AUTHORIZED DOCUMENTATION

Developer Guide and Reference

Novell® PlateSpin® Orchestrate

2.6

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About This Guide

This *Developer Guide and Reference* is a component of the documentation library for PlateSpin Orchestrate. While PlateSpin Orchestrate 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 PlateSpin Orchestrate functionality. This guide provides developer information to create and run custom PlateSpin Orchestrate jobs. It also helps provides the basis to build, debug, and maintain policies using PlateSpin Orchestrate.

This guide contains the following sections:

Audience

The developer has control of a self-contained development system where he or she creates jobs and policies and tests them in a laboratory environment. When the jobs are tested and proven to function as intended, the developer delivers them to the PlateSpin Orchestrate administrator.

Prerequisite Skills

As data center managers or IT or operations administrators, it is assumed that users of the product have the following background:

- General understanding of network operating environments and systems architecture.
- Knowledge of basic Linux* shell commands and text editors.

Additional Product Documentation

In addition to this *Job Developer Guide and Reference*, PlateSpin Orchestrate 2.6 includes the following additional guides that contain valuable information about the product:

- *PlateSpin Orchestrate 2.6 Getting Started Reference*
- *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*

* *PlateSpin Orchestrate 2.6 Upgrade Guide*
* *PlateSpin Orchestrate 2.6 High Availability Configuration Guide*
* *PlateSpin Orchestrate 2.6 Administrator Reference*
* *PlateSpin Orchestrate 2.6 VM Client Guide and Reference*
* *PlateSpin Orchestrate 2.6 Virtual Machine Management Guide*
* *PlateSpin Orchestrate 2.6 Development Client Reference*
* *PlateSpin Orchestrate 2.6 Command Line Reference*
* *PlateSpin Orchestrate 2.6 Troubleshooting Reference*
* *PlateSpin Orchestrate 2.6 Server Portal Reference*

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Getting Started With Development 1

This *Developer Guide* for PlateSpin Orchestrate is intended for individuals acting as PlateSpin Orchestrate job developers. This document discusses the tools and technology required to create discrete programming scripts—called “jobs”—that control nearly every aspect of the PlateSpin Orchestrate product. The guide also explains how to create, debug, and maintain policies that can be associated with jobs running on the PlateSpin Orchestrate Server.

As a job developer, you need your own self-contained, standalone system with full access to your network environment. As a job developer, you might eventually assume all system roles: job creator, job deployer, system administrator, tester, etc. For more information about jobs, see “Jobs” in the *PlateSpin Orchestrate 2.6 Getting Started Reference*.

This section includes the following information:

- Section 1.1, “What You Should Know,” on page 11
- Section 1.2, “Prerequisites for the Development Environment,” on page 12

1.1 What You Should Know

This section includes the following information:

- Section 1.1.1, “Prerequisite Knowledge,” on page 11
- Section 1.1.2, “Setting Up Your Development Environment,” on page 12

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://www.pydev.org/) enables developers to use Eclipse* for Python and Jython development. The plug-in makes Eclipse a more robust Python IDE and comes with tools for code completion, syntax highlighting, syntax analysis, refactoring, debugging, etc.
  - **Python Reference Manual:** This reference (http://python.org/doc/2.1/ref/ref.html) describes the exact syntax and semantics but does not describe the Python Library Reference, (http://python.org/doc/2.1/lib/lib.html) which is distributed with the language and assists in development.
  - **Python Tutorial:** This online tutorial (http://python.org/doc/2.1/ref/ref.html)helps developers get started with Python.

  The PlateSpin Orchestrate Job Development Language (JDL) incorporates compact Python scripts to create job definitions to manage nearly every aspect of the PlateSpin Orchestrate grid. For more information, see Appendix B, “PlateSpin Orchestrate Job Classes and JDL Syntax,” on page 229.
- 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 PlateSpin Orchestrate infrastructure.
- Familiarity with the PlateSpin Orchestrate Development Client layout and use, as explained in the *PlateSpin Orchestrate 2.6 Development Client Reference*.
- Familiarity with basic administrative tasks, as explained in the *PlateSpin Orchestrate 2.6 Administrator Reference* and in the "The zosadmin Command Line Tool" section of the *PlateSpin Orchestrate 2.6 Command Line Reference*
- Familiarity with on-line PlateSpin Orchestrate API Javadoc as you build custom client applications. For more information see Appendix A, "PlateSpin Orchestrate Client SDK," on page 209.
- Assumption of both PlateSpin Orchestrate 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, deploying, and testing 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 "Installing the Orchestrate Agent Only" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.
2. As you get closer to a production environment, your setup might evolve to handle more complex system demands, such as any of the following:
   - An Orchestrate Server instance deployed on one computer.
   - An Orchestrate Agent installed on every managed server.
   - An Orchestrate Development Client installed on your desktop machine.

     From your desktop machine, you can build jobs/policies, and then remotely deploy them using zosadmin command linetool. You can then remotely modify the jobs and other grid object through the PlateSpin Orchestrate Development Client.
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. This will help you keep your job versions organized.
5. Create make or Ant scripts for bundling and deploying your jobs.

By leveraging the flexibility of the PlateSpin Orchestrate environment, you should not have to write jobs targeted specifically for one hypervisor technology (Xen, VMware, etc.).

1.2 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 PlateSpin Orchestrate environment. The PlateSpin Orchestrate installer ships with a Java Runtime Environment (JRE) suitable for running PlateSpin Orchestrate jobs.

- **Components to write Python-based Job Description Language (JDL) scripts:**
  - Eclipse version 3.2.1 or later. (http://www.eclipse.org/).
- **Development Environment:** Set up your environment according to the guidelines outlined in "Planning the Orchestrate Server Installation" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*. In general, the installed PlateSpin Orchestrate Server requires 2 (minimum for 100 or fewer managed resources) to 4 gigabytes (recommended for more than 100 managed resources) of RAM.
- **Network Capabilities:** For Virtual Machine Management, you need a high-speed Gigabit Ethernet. For more information about network requirements, see "PlateSpin Orchestrate VM Client" and "VM Hosts" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.
- **Initial Configuration:** After you install and configure PlateSpin Orchestrate, start in the agent and user auto registration mode as described in "First Use of Basic PlateSpin Orchestrate Components" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*. 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, make sure that this mode is deactivated.

Job Development Concepts 2

This section provides advanced conceptual information to help you create your own PlateSpin Orchestrate jobs:

2.1 Contents of a Job Package

A job package might consist of the following elements:

- Job description language (JDL) code (the Python-based script containing the bits to control jobs).
- One or more policy files, which apply constraints and other job facts to control jobs.
- Any other associated executables or data files that the job requires. For example, the `cracker.jdl` sample job includes a set of Java code that discovers the user password in every configured agent before the Java class is run.

  Many discovery jobs that measure performance of Web servers or monitor any other applications can also include resource discovery utilities that enable resource discovery.

Section 3.2, “JDL Package,” on page 36 provides more information about job elements.

2.2 JDL Job Scripts

This section contains the following information:

2.2.1 What is JDL?

The PlateSpin Orchestrate job definition language (JDL) is an extended and embedded implementation of Python. The PlateSpin Orchestrate 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 movement of files across the infrastructure.
- Automatic distribution of parallel operations
- Failover logic

For more information about the PlateSpin Orchestrate JDL script editor, see Section 3.2, "JDL Package," on page 36.

The JDL language allows for the scripted construction of logic that can be modified by external parameters and constraints (through one or more associated policies) at the time the job instance is executed. 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, "PlateSpin Orchestrate Job Classes and JDL Syntax," on page 229.

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. If none are specified, all resources match. The `exampleJoblet` class would typically execute some process or test based on unique parameters.

2.2.2 Using Facts in Job Scripts

This section contains the following information:

- "Fact Values" on page 17
- "Fact Operations in the Joblet Class" on page 17
- "Using the Policy Debugger to View Facts" on page 18

Fact Values

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 Section 2.3.2, "Job Arguments and Parameter Lists in Policies," on page 19, 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 240).

Fact Operations in the Joblet Class

Each joblet is also a Grid object with its own set of well known facts. These facts are listed in Section B.2, "Joblet Class," on page 229. An instance of the Joblet class runs on the resource. The joblet instance on the resource has access to the fact set of the resource where it is running. The resource fact set has no meaning outside of this execution context, because the Joblet can be scheduled to run on any of the resources that match the resource and allocation constraints.

For example, using the `cracker` job example shown in "Job Arguments and Parameter Lists in Policies" on page 19, you would write the following JDL code to retrieve the `cryptpw` job argument fact, the OS family fact for the resource, the Job instance ID fact, and the joblet number:

```
1 class CrackerJoblet(Joblet):
2    def joblet_started_event(self):
3        pw = self.getFact("jobargs.cryptpw")
4        osfamily = self.getFact("resource.os.family")
5        jobid = self.getFact("jobinstance.id")
6        jobletnum = self.getFact("joblet.number")
```

In line 3, the function `getFact()` retrieves the value of the job argument fact. `getFact()` is invoked on the joblet instance grid object. In line 4, the `resource.os.family` fact is retrieved for the resource where the Joblet is being executed. This varies, depending on which resource the Joblet is scheduled to run on. In line 5, the ID fact for the job instance is retrieved. This changes for every job instance. In line 6, the joblet index number for this joblet instance is returned. The index is 0 based.

Using the Policy Debugger to View Facts

The Policy Debugger page of the PlateSpin Orchestrate Development Client provides a table view of all facts in a running or completed job instance. This view includes the Job instance facts (`jobinstance.*` namespace) and the facts from the job context. After you select the Policy Debugger tab in the Job Monitor view, the right side panel displays this fact table. For more details, see “The Policy Debugger” in the *PlateSpin Orchestrate 2.6 Development Client Reference*.

2.3 Policies

Policies are XML-based files that aggregate the resource facts and constraints that are used to control resources. This section includes the following information about policies:

- Section 2.3.1, “Policy Types,” on page 18
- Section 2.3.2, “Job Arguments and Parameter Lists in Policies,” on page 19
- Section 2.3.3, “The Role of Policy Constraints in Job Operation,” on page 21

For information about facts, see Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53.

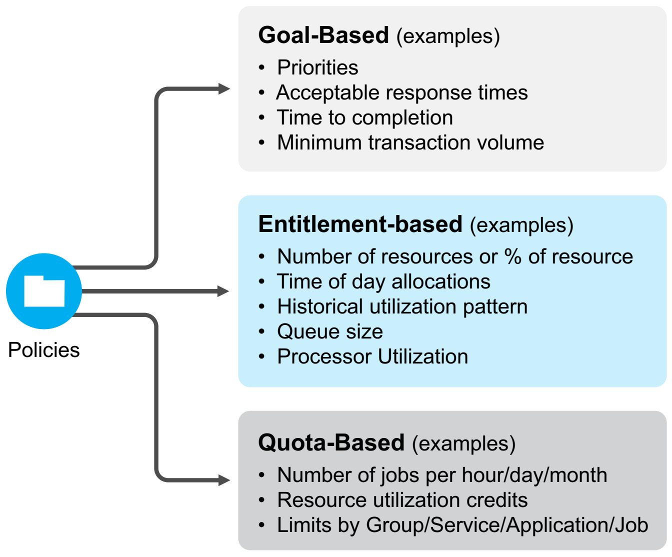
2.3.1 Policy Types

Policies are used to enforce quotas, job queuing, resource restrictions, permissions, etc. They can be associated with various grid objects (jobs, users, resources, etc.). The policy example below shows a constraint that limits the number of running jobs to a defined value, while exempting certain users from this limit. Jobs started that 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>
```

Policies can be based on goals, entitlements, quotas, and other factors, all of which are controlled by jobs.

***Figure 2-1** Policy Types and Examples*


Goal-Based (examples)
• Priorities
• Acceptable response times
• Time to completion
• Minimum transaction volume
Entitlement-based (examples)
• Number of resources or % of resource
• Time of day allocations
• Historical utilization pattern
• Queue size
• Processor Utilization
Quota-Based (examples)
• Number of jobs per hour/day/month
• Resource utilization credits
• Limits by Group/Service/Application/Job
Policies

2.3.2 Job Arguments and Parameter Lists in Policies

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, which is typically given 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 being 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, 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 Job Scheduler, either with the PlateSpin Orchestrate Development Client or by a `.sched` file.

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 `jobargs` 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's XML policy for every given job.

The job argument fact values can be passed to a job with any of the following methods used for running a job:.

- as command-line arguments to the `zos run` command
- from the Job Arguments tab of the Job Scheduler in the Development Client
- from the Server Portal
- through the `runJob()` method of the JDL Job class

Consequently, the Orchestrate 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 when you use the Server 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 143).

As noted, when running a job, you can pass in a policy to control job behavior. Policy files define 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
```

2.3.3 The Role of Policy Constraints in Job Operation

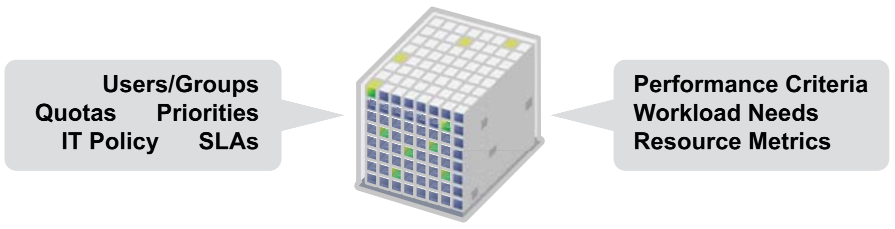
This section includes the following information:

- "How Constraints Are Used" on page 21
- "Constraint Types" on page 23
- "Scheduling with Constraints" on page 26
- "Constraints Constructed in JDL" on page 27

How Constraints Are Used

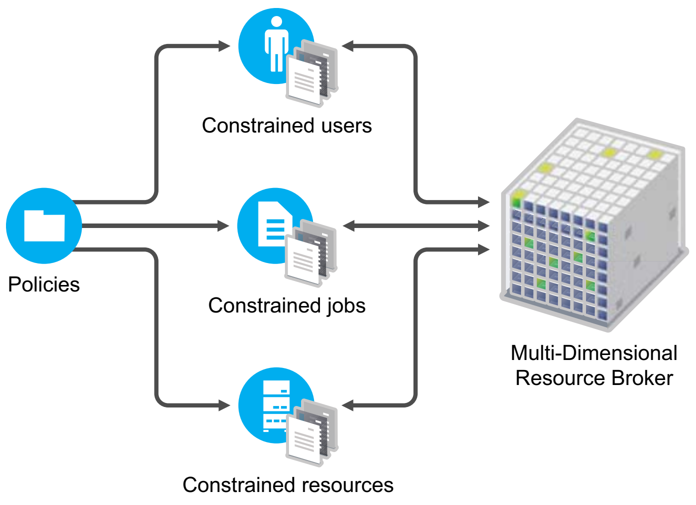
PlateSpin Orchestrate lets you create jobs that meet the infrastructure scheduling and resource management requirements of your data center, as illustrated in the following figure.

Figure 2-2 *Multi-Dimensional Resource Scheduling Broker*



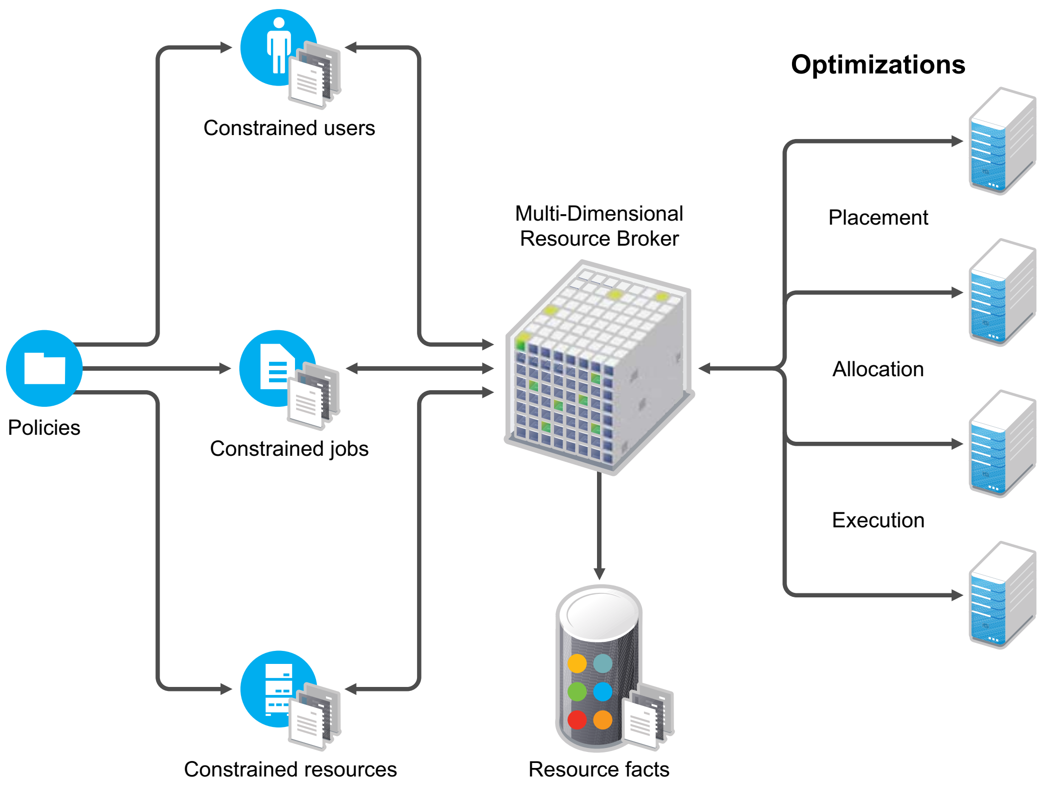
There are many combinations of constraints and scheduling demands on the system that can be managed by the highly flexible PlateSpin Orchestrate Resource Broker. As shown in the figure below, many object types are managed by the Resource Broker. Resource objects are discovered (see Section 2.4, "Resource Discovery," on page 28). Other object types such as users and jobs can also be managed. All of these object types have "facts" that define their specific attributes and operational characteristics. PlateSpin Orchestrate compares these facts to requirements set by the administrator for a specific data center task. These comparisons are called "constraints."

Figure 2-3 *Policy-Based Resource Management Relying on Various Constraints*



A policy is an XML file that specifies (among other things) constraints and fact values. Policies govern how jobs are dynamically scheduled based on various job constraints. These job constraints are represented in the following figure.

Figure 2-4 *Policy-Based Job Management*



The Resource Broker allocates or “dynamically schedules” resources based on the runtime requirements of a job (for example, the necessary CPU type, OS type, and so on) rather than allocating a specific machine in the data center to run a job. These requirements are defined inside a job policy and are called “resource constraints.” In simpler terms, in order to run a given job, the Resource Broker looks at the resource constraints defined in a job and then allocates an available resource that can satisfy those constraints.

Constraint Types

The constraint element of a policy can define the selection and allocation of Grid objects (such as resources) in a job. The required type attribute defines the selection type.

The following list explains how constraint types are applied in a job’s life cycle through policies:

- **accept:** A job-related constraint used to prevent work from starting; enforces a hard quota on the jobs. If the constraint is violated, the job fails.
- **start:** A job-related constraint used to queue up work requests; limits the quantity of jobs or the load on a resource. If the constraint is violated, the job stays queued.
- **continue:** A job-related constraint used to cancel jobs; provides special timeout or overrun conditions. If the constraint is violated, the job is canceled.
- **provision:** A joblet-related constraint (for resource selection) used to control automatic provisioning.

  Provision constraints are used by the Orchestrate Broker as it evaluates VMs or VM templates tthat could be automatically provisioned to satisfy a scheduled joblet. By default, a job’s `job.provision.maxcount` fact is set to 0, which means no automatic provisioning. If this value is greater than 0 and a joblet cannot be allocated to a physical resource, the provision constraints are evaluated to find a suitable VM or a VM template to provision that also satisfies the allocation and resource constraints.
- **allocation:** A joblet-related constraint (for resource selection) used to put jobs in a waiting state when the constraint is violated.
- **resource:** A joblet-related constraint (for resource selection) used to select specific resources. The joblet is put in a waiting state if the constraint is violated.
- **vmhost:** A VM-related constraint used to define a suitable VM host and repository for VM provisioning.
- **repository:** A VM-related constraint used to define a suitable repository for the storage of a VM.

  It is possible to create or edit a policy that constrains a repository during VM provisioning; however, a `vmhost` constraint type must be used, rather than a `repository` constraint type.

  For example:

  ```
  <constraint type="vmhost">
      <eq fact="repository.id" value="XXXX"/>
  </constraint>
  ```
- **authorize:** A VM-related constraint evaluated before a `vmhost` or `repository` constraint.

