-9-
flat.vmd
```

```
[freeze] grid:///images/suse-9-flat.vmd downloaded successfully.
[freeze] 16732 -rw-r--r-- 1 root root 17108462 Dec 21 21:31 suse-9-
flat.vmd
[freeze] Datagrid test completed
```

Finally, the file is deployed from the dataGrid and copied successfully. However, you will not find it if you look for it on the agent after the joblet is finished. By default, the file is deployed only for the joblet's lifetime into a directory for the joblet, like the following:

```
/var/opt/novell/zenworks/zos/agent/node.default/melt/
vmmanager.dgtest.326.0
```

So, for a more permanent demonstration, see lines 118-120 in dgtest.jdl (page 158). Uncomment line 120 and comment out line 121 to store your file in the `/tmp` directory and have it continue to exist on the agent after the joblet executes completely.

failover.job

A test job that demonstrates handling of joblet failover.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail failover
Jobname/Parameters    Attributes
------------------    ----------
failover              Desc: This test jobs can be used to demonstrate
joblet
                            failover handling.

    sleeptime         Desc: specify the execute length of joblet before
failure in
                            seconds
                      Type: Integer
                   Default: 7

    numJoblets        Desc: joblets to run
                      Type: Integer
                   Default: 1
```

Description

Schedules one joblet, which fails, then re-instantiates in a repeating cycle until a specified retry limit is reached and the Orchestration Server does not create another instance. This example demonstrates how the orchestration server can be made more robust, as described in Section 7.13, “Improving Job and Joblet Robustness,” on page 84.

The files that make up the Failover job include:

```
failover                                    # Total: 63 lines
|-- failover.jdl                            #   50 lines
`-- failover.policy                         #   13 lines
```

failover.jdl

```
  1  # Test job to illustrate joblet failover and max retry limits
  2  #
  3  # Job args:
  4  #    numJoblets - specify number of Joblets to run
  5  #    sleeptime -- specify the execute length of joblet before
failure in seconds
  6  #
  7
  8  import sys,os,time
  9
 10  #
```

```
 11  # Add to the 'examples' group on deployment
 12  #
 13  if __mode__ == "deploy":
 14      try:
 15          jobgroupname = "examples"
 16          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
 17          if jobgroup == None:
 18              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
 19          jobgroup.addMember(__jobname__)
 20      except:
 21          exc_type, exc_value, exc_traceback = sys.exc_info()
 22         print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
 23
 24
 25  class failover(Job):
 26
 27       def job_started_event(self):
 28            numJoblets = self.getFact("jobargs.numJoblets")
 29            print 'Launching ', numJoblets, ' joblets'
 30            self.schedule(failoverjoblet,numJoblets)
 31
 32
 33  class failoverjoblet(Joblet):
 34
 35       def joblet_started_event(self):
 36            print "------------------ joblet_started_event"
 37            print "node=%s joblet=%d" %
(self.getFact("resource.id"), self.getFact("joblet.number"))
 38            print "self.getFact(joblet.retrynumber)=%d" %
(self.getFact("joblet.retrynumber"))
 39            print "self.getFact(job.joblet.maxretry)=%d" %
(self.getFact("job.joblet.maxretry"))
 40
 41            sleeptime = self.getFact("jobargs.sleeptime")
 42            print "sleeping for %d seconds" % (sleeptime)
 43            time.sleep(sleeptime)
 44
 45            # This will cause joblet failure and thus retry
 46           raise RuntimeError, "Artifical error in joblet. node=%s"
% (self.getFact("resource.id"))
```

failover.policy

```
  1  <policy>
  2      <jobargs>
  3           <fact name="sleeptime" description="specify the execute
length of joblet before failure in seconds" value="7" type="Integer"  /
>
  4            <fact name="numJoblets" description="joblets to run"
value="1" type="Integer" />
  5      </jobargs>
  6
```

```
  7       <job>
  8            <fact name="description" value="This test jobs can be
used to demonstrate joblet failover handling." type="String" />
  9
 10           <!-- Number of times to retry joblet on failure -->
 11           <fact name="joblet.maxretry" type="Integer" value="3" />
 12       </job>
 13  </policy>
```

Classes and Methods

Definitions:

Class failover in line 25 of failover.jdl (page 167) is derived from the Job (page 265) class; and the class failoverjoblet in line 33 of failover.jdl (page 167) is derived from the Joblet (page 276) class.

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

test

Class test (line 42 in dgtest.jdl (page 158) is derived from the Job class.

testnode

Class testnode (line 73 in dgtest.jdl (page 158) is derived from the Joblet (page 276) class.

Job Details

The following sections describe the Failover job:

- "zosadmin deploy" on page 170
- "job_started Event" on page 170
- "job_started Event" on page 170

zosadmin deploy

In failover.policy (page 168), in addition to describing the jobargs and default settings for `sleeptime` and `numJoblets` (lines 2-5), the <job/> section (lines 7-12) describes static facts (see Section 5.1.2, “Facts,” on page 57).

Note that the `joblet.maxretry` attribute in line 11 has a default setting of 0 but is set here to 3. This attribute can also be modified in the failover.jdl (page 167) file by inserting a line between line 27 and 28, as shown in the following example:

```
27        def job_started_event(self):
++             self.setFact("job.joblet.maxretries", 3)
28             numJoblets = self.getFact("jobargs.numJoblets")
```

job_started Event

After the Orchestrator server deploys a job for the first time (see Section 7.5, “Deploying Jobs,” on page 75), the job JDL files are executed in a special “deploy” mode. When the job is deployed (line 13, failover.jdl (page 167), it attempts to find the `examples` jobgroup (lines 15-16), creates it if is missing (lines 17-18), and adds the failover job to the group (line 19).

Jobs can be deployed using either the Orchestrator console (zoc) or the zosadmin deploy command. If the deployment fails for some reason, an exception is thrown (line 20), which prints the job name (line 22), group name, exception type, and value.

job_started Event

In failover.jdl (page 167), the failover class (line 25) defines only the required `job_started_event` (line 27) method. This method runs on the Orchestrator server when the job is run to launch the joblets.

On execution, the `job_started_event` simply gets the number of joblets to create (numJoblets in line 28), then schedules that specified number of instances (line 30) of the `failoverjoblet class.failoverjoblet`. The failoverjoblet class (lines 33-46) defines only the required `joblet_started_event` (line 35) method.

When executed on an agent node, the `joblet_started_event` prints some helpful information for tracking execution (lines 36-39). The first output is where the joblet is running and which instance is running (line 37). The current joblet retry number (line 38) is displayed, followed by the job’s static `joblet.maxretry` (line 39) that was specified in the policy file.

The joblet then sleeps for `jobargs.sleeptime` seconds (lines 41-43) and on waking raises an exception of type `RuntimeError` (line 46).

This is the point of this example. After a `RuntimeError` exception is thrown, the zos server attempts to run the same instance of the joblet again if `job.joblet.maxretry` (default is 0) is less than or equal to `joblet.retrynumber`.

Configure and Run

You must be logged into the Orchestrator Server before you run `zosadmin` or `zos` commands.

1. Deploy failover.job into the grid:

```
> zosadmin deploy failover.job
JobID: vmmanager.failover.269
```

The job appears to have run successfully, now take a look at the log and see the joblet failure and being relaunched until finally the "maxretry" count is exceeded and the job exits with a failure status:

2. Display the list of deployed jobs:

```
> zos joblist
```

failover should appear in this list.

3. Run the job on one or more resources using the default values for numJoblets and sleeptime, specified in the `failover.policy` file:

```
> zos run failover sleeptime=1 numJoblets=2
JobID: vmmanager.failover.269
```

The job appears to have run successfully, now take a look at the log and see the joblet failure and being relaunched until finally the `maxretry` count is exceeded and the job exits with a failure status:

```
> zos log vmmanager.failover.269
Launching  2  joblets
[melt] ------------------ joblet_started_event
[melt] node=melt joblet=1
[melt] self.getFact(joblet.retrynumber)=0
[melt] self.getFact(job.joblet.maxretry)=3
[melt] sleeping for 1 seconds
[melt] Traceback (innermost last):
[melt]   File "failover.jdl", line 46, in joblet_started_event
[melt] RuntimeError: Artifical error in joblet. node=melt
[freeze] ------------------ joblet_started_event
[freeze] node=freeze joblet=0
[freeze] self.getFact(joblet.retrynumber)=0
[freeze] self.getFact(job.joblet.maxretry)=3
[freeze] sleeping for 1 seconds
[freeze] Traceback (innermost last):
[freeze]   File "failover.jdl", line 46, in joblet_started_event
[freeze] RuntimeError: Artifical error in joblet. node=freeze
[melt] ------------------ joblet_started_event
[melt] node=melt joblet=0
[melt] self.getFact(joblet.retrynumber)=1
[melt] self.getFact(job.joblet.maxretry)=3
[melt] sleeping for 1 seconds
[melt] Traceback (innermost last):
[melt]   File "failover.jdl", line 46, in joblet_started_event
[melt] RuntimeError: Artifical error in joblet. node=melt
[freeze] ------------------ joblet_started_event
[freeze] node=freeze joblet=1
[freeze] self.getFact(joblet.retrynumber)=1
[freeze] self.getFact(job.joblet.maxretry)=3
[freeze] sleeping for 1 seconds
[freeze] Traceback (innermost last):
[freeze]   File "failover.jdl", line 46, in joblet_started_event
[freeze] RuntimeError: Artifical error in joblet. node=freeze
[melt] ------------------ joblet_started_event
[melt] node=melt joblet=1
[melt] self.getFact(joblet.retrynumber)=2
[melt] self.getFact(job.joblet.maxretry)=3
```

```
[melt] sleeping for 1 seconds
[melt] Traceback (innermost last):
[melt]   File "failover.jdl", line 46, in joblet_started_event
[melt] RuntimeError: Artifical error in joblet. node=melt
[freeze] ------------------ joblet_started_event
[freeze] node=freeze joblet=0
[freeze] self.getFact(joblet.retrynumber)=2
[freeze] self.getFact(job.joblet.maxretry)=3
[freeze] sleeping for 1 seconds
[freeze] Traceback (innermost last):
[freeze]   File "failover.jdl", line 46, in joblet_started_event
[freeze] RuntimeError: Artifical error in joblet. node=freeze
```

See Also

- Setting Constraints Using Policies (Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57)
- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Executing Commands Using Exec (page 249)

instclients.job

Installs the ZENworks Orchestrator client applications to the specified resource machine. Note that while most of the other examples are deployed by default, this example is not.

Detail

The following concepts are demonstrated:

- Using constraints to restrict joblet execution to a specific resource.
- Adding files to a job's directory in the datagrid, and retrieving them during joblet execution.
- Using the Exec class to send a command to the operating system. The system command is invoked directly without using the system command interpreter (neither cmd.exe or /bin/sh).

Usage

```
> zosadmin login --user zosadmin Login to server: skate
Please enter current password for 'zosadmin':
Logged into grid on server 'skate'

> cd /opt/novell/zenworks/zos/server/examples
> zosadmin deploy instclients.job
instclients successfully deployed

> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail instclients Jobname/Parameters    Attributes
------------------    ----------
instclients        Desc: This job installs the Redmojo clients on a
resource

    host           Desc: The host name of resource to install on
                   Type: String
                Default: None! Value must be specified
```

Description

The files that make up the Instclients job include:

```
instclients                                 # Total: 107 lines
|-- instclients.jdl                         #   83 lines
`-- instclients.policy                      #   24 lines
```

instclients.jdl

```
 1  """
 2
 3  Run install clients on a resource
 4
 5  Setup:
```

```
 6      Before running the job, you must copy installers into datagrid
of GMS
 7      server.
 8
 9      >zos copy zosclients_windows_1_1_0_with_jre.exe grid:///
\!instclients/
10
11  """
12  import os,time
13
14  #
15  # Add to the 'examples' group on deployment
16  #
17  if __mode__ == "deploy":
18      try:
19          jobgroupname = "examples"
20          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
21          if jobgroup == None:
22              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
23          jobgroup.addMember(__jobname__)
24      except:
25          exc_type, exc_value, exc_traceback = sys.exc_info()
26          print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
27
28  class InstClients(Job):
29
30      def job_started_event(self):
31          print "Scheduling joblet"
32          self.schedule(InstClientsJoblet)
33
34  class InstClientsJoblet(Joblet):
35
36      def joblet_started_event(self):
37          print "Launching Installer"
38          windowsInstaller = "zosclients_windows_1_1_0_with_jre.exe"
39          linuxInstaller = "zosclients_linux_1_1_0_with_jre.sh"
40          if self.getFact("resource.os.family") == "windows":
41              print "Downloading Windows install"
42              dg = DataGrid()
43              dg.copy("grid:///!instclients/" +
windowsInstaller,windowsInstaller)
44
45              print "Starting install"
46              cmd = self.getcwd() + "/" + windowsInstaller + " -q "
47              e = Exec()
48              e.setCommand(cmd)
49              e.setRunAsJobUser(False)
50              e.writeStdoutToLog()
51              e.writeStderrToLog()
52              result = e.execute()
53          else:
54              print "Downloading Linux install"
```

```
55              dg = DataGrid()
56              dg.copy("grid:///!instclients/" +
linuxInstaller,linuxInstaller)
57
58              print "Starting install"
59             cmd = "chmod +x " + self.getcwd() + "/" + linuxInstaller
60              print "cmd=%s" % (cmd)
61              e = Exec()
62              e.setCommand(cmd)
63              e.setRunAsJobUser(False)
64              e.writeStdoutToLog()
65              e.writeStderrToLog()
66              result = e.execute()
67
68              cmd = self.getcwd() + "/" + linuxInstaller + " -q"
69              print "cmd=%s" % (cmd)
70              e = Exec()
71              e.setRunAsJobUser(False)
72              e.setCommand(cmd)
73              e.writeStdoutToLog()
74              e.writeStderrToLog()
75              result = e.execute()
76
77          if result == 0:
78              print "Install complete"
79          else:
80              print "result=%d" % (result)
```

instclients.policy

```
 1  <policy>
 2      <jobargs>
 3          <fact name="host"
 4                type="String"
 5               description="The host name of resource to install on"
/>
 6      </jobargs>
 7      <job>
 8          <fact name="description"
 9                type="String"
10                value="This job installs the Redmojo clients on a
resource" />
11      </job>
12      <constraint type="resource" >
13          <eq fact="resource.id" factvalue="jobargs.host" />
14      </constraint>
15  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Exec

Used to manage command line execution on resources.

DataGrid

Provides a way to interact with the Data Grid. Operations include copying files from the Data Grid down to the resource for joblet usage and uploading files from a resource to the Data Grid.

Job Details

The following sections describe the Instclients job:

- "zosadmin deploy" on page 176
- "job_started_event" on page 176
- "joblet_started_event" on page 177

zosadmin deploy

The deployment for the Instclients job is performed on lines 14-26 of instclients.jdl (page 173). When jobs are deployed into the grid, they can optionally be placed in groups for organization and easy reference. In this case, the Instclients job will be added to the group named Examples, and will show up in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples.
```

For a general overview of how jobs are added to groups during deployment, see Deploying a Sample Job (http://www.novell.com/documentation/zen_orchestrator11/zos11_admin/data/bbnt24e.html).

job_started_event

When the Instclients job receives a job_started_event, it schedules a single instance of the Instclients joblet to be run (see line 32 of instclients.jdl (page 173)). The resource that runs the joblet is

determined from the resource constraint specified in instclients.policy (page 175), lines 12-14, and from the value for the parameter `host` supplied on the command line.

joblet_started_event

After the Instclients joblet is executed on a particular resource, it receives a joblet_started_event. When this happens, the Instclients joblet decides which ZOS client installation file to download, and the commands to execute on the operating system by checking the value of `resource.os.family` (see line 40 of instclients.jdl (page 173)). The `resource.os.family` fact does not exist in the `instclients.policy` file, but is instead provided by the ZENworks Orchestrator system.

After deciding which operating system the joblet is being run on, the Instaclients joblet uses the DataGrid class to download the appropriate client installation file to the current working directory of the running joblet (see lines 41-43 and 54-56 in instclients.jdl (page 173)). The URL `grid://!instclients/` points to a directory reserved for the joblet in the datagrid on the server.

After the client installation file has been downloaded from the server, the Instclients joblet uses the Exec class to begin the installation (see lines 46-52 and 58-75 in instclients.jdl (page 173)l). As indicated by lines 50, 51, 64, 65, 73 and 74, all standard out and standard err are written to the job's log file.

To view the log file for the Instclients job after it has been run, you can execute the command

```
zos log instclients
```

For more information about using zos, see Section 7.5.2, "Using the ZOSADMIN Command Line Tool," on page 75. See the Exec (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/data/baj3myi.html) class for more information on running commands.

NOTE: The Instclients job uses the Exec class twice when running on a Linux resource. The first command changes the mode of the installation file to be an executable, and the second runs the installation file.

Configure and Run

Execute the following commands to deploy and run `instclients.job`:

1. Copy client installation files into the directory reserved for the Instclients joblet in the Data Grid of the ZOS server (note: replace windows with Linux*, Solaris*, etc. for your given operating system):

   ```
   zos copy zosclients_linux_1_1_1_with_jre.sh grid:///\!instclients/
   ```

   This command copies the file `zosclients_linux_1_1_1_with_jre.sh` into the Data Grid job directory for instclients.

   For more information about using ZENworks Orchestrator Console to copy files, type `zos copy -help`.

   NOTE: Replace windows with *linux*, *solaris*, etc. for your given operating system.

   ---

2. Deploy instclients.job into the grid by entering:

   ```
   zosadmin deploy instclients.job
   ```

3 Display the list of deployed jobs by entering:

```
zos joblist
```

`instclients` should appear in this list.

4 Run the job on the resource with the given host:

```
zos run instclients host=my_resource_host
```

Installs the Orchestrator client onto the resource with the host: my_resource_host.

See Also

- Setting Constraints Using Policies (Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57)
- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Scheduling multiple instances of a joblet
- Setting default parameter values using policies
- Configuring constraints in a policy file
- Naming conventions for policy facts (Section 3.1.1, “Naming Orchestrator Job Files,” on page 43.Section 3.1.1, “Naming Orchestrator Job Files,” on page 43)
- Facts provided by the ZENworks Orchestrator system that can be referenced within a JDL file
- Using ZENworks Orchestrator ConsoleUsing ZENworkd Orchestrator (“How Do I Interact with ZENworks Orchestrator?”)
- Running commands using the Exec class.

notepad.job

Launches the Notepad application on a Windows resource.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail notepad
Jobname/Parameters    Attributes
------------------    ----------
notepad            Desc: No description available.
```

Description

The files that make up the Notepad job include:

```
notepad                                      # Total: 55 lines
|-- notepad.jdl                              #   40 lines
`-- notepad.policy                           #   15 lines
```

notepad.jdl

```
0    """
1
2    Run Notepad Application on windows resource
3
4    """
5    import os,time
6
7    #
8    # Add to the 'examples' group on deployment
9    #
10   if __mode__ == "deploy":
11       try:
12           jobgroupname = "examples"
13           jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
14           if jobgroup == None:
15               jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
16           jobgroup.addMember(__jobname__)
17       except:
18           exc_type, exc_value, exc_traceback = sys.exc_info()
19          print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)

21
22   class Notepad(Job):
23
24       def job_started_event(self):
25           print "Scheduling joblet"
```

```
26            self.schedule(NotepadJoblet)
27
28
29    class NotepadJoblet(Joblet):
30
31        def joblet_started_event(self):
32            print "Starting Notepad"
33            cmd = "notepad"
34            e = Exec()
35            e.setCommand(cmd)
36            e.writeStdoutToLog()
37            e.writeStderrToLog()
38            result = e.execute()
```

notepad.policy

```
0     <policy>
1         <constraint type="accept" >
2             <gt fact="jobinstance.matchingresources" value="0"
reason="No Windows's resources are available to run Notepad" />
3         </constraint>
4         <constraint type="resource" >
5             <eq fact="resource.os.family" value="windows"
reason="Notepad only runs on Windows OS" />
6         </constraint>
7     </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Exec

Used to manage command line execution on resources.

Job Details

The Notepad job is broken down into three separate operations:

- “zosadmin deploy” on page 181
- “job_started_event” on page 181
- “joblet_started_event” on page 181

zosadmin deploy

In notepad.jdl (page 179), lines 7-19 deploy the job into the grid. After jobs are deployed into the grid, they can optionally be placed in groups for organization and easy reference. In this case, the Notepad job is added to the group named Examples and appears in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples
```

For a general overview of how jobs are added to groups during deployment, see Deploying a Sample Job (http://www.novell.com/documentation/zen_orchestrator11/zos11_admin/data/bbnt24e.html).

job_started_event

Scheduling the Notepad joblet to run immediately is the second operation performed by the Notepad job in line 26 of notepad.jdl (page 179). When the Notepad job class receives a `job_started_event()` notification, it simply schedules the NotepadJoblet class to be run on any target device that meets the restrictions identified in the `notepad.policy` file.

As specified in lines 2 and 5 of notepad.policy (page 180), there must be at least one Windows machine available in the grid for the Notepad job to run. The `accept` constraint in lines 1-3 prevents the Notepad job from being accepted for running if there are no Windows resources available.

The `resource` constraint in lines 4-7 constrain the Orchestrator scheduler to only choose a resource that is running a Windows OS.

For more information on setting constraints using policies, see Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57.

joblet_started_event

As specified in lines 33-38 in notepad.jdl (page 179), the joblet executing a command on the target machine is the last operation performed by the Notepad job.

In this example, after the `joblet_started_event()` method of the NotepadJoblet class gets called, the ZENworks Orchestrator API class named Exec (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/data/baj3myi.html) is used to run the command `notepad` on is captured and written to the log file for the Notepad job.

Configure and Run

Execute the following commands to deploy and run `notepad.job`:

1 Deploy notepad.job into the grid:

```
> zosadmin deploy notepad.job
```

2 Display the list of deployed jobs:

```
> zos joblist
```

notepad should appear in this list.

3 Run the job on the first available Windows resource.

```
> zos run notepad
```

You should now see the Windows Notepad application appear on the screen of the target Windows system.

See Also

- Setting Constraints Using Policies see Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57.
- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Executing Commands Using Exec (page 249)

sweeper.job

This example job illustrates how to schedule a sweep, an ordered serialized scheduling of the joblets, across all matching resources.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail sweeper
Jobname/Parameters    Attributes
------------------    ----------
sweeper            Desc: This example job ilustrates how to schedule a
'sweep'
                         accross all matching resources.

    sleeptime       Desc: time to sleep (in seconds)
                    Type: Integer
                 Default: 1
```

Options

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Exec

Used to manage command line execution on resources.

sleeptime

Specifies the time in seconds that the job remains dormant before running (default 1).

Description

The files that make up the Sweeper job include:

```
sweeper                                                 # Total: 109 lines
|-- sweeper.jdl                                         #   52 lines
`-- sweeper.policy                                      #   57 lines
```

The ScheduleSpec (page 305) utility class is also related to this example.

sweeper.jdl

```
  1  import time
  2
  3  #
  4  # Add to the 'examples' group on deployment
  5  #
  6  if __mode__ == "deploy":
  7     try:
  8        jobgroupname = "examples"
  9        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
 10        if jobgroup == None:
 11           jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
 12        jobgroup.addMember(__jobname__)
 13     except:
 14        exc_type, exc_value, exc_traceback = sys.exc_info()
 15        print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname,  exc_type, exc_value)
 16
 17
 18  class sweeperJob(Job):
 19
 20     def job_started_event(self):
 21        self.setFact("jobinstance.memo",
self.getFact("job.description"))
 22
 23        sp = ScheduleSpec()
 24
 25       # Optionally a constraint can be specified to further limit
matching
 26        # resources from the job's default 'resource' constraint.
Could also
 27        # compose an object Constraint.
 28        # For example, uncomment to restrict to resource group
'sweeper'
 29        #sp.setConstraint("<contains fact='resource.groups'
value='sweeper' />")
 30
 31        # Specify the joblet to run on each resource
 32        sp.setJobletClass(sweeperJoblet)
 33
 34        # Specify the sweep across active nodes
 35        sp.setUseNodeSet(sp.ACTIVE_NODE_SET)
 36
 37        # Schedule a sweep (creates preassigned joblets)
 38        self.scheduleSweep(sp)
 39
```

```
 40        # Now the ScheduleSpec contains the number of joblets
created
 41        print 'Launched', sp.getCount(), 'joblets'
 42
 43
 44  class sweeperJoblet(Joblet):
 45
 46     def joblet_started_event(self):
 47        msg = "run on resource %s" % (self.getFact("resource.id"))
 48        self.setFact("joblet.memo", msg)
 49        print "Sweep", msg
 50        sleeptime = self.getFact("jobargs.sleeptime")
 51        time.sleep(sleeptime)
```

sweeper.policy

```
  1  <policy>
  2
  3     <jobargs>
  4        <!--
  5         -  Defines and sets the length of time the joblet should
pretend
  6         -  it is doing something important
  7         -->
  8        <fact name="sleeptime"
  9              type="Integer"
 10              description="time to sleep (in seconds)"
 11              value="1"
 12              visible="true" />
 13     </jobargs>
 14
 15
 16     <job>
 17        <!--
 18          -  Give the job a description for GUI's
 19          -->
 20        <fact name="description"
 21              type="String"
 22              value="This example job ilustrates how to schedule a
'sweep' accross all matching resources." />
 23
 24        <!--
 25          -  This activates a built in throttle to limit the number
of
 26          -  resources this job will run on at a time
 27          -->
 28        <fact name="maxresources"
 29              type="Integer"
 30              value="3" />
 31
 32        <!--
 33         -  Rank resources from least loaded to the highest loaded.
The
 34          -  idea is to run the joblets on the least loaded node
```

```
first
 35          -  and hopefully by the time we get to the higher loaded
machines
 36          -  their load may have gone down
 37          -->
 38        <!--
 39        <fact name="resources.rankby">
 40           <array>
 41              <string>resource.loadaverage/a</string>
 42           </array>
 43        </fact>
 44          -->
 45
 46        <!--
 47          -  Alternative ranking that is easier to see:
 48          -  decending alphabetic of node name
 49          -->
 50        <fact name="resources.rankby">
 51           <array>
 52              <string>resource.id/d</string>
 53           </array>
 54        </fact>
 55     </job>
 56
 57  </policy>
```

Classes and Methods

The class sweeperJob (see line 18, sweeper.jdl (page 184)) is derived from the Job (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/index.html?page=/documentation/zen_orchestrator11/zos11_developer/data/b9j1ok9.html) class.

The class sweeperJoblet (see line 44, sweeper.jdl (page 184)) is derived from the Joblet (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/index.html?page=/documentation/zen_orchestrator11/zos11_developer/data/b9j1ok9.html) class.

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

Job Details

The sweeper.job can be broken down into four separate parts:

- "Policy" on page 187
- "zosadmin deploy" on page 187
- "job_started_event" on page 187

- "joblet_started_event" on page 188

Policy

In addition to specifying the jobarg and default settings for `sleeptime` in lines 8-12, sweeper.policy (page 185)), there also is the <job/> section in lines 16-55, which describes static facts (see "Facts" on page 57).

The `resources.rankby` array has two notable setting in this example:

- **resource.loadaverage:** This is the first string assignment (lines 38-44), which is commented out, that causes joblets to run on the least loaded nodes first.This is the default value and the default launch order for scheduleSweep.
- **resource.id:** This is the second string assignment (lines 50-54), which is actually used, and assigns the string to the rank by array so that joblets run on nodes in reverse alphabetical order.

zosadmin deploy

When the Orchestrator server deploys a job for the first time (see Section 7.5, "Deploying Jobs," on page 75), the job JDL files are executed in a special deploy mode. When `sweeper.jdl` is run in this way (either via the zoc or the zosadmin deploy command), lines 6-15 are executed. This attempts to locate the examples jobgroup (lines 8-9), creates the group if it is not found (lines 10-11), and adds the sweeper job to the group (line 12).

If the deployment fails for any reason, then an exception is thrown (line 13), which prints the job name, group name, exception type and value (line 15).

job_started_event

The sweeperJob class (line 18) defines only the required `job_started_event` (line 20) method. This method runs on the Orchestrator server when the job is run to launch the joblets.

When executed, `job_started_event` displays a message on the memo line of the Job Log tab within the Jobs view in the Orchestrator console (line 21), via `jobinstance.memo` (see Section 7.12.1, "Creating a Job Memo," on page 83).

Jumping ahead for a moment, instead of calling `self.schedule()` as most the other examples do to instantiate joblets, sweeperJob calls `self.scheduleSweep()` (line 38). scheduleSweep "scheduleSweep" on page 273 requires an instance of ScheduleSpec (page 305), so one is created (line 23).

The ScheduleSpec method setConstraint can be used to constrain the available resources to a particular group, as shown with a comment (line 29). If this setConstraint line is uncommented, joblets will only run on members of the sweeper `resource.group` instead of using the default resource group `all`.

NOTE: The sweeper group must already be created and have computing nodes assigned to it (see "Walkthrough: Create a Resource Account". This constraint would also be ANDed to any existing constraint, including any aggregated policies.

The sweeperJoblet is set to be scheduled (line 32), and "setUseNodeSet(int nodeSet)" on page 306 is assigned (line 35) the value sp.ACTIVE_NODE_SET. So, the joblet set is constructed after

applying resource constraints to the active/online resources. This in contrast to the other possible value of sp.PROVISIONABLE_NODE_SET, where constraints are applied to all provisionable resources.

joblet_started_event

The sweeperJoblet class (lines 44-51) defines only the required `joblet_started_event` (line 46) method. After this method is executed, it displays a message on the memo line of the Joblet tab within the Jobs view in the Orchestrator console (lines 47-48). It. also prints a similar log message (line 49), and then just sleeps for `jobargs.sleeptime` seconds (lines 50-51) before completion.

Configure and Run

Execute the following commands to deploy and run `sweeper.job`:

1. Deploy notepad.job into the grid:

   ```
   > zosadmin deploy sweeper.job
   ```

2. Display the list of deployed jobs:

   ```
   > zos joblist
   ```

   sweeper should appear in this list.

3. Run the job on one or more resources using the default values for numJoblets and resource, specified in the `sweeper.policy` file:

   ```
   > zos run sweeper sleeptime=30
   JobID: vmmanager.sweeper.420

   > zos status vmmanager.sweeper.420
   Completed

   > zos log vmmanager.sweeper.420
   Launched 3 joblets
   [melt] Sweep run on resource melt
   [freeze] Sweep run on resource freeze
   [skate] Sweep run on resource skate
   ```

See Also

- Setting Constraints Using Policies, see Section 4.4, “Policy Management,” on page 54 and Chapter 5, “Developing Policies,” on page 57

whoami.job

Demonstrates using the Exec class to send a command to the operating system's default command interpreter. On Microsoft Windows, this is `cmd.exe`. On POSIX systems, this is `/bin/sh`.

Usage

```
> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

~> zos jobinfo --detail whoami
Jobname/Parameters    Attributes
------------------    ----------
whoami              Desc: This is a demo example of enhanced exec

    numJoblets      Desc: The number of joblets to schedule
                    Type: Integer
                 Default: 1

    resource        Desc: The resource id to run on
                    Type: String
                 Default: .*
```

Description

The files that make up the Whoami job include:

```
whoami                                                  # Total: 87 lines
|-- whoami.jdl                                          #   55 lines
`-- whoami.policy                                       #   32 lines
```

whoami.jdl

```
 1  """
 2
 3  Demonstrates running setuid exec.
 4
 5  """
 6  import os,time
 7
 8  #
 9  # Add to the 'examples' group on deployment
10  #
11  if __mode__ == "deploy":
12      try:
13          jobgroupname = "examples"
14          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
15          if jobgroup == None:
16              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
17          jobgroup.addMember(__jobname__)
18      except:
```

```
19          exc_type, exc_value, exc_traceback = sys.exc_info()
20         print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
21
22
23  class Whoami(Job):
24
25      def job_started_event(self):
26          # Launch the joblets
27          numJoblets = self.getFact("jobargs.numJoblets")
28          user = self.getFact("user.id")
29          print "Launching %d joblets for user '%s'" %
(numJoblets,user)
30          self.schedule(WhoamiJoblet,numJoblets)
31
32
33  class WhoamiJoblet(Joblet):
34
35      def joblet_started_event(self):
36          if self.getFact("resource.os.family") == "windows":
37              cmd = "echo %USERNAME%"
38          elif self.getFact("resource.os.family") == "solaris":
39              cmd = "echo $USER"
40          else:
41              cmd = "whoami"
42          print "cmd=%s" % (cmd)
43
44          # example using built-in system()
45          #result = system(cmd)
46
47          # example using Exec class
48          e = Exec()
49          e.setShellCommand(cmd)
50          e.writeStdoutToLog()
51          e.writeStderrToLog()
52          result = e.execute()
53
54          print "result=%d" % (result)
```

whoami.policy

```
 1  <policy>
 2      <jobargs>
 3          <fact name="numJoblets"
 4                type="Integer"
 5                description="The number of joblets to schedule"
 6                value="1" />
 7          <fact name="resource"
 8                type="String"
 9                description="The resource id to run on"
10                value=".*" />
11      </jobargs>
12      <job>
13          <fact name="description"
```

```
14                type="String"
15                value="This is a demo example of enhanced exec" />
16          <!-- only allow one run resource at a time so that multiple
resources can be visited -->
17           <fact name="joblet.maxperresource"
18                type="Integer"
19                value="1" />
20      </job>
21      <constraint type="resource" >
22          <eq fact="resource.id" factvalue="jobargs.resource"
match="regexp" />
23      </constraint>
24  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Exec

Used to manage command line execution on resources.

Job Details

The following sections describe the Whoami job:

- "zosadmin deploy" on page 191
- "job_started_event" on page 192
- "joblet_started_event" on page 192

zosadmin deploy

The deployment for the Whoami job is performed on lines 8-20 of whoami.jdl. When jobs are deployed into the grid, they can optionally be placed in groups for organization and easy reference.

In this case, the Whoami job will be added to the group named “examples”, and will show up in the ZENworks Orchestrator Console in the Explorer panel at the location:
`/ZOS/YOUR_GRID/Jobs/examples.`

For a general overview of how jobs are added to groups during deployment, see Deploying a Sample Job (http://www.novell.com/documentation/zen_orchestrator11/zos11_admin/data/bbnt24e.html).

job_started_event

When the Whoami job receives a job_started_event, it schedules one or more instances of the Whoami joblet to be run (see line 30 in whoami.jdl (page 189)). The number of WhoamiJoblet instances is indicated by the value of the `numJoblets` fact, whose value might have been supplied on the command-line, or referenced from what’s been supplied in the whoami.policy file by default (see lines 3-6 in whoami.policy (page 190)).

In addition to supplying a default value for `numJoblets`, the `whoami.policy` file also supplies a default value for the ID of the resource on which the joblet runs. The default value is `.*`, which means all resources are included (see lines 7-10 in whoami.policy (page 190)).

Note that the setting for resource isn’t used in the JDL code but is used to affect which resources on which the joblet run. This occurs because a constraint is specified in `whoami.policy` that restricts the resources that can run this joblet to the current value of the `resource` fact (see line 22 in whoami.jdl (page 189)).

`maxperresource` is another job setting that affects scheduling of the Whoami joblet. The system uses `maxperresource` to determine how many instances of the joblet can run simultaneously on the same resource. In this case, only one instance of the Whoami job can be run on a machine at a time, as specified in lines 17-19 in whoami.policy (page 190).

When facts are referenced in the JDL file, they are prepended with `jobargs.` or `job.`. However, when supplied on the command line, this prefix is omitted. JDL files must use an explicit naming convention when it references facts from the different sections of the policy files. For more information on naming conventions for policy facts, see Section 3.1.1, “Naming Orchestrator Job Files,” on page 43.

joblet_started_event

When the Whoami joblet is executed on a particular resource it receives a joblet_started_event. After this happens, the Whoami joblet decides which command to use to get the current username by checking the value of `resource.os.family` (see lines 36-42 in whoami.jdl (page 189)). This setting is not set in the `whoami.policy`, but instead is available from the ZENworks Orchestrator system.

After the command to get the current username has been decided, the ZENworks Orchestrator API class named Exec is used to execute the command on the resource where the joblet is running (see lines 48-54 in whoami.jdl (page 189)).

By passing the command to the Exec setShellCommand method, the command will be executed by the operating system’s default command interpreter. On Microsoft Windows this `cmd.exe`. On POSIX systems, this is `/bin/sh`. As indicated by lines 50-51 in whoami.jdl (page 189), all standard out and standard errors are written to the job’s log file.

To view the log file for the whoami job after it has been run, execute the command
`> zos log whoami.`

For more information about using the zos command line, see "The Zosadmin Command Line Tool". For more information on running commands using the Exec class, see Exec (page 249).

Configure and Run

Execute the following commands to deploy and run `whoami.job`:

1. Deploy notepad.job into the grid:
   ```
   > zosadmin deploy whoami.job
   ```
2. Display the list of deployed jobs:
   ```
   > zos joblist
   ```
   whoami should appear in this list.
3. Run the job on one or more resources using the default values for numJoblets and resource, specified in the `whoami.policy` file:
   ```
   > zos run whoami
   ```
4. Run the job on one or more resources using supplied values for numJoblets and resource:
   ```
   > zos run whoami numJoblets=10 resource=my_resource_.*
   ```
   Run 10 joblets simultaneously, but only on resources beginning with the name "my_resource_".

   NOTE: The value for "resource" is specified using regular expression syntax.

See Also

- Setting Constraints Using Policies (Section 4.4, "Policy Management," on page 54 and Chapter 5, "Developing Policies," on page 57).
- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Scheduling multiple instances of a joblet
- Setting default parameter values using policies
- Configuring constraints in a policy file
- Naming conventions for policy facts (Section 3.1.1, "Naming Orchestrator Job Files," on page 43.Section 3.1.1, "Naming Orchestrator Job Files," on page 43)
- Facts provided by the ZENworks Orchestrator system that can be referenced within a JDL file
- Using ZENworkd Orchestrator ("How Do I Interact with ZENworks Orchestrator?")
- Running commands using the Exec class.

10.6 Miscellaneous Code-Only Jobs

The following examples demonstrate useful, miscellaneous code-only job concepts:

factJunction.job

Demonstrates using fact junctions to retrieve information about objects in the grid relative to another object.

Detail

Each object in the grid has a set of facts which can be read and modified. Some of these facts are special in the sense that their value contains the name of another object that must exist in the grid. These special facts are called fact junctions.

Fact junctions provide a way to reference the facts of one object, using another object as a starting point. For example, all jobs in the grid have a fact named job.accountinggroup. The value for `job.accountinggroup` must be the name of a job group currently existing in the grid (the default being the group named all). The following JDL code prints the ID of the accounting group for the job named myJob without using fact junctions:

```
job = getMatrix().getGridObject(TYPE_JOB, "myJob")
groupName = job.getFact("job.accountinggroup")
group = getMatrix().getGridObject(TYPE_JOBGROUP, groupName)
print "Group ID: " + group.getFact("group.id")
```

Using fact junctions, you can obtain the ID of the accounting group without having to retrieve a reference to the group object first, as follows:

```
job = getMatrix().getGridObject(TYPE_JOB, "myJob")
print "Group ID: " + job.getFact("job.accountinggroup.id")
```

Notice the job `myJob` does not have a fact named job.accountinggroup.id. However, it does have a fact named "job.accountinggroup", which contains the name of an existing job group. This job group has the fact "group.id", and using fact junctions you can obtain the value of this fact without explicitly reading it off of the job group object itself.

Usage

```
> zosadmin login --user zosadmin Login to server: skate
Please enter current password for 'zosadmin':
Logged into grid on server 'skate'

> cd /opt/novell/zenworks/zos/server/examples
> zosadmin deploy factJunction.job
factJunction successfully deployed

> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail factJunction
Jobname/Parameters    Attributes
------------------    ----------
factJunction       Desc: This is a test job to exercise fact junctions.

No parameters defined for this job.
```

Description

The files that make up the factJunction job include:

```
factJunction                                        # Total: 174 lines
|-- factJunction.jdl                                #  165 lines
`-- factJunction.policy                             #    9 lines
```

factJunction.jdl

```
  1  #
  2  # This is a test job, but also illustrates all the implemented
fact junctions.
  3  # A fact junction is a way to access facts on a 'referenced'
object.
  4  # E.g. vmhost.resource.***  redirects from the vmhost object
through the
  5  #      juction onto the underlying physical resource object.
  6  #
  7  # To setup for test, copy job into the 'provisionAdapter' job
group.
  8  #
  9
 10  #
 11  # Add to the 'examples' group on deployment
 12  #
 13  if __mode__ == "deploy":
 14      try:
 15          jobgroupname = "examples"
 16          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
 17          if jobgroup == None:
 18              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
 19          jobgroup.addMember(__jobname__)
 20      except:
 21          exc_type, exc_value, exc_traceback = sys.exc_info()
 22         print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
 23
 24
 25  class factJunctionJob(Job):
 26
 27      def job_started_event(self):
 28          m = getMatrix()
 29          nptt = "<Not Possible To Test>"
 30
 31          # Setup test environment
 32          user = m.getGridObject(TYPE_USER, "test")
 33          if (user == None):
 34              user = m.createGridObject(TYPE_USER, "test")
 35          user.setArrayFact("user.privilegedjobgroups", ["all"])
 36
 37          repository = m.getGridObject(TYPE_REPOSITORY, "test")
 38          if (repository == None):
 39              repository = m.createGridObject(TYPE_REPOSITORY,
```

```
"test")
 40          repository.setArrayFact("repository.provisioner.jobs",
["factJunction"])
 41
 42          node = m.getGridObject(TYPE_RESOURCE, "test")
 43          if (node == None):
 44              node = m.createGridObject(TYPE_RESOURCE, "test")
 45
 46          vm = m.getGridObject(TYPE_RESOURCE, "vmtest")
 47          if (vm == None):
 48              vm = m.createResource("vmtest",
ResourceInfo.TYPE_VM_INSTANCE)
 49          vm.setFact("resource.provisioner.job", "factJunction")
 50          vm.setFact("resource.vm.repository", "test")
 51          vm.setFact("resource.provisioner.recommendedhost",
"test_test")
 52
 53          vmt = m.getGridObject(TYPE_RESOURCE, "vmttest")
 54          if (vmt == None):
 55              vmt = m.createResource("vmttest",
ResourceInfo.TYPE_VM_TEMPLATE)
 56          vmt.setFact("resource.provisioner.job", "factJunction")
 57          vmt.setFact("resource.vm.repository", "test")
 58
 59          try:
 60              vmhost = node.getVmHost("test")
 61          except:
 62              vmhost = node.createVmHost("test")
 63          vmhost.setFact("vmhost.provisioner.job", "factJunction")
 64          vmhost.setArrayFact("vmhost.repositories", ["test"])
 65         vmhost.setArrayFact("vmhost.vm.available.groups", ["all"])
 66
 67          job = m.getGridObject(TYPE_JOB, "factJunction")
 68
 69          # Test junctions
 70
 71          print
 72          print "Testing User fact junctions (3):"
 73          r = user.getFact("user.accountinggroup.id")
 74          print "1. user.accountinggroup.id = %s" % r
 75          # Array junctions
 76          r = user.getFact("user.privilegedjobgroups[all].id")
 77          print "2. user.privilegedjobgroups[all].id = %s" % r
 78          r = user.getFact("user.groups[all].jobcount")
 79          print "3. user.groups[all].jobcount = %s" % r
 80
 81
 82          print
 83          print "Testing Job fact junctions (3):"
 84          r = job.getFact("job.accountinggroup.id")
 85          print "1. job.accountinggroup.id = %s" % r
 86          r = job.getFact("job.resourcegroup.id")
 87          print "2. job.resourcegroup.id = %s" % r
 88          # Array junctions
```

```
 89          r = job.getFact("job.groups[all].jobinstances.total")
 90          print "3. job.groups[all].jobinstances.total = %s" % r
 91
 92
 93          print
 94          print "Testing VmHost fact junctions (7):"
 95          r = vmhost.getFact("vmhost.resource.id")
 96          print "1. vmhost.resource.id = %s" % r
 97          r = vmhost.getFact("vmhost.accountinggroup.id")
 98          print "2. vmhost.accountinggroup.id = %s" % r
 99          r = vmhost.getFact("vmhost.provisioner.job.id")
100          print "3. vmhost.provisioner.job.id = %s" % r
101          # Array junctions
102          r = vmhost.getFact("vmhost.groups[all].vmcount")
103          print "4. vmhost.groups[all].vmcount = %s" % r
104          r = vmhost.getFact("vmhost.repositories[test].id")
105          print "5. vmhost.repositories[test].id = %s" % r
106          r = vmhost.getFact("vmhost.vm.available.groups[all].id")
107          print "6. vmhost.vm.available.groups[all].id = %s" % r
108          #r = vmhost.getFact("vmhost.vm.instanceids[vmtest].id")
109          r = nptt
110          print "7. vmhost.vm.instanceids.[vmtest].id = %s" % r
111
112
113          print
114          print "Testing Resource fact junctions (9):"
115          r = vm.getFact("resource.provisioner.job.id")
116          print "1. resource.provisioner.job.id = %s" % r
117          r = vm.getFact("resource.vm.repository.id")
118          print "2. resource.vm.repository.id = %s" % r
119          r = vm.getFact("resource.provisioner.recommendedhost.id")
120         print "3. resource.provisioner.recommendedhost.id = %s" %
r
121          #r = vm.getFact("resource.provision.vmhost.id")
122          r = nptt
123          print "4. resource.provision.vmhost.id = %s" % r
124          #r = vm.getFact("resource.provision.template.id")
125          r = nptt
126          print "5. resource.provision.template.id = %s" % r
127          # Array junctions
128          r = vm.getFact("resource.groups[all].loadaverage")
129          print "6. resource.groups[all].loadaverage = %s" % r
130          r = node.getFact("resource.vmhosts[test_test].id")
131          print "7. resource.vmhosts[test_test].id = %s" % r
132          r = node.getFact("resource.repositories[test].id")
133          print "8. resource.repositories[test].id = %s" % r
134          #r =
vmt.getFact("resource.provisioner.instances[vmttest_2].id")
135          r = nptt
136          print "9. resource.provisioner.instances[vmtest_2].id =
%s" % r
137
138
139          print
```

```
140          print "Testing Repository fact junctions (4):"
141          r = repository.getFact("repository.groups[all].id")
142          print "1. repository.groups[all].id = %s" % r
143          r = repository.getFact("repository.vmimages[vmtest].id")
144          print "2. repository.vmimages[vmtest].id = %s" % r
145         r = repository.getFact("repository.vmhosts[test_test].id")
146          print "3. repository.vmhosts[test_test].id = %s" % r
147          r =
repository.getFact("repository.provisioner.jobs[factJunction].id")
148          print "4. repository.provisioner.jobs[factJunction].id =
%s" % r
149
150
151          print
152          print "Testing multiple junctions (1):"
153          r =
repository.getFact("repository.vmhosts[test_test].resource.repositorie
s[test].vmhosts[test_test].groups[all].id")
154          print "1.
repository.vmhosts[test_test].resource.repositories[test].vmhosts[test
_test].groups[all].id = %s" % r
155
156          # Now make sure they are all accessable by the joblet...
157          #self.schedule(factJunctionJoblet, {})
158
159  class factJunctionJoblet(Joblet):
160
161      def joblet_started_event(self):
162          # TODO
163          time.sleep(sleeptime)
```

factJunction.policy

The description fact displays the commands x, y, z ...