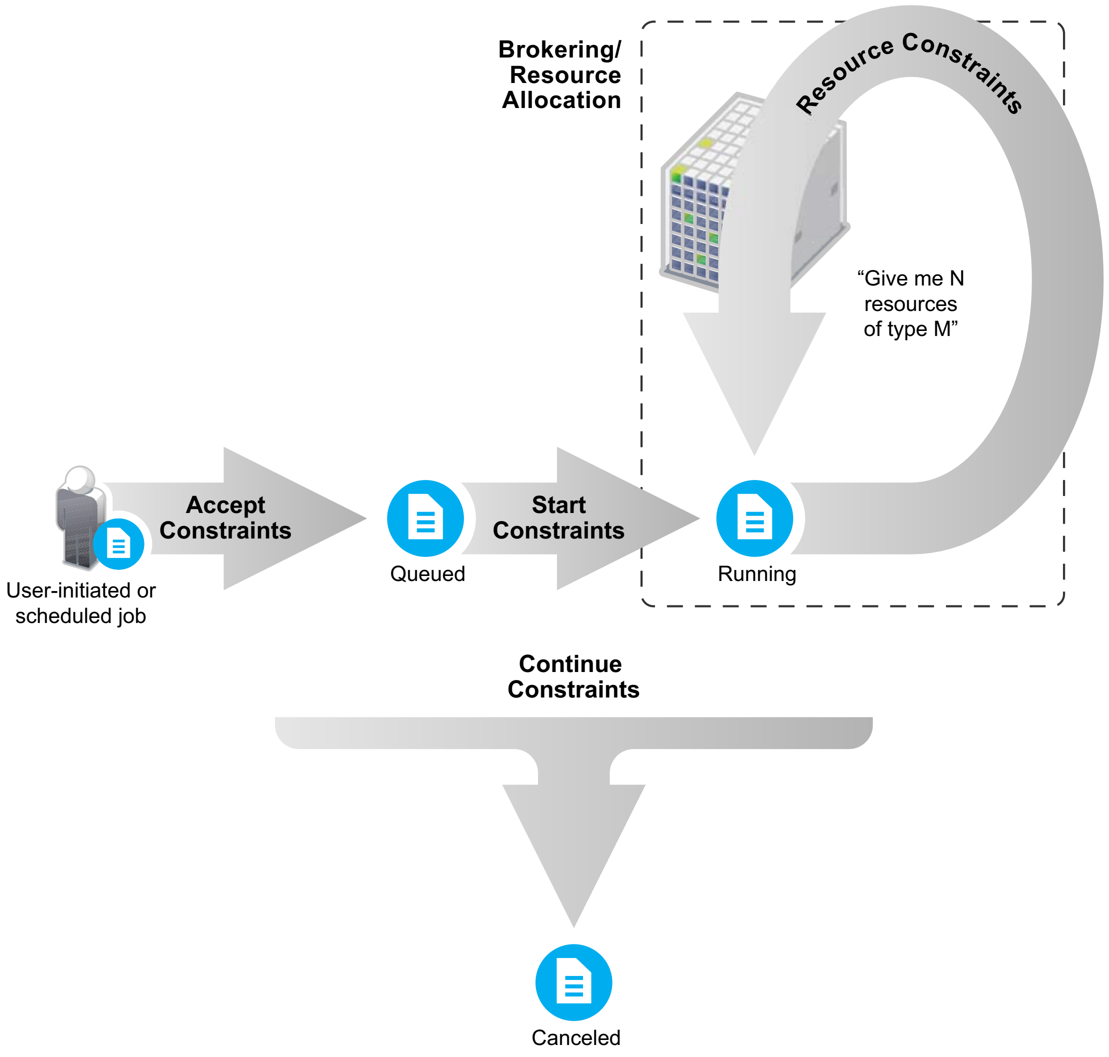
While `allocation` constraints are continuously evaluated, the results of `resource` constraints are cached for a short period of time (30 seconds). This difference allows you as a job writer to separate constraints between those that require an immediate check of a constantly changing fact, and those that require fewer checks because the fact changes infrequently.

For example, a resource's OS type might be unlikely to change, so a constraint that checks this fact fits in the `resource` constraint type (the assumption is that resource facts change infrequently, especially if they are used for determining joblet assignment). In contrast, a job instance fact can be changed frequently by a job instance, so a constraint that checks a job instance fact should fit in the `allocation` constraint type.

All of these constraints are visible and can be tested in the Policy Debugger in the PlateSpin Orchestrate Development Client.

A job's life cycle as determined by constraints is illustrated in the following figure.

***Figure 2-5** Constraint-Based Job State Transition*



The following three figures provide more detail about the sequence of a job initiated by a user and the constraints it must satisfy before it runs. The diagrams are not intended to represent a finely-detailed flow, with every possible constraint, action, or state, but they do illustrate a high-level constraint workflow.

Figure 2-6 *VM-related Constraint Workflow*

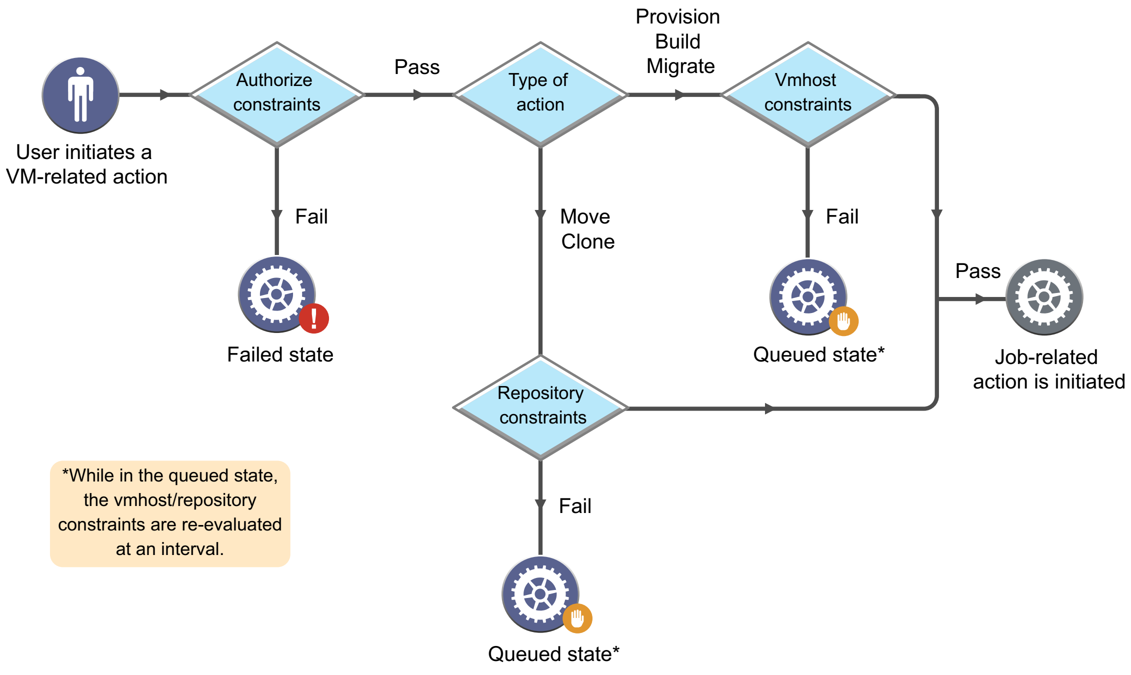


Figure 2-7 *Job-related Constraint Workflow*

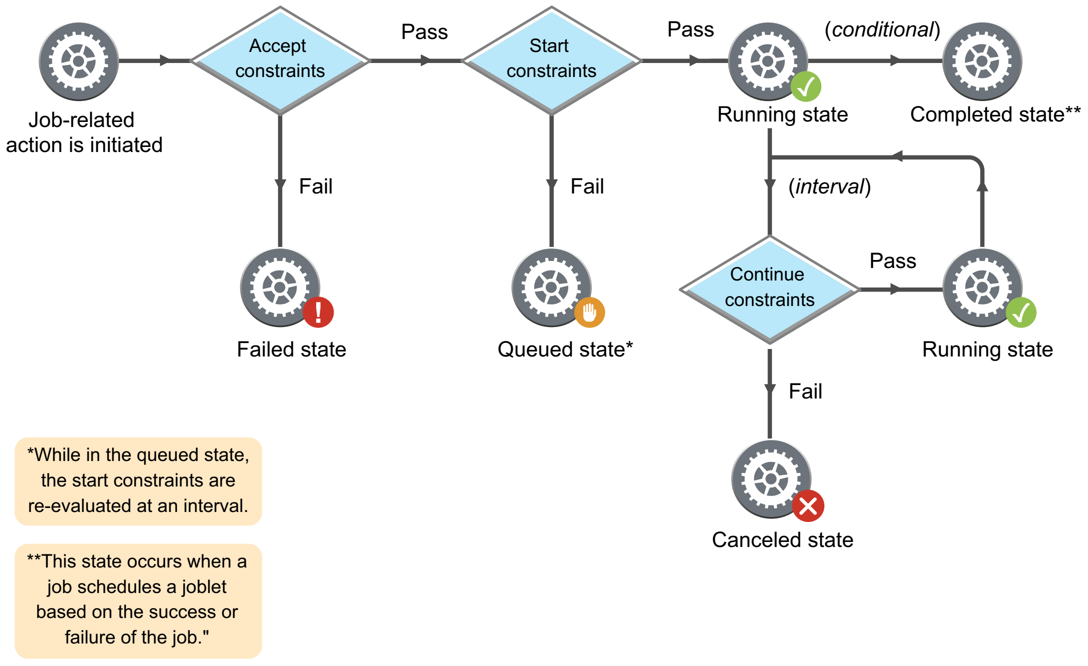
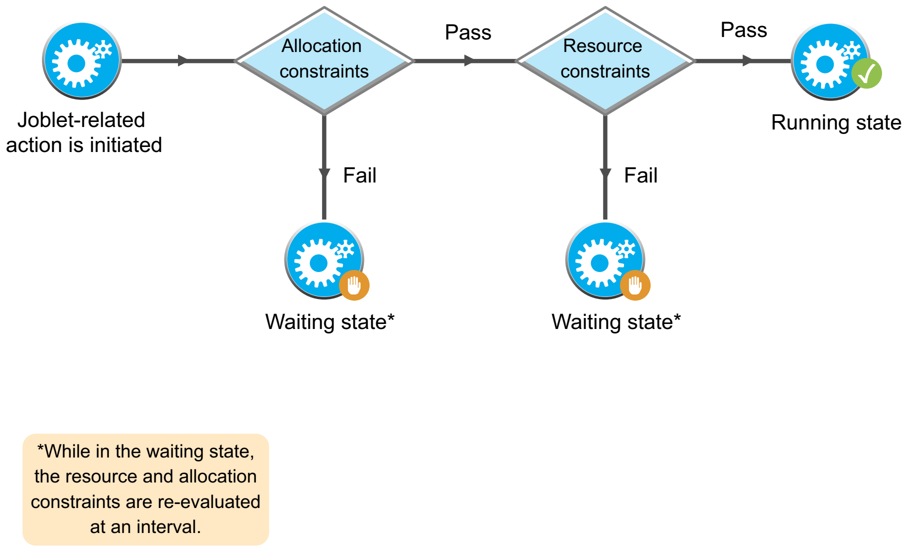

Job-related action is initiated
Accept constraints
Pass
Fail
Failed state
Start constraints
Pass
Fail
Queued state*
Running state
(conditional)
Completed state**
(interval)
Continue constraints
Pass
Running state
Fail
Canceled state
*While in the queued state, the start constraints are re-evaluated at an interval.
**This state occurs when a job schedules a joblet based on the success or failure of the job."

Figure 2-8 Joblet-related Constraint Workflow


Joblet-related action is initiated
Allocation constraints
Pass
Resource constraints
Pass
Running state
Fail
Fail
Waiting state*
Waiting state*
*While in the waiting state, the resource and allocation constraints are re-evaluated at an interval.

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.

You can also set constraints through the use of deployed policies, and you can use jobs to specify additional constraints that can further restrict a particular job instance. The figure below shows the complete process employed by the Orchestrate 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 where constraints can be executed.

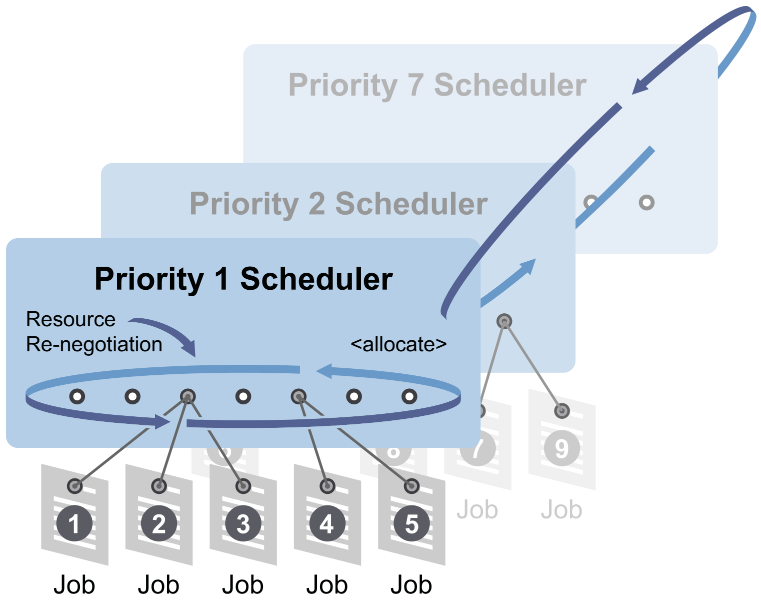
The Job Scheduling Manager applies a logic ANDing of job constraints (specified in the policies), grid policy constraints (set on the server), optionally additional user-defined constraints specified on job submission, and optional constraints specified by the resources.

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

- Available resources
- Pre-emptable 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 along with minimum acceptable allocation information. The Job Scheduling Manager uses all of this data to appropriate resources for all jobs within the same priority group.

Figure 2-9 *Job Scheduling Priority*



As the Job Scheduling Manager continually re-evaluates the allocation of resources, it relies on the job policies as part of its real-time algorithm to help provide versatile and powerful job scheduling.

Setting up a constraint for use by the Job Scheduling Manager is accomplished by adding a constraint in the job policy. For example, you might write just a few lines of policy code to describe a job requiring 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>
```

Constraints Constructed in JDL

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.

When you create constraints, it is sometimes useful to access facts on a Grid object that is not in the context of the constraint evaluation. An example scenario would be to sequence the running of jobs triggered by the Job Scheduler.

In this example, you need to make `job2` run only when all instances of `job1` are complete. To do this, you could add the following start constraint to the `job2` definition:

```
<constraint type="start">
  <eq fact="job[job1].instances.active" value="0"/>
</constraint>
```

Here, the job in the context is `job2`, however the facts on `job1` (instances.active) can still be accessed. The general form of the fact name is:

```
<grid_object_type>[<grid_object_name>].rest.of.fact.space
```

PlateSpin Orchestrate supports specific Grid object access for the following Grid objects:

- Jobs
- Resources (physical or virtual machines)
- VM hosts (physical machines hosting guest VMs)
- Virtual Disks
- Virtual NICs
- Repositories
- Virtual Bridges
- Users

Currently, explicit group access is not supported.

For more detailed information, see the following JDL constraint definitions:

- AndConstraint (page 235)
- BinaryConstraint (page 235)
- Constraint (page 236)
- ContainerConstraint (page 237)
- ContainsConstraint (page 237)
- DefinedConstraint (page 238)
- EqConstraint (page 238)
- GeConstraint (page 240)
- GtConstraint (page 240)
- LeConstraint (page 242)
- LtConstraint (page 243)
- NeConstraint (page 244)
- NotConstraint (page 244)
- OrConstraint (page 245)
- UndefinedConstraint (page 247)

2.4 Resource Discovery

Resource discovery jobs inspect a resource's environment to set resource facts that are to be stored with the Resource grid object. These jobs automatically discover the resource attributes (fully extensible facts relating to such things as CPU, memory, storage, bandwidth, load, software inventory) of the resources being managed by the PlateSpin Orchestrate Server. These facts are later used during PlateSpin Orchestrate runtime from within a policy or constraint to select resources that have certain identifiable attributes.

- Section 2.4.1, "Resource Discovery in Provisioning Jobs," on page 29
- Section 2.4.2, "Some Specific Resource Discovery Jobs," on page 29

For more information, see "Walkthrough: Observing Discovery Jobs" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*, and "Discovering Registered VM Hosts" in the *PlateSpin Orchestrate 2.6 VM Client Guide and Reference*.

2.4.1 Resource Discovery in Provisioning Jobs

Provisioning jobs (also known as "provisioning adapters") are used to discover VM hosts (those resources running a VM technology such as Xen, VMware, or Hyper-V) and VM image repositories (such as Amazon EC2), as well as VM images residing in those repositories.

For more information, see "Configuring VM Provisioning Adapters and Discovered VMs" in the *PlateSpin Orchestrate 2.6 Virtual Machine Management Guide*.

2.4.2 Some Specific Resource Discovery Jobs

Some of the commonly used resource discovery jobs include:

- "cpuInfo.job" on page 29
- "demoInfo.job" on page 29
- "findApps.job" on page 29
- "osInfo.job" on page 29

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 datagrid.

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`.

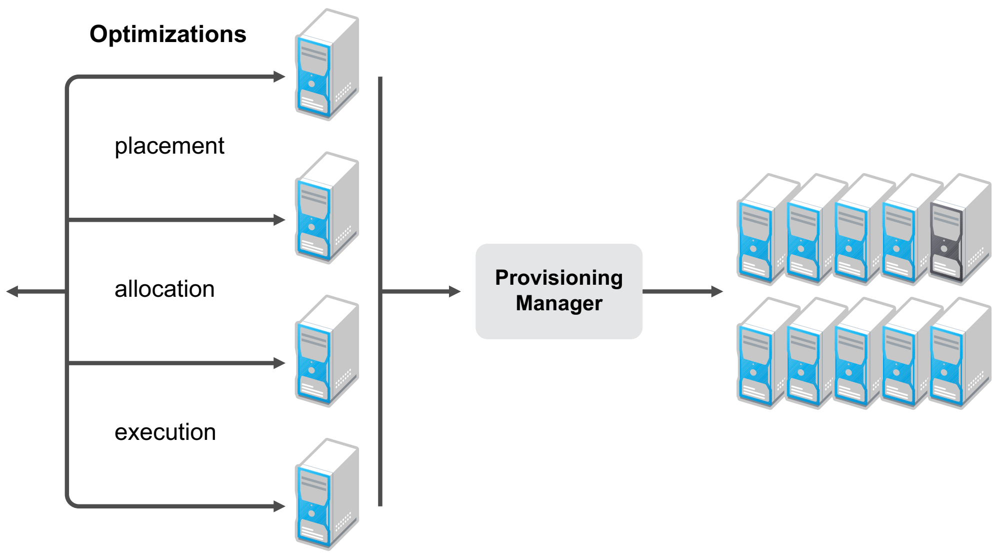
```
resource.cpu.mhz (integer) e.g., "800" (in Mhz)
resource.cpu.vendor (string) e.g. "GenuineIntel"
resource.cpu.model (string) e.g. "Pentium III"
resource.cpu.family (string) e.g. "i686"
```

2.5 Workload Management Performed by the Provisioning Manager

The Orchestrate Server uses a Provisioning Manager to allocate (assign) and preempt (reassign) resources.

The Provisioning Manager preempts a resource by monitoring the job queue that is waiting for allocation. The manager then compares the job's relative priority to jobs already consuming resources. Higher priority jobs can preempt lower priority jobs.

Figure 2-10 *Workload Management*



Depending on the tasks that applications might require, the Orchestrate Server submits the required jobs to one or more of the connected managed resources to perform specific tasks.

For more information about how job scheduling and provisioning works, see the following sections:

- Chapter 8, "Job Scheduling," on page 197
- Section 6.6, "Automatically Provisioning a VM," on page 124
- Examples: dgtest.job (page 148)

2.6 Deploying Packaged Job Files

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

- Copying job files into the "hot" Orchestrate Server deployment directory. See "Deploying a Sample System Job" in the *PlateSpin Orchestrate 2.6 Development Client Reference*.
- Using the Orchestrate Development Client. This process is discussed in Section 3.5.1, "Using the PlateSpin Orchestrate Development Client to Deploy Jobs," on page 40.
- Using the PlateSpin Orchestrate command line (CLI) tools. This process is discussed in Section 3.5.2, "Using the zosadmin Command Line Tool to Deploy Jobs," on page 40.

2.7 Running Your Jobs

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

- **Command Line Interface:** Nearly all PlateSpin Orchestrate 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 CLI information is available in the zos command line tool.

- **Server Portal:** After PlateSpin Orchestrate is installed, you can use the PlateSpin Orchestrate Server Portal to run jobs. This process is discussed in the *PlateSpin Orchestrate 2.6 Server Portal Reference*.
- **Custom Client:** The PlateSpin Orchestrate toolkit provides an SDK that provides a custom client that can invoke your custom jobs. This process is discussed in Appendix A, "PlateSpin Orchestrate Client SDK," on page 209.
- **Built-in Job Scheduler:** The Orchestrate Server uses a built-in Job Scheduler to run deployed jobs. This tool is discussed in Chapter 8, "Job Scheduling," on page 197 and in "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference*.
- **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 197.

2.8 Monitoring Job Results

PlateSpin Orchestrate lets you monitor jobs by using the same methods outlined in Section 2.7, "Running Your Jobs," on page 30.

This section includes the following information:

- Section 2.8.1, "Monitoring Jobs from the Command Line," on page 31
- Section 2.8.2, "Monitoring Jobs from the Server Portal," on page 32

2.8.1 Monitoring Jobs from the Command Line

The following example shows the status of the job `ray.buildtest.18` using different monitoring interfaces:

```
zos status -e ray.buildtest.18

Job Status for ray.buildtest.18
-------------------------------
              State: Completed      (0 this job)
     Resource Count: 0
   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 02-02-09 1705 , failed: 1, Run: 5,
                     Passed: 4
           Priority: medium
          Arguments: <none>

        Submit Time: 02/02/2009 01:46:12
      Delayed Start: n/a
         Start Time: 02/02/2009 01:46:12
```

```
          End Time: 01/01/1009 01:46:14
      Elapsed Time: 0:00:01
        Queue Time: 0:00:00
        Pause Time: 0:00:00

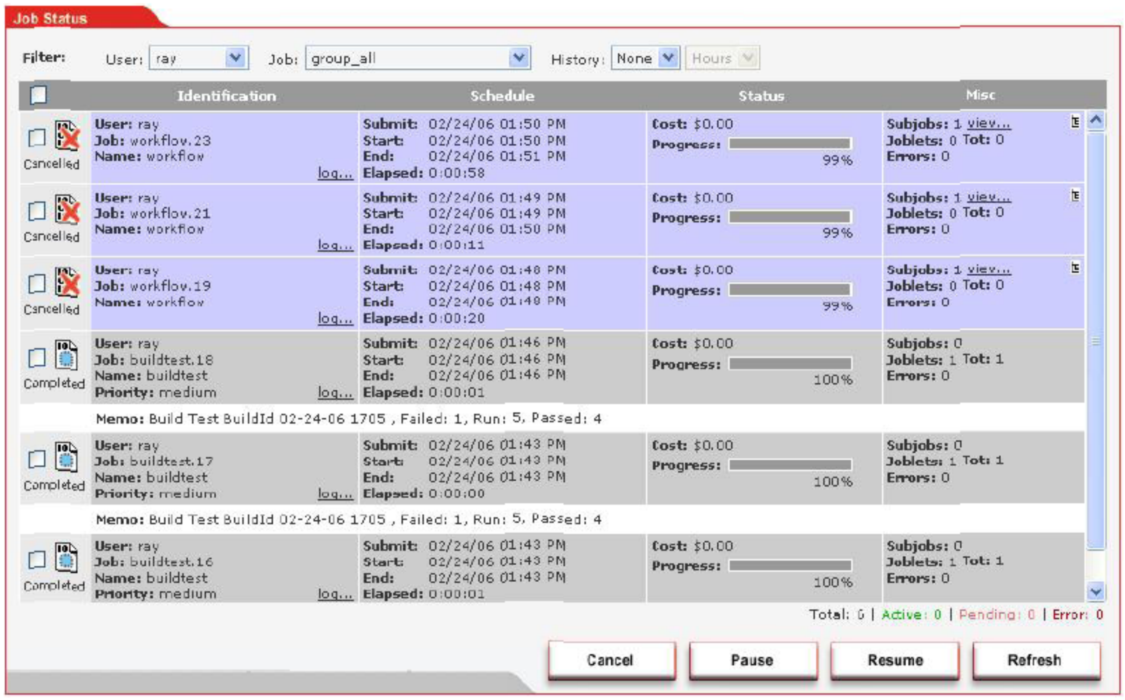
    Total CPU Time: 0:00:00        (0:00:00 this job)
     Total GCycles: 0:00:00        (0:00:00 this job)
        Total Cost: $0.0002        ($0.0002 this job)
         Burn Rate: $0.0003/hr     (0.0003/hr this job)
```

The bottom section of the status report shows that you can also monitor job costing metrics, which are quite minimal in this example. More sophisticated job monitoring is possible.

2.8.2 Monitoring Jobs from the Server Portal

You can use the status page of the Server Portal to monitor jobs. In this example, the job memo field is displayed.

Figure 2-11 *Server Portal Job Monitoring Example*



Job Status

Filter: User: ray Job: group_all History: None Hours

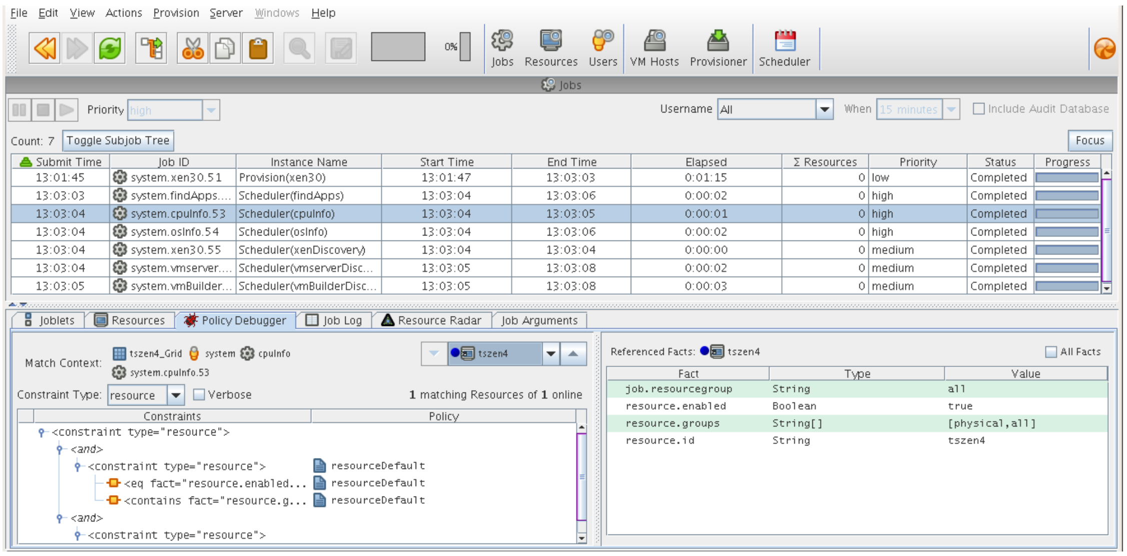
	Identification	Schedule	Status	Misc
Cancelled	**User:** ray **Job:** workflow.23 **Name:** workflow log...	**Submit:** 02/24/06 01:50 PM **Start:** 02/24/06 01:50 PM **End:** 02/24/06 01:51 PM **Elapsed:** 0:00:58	**Cost:** $0.00 **Progress:** 99%	**Subjobs:** 1 view... **Joblets:** 0 **Tot:** 0 **Errors:** 0
Cancelled	**User:** ray **Job:** workflow.21 **Name:** workflow log...	**Submit:** 02/24/06 01:49 PM **Start:** 02/24/06 01:49 PM **End:** 02/24/06 01:50 PM **Elapsed:** 0:00:11	**Cost:** $0.00 **Progress:** 99%	**Subjobs:** 1 view... **Joblets:** 0 **Tot:** 0 **Errors:** 0
Cancelled	**User:** ray **Job:** workflow.19 **Name:** workflow log...	**Submit:** 02/24/06 01:48 PM **Start:** 02/24/06 01:48 PM **End:** 02/24/06 01:48 PM **Elapsed:** 0:00:20	**Cost:** $0.00 **Progress:** 99%	**Subjobs:** 1 view... **Joblets:** 0 **Tot:** 0 **Errors:** 0
Completed	**User:** ray **Job:** buildtest.18 **Name:** buildtest **Priority:** medium log...	**Submit:** 02/24/06 01:46 PM **Start:** 02/24/06 01:46 PM **End:** 02/24/06 01:46 PM **Elapsed:** 0:00:01	**Cost:** $0.00 **Progress:** 100%	**Subjobs:** 0 **Joblets:** 1 **Tot:** 1 **Errors:** 0
	Memo: Build Test BuildId 02-24-06 1705 , Failed: 1, Run: 5, Passed: 4			
Completed	**User:** ray **Job:** buildtest.17 **Name:** buildtest **Priority:** medium log...	**Submit:** 02/24/06 01:43 PM **Start:** 02/24/06 01:43 PM **End:** 02/24/06 01:43 PM **Elapsed:** 0:00:00	**Cost:** $0.00 **Progress:** 100%	**Subjobs:** 0 **Joblets:** 1 **Tot:** 1 **Errors:** 0
	Memo: Build Test BuildId 02-24-06 1705 , Failed: 1, Run: 5, Passed: 4			
Completed	**User:** ray **Job:** buildtest.16 **Name:** buildtest **Priority:** medium log...	**Submit:** 02/24/06 01:43 PM **Start:** 02/24/06 01:43 PM **End:** 02/24/06 01:43 PM **Elapsed:** 0:00:01	**Cost:** $0.00 **Progress:** 100%	**Subjobs:** 0 **Joblets:** 1 **Tot:** 1 **Errors:** 0

Total: 6 | Active: 0 | Pending: 0 | Error: 0

2.9 Debugging Jobs

The following view of the Development Client shows how you can determine 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 2-12 *Debugging Jobs Using the Orchestrate Development Client*



Priority high

Username All

When 15 minutes

Include Audit Database

Count: 7 Toggle Subjob Tree

Focus

Submit Time	Job ID	Instance Name	Start Time	End Time	Elapsed	Σ Resources	Priority	Status	Progress
13:01:45	system.xen30.51	Provision(xen30)	13:01:47	13:03:03	0:01:15	0	low	Completed	
13:03:03	system.findApps....	Scheduler(findApps)	13:03:04	13:03:06	0:00:02	0	high	Completed	
13:03:04	system.cpuInfo.53	Scheduler(cpuInfo)	13:03:04	13:03:05	0:00:01	0	high	Completed	
13:03:04	system.osInfo.54	Scheduler(osInfo)	13:03:04	13:03:06	0:00:02	0	high	Completed	
13:03:04	system.xen30.55	Scheduler(xenDiscovery)	13:03:04	13:03:04	0:00:00	0	medium	Completed	
13:03:04	system.vmserver....	Scheduler(vmserverDisc...	13:03:05	13:03:08	0:00:02	0	medium	Completed	
13:03:05	system.vmBuilder...	Scheduler(vmBuilderDisc...	13:03:05	13:03:08	0:00:03	0	medium	Completed	

Match Context: tszen4_Grid system cpuInfo system.cpuInfo.53

tszen4

Constraint Type: resource Verbose

1 matching Resources of **1** online

Constraints	Policy
`<constraint type="resource">`	
`  <and>`	
`    <constraint type="resource">`	resourceDefault
`      <eq fact="resource.enabled...`	resourceDefault
`      <contains fact="resource.g...`	resourceDefault
`  <and>`	
`    <constraint type="resource">`	

Referenced Facts: tszen4

All Facts

Fact	Type	Value
job.resourcegroup	String	all
resource.enabled	Boolean	true
resource.groups	String[]	[physical,all]
resource.id	String	tszen4

The policy debugger shows the blocking constraint, and the tooltip gives the reason. If you drag and drop to add resources to the required group, the job continues quickly with no restart.

3 Job Architecture

The PlateSpin Orchestrate Job Scheduler 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:

3.1 Understanding JDL

The PlateSpin Orchestrate 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 Orchestrate 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 241) class) defines a method as follows:

```
def my_custom_event(self, params):
  print Got a my_custom event carrying ", params
```

And the joblet (Joblet (page 241) class) sends an event/message as follows:

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

NOTE: The event being sent has to be the same name as the defined method receiving the event.

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.

TIP: If you utilize the sys module in custom JDL files that you use in PlateSpin Orchestrate, an "import sys" directive must be included in the file in the appropriate place. In prior versions of PlateSpin Orchestrate, you were not required to explicitly import the sys module, but this changed in version 2.5.

In PlateSpin Orchestrate 2.6, if this import is not performed, you see the following error message:

```
NameError: name 'sys' is not defined
```

3.2 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 PlateSpin Orchestrate Development Client 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.

3.2.1 .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 `.sched` file. The discovery job "osInfo.job" on page 29 has a schedule XML file that specifies to always run a specified job whenever a specific resource is started and becomes available.

3.3 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 3.3.1, "Job State Transition Events," on page 37.

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. A Resource is a physical or virtual machine on which the Orchestrate Agent is installed and running and where the Joblet code is executed.

3.3.1 Job State Transition Events

Each job has a set of events that are invoked at the state transitions 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.

3.3.2 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 following 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 PlateSpin Orchestrate client command line tool:

```
zos event <jobid_of_running_job> 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", {"directory_to_list":"/tmp"} )
```

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 240) 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)
```

For further details about each of the events above, see Section B.1, "Job Class," on page 229.

The following example uses the `joblet_started_event` to determine the resource a Joblet is running on. If you implement the `joblet_started_event` job method, your job is notified when a Joblet has started execution:

```
1  class test(Job):
2     def job_started_event(self):
3         self.schedule(TestJoblet)
4
5   def joblet_started_event(self,jobletNum,resourceId):
6        print "joblet %d is running on  %s" % (jobletNum, resourceId)
7
8  class TestJoblet(Joblet):
9    def joblet_started_event(self):
10       import time
11       time.sleep(10)
```

In lines 5 and 6, the `joblet_started_event` is notified when the instance of `TestJoblet` is executing on a resource.

3.4 Job Invocation

Jobs can be started using either the zos command line tool, scheduling through a `.sched` file, or manually through the PlateSpin Orchestrate Development Client. 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.

3.5 Deploying Jobs

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

- Section 3.5.1, "Using the PlateSpin Orchestrate Development Client to Deploy Jobs," on page 40
- Section 3.5.2, "Using the zosadmin Command Line Tool to Deploy Jobs," on page 40

3.5.1 Using the PlateSpin Orchestrate Development Client to Deploy Jobs

1. In the *Actions* menu, click *Deploy Job*.
2. For additional deployment details, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

3.5.2 Using the zosadmin Command Line Tool to Deploy Jobs

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 Orchestrate Server to perform.
2. Use the preconfigured JDL files for specific tasks listed in Appendix B, "PlateSpin Orchestrate Job Classes and JDL Syntax," on page 229.
3. To configure jobs, edit the JDL file with an external text editor.

4. Repackage the job as a `.jar` file.

   NOTE: The job could also be packaged and sent as an "exploded" file.

5. Run the zos CLI administration tool to redeploy the packaged job into the Orchestrate Server.
6. Run the job using the zos command line tool.
7. Monitor the results of the job in the PlateSpin Orchestrate Development Client.

Another method to deploy jobs is to edit JDL files through the Orchestrate Development Client. The Development Client 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 Orchestrate Development Client, 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 Orchestrate Server. The Orchestrate Development Client has a *Save File* menu option if you want to preserve JDL modifications you made using the Orchestrate Development Client.

There is no way "undo" a change to a `.jdl` file after the JDL editor in the Orchestrate Development Client has saved the file, nor is there a method for rolling back to a previously deployed version. We recommend that you use an external source code control system such as CVS or SVN for version control.

3.6 Starting PlateSpin Orchestrate Jobs

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

- Running jobs from the `zos` command line (see "The zos Command Line Tool" in the *PlateSpin Orchestrate 2.6 Command Line Reference*).
- Running jobs from the PlateSpin Orchestrate Job Scheduler (see "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference*).
- Running jobs from Web applications (see "Using the PlateSpin Orchestrate Server Portal" in the *PlateSpin Orchestrate 2.6 Server Portal Reference*).
- Running jobs from within jobs (see Section 2.2.2, "Using Facts in Job Scripts," on page 16).

3.7 Using Other Grid Objects

Grid objects can be created and 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 243) 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")
```

In Line 1, the `ResourceInfo` Grid object for `webserver` is retrieved. The `getMatrix()` built-in function retrieves the `MatrixInfo` object instance. `getGridObject()` is a method on the `MatrixInfo` class. In Line 2, the fact value for the resource fact `resource.id` is retrieved.

The `MatrixInfo` Grid object also provides functions for creating other Grid objects. For more complete information about these functions, see MatrixInfo (page 243).

The `MatrixInfo` object can be used in both `Job` and `Joblet` classes. In the `Joblet` class, `MatrixInfo` cannot create new Grid objects. If your job is required to create Grid objects, you must use `MatrixInfo` in the Job class.

3.8 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 transitioned 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 directly or indirectly with any other partition of a job by 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 signaling 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 241) and Section B.7, “Joblet State Values,” on page 232.

3.8.1 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 241) and Joblet (page 241) documentation.

3.8.2 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.

3.9 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 239).

3.9.1 Output Handling

The Exec (page 239) 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
```

3.9.2 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 3-1 *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 Orchestrate Agent. A resource might not support PlateSpin Orchestrate 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.

3.9.3 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 3.11, "Improving Job and Joblet Robustness," on page 47.

```
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.

3.10 Logging and Debugging

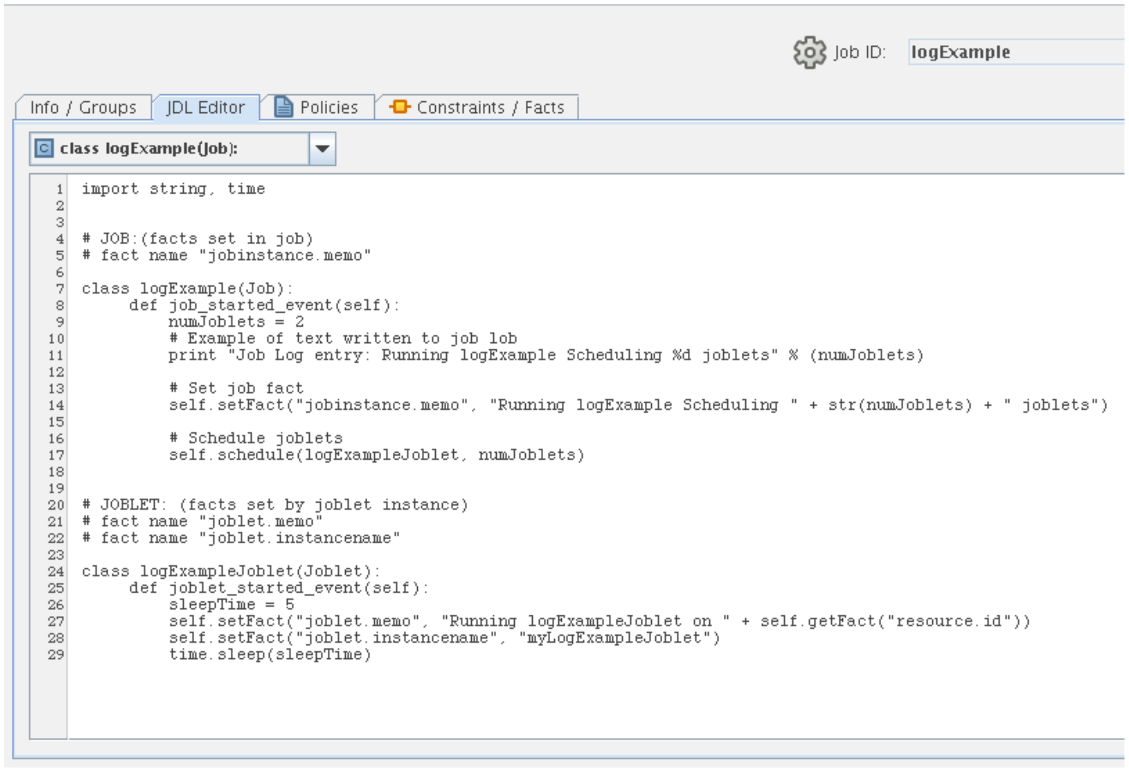
The following sections show some examples how jobs can be logged and debugged:

- Section 3.10.1, "Creating a Job Memo," on page 45
- Section 3.10.2, "Tracing," on page 47

3.10.1 Creating a Job Memo

The following job example shows `logExample.jdl` output inthe JDL editor of the Orchestrate Development Client.

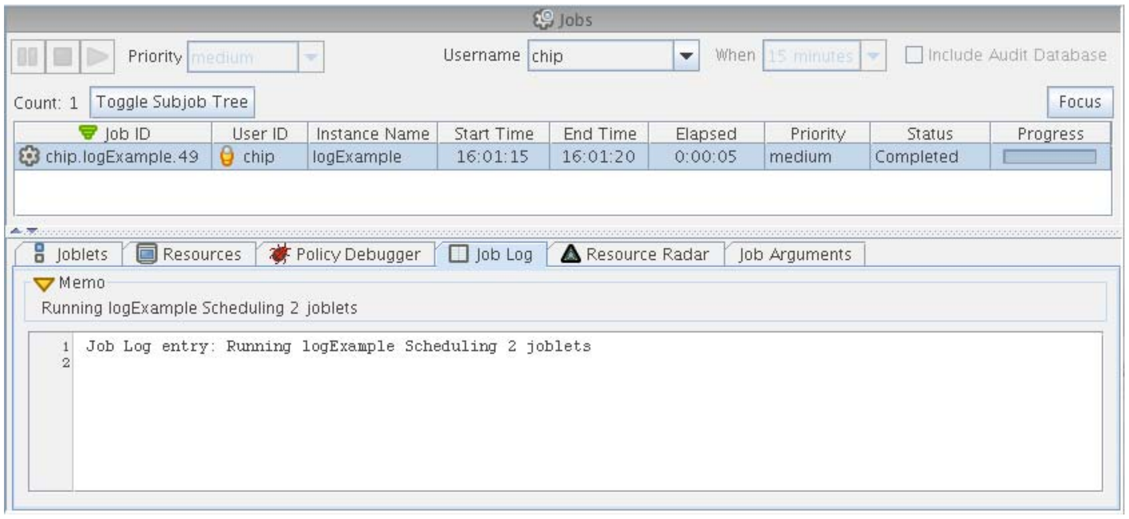
Figure 3-1 Example Job Displayed in the JDL Editor of the Development Client