```
1  <policy>
2      <job>
3          <fact name="description"
4                type="String"
5               value="This is a test job to exercise fact junctions."
/>
6      </job>
7  </policy>
```

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

UserInfo

A representation of a User grid object. This class provides accessors and setters for User facts.

RepositoryInfo

A representation of a Repository grid object. This class provides accessors and setters for Repository facts. To script the creation of Repository objects, see MatrixInfo (page 286).

ResourceInfo

A representation of a Resource Grid Object. This class inherits the base fact operations from GridObjectInfo and adds the provisioning operations for provisionable resources such as virtual machines. See MatrixInfo (page 286) for how to script creation of Resource objects.

JobInfo

A representation of a deployed Job. The factset available on the JobInfo class is the aggregation of the Job's policy and policies on the groups the Job is a member of. This includes the `job.*` and `jobargs.*` fact namespaces.

Job Details

The FactJunction job performs its work by handling the following events:

- "zosadmin deploy" on page 199
- "job_started_event" on page 199
- "joblet_started_event" on page 200

zosadmin deploy

Deploying FactJunction job is performed by lines 10-22 of factJunction.jdl. When jobs are deployed into the grid, they can optionally be placed in groups for organization and easy reference. In this case, the FactJunction job will be added to the group named "examples", and will show up in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples
```

job_started_event

When the FactJunction job receives a `job_started_event`, it gets a reference to the MatrixInfo object, which allows it to obtain references to other objects in the grid, such as Users, Resources, Jobs, etc. (see lines 28, 32, 37, 42, 46, and 53 in "factJunction.jdl" on page 195). If these objects

don't exist in the grid, they are immediately created so they can be used later on (see lines 34, 39, 44, 48, 55, and 62).

After references exist for the various objects in the grid, values for other objects are printed out using the fact junctions that exist on each object (see lines 69-154 in factJunction.jdl (page 195)).

There are several instances where the FactJunction job uses “array notation” to handle fact junctions that contain multiple values (see lines 76, 78, 89, 102, 104, 106, 108, 128, 130, 132, 142, 144, 146, and 153 in factJunction.jdl (page 195)). As previously explained, fact junctions are special facts because their value contains the name of another object that must exist in the grid. However, fact junctions don't always contain a single name. Some fact junctions allow for an array of names to be specified. For example, the value for the fact “job.groups” is supplied as a String array.

In this case, the fact junction can be refined using array notation, which allows for the selection of one of the values. For example, the following code retrieves the ID of the group named “myGroup”, which is one of the groups the given job is a member of:

```
job.getFact("job.groups[myGroup].id")
```

joblet_started_event

The FactJunction job only illustrates using fact junctions to retrieve information about objects in the grid. Therefore, no work is performed on the resource by the FactJunction joblet.

Configure and Run

To run this example, you must have ZENworks Orchestrator installed and configured properly. No agents on separate resources are required. You also must be logged into your Orchestrator server before you run `zosadmin` or `zos` commands.

Execute the following commands to deploy and run factJunction.job:

1. Deploy factJunction.job into the grid:

   ```
   > zosadmin deploy factJunction.job
   ```

2. Display the list of deployed jobs:

   ```
   > zos joblist
   ```

   factJunction should appear in this list.

3. Run the FactJunction job, and view the results:

   ```
   > zos run factJunction
   JobID: vmmanager.factJunction.421
   > zos log factJunction
   > zos status vmmanager.factJunction.421
   Completed

   > zos log factJunction
   ```

4. Testing User fact junctions:

   1. `user.accountinggroup.id = all`
   2. `user.privilegedjobgroups[all].id = all`
   3. `user.groups[all].jobcount = 147`

5. Testing Job fact junctions:
    1. `job.accountinggroup.id = all`
    2. `job.resourcegroup.id = all`
    3. `job.groups[all].jobinstances.total = 1`
6. Testing VmHost fact junctions:
    1. `vmhost.resource.id = test`
    2. `vmhost.accountinggroup.id = all`
    3. `vmhost.provisioner.job.id = factJunction`
    4. `vmhost.groups[all].vmcount = 0`
    5. `vmhost.repositories[test].id = test`
    6. `vmhost.vm.available.groups[all].id = all`
    7. `vmhost.vm.instanceids.[vmtest].id = <Not Possible To Test>`
7. Testing Resource fact junctions:
    1. `resource.provisioner.job.id = factJunction`
    2. `resource.vm.repository.id = test`
    3. `resource.provisioner.recommendedhost.id = test_test`
    4. `resource.provision.vmhost.id = <Not Possible To Test`
    5. `resource.provision.template.id = <Not Possible To Test>`
    6. `resource.groups[all].loadaverage = 0.03666666666666667`
    7. `resource.vmhosts[test_test].id = test_test`
    8. `resource.repositories[test].id = test`
    9. `resource.provisioner.instances[vmtest_2].id = <Not Possible To Test>`
8. Testing Repository fact junctions:
    1. `repository.groups[all].id = all`
    2. `repository.vmimages[vmtest].id = vmtest`
    3. `repository.vmhosts[test_test].id = test_test`
    4. `repository.provisioner.jobs[factJunction].id = factJunction`
9. Testing multiple junctions
    1. `repository.vmhosts[test_test].resource.repositories[test].vmhosts[test_test].groups[all].id = all`

See Also

- Adding jobs to groups during deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- View the list of fact junctions available for each object type in a ZENworks Orchestrator grid
- Using array notation to refine multi-valued fact junctions
- Using ZENworkd Orchestrator (“How Do I Interact with ZENworks Orchestrator?”)

jobargs.job

Demonstrates the usage of the various argument types that jobs can accept. These types are integer, Real, Boolean, String, Time, Date, List, Dictionary, and Array (which can contain the types Integer, Real, Boolean, Time, Date, String). For more information about how to define job arguments, and specify their values on the command line, see Section 7.7, “Working with Facts and Constraints,” on page 76.

Usage

```
> zosadmin login --user zosadmin Login to server: skate
Please enter current password for 'zosadmin':
Logged into grid on server 'skate'

> cd /opt/novell/zenworks/zos/server/examples
> zosadmin deploy jobargs.job
jobargs successfully deployed

> zos login --user vmmanager
Please enter current password for 'vmmanager':
 Logged into grid as vmmanager

> zos jobinfo --detail jobargs
Jobname/Parameters    Attributes
------------------    ----------
jobargs                Desc: This example job tests all fact types.

    TimeArgReq         Desc: Required Time arg test
                       Type: Time
                    Default: None! Value must be specified

    IntegerArg         Desc: Integer arg test
                       Type: Integer
                    Default: 1

    DateArg            Desc: Date arg test
                       Type: Date
                    Default: Wed Apr 05 09:00:00 EDT 2006

    RealArgReq         Desc: Required Real arg test
                       Type: Real
                    Default: None! Value must be specified

    IntegerArrayArg    Desc: Integer[] arg test
                       Type: Integer[]
                    Default: [100,200,300]

    RealArrayArg       Desc: Real[] arg test
                       Type: Real[]
                    Default: [1.23,3.456,7.0]

    DictArg            Desc: Dictionary arg test
```

```
                      Type: Dictionary
                   Default: {name=moe, dob=Fri Jan 02 00:00:00 EST
1970,
                            age=35}

    DateArrayArg       Desc: Date[] arg test
                      Type: Date[]
                   Default: [Wed Jul 08 22:00:00 EDT 2009,Thu Jan 02
00:01:00
                            EST 2003]

    StringArgReq       Desc: Required String arg test
                      Type: String
                   Default: None! Value must be specified

    TimeArrayArg       Desc: Time[] arg test
                      Type: Time[]
                   Default: [79200000,60000]

    StringArrayArg     Desc: String[] arg test
                      Type: String[]
                   Default: [abc,def,ghi jkl]

    TimeArg            Desc: Time arg test
                      Type: Time
                   Default: 32400000

    BooleanArgReq      Desc: Required Boolean arg test
                      Type: Boolean
                   Default: None! Value must be specified

    BooleanArg         Desc: Boolean arg test
                      Type: Boolean
                   Default: true

    IntegerArgReq      Desc: Required Integer arg test
                      Type: Integer
                   Default: None! Value must be specified

    StringArg          Desc: String arg test
                      Type: String
                   Default: Hello World

    BooleanArrayArg    Desc: Boolean[] arg test
                      Type: Boolean[]
                   Default: [true,false,true]

    RealArg            Desc: Real arg test
                      Type: Real
                   Default: 3.1415

    ListArg            Desc: List arg test
                      Type: List
                   Default: [abc, d, efghij]
```

```
    DateArgReq         Desc: Required Date arg test
                       Type: Date
                    Default: None! Value must be specified
```

Description

The files that make up the Jobargs job include:

```
jobargs                                              # Total: 210 lines
|-- jobargs.jdl                                      #   63 lines
`-- jobargs.policy                                   #  147 lines
```

jobargs.jdl

```
 1  """
 2  Example job showing all available job argument types.
 3
 4  Example cmd line to run job:
 5       matrix run jobargs TimeArgReq="12:01:02" RealArgReq="3.14"
IntegerArgReq="123" StringArgReq="foo" BooleanArgReq="true"
ListArg="hi,mom"
 6  """
 7
 8  import time
 9
10  #
11  # Add to the 'examples' group on deployment
12  #
13  if __mode__ == "deploy":
14      try:
15          jobgroupname = "examples"
16          jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
17          if jobgroup == None:
18              jobgroup = getMatrix().createGroup(TYPE_JOB,
jobgroupname)
19          jobgroup.addMember(__jobname__)
20      except:
21          exc_type, exc_value, exc_traceback = sys.exc_info()
22          print "Error adding %s to %s group: %s %s" % (__jobname__,
jobgroupname, exc_type, exc_value)
23
24
25  class jobargs(Job):
26
27      def job_started_event(self):
28
29          jobid = self.getFact("jobinstance.id")
30          print "*****Dumping %s JobInstance jobargs facts*****" %
(jobid)
31          keys = self.getFactNames()
32          keys.sort()
33          for s in keys:
34              if s.startswith("jobargs"):
```

```
35                  v = self.getFact(s)
36                  ty = type(v)
37
38                  if str(ty).endswith("Dictionary"):
39                      self.dump_dict(s,v)
40                  else:
41                      if s.endswith("TimeArg") or
s.endswith("TimeArgReq"):
42                          v = time.ctime(v/1000)
43
44                      print "%s %s %s" % (s,type(v),str(v))
45          print "*****End %s dump*****" % (jobid)
46
47          #self.schedule(jobargsJoblet)
48
49      def dump_dict(self,name,dict):
50          print "Dict: %s" % (name)
51          keys = dict.keys()
52          for k in keys:
53              v = dict[k]
54              ty = type(v)
55              if k == "dob":
56                  v = time.ctime(v/1000)
57              print "   %s %s %s" % (k,ty,str(v))
58
59
60  class jobargsJoblet(Joblet):
61
62      def joblet_started_event(self):
63          pass
```

jobargs.policy

```
 1  <policy>
 2
 3       <jobargs>
 4            <fact name="IntegerArg"
 5                  type="Integer"
 6                  description="Integer arg test"
 7                  value="1"
 8                  />
 9
10            <fact name="IntegerArgReq"
11                  type="Integer"
12                  description="Required Integer arg test"
13                  />
14
15            <fact name="RealArg"
16                  type="Real"
17                  description="Real arg test"
18                  value="3.1415"
19                  />
20
21            <fact name="RealArgReq"
```

```
22                type="Real"
23                description="Required Real arg test"
24                />
25
26          <fact name="BooleanArg"
27                type="Boolean"
28                description="Boolean arg test"
29                value="true"
30                />
31
32          <fact name="BooleanArgReq"
33                type="Boolean"
34                description="Required Boolean arg test"
35                />
36
37          <fact name="StringArg"
38                type="String"
39                description="String arg test"
40                value="Hello World"
41                />
42
43          <fact name="StringArgReq"
44                type="String"
45                description="Required String arg test"
46                />
47
48          <fact name="TimeArg"
49                type="Time"
50                description="Time arg test"
51                value="9:00 AM"
52                />
53
54          <fact name="TimeArgReq"
55                type="Time"
56                description="Required Time arg test"
57                />
58
59          <fact name="DateArg"
60                type="Date"
61                description="Date arg test"
62                value="04/05/06 9:00 AM"
63                />
64
65          <fact name="DateArgReq"
66                type="Date"
67                description="Required Date arg test"
68                />
69
70          <fact name="ListArg"
71                description="List arg test">
72            <list>
73                <listelement value="abc" />
74                <listelement value="d" />
75                <listelement value="efghij" />
```

```
 76              </list>
 77            </fact>
 78
 79            <fact name="DictArg"
 80                  description="Dictionary arg test">
 81              <dictionary>
 82                 <dictelement key="name" type="String" value="moe"
/>
 83                  <dictelement key="age" type="Integer" value="35" />
 84                    <dictelement key="dob" type="Date" value="01/02/
70" />
 85              </dictionary>
 86            </fact>
 87
 88            <fact name="IntegerArrayArg"
 89                  description="Integer[] arg test">
 90              <array>
 91                  <integer>100</integer>
 92                  <integer>200</integer>
 93                  <integer>300</integer>
 94              </array>
 95            </fact>
 96
 97            <fact name="RealArrayArg"
 98                  description="Real[] arg test">
 99              <array>
100                  <real>1.23</real>
101                  <real>3.456</real>
102                  <real>7</real>
103              </array>
104            </fact>
105
106            <fact name="BooleanArrayArg"
107                  description="Boolean[] arg test">
108              <array>
109                  <boolean>true</boolean>
110                  <boolean>false</boolean>
111                  <boolean>true</boolean>
112              </array>
113            </fact>
114
115            <fact name="TimeArrayArg"
116                  description="Time[] arg test">
117              <array>
118                  <time>10:00 PM</time>
119                  <time>12:01 AM</time>
120              </array>
121            </fact>
122
123            <fact name="DateArrayArg"
124                  description="Date[] arg test">
125              <array>
126                  <date>07/08/09 10:00 PM</date>
```

```
127                   <date>01/02/03 12:01 AM</date>
128               </array>
129            </fact>
130
131            <fact name="StringArrayArg"
132                  description="String[] arg test">
133               <array>
134                   <string>abc</string>
135                   <string>def</string>
136                   <string>ghi jkl</string>
137               </array>
138            </fact>
139       </jobargs>
140
141       <job>
142            <fact name="description"
143                  type="String"
144                 value="This example job tests all fact types." />
145       </job>
146
147  </policy>
```

Schedule File (optional)

Classes and Methods

Definitions:

Job

A representation of a running job instance.

Joblet

Defines execution on the resource.

MatrixInfo

A representation of the matrix grid object, which provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in `getMatrix()` function. Write capability is dependent on the context in which `getMatrix()` is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

GroupInfo

A representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group.

Job Details

The Jobargs job performs its work by handling the following events:

- “zosadmin deploy” on page 209
- “job_started_event” on page 209

- “joblet_started_event” on page 209

zosadmin deploy

In jobargs.jdl (page 204), lines 10-229 deploy the job into the grid. After jobs are deployed into the grid, they can optionally be placed in groups for organization and easy reference. In this case, the jobargs job will be added to the group named “examples”, and will show up in the ZENworks Orchestrator Console in the Explorer panel at the location:

```
/ZOS/YOUR_GRID/Jobs/examples
```

For a general overview of how jobs are added to groups during deployment, see Deploying a Sample Job (http://www.novell.com/documentation/zen_orchestrator11/zos11_admin/data/bbnt24e.html).

job_started_event

After the Jobargs job receives a job_started_event, it gets a list of all the facts available to it, as shown in line 31 of jobargs.jdl (page 204). This list is sorted, filtered according to whether or not it’s a jobarg fact, and then enumerated (lines 32-42). Each jobarg fact is printed in a “name type value” format. When the complex Dictionary type is encountered (line 38), a separate method is used to print the values for all the key-value pairs (lines 49-57).

The list of optional and required arguments for this Jobargs example are available as facts within the <jobargs> section (see lines 3-139 in jobargs.policy (page 205)).

For more information about defining job arguments and their types, see Developing Policies (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/data/b9j1vd2.html) and Policy Management (http://www.novell.com/documentation/zen_orchestrator11/zos11_developer/data/baba5sr.html).

joblet_started_event

The Jobargs job only illustrates passing job arguments to a job. Therefore, no work is performed on the resource by the jobargsJoblet.

Configure and Run

To run this example, you must have ZENworks Orchestrator installed and configured properly. No agents on separate resources are required. You also must be logged into your Orchestrator server before you run `zosadmin` or `zos` commands.

Execute the following commands to deploy and run `jobargs.job`:

1. Deploy jobargs.job into the grid:

   ```
   > zosadmin deploy jobarg.job
   ```

   NOTE: Run zosadmin login to log in for zos administration.

2. Display the list of deployed jobs:

   ```
   > zos joblist
   ```

   jobargs should appear in this list.

   NOTE: Run `zos login` to run zos client jobs.

3 Display the list of optional and required arguments for this job:

```
> zos jobinfo jobargs
```

4 Run the jobargs job and view the results.

NOTE: You must supply values for TimeArgReq, RealArgReq, StringArgReq, BooleanArgReq, IntegerArgReq, and DateArgReq as follows (see jobargs.policy (page 205) for the full list of arguments that can be specified):

```
> zos run jobargs TimeArgReq=12:01:02 RealArgReq=3.14
StringArgReq=Hello BooleanArgReq=True IntegerArgReq=42
DateArgReq="04/05/07 7:45 AM"
zos log jobargs
```

See Also

- Adding Jobs to Groups During Deployment (see how the JDL code can print the ID of group of jobs in factJunction.job (page 194)).
- Defining job arguments and their types
- Using ZENworkd Orchestrator (“How Do I Interact with ZENworks Orchestrator?”)

Orchestrator Client SDK

A

This section provides the reference information for the internal Java classes used by the Novell® ZENworks Orchestrator® Client:

- Section A.1, “Gridion Package,” on page 211
- Section A.2, “Gridion Datagrid Package,” on page 216
- Section A.3, “Gridion Constraint Package,” on page 217
- Section A.4, “Gridion Toolkit Package,” on page 221

A.1 Gridion Package

The Java classes included in the Gridion package form the basis of the ZENworks Orchestrator infrastructure. For complete documentation of each class, click on the links to access the online documentation Javadoc.

- Section A.1.1, “AgentListener,” on page 212
- Section A.1.2, “ClientAgent,” on page 212
- Section A.1.3, “Credential,” on page 212
- Section A.1.4, “Fact,” on page 212
- Section A.1.5, “FactSet,” on page 212
- Section A.1.6, “GridObjectInfo,” on page 212
- Section A.1.7, “ID,” on page 213
- Section A.1.8, “JobInfo,” on page 213
- Section A.1.9, “Message,” on page 213
- Section A.1.10, “Message.Ack,” on page 213
- Section A.1.11, “Message.AuthFailure,” on page 213
- Section A.1.12, “Message.ClientResponseMessage,” on page 213
- Section A.1.13, “Message.Event,” on page 213
- Section A.1.14, “Message.GetGridObjects*,” on page 214
- Section A.1.15, “Message.GridObjects*,” on page 214
- Section A.1.16, “Message.JobAccepted *,” on page 214
- Section A.1.17, “Message.JobError*,” on page 214
- Section A.1.18, “Message.JobFinished *,” on page 214
- Section A.1.19, “Message.JobIdEvent*,” on page 214
- Section A.1.20, “Message.JobInfo*,” on page 214
- Section A.1.21, “Message.Jobs*,” on page 215
- Section A.1.22, “Message.JobStarted *,” on page 215
- Section A.1.23, “Message.JobStatus *,” on page 215
- Section A.1.24, “Message.LoginFailed*,” on page 215

- Section A.1.25, “Message.LoginSuccess*,” on page 215
- Section A.1.26, “Message.LogoutAck *,” on page 215
- Section A.1.27, “Message.RunningJobs*,” on page 215
- Section A.1.28, “Message.ServerStatus *,” on page 216
- Section A.1.29, “Priority*,” on page 216
- Section A.1.30, “WorkflowInfo*,” on page 216

A.1.1 AgentListener

Provides the interface necessary for processing messages sent from the Orchestrator Server.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.2 ClientAgent

API for client communication with server for job and datagrid operations.

For complete documentation, see ClientAgent (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/ClientAgent.html).

A.1.3 Credential

A Credential used for identity on the GMS system.

For complete documentation, see Credential (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Credential.html).

A.1.4 Fact

The Grid Fact object.

For complete documentation, see Fact (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Fact.html).

A.1.5 FactSet

Definition of a set of facts.

For complete documentation, see FactSet (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/FactSet.html).

A.1.6 GridObjectInfo

Client interface to any GMS grid object.

For complete documentation, see GridObjectInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/GridObjectInfo.html).

A.1.7 ID

A unique identifier for an engine or a facility or Grid object.

For complete documentation, see ID (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/ID.html).

A.1.8 JobInfo

The interface decribing details about a deployed job.

For complete documentation, see JobInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/JobInfo.html).

A.1.9 Message

The Message interface is a base interface for all the messages in the system.

For complete documentation, see Message (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Message.html).

A.1.10 Message.Ack

A general acknowlegement of "action" message.

For complete documentation, see Message.Ack (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Message.Ack.html).

A.1.11 Message.AuthFailure

Authentication failure messages indicates that processing of a client message will not occur because client credentials are invalid.

For complete documentation, see Message.AuthFailure (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Message.AuthFailure.html).

A.1.12 Message.ClientResponseMessage

MessageAll messages that can optionally carry an error string back to the client extend this.

For complete documentation, see Message.ClientResponseMessage (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Message.ClientResponseMessage.html).

A.1.13 Message.Event

An Event is used to signal clients and workflows.

For complete documentation, see Message.Event (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/Message.Event.html).

A.1.14 Message.GetGridObjects*

Client request to retrieve an (optionally ordered) set of grid objects that match a search criteria (constraint).

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.15 Message.GridObjects*

Server response to client request to retrieve grid a grid object set.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.16 Message.JobAccepted*

A JobAccepted message is sent in response to a RunJob message when a job is successfully accepted into the system.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.17 Message.JobError*

A JobError message is sent when an unrecoverable error occurs in a job.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.18 Message.JobFinished*

A JobFinished message is sent when processing of a job completes.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.19 Message.JobIdEvent*

Base Event interface for retrieving JobID used for jobid messages.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.20 Message.JobInfo*

A JobInfo message contains information describing a deployed job.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.21 Message.Jobs*

A Jobs messages contains a list of deployed job names.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.22 Message.JobStarted*

A JobStarted message is sent when a job is successfully started.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.23 Message.JobStatus*

A JobStatus message contains the state of the specified job.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.24 Message.LoginFailed*

Response message for an unsuccessful login

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.25 Message.LoginSuccess*

Response message for a successful login.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.26 Message.LogoutAck*

A LogoutAck indicates success or failure of logout operation.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.27 Message.RunningJobs*

A RunningJobs message contains the list of running jobs.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.28 Message.ServerStatus*

A ServerStatus message.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.29 Priority*

Priority information.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.1.30 WorkflowInfo*

A WorkflowInfo can represent either a snapshot of a running instance or an historical record of an instance.

For complete documentation, see AgentListener (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/class-use/AgentListener.html).

A.2 Gridion Datagrid Package

The following Java files form the classes, interfaces, and exceptions for the internal Orchestrator datagrid structure:

- Section A.2.1, “DGLogger,” on page 216
- Section A.2.2, “GridFile,” on page 216
- Section A.2.3, “GridFileFilter,” on page 217
- Section A.2.4, “GridFileNameFilter,” on page 217
- Section A.2.5, “DataGridException,” on page 217
- Section A.2.6, “DataGridNotAvailableException,” on page 217
- Section A.2.7, “GridFile.CancelException,” on page 217

A.2.1 DGLogger

Definitions of the DataGrid Logger options used for multicast.

For complete documentation of the class, see DGLogger (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/DGLogger.html).

A.2.2 GridFile

Specifies the ZENworks Orchestrator Data Grid interface for individual files and directories.

For complete documentation of the class, see GridFile (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/GridFile.html).

A.2.3 GridFileFilter

Filter for accepting/rejecting file names in a directory list.

For complete documentation of the class, see GridFileFilter (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/GridFileFilter.html).

A.2.4 GridFileNameFilter

Filter for accepting/rejecting file names in a directory list.

For complete documentation of the class, see GridFileNameFilter (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/GridFileNameFilter.html).

A.2.5 DataGridException

General exception class for Data Grid errors.

For complete documentation of the class, see DataGridException (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/DataGridException.html).

A.2.6 DataGridNotAvailableException

Exception thrown if the data grid cannot be reached due to a network error.

For complete documentation of the class, see DataGridNotAvailableException (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/DataGridNotAvailableException.html).

A.2.7 GridFile.CancelException

Exception thrown by cancelled requests.

For complete documentation of the class, see GridFile.CancelException (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/dataGrid/GridFile.CancelException.html).

A.3 Gridion Constraint Package

The following Java files form the interfaces and exceptions for the internal Orchestrator constraint grid structure:

- Section A.3.1, “AndConstraint,” on page 218
- Section A.3.2, “BetweenConstraint,” on page 218
- Section A.3.3, “BinaryConstraint,” on page 218
- Section A.3.4, “Constraint,” on page 218
- Section A.3.5, “ContainerConstraint,” on page 219
- Section A.3.6, “ContainsConstraint,” on page 219

- Section A.3.7, “ConstraintException,” on page 219
- Section A.3.8, “DefinedConstraint,” on page 219
- Section A.3.9, “EqConstraint*,” on page 219
- Section A.3.10, “GeConstraint*,” on page 219
- Section A.3.11, “GtConstraint*,” on page 219
- Section A.3.12, “IfConstraint*,” on page 220
- Section A.3.13, “LeConstraint*,” on page 220
- Section A.3.14, “LtConstraint*,” on page 220
- Section A.3.15, “NeConstraint*,” on page 220
- Section A.3.16, “NotConstraint*,” on page 220
- Section A.3.17, “OperatorConstraint*,” on page 220
- Section A.3.18, “OrConstraint*,” on page 220
- Section A.3.19, “TypedConstraint*,” on page 221
- Section A.3.20, “UndefinedConstraint*,” on page 221

A.3.1 AndConstraint

Perform a logical and-ing of all child constraints.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.2 BetweenConstraint

Binary Operator Constraints that have both a left and right side.

For complete documentation of the class, see BetweenConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/BetweenConstraint.html).

A.3.3 BinaryConstraint

Binary Operator Constraints that have both a left and right side.

For complete documentation of the class, see BinaryConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/BinaryConstraint.html).

A.3.4 Constraint

Basic Constraint interface which allows traversal and evaluation of a constraint tree.

For complete documentation of the class, see Constraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/Constraint.html).

A.3.5 ContainerConstraint

Constainer constraints that perform logical aggregation operations on contained constraints.

For complete documentation of the class, see ContainerConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.6 ContainsConstraint

Performs a simple set operation that returns true is the right side of the operation is found in the value set of the left side.

For complete documentation of the class, see ContainsConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/ContainsConstraint.html).

A.3.7 ConstraintException

For exceptions that occur in parsing or executing constraints.

For complete documentation of the class, see ConstraintException (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/ConstraintException.html).

A.3.8 DefinedConstraint

Evaluates to true only if the left side fact is defined in the match context.

For complete documentation of the class, see DefinedConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/DefinedConstraint.html).

A.3.9 EqConstraint*

Performs a equality constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.10 GeConstraint*

Performs a 'greater than or equal to' constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.11 GtConstraint*

Performs a 'greater than' constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.12 IfConstraint*

Perform a conditional if,then,else block.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.13 LeConstraint*

Performs a 'less than or equal to' constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.14 LtConstraint*

Performs a 'less than' constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.15 NeConstraint*

Performs a not equal constraint operation.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.16 NotConstraint*

Perform a logical not operation of all the child constraints.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.17 OperatorConstraint*

Operator constraints that perform camparision operation on facts.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.18 OrConstraint*

Perform a logical or-ing operation of all the child constraints.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.19 TypedConstraint*

Typed constraint must only be used as the outermost wrapper when it is necessary to override the default constraint type of 'resource'.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.3.20 UndefinedConstraint*

Evaluates to true only if the left side fact is not defined in the match contect.

For complete documentation of the class, see AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/constraint/AndConstraint.html).

A.4 Gridion Toolkit Package

The Client agent, Constraint, and Credentials factory patterns used internally by Orchestrator Server:

- Section A.4.1, “ClientAgentFactory,” on page 221
- Section A.4.2, “ConstraintFactory*,” on page 221
- Section A.4.3, “CredentialFactory*,” on page 221

A.4.1 ClientAgentFactory

Factory pattern used to create new clients for connection to a GMS server.

For complete documentation of the class, see ClientAgentFactory (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/toolkit/ClientAgentFactory.html).

A.4.2 ConstraintFactory*

Factory pattern used to create constraint objects which may be combined into larger constraint hierarchies for use in searches or other constraint based matching.

For complete documentation of the class, see ClientAgentFactory (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/toolkit/ClientAgentFactory.html).

A.4.3 CredentialFactory*

Factory pattern used to create a Credential used for connection to a GMS server.

For complete documentation of the class, see ClientAgentFactory (http://www.novell.com/documentation/zen_orchestrator11/reference/javadoc/com/gridion/toolkit/ClientAgentFactory.html).

Orchestrator Job Classes and JDL Syntax

B

- Section B.1, “Job Class,” on page 223
- Section B.2, “Joblet Class,” on page 223
- Section B.3, “Utility Classes,” on page 223
- Section B.4, “Built-in JDL Functions,” on page 223
- Section B.5, “Job State Field Values,” on page 224
- Section B.6, “Repository Information String Values,” on page 225
- Section B.7, “Joblet State Values,” on page 226
- Section B.8, “Resource Information Values,” on page 226
- Section B.9, “JDL Class Definitions,” on page 227

B.1 Job Class

To review the detailed JDL structure of the joblet class, see Job (page 265).

B.2 Joblet Class

To review the detailed JDL structure of the joblet class, see Joblet (page 276).

B.3 Utility Classes

The following are some of the main utility JDL classes you can use to customize your Orchestrator jobs:

- DataGrid (page 243)
- Exec (page 249)
- MatrixInfo (page 286)
- ResourceInfo (page 298)
- RunJobSpec (page 302)
- ScheduleSpec (page 305)

B.4 Built-in JDL Functions

The following files define some of the built-in ZENworks Orchestrator JDL variables and functions:

getMatrix

Returns the matrix grid object. See MatrixInfo (page 286).

Description

The matrix object is used to retrieve other grid objects in the system.

Built-in Variables: Constants for grid object type:

```
TYPE_USER
TYPE_JOB
TYPE_RESOURCE
TYPE_VMHOST
TYPE_REPOSITORY
TYPE_USERGROUP
TYPE_JOBGROUP
TYPE_RESOURCEGROUP
TYPE_REPOSITORYGROUP

__mode__
            String Defines the execution mode
            Values:   "parse" ,  "deploy",  "undeploy",  "runtime"

__jobname__
            String Defines name of deployed job
```

Constructor

getMatrix(): Returns a matrix grid object.

Methods

system(cmd)

Executes a system command in a shell on the resource. The command is passed to the operating system's default command interpreter. On Microsoft Windows systems this is cmd.exe, while on POSIX systems, this is `/bin/sh`. Stdout and stderr are directed to the job log. No access to stdin is provided.

Returns: exit code result of command execution.

See Also

See MatrixInfo (page 286).

B.5 Job State Field Values

Here are the job state field values for the Job (page 265) class:

Constant	Value	Description
int CANCELLED_STATE	9	Cancelled end state.
int CANCELLING_STATE	6	Cancelling. Transistions to: Cancelled.
int COMPLETED_STATE	8	Completed end state.
int COMPLETING_STATE	5	Completing. Transitions to: Completing.
int FAILED_STATE	10	Failed end state.
int FAILING_STATE	7	Failing. Transitions to: Failed.
int PAUSED_STATE	4	Paused. Transitions to: Running/Completing/ Failing/Cancelling.
int QUEUED_STATE	1	Queued. Transitions to: Starting/Failing/ Cancelling.
int RUNNING_STATE	3	Running. Transistions to: Paused/Completing/ Failing/Cancelling.
int STARTING_STATE	2	Starting. Transistions to: Running/Failing/ Cancelling.
int SUBMITTED_STATE	0	Submitted. Transitions to: Queued/Failing.
String TERMINATION_TYPE_ADMIN	“Admin"	Indicates Job was cancelled by the admin and pnly applies if Job is in CANCELLED_STATE. Value is obtained from `jobinstance.terminationtype fact`.
String TERMINATION_TYPE_JOB	“Job”	Indicates Job was cancelled due to exceeding the job timeout value and only applies if Job is in CANCELLED_STATE. The value is obtained from `jobinstance.terminationtype fact`.
String TERMINATION_TYPE_TIMEOUT	“Timeout”	Indicates Job was cancelled due to exceeding the job timeout value and only applies if Job is in CANCELLED_STATE. Value is obtained from `jobinstance.terminationtype fact`.
String TERMINATION_TYPE_USER	“User”	Indicate Job was cancelled by client user and only applies if Job is in CANCELLED_STATE. The value is obtained from `jobinstance.terminationtype fact`.

B.6 Repository Information String Values

Constant	Value	Description
SAN_TYPE_FibreChannel	Fibre Channel	Specifies a fibre channel SAN repository.
SAN_TYPE_ISCSI	iSCSI	Specifies an iSCSI SAN repository.
SAN_VENDOR_IQN	iqn	Specifies an IQN SAN repository.

Constant	Value	Description
SAN_VENDOR_NPIV	npiv	Specifies a N_Port ID Virtualization SAN repository.
TYPE_DATAGRID	datagrid	Specifies a datagrid repository.
TYPE_LOCAL	local	Specifies a local repository.
TYPE_NAS	NAS	Specifies a NAS repository.
TYPE_SAN	SAN	Specifies a SAN repository.
TYPE_VIRTUAL	virtual	Specifies a virtual repository.
TYPE_WAREHOUSE	warehouse	Specifies a warehouse repository.

B.7 Joblet State Values

The following values are defined for the various states that the joblet can be in:

Constant	Value	Description
INITIAL_STATE	0	Joblet initial state.
WAITING_STATE	1	Joblet waiting for a resource
WAITING_RETRY_STATE	2	Joblet waiting for a resource for retry.
CONTRACTED_STATE	3	Joblet waiting for a resource for retry.
STARTED_STATE	4	Joblet started on a resource.
PRE_CANCEL_STATE	5	Joblet starting cancellation.
CANCELLING_STATE	6	Joblet cancelling.
POST_CANCEL_STATE	7	Joblet finishing cancellation.
COMPLETING_STATE	8	Joblet completing state.
FAILING_STATE	9	Joblet failing state.
FAILED_STATE	11	Joblet failed end state.
CANCELLED_STATE	12	Joblet cancelled end state.
COMPLETED_STATE	13	Joblet completed end state.

See Joblet (page 276).

B.8 Resource Information Values

Use the following values to specify the

Constant	Value Type	Resource Description
TYPE_BM_INSTANCE	String	Blade server.

Constant	Value Type	Resource Description
TYPE_BM_TEMPLATE	String	Blade server template.
TYPE_FIXED_PHYSICAL	String	Fixed physical server.
TYPE_VM_INSTANCE	String	VM server.
TYPE_VM_TEMPLATE	String	VM template.

For full class descriptions, see ResourceInfo (page 298).

B.9 JDL Class Definitions

The following Orchestrator JDL classes can be implemented in the custom jobs that you create. Because JDL is implemented in Java, we have provided direct links to detailed Javadoc for each of the "Pythonized" JDL classes below:

- "AndConstraint()" on page 229
- "BinaryConstraint" on page 231
- "CharRange" on page 233
- "ComputedFact" on page 235
- "ComputedFactContext" on page 237
- "Constraint" on page 239
- "ContainerConstraint" on page 240
- "ContainsConstraint" on page 241
- "DataGrid" on page 243
- "DefinedConstraint" on page 247
- "EqConstraint" on page 248
- "Exec" on page 249
- "ExecError" on page 255
- "FileRange" on page 256
- "GeConstraint" on page 258
- "GridObjectInfo" on page 259
- "GroupInfo" on page 262
- "GtConstraint" on page 263
- "Job" on page 265
- "JobInfo" on page 275
- "Joblet" on page 276
- "JobletInfo" on page 280
- "JobletParameterSpace" on page 282
- "LeConstraint" on page 284
- "LtConstraint" on page 285

- "MatrixInfo" on page 286
- "NeConstraint" on page 290
- "NotConstraint" on page 291
- "OrConstraint" on page 292
- "ParameterSpace" on page 293
- "PolicyInfo" on page 294
- "ProvisionSpec" on page 295
- "RepositoryInfo" on page 297
- "ResourceInfo" on page 298
- "RunJobSpec" on page 302
- "ScheduleSpec" on page 305
- "Timer" on page 307
- "UndefinedConstraint" on page 308
- "UserInfo" on page 309
- "VMHostInfo" on page 310
- "VmSpec" on page 311

AndConstraint()

Representation of the And Constraint. Perform a logical ANDing of all child constraints. If this constraint contains no children, no operation is performed. Constraints are added to this constraint using `add()`.

Constructor

AndConstraint(GridObjectInfo): Constructs a default AndConstraint.

Methods

Inherited from ContainerConstraint class:

add(Constraint constraint)

Adds a constraint as a child of this constraint.

Parameters: constraint - Child constraint to add.

Inherited from Constraint class:

getFact()

Retrieves the fact id of the left side of the operation.

getFactValue()

If set with `setFactValue()`, retrieves the fact name whose value is used on the right side of the operation, otherwise this will return None.

getReason()

Retrieves the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to False.

getValue()

If set as a value, retrieves the value of the right side of the operation, otherwise it returns null.

setFact(String fact)

Sets the fact identification string for the left side of the operation.

setFactValue(String factvalue)

Sets the fact name whose value is used in the right side of the operation and, in doing so, negates any previous `setValue()` call.

setReason(String reason)

Retrieves the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to false.

setValue(Object value)

Sets the value of the right side of the operation and, in doing so, negates any previous `setFactValue()` call.

See Also

- ContainerConstraint (page 240)
- Javadoc: AndConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/AndConstraint.html)

BinaryConstraint

Representation of a Constraint operating on the left and right operands. This is a base class and is not directly constructed. Direct known subclasses include:

Fields

Summary:

MATCH_MODE_EXACT (0)

Exactly match the left and right sides of operation.

MATCH_MODE_REGEXP (1)

If possible, performs a regular expresion matching by treating the right side of the operation as a regular expression.This is only considered for String arguments.

MATCH_MODE_GLOB (2)

If possible, performs a glob-style matching by treating the right side of the operation as a glob expression. This is only considered for String arguments.

Methods

Summary:

getMatchMode()

Retrieves the match mode for this binary constraint operation.

setMatchMode(int matchMode)

Sets the match mode used by some individual binary operator constraints. The match mode only has effect if the operator supports the specified type and the type of the left and right side of the operation are compatible with the mode otherwise the default of MATCH_MODE_EXACT is assumed.

Inherited from Constraint class:

getFact()

Retrieves the fact id of the left side of the operation.

getFactValue()

If set with setFactValue(), retrieves the fact name whose value is used on the right side of the operation, otherwise this will return None.

getReason()

Retrieves the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to False.

getValue()

If set as a value, retrieves the value of the right side of the operation, otherwise it returns null.

setFact(String fact)

Sets the fact identification string for the left side of the operation.

setFactValue(String factvalue)

Sets the fact name whose value is used in the right side of the operation and, in doing so, negates any previous setValue() call.

setReason(String getReason())

Retrieves the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to false.

setValue(Object value)

Sets the value of the right side of the operation and, in doing so, negates any previous setFactValue() call.

See Also

- Subclasses: ContainsConstraint (page 241), EqConstraint (page 248), GeConstraint (page 258), GtConstraint (page 263), LeConstraint (page 284), LtConstraint (page 285), NeConstraint (page 290).
- Javadoc: BinaryConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/BinaryConstraint.html)

CharRange

Defines the attributes for creating a virtual machine. An instance of this class is passed to resource.createInstance(), resource.createTemplate(), resource.clone().

Description

This class represents a set of strings which exist inclusively between an upper and lower boundary string. Strings within the range are ordered as follows:

1. Longer strings always appear after shorter strings. For example, “aaaa” appears after “bbb”. This differs from traditional dictionary order, but is more useful..
2. Strings of the same length are sorted in dictionary order, according to the defined lexical order of the character set.
3. The lexical order of characters is determined by their position in charSet in the constructor.
4. Character orderings are case sensitive. Two characters differing only by case (such as ”a” and “A”) have no special relation to each other. They are completely unique characters.

A typical use of this class is to define a range of character strings and split it up into many smaller subranges for parallel processing. The following is an example of this usage:

```
range = CharRange("ACGT", "", "TTTTTTT");
pspace = ParameterSpace()
pspace.appendDimension("dna",range)
pspace.setMaxJobletSize(10000)
self.schedule(MyJoblet,pspace,())
```

The above code defines a string range consisting of all DNA sequences up to length 7. Then adds the range to a ParameterSpace which sets the split up (JobletSize) into unique subsets of 10000 sequences, and passes to schedule to schedule the parallel processing.

Constructor

CharRange(String charSet, String first, String last): Creates a new string range definition.

Defines a range of strings starting with first and ending with last. Longer strings are "greater than" shorter strings, and lexical ordering among equal-length strings is determined by the ordering of characters in charSet.

If last is "greater than" first then the set is defined in reverse order, such that longer strings appear first, and strings of the same length appear in the reverse lexical order of that defined by charSet.

Parameters: charSet - The character set over which the range is defined. Lexical order of characters is determined by their position in this string, with leftmost characters being ordered first.
first - The first string in the set.
last - The last string in the set..

Raises: Thrown - if first or last contain characters not in charSet.

Methods

Inherited from PySequence class:

```
__delitem__, __delslice__, __eq__, __finditem__, __finditem__, __ge__,
__getitem__, __getslice__, __gt__, __le__, __lt__, __ne__,
__nonzero__, __setitem__, __setitem__, __setslice__, __tojava__,
classDictInit, del, delRange, fastSequence, fixindex, get, getslice,
getStart, getStep, getStop, isMappingType, isNumberType, repeat, set,
setslice, sliceLength
```

Inherited from PyObject class :

```
__abs__, __add__, __and__, __call__, __call__, __call__, __call__,
__call__, __call__, __call__, __call__, __cmp__, __coerce__,
__coerce_ex__, __complex__, __contains__, __delattr__, __delattr__,
__delitem__, __delslice__, __dir__, __div__, __divmod__, __findattr__,
__findattr__, __finditem__, __float__, __getattr__, __getattr__,
__getitem__, __getslice__, __hash__, __hex__, __iadd__, __iand__,
__idiv__, __idivmod__, __ilshift__, __imod__, __imul__, __int__,
__invert__, __ior__, __ipow__, __irshift__, __isub__, __ixor__,
__len__, __long__, __lshift__, __mod__, __mul__, __neg__, __not__,
__oct__, __or__, __pos__, __pow__, __pow__, __radd__, __rand__,
__rdiv__, __rdivmod__, __repr__, __rlshift__, __rmod__, __rmul__,
__ror__, __rpow__, __rrshift__, __rshift__, __rsub__, __rxor__,
__setattr__, __setattr__, __setitem__, __setslice__, __str__, __sub__,
__xor__, _add, _and, _callextra, _cmp, _div, _divmod, _dodel, _doget,
_doget, _doset, _eq, _ge, _gt, _in, _is, _isnot, _jcall, _jcallexc,
_jthrow, _le, _lshift, _lt, _mod, _mul, _ne, _notin, _or, _pow,
_rshift, _sub, _xor, addKeys, equals, getPyClass, hashCode, impAttr,
invoke, invoke, invoke, invoke, invoke, isCallable, isSequenceType,
safeRepr
```

See Also

- Javadoc: CharRange (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/CharRange.html)

ComputedFact

Defines the base class for creating custom computed facts. Computed facts provide the ability to create custom calculations that extend the built-in factsets for a grid object. The computed fact can be in constraints.