```
 1  import string, time
 2
 3
 4  # JOB:(facts set in job)
 5  # fact name "jobinstance.memo"
 6
 7  class logExample(Job):
 8       def job_started_event(self):
 9           numJoblets = 2
10           # Example of text written to job lob
11           print "Job Log entry: Running logExample Scheduling %d joblets" % (numJoblets)
12
13           # Set job fact
14           self.setFact("jobinstance.memo", "Running logExample Scheduling " + str(numJoblets) + " joblets")
15
16           # Schedule joblets
17           self.schedule(logExampleJoblet, numJoblets)
18
19
20  # JOBLET: (facts set by joblet instance)
21  # fact name "joblet.memo"
22  # fact name "joblet.instancename"
23
24  class logExampleJoblet(Joblet):
25       def joblet_started_event(self):
26           sleepTime = 5
27           self.setFact("joblet.memo", "Running logExampleJoblet on " + self.getFact("resource.id"))
28           self.setFact("joblet.instancename", "myLogExampleJoblet")
29           time.sleep(sleepTime)
```

In the job section of this example (lines 7-17), the fact `jobinstance.memo` (line 14) is set by the job instance. The job log text is emitted on line 11. Both of those are visible in the following example.

Figure 3-2 Example Displaying the `jobinstance.memo` Fact and Job Log Text in the Jobs Monitor View of the Development Client



Job ID	User ID	Instance Name	Start Time	End Time	Elapsed	Priority	Status	Progress
chip.logExample.49	chip	logExample	16:01:15	16:01:20	0:00:05	medium	Completed	

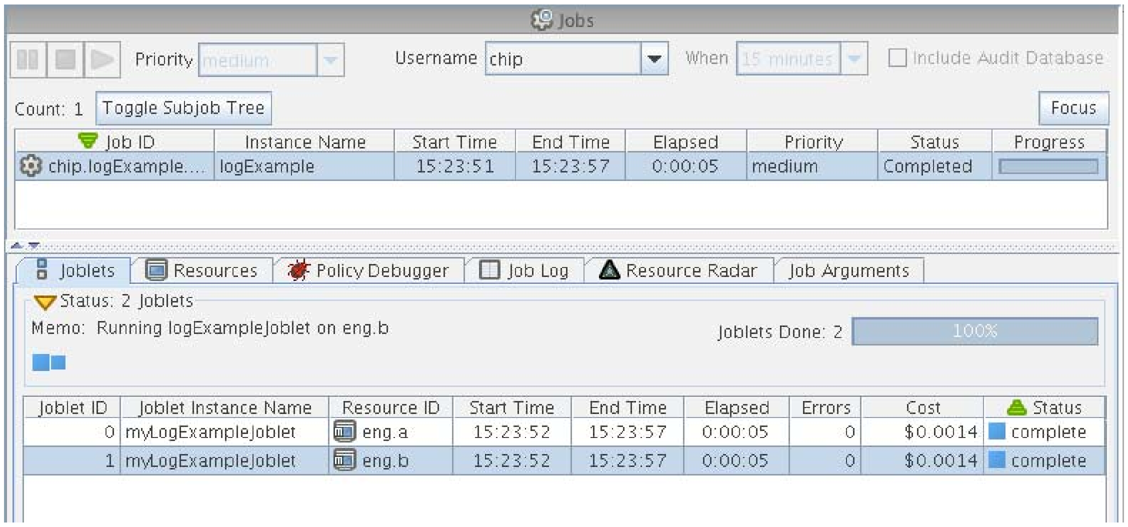
Memo
Running logExample Scheduling 2 joblets

```
Job Log entry: Running logExample Scheduling 2 joblets
```

In the `joblet` section of this example (lines 24-29), the fact named `joblet.memo` (line 27) is set by the joblet instance and consists of a brief memo for each joblet. This is typically used for providing detailed explanations, such as the name of the executable being run.

The name of the joblet is specified by the fact named `joblet.instancename` (line 28). This is typically a simple word displayed in the Development Client joblet column view. The following example shows the joblet facts `joblet.memo` and `joblet.instancename` in the Development Client.

Figure 3-3 *Example of Joblet Facts Displayed in the Development Client*



Job ID	Instance Name	Start Time	End Time	Elapsed	Priority	Status	Progress
chip.logExample....	logExample	15:23:51	15:23:57	0:00:05	medium	Completed	

Status: 2 Joblets

Memo: Running logExampleJoblet on eng.b

Joblets Done: 2 100%

Joblet ID	Joblet Instance Name	Resource ID	Start Time	End Time	Elapsed	Errors	Cost	Status
0	myLogExampleJoblet	eng.a	15:23:52	15:23:57	0:00:05	0	$0.0014	complete
1	myLogExampleJoblet	eng.b	15:23:52	15:23:57	0:00:05	0	$0.0014	complete

3.10.2 Tracing

There are two facts on the job grid object to turn tracing on or off. 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 using the Orchestrate Development Client or you can use the `zos run` command tool.

3.11 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 timeout, fail the joblet.

To configure this setup, you use the following facts in either the job policy (using the Orchestrate Development Client 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.

3.12 Using an Event Notification in a Job

Jobs can be notified of a PlateSpin Orchestrate event in two ways.

- A running Job can subscribe to receive PlateSpin Orchestrate event notifications. (See Section 3.12.1, “Receiving Event Notifications in a Running Job,” on page 48)
- A Job can be scheduled to start upon an Event notification.

  For more information about job scheduling, see Chapter 8, “Job Scheduling,” on page 197 or “The PlateSpin Orchestrate Job Scheduler” in the *PlateSpin Orchestrate 2.6 Development Client Reference*.

3.12.1 Receiving Event Notifications in a Running Job

- “Subscribe” on page 48
- “Unsubscribe” on page 49
- “Callback Method Signature” on page 49
- “How an Event Notification Can Start a Job” on page 49

Subscribe

For a job to receive notifications, a job subscribes to an event and must remain running for the notification to occur.

How to subscribe to an event is accomplished using the `subscribeToEvent()` Job method, shown below:

```
        def subscribeToEvent( <event Name>, <Job callback method> )
```

In this method, `<event name>` is the string name of the event being subscribed to; `<Job callback method>` is the reference to a Job method. Joblets and globals are not supported.

Example: The following is an example of the `subscribeToEvent()` method.

```
             self.subscribeToEvent(  "vmhost" ,self.eventHandler)
```

In this example, `vmhost` is the name of the event and `self.eventHandler` is a reference to the callback method.

Unsubscribe

To unsubscribe, use the `unscribeFromEvent()` Job method. For the subscribe example shown above, the following is how to unsubscribe.

```
self.unsubscribeFromEvent("vmhost",self.eventHandler)
```

Callback Method Signature

```
def <Job callback method>( self, context):
```

The callback method must be a Job method. The context argument is a dictionary containing name/value pairs. The dictionary contents passed to the callback vary depending on the event type.

Example: The following is an example of the callback method.

```
def eventHandler(self,context):
```

In this method, `context` is the required dictionary argument passed to every callback. The contents of the dictionary vary depending on event type (for details, see Section 3.12.2, “Event Types,” on page 50).

How an Event Notification Can Start a Job

You can create a schedule using the Job Scheduler or deploy a `.sched` file to start a job on an event notification. For more information, see Chapter 8, “Job Scheduling,” on page 197 or “The PlateSpin Orchestrate Job Scheduler” in the *PlateSpin Orchestrate 2.6 Development Client Reference*.

The job to be started must match a required job argument signature where the job must define at least one job argument.

The required job argument must be called “context” and be of type Dictionary. The contents of the dictionary vary depending on event type (refer to "Event Types " below for details).

The contents of `EventResponse.jdl` is an example of a job and policy that can be scheduled on an event notification:

```
1class EventResponse(Job):
2
3   def job_started_event(self):
4       context = self.getFact("jobargs.context")
5
6       print "Context:"
7       keys = context.keys()
8       keys.sort()
9       for k in keys:
10          v = context[k]
11          print "  key(%s) type(%s) value(%s)" % (k,type(v),str(v))
```

Line 4: This line pulls out the job argument for the event context.

Lines 6-11: These lines print out the contents of the context dictionary.

The contents of `EventResponse.policy` are shown below:

```
1<policy>
2  <jobargs>
3    <fact name="context" type="Dictionary"
4         description="Dictionary containing the context for the event " />
5   </jobargs>
6</policy>
```

Lines 3-4: These lines define the required job argument containing the Event context. The running job receives the job argument named `context` with the dictionary completed by the PlateSpin Orchestrate Event Manager with the context that matches the trigger rules.

3.12.2 Event Types

- "Event Objects" on page 50
- "Built-in Events" on page 51
- "External Events" on page 51

Event Objects

Event objects are defined in an XML document and deployed to a server and managed using the Orchestrate Development Client. In the Development Client, these objects are shown in the tree view.

The callback method context argument dictionary contains every grid object type and a value or list of values. The dictionary depends on the event XML definition and the matching grid objects of the `<trigger>` rule.

The following example event file (`vmhost.event`) shows the contents of the dictionary that will be passed as either a jobarg to a job to be scheduled to start, or as a argument to an event callback for a running job.

```
1<event>
2
3   <context>
4      <vmhost />
5      <user>system</user>
6   </context>
7
8   <trigger>
9       <gt fact="vmhost.resource.loadaverage" value="2" />
10   </trigger>
11
12</event>
```

Lines 3-6: Define the context for the Event object.

Line 4: Defines the match for the trigger rule that iterates over all vmhosts.

Line 5: Defines the context, and contains the user grid object named `system`.

Assuming that there are 10 vmhosts named "`vmhost1`, `vmhost2`, ... `vmhost10`, but only the first three vmhosts match the trigger rule, the context includse a list of the matching vmhosts. In this case, the context dictionary contains the following:

```
        {
1          "vmhost" : [  "vmhost1", "vmhost2", "vmhost3" ],
2         "user" : "system",
3          "repository" : "" ,
4          "resource" : "",
5          "job" : ""
         }
```

Line 1: List of the matching VM Hosts that passed the `<trigger>` rule.

Line 2: The user object that is defined in the `<context>` XML. In this case, `system`.

Lines 3-5: These grid objects are not defined in the context. Their value is empty.

In this example, the dictionary is passed as a job argument to a scheduled job that triggers on the event or is passed to a callback method in a running job that has subscribed to the event.

Built-in Events

Built-in events occur when a managed object comes online or offline or when that object has a health status change. For built-in events, the dictionary contains the name of the grid object type. The value is the name of the grid object.

The PlateSpin Orchestrate built-in events are named as follows:

- `RESOURCE_ONLINE`
- `RESOURCE_NEEDS_UPGRADE`
- `USER_ONLINE`
- `RESOURCE_HEALTH`
- `USER_HEALTH`
- `VMHOST_HEALTH`
- `REPOSITORY_HEALTH`

For example, when the resource `xen1` comes online, the built-in event called `RESOURCE_ONLINE` is invoked. Any scheduled jobs are started and any running jobs that have subscribed are invoked. The context dictionary contains the following:

```
{
    "resource" : "xen1"
}
```

The dictionary shown above is passed as a job argument to a scheduled job that triggers on the event or that is passed to a callback method in a running job that has subscribed to the event.

External Events

External events are events that are invoked by an outside process. In this case, the callback method context dictionary is free form and contains what was supplied to the external event.

For example, if the external event was invoked with a dictionary mapping of two elements like this:

```
{ "name" : "foo", "age" : 40 }
```

The corresponding JDL callback method receives the same dictionary.

Example: The following example of an external event subscribes to a previously deployed event named `vmhost`. This job continue running until the job is canceled or an error occurs.

```
1 EVENT = "vmhost"
2
3 class EventDaemon(Job):
4
5   def job_started_event(self):
6
7       self.setFact("job.autoterminate",False)
8       self.subscribeToEvent(EVENT,self.eventHandler)
9       print "Waiting for notification for event '%s'" % (EVENT)
10
11
12  def eventHandler(self,context):
13       print "Context:"
14
15       keys = context.keys()
16       keys.sort()
17       for k in keys:
18          v = context[k]
19          print "  key(%s) type(%s) value(%s)" % (k,type(v),str(v))
```

Line 7: Sets the `autoterminate` fact so that the job remains running upon completion of the `job_started_event()`.

Line 8: Subscribes to the named event `vmhost` and passes in a reference to the Job method `eventHandler()` to callback on when the event notification occurs.

Line 12: Definition of the callback method to invoke when the event notification occurs.

Lines 15-19: prints out the context dictionary received upon event notification.

Understanding Grid Object Facts and Computed Facts

4

This section includes the following information:

4.1 Grid Object Facts and Fact Junctions

Every component discovered in a PlateSpin Orchestrate-enabled network is identified and abstracted as an object. Within the PlateSpin Orchestrate 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 its properties and characteristics. Essentially, by building, deploying, and running jobs on the PlateSpin Orchestrate 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 Jobs, Resources (including physical machines, virtual machines and VM hosts), Virtual Disks (vDisks), Virtual NICs (vNICs), Repositories, Virtual Bridges, and Users. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator (unless they are read-only).

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

As a Job Developer, you might want certain constraints to be used for a job and you 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. See

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.

This section includes the following information:

- Section 4.1.7, “Repository Object Facts and Fact Junctions,” on page 94
- Section 4.1.8, “Virtual Bridge Object Facts and Fact Junctions,” on page 97
- Section 4.1.9, “User Object Facts and Fact Junctions,” on page 99
- Section 4.1.10, “Matrix Object Facts,” on page 104

For further fact information found in jobs, see Chapter 7, “Job Examples,” on page 127 and Section 2.2.2, “Using Facts in Job Scripts,” on page 16.

4.1.1 Fact Type Definitions

The following table explains the abbreviated codes used to describe facts for PlateSpin Orchestrate Grid objects:

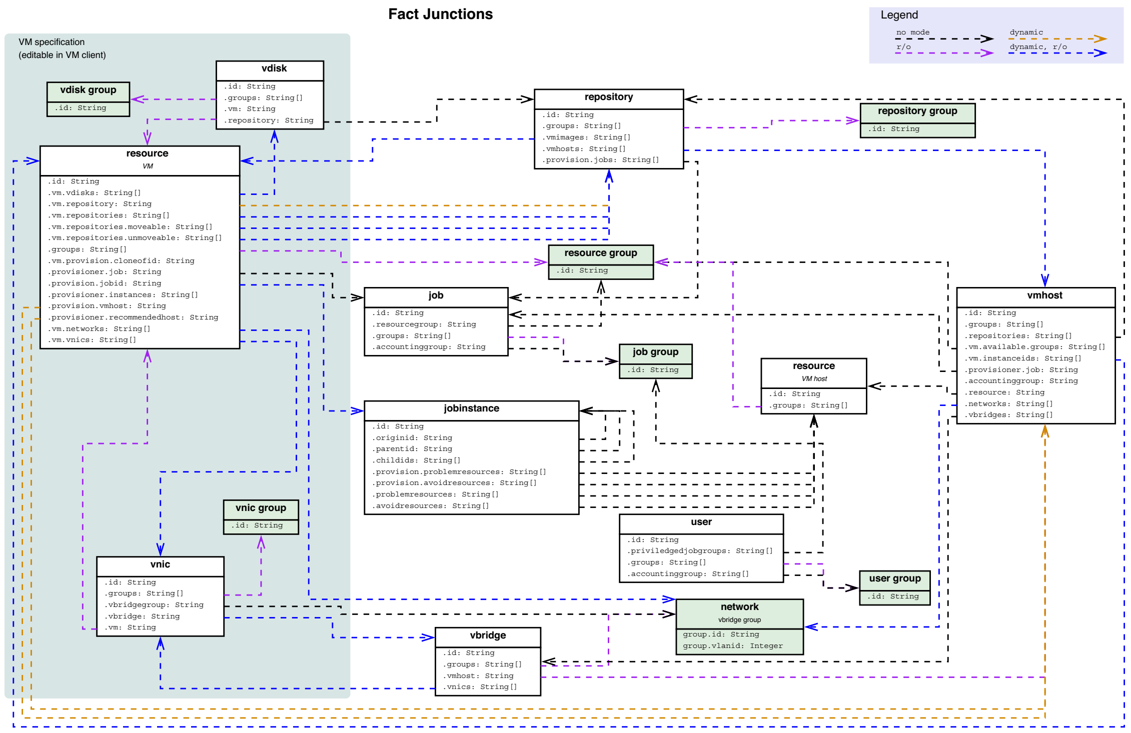
Table 4-1 *PlateSpin Orchestrate Fact Types*

Type	Description
Automatic	The fact should be automatically set after the successful discovery of virtual resources (VM Hosts 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.

4.1.2 Understanding Fact Junctions

A fact junction is a special type of fact that provides a convenient way to access facts on Grid objects related to the one where the fact lookup is being performed. The following diagram shows the fact junction relationships of all the Grid objects:

Figure 4-1 Fact Junctions Between Objects in a Sample PlateSpin Orchestrate Grid



As an example of how a fact junction works, a fact lookup on `vmhost.resource.id` is redirected from the VM host object, through the junction onto the underlying physical Resource object. In other words, the value returned is the same as if a fact lookup for `resource.id` was performed on the underlying physical resource. This is accomplished with the following JDL:

```
vmhost1 = getMatrix().getGridObject(TYPE_VMHOST, "vmhost1")
print vmhost1.getFact("vmhost.resource.id")
```

Another example is `vdisk.repository.freespace,` which returns the amount of free space in the repository that is associated with the virtual disk where the fact lookup is being performed:

```
vdisk = getMatrix().getGridObject(TYPE_VDISK, "vm1_vdisk1")
print vdisk.getFact("vdisk.repository.freespace")
```

Note that the fact junction refers to the related Grid object rather than to any of its facts. Therefore, to obtain the ID of the repository associated with a given virtual disk, you must perform a lookup on `vdisk.repository.id` rather than `vdisk.repository`.

It is important to understand how the fact name is constructed from the junction, otherwise certain usages of fact junctions can be confusing, especially when used with facts that contain the dot (".") character. For example, starting with a vDisk Grid object as above:

```
vdisk = getMatrix().getGridObject(TYPE_VDISK, "vm1_vdisk1")
```

vDisk objects have a fact junction, `vdisk.vm,` that points to the VM associated with the vDisk. If you want to find all VNICs associated with this VM, remember that VMs have a fact `resource.vm.vnics` that provides the desired array. However, because PlateSpin Orchestrate accesses this fact by using the `vdisk.vm` fact junction, you must replace the resource component of the `resource.vm.vnics` fact with `vdisk.vm`. Therefore, the required code is:

```
print vdisk.getFact(“vdisk.vm.vm.vnics”)
```

Some fact junctions return an array of values rather than a single value. For example, the junction `vmhost.repositories` returns an array of all the repositories visible to the VM host where the lookup is being performed:

```
vmhost1 = getMatrix().getGridObject(TYPE_VMHOST, "vmhost1")
print host1.getFact("vmhost.repositories")
```

In this case, you can also single out one of the Grid objects returned in the array and perform fact lookups on that object. For example, if the repository `san1` is accessible by `vmhost1`, then

```
print vmhost1.getFact("vmhost.repositories[san1].freespace")
```

returns the amount of free space available in the `san1` repository.