User defined computed facts are required to subclass this class. In order to use `ComputedFact`, you must deploy a subclass of `ComputedFact` and then create a linked fact referencing the deployed `ComputedFact`. The linked fact is then used in constraints. See the Example below.

Methods

Summary:

getContext()

Retrieves the context object for this computed fact instance.

The context object allows read-only access to the grid objects in the evaluation context. For example, when a computed fact is evaluated in the context of a Start constraint, the context object provides access to the job instance's factset.

Returns: ComputedFactContext (page 237) for this computed fact evaluation or None if there is no context.

Example

VmSpec here is used for creating a clone on a named host from a template resource:

```
class ActiveFooJobs(ComputedFact):

      def compute(self):
          count = 0
          ctx = self.getContext()
          if ctx == None:
              print "No context"
          else:
              jobInstance = ctx.getJobInstance()
              if jobInstance == None:
                  print "No job instance in context"
              else:
                  activejobs = getMatrix().getActiveJobs()
                  for j in activejobs:
                      state = j.getFact("jobinstance.state.string")
                      if j.getFact("job.id") == "foo" and \
                       j.getFact("user.id") == ctx.getFact("user.id")
and \
                          (state == "Running" or state == "Starting"):
                          count+=1
          return count
```

See Also

- ComputedFactContext (page 237)
- Javadoc: ComputedFact (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ComputedFact.html)

ComputedFactContext

Provides access to the evaluation context. See Example below.

Description

The context contains the grid objects that the constraint engine uses to evaluate constraints.If they are available in the current context, the ComputedFactContext provides access to the current job instance, deployed job, user, resource, VM host, and repository grid objects.

The VM host and repository grid objects are only in the context for the evaluation of the provisioning constraints such as vmHost. The job and job instance objects are only in the context for a resource or allocation constraint evaluation.

Methods

Detail:

jobInfo getJob()

Retrieves the JobInfo grid object from the context for a computed fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a Start constraint, the returned JobInfo grid object provides access to the factset of the deployed job.

Returns: JobInfo grid object for this computed fact evaluation or None if the object is not in the context.

JobInstanceInfo getJobInstance()

Retrieves the JobInstanceInfo grid object from the context for a computed fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a Start constraint, the returned JobInstanceInfo grid object provides access to the factset of the current job instance.

Returns: JobInstanceInfo representing a job instance for this computed fact evaluation or None if the object is not in the context.

RepositoryInfo getRepository()

Retrieves the RepositoryInfo grid object from the context for a computed fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a repository constraint, the returned RepositoryInfo grid object provides access to the factset of a repository.

Returns: RepositoryInfo representing a repository instance for this computed fact evaluation or None if the object is not in the context.

ResourceInfo getResource()

Retrieves the ResourceInfo grid object from the context for a computed fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a resource constraint, the returned ResourceInfo grid object provides access to the factset of the resource.

Returns: ResourceInfo grid object for this computed fact evaluation or None if the object is not in the context.

UserInfo getUser()

Retrieves the UserInfo grid object from the context for a computed fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a Start constraint, the returned UserInfo grid object provides access to the factset of the user who started the job.

Returns: UserInfo grid object for this computed fact evaluation or None if object is not in the context.

VMHostInfo getVmHost()

Retrieves the VmHostInfo grid object from the context for a Computed Fact evaluation.

The returned grid object allows read-only access to its factset. For example, when a computed fact is evaluated in the context of a vm host constraint, the returned VmHostInfo grid object provides access to the factset of a vm host.

Returns: UserInfo grid object for this computed fact evaluation or None if object is not in the context.

Example

How to retrieve the current job instance in which a computed fact is being executed during a resource constraint:

```
      class myComputedFact(ComputedFact):
          def compute(self):
              ctx = self.getContext()
              if ctx == None:
                  print "No context"
                  ...
              else:
                  jobInstance = ctx.getJobInstance()
                  if jobInstance == None:
                      print "No job instance in context"
                      ...
                  else:
                      print "jobInstance.id=%s" %
(jobInstance.getFact("jobinstance.id"))
```

See Also

- ComputedFact (page 235)
- Javadoc: ComputedFactContext (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ComputedFactContext.html)

Constraint

Defines the base class for all constraint classes.

Constructor

VmSpec(GridObjectInfo): Constructs a default VmSpec.

Methods

Detail:

getFact()

Retrieves the fact id of the left side of the operation.Returns the fact id.

getFactValue()

If set with setFactValue(), retrieves the fact name whose value is used on the right side of the operation, otherwise this will return None.

getReason()

Retrieves the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to False.

getValue()

If set as a value, retrieves the value of the right side of the operation or else it returns null.

setFact(String fact)

Sets the fact ID for the left side of the operation.

setFactValue(String factvalue)

Sets the fact name whose value is used in the right side of the operation and, in doing so, negates any previous setValue() call.

setReason(String reason)

Sets the reason string that contains the human readable explanation that can be displayed as an error when a constraint evaluates to false.

setValue(Object value)

Sets the value of the right side of the operation and, in doing so, negates any previous setFactValue() call.

See Also

- BinaryConstraint (page 231), ContainerConstraint (page 240), DefinedConstraint (page 247), UndefinedConstraint (page 308).
- Javadoc: Constraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/Constraint.html)

ContainerConstraint

Representation of a Constraint that contains other Constraints. This is a base class and is not directly constructed.

Constructor Summary

```
ContainsConstraint()
```

Methods

Summary:

add(Constraint constraint)

Add a constraint as a child of this constraint.

See Constraint (page 239) class.

See Also

- Subclasses: AndConstraint() (page 229), NotConstraint (page 291), OrConstraint (page 292)
- Javadoc: ContainerConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ContainerConstraint.html)

ContainsConstraint

Representation of the Contains Constraint. Evaluates to true only if the left side fact is defined in the match context. If the left side is not defined, this will evaluate to False. Contains is typically used to check membership of a value in a group fact.

Constructor

ContainsConstraint(): Constructs a default constraint.

Fields Inherited from Binary Constraint

Summary:

MATCH_MODE_EXACT (0)

Exactly match the left and right sides of operation.

MATCH_MODE_REGEXP (1)

If possible, performs a regular expresion matching by treating the right side of the operation as a regular expression.This is only considered for String arguments.

MATCH_MODE_GLOB (2)

If possible, performs a glob-style matching by treating the right side of the operation as a glob expression. This is only considered for String arguments.

See BinaryConstraint (page 231).

Methods

Summary:

validate()

Overrides: validate in class BinaryConstraint.

Inherited from class com.gridion.jdl.BinaryConstraint

`getMatchMode, setMatchMode`

See BinaryConstraint (page 231).

Inherited from class Constraint

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

Example

Example of building a ContainsConstraint to constrain that a resource belongs to a group:

```
c = ContainsConstraint()
c.setFact("resource.groups")
c.setValue("webserver-group")
```

This constraint can be used independently or added to a AndConstraint>, OrConstraint, NotConstraint to combine with other constraints.

See Also

Javadoc: ContainsConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ContainsConstraint.html)

DataGrid

General interface to the Data Grid. See Chapter 3, “Setting Up a Development Grid,” on page 43.

Description

Interactions with the Data Grid revolve around instances of this class. Operations include copying files from the DataGrid down to the resource for joblet usage and likewise uploading files from a resource to the DataGrid.

A Data Grid URL is the convention for denoting paths in the Data Grid. The Data Grid URL convention is the form grid:///. The gridID is optional and if absent means the default grid. The ^ symbol can be used as a shortcut to the directory either standalone indicating the current job or followed by the jobid to identify a particular job. The ! symbol can be used as a shortcut to the deployed job’s home directory either standalone indicating the current jobs type or followed by the deployed jobs name. The ~ symbol can be used as a shortcut to the users home directory (in the datagrid) either standalone indicating the current user or followed by the desired user id to identify a particular user.

Constructor

DataGrid(GridObjectInfo): Construct a DataGrid instance.

Methods

Summary:

append(String destfile, String value)

Appends the string data to the end of the grid file referenced by this path.

Parameters: destfile - File to append to.
value - String data to append

Raises: Exception - Thrown if a system or configuration error prevents the append of data to the grid file.

copy(String source, String dest)

Obtains the specified source file to the destination.A recursive copy is attempted if `setRecursive(True)` is set. The default is a single file copy. A multicast is attempted if `setMulticast(True)` is set. The default is to do a unicast copy.

delete(String path)

Deletes the file or directory referenced by this path. If this path references a file, then the file is removed from the grid. If a directory is referenced, then the directory is recursively deleted.

Parameters: path - File or directory to delete.

Raises: Exception.

getCache()

Retrieves the Boolean.setting for using cached data or not; if caching, true; otherwise, false.

getDebug()

Retrieves the Boolean value of debug logging. If debug logging is on, true; otherwise false..

getMulticast()

Returns Boolean true if operation is to attempt multicast, otherwise false.

getMulticastFallBack()

If true then fallback to unicast if multicast does not meer the setMulticastMin requirement; false to not fallback.

getMulticastMin()

Retrieves an integer indicating the minimum number of receivers needed in order to multicast. If minimum number is not reached, then unicast is used.

getMulticastMinFileSize()

Retreives the multicast minimum file size; returns the minimum file size for multicasting.

getMulticastQuorum()

Retrieves the number of receivers that constitute a quorum and allow multicast to start.

getMulticastRate()

Retrieves the requested data rate in bytes per second for multicast. Returns the requested data rate in bytes per second.

getMulticastWait()

Retrieves the maximum amount of time a receiver is prepared to wait before start of multicast. Returns the wait time in milliseconds (ms).

mkdir(String dir)

Recursively creates a new empty directory. If no component in the path referenced by this object is a regular file, and the current user has permission to do so, then a directory is created that reflects the current data grid path. Any intermediate subdirectories are automatically created as well.

Parameter: dir - Directory path to create

Raises: Exception

rename(String source, String dest))

Moves a file or directory from one path to another.

Parameter: source - The source to move.
dest - Destination of move

Raises: Exception

rmdir(String dir)

Deletes the file or directory referenced by this path. If this path references a file, then the file is removed from the grid. If a directory is referenced, then the directory is recursively deleted.

Parameter: dir - Directory to delete

Raises: Exception

setCache(boolean caching)

To use cached data or not.\.

Parameter: caching - true to use caching, false to not.

setMulticast(boolean mcast)

Attempts to obtain a file as part of a combined multicast transfer. This only applies to the `copy()` operation.

Behaves the same as a unicast `copy()`, except that an initial attempt is made to fetch the file as part of a multicast to this and potentially many other hosts at the same time. If successful, the total network bandwith consumed by all hosts can be greatly reduced.

If multicasting is not available or not enough hosts are willing to multicast the same file in the specified wait period, then this operation transparently falls back to a normal unicast `copy()` request.

Multicasting is intended for use by a set of nodes running the same job and requesting the same large file from the data grid. The multicastMin, multicastQuorum, and multicatWait are ignored for requests after the first to join any given multicast session.

Multicast also honors caching requests if caching is used.

Paramters: mcast - true to attempt multicast. Default is false.

setMulticastFallBack(boolean mcastFallBack)

If <>true, then a multicast attempt that does not meet the `setMulticastMin` requirement will fall back to a unicast file copy.

Parameters: mcastFallBack - true to fallback to unicast, false to not.

setMulticastMin(int mcastMin)

Sets the minimum number of receivers required in order to proceed with the multicast. If this number is not reached within the "setMulticastWait" time limit, then the receivers will either fall back to unicast or fail, depending on the "setMulticastFallback" option..

Returns: The minimum number of receivers.

setMulticastMinFileSize(long minFileSize)

Sets the multicast minimum file size. If file size is equal to or larger than this limit then it is considered for multcast. If it is smaller, then it is always unicast, despite the setting of setMulticast().

Parameters: minFileSize - The filesize in bytes. Default is 10,000,000 (10M)

setMulticastQuorum(int mcastQuorum)

Sets the number of receivers that constitute a quorum and allow multicast to start.

Once this many receivers join a multicast, the server is free to start sending immediately. A negative or zero value means there is no quorum. The wait time is allowed to fully expire before sending begins.

Parameters: mcastQuorum - The number of receivers.

setMulticastRate(int mcastRate)

Sets the multicast send rate limit in bytes per second. If zero, then the default rate limit defined on the server is used. This value may be capped by a maximum rate limit on the server, as well.

Parameters: mcastRate - The requested data rate in bytes per second.

setMulticastWait(int mcastWait)

Set the number of milliseconds to wait for a more receivers to join the multicast. The multicast will begin if this time expires, or if the "setMulticastQuorum" number of receivers is reached. This allows other hosts to join in the requested multicast. Zero wait means the default wait of 15 seconds. -1 means to wait infinitely.

Parameters: mcastWait - Wait time in milliseconds.

setRecursive(boolean recursive)

Performs recursive copy. Default is to not recurse.

Parameters: recursive - True for the copy() to do a recursive copy, including creating any directories.

Examples

Copies a file from the a Datagrid directory to a local file. This example assumes you have created the directory “newdir” in the DataGrid and have uploaded a file named “results.txt” there:

```
DataGrid().copy("grid:///newdir/results.txt","local.txt")
```

Copies a file from the job instance directory to a local file:

```
DataGrid().copy("grid:///^/results.txt","local.txt")
```

Copies a file from a named job instance directory to a local file:

```
DataGrid().copy("grid:///^user.myjob.1024/
results.txt","local.txt")
```

Copies a local file into the job directory for job 'myjob':

```
DataGrid().copy("local.txt","grid:///!myjob")
```

Copies a local file into a subdir of the job directory:

```
DataGrid().copy("local.txt","grid:///!myjob/subdir")
```

Copies a local file into the current job instance directory:

```
DataGrid().copy("local.txt","grid:///^/")
```

See Also

- GridObjectInfo (page 259)
- Javadoc: DataGrid (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/DataGrid.html)

DefinedConstraint

Representation of the Defined Constraint. Evaluates to true only if the left side fact is defined in the match context. If the left side is not defined, this will evaluate to False. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Constructor

DefinedConstraint(): Constructs a default instance.

Methods

Inherited from Constraint class:

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

- Constraint (page 239), ContainerConstraint (page 240), and ContainsConstraint (page 241)
- Javadoc: DefinedConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/DefinedConstraint.html)

EqConstraint

Representation of the Equals Constraint. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints. Extends BinaryConstraint (page 231).

Constructor

EqConstraint(): Constructs a default equals constraint.

Field Summary

`MATCH_MODE_EXACT, MATCH_MODE_GLOB, MATCH_MODE_REGEXP`

See BinaryConstraint (page 231).

Methods

Inherited from BinaryConstraint class :

`getMatchMode(), setMatchMode`

Inherited from Constraint class:

`See Constraint (page 239): getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue.`

Examples

Example of a Constraint to find resources that are running on Linux:

```
eq = EqConstraint()
eq.setFact("resource.os.family")
eq.setValue("linux")
```

Example of a Constraint to match resource IDs using a regular expression:

```
eq = EqConstraint()
eq.setFact("resource.id")
eq.setValue("webserver*")
eq.setMatchMode(EqConstraint.MATCH_MODE_REGEXP)
```

See Also

- BinaryConstraint (page 231)
- Javadoc: EqConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/EqConstraint.html)

Exec

The Exec class is used to manage command line execution on resources. This class defines options for input, output and error stream handling, and process management including signaling, error and timeout control.

Description

A command's standard output and error can be redirected to a file, to a stream, to write to the job log, or be discarded. By default, the output is discarded. A command's standard input can be directed from a file or a stream can be written to. By default, the input is not used.

By default, command line execution is done in behalf of the job user. Exec instances are only allowed during the running of the Joblet class on a resource. The built-in function system() can also be used for simple execution of command lines. .

Constructor

Exec(): Constructs an Exec instance to run an executable.

Fields

Summary:

Constant	Integer Value
PROCESS_HAS_NOT_BEEN_CREATED	-200
PROCESS_HAS_NOT_EXITED	-100

Methods

Details:

addEnv(String name, String value)

Adds an environment variable to the set of environment variables, which overwrites the existing name and value environmental values.

Parameters: name - Name of environment variable
value - Value of environment variable

close()

Flush and close all input and output streams.

detach()

Detachs a process from a resource.

Used when a joblet starts a process it wants to leave running. If the process has pipes open, then the pipes are closed. The process is not explicitly killed, and may continue to run in the background.

After the process is detached, it is no longer possible to obtain the exit status or to await completion, so this method should only be called when there is no longer any interest in the final result of a command.

execute()

Specifies the integer for the run command. This blocks until the command has completed, or an error or timeout has occurred.

Returns: The exit status value from command execution.

Raises: ExecError if the command is not correctly setup or cannot be executed.

execute1()

Run command and immediately return a stream object for standard input.

Returns: An input stream object representing standard input.

Raises: ExecError if the command is not correctly setup or cannot be executed.

Example: How to write a line of text to standard input:

```
e = Exec()
e.setCommand("mycommand")
input = e.execute1()
input.write("input data")
e.waitFor()
```

execute2()

Run command and immediately return a tuple of stream objects for standard input and standard output. If standard error output is not redirected to a file using setStderrFile() or to the job log, it is discarded. The returned standard output stream will block on read, so use the ready() method to determine if the stream has data available.

Returns: A tuple containing two stream objects representing stdin and stdout of the process.

Raises: ExecError if the command is not correctly setup or cannot be executed.

Example: How to read the stdout stream and write the contents to the job log:

```
e = Exec()
e.setShellCommand("help")
input,output = e.execute2()
while e.isRunning():
     while output.ready():
         c = output.read()
         sys.stdout.write(c)
```

execute3()

Run command and immediately return a tuple of three stream objects for standard input,standard output and standard error. The returned stdout and stderr streams will block on read, so use the ready() method to determine if the stream has data available.

Returns: A tuple containing three stream objects representing stdin, stdout, stderr of the process.

Raises: ExecError if the command is not correctly setup or cannot be executed.

execute4()

Run command and immediately return a tuple of stream objects for standard input and one combined of standard output and standard error. The returned stdout and stderr stream will block on read, so use the ready() method to determine if the stream has data available..

Returns: A tuple containing two stream objects. The first repesenting stdin and the second a combined stdout and stderr stream of the process.

Raises: ExecError if the command is not correctly setup or cannot be executed.

Example: How to read the combined stdout and stderr stream and write the contents to the job log:

```
e = Exec()
e.setShellCommand("help")
input,output = e.execute4()
while e.getExitStatus() < 0:
     while output.ready():
         c = output.read()
         sys.stdout.write(c)
```

getExitStatus()

Retrieves the integer value for the exit status of executable without blocking. If the process has not completed or not started, then the possible values are:

```
PROCESS_HAS_NOT_EXITED          =   -100
PROCESS_HAS_NOT_BEEN_CREATED    =   -200
```

isRunning()

Returns true if the process is still running.

Returns true if the process has not yet exited or terminated abnormally. If the process is killed using one of the termination methods like kill(), this method will continue to return true until the termination is confirmed by the execution manager.

isTimeout()

Check if the process reached the timeout limit defined by setTimeout().

Returns: true if process ended due to reaching the timeout limit.

Example: How to check whether a process has reached the timeout limit:

```
class MyJob(Job):
    def job_started_event(self):
        self.schedule(MyJoblet)

class MyJoblet(Joblet):
    def joblet_started_event(self):
        e = Exec()
        e.setCommand("sleep 62")
        # put a 60 second timeout on this
        e.setTimeout(60)
        e.execute()
        if e.isTimeout():
            print "Command took more than 60 seconds"
```

kill()

Kill the process.

Attempts to stop the process using the forceful system termination signal. This signal cannot be caught or ignored, so unless an error occurs the process will terminate. This has no effect if the process is not running.

Raises: ExecError if it is not possible to send the kill signal.

setUserEnv(boolean userenv)

Sets execution to inherit the user's environment variables. Requires environment variables to be retrieved at job execution. The user environment variables come down with the joblet instance. Default is False.

Parameters: userenv - true to set user environment variables.

setCommand(String cmd)

Defines a system command to execute. The system command is invoked directly without using the system command interpreter.

Parameters: cmd - The system command line to invoke.

setCommand(String[] args)

Define a system command line to execute using a list of strings. This avoids possible errors with trying to parse command lines.

Parameters: args - The list of strings to form a command line.

setDebug(boolean debug)

Show extra debugging information when trying to execute.

Parameters: debug - true to write more information to log. Default is false.

setDir(String dir)

Set the working directory of the process.

Parameters: The path of a working directory.

Raises: Exception - for invalid directory.

setExecutable(String value)

The command to execute.

Parameters: The string to be the executable command.

setUserEnv(boolean userenv)

Set execution to inherit the user's environment variables. Requires environment variables to be retrieved at job execution. The user environment variables come down with the joblet instance. Default is False.

Parameters: The userenv - true to set user environment variables.

setSoftTimeout(int value)

Set a soft timeout in seconds after which the process is sent the SIGUSR1 signal. This setting is used in conjuction with setTimeout(). The soft timeout must be less than the setting for setTimeout().

Parameters: value - Seconds to wait before sending the SIGUSR1 signals.

setStderrFile(String filename)

File that standard error output is directed to. Both stdout and stderr is combined if the same filename is also set with setStdoutOutput().

Parameters: filename - Filename of file to write to.

setStdinFile(String filename)

File that standard Input is directed from.

Parameters: filename - Filename of file to read from.

setStdoutFile(String filename)

File that standard output is directed to. Both stdout and stderr is combined if the same filename is also set with setStderrOutput().

Parameters: filename - Filename of file to write to.

setTimeout(int value)

Set a timeout in seconds after which the process is killed.

isTimeout() will return true if a prcoess is terminated due to exceeding this timeout limit. The timer starts after execute() has been called and the underlying process has started. .

Parameters: value - Seconds to wait before terminating the process.

setUserEnv(boolean userenv)

Set execution to inherit the user's environment variables. Requires environment variables to be retrieved at job execution. The user environment variables come down with the joblet instance. Default is False..

Parameters: userenv - true to set user environment variables.

signal(int sig)

Send a signal to the process using a signal number.

Parameters: sig - the signal number, e.g. 1 for SIGHUP, 12 for SIGUSR2.

signal(String sigName)

Send a signal to the process using a symbolic name. The symbol can be case insensitive.

Parameters: sigName - the symbolic signal name, e.g. "SIGHUP" or "sigusr2".

toString()

.

validate()

Validate setup. Called by the public execute() methods.

waitFor()

Wait for the process to finish running or terminate and return the exit status.

Block and wait for the process to finish executing or to terminate. If the process terminates abnormally, an exception is thrown to indicate the cause of termination, or the error.

Returns: Exit status code of process.

Raises: ExecError thrown if there are abnormal termination errors.

writeStderrToLog()

Writes standard error output to the job log.

Examples

Example of command line invocation that writes the command's standard output and standard error to files and then reads in the standard output file if the command executed without errors:

```
e = Exec()
e.setCommand("ps -aef")
e.setStdoutFile("/tmp/ps.out")
e.setStderrFile("/tmp/ps.err")
result = e.execute()
if result == 0:
    output = open("/tmp/ps.out").read()
    print output
```

Example of a command line invocation that writes the command's standard output and standard error to the job log:

```
e = Exec()
e.setCommand("ls -la /tmp")
e.writeStdoutToLog()
e.writeStderrToLog()
e.execute())
```

See Also

- BinaryConstraint (page 231) and ExecError (page 255)
- Javadoc:Exec (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/Exec.html)

ExecError

`ExecError` is raised for errors in executing a command line using the Exec (page 249) class or system(). Normal raising of this error causes the joblet to fail. Put this Error in an try except block to handle the error.

Example

Example to handle an ExecError:

```
class MyJoblet(Joblet):
    def joblet_started_event(self):
        try:
            e = Exec()
            e.setCommand("ls -la")
            e.execute()
        except ExecError:
            print "ls failed. but okay to continue"
```

See Also

- Exec (page 249)
- Javadoc: ExecError (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ExecError.html)

FileRange

Define a range of values for a ParameterSpace (page 293) based on the lines of a text file. An instance of this class is used as a dimension in a `ParameterSpace` definition.The file name must either refer to a file that is readable from the server and resources (on a shared file system) or must be a DataGrid (page 243) file URL.

Constructor

FileRange(String filename): Constructs a `FileRange` using the supplied filename. The file must be readable.

Parameters: The userenv - true to set user environment variables.

Methods

Detail:

setDelimiter(char delimiter)

Define the line delimiter to separate lines. Defaults to line feed.

Parameters: delimiter - Character to use for delimiting lines.

setSkipBlankLines(boolean value)

Defines whether to ignore blank lines or not. Default is to not ignore blank lines.

Parameters: delimiter - Character to use for delimiting lines.

Inherited from org.python.core.PySequence class:

```
__delitem__, __delslice__, __eq__, __finditem__, __finditem__, __ge__,
__getitem__, __getslice__, __gt__, __le__, __lt__, __ne__,
__nonzero__, __setitem__, __setitem__, __setslice__, __tojava__,
classDictInit, del, delRange, fastSequence, fixindex, get, getslice,
getStart, getStep, getStop, isMappingType, isNumberType, repeat, set,
setslice, sliceLength
```

Inherited from org.python.core.PyObject class:

```
__abs__, __add__, __and__, __call__, __call__, __call__, __call__,
__call__, __call__, __call__, __call__, __cmp__, __coerce__,
__coerce_ex__, __complex__, __contains__, __delattr__, __delattr__,
__delitem__, __delslice__, __dir__, __div__, __divmod__, __findattr__,
__findattr__, __finditem__, __float__, __getattr__, __getattr__,
__getitem__, __getslice__, __hash__, __hex__, __iadd__, __iand__,
__idiv__, __idivmod__, __ilshift__, __imod__, __imul__, __int__,
__invert__, __ior__, __ipow__, __irshift__, __isub__, __ixor__,
__len__, __long__, __lshift__, __mod__, __mul__, __neg__, __not__,
__oct__, __or__, __pos__, __pow__, __pow__, __radd__, __rand__,
__rdiv__, __rdivmod__, __repr__, __rlshift__, __rmod__, __rmul__,
__ror__, __rpow__, __rrshift__, __rshift__, __rsub__, __rxor__,
__setattr__, __setattr__, __setitem__, __setslice__, __str__, __sub__,
__xor__, _add, _and, _callextra, _cmp, _div, _divmod, _dodel, _doget,
```

```
_doget, _doset, _eq, _ge, _gt, _in, _is, _isnot, _jcall, _jcallexc,
_jthrow, _le, _lshift, _lt, _mod, _mul, _ne, _notin, _or, _pow,
_rshift, _sub, _xor, addKeys, equals, getPyClass, hashCode, impAttr,
invoke, invoke, invoke, invoke, invoke, isCallable, isSequenceType,
safeRepr
```

Examples

Example to distribute each line of a text file residing on a shared filesystem to a joblet:

```
class myjob(Job):
    def job_started_event(self):
       fr = FileRange("/mytests/testlist")
       fr.setSkipBlankLines(True)
       parameterSpace = ParameterSpace()
       parameterSpace.appendDimension("testlist",fr)
       # Setting JobletSize to 1 creates one Joblet per line
       parameterSpace.setMaxJobletSize(1)
       self.schedule(myJoblet,parameterSpace)
```

In the example above, only a single dimension is defined. So each line of the source text file makes up a single row in the ParameterSpace.

```
class myJoblet(Joblet):
     def joblet_started_event(self):
        parameterSpace = self.getParameterSpace()
        while parameterSpace.hasNext():
             row = parameterSpace.next()
             element = row["testlist"]
             print "element=%s" % (element)
```

See Also

- DataGrid (page 243) and ParameterSpace (page 293)
- Javadoc: FileRange (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/FileRange.html)

GeConstraint

Representation of the Greater than or Equals constraint. Performs a ‘greater than or equal to’ constraint operation. Missing arguments will always result in this constraint evaluating to false. The standard lexographical ordering of values is used to determine result. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Extends BinaryConstraint (page 231).

Constructor

GeConstraint(): Constructs a default constraint.

Field Summary

Fields inherited from class com.gridion.jdl.BinaryConstraint:

`MATCH_MOVD_EXACT, MATCH_MODE_GLOB, MACH_MODE_REGEXP`

See BinaryConstraint (page 231).

Methods

Inherited from class com.gridion.jdl.BinaryConstraint:

`getMatchMode, setMatchMode`

See BinaryConstraint (page 231).

Inherited from class com.gridion.jdl.Constraint:

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

- Constraint (page 239) and BinaryConstraint (page 231).
- Javadoc: GeConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/GeConstraint.html)

GridObjectInfo

The `GridObjectInfo` class is the base class representation of all grid objects in the system. This provides accessors and setters to a grid object's fact set.

Methods

Summary:

deleteFact(String factname)

Removes a fact from this grid object.Factname must be fully qualified with the object's namespace.

Parameters: factname - The name of the fact to remove.

Raises: Exception - if fact does not exist or fact is not deleteable.

factExists(String factname)

Determines if the given factname exists in this grid object.

Parameters: factname - Name of fact to check.

Returns: true if fact exists, false if not.

getFact(String factname)

Retrieve the value of the named fact on this grid object. Factname must be fully qualified with the object's namespace.

Examples:

How to retrieve a job argument fact (from quickie example):

```
def job_started_event(self):
    d = self.getFact("jobinstance.time.submitted")
    print "time.ctime(d/1000)=",time.ctime(d/1000)
```

How to retrieve a date fact and displaying in a readable form:

```
def job_started_event(self):
    d = self.getFact("jobinstance.time.submitted")
    print "time.ctime(d/1000)=",time.ctime(d/1000)
```

Parameters: factname - Name of fact to retrieve value for.

Returns: Value of fact. Can be None.

Raises: Exception - if fact does not exist

getFactLastModified(String factname)

Retrieves the last modified timestamp for a fact. Factname must be fully qualified with the object's namespace.

Parameters: factname - job instance fact name.

Returns: last modified timestamp in milliseconds from epoch,.

Example:

How to retrieve a job argument fact (from the quickie job example):

```
def job_started_event(self):
    last_modified_secs = self.getFact("job.timeout") / 1000
    import time
    print time.ctime(last_modified_secs)
```

See quickie.job (page 153).

getFactNames()

Retrieves a list of all fact names for this grid object.

Parameters: Returns list of all fact names..

refresh()

Refreshes the fact set for this grid object. It only applies for grid objects retrieved remotely such as when running on the resource.

setArrayFact(String factname, PyList list)

Set an Array typed fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace.

Parameters: factname - Factname to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setBooleanArrayFact(String factname, org.python.core.PyList list)

Sets a Boolean Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace. Note: this is the only way to set empty boolean array facts.

Parameters: factname - Factname to set.
list - Fact value to set. Must be a Python list where all elements are the same type

setDateArrayFact(String factname, PyList list)

Sest an Date Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace..

Parameters: factname - Factname to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setDateFact(String factname, PyObject value)

Set the value of a fact of type Date. Creates a new fact if fact does not exist. Factname must be fully qualified with the object's namespace. Date fact values are integers indicating milliseconds since the epoch.

Parameters: factname - Factname to set.
value - Integer or long value in milliseconds since the epoch.

Example:

Example to set a jobinstance date fact to indicate the current date and time:

```
def job_started_event(self):
    import time
    now_in_millis = long(time.time()) * 1000
    self.setDateFact("myDateFact",now_in_millis)
```

setFact(String factname, PyObject value)

Sets the value of a fact. Creates a new fact if fact does not exist. Factname must be fully qualified with the object's namespace.

Parameters: factname - Name of fact to set.
value - Value of fact to set.

setIntegerArrayFact(String factname, org.python.core.PyList list)

Sets an Integer Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace.

NOTE: This is the only way to set empty integer array facts.

Parameters: factname - Name of fact to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setRealArrayFact(String factname, PyList list)

Sets a Real Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace. Note: this is the only way to set empty real array facts.

Parameters: factname - Name of fact to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setStringArrayFact(String factname, PyList list)

Set a String Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace.

NOTE: This is the only way to set empty string array facts.

Parameters: factname - Name of fact to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setTimeArrayFact(String factname, PyList list)

Sets a Time Array fact on this grid object. Creates a new fact if fact does not exist. The type of all list elements must match. Factname must be fully qualified with the object's namespace.

Parameters: factname - Name of fact to set.
list - Fact value to set. Must be a Python list where all elements are the same type.

setTimeFact(String factname, PyObject value)

Sets the value of a fact of type Time. Creates a new fact if fact does not exist. Factname must be fully qualified with the object's namespace. Time fact values are integers indicating milliseconds elapsed.

Parameters: factname - Name of fact to set.
value - Time value of fact to set. Must be integer or long to indicate number of milliseconds elapsed.

Example: To set a jobinstance date fact to indicate the current date and time:

```
def job_started_event(self):
    self.setTimeFact("myTimeFact",5*60000)
```

See Also

Javadoc: GridObjectInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/GridObjectInfo.html)

GroupInfo

he GroupInfo class is a representation of Group grid objects. Operations include retrieving the group member lists and adding/removing from the group member lists, and retrieving and setting facts on the group. Extends GridObjectInfo (page 259).

Methods

Summary:

addMember(GridObjectInfo member)

Adds a member to this group.

Parameters: member - Grid object to add. No effect if already in group.

addMember(String member)

Add a member to this group.

Parameters: member - Name of grid object to add.

getMembers()

Retrieve list of grid object members of this group.

Returns: List of group grid object members.

removeMember(GridObjectInfo member)

Removes a member from this group by grid object.

Parameters: member - Grid object to remove from group.

removeMember(String member)

Removes a member from this group by name.

Parameters: member - Grid object to remove from group.

Inherited from class com.gridion.jdl.GridObjectInfo:

`deleteFact, factExists, getFact, getFactLastModified, getFactNames, refresh, setArrayFact, setBooleanArrayFact, setDateArrayFact, setDateFact, setFact, setIntegerArrayFact, setRealArrayFact, setStringArrayFact, setTimeArrayFact, setTimeFact`

See GridObjectInfo (page 259).

See Also

- GridObjectInfo (page 259)
- Javadoc: GroupInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/GroupInfo.html)

GtConstraint

Representation of the Greater than Constraint. Performs a ‘greater than’ constraint operation. Missing arguments will always result in this constraint evaluating to false. The standard lexographical ordering of values is used to determine result. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Constructor

GtConstraint(): Constructs a default greather-than constraint.

Field Summary

Fields inherited from class com.gridion.jdl.BinaryConstraint:

MATCH_MODE_EXACT (0)

Exactly match the left and right sides of operation.

MATCH_MODE_REGEXP (1)

If possible, performs a regular expresion matching by treating the right side of the operation as a regular expression.This is only considered for String arguments.

MATCH_MODE_GLOB (2)

If possible, performs a glob-style matching by treating the right side of the operation as a glob expression. This is only considered for String arguments.

Methods

Inherited from class com.gridion.jdl.BinaryConstraint:

getMatchMode()

Retrieves the match mode for this binary constraint operation.

Returns: The match mode.

setMatchMode(int matchMode)

Sets the match mode used by some individual binary operator constraints. The match mode only has effect if the operator supports the specified type and the type of the left and right side of the operation are compatible with the mode otherwise the default of MATCH_MODE_EXACT is assumed.

Parameters: matchMode - the (advisory) match mode.

setNewName(String name)

Sets the name of the VM to be created.

setRepository(String repository)

Sets the name of a repository for creating the VM if required by the provisioning adapter.

setUseAutoprep(boolean value)

Sets whether to use the autoprep facts on the resource for creating the new VM.

Inherited from class com.gridion.jdl.Constraint:

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

- Constraint (page 239)
- Javadoc: GtConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/GtConstraint.html)

Job

The `Job` class represents a running job instance. This class defines functions for interacting with the server including handling notification of job state transitions, child job submission, managing joblets and for receiving and sending events from resources and from clients. A job writer defines a subclass of the Job class and uses the methods available on the Job class for scheduling joblets and event processing.

Examples

The following example job schedules a single joblet to run on one resource:

```
class Simple(Job):
     def job_started_event(self):
         self.schedule(SimpleJoblet)

class SimpleJoblet(Joblet):
     def joblet_started_event(self):
         print "Hello from Joblet"
```

For this example, the class `Simple` is instantiated on the server when a job is run either by client tools or by the job scheduler. When a job transitions to the started state, the method job_started_event is invoked. Here the job_started_event invokes the base class method schedule() to create a single joblet and schedule the joblet to run on a resource. The `SimpleJoblet` class is instantiated and run on a resource.

Job Events

Each job has a set of events that are invoked at the state transistions of a job. For example, on the starting state of a job, the `job_started_event` is always invoked. The following events that might be associated with jobs:

- "Job State Transition Events" on page 265
- "Child Job State Transition Events" on page 265
- "Job State Transition Provisioner Events" on page 266
- "Joblet State Transition Events" on page 266
- "Handling Custom Job Events" on page 266

Job State Transition Events

Following is a list of job events that are invoked upon job state transitions:

```
job_started_event
job_completed_event
job_cancelled_event
job_failed_event
job_paused_event
job_resumed_event
```

Child Job State Transition Events

The following lists job events that are invoked upon child job state transitions:

```
child_job_started_event
child_job_completed_event
child_job_cancelled_event
child_job_failed_event
```

Job State Transition Provisioner Events

The following lists provisioner events that are invoked upon provisioner state transitions:

```
provisioner_completed_event
provisioner_cancelled_event
provisioner_failed_event
```

Joblet State Transition Events

The following lists joblet events that are invoked upon joblet state transitions:

```
joblet_started_event
joblet_completed_event
joblet_failed_event
joblet_cancelled_event
joblet_retry_event
```

NOTE: In each of the events listed above, only job_started_event event is required; the remainder are optional.

Handling Custom Job Events

A job writer can also handle and invoke custom events within a job. Events can come from clients, other jobs, and from joblets.

Example of defining an event handler named mycustom_event in a job:

```
class Simple(Job):
    def job_started_event(self):
        ...

    def mycustom_event(self,params):
        dir = params["directory_to_list"]
        self.schedule(MyJoblet,{ "dir" : dir }
```

For this example, the event retrieves a element from the params dictionary that is supplied to every custom event. The dictionary is optionally filled by the caller of the event.

Example of invoking the custom event named 'mycustom_event' from the zos client command line tool:

```
zos event mycustom_event directory_to_list="/tmp"
```

In this example, a message is sent from the client tool to the job running on the server.

Example of invoking the same custom event from a joblet:

```
class SimpleJoblet(Joblet):
    def joblet_started_event(self):
        ...
        self.sendEvent("mycustom_event", { ... } )
```

In the example above, a message is sent from the joblet running on a resource to the job running on the server. The running job has access to a factset which is the aggregation of the job instance factset (jobinstance.*), the deployed job factset (job.*, jobargs.*), the User factset (user.*), the Matrix factset (matrix.*) and any jobargs or policy facts supplied at the time the job is started.

Fact values are retrieved using the GridObjectInfo (page 259) functions that the Job class inherits.

Example of retrieving the value of the job instance fact state.string from the jobinstance namespace:

```
class Simple(Job):
     def job_started_event(self):
         jobstate = self.getFact("jobinstance.state.string")
         print "job state=%s" % (jobstate)
```

Field Summary

static int CANCELLED_STATE

Cancelled end state.

See Constant Field Values

static int CANCELLING_STATE

The job is cancelling and transistions to Cancelled.

See Constant Field Values

static int COMPLETED_STATE

The job has completed the end state.

See Constant Field Values

static int COMPLETING_STATE

The job is completing and transitions to: Completing.

See Constant Field Values

static int FAILED_STATE

The job failed end state.

See Constant Field Values

static int FAILING_STATE

The job is failing and transitions to Failed.

See Constant Field Values

static int PAUSED_STATE

The job is paused and transitions to: Running/Completing/Failing/Cancelling.

See Constant Field Values

static int QUEUED_STATE

The job is queued and transitions to Starting/Failing/Cancelling.

See Constant Field Values

static int RUNNING_STATE

The job is running and transistions to Paused/Completing/Failing/Cancelling.

See Constant Field Values

static int STARTING_STATE

The job is starting and transitions to Running/Failing/Cancelling.

See Constant Field Values

static int SUBMITTED_STATE

The job is submitted and transitions to Queued/Failing.

See Constant Field Values

String TERMINATION_TYPE_ADMIN

Indicates the job was cancelled by the admin.

See Constant Field Values

String TERMINATION_TYPE_JOB

Indicates the job was cancelled by a job function and only applies if the job is in CANCELLED_STATE. The value is obtained from the `jobinstance.terminationtype` fact.

See Constant Field Values

String TERMINATION_TYPE_TIMEOUT

Indicates the job was cancelled due to exceeding the job timeout value and only applies if the job is in CANCELLED_STATE. The value is obtained from the `jobinstance.terminationtype` fact.

See Constant Field Values

String TERMINATION_TYPE_USER

Indicates the job was cancelled by a client user and only applies if the job is in CANCELLED_STATE. The value is obtained from the `jobinstance.terminationtype` fact.

See Constant Field Values

Methods

Detail:

cancel ()

Cancel this job instance.

cancel(reason)

Cancel this job instance with a reason.

cancelAllJoblets()

Cancel all joblets for this job instance. Any joblets that are running or waiting are cancelled. If the job is set to autoterminate, then the job will terminate normally.

changePriority(priority)

Change priority of this job with the specified string priority name.

child_job_cancelled_event(Job job)

`child_job_cancelled_event` is fired when a child job has transitioned to the cancelled state. A job writer can optionally implement this event to handle job cleanup.

child_job_completed_event(Job job)

`child_job_completed_event` is fired when a child job has transitioned to the completed state. A job writer can optionally implement this event to handle any job cleanup.

child_job_failed_event(Job job)

`child_job_failed_event` is fired when a child job has transitioned to the failed state. A job writer can optionally implement this event to handle any job cleanup.

child_job_started_event(Job job)

child_job_started_event is fired when a child job has transitioned to the running state. A job writer can optionally implement this event to handle job state transitions.

getChildJobs()

Retrieves a list of child jobs submitted by this job. The elements are instance of job.

getJoblet(int jobletNumber)

Retrieves a scheduled joblet. joblet may not be running on a resource. The joblet factset is available using the base GridObjectInfo (page 259) methods. Retrieves the `state` facts to determine the state of the joblet.

Parameters: jobletNumber - number of joblet.

Returns: Joblet instance..

Raises: Exception - if joblet number refers to a joblet that has not yet been created.

fail()

Fail this job instance.

fail(String reason)

Fail this job instance with a reason.

Parameters: reason - Reason message to put in job log.

id

Retrieve job identification assigned by server on job submission. Returns None until job is submitted or scheduled.

job_cancelled_event()

`job_cancelled_event` is fired when a job is transitioning to the cancelled state. A job writer can optionally implement this event to handle job cleanup.

job_completed_event()

`job_completed_event` is fired when the job is transitioning to the completed state. A job writer can optionally implement this event to handle any job cleanup.

job_failed_event()

`job_failed_event` is fired when the job is transitioning to the failed state. A job writer can optionally implement this event to handle any job cleanup.

job_paused_event()

Fired when a job is paused by user or administrator. A job writer can optionally implement this event to handle state changes.

job_resumed_event()

Fired when a previously paused job is resumed. A job writer can optionally implement this event to handle state changes.

job_started_event()

`job_started_event` is the first event to be called when a job is started. A job writer is required to implement this event. This event is not fired until a job instance has transitioned out of the queued state. After this event has completed, the job instance is in the running state. Job setup or scheduling of joblets is typically implemented in this event.

joblet_cancelled_event(int jobletNumber, String resourceID, String reason)

`joblet_cancelled_event` is fired when the joblet has had execution cancelled. The joblet may or may not have been running. A job writer can optionally implement this event to handle a joblet state change. Not that if the job has ended, this event will not be called.

Parameters:

`jobletNumber` - Joblet number that has been cancelled (0 based).

`resourceId` - ID of resource where joblet was cancelled. Can be None if was not running.

`reason` - ID of resource where joblet ran to completion.

joblet_completed_event(int jobletNumber, String resourceId)

`joblet_completed_event` is fired when the joblet has completed execution on a resource. A job writer can optionally implement this event to handle a joblet state change. Not that if the job has ended, this event will not be called.

Parameters:

`jobletNumber` - Joblet number that has completed (0 based).

`resourceId` - ID of resource where joblet ran to completion.

joblet_failed_event(int jobletNumber, String resourceId, String errorMsg)

`joblet_failed_event` is fired when the joblet has failed execution on a resource. A job writer can optionally implement this event to handle a joblet state change. Not that if the job has ended, this event will not be called.

Parameters:

`jobletNumber` - Joblet number that has failed.

`resourceId` - ID of resource where joblet ran.

`errorMsg` - Error message for the joblet error.

joblet_retry_event(int jobletNumber, String resourceId, String errorMsg)

`joblet_retry_event` is fired when the joblet is transitioning back to a waiting state after a failed execution on a resource. This event will not fire if the maximum retry settings have

been met and joblet transitions to the failed state. A job writer can optionally implement this event to handle a joblet state change.

Parameters:

`jobletNumber` - Joblet number that is to be retried.

`resourceId` - ID of resource where joblet ran.

`errorMsg` - Error message for the joblet error.

joblet_started_event(int jobletNumber)

`joblet_started_event` is fired when the joblet has started execution on a resource. A job writer can optionally implement this event to handle a joblet state change.

Parameters:

`jobletNumber` - Joblet number that is to be retried.

pause()

Pause this job instance.

provisioner_cancelled_event(PyDictionary params)

`provisioner_cancelled_event` is fired when the provision operation submitted by this job has been cancelled. A job writer can optionally implement this event to handle any job response to provision cancellation.