```
repo_host1 = getMatrix().getGridObject(TYPE_REPOSITORY, "host1")
print repo_host1.getFact("repository.vmhosts[host1_demoAdapter].networks")
```

Fact junction lookups can be chained multiple times, even mixing use of single-valued and array-valued junctions:

```
vdisk = m.getGridObject(TYPE_VDISK, "vm1_vdisk1")
print vdisk.getFact("vdisk.repository.vmhosts[vmhost1].networks")

host1 = m.getGridObject(TYPE_RESOURCE, "host1")
print
host1.getFact("resource.vmhosts[host1_demoAdapter].repositories[san1].freespa
ce")
```

For a more comprehensive list of available fact junctions, see the example `factJunction.job` stored at `/opt/novell/zenworks/zos/server/examples` on your server installation system.

4.1.3 Job, Jobinstance, and Joblet Object Facts and Fact Junctions

This section includes the following information:

- “Job Object Facts” on page 56
- “Job Object Fact Junctions” on page 63
- “Job Group Facts” on page 64
- “Jobinstance Facts” on page 64
- “Jobinstance Fact Junctions” on page 66
- “Joblet Facts” on page 67

Job Object Facts

The Constraints/Facts tab opens a page that shows all of the effective constraints and facts for a Grid object. Each Grid object has an associated set of facts and constraints that define its properties. In essence, by changing the policy constraints and fact values for a job, you can change the behavior of the job and how the PlateSpin Orchestrate Server allocates available system resources to it. The Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the Job object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time. Where facts can be deleted in the Development Client, they can also be deleted in the `GridObjectInfo.deleteFact()` method in JDL.

Table 4-2 *Job Facts*

Fact Name	Fact Type	Mode	Description
`job.accountinggroup`	String		The default job group whose statistics are updated when this job runs.
`job.autoterminate`	Boolean		Whether this job ends when all child jobs and joblets end
`job.cacheresourcematches.ttl`	Integer		Indicates the jobs willingness to allow resource maches to be cached if the scheduler becomes too loaded. The value is the TTL of the cache in seconds ('<=0' to disable caching)
`job.description`	String		Textual description of job
`job.enabled`	Boolean		True if the job is enabled (able to be run).
`job.groups`	String[]	r/o	The groups where this job is a member.
`job.history.cost.average`	Real	dynamic, r/o	The average cost of running this job measured since job deployment or last modification. Only updated if the job finishes successfully.
`job.history.cost.total`	Real	dynamic, r/o	The total cost of running this job measured since job deployment or last modification
`job.history.gcycles.average`	Integer	dynamic, r/o	The average amount of normalized grid time (gcycles) taken by running this job. Only updated if the job finishes successfully.

Fact Name	Fact Type	Mode	Description
`job.history.gcycles.total`	Integer	dynamic, r/o	The total amount of normalized grid time (gcycles) consumed by this job since deployment
`job.history.jobcount`	Integer	dynamic, r/o	The total number of job instances of this job ever initiated on the system (includes those denied by 'accept' constraints
`job.history.jobcount.cancelled`	Integer	dynamic, r/o	The total number of job instances of this job that were cancelled
`job.history.jobcount.complete`	Integer	dynamic, r/o	The total number of job instances of this job that were completed
`job.history.jobcount.failed`	Integer	dynamic, r/o	The total number of job instances of this type that failed
`job.history.queuetime.average`	Integer	dynamic, r/o	The average wall time spent waiting for this job to start in seconds
`job.history.queuetime.total`	Integer	dynamic, r/o	The total amount of time this job has spent in a queued state since last deployment.
`job.history.runtime.average`	Integer	dynamic, r/o	The average runtime of this job in seconds. Only updated if the job finishes successfully.
`job.history.runtime.total`	Integer	dynamic, r/o	The total runtime of the job since deployment in seconds
`job.history.samplesize`	Integer		The number of points used in the trailing average calculation for all historical averages
`job.history.time.average`	Integer	dynamic, r/o	The average wall time taken by running this job in seconds. This fact is updated only if the job finishes successfully.
`job.history.time.total`	Integer	dynamic, r/o	The total combined resource wall time of all work performed on behalf of this job since deployment in seconds
`job.id`	String	r/o	The name of the job.
`job.instances.active`	Integer	dynamic, r/o	The number of job instances of this type that are active in the system ('running' or 'paused')c

Fact Name	Fact Type	Mode	Description
`job.instances.queued`	Integer	dynamic, r/o	The number of job instances of this type that are in a queued state
`job.instances.total`	Integer	dynamic, r/o	The total number of job instances of this type that exist in the sytem
`job.joblet.immediateretry`	Boolean		Specifies whether the system to attempt to immediately retry a joblet rather than waiting until all others are running/ complete before retrying
`job.joblet.max`	Integer		The absolute maximum number of joblets this job may schedule.
`job.joblet.maxfailures`	Integer		Specifies the number of non-fatal joblet errors to tolerate before failing completely or '-1' to attempt to continue after errorsc
`job.joblet.maxperresource`	Integer		The absolute maximum number of joblets this job may occupy on any one resource ('-1' indicates no limit)
`job.joblet.maxretry`	Integer		The maximum number of joblet retries of any type that will be attempted before considering the joblet as failed (0 means don't retry, <0 means keep retrying)
`job.joblet.maxrunning`	Integer		The absolute maximum number of joblets a job is allowed to have running at one time. This value will never be exceeded ('-1' indicates no limit)
`job.joblet.maxwaittime`	Integer		The maximum (resource) wait time permitted by a joblet in seconds ('-1' indicates no timeout)
`job.joblet.retrylimit.disconnect`	Integer		The number of joblet retries caused by unexpected resource disconnect that will be allowed before considering the joblet as failed (0 means don't retry, <0 means keep retrying). Can never exceed job.joblet.maxretry

Fact Name	Fact Type	Mode	Description
`job.joblet.retrylimit.forced`	Integer		The number of forced joblet retries (requested by the joblet to run an another resource) that will be allowed before considering the joblet as failed (0 means don't retry, <0 means keep retrying). Can never exceed job.joblet.maxretry
`job.joblet.retrylimit.timeout`	Integer		The number of joblet retries caused by server inititated joblet timeout that will be allowed before considering the joblet as failed (0 means don't retry, <0 means keep retrying). Can never exceed `job.joblet.maxretry`.
`job.joblet.retrylimit.unforced`	Integer		The number of unforced joblet retries that will be allowed before considering the joblet as failed (0 means don't retry, <0 means keep retrying). Can never exceed `job.joblet.maxretry`
`job.joblet.runtype`	String		Specify file and executable operations run in Joblet are in behalf of the Job user or not.
`job.joblet.timeout`	Integer		The timeout after which the server will take action to cancel the joblet (seconds, '-1' indicates no timeout)
`job.joblet.tracing`	Boolean		Indicates whether the joblet should include tracing information in the job log when executing joblet events
`job.jobtime`			The average wall time this job should take to run. Used to override the computed average when job is of type 'fixedtime' (in seconds)
`job.jobtype`	String		The type of job -- used in completion time calulation (normal, workflow, pspace, fixedtime, fixedcycles)

Fact Name	Fact Type	Mode	Description
`job.maxnodefailures`	Integer		The maximum number of resource failures that are to be tolerated before excluding the node from future joblet processing. A value of `-1` indicates that unlimited failures are acceptable.
`job.maxresources`	Integer		The absolute maximum number of resources that a job is allow to use at one time. This value will never be exceeded. A value of `-1` indicates no limit.
`job.persistfactsonfinish`	Boolean		Whether the Grid objects that this job modifies are to be persisted at job end. Used and applicable only when installed in a high availablity cluster.
`job.preemptible`	Boolean		Indicates whether this job is willing or able to be preempted. Turned on by setting `joblet.preemptible`. (can be overridden by the job instance).
`job.preemption.rankby`	String[]		The ranking specification used to select suitable jobs to automatically preempt a resource on. The syntax for each element in the list is `<fact>/<`*`order`*`>` where *`order`* is either “a” for `ascending` or “d” for `descending`.
`job.provision.hostselection`	String		The strategy used in finding a host for any automatically provisioned resource (`queue`, `immediate`).
`job.provision.maxcount`	Integer		The number of resources that can be automatically provisioned on behalf of this job. A value of `0` turns off automatic provisioning behavior. A value of `-1` allows unlimited provisioning.

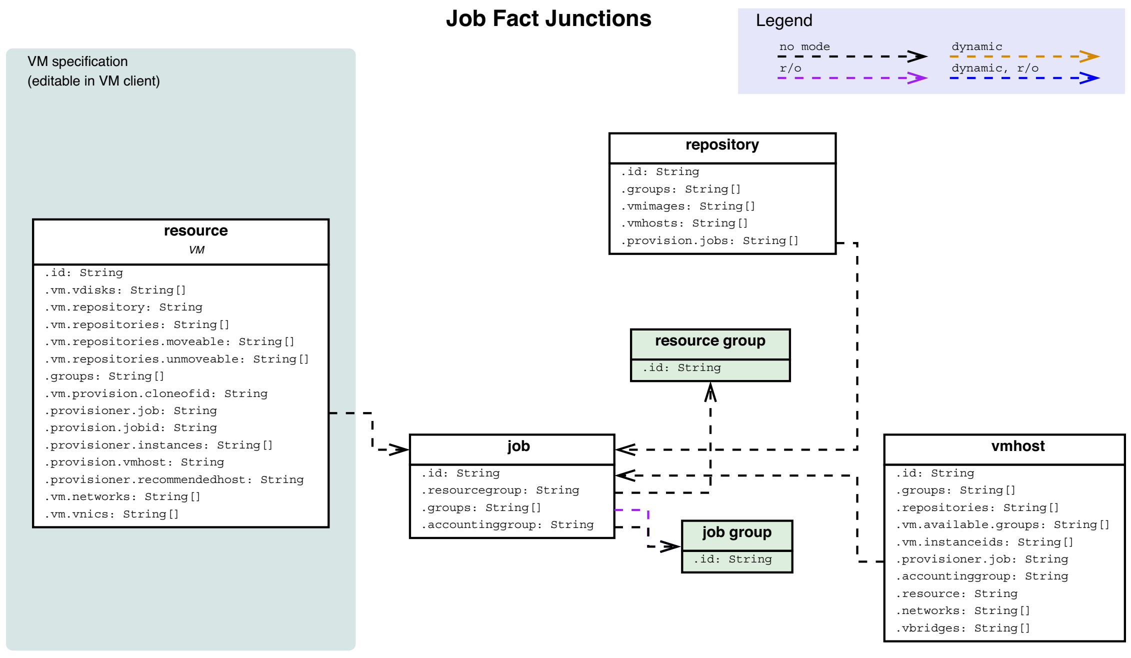
Fact Name	Fact Type	Mode	Description
`job.provision.maxnodefailures`	Integer		The maximum number of provision failures that will be tolerated before excluding the node from future automatic provisioning. A value of `-1` indicates that unlimited failures are acceptable.
`job.provision.maxpending`	Integer		The number of resources tha can be automatically provisioned at one time (simulataneously) on behalf of this job. A value of `<=0` turns off automatic provisioning behavor.
`job.provision.rankby`	String[]		The ranking specification used to select suitable resources to automatically provision. Element syntax is `<fact>/<order>` where order is either `ascending` or `descending`.
`job.queuedtimeout`	Integer		The timeout (measured in seconds) after which the server takes action to cancel a queued job, including all joblets and subjobs. A value of `-1` indicates no timeout.
`job.queuetime`	String		The average wall time (measured in seconds) spent waiting for this job to start . Used to override the computed average when queue is of type `fixedtime`.
`job.queuetype`	String		The type of queue from which this job is typically accessed. This is used in start time calculation (none, `pfifo`, `fifo`, `lifo`, `fixedtime`).
`job.resourcegroup`	String		The default resource group from which resources will be selected for this job (in addition to any resource policies).
`job.resources.rankby`	String[]		The ranking specification used to select suitable resources. Element syntax is `<fact>/<order>` where order is either `ascending` or `descending`.

Fact Name	Fact Type	Mode	Description
`job.restartable`	Boolean		Indicates whether this job is willing to be restarted on server restarts (can be overridden by the job instance).
`job.timeout`	Integer		The timeout (measured in seconds) after which the server will take action to cancel the whole job including all joblets and subjobs. A value of `-1` indicates no timeout.
`job.tracing`	Boolean		Indicates whether this job should include tracing information in the job log when executing job events.
`job.visible`	Boolean		Whether this job should be visible to the client in queries or UI (it does not stop it being run).

Job Object Fact Junctions

The following diagram illustrates the relationship between the Job Grid object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the Job Grid object itself.

Figure 4-2 *Job Fact Junctions*



Job Group Facts

Table 4-3 *Job Group Facts*

Fact Name	Fact Type	Mode	Description
`group.id`	String	r/o	The name of the group.
`group.jobinstances.active`	Integer	dynamic, r/o	The number of job instances that are active on resources in this group ('running' or 'paused').
`group.jobinstances.queued`	Integer	dynamic, r/o	The number of job instances that are in a queued state awaiting start on resources in this group.
`group.jobinstances.total`	Integer	dynamic, r/o	The total number of job instances running on, or awaiting start on resources in this group.

Jobinstance Facts

A job instance is a currently running or recently completed job. All jobinstance facts are viewable only in the Policy Debugger page of the Jobs Monitor. You need to select the *All Facts* check box to view these facts. These facts are not editable.

NOTE: If the job you want to view finished previously, it is possible that it can no longer be viewed in the Policy Debugger if other jobs followed it on the Orchestrate Server.

Table 4-4 *Jobinstance Facts*

Fact Name	Fact Type	Description
`jobinstance.childids`	String[]	String array of child job IDs. If no child jobs were launched, the arrayis empty.
`jobinstance.cost`	Real	The cost (measured in dollars) of this job.
`jobinstance.cost.burnrate`	Real	The computed moving average burn rate (measured in dollars per hour) of the job.
`jobinstance.errors`	String	The error messages recorded for a failed job.
`jobinstance.id`	String	The job instance unique identifier
`jobinstance.instancename`	String	The optional, human readable name for this job instance.
`jobinstance.joblet.pspace`	Integer	The number of rows in a fully expanded p-space definition. Will be equal to the number of joblets only if `jobinstance.joblet.size` is `1`.

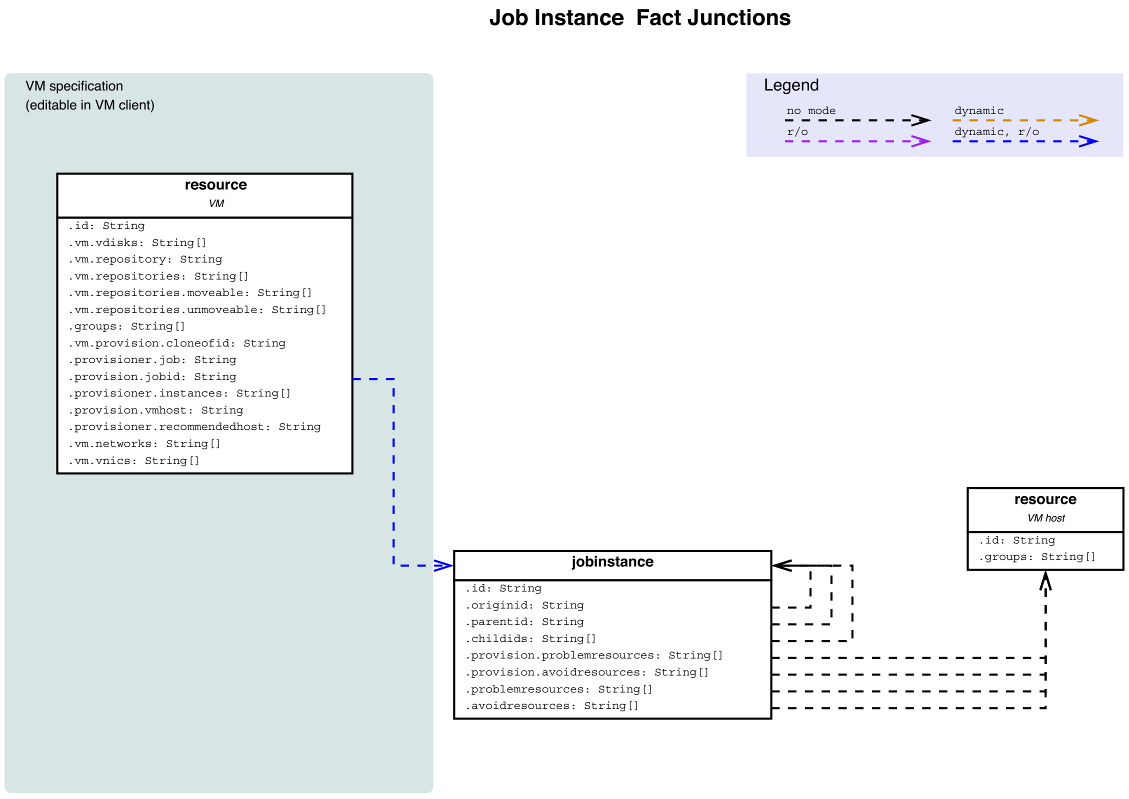
Fact Name	Fact Type	Description
`jobinstance.joblet.size`	Integer	The number of p-space rows encapsulated in each joblet. May be explicitly set of derived as a result of specifing joblet count
`jobinstance.joblets.cancelled`	Integer	The number of joblets that ended in a cancelled state.
`jobinstance.joblets.complete`	Integer	Number of joblets that completed successfully.
`jobinstance.joblets.count`	Integer	The number of joblets under management of this job instance.
`jobinstance.joblets.failed`	Integer	The number of joblets that ended in a failed state.
`jobinstance.joblets.running`	Integer	The number of joblets that are actively running on resources.
`jobinstance.joblets.waiting`	Integer	The number of joblets that are waiting for available resources.
`jobinstance.matchingresources`	Integer	The number of currently active resources that match the `resource` contraints.
`jobinstance.memo`	String	A brief memo set by this job instance that can be seen in user/administrator portals.
`jobinstance.originid`	String	The job identifier of the root job of this hierarchy or this job if a top level job.
`jobinstance.parentid`	String	The job identifier of the parent job of this hierarchy or empty if this is a top level job with no parent.
`jobinstance.preemptible`	Boolean	Specifies that this job instance is willing to give up resources if required. Initially set from the equivalent job fact.
`jobinstance.priority`	Integer	The numeric representation of the current priority of this job instance (1=lowest, 9=highest). Default value is the user's default priority.
`jobinstance.priority.string`	String	The string representation of the current priority of this job instance.
`jobinstance.problemresources`	String[]	The number of resources that are excluded from this job instance due to reaching the `job.maxnodefailures` limit.
`jobinstance.provision.avoidresources`	String[]	The names of automatically provisioned resources that are currently being avoided (not yet excluded) because of prior provisioning errors.
`jobinstance.provision.count`	Integer	The total number of resources that have been automaticaly provisioned (or are in progress) for this job.

Fact Name	Fact Type	Description
`jobinstance.provision.pending`	Integer	The total number of automatically provisioned resources that are pending online status.
`jobinstance.provision.problemresources`	String[]	The names of automatically provisioned resources that encountered provisioning errors and have been excluded.
`jobinstance.provision.problemresources.count`	Integer	The number of automatically provisioned resources that encountered provisioning errors and have been excluded.
`jobinstance.resources`	String[]	The resources currently in use by this job
`jobinstance.resources.count`	Integer	Number of resources currently in use by this job
`jobinstance.restarted`	Boolean	Whether this job instance was been restarted due to server restart.
`jobinstance.startat`	Date	The date/time that this job was requested to start atc
`jobinstance.starttime`		The formated start date and time for this job instance
`jobinstance.state`	Integer	The numeric state of this job instance
`jobinstance.state.string`	String	String representation of the current state of this job instance
`jobinstance.terminationtype`	String	The cause of the termination for a cancelled or failed job.
`jobinstance.time.completed`	Date	The time this job instance completed or an estimation if still active
`jobinstance.time.elapsed`	Integer	The elapsed wall time this job instance has been running or ran (in seconds)
`jobinstance.time.elapsed.string`	String	The elapsed wall time this job instance has been in a running
`jobinstance.time.queued`	Integer	The elapsed wall time this job instance has been a queued (in second)s
`jobinstance.time.started`	Date	The time this job instance was actually started or an estimating if queued
`jobinstance.time.submitted`	Date	The time this job instance was submitted

Jobinstance Fact Junctions

The following diagram illustrates the relationship between the Jobinstance facts and other Grid objects.

***Figure 4-3** Jobinstance Fact Junctions*


Job Instance Fact Junctions
Legend
no mode
dynamic
r/o
dynamic, r/o
VM specification
(editable in VM client)
resource
VM
.id: String
.vm.vdisks: String[]
.vm.repository: String
.vm.repositories: String[]
.vm.repositories.moveable: String[]
.vm.repositories.unmoveable: String[]
.groups: String[]
.vm.provision.cloneofid: String
.provisioner.job: String
.provision.jobid: String
.provisioner.instances: String[]
.provision.vmhost: String
.provisioner.recommendedhost: String
.vm.networks: String[]
.vm.vnics: String[]
jobinstance
.id: String
.originid: String
.parentid: String
.childids: String[]
.provision.problemresources: String[]
.provision.avoidresources: String[]
.problemresources: String[]
.avoidresources: String[]
resource
VM host
.id: String
.groups: String[]

Joblet Facts

Joblet facts can be accessed only if you write code within the Joblet subclass of a JDL file. If you code a job to expose the joblet fact values, PlateSpin Orchestrate runs the scheduled joblets and you can see the joblet fact values in the Job Log tab of the Devlopment Client.

The available joblet facts and their descriptions are listed in the following table.

***Table 4-5** Joblet Facts*

Fact Name	Description
`joblet.autoterminate`	Whether the joblet ends when all events for the joblet ends.
`joblet.errors`	The list of error dictionaries encapsulating the error history for this joblet. Dictionary keys: ◆ **ts:** timestamp in milliseconds ◆ **node:** the node name where execution failed ◆ **error:** the error message
`joblet.history`	The list of resource IDs where the joblet has run.
`joblet.id`	The unique identifier for this joblet.
`joblet.instancename`	A human readable name for this joblet instance.

Fact Name	Description
`joblet.memo`	An (optional) memo field for this joblet that can be displayed in the management console.
`joblet.number`	The joblet number.
`joblet.preemptible`	Indicates whether this joblet is willing or able to be preempted.
`joblet.retrynumber`	The number of retries for this joblet (0 on first attempt).
`joblet.state`	The numeric state of this joblet instance.
`joblet.state.string`	String representation of the current state of this joblet instance.
`joblet.timeout`	The time after which this joblet will be cancelled/retried. (seconds, defaults to `job.joblet.timeout`).

4.1.4 Resource Object Facts and Fact Junctions

This section includes the following information:

- "Resource Object Facts" on page 68
- "Resource Object Fact Junctions" on page 82
- "VM Host Object Facts" on page 83
- "VM Host Resource Object Fact Junctions" on page 85
- "Resource Group Facts" on page 86
- "Understanding Resource Metrics Facts" on page 87

Resource Object Facts

The Resource object (a physical or virtual machine) has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only. Facts with mode r/o have read-only values, which can be viewed but changes cannot be made.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the Resource object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-6 Resource Facts

Fact Name	Fact Type	Mode	Description
`resource.agent.clustered`	Boolean		Whether the agent is clustered (converts duplicate logins to failover logins)
`resource.agent.config.datagrid.cache`	Boolean		Whether the agent caches datagrid files.
`resource.agent.config.datagrid.cache.cleanupinterval`	Integer		Wait time (measured in minutes) between cleanup sweeps of the datagrid cache.
`resource.agent.config.datagrid.cache.lifetime`	Integer		How long inactive files should remain in the agent's datagrid cache (in minutes). 0 turns off the cache.
`resource.agent.config.exec.asagentuseronly`	Boolean		Whether the agent always runs executables only as the agent user. This overrides any Job fact settings ('job.joblet.runtype').
`resource.agent.config.exec.daemon.timeout`	Integer		How long for the enhanced exec daemon to remain running (in seconds). 0 means remain running.
`resource.agent.config.exec.enhancedused`	Boolean		Whether the agent uses the enhanced exec or not.
`resource.agent.config.gmond.port`	Integer		Setting for gmond port (8649 is the default). 0 or less means values will not be read.
`resource.agent.config.joblet.cleanup`	Boolean		Whether the agent cleans up temporary directories created for each joblet. Can be turned off for debugging purposes and then "catches up" when re-enabled.
`resource.agent.config.logdebug`	Boolean		Turns on agent debugging (additive to log level)
`resource.agent.config.loglevel`	String		Controls the verbosity of agent logging (quiet, normal, verbose)

Fact Name	Fact Type	Mode	Description
`resource.agent.exec.installed`	Boolean		Whether the agent is installed with the enhanced exec or not.
`resource.agent.home`	String		The home directory of the agent install.
`resource.agent.jvm.home`	String		The home directory of the JVM in use by the agent.
`resource.agent.jvm.memory`	Integer		The memory available to the agent (megabytes).
`resource.agent.jvm.runtime`	String		The Java JVM runtime in use by the agent.