Parameters:

`params` - Dictionary containing "action", "resource" and "provisionjob" keys.

provisioner_completed_event(PyDictionary params)

`provisioner_completed_event` is fired when the provision operation submitted by this job has completed. A job writer can optionally implement this event to handle any job response to provision completion.

The following example demonstrates a handler for the completion of suspending a resource

```
    def provisioner_completed_event(params):
        if params["action"] == "Suspend":
            print "Successfully suspended resource '%s'" %
(params["resource"])
```

Valid “action” strings include:

```
"Provision"
"Clone"
"Move"
"Shutdown"
"Restart"
"Destroy"
"Suspend"
"Pause"
"Resume"
"Personalize"
"Save Config"
"Apply Config"
"Create Template"
"Migrate"
"Checkpoint"
```

```
"Restore"
"Install Agent"
"Make Standalone"
"Check Status"
"Delete"
"Cancel Action"
```

The "resource" key contains the resource ID of the resource the action was acted on. The "provisionjob" key contains the job ID of the provisioning adapter job that was run.

Parameters:

`params` - Dictionary containing “action”, “resource” and “provisionjob” keys.

provisioner_failed_event(PyDictionary params)

provisioner_failed_event is fired when the provision operation submitted by this job has failed. A job writer can optionally implement this event to handle any job response to provision failure.

Parameters:

`params` - Dictionary containing “action”, “resource” and “provisionjob” keys.

resume()

Resume this job instance if it is currently paused.

runJob(String job, PyDictionary params, String policy)

Run a new child job using supplied policy text. The supplied policy text is aggregated with the child job's policies.

Parameters:

`job` - Name of job to run.

`params` - Dictionary of job arguments.

`constraint` - Constraint object.

Raises:

Job instance of new child job.

runJob(String job, PyDictionary params, Constraint constraint)

Run a new child job using supplied resource Constraint. The supplied constraint is aggregated with the child job's resource constraints.

Parameters:

`job` - Name of job to run.

`params` - Dictionary of job arguments.

`policy` - Policy text.

Raises:

Job instance of new child job.

runJob

Run a new child job. for processing optionally not returning until the child job's job_started_event has completed.

runJob

Run a new child job using attributes defined in the supplied RunJobSpec (page 302).

runJob

Run a new child job.

runJob

Run a new child job.

schedule

Schedule a single joblet.

schedule

Schedule one or more joblets.

schedule

Schedule one or more joblets with additional joblet facts.

schedule

Schedule a set of joblets using the passed ParameterSpace as the basis for joblet assignment.

schedule

Schedule a set of joblets using the passed ParameterSpace as the basis for joblet assignment.

scheduleSweep

Schedule as many joblets as there are matching resources using the job's resource constraints. Each created joblet is preassigned to run on only the specified resource. <p> Note that joblets created with `scheduleSweep()` will take precedence over regularly scheduled joblets and will prevent regular joblets from running until all preassigned ones are complete. For this reason it is not normally recommended to mix `schedule()` and `scheduleSweep` in the same job.

scheduleSweep

Schedule as many joblets as there are matching resources using the job's resource constraints. Each created joblet is preassigned to run on only the specified resource. <p> Note that joblets created with `scheduleSweep()` will take precedence over regularly scheduled joblets and will prevent regular joblets from running until all preassigned ones are complete. For this reason it is not normally recommended to mix <code>`schedule()` and `scheduleSweep` in the same job.

sendEvent

Send an event to the parent job.

sendEventToChildren

Send an event to all children of this parent job.

sendEvent

Send an event to another job. This is typically used to communicate to a child job.

sendClientEvent

Send an event to the client. This allows communication from the job running on the server to a client that is listening to job events using the Client Toolkit.

The following example sends an event to a client with a payload consisting of integer and a string:

```
    self.sendClientEvent("client_event",{ "param1": 1024,
"param2":"hello world" })
```

sendJobletEvent

Send an event from server to joblet execution on a resource. Joblet must be running on a resource or this event is ignored. Typically used to communicate state changes to a long running joblet.

setAutoTerminate

Control whether a job auto terminates when all child jobs and joblets are finished. Setting to false makes the job a daemon and will not cease until an error or `terminate()` is called. Default is true.

setAutoTerminateTime

Control whether a job auto terminates when all child jobs and joblets are finished. Setting to a value > 0 causes the job to terminate (cancel) after the specified number of seconds. A value =0 is equivalent to 'true'. This may be called multiple times to reset the termination timer.

start

Start a job that is queued.

terminate

Terminate this job instance. Typically used when the fact <code>job.autoterminate</code> has been set to <code>False</code>.

validateJobContainer

Assert instance is correctly initialized

_getTimers

Retrieve list of timers if any need to be cancelled on job end.

See Also

- JobInfo (page 275), Joblet (page 276), JobletInfo (page 280), JobletParameterSpace (page 282)
- Javadoc: Job (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/Job.html)

JobInfo

The JobInfo class is a representation of a deployed job. The factset available on the JobInfo class is the aggregation of the job's policy and policies on the groups the job is a member of. This includes th "job.*" and "jobargs.*" fact namespaces.

Methods

Inherited from GridObjectInfo class :

`deleteFact, factExists, getFact, getFactLastModified, getFactNames, refresh, setArrayFact, setBooleanArrayFact, setDateArrayFact, setDateFact, setFact, setIntegerArrayFact, setRealArrayFact, setStringArrayFact, setTimeArrayFact, setTimeFact`

See GridObjectInfo (page 259).

See Also

- Job (page 265)
- Javadoc: JobInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/JobInfo.html)

Joblet

Defines the attributes for creating a virtual machine. An instance of this class is passed to resource.createInstance(), resource.createTemplate(), resource.clone().

Description

The job writer invokes the schedule() function in the job subclass to define when, where and which resource the joblet is executed.

Each joblet instance has the job instance (jobinstance.*,job.*,jobargs.*,user.*), Resource (resource.*) and joblet (joblet.*) fact sets available using the base GridObjectInfo fact functions.

Interaction with the job and the client is accomplished using event methods on the joblet class. If a ParameterSpace has been defined for this joblet, the self.getParamterSpace() method retrieves the joblet's JobletParameterSpace.

Fields

Summary:

To see detailed joblet state field description, click on the following values:

INITIAL_STATE
WAITING_STATE
WAITING_RETRY_STATE
CONTRACTED_STATE
STARTED_STATE
PRE_CANCEL_STATE
CANCELLING_STATE
POST_CANCEL_STATE
COMPLETING_STATE
FAILING_STATE
FAILED_STATE
CANCELLED_STATE
COMPLETED_STATE

Methods

Summary:

cancel()

Cancels this joblet if it is waiting or running. Has no effect if joblet is finished.

cancel(String reason)

Cancel this joblet if it is running. Has no effect if joblet is finished.

Parameters: reason - String to store in the job log.

fail()

Fail a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

fail(String reason)

Fail a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

Parameters: reason - String to store in the job log.

getcwd()

Retrieves the path of the current working directory in which this joblet is running.

Returns: Path of joblet's current working directory.

getParameterSpace()

Retrieves the JobletParameterSpace defined for this joblet instance.

Returns: JobletParameterSpace for this joblet. None if no ParameterSpace is defined.

isValidUser(String username)

Test if a supplied username is valid on a resource. If true is returned, then the username can run operations as that user on the resource. This includes running execs (assuming any required credentials are supplied) and running file operations on the resource. If enhanced exec is not installed on the resource, this returns False.

Parameters: username - Name of user to test.

Returns: true if user is valid on this resource, False if not.

joblet_cancelled_event()

The joblet_failed_event is fired when joblet execution has failed either by code, runtime errors or by the self.fail() function. The job writer can optionally implement this function to handle special postprocessing such as cleanup of a running process.

Examples: Sends a signal to a running process before joblet is ended:

```
class MyJoblet(Joblet):
     def joblet_started_event(self):
         self.exec = Exec()
         self.exec.setCommand("sleep 100")
         self.exec.execute()

     def joblet_failed_event(self):
         self.exec.signal("SIGABRT")
```

joblet_pre_cancel_event()

The joblet_before_cancel_event is fired when Joblet execution is about to be interrupted. The job writer can optionally implement this function to handle special preprocessing before cancellation such as sending a signal to a running process.

Example: Sends a signal to a running process before joblet is cancelled:

```
class MyJoblet(Joblet):
     def joblet_started_event(self):
         self.exec = Exec()
         self.exec.setCommand("sleep 100")
         self.exec.execute()

     def joblet_pre_cancel_event(self):
         self.exec.signal("SIGABRT")
```

joblet_started_event()

joblet_started_event is fired when Joblet execution is started on a resource. The job writer is required to implement this function.

retry()

Retry this joblet elsewhere if it is running. Has no effect if joblet is finished.

retry(String reason)

Retry this joblet if it is running. Has no effect if joblet is finished.

Parameters: reason - string to store in job log.

sendClientEvent(String name, PyDictionary paramst)

Send an event to a client. The sends an event directly to a client application listening for events using the Toolkit.

Parameters: name - Name of event.
params - Dictionary of event parameters

sendEvent(String name, PyDictionary params)

Send an event to the job that scheduled this joblet.

Parameters: name - Name of event.
params - Dictionary of event parameters.

Examples: Sends an event with the parameters dictionary containing two elements:

```
self.sendEvent("custom_event", { "arg1":1,"arg2":"foo" } )
```

sendEventString jobID, String name, PyDictionary params)

Sends an event to the supplied job instance. Use this method for sending events to a job different from the job that scheduled this joblet..

Returns: jobID - ID of job to send event to.
name - Name of event
params - Dictionary of event parameters

terminate()

Terminate a joblet that is running. This joblet will end execution upon exit of the last running joblet event. This method is necessary to end the joblet execution if the fact joblet.autoterminate is true.

Inherited from class class com.gridion.jdl.GridObjectInfo:

```
deleteFact, factExists, getFact, getFactLastModified, getFactNames,
refresh, setArrayFact, setBooleanArrayFact, setDateArrayFact,
setDateFact, setFact, setIntegerArrayFact, setRealArrayFact,
setStringArrayFact, setTimeArrayFact, setTimeFact
```

See GridObjectInfo (page 259).

Examples

Example of a joblet that runs a command line and forces a joblet failure if the command line returns an exit code greater than zero

```
class MyJoblet(Joblet):
    def joblet_started_event(self):
        e = Exec()
        e.setCommand("ls -la")
        rslt = e.execute()
        if rslt > 0:
           self.fail("ls command failed")
```

In this example, the joblet may be retried on another resource depending on the value of the fact job.joblet.maxfailures and how many times the joblet has already been retried.

See Also

- Job, JobInfo
- Javadoc: Joblet (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/Joblet.html)

JobletInfo

JobletInfo is a representation of the joblet grid object created when a job calls schedule() to create joblets. This class provides access to a joblet's factset and operations on a joblet such as cancellation and sending events to a joblet that is running on a resource. The separate Joblet class defines execution on a resource.

Methods

Detail:

cancel()

Cancel this joblet if it is waiting or running. Has no effect if joblet is finished.

cancel(String reason)

Cancel this joblet if it is waiting or running. Has no effect if joblet is finished.

fail()

Fail a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

fail(String reason)

Fail a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

Parameters: reason - string to store in job log.

getParameterSpace(int jobletNumber)

Retrieve a joblet's JobletParameterSpace instance. The JobletParameterSpace is created when schedule() is invoked with a JobletParameterSpace. The scheduler creates slices of the ParameterSpace for each joblet.

Parameters: jobletNumber - Joblet number to retrieve JobletParameterSpace for

Returns: jobletNumber - Joblet number to retrieve JobletParameterSpace for

getResource()

Retrieve the ResourceInfo that is running this joblet.

Returns: ResourceInfo instance.

Raises: Exception - if joblet is not running on a resource.

retry()

Retry a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

retry(String reason)

Retry a running joblet to force failover to another resource. If joblet has reached retry limit, then joblet ends in failed state. Has no effect if joblet is finished.

Parameters: reason - string to store in job log.

sendEvent(String name, PyDictionary params)

Sends an event from job to a joblet running on a resource. Joblet must be running on a resource or this event is ignored. Typically used to communicate state changes to a long running joblet.

Parameters: name - Name of event
params - Dictionary of parameters to send to joblet event

Raises: .PyException - if event does not exist or joblet is not running

Inherited from class com.gridion.jdl.GridObjectInfo:

`deleteFact, factExists, getFact, getFactLastModified, getFactNames, refresh, setArrayFact, setBooleanArrayFact, setDateArrayFact, setDateFact, setFact, setIntegerArrayFact, setRealArrayFact, setStringArrayFact, setTimeArrayFact, setTimeFact`

See GridObjectInfo (page 259).

See Also

Javadoc: JobletInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/JobletInfo.html)

JobletParameterSpace

JobletParameterSpace is a slice of the ParameterSpace allocated to a joblet. As the scheduler defines slices of the parameter space for a given schedule(), JobletParameterSpace instances are created for each joblet. This slice of the parameter space is delivered to the resource on joblet execution. The JobletParameterSpace can also be retrieved from the joblet object..

Methods:

Detail:

getFirst()

Returns a dictionary representing the first row in the parameter space iteration. Each element of the returned dictionary represents a column in the parameter space row.

Returns: Dictionary representing the first row in the iteration.

getLast

Returns a dictionary representing the last row in the parameter space iteration. Each element of the returned dictionary represents a column in the parameter space row. If parameter space iteration only contains one row then this returns the same row as getFirst()

Returns: Dictionary representing the last row in the iteration.

hasNext()

Returns true if the iteration has more elements.

Returns: true if the iterator has more elements.

next()

Returns a dictionary representing a row in the parameter space iteration. Each element of the returned dictionary represents a column in the parameter space row.

Returns: Dictionary representing the next element in the iteration.

Raises: NoSuchElementException - iteration has no more elements.

reset()

Resets the iteration to beginning.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

Files

/etc/opt/novell/zenworks/zmd/zmd.conf

Configuration file. Options such as proxy and cache settings can be adjusted through this file directly or with the `rug set` command.

/etc/init.d/novell-zmd

Initialization script. It is recommended that you use this script to start and stop zmd, rather than running it directly.

/var/opt/novell/log/zenworks/zmd-messages.log

Log file.

/var/opt/novell/zenworks/cache/zmd

Cached information from servers.

/etc/opt/novell/zenworks/zmd/initial-service

Url for the ZENworks service that zmd will use at initial startup. You can optionally specify a registration key on the next line.

Examples

Example of constructing a two-row and two-column ParameterSpace in which schedule() creates a JobletParameterSpace instance:.

```
class MyJob(Job):
     job_started_event(self):
         ps = ParameterSpace()
         ps.appendRow( { "column1" : "row1 col1", "column2" :"row1
col2" } )
         ps.appendRow( { "column1" : "row2 col1", "column2" :"row2
col2" } )
         self.schedule(MyJoblet,ps,{})
```

Example of retrieving the JobletParameterSpace instances in the joblet. Here the joblet iterates over the two rows and prints the row contents:

```
class MyJoblet(Joblet):
     joblet_started_event(self):
         rowno = 0
         parameterSpace = self.getParameterSpace()
         while parameterSpace.hasNext():
             row = parameterSpace.next()
             col1 = row["column1"]
             col2 = row["column2"]
             print "row %d col1=%s col2=%s" % (rowno,col1,col2)
             rowno += 1
```

See Also

Javadoc: JobletParameterSpace (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/JobletParameterSpace.html)

LeConstraint

Representation of the Less than or equals Constraint. Performs a 'less than or equal to' constraint operation. Missing arguments will always result in this constraint evaluating to false. The standard lexographical ordering of values is used to determine result. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Inheritance Structure

```
extended bycom.gridion.jdl.Constraint
    extended bycom.gridion.jdl.BinaryConstraint
        extended bycom.gridion.jdl.LeConstraint
```

Constructor

LeConstraint()

Fields

Inherited from class com.gridion.jdl.BinaryConstraint:

`MATCH_MODE_EXACT, MATCH_MODE_GLOB, MATCH_MODE_REGEXP`

See BinaryConstraint (page 231).

Methods

Inherited from class com.gridion.jdl.BinaryConstraint

`getMatchMode, setMatchMode`

See BinaryConstraint (page 231).

Inherited from class com.gridion.jdl.Constraint:

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

Javadoc: LeConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/LeConstraint.html)

LtConstraint

Representation of the Less than Constraint. Performs a "less than" constraint operation. Missing arguments always result in this constraint evaluating to false. The standard lexographical ordering of values is used to determine result. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Inheritance Structure

```
extended bycom.gridion.jdl.Constraint
    extended bycom.gridion.jdl.BinaryConstraint
        extended bycom.gridion.jdl.LtConstraint
```

Constructor

LtConstraint()

Fields

Inherited from class com.gridion.jdl.BinaryConstraint:

`MATCH_MODE_EXACT, MATCH_MODE_GLOB, MATCH_MODE_REGEXP`

See BinaryConstraint (page 231).

Methods

Inherited from class com.gridion.jdl.BinaryConstraint

`getMatchMode, setMatchMode`

See BinaryConstraint (page 231).

Inherited from class com.gridion.jdl.Constraint:

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

Javadoc: LtConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/LtConstraint.html)

MatrixInfo

The MatrixInfo class is a representation of the matrix grid object (see GridObjectInfo (page 259)). This provides operations for retrieving and creating grid objects in the system. MatrixInfo is retrieved using the built-in getMatrix() function. Write capability is dependent on the context in which getMatrix() is called. For example, in a joblet process on a resource, creating new grid objects is not supported.

Inheritance Structure

```
extended bycom.gridion.jdl.GridObjectInfo
    extended bycom.gridion.jdl.MatrixInfo
```

Fields

Inherited from class com.gridion.jdl.BinaryConstraint:

`MATCH_MODE_EXACT, MATCH_MODE_GLOB, MATCH_MODE_REGEXP`

See BinaryConstraint (page 231).

Methods:

Detail:

createGridObject(String objectType, String objectName)

Create a Grid object using supplied type and name. Built-in “object type” variable constants:.

```
TYPE_USER
TYPE_RESOURCE
TYPE_REPOSITORY
```

Parameters: objectType - Grid object type
objectName - Grid object name.

Returns: GridObjectInfo for new object.

Raises: Exception - if object already exists.

createGroup(String gridObjectType, String groupName)

Create and return a group grid object using the supplied grid object type and group name (see GroupInfo (page 262)). The grid object type must be one of the known types and the group must not already exist

Parameters: gridObjectType - One of the known grid object types.
groupName - Name of group to retrieve. It must not exist..

Returns: Group grid object that was created.

Raises: Exception - if the group already exists.

createResource(String name)

Create a physical resource grid object with supplied name. See ResourceInfo.

Parameters: name - Name of new resource grid object.

Returns: New resource grid object.

Raises: Exception - if resource already exists.

createResource(String name, String type, boolean addSuffix)

Create a resource grid object using supplied Resource type. The Resource type must be one of the constants from ResourceInfo.
ResourceInfo.TYPE_FIXED,ResourceInfo.TYPE_VM_INSTANCE,ResourceInfo.TYPE_VM_TEMPLATE .

Parameters: name - Name of new resource grid object
type - One of the Resource types
addSuffix - true to make the name unique by automatically adding a numeric suffix.

Returns: New resource grid object.

Raises: Exception - if the resource already exists.

createResource(String name, String type, boolean addSuffix)

Creates and returns a group grid object using the supplied grid object type and group name. The grid object type must be one of the known types and the group must not already exist. See ResourceInfo.

Parameters: gridObjectType - One of the known grid object types
groupName - Name of group to retrieve. It must not exist.

Returns: Group grid object that was created.

Raises: Exception - if the group already exists.

getActiveJobs()

Retrieve a list of job instance frid objects representing the currently active job instances. This includes job instances that are queued.

Returns: List of job instance grid objects, list is empty if no jobs are active.

getGridObject(String objectType, String objectName)

Retrieve a named grid object of the requested type. Example to retrieve the grid object for the user named 'foo' and print the value of the user object's id fact:

```
gridObject = getMatrix().getGridObject(TYPE_USER,"foo")
print gridObject.getFact("user.id")
```

Built-in "object type" variable constants:

```
TYPE_USER
TYPE_JOB
TYPE_RESOURCE
TYPE_VMHOST
TYPE_REPOSITORY
TYPE_USERGROUP
TYPE_JOBGROUP
TYPE_RESOURCEGROUP
TYPE_VMHOSTGROUP
TYPE_REPOSITORYGROUP
```

Parameters: objectType - Grid object type
objectName - Grid object name.

Returns: GridObjectInfo representing the grid object or None if object does not exist.

Raises: Exception - if supplied object type is invalid.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

size()

Return number of rows in this ParameterSpace.

Returns: Number of rows.

See Also

- Javadoc: MatrixInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/MatrixInfo.html)
- Section B.4, “Built-in JDL Functions,” on page 223.

NeConstraint

Representation of the Not Equals Constraint. Performs a not equal constraint operation. Missing arguments will always result in this constraint evaluating to false. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Constructor

NeConstraint()

Field Summary

Inherited from class com.gridion.jdl.BinaryConstraint

`MATCH_MODE_EXACT, MATCH_MODE_GLOB, MATCH_MODE_REGEXP`

Methods

Inherited from class com.gridion.jdl.BinaryConstraint

`getMatchMode, setMatchMode`

See BinaryConstraint (page 231).

Inherited from class com.gridion.jdl.Constraint

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

Javadoc: NeConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/NeConstraint.html)

NotConstraint

Representation of a Not Constraint Object. Performs a logical not operation of all the child constraints. This is a no-op if this constraint contains no children. Constraints are added to this constraint using `add()`.

Constructor

NotConstraint()

Methods

Inherited from class com.gridion.jdl.ContainerConstraint

`add`

See ContainerConstraint (page 240).

Inherited from class com.gridion.jdl.Constraint

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

- See Constraint (page 239) and ContainerConstraint (page 240).
- Javadoc: NotConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/NotConstraint.html)

OrConstraint

Representation of Or Constraint Object. Perform a logical or-ing operation of all the child constraints. This is a no-op if this constraint contains no children. Constraints are added to this constraint using `add()`.

Constructor

OrConstraint()

Methods

Inherited from class com.gridion.jdl.ContainerConstraint

`add`

See ContainerConstraint (page 240).

Inherited from class com.gridion.jdl.Constraint

`getFact, getFactValue, getReason, getValue, setFact, setFactValue, setReason, setValue`

See Constraint (page 239).

See Also

- See Constraint (page 239) and ContainerConstraint (page 240).
- Javadoc: OrConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/OrConstraint.html)

ParameterSpace

Defines a parameter space to be used by the scheduler to create a joblet set. A parameter space may consist of rows of columns or a list of columns that is expanded and can be turned into a cross product.

Use `appendRow` to create a `rowMajor` parameter space or `appendCol` to define a column expansion. You cannot use both `appendRow()` and `appendCol()` in the same `ParameterSpace`. Once the scheduler defines a slice of the parameter space for a given joblet, the scheduler creates `JobletParameterSpace` instances for each joblet. This slice of the parameter space is delivered to the resource.

Constructor

ParameterSpace(): Constructs an instance of ParameterSpace.

Methods

Detail:

appendDimension(String name, org.python.core.PyObject sequence)

Append a definition for elements of a column. When more than one dimension is defined, a cross product is generated by the scheduler. A List, XRange and FileRange can be supplied as a dimension.

Parameters: name - Name of column
sequence - Definition for elements of column

appendRow(PyDictionary row)

Append row to parameter list. Each row corresponds to a row that is received by a joblet that the Scheduler will assign to nodes. The number of rows assigned to a given joblet is determined by maxJobletSize

Parameters: row - Dictionary of name/value pairs representing a column name and value.

setMaxJobletSize(int maxJobletSize)

Set maximum number of joblets to project this ParameterSpace into.

Parameters: maxJobletSize - Maximum number of joblets to create.

See Also

Javadoc: ParameterSpace (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ParameterSpace.html)

PolicyInfo

Representation of a Policy Object. This class allows for associating and unassociation of Grid objects using this policy

Constructor

PolicyInfo Construct a policy.

Methods

Summary:

PolicyInfo(String type)

Construct a policy.

associate(GridObjectInfo gridObject)

Associate a grid object with this policy.

Parameters: gridObject - Grid object to associate this policy with.

unassociate(GridObjectInfo gridObject)

Unassociate a grid object with this policy.

Parameters: gridObject - Grid object to unassociate this policy with.

getPolicyText()

Retrieve policy text from policy

Returns: String Policy text

setPolicyText(String policyText)

Set new policy text for policy

Parameters: policyText - String policy text.

Raises: Exception - if syntax or validation errors occur.

Examples

Example of retrieving a policy object and associating an object to the policy:

```
policy = getMatrix().getPolicy("myPolicy")
policy.associate(myResource)
```

See Also

Javadoc: PolicyInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/PolicyInfo.html)

ProvisionSpec

Defines the attributes for starting a provision. An instance of this class is passed to `self.provision()`. As shown in “Examples” on page 296, defining a provision to reserve a provisioned resource "nightly" for a user is an instance of when this function might be used:

```
spec = ProvisionSpec() spec.setReserveForUser('nightly')
self.provision(spec)
```

Constructor

ProvisionSpec(): Construct a default `ProvisionSpec`.

Methods

Summary:

setReserveForJob(String jobID)

Set the job ID to reserve the provisioned resource for. Default is the job initiating the provision.

getReserveForJob()

setReserveForUser(String userID)

Set the user ID to reserve the provisioned resource for. Default is the user of the initiating job.

getReserveForUser()

setIdleTimeout(int idleTimeout)

Set idle timeout for provisioned resource. Default is value of `resource.provisioned.timeout`.

getIdleTimeout()

setPriority(String priority)

Set a priority for this provision using supplied string. Default is the user's priority.

setPriority(int priority)

Set a priority for this provision using supplied integer constant. Default is the user's priority.

getPriority()

setReserveWithPolicy(String policyText)

Set a policy to use for reserving the provisioned resource. Default is no policy.

getReserveWithPolicy()

setPolicyName(String policyName)

Set a policy to use for reserving the provisioned resource. Default is no policy.

getPolicyName()

setReserveWithConstraint(Constraint constraint)

Set a constraint to use for reserving the provisioned resource. Default is no constraint.

getConstraint()

setHost(String host)

Set the host to provision the resource on. Default is to provision on the affiliated host.

getHost()

setRepository(String repository)

Set the repository to provision the resource on. Default is to use the same repository as source.

getRepository()

setAssignHostImmediately(boolean value)

Set whether to wait or assign the host immediately. Default is false.

getAssignHostImmediately()

Examples

Example of using `ProvisionSpec` for defining a provision to reserve a provisioned resource for user “nightly”:

```
spec = ProvisionSpec()
spec.setReserveForUser('nightly')
self.provision(spec)
```

See Also

Javadoc: ProvisionSpec (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ProvisionSpec.html)

RepositoryInfo

`RepositoryInfo` is a representation of a repository grid object. This class provides accessors and setters for Repository facts. See MatrixInfo (page 286) for how to script creation of Repository objects.

Constructor

RepositoryInfo Construct an instance of RepositoryInfo

Field Summary

```
static String SAN_TYPE_FibreChannel
static String SAN_TYPE_ISCSI
static String SAN_VENDOR_IQN
static String SAN_VENDOR_NPIV
static String TYPE_DATAGRID
static String TYPE_LOCAL
static String TYPE_NAS
static String TYPE_SAN
static String TYPE_VIRTUAL
static String TYPE_WAREHOUSE
```

Methods

Inherited from class com.gridion.jdl.GridObjectInfo:

```
deleteFact, factExists, getFact, getFactLastModified, getFactNames,
refresh, setArrayFact, setBooleanArrayFact, setDateArrayFact,
setDateFact, setFact, setIntegerArrayFact, setRealArrayFact,
setStringArrayFact, setTimeArrayFact, setTimeFact
```

See GridObjectInfo (page 259).

Examples

VmSpec here is used for creating a clone on a named host from a template resource:

```
    resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec()       spec.setNewName("newvm")
spec.setHost('vmhost-qa')       resource.clone(spec)
```

See Also

- See GridObjectInfo (page 259) and MatrixInfo (page 286).
- Javadoc: RepositoryInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/RepositoryInfo.html)

ResourceInfo

ResourceInfo is a representation of a resource grid object. This class inherits the base fact operations from GridObjectInfo (page 259) and adds the provisioning operations for provisionable resources such as VMs. See MatrixInfo (page 286) for how to script creation of Resource objects.

Constructor

ResourceInfo Construct a ResourceInfo

Methods

Summary:

ResourceInfo(String name)

Construct a ResourceInfo

setResourceManagerContainer(ResourceManagerContainer resourceManagerContainer)

Assign resource manager API

shutdownAgent()

Shut down the agent on this resource if it is online. Operation has no effect if agent is already offline.

setProvisioningContainer(ProvisioningContainer pc)

The ProvisioningContainer is implemented by the NodeManager. This sets the redirection.

provision()

Provision this resource for general use. If this resource is a template, a new instance is created.

provision(ProvisionSpec provisionSpec)

Provision this resource using the supplied <code>ProvisionSpec</code> instance. If this resource is a template, a new instance is created.

getProvisionedInstances()

Return all provisioned instances of this resource.

shutdown()

Initiate a soft shut down of this provisioned resource.

move(String repository)

Move the disk images for this VM to new repository.

shutdown(boolean hard)

Shut down this provisioned resource. Optionally initiating a hard shut down.

suspend()

Suspend this provisioned resource.

suspend(boolean hard)

Suspend this provisioned resource. Optionally initiating a hard shut down.

pause()

Pause this provisioned resource.

resume()

Resume a previsously paused provisioned resource.

personalize()

Personalize (autoprep) a provisioned resource.

saveConfig()

Save VM config of a provisioned resource.

applyConfig()

Apply VM config to a provisioned resource.

restart()

Restart this provisioned resource.

restart(boolean hard)

Restart this provisioned resource. Optionally initiating a hard shut down.

createTemplate(String newName)

Create a new Template resource from this resource using the supplied name.

createTemplate(VmSpec vmSpec)

Create a new Template resource from this resource using the supplied <code>VmSpec</code> instance.

clone(String newName)

Create a copy of this Resource using the supplied name.

clone(VmSpec vmSpec)

Create a copy of this Resource using the supplied <code>VmSpec</code>.

migrate()

Migrate this provisioned resource to another host.

migrate(String newHostName)

Migrate this provisioned resource to the supplied host.

check()

Check and resync the state of this resource. If this is a provisioned resource, this will determine whether the resource is up or down or does not exist.

createInstance()

Create a new provisionable resource. The name of the new resource is generated.

createInstance(VmSpec vmSpec)

Create a new provisionable resource using the supplied <code>VmSpec</code>.

destroy()

Destroy this provisionable resource.

cancel()

Cancel the current action on this resource.

checkpoint()

Create a checkpoint for a provisioned resource.

checkpoint(String checkpointName)

Create a checkpoint for a provisioned resource supplying a checkpoint name.

restore()

Restore a provisioned resource to a checkpoint

restore(String checkpointName)

Restore a provisioned resource to a checkpoint

makeStandAlone()

Remove dependencies from provisionable instance to a parent template This allows the template to be removed from the system without affecting the instance.

installAgent()

Install a GMS Agent on this provisionable resource. The new GMS Agent will communicate with this GMS server.

installAgent(PyDictionary params)

Install a GMS Agent on this provisionable resource. The new GMS Agent will communicate with this GMS server or the server specified in the params dictionary. The key value pairs supplied in the dictionary are the equivalent to the install command line <pre>-D</pre> options.

createVmHost(String provisionAdapter)

Create a new Vm host grid object associated with this physical resource. <p> The supplied provisioning adapter job name is required for qualifying the name of the new Vm Host. This operation is not supported if this is not a physical resource object.

getVmHost(String provisionAdapter)

Retrieve an existing Vm host grid object associated with this physical resource. <p> The supplied provisioning adapter job name is required for qualifying which Vm Host to retrieve. This operation is not supported if this is not a physical resource object.

Examples

- `VmSpec` is used here for creating a clone on a named host from a template resource:

```
resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec() spec.setNewName("newvm") spec.setHost('vmhost-qa')
resource.clone(spec)
```

- `VmSpec` is used here to retrieve an existing ResourceInfo (page 298) and print the value of a fact:

  ```
  resource = getMatrix().getGridObject("resource","redhat_lab1")
  print resource.getFact("resource.os.name")
  ```

- `VmSpec` is used here to retrieve an existing ResourceInfo and initiate a provision operation on the Resource:

  ```
  vm = getMatrix().getGridObject("resource","winxpvm")
  vm.provision()
  ```

See Also

- GridObjectInfo (page 259) and MatrixInfo (page 286).
- Javadoc: ResourceInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ResourceInfo.html)

RunJobSpec

Defines the attributes for starting a child job. An instance of this class is passed to `self.runJob()`.

Constructor

RunJobSpec Construct a default RunJobSpec.

Methods

Summary:

RunJobSpec()

Construct a default RunJobSpec.

setJobArgs(PyDictionary arguments)

Define the job arguments to supply to the child job. These are any facts defined in policy for the <code>jobargs</code> namespace. If job arguments are required by the job then the arguments are required. This function is not use if no job arguments are defined for the job to run.

getJobArgs()

setJobTracing(boolean tracing)

Enable or disable job and joblet tracing (for debug purposes).

isJobTracing()

setJobName(String jobName)

Define the deployed job name of the child job to run. Required.

getJobName()

setInstanceName(String instanceName)

Define a job instance name. The default is to use the deployed job name as the instance name. Optional.

getInstanceName()

setPriority(String priority)

Set a priority for this job using supplied string. Default is the user's priority. Optional.

setPriority(int priority)

Set a priority for this job using supplied integer constant. Default is the user's priority. Optional.

getPriority()

setStartTime(long time)

Set the start time for this job based on number of milliseconds since epoch. Optional.

setStartTime(String time)

Set the start time for this job using a supplied date/time string. Examples: <pre> "2/15/07" "2/15/07 5 PM" "8 AM" </pre> Optional.

getStartTime()

setPolicy(String policy)

Set an additional policy of constraints to use for the new job instance. Optional

getPolicy()

setPolicyName(String policyName)

Set an additional previously deployed policy of constraints to use for the new job instance. The policy must already exist. Optional.

getPolicyName()

setConstraint(Constraint constraint)

Set an additional constraint to use for the new job instance. Optional.

getConstraint()

Examples

- `RunJobSpec` here is used for starting a child job with a custom instance name and supplying a job argument:

```
spec = RunJobSpec() spec.setJobName("quickie")
spec.setInstanceName("quickie child") spec.setJobArgs( {
"numJoblets" : 5 } ) self.runJob(spec)
```

- `RunJobSpec` here is used with a Constraint to constrain that a resource belongs to a group and use the constraint in starting a child job:

```
c = ContainsConstraint() c.setFact("resource.groups")
c.setValue("webserver-group") spec = RunJobSpec()
spec.setJobName("myChildJob") spec.setConstraint(c)
self.runJob(spec)
```

See Also

Javadoc: RunJobSpec (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/RunJobSpec.html)

ScheduleSpec

Defines one or more joblets to be scheduled and run on resources. A `ScheduleSpec` instance is passed to the job's `schedule()`. `schedule()` creates the joblets and schedules joblets to run on resources.

Constructor

ScheduleSpec Construct a ScheduleSpec with defaults.

Methods

Summary:

ScheduleSpec()

Construct a ScheduleSpec with defaults.

setParameterSpace(ParameterSpace parameterSpace)

Assign an optional ParameterSpace for this ScheduleSpec.

getParameterSpace()

Retrieve the supplied ParameterSpace for this ScheduleSpec.

setCount(int count)

Assign the number of joblets to create for this set.

getCount()

Retrieve number of joblets created for this set. Only valid after <code>scheduleSweep()</code>.

setJobletClass(PyClass jobletClass)

Assign the Joblet class to use for joblet execution on the resource.

getJobletClass()

Retrieve the Joblet class to schedule no a resource

setConstraint(Constraint constraint)

Assign a Constraint for resource selection. This additional Constraint is ANDed to any existing constraints including the aggregated Policies:

```
constraint = EqConstraint() constraint.setFact("resource.os.name")
constraint.setValue("Windows XP") ScheduleSpec = ScheduleSpec()
ScheduleSpec.setJobletClass(MyJoblet)
ScheduleSpec.setConstraint(constraint)
```

getConstraint()

Retrieve constraint object

setConstraint(String constraint)

Assign a Constraint in XML for resource selection. This additional Constraint is AND'd to any existing constraints including the aggregated Policies:

```
ScheduleSpec = ScheduleSpec()
ScheduleSpec.setJobletClass(MyJoblet)
ScheduleSpec.setConstraint("<eq fact=\"resource.os.name\"
value=\"Windows XP\" />")
```

getConstraintStr()

Retrieve constraint object

setUseNodeSet(int nodeSet)

If set to true, the joblet set is constructed after applying resource constraints to the set of provisionable resource. If false (the default) the active or online set of resources is used instead.

getUseNodeSet()

setJobletArgs(PyDictionary facts)

Define facts for this `jobletargs` namespace for a Joblet (page 276). Each joblet created for this schedulet gets a copy of this set of joblet arguments facts.

getJobletArgs()

setJobletFacts(PyDictionary facts)

Define additional joblet facts for this ScheduleSpec. Each joblet created for this set inherits the base set of joblet facts and any facts supplied to this function.

getJobletFacts()

Example

`ScheduleSpec` here is used to schedule a single joblet:

```
s = ScheduleSpec() s.setJobletClass(MyJoblet) self.schedule(s)
```

See Also

- Joblet (page 276)
- Javadoc: ScheduleSpec (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/ScheduleSpec.html)

Timer

Timer schedules a callback to a job or joblet method. Timers can schedule a one time or a repeated callback on an interval basis. Any Timers created in a job or joblet are shut down on job or joblet completion.

Constructor

Timer Construct a one-time Timer instance

Methods

Summary:

Timer(PyMethod method)

Construct a one-time Timer instance

Timer(PyMethod method)

Construct a Timer that repeatedly calls the method.

cancel()

Stop this timer.

Example

VmSpec here is used for creating a clone on a named host from a template resource:

```
resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec() spec.setNewName("newvm") spec.setHost('vmhost-qa')
resource.clone(spec)
```

See Also

Javadoc: Timer (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/Timer.html)

UndefinedConstraint

Representation of the Undefined Constraint. Evaluates to true only if the left side fact is *not* defined in the match contect. If the left side is not defined, this will evaluate to `false`. This constraint can be used independently or added to a And, Or, Not constraint to combine with other constraints.

Constructor

UndefinedConstraint

Methods

Summary:

UndefinedConstraint()

Example

VmSpec here is used for creating a clone on a named host from a template resource:

```
    resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec()
      spec.setNewName("newvm")
      spec.setHost('vmhost-qa')
      resource.clone(spec)
```

See Also

- Constraint (page 239)
- Javadoc: UndefinedConstraint (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/UndefinedConstraint.html)

UserInfo

UserInfo is a representation of a user grid object. This class provides accessors and setters for User facts.

Constructor

UserInfo Construct an instance of `UserInfo`

Methods

Summary:

UserInfo(String name)

Construct an instance of UserInfo

Examples

VmSpec here is used for creating a clone on a named host from a template resource:

```
    resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec()
     spec.setNewName("newvm")
     spec.setHost('vmhost-qa')
     resource.clone(spec)
```

See Also

Javadoc: UserInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/UserInfo.html)

VMHostInfo

The `VmHostInfo` class is a representation of a virtual machine host grid object. This class provides accessors and setters to the VM host facts and operations to control the state of the VM host object.

Constructor

VMHostInfo Construct a vmhost info

Methods

Summary:

VMHostInfo(String name)

Construct a vmhost info

setProvisioningContainer(ProvisioningContainer pc)

The ProvisioningContainer is implemented by the NodeManager, which sets the redirection.

Example

Retrieves an existing instance of a VmHostInfo and initiates a soft shut down on it:

```
      vmhost = getMatrix().getGridObject("vmhost","MyVmHost")
vmhost.shutdown()
```

See Also

- VmSpec (page 311)
- Javadoc: VMHostInfo (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/VMHostInfo.html)

VmSpec

Defines the attributes for creating a virtual machine. An instance of this class is passed to resource.createInstance(), resource.createTemplate(), resource.clone().

Constructor

VmSpec(GridObjectInfo): Constructs a default VmSpec.

Methods

Summary:

setAutoprep(Dictionary autoprep)

Set facts for preparing the new VM.

setHost(String host)

Set facts for preparing the new VM.

setNewName(String name)

Sets the name of the VM to be created.

setRepository(String repository)

Sets the name of a repository for creating the VM if required by the provisioning adapter.

setUseAutoprep(boolean value)

Sets whether to use the autoprep facts on the resource for creating the new VM.

Examples

VmSpec here is used for creating a clone on a named host from a template resource:

```
resource = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec()
spec.setNewName("newvm")
spec.setHost('vmhost-qa')
resource.clone(spec)
```

See Also

- VMHostInfo (page 310)
- Javadoc: VmSpec (http://www.novell.com/documentation/zen_orchestrator11/reference/jdldoc/com/gridion/jdl/VmSpec.html)

Orchestrator Job Scheduling DTD

C

schedule_1_0

```
<?xml version="1.0" encoding="UTF-8" ?>

<!--
 * Copyright (c) 2007 Novell, Inc. All Rights Reserved.
 *
 * This software and documentation is the confidential and proprietary
 * information of Novell, Inc. ("Confidential Information").
 * You shall not disclose such Confidential Information and shall use
 * it only in accordance with the terms of the license agreement you
 * entered into with Novell.
 *
-->

<!--
A DTD for Novell Zenworks ZOS job scheduling

 Use:
   <!DOCTYPE schedule PUBLIC '-//Novell Inc//DTD Zenworks ZOS Schedule
1.0//EN' 'http://www.novell.com/dtds/zenworks/zos/schedule_1_0.dtd'>
-->

<!--
The schedule element is the root element for defining job scheduling
and triggers.
A schedule contains job schedules and triggers.
-->
<!ELEMENT schedule (job|trigger)* >

<!--
The job element is the root element for job scheduling.
A job contains jobargs, scheduling options and which triggers to use.

-->
<!ELEMENT job
(jobargs?,resourcediscovery?,active?,passuserenv?,runonresourcestart?,
runonserverstart?,runoneachresource?,triggers*)>

<!--
The resourcediscovery element indicates this job is to be run to
discover facts on a resource.
-->
<!ELEMENT resourcediscovery (#PCDATA)>

<!--
```

```
The active element indicates this schedule is to be activated upon
deployment.
-->
<!ELEMENT active (#PCDATA)>

<!--
The passuserenv element indicates that the user's environment factset,
if available, is to be available in job execution.
-->
<!ELEMENT passuserenv (#PCDATA)>

<!--
The runonresourcestart element indicates the job is to run when a
resource has logged in.
-->
<!ELEMENT runonresourcestart (#PCDATA)>

<!--
The runonserverstart element indicates the job is to be run after the
server has started.
-->
<!ELEMENT runonserverstart (#PCDATA)>

<!--
the runoneachresource element indicates the job is to be run on every
resource.
This is also subject to the job's policies.
-->
<!ELEMENT runoneachresource (#PCDATA)>

<!--
The triggers element defines what triggers if any are used for this
scheduled job. Triggers listed here must be defined either in this file
or already exist.
-->
<!ELEMENT triggers (#PCDATA)>


<!--
The trigger element is the root element for trigger definition. The
trigger element defines an event trigger for starting a scheduled job.
The name attribute is required for uniquely identifying the trigger.
-->
<!ELEMENT trigger (cron?,startin?,interval?,repeat?)>

<!--
The cron element defines a cron string
```

```
-->
<!ELEMENT cron (#PCDATA)>

<!--
The startin element defines the number of minutes to delay until
starting a scheduled job.
-->
<!ELEMENT startin (#PCDATA)>

<!--
The interval element defines the number of minutes to wait in between
scheduled jobs.
-->
<!ELEMENT interval (#PCDATA)>

<!--
The repeat element defines the number of iterations to run a scheduled
job.
-->
<!ELEMENT repeat (#PCDATA)>

<!--
The jobargs element allows specifying values for jobargs facts on job
submission.
-->
<!ELEMENT jobargs (fact)*>

<!--
The fact element defines which jobarg fact is being assigned. The name,
type and value of the fact are specified as attributes. For list or
array fact types, the element tag defines list or array members. For
dictionary fact types, the dict tag defines dictionary members.

The jobarg fact must be defined in the jobargs namespace for the job.
-->
<!ELEMENT fact (element*,dict*)>

<!--
The element tag defines a member of a list or array fact. The required
value attribute defines the value of a member of the list or array.
-->
<!ELEMENT element (#PCDATA)>

<!--
The dict tag defines a member of a dictionary fact. The required key,
type and value attributes define a dictionary member.
-->
<!ELEMENT dict (#PCDATA)>
```

```
<!ATTLIST job
name CDATA #REQUIRED
job CDATA #REQUIRED
user CDATA #IMPLIED
priority CDATA #IMPLIED
>

<!ATTLIST triggers
value CDATA #REQUIRED
>

<!ATTLIST trigger
name CDATA #REQUIRED
description CDATA #REQUIRED
>

<!ATTLIST cron
value CDATA #REQUIRED
>

<!ATTLIST startin
value CDATA #REQUIRED
>

<!ATTLIST interval
value CDATA #REQUIRED
>

<!ATTLIST repeat
value CDATA #REQUIRED
>


<!ATTLIST fact
name CDATA #REQUIRED
type CDATA #REQUIRED
value CDATA #IMPLIED
>

<!ATTLIST dict
key CDATA #REQUIRED
type CDATA #IMPLIED
value CDATA #REQUIRED
>

<!ATTLIST element
type CDATA #IMPLIED
value CDATA #REQUIRED
```

>