`resource.agent.jvm.vendor`	String		The Java JVM vendor in use by the agent.
`resource.agent.jvm.version`	String		The Java JVM version in use by the agent.
`resource.agent.version`	String	dynamic, r/o	The agent version and build number <major>.<minor>.<point>_<build>
`resource.auth.provider`	String	dynamic, r/o	The authentication provider to which the node authenticates
`resource.becameidle`	Date	dynamic, r/o	The date/time the resource became idle or '-1' if not idle
`resource.billfor`	String		Whether to bill on wall time or grid time (walltime, gcycles)
`resource.billingrate`	Real		The billing rate for this resources in $/hr
`resource.cpu.architecture`	String	del	The CPU architecture e.g. x86, x86_64, sparc (requires cpuInfo system job).
`resource.cpu.hvm`	Boolean	del	True if the CPU has hardware virtualization support.
`resource.cpu.mhz`	Integer	del	The speed (measured in MHz) of the processor (requires cpuInfo system job)
`resource.cpu.model`	String	del	The CPU model number (requires cpuInfo system job)

Fact Name	Fact Type	Mode	Description
`resource.cpu.number`	Integer		The number of available CPU cores available for processing. This counts each core in a multicore package as its own core, so a Core 2 duo physical CPU displays as two CPUs.
`resource.cpu.vendor`	String	del	The CPU vendor (requires cpuInfo system job).
`resource.cpuload`	Integer	dynamic, r/o	The percent CPU load on the resource.
`resource.enabled`	Boolean		True if the resource is enabled (allowed to log in and accept work).
`resource.groups`	String[]	`r/o`	The groups this node is a member of.
`resource.hardware.model`	String		The vendor-specific hardware model (for example, Dell PowerEdge 1850).
`resource.hardware.vendor`	String		The name of the hardware vendor (for example, Dell, IBM, or similar).
`resource.health`	Boolean		The health of this resource. True indicates good health.
`resource.history.cost.total`	Real	dynamic, r/o	The cost (measured in matrix dollars ($)) of all work performed on this resource.
`resource.history.gcycles.total`	Integer	dynamic, r/o	The total grid time (gcycles) of all work performed on this resource.
`resource.history.jobletcount`	Integer	dynamic, r/o	The total number of joblets ever run on this resource.
`resource.history.jobletcount.cancelled`	Integer	dyanmic, r/o	The total number of joblets that were canceled.
`resource.history.jobletcount.completed`	Integer	dynamic, r/o	The total number of joblets that completed successfully.

Fact Name	Fact Type	Mode	Description
`resource.history.jobletcount.failed`	Integer	dynamic, r/o	The total number of joblets that failed.
`resource.history.time.total`	Integer	dynamic, r/o	The total wall time (measured in seconds) of all work performed on this resource.
`resource.hostname`	String	del	The resource’s hostname
`resource.hostname.full`	String	del	The fully qualified hostname.
`resource.id`	String	r/o	The node’s login name
`resource.installed.apps`	String[]	del	The installed applications
`resource.ip`	String	del	The resources IP address
`resource.joblets.active`	Integer	dynamic, r/o	The number of joblets currently active on this resource
`resource.joblets.maxslots`	Integer	dynamic, r/o	The absolute maximum number of work slots availabe to regular and privileged joblets.
`resource.joblets.slots`	Integer		The number of regular joblets that this resource runs at one time.
`resource.joblets.systemslots`	Integer		The number of extra slots that will be made available to privileged “system” joblets.
`resource.loadaverage`	Real	dynamic, r/o	The load average on the resource (from 'uptime' or equivalent).
`resource.memory.physical.available`	Integer	del	The amount (measured in Mb) of free physical memory available on the resource.
`resource.memory.physical.total`	Integer	del	The total amount (measured in Mb) of physical memory on the resource.
`resource.memory.swap.available`	Integer	del	The amount (measured in Mb) of free swap space.

Fact Name	Fact Type	Mode	Description
`resource.memory.swap.total`	Integer	del	The total amount (measured in Mb) of external VM swap space configured on the host. Wwap space allows the hypervisor or OS to swap out infrequently used memory pages to disk or other storages to make it appear that virtual memory is larger than physical memory.
`resource.memory.virtual.available`	Integer	del	The amount of available (free) virtual memory (measured in Mb) on the system. This might be more than the amount of physical memor if the host hypervisor or Operating system supports paging of VM to disk or other swap storage.
`resource.memory.virtual.total`	Integer	del	The total amount (measured in Mb) of virtual memory on the resources.
`resource.network.agent.address`			The agent side IP address for the current connection
`resource.network.agent.port`			The agent side TCP port number for the current connection
`resource.network.config.server.address`			The IP address used by the agent to connect to the server
`resource.network.config.server.hostname`			The host name used by the agent to connect to the server
`resource.network.config.server.port`			The TCP port number used by the agent to connect to the server
`resource.network.server.address`			The server side IP address for the current connection
`resource.network.server.port`			The server side TCP port number for the current connection

Fact Name	Fact Type	Mode	Description
`resource.network.throughput`			The measured average network connection throughput in Mbits/sec to neighouring resource (requires netInfo system job)
`resource.network.throughput.max`			The maximium network connection speed in Mbits/sec (requires netInfo system job)
`resource.online`	Boolean	dynamic, r/o	True if the agent is online
`resource.os.arch`	String	del	The operating system architecture e.g. x86, amd64, i386, sparc
`resource.os.family`	String		The family of operating system (windows, linux, solaris, unix, aix, mac
`resource.os.file.separator`	String	del	The resource operating system file separator
`resource.os.name`	String		The name of the resource operating system
`resource.os.type`	String		Unique string identifier for each OS release (e.g. 'sles11')
`resource.os.vendor`	String		The operating system vendor (SuSE for SLES/ SLED)
`resource.os.vendor.string`	String	del	The operating system full identification string (requires osInfo system job)
`resource.os.vendor.version`	String	del	The vendor defined version number, for example, `10` for SUSE v10.
`resource.os.version`	String	del	The operating system version numberc
`resource.os.version.string`	String	del	The operating system vendor full identification string (requires osInfo system job)
`resource.password`	string	dynamic	The agents's login password

Fact Name	Fact Type	Mode	Description
`resource.powerfactor`	Real	dynamic, r/o	The normalized power index of this machine relative to a 2.0Ghz, Intel Pentium 4
`resource.provision.automatic`	Boolean	dynamic, r/o	Signifies that this resource was cloned/ provisioned automatically and thus will be shutdown/destroyed automatically as well
`resource.provision.currentaction`	String	dynamic, r/o	The current management action in progress on this provisionable resource
`resource.provision.jobid`	String	dynamic, r/o	The current or last job id that performed a provisioning action on this resource. Useful for viewing job log.
`resource.provision.resync`	Boolean	dynamic	Specifies that the provisioned resource's state needs to be resynced with the underlying provisioning technology and the next opportunity
`resource.provision.state`	String	dynamic, r/o	The current state of this provisioned instance ('down', 'suspended', 'up', 'paused') or 'unknown' if an admin action is currently being performed.
`resource.provision.status`	String	dynamic, r/o	The current descriptive status of the provisioned resource
`resource.provision.template`	String	dynamic, r/o	The id of the template resource that this instance was created from (if applicable)
`resource.provision.time.hostwait`	Integer	dynamic, r/o	The time (seconds) this resource has been waiting / waited for a suitable host
`resource.provision.time.request`	Date	dynamic, r/o	The time when the last provision (or other administrative action) request was made

Fact Name	Fact Type	Mode	Description
`resource.provision.time.shutdown`	Date	dynamic, r/o	The time when the resource was last shutdown
`resource.provision.time.start`	Date	dynamic, r/o	The time when the resource was last successfully provisionedc
`resource.provision.vmhost`	String	dynamic	The id of the host currently housing this provisioned resource
`resource.provisionable`	Boolean	dynamic, r/o	True if the resources is a provisionable type
`resource.provisioner.autoprep.DNSServers`			List of DNS servers for name lookup. This is only for cloning/personalize actions.
`resource.provisioner.autoprep.DNSSuffixes`			List of suffixes to append to a name for lookup. This is only for cloning/ personalize actions.
`resource.provisioner.autoprep.Gateways`			List of internet gateways available to this VM. This is only for cloning/ personalize actions.
`resource.provisioner.autoprep.linuxglobal.ComputerName`			Host name of new VM. An asterisk (*) means use the new VM's ID.
`resource.provisioner.autoprep.linuxglobal.Domain`			The name of the domain where the new new VM belongs.
`resource.provisioner.autoprep.options.changeSID`			The Windows Security ID. If true, sysprep generates a new Security ID.
`resource.provisioner.autoprep.options.deleteAccounts`			If true, removes all accounts from the destination VM. If false, existing accounts from the source VM are retained.

Fact Name	Fact Type	Mode	Description
`resource.provisioner.autoprep.sysprep.GuiRunOnce.Command`			List of commands that r un the first time a user logs on after the new VM is created. Commands are sched uled using the `HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\RunOnce` registry key.
`resource.provisioner.autoprep.sysprep.GuiUnattended.AdminPassword.plainText`			True if the AdminPassword is plain text.
`resource.provisioner.autoprep.sysprep.GuiUnattended.AdminPassword.value`			The AdminPassword.
`resource.provisioner.autoprep.sysprep.GuiUnattended.AutoLogon`			If true, the VM auto logs into the Administrator account using AdminPassword. If false, login is prompted..
`resource.provisioner.autoprep.sysprep.GuiUnattended.AutoLogonCount`			The limit count for the VM to auto log in with the Administrator account. `AutoLogon` must be True.
`resource.provisioner.autoprep.sysprep.GuiUnattended.TimeZone`			The time zone of the new VM. See provisioning reference for values, for example: `04` indicates PST, `10` indicates MST, `20` indicates CST, and 35 indicates EST.
`resource.provisioner.autoprep.sysprep.Identification.DomainAdmin`			Windows domain administrator name.
`resource.provisioner.autoprep.sysprep.Identification.DomainAdminPassword.plainText`			True if `DomainAdminPassword` is in plain text.
`resource.provisioner.autoprep.sysprep.Identification.DomainAdminPassword.value`			Windows domain administrator account password.
`resource.provisioner.autoprep.sysprep.Identification.JoinDomain`			Windows domain n ame. If joining a workgroup, then use JoinWorkgroup. For joining a domain, `Domai nAdmin` and `DomainAdminPassword` must be defined.

Fact Name	Fact Type	Mode	Description
`resource.provisioner.autoprep.sysprep.Identification.JoinWorkgroup`			Windows workgroup name. If joining a domain, use `JoinDomain`.
`resource.provisioner.autoprep.sysprep.LicenseFilePrintData.AutoMode`			Value is either `PerServer` or `PerSeat.` If `PerServer`, `AutoUsers` must be set.
`resource.provisioner.autoprep.sysprep.LicenseFilePrintData.AutoUsers`			The number of client licenses. Used only if `AutoMode` is `PerServer`.
`resource.provisioner.autoprep.sysprep.UserData.ComputerName`			The VM's new host na me. An asterisk (*) means to generate the name based on source VM name.
`resource.provisioner.autoprep.sysprep.UserData.FullName`			The user's full name.
`resource.provisioner.autoprep.sysprep.UserData.OrgName`			The organization name.
`resource.provisioner.autoprep.sysprep.UserData.ProductID`			The Windows product key.
`resource.provisioner.count`	Integer	dynamic, r/o	The total count of operational instances and provisions in progress
`resource.provisioner.debug`	Boolean		Controls the debug log level in the provisioner
`resource.provisioner.host.maxwait`	Integer		The maximum time to wait for a suitable host before timing out (in seconds, '<0' to wait indefinitely
`resource.provisioner.host.preferredwait`	Integer		The time after which some vmhost constraints will be lifted to increase the available pool by, for example, considering moving the disk image (in seconds, '<0' to wait indefinitely
`resource.provisioner.instancecount`	Integer	dynamic, r/o	The total count of cloned instances of the template
`resource.provisioner.instances`	String[]	dynamic, r/o	The list of id's of the instances of this template resource (if applicable)

Fact Name	Fact Type	Mode	Description
`resource.provisioner.job`	String		The name of the provisioning job that manages the lifecycle of this resource
`resource.provisioner.maxinstances`	Integer		The maximum allowed number of instances of this provisionable resource (applicable only to templates)c
`resource.provisioner.recommendedhost`	String	dynamic	The host on which the image for this resource is associated. E.g. was suspended or is the preferred host for quick start up. Combined with the 'resource.provisioner.host .preferredwait' can lock a VM to one host.
`resource.remotedesktop`	Boolean		Whether the resource has a remote desktop (or VNC) access enabled.
`resource.repositories`			The list of VM repositories visible by this resource (aggregated from VM host containers)
`resource.runningjobs`	String[]	dynamic, r/o	The list of jobs currently running on this resource
`resource.sessions`	Integer	dynamic, r/o	The number of active sessions (resource instances with active agent). Will be 0 or 1 unless a resource template
`resource.shuttingdown`	Boolean	dynamic, r/o	True if the node is attempting to shutdown/ pause/suspend and does not want new workc
`resource.type`	String	dynamic	The type of resource (whether or not the resource is a VM and if so what type of image (physical, vm, vmTemplate)
`resource.vm.basepath`	String		The filesystem location of the VM file(s) either absolute or relative to the 'repository.location'.

Fact Name	Fact Type	Mode	Description
`resource.vm.cpu.architecture`	String		The required cpu architecture e.g. x86, x86_64, sparc, ppcc
`resource.vm.cpu.hvm`	Boolean		True if the VM requires host HVM support (for para virtualization otherwise only full virtualization will be possible).
`resource.vm.cpu.weight`	Real		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.
`resource.vm.files`	Dictionary		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`.
`resource.vm.maxinstancespervmhost`	Integer		The maximum allowed number of instances of this VM image per vmhost
`resource.vm.memory`	Integer		The configured virtual memory requirement of this VM image (megabytes)
`resource.vm.networks`	String[]	dynamic, r/o	The networks associated with the vm network interfaces.
`resource.vm.preventmove`	Boolean		Administrator set attribute that will prevent moving VM disks and thus consideration potential other hosts.
`resource.vm.repositories`	String[]	dynamic, r/o	The repositories where the vm disk images are stored.

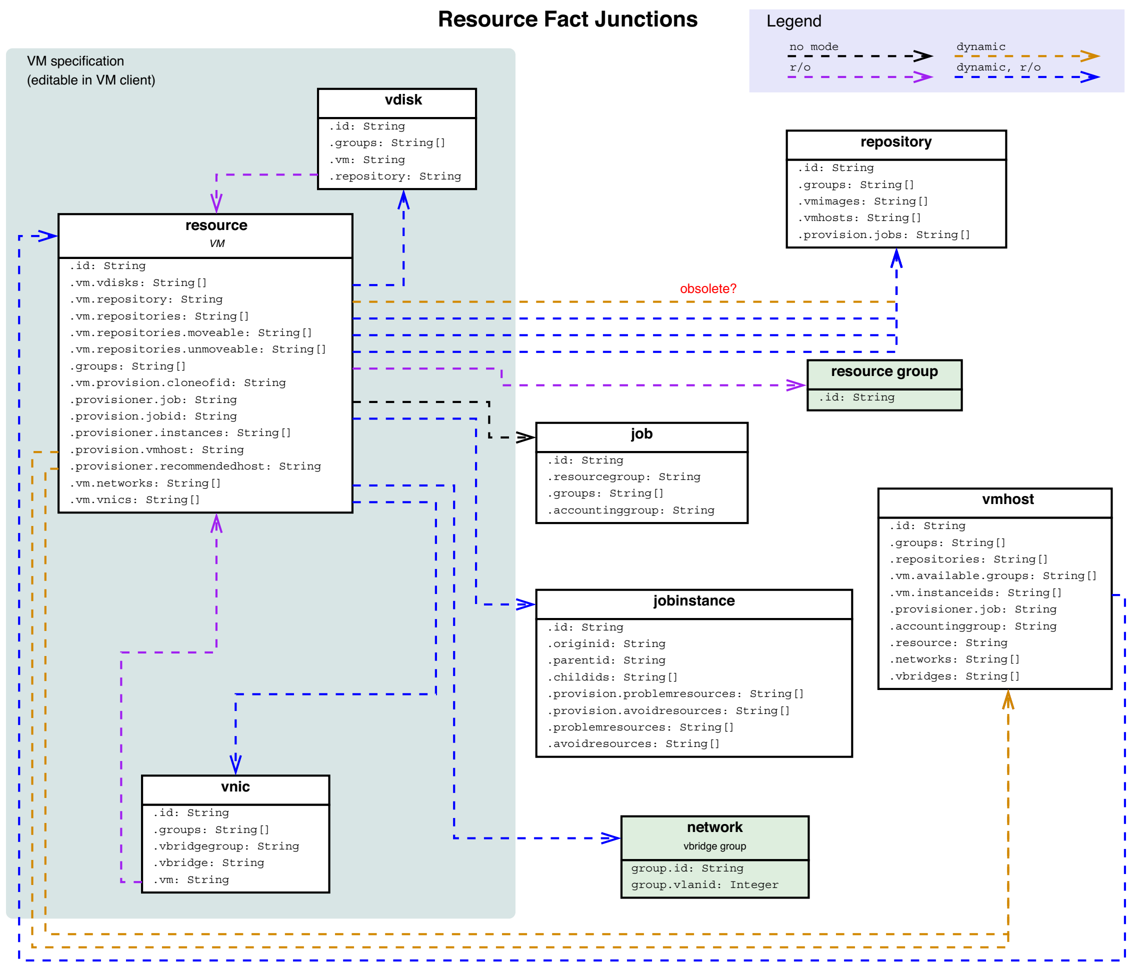
Fact Name	Fact Type	Mode	Description
`resource.vm.repositories.moveable`	String[]	dynamic, r/o	The repositories where the moveable vm disk images are stored.
`resource.vm.repositories.unmoveable`	String[]	dynamic, r/o	The repositories where the unmoveable vm disk images are stored.c
`resource.vm.repository`	String	dynamic	The default repository where this vm disk images and other config files are/will be stored.
`resource.vm.spec`			Dictionary containing the specification for building this VM. Interpreted by the Provisioning Adapter.
`resource.vm.underconstruction`	Boolean		True if the VM is currently under construction
`resource.vm.uuid`	String		The UUID of a virtual machine (vendor/adapter specific).
`resource.vm.vcpu.number`	Integer		The number of virtual CPUs for this VM.
`resource.vm.vdisks`	String[]	dynamic, r/o	The list of virtual disks that make up this VM.c
`resource.vm.vdisksize`	Integer	dynamic, r/o	The total size of all the moveable virtual disks for this VM image (megabytes)
`resource.vm.vendor`	String		The vendor of a virtual machine
`resource.vm.version`	Integer		The version number for this VM.
`resource.vm.vmhost.rankby`	String[]		The ranking specification used to select suitable vm hosts. Element syntax is '<fact>/<order>' where order is either 'ascending' or 'descending'
`resource.vm.vnics`	String[]	dynamic, r/o	The list of virtual nics that make up this VM. (aggregated from the VNIC containers)
`resource.vmhosts`	String[]	dynamic, r/o	The list of VM host containers supported by this resource (aggregated from VM host containers)

Fact Name	Fact Type	Mode	Description
`resource.vnc.ip`	String		The port number for a vnc session running on the resource.
`resource.vnc.port`	Integer		The port number for a vnc session running on the resource.

Resource Object Fact Junctions

The following diagram illustrates the relationship between the Resource Grid object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the Resource Grid object itself.

Figure 4-4 *Resource Fact Junctions*



VM Host Object Facts

The VM Host Resource object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only. Facts with mode r/o have read-only values, which can be viewed but changes cannot be made.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the VM Host Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-7 *VM Host Facts*

Fact Name	Fact Type	Mode	Description
`vmhost.accountinggroup`	String		The default VM host group which will be adjusted for VM stats
`vmhost.controllingjob`	String	dynamic	The ID of a running job that manages VM operations on this host. Setting this informs the VM Manager to prevent other jobs from initiating provisioning actions. This fact is cleared when the managing job ends.
`vmhost.enabled`	Boolean		True if the VM host is enabled (new VM instances can be provisioned)
`vmhost.groups`	String[]	r/o	The groups this VM host is a member of
`vmhost.health`	Boolean		The health of this VM host. True indicates good health
`vmhost.hvm`	Boolean		True if the hypervisor supports the hardware virtualization.
`vmhost.id`	String	r/o	The VM host's unique name
`vmhost.loadindex.slots`	Real	dynamic, r/o	The loading index (the ratio of active hosted VMs to the specified max)

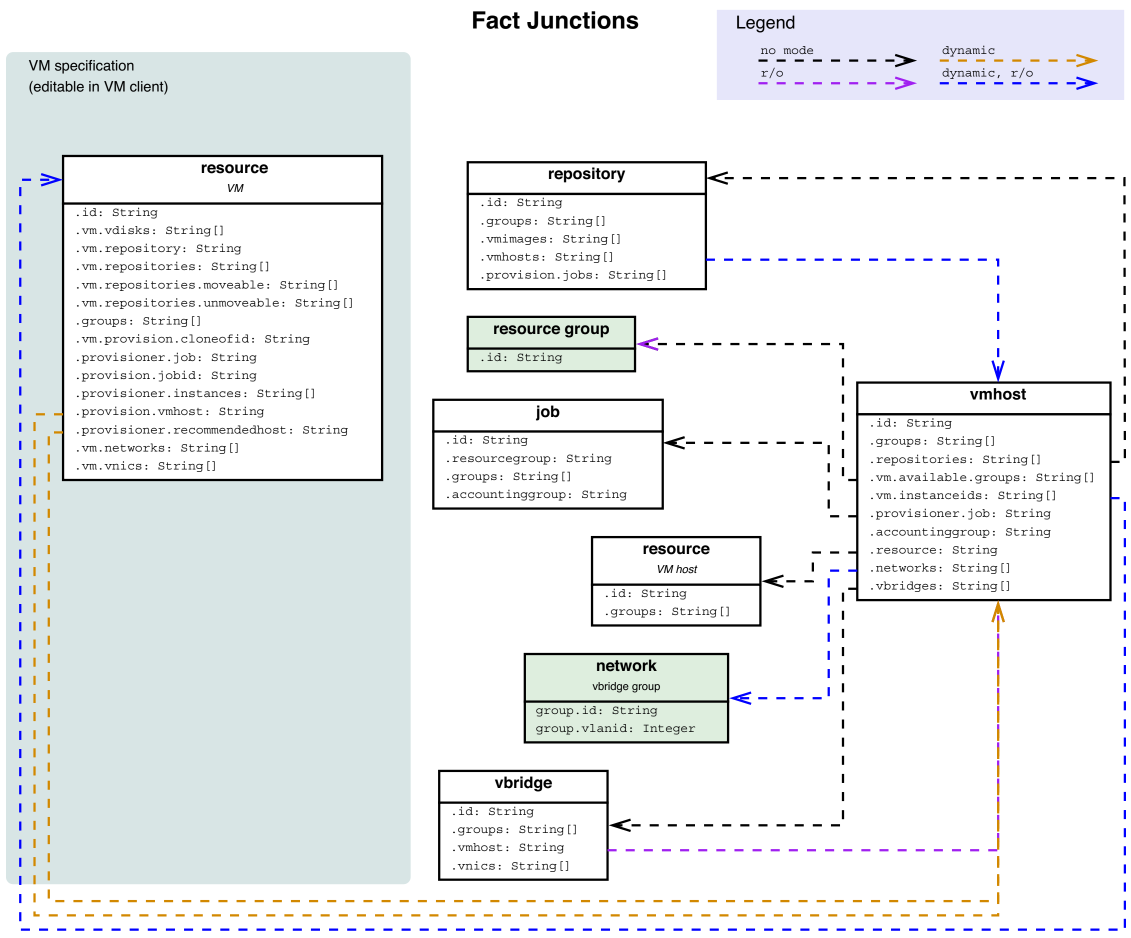
Fact Name	Fact Type	Mode	Description
`vmhost.loadindex.virtualmemory`	Real	dynamic, r/o	The loading index (ratio of consumed memory to the specifed max)
`vmhost.location`	String		The VM host's physical location
`vmhost.maxvmslots`	Integer		The maximum number of hosted VM instances
`vmhost.memory.available`	Integer	dynamic, r/o	The amount of memory available to new virtual machines
`vmhost.memory.max`	Integer		The maximum amount of memory available to virtual machines (in megabytes)
`vmhost.migration`	Boolean		True if the VM host can support VM migration (also subject to provision adapter cababilities
`vmhost.networks`	String[]	dynamic, r/o	List of Networks visible to this VM host
`vmhost.online`	Boolean	dynamic, r/o	True if the agent on the physical host is online
`vmhost.provisioner.job`	String		The name of the provisioning adapter job that manages VM discovery on this host
`vmhost.provisioner.password`	String		The password required for provisioning on the VM host (Used by provisioning adapter)
`vmhost.provisioner.username`	String		The username required for provisioning on the VM host (Used by provisioning adapter)
`vmhost.repositories`	String[]		This list of repositories (VM disk stores) visible to this VM host
`vmhost.resource`	String	r/o	The name of the resource that houses this vm host container
`vmhost.resync`	Boolean	dynamic	Specifies that the host should be probed to resync all VMs managed on this host at the next opportunity

Fact Name	Fact Type	Mode	Description
`vmhost.shuttingdown`	Boolean	dynamic, r/o	True if the VM host is attempting to shutdown and does not want to be provisioned
`vmhost.vbridges`	String[]	dynamic, r/o	List of Vbridge objects visible to this VM host
`vmhost.vm.available.groups`	String[]		The list of resource groups containing VMs that are allowed to run on this host
`vmhost.vm.count`	Integer	dynamic, r/o	The current number of active VM instances
`vmhost.vm.instanceids`	String[]	dynamic, r/o	The list of active VM instances
`vmhost.vm.placement.score`	Integer	dynamic, r/o	The 'cost' (score) of moving the disks for a VM to this vmhost. This is *only* visible and valid during a 'vmhost' constraint match (-1 = not possible, 0 = affinity, >0 = expense)
`vmhost.vm.templatecounts`	Dictionary	dynamic, r/o	A dictionary of running instance counts for each running VM templatec

VM Host Resource Object Fact Junctions

The following diagram illustrates the relationship between the Vm Host Resource Grid object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the VM Host Resource Grid object itself.

Figure 4-5 VM Host Fact Junctions



Resource Group Facts

Table 4-8 Resource Group Facts

Fact Name	Fact Type	Mode	Description
`group.id`	String	r/o	The group's name
`group.loadaverage`	Real	dynamic, r/o	The aggregated load average of all the resource in this group (the membership may be dynamic).
`group.loadpercent`	Integer	dynamic, r/o	The percentage of online resources in this group that are currently busy.
`group.resources.busy`	Integer	dynamic, r/o	The total number of available resources that are currently busy performing work in this group.

Fact Name	Fact Type	Mode	Description
`group.resources.idle`	Integer	dynamic, r/o	The total number of available resources that are ready for work in this group.
`group.resources.online`	Integer	dynamic, r/o	The total number of online resources (busy and idle) in this group.

Understanding Resource Metrics Facts

When you install the PlateSpin Orchestrate Agent on a machine, you can optionally install the Orchestrate Monitoring Agent along with it. The Monitoring Agent uses the Ganglia Monitoring Daemon (gmond) to automatically collect metrics and send them to the Orchestrate Monitoring Server. You can use the following command to check the status of an installed Monitoring Agent:

```
# /etc/init.d/novell-gmond status
```

If the daemon is operating normally, it returns a `running` status.

When you install and configure the Orchestrate Monitoring Agent (gmond), it is set by default to report metrics on port 8649, which is also detected by the Orchestrate Agent. When communication is established, the gmond daemon sends out metrics data, which are then gathered by the Orchestrate Agent and set as fact values associated with the resource where the daemon is running. You can verify the connection with the following command:

```
telnet localhost 8649
```

If gmond is running and communicating properly, an XML document listing the reported metrics is displayed.

This section includes information about the resource metrics facts that are gathered, the unit conversion performed by Orchestrate on the Ganglia-provided values, and how you can use these facts to help you manage the resources in the grid.

- "Resource Metrics Facts" on page 87
- "Interpreting the Units of Metrics Fact Values" on page 89

Resource Metrics Facts

The Orchestrate Agent uses the metrics collected by gmond to create fact values for a given resource. These facts are therefore externally generated and are not among the default facts reported by the PlateSpin Orchestrate Agent. The agent updates these externally generated fact values every 30 seconds. All of these fact values have a `resource.metrics.` prefix.

For example, gmond collects a metrics value called `load_one`. The Orchestrate Agent sets this value as the `resource.metrics.load_one` fact.

To see a list of these facts in the Orchestrate Development Client,

1. In the Explorer panel, select a resource.
2. In the Workspace panel, select *Constraints/Facts*.

The names of the resource metrics facts are displayed in bold font (in the Development Client interface) because they were added as new facts to the default fact list. The following sample is a list of the default Ganglia-generated metrics facts with data type and an example value:

```
<fact name="resource.metrics.boottime" value="1239122234.0000" type="Real" />
<fact name="resource.metrics.bytes_in" value="208.8800" type="Real" />
<fact name="resource.metrics.bytes_out" value="68.9700" type="Real" />
<fact name="resource.metrics.cpu_aidle" value="76.9000" type="Real" />
<fact name="resource.metrics.cpu_idle" value="95.2000" type="Real" />
<fact name="resource.metrics.cpu_nice" value="0.0000" type="Real" />
<fact name="resource.metrics.cpu_num" value="2" type="Integer" />
<fact name="resource.metrics.cpu_speed" value="1596" type="Integer" />
<fact name="resource.metrics.cpu_system" value="0.3000" type="Real" />
<fact name="resource.metrics.cpu_user" value="4.0000" type="Real" />
<fact name="resource.metrics.cpu_wio" value="0.4000" type="Real" />
<fact name="resource.metrics.disk_free" value="27090" type="Integer" />
<fact name="resource.metrics.disk_total" value="48213" type="Integer" />
<fact name="resource.metrics.gexec" value="OFF" type="String" />
<fact name="resource.metrics.load_fifteen" value="0.2000" type="Real" />
<fact name="resource.metrics.load_five" value="0.4100" type="Real" />
<fact name="resource.metrics.load_one" value="1.1900" type="Real" />
<fact name="resource.metrics.machine_type" value="x86" type="String" />
<fact name="resource.metrics.mem_buffers" value="299" type="Integer" />
<fact name="resource.metrics.mem_cached" value="761" type="Integer" />
<fact name="resource.metrics.mem_free" value="65" type="Integer" />
<fact name="resource.metrics.mem_shared" value="0" type="Integer" />
<fact name="resource.metrics.mem_total" value="1989" type="Integer" />
<fact name="resource.metrics.os_name" value="Linux" type="String" />
<fact name="resource.metrics.os_release" value="2.6.27.19-5-pae" type="String"
/>
<fact name="resource.metrics.part_max_used" value="70.8000" type="Real" />
<fact name="resource.metrics.part_max_used.units" value="" type="String" />
<fact name="resource.metrics.pkts_in" value="0.4500" type="Real" />
<fact name="resource.metrics.pkts_out" value="0.6300" type="Real" />
<fact name="resource.metrics.proc_run" value="0" type="Integer" />
<fact name="resource.metrics.proc_total" value="411" type="Integer" />
<fact name="resource.metrics.swap_free" value="2039" type="Integer" />
<fact name="resource.metrics.swap_total" value="2047" type="Integer" />
<fact name="resource.metrics.vm_type" value="" type="String" />
<fact name="resource.metrics.vm_type.units" value="" type="String" />
```

These are the metrics reported in Orchestrate systems that use the `gmond.conf` created when Orchestrate Monitoring Agent was installed and configured. The open source gmond might include other metrics that can be monitored. You can modify the default Orchestrate gmond configuration file to report these metrics after it is initially installed and configured. For information about modifying the file, see the gmond.conf man page (http://linux.die.net/man/5/gmond.conf).

By using the XML constraint language, you can utilize these resource metrics facts as you would use any other fact in PlateSpin Orchestrate. For example, you could create an Event that sets thresholds for the amount of incoming network packets. When that threshold is exceeded, a Scheduled Job could be triggered or a notification e-mail sent. For more information, see Section 3.12, "Using an Event Notification in a Job," on page 48.

Interpreting the Units of Metrics Fact Values

The Orchestrate Agent converts most of the Ganglia metrics values to PlateSpin Orchestrate standard units. This allows fact values to be compared in constraints without the need to perform conversions explicitly. In cases where units are not known or cannot be converted, a separate fact with a `.units` suffix is included. For example:

```
<fact name="resource.metrics.bytes_in" value="bytes/sec" type="String" />
```

The following table lists the `resource.metrics` facts and the units of measure used for each fact value:

Table 4-9 *Resource Metrics Facts*

Resource Metric Fact With Reported Value	Orchestrate Measurement Unit of the Value
boottime	32-bit seconds timestamp
bytes_in	byte rate measured in bytes per second
bytes_out	byte rate measured in bytes per second
cpu_aidle	percentage
cpu_idle	percentage
cpu_nice	percentage
cpu_num	number of CPUs
cpu_speed	megahertz as an integer
cpu_system	percentage
cpu_user	percentage
cpu_wio	percentage
disk_total	total in binary megabytes
disk_free	total in binary megabytes
gexec	simple string
load_fifteen	real number
load_five	real number
load_one	real number
machine_type	simple string
mem_buffers	memory in megabytes (integer)
mem_cached	memory in megabytes (integer)
mem_free	memory in megabytes (integer)
mem_shared	memory in megabytes (integer)
mem_total	memory in megabytes (integer)
os_name	simple string

Resource Metric Fact With Reported Value	Orchestrate Measurement Unit of the Value
os_release	simple string
pkts_in	packet rate in packets per second
pkts_out	packet rate in packets per second
proc_run	processes run (integer)
proc_total	total processes (integer)
swap_free	memory in megabytes (integer)
swap_total	memory in megabytes (integer)

4.1.5 Virtual Disk Object Facts and Fact Junctions

This section includes the following information:

- "Virtual Disk Object Facts" on page 90
- "Virtual Disk Object Fact Junctions" on page 91

Virtual Disk Object Facts

The vDisk object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only. Facts with mode r/o have read-only values, which can be viewed but changes cannot be made.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the vDisk Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deletable, which means they can be deleted at any time.

Table 4-10 *vDisk Facts*

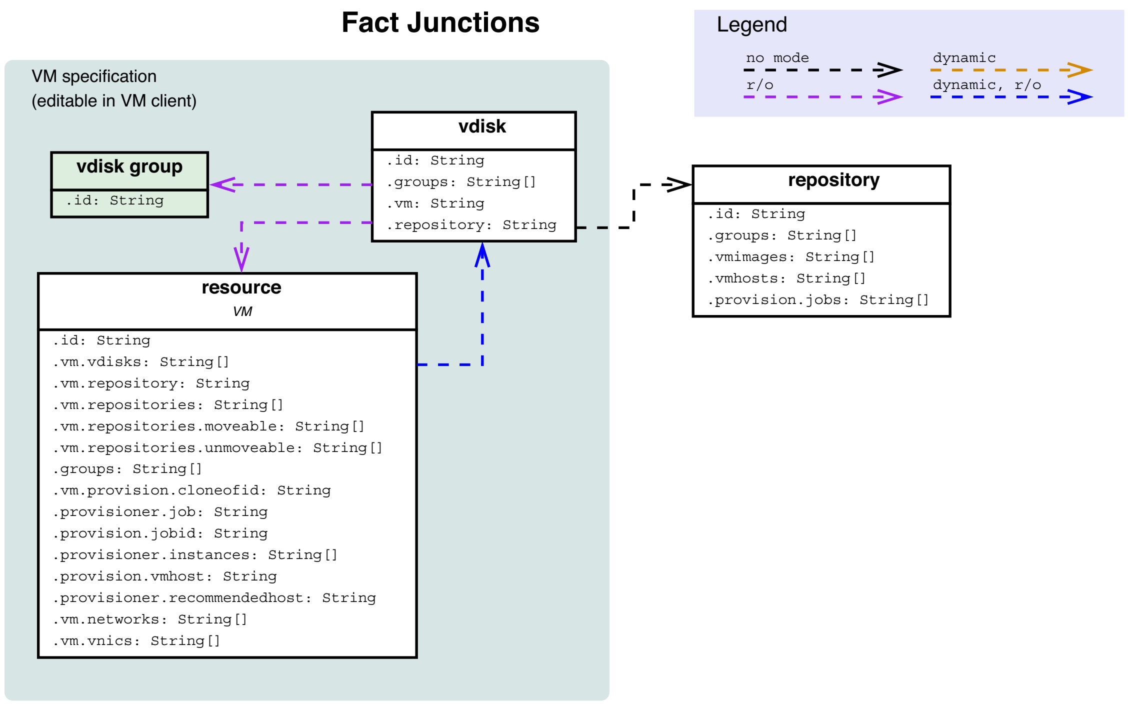
Fact Name	Fact Type	Mode	Description
`vdisk.description`	String		Description of vDisk
`vdisk.groups`	String[]	r/o	The groups this vDisk is a member of
`vdisk.health`	Boolean		The health of this vDisk. True indicates good health
`vdisk.id`	String	r/o	The vDisk's unique ID.
`vdisk.location`	String		The repository dependent location definition

Fact Name	Fact Type	Mode	Description
`vdisk.moveable`	Boolean		True if the vDisk is moveable. The vDisk cannot be deleted if this fact is set to false.
`vdisk.repository`	String		The name of the repository containing the vDisk image
`vdisk.size`	Integer		The size of this virtual disks (megabytes)
`vdisk.type`	String		The type of vDisk: - file (file backed disk) - block (block device)
`vdisk.vm`	String	r/o	The name of the VM that uses this vDisk

Virtual Disk Object Fact Junctions

The following diagram illustrates the relationship between the Virtual Disk object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the Virtual Disk Grid object itself.

Figure 4-6 *Virtual Disk Fact Junctions*



4.1.6 Virtual NIC Object Facts and Fact Junctions

This section includes the following information:

- "Virtual NIC Object Facts" on page 92
- "Virtual NIC Object Fact Junctions" on page 93

Virtual NIC Object Facts

The VNIC object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the VNIC Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-11 *VNIC Facts*

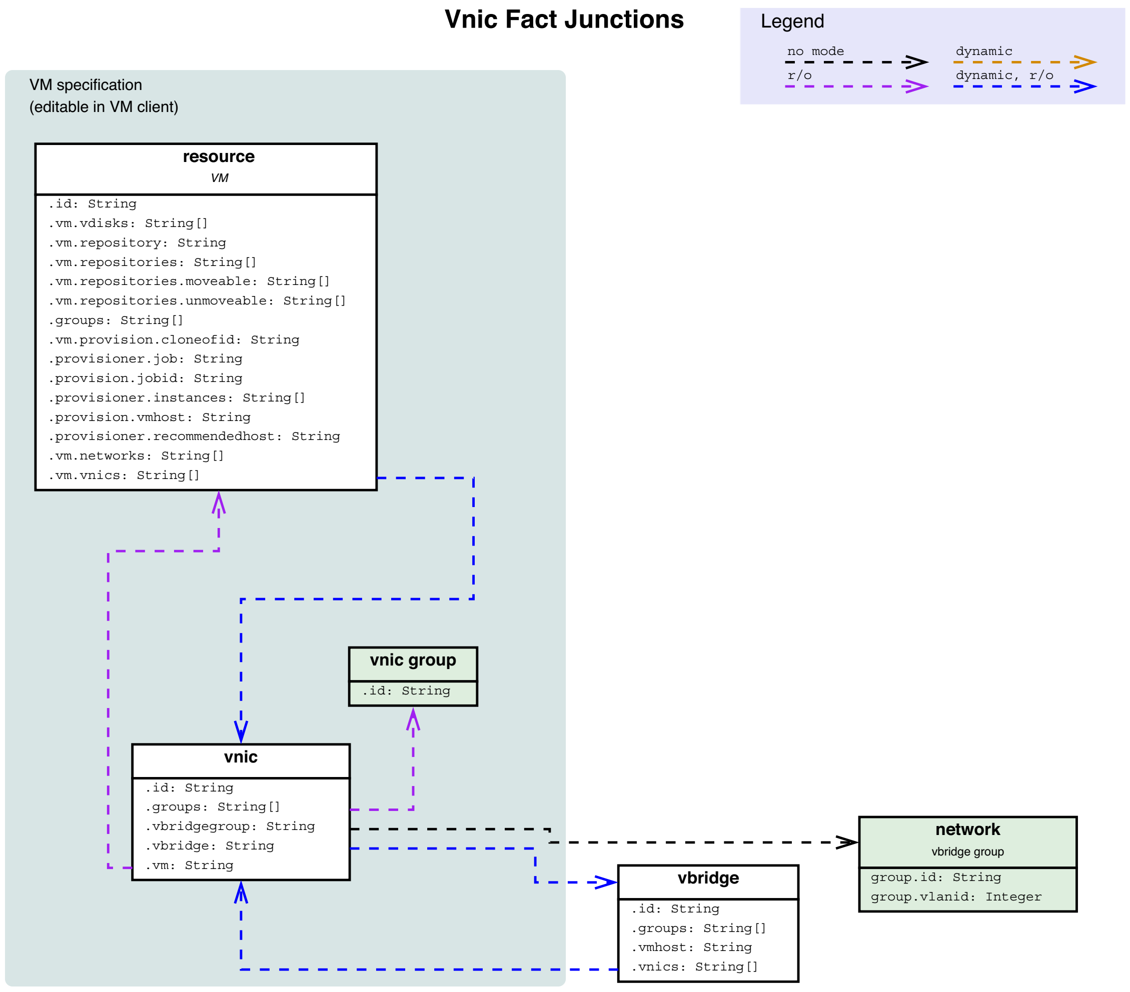
Fact Name	Fact Type	Mode	Description
`vnic.description`	String		Description of vNIC
`vnic.groups`	String[]	r/o	The groups that this vNIC belongs to.
`vnic.health`	Boolean		The health of this vNIC. True indicates good health
`vnic.id`	String	r/o	The unique name of this VNIC.
`vnic.mac`	String		The MAC address assigned to this VNIC. A empty string implies auto-generate MAC address.
`vnic.network`	String		The network (vbridge group) on which this Vnic is provisioned or wishes to be provisioned.
`vnic.provisioner.autoprep.DNSDomain`	String		Windows only. Adapter's Domain.
`vnic.provisioner.autoprep.DNSFromDHCP`	Boolean		(Optional, SUSE VM only.) If true, then the SUSE VM is configured to retrieve its DNS server settings from DHCP.
`vnic.provisioner.autoprep.DNSServers`			Adapter's list of DNS servers for name look up.
`vnic.provisioner.autoprep.DNSSuffixes`			Adapter's suffix appended to name for lookup.
`vnic.provisioner.autoprep.Gateways`			List of Internet gateways available to the interface.

Fact Name	Fact Type	Mode	Description
`vnic.provisioner.autoprep.IPAddress`	String	del	IP address for this adapter.
`vnic.provisioner.autoprep.MACAddress`	String	del	MAC address for the interface. Asterisk (*) or not set means to generate a new MAC.
`vnic.provisioner.autoprep.UseDHCP`	Boolean	del	If true, new VM retrieves its network settings from a DHCP server and any adapter settings are ignored. If false, then any req uired adapter settings must be defined.
`vnic.provisioner.autoprep.netBIOS`	String	del	NetBios options for VM. The values are: ◆ EnableNetBIOSViaDhcp ◆ EnableNetBIOS ◆ DisableNetBIOS
`vnic.provisioner.autoprep.primaryWINS`	String	del	Windows only. Adapter's Primary WINS server.
`vnic.provisioner.autoprep.secondaryWINS`	String	del	Windows only. Adapter's Secondary WINS server.
`vnic.provisioner.autoprep.subnetMask`	String	del	Subnet mask for this adapter.
`vnic.vbridge`	String	dynamic, r/o	The name of the Vbridge used by this vNIC
`vnic.vm`	String	r/o	The name of the VM that uses this vNIC

Virtual NIC Object Fact Junctions

The following diagram illustrates the relationship between the VNIC object facts and other Grid objects. It also shows the relationship between other discrete object facts and the VNIC object itself.

Figure 4-7 *Virtual NIC Fact Junctions*



4.1.7 Repository Object Facts and Fact Junctions

This section includes the following information:

- "Repository Object Facts" on page 94
- "Repository Object Fact Junctions" on page 97
- "Repository Group Facts" on page 97

Repository Object Facts

The Repository object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the Repository Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-12 *Repository Facts*

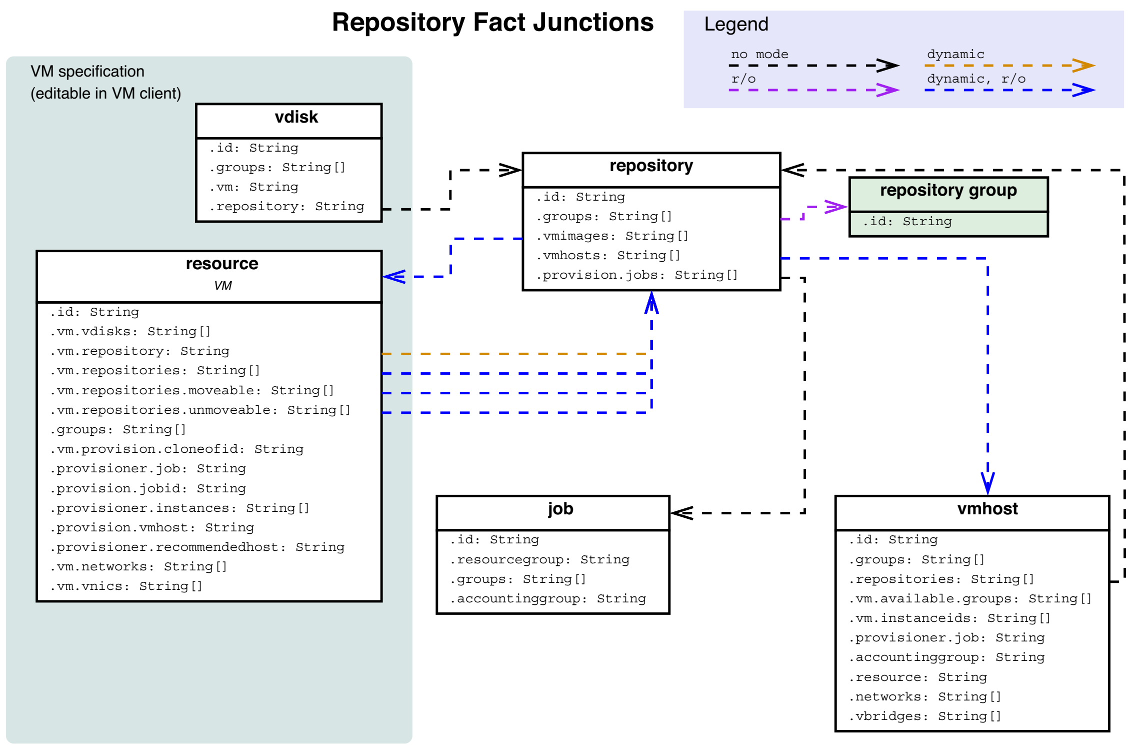
Fact Name	Fact Type	Mode	Description
`repository.capacity`	Integer		The maximum amount of storage space available to virtual machines (in megabytes). `-1` means unlimited.
`repository.description`	String		Description of repository
`repository.efficiency`	Real		The efficiency coefficient used to calculate 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 score (thus `0` means no cost -- very efficient).
`repository.enabled`	Boolean		True if the Repository is enabled (new VM instances can be provisioned)
`repository.freespace`	Integer	Dynamic r/o	The amount of storage space available to new virtual machines (in megabytes). `-1` means unlimited.
`repository.groups`	String[]	r/o	The groups to which this repository belongs.
`repository.health`	Boolean		The health of this repository. True indicates good health
`repository.id`	String	r/o	The Repository's unique name
`repository.location`	String		The Repository's logical root location, for example, `/` or `c:/vm` or `nas:/vol1`
`repository.preferredpath`	String		The relative path from `repository.location` to search and place VM files for movement and cloning

Fact Name	Fact Type	Mode	Description
`repository.provisioner.jobs`	String[]		The names of the provisioning adapter jobs that can manage VM's on this repository
`repository.san.type`	String		The type of SAN (Adapter specific, `iSCSI` or `Fibre Channel`)
`repository.san.vendor`	String		The vendor of SAN (Adapter specific, `iqn`, `npiv`, `emc`). An empty string indicates bind/unbind is a noop.
`repository.searchpath`	String[]		The relative path from `repository.location` to search for VM configuration files (implicitly includes `resource.preferredpath`)
`repository.type`	String		The type of repository: ◆ `local` (for example, local disk) ◆ `NAS` (for example, NFS mount) ◆ `SAN` (a Storage area Network such as iSCSI or Fibre Channel) ◆ `datagrid` (an Orchestrate built-in, datagrid-backed store) ◆ `virtual` (an externally managed store such as VMware Virtual Center)
`repository.usedspace`	Integer	Dynamic r/o	The amount of storage space used for virtual machines
`repository.vmhosts`	String[]	Dynamic r/o	The amount of storage space used for virtual machines
`repository.vmimages`	String[]	Dynamic r/o	The list of VM images stored in this repository (aggregated from individual VM fact)

Repository Object Fact Junctions

The following diagram illustrates the relationship between the Repository object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the Repository object itself.

Figure 4-8 Repository Fact Junctions



Repository Group Facts

Table 4-13 Repository Group Facts

Fact Name	Fact Type	Mode	Description
`group.id`	String	r/o	The name of the group.

4.1.8 Virtual Bridge Object Facts and Fact Junctions

This section includes the following information:

- "Virtual Bridge Object Facts" on page 98
- "Virtual Bridge Object Fact Junctions" on page 98
- "Network Group Facts" on page 99

Virtual Bridge Object Facts

The VNIC object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the Vbridge Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

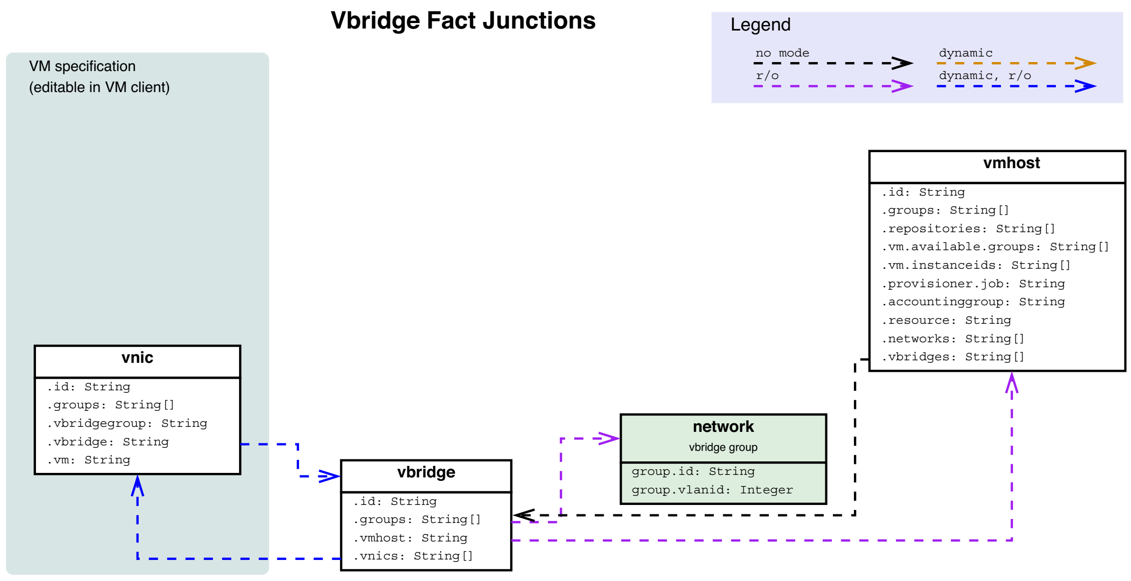
Table 4-14 *Vbridge Facts*

Fact Name	Fact Type	Mode	Description
`vbridge.description`	String		Description of Vbridge
`vbridge.enabled`	Boolean		True if the vbridge is enabled
`vbridge.groups`	String[]	r/o	The groups this Vbridge is a member of
`vbridge.health`	Boolean		True if the vbridge is in a healthy state
`vbridge.id`	String	r/o	The unique identifier for the Vbridge.
`vbridge.vmhost`	String	r/o	The ID of the vmhost containing this vbridge
`vbridge.vnics`	String[]	dynamic, r/o	The virtual NICs attached to this vbridge

Virtual Bridge Object Fact Junctions

The following diagram illustrates the relationship between the Virtual Bridge (Vbridge) object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the Vbridge object itself.

Figure 4-9 *Virtual Bridge Fact Junctions*



Network Group Facts

Table 4-15 *Network Group Facts*

Fact Name	Fact Type	Mode	Description
`group.id`	String	r/o	The group name.
`group.provisioner.jobs`	String[]	dynamic, r/o	Provision adapters with vBridge instances on this network.
`group.provisioner.preferred`	String[]		Provision adapters explicitly associated with this network.
`group.vlanid`	String		The name of the VLAN accessed by this network (Vbridge group).

4.1.9 User Object Facts and Fact Junctions

This section includes the following information:

- "User Object Facts" on page 99
- "User Object Fact Junctions" on page 103
- "User Group Facts" on page 103

User Object Facts

The User object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the User Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-16 *User Facts*

Fact Name	Fact Type	Mode	Description
`user.account.balance`	Real	dynamic	The amount of matrix dollars spent by this user since last reset ($). Useful for implementation of quotas
`user.account.gcycles`	Integer	dynamic	The amount of grid time (gcycles) spent by this user since last reset. Useful for implementation of quotas
`user.account.maxspendrate`	Real		This value is used by the resource scheduler to throttle the rate at which matrix computing cycles are comsumed by the user ($/hr, <=0 turns feature off)
`user.account.spendrate`	Real	dynamic, r/o	The computed moving average spending over the last hour of user activity ($/hr)
`user.account.time`	Integer	dynamic	The amount of wall time spent by this user since last reset. Useful for implementation of quotas
`user.accountinggroup`	String		The default user group which will be billed for work conducted by this user
`user.auth.provider`	String		The authentication provider to which the user authenticates
`user.datagrid.maxhistory`	Integer		The maximum number job instance directories that should be kept in the datagrid for this user
`user.enabled`	Boolean		True if the user is enabled (allowed to log in and run jobs)
`user.env`	Dictionary		The uploaded and default user environment

Fact Name	Fact Type	Mode	Description
`user.external.groups`	String[]	dynamic, r/o	The external groups (e.g. LDAP) this user is a member ofc
`user.groups`	String	r/o	The groups this user is a member of
`user.health`	Boolean		The health of this user. True indicates good health
`user.history.cost.total`	Real	dynamic, r/o	The total amount of matrix dollars spent by this user on the matrix
`user.history.gcycles.total`	Integer	dynamic, r/o	The total amount of grid time (gcycles) spent by this user on the matrix
`user.history.jobcount`	Integer	dynamic, r/o	The total number of jobs a user has ever initiated on the matrix
`user.history.time.total`	Integer	dynamic, r/o	The total amount of wall time spent by this user on the matrix
`user.id`	String	r/o	The user's login name
`user.jobcount`	Integer	dynamic	A counter that records the number of jobs a user has initiated since last reset. Useful for implementation of quotas
`user.jobs.active`	Integer	dynamic, r/o	The number of top-level jobs a user has in an active state
`user.jobs.queued`	Integer	dynamic, r/o	The number of top-level jobs that are queued for this user
`user.jobs.total`	Integer	dynamic, r/o	The total number of top-level jobs a user currently has in the matrix
`user.location.city`	String		The city of location of the user
`user.location.country`	String		The country of location of the user
`user.location.site`	String		The site where the users work, for example, a building number.
`user.location.state`	String		The state of location of the user
`user.name.email`	String		The user's email address
`user.name.first`	String		The user's first name
`user.name.last`	String		The user's last name
`user.online`	Boolean	dynamic. r/o	Whether the user is currently logged into the matrix
`user.password`	String	dynamic	The user's login password

Fact Name	Fact Type	Mode	Description
`user.preemption.enabled`	Boolean		Allows this user to preempt willing jobs of a priority less than the priority of the running job instance
`user.preemption.priority.delta`	Integer		Indicates the highest job priority band that this user is allowed to preempt resources from (acts as a delta from the current job instance priority). The maximum preemptible priority is always <= user.priority.max
`user.priority.default`	Integer		The numeric representation of the default priority at which this user's jobs will run (1=lowest, 9=highest)
`user.priority.default.string`	String	dynamic, r/o	The string representation of the default priority at which this user can run a job (matches user.priority.default)
`user.priority.max`	Integer		The numeric representation of the maximum priority that this user can run a job at (1=lowest, 9=highest)
`user.priority.max.string`	String	dynamic, r/o	The string representation of the maximum priority at which this user can run a job (matches user.priority.max)
`user.privilegedjobgroups`	String[]		Allows this user's to run jobs and thus joblets on resources that have reached their slot maximum or are provisioned resources that have been reserved for another user/job. This is primarily to allow discovery jobs to be 'squeezed' onto the resource
`user.sessions`	Integer	dynamic, r/o	The number of active sessions (connections) a user currently has with the matrix
`user.stealing.enabled`	Boolean		Allows this user to steal resources running jobs of a priority less than the priority of running job instance
`user.stealing.priority.delta`	Integer		Indicates the highest job priority band that this user is allowed to steal resources from (acts as a delta from the current job instance priority, must be < '0')

User Object Fact Junctions

The following diagram illustrates the relationship between the User object facts and other Grid objects. It also shows the relationship between other discrete Grid object facts and the User object itself.

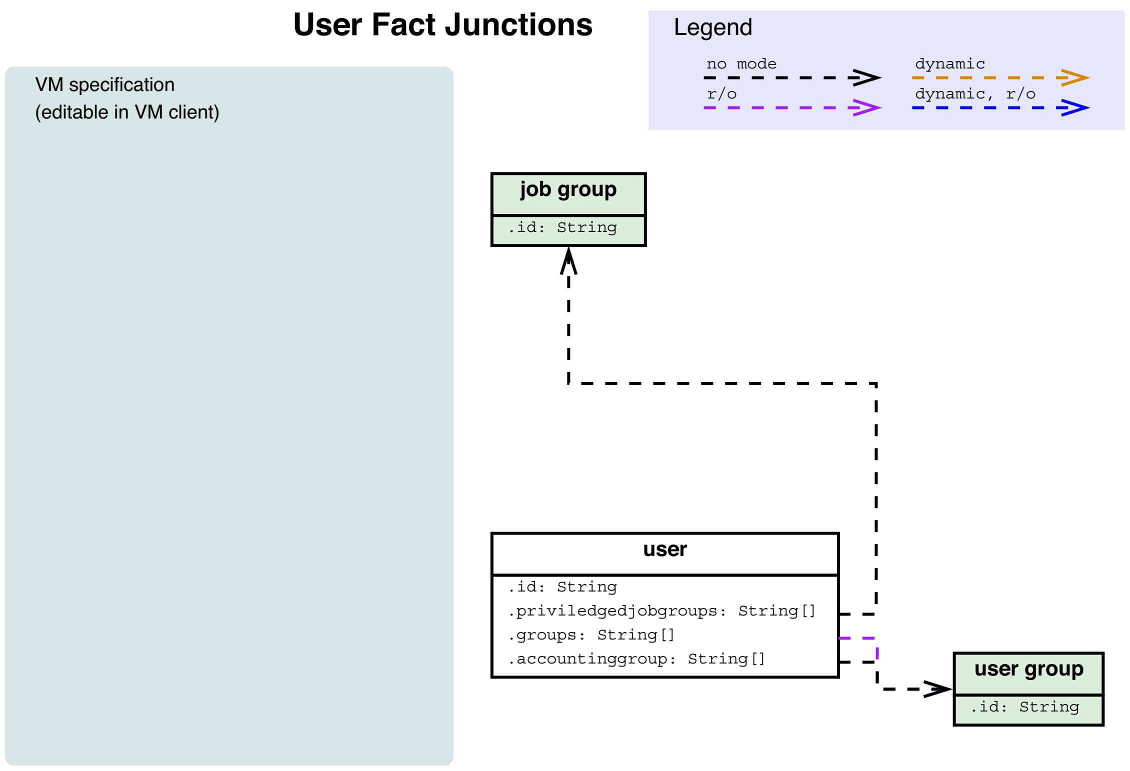


Figure 4-10 *User Fact Junctions*

User Group Facts

Table 4-17 *User Group Facts*

Fact Name	Type	Mode	Description
`group.account.balance`	Real	dynamic	he aggregated cost of work done by members of this group since last reset ($).
`group.account.gcycles`	Integer	dynamic	The aggregated amount of grid time (gcycles) spent by members of this group since last reset.
`group.account.time`	Integer	dynamic	The aggregated amount of wall time spent by members of this group since last reset
`group.id`	String	r/o	The name of the group.

Fact Name	Type	Mode	Description
`group.jobcount`	Integer	dynamic	The aggregated number of jobs run by members of this group since last reset.

4.1.10 Matrix Object Facts

The Matrix object has an associated set of facts and constraints that define its properties. The PlateSpin Orchestrate Server assigns default values to each of the component facts, although they can be changed at any time by the administrator, unless they are read-only.

The following table lists the default facts created by the PlateSpin Orchestrate Server for the Matrix Grid object.

NOTE: Facts with mode `dynamic` are dyamic read/write facts, which means you can dynamically change the values for that fact.

Facts with mode `r/o` have read-only values, which means they can be viewed but changes cannot be made.

Facts with mode `del` are deleteable, which means they can be deleted at any time.

Table 4-18 *Matrix Facts*

Fact Name	Fact Type	Mode	Description
`matrix.activejobs`	Integer	dynamic, r/o	The number of active jobs (including child jobs) for this Orchestrate Server.
`matrix.clustered`	Boolean	dynamic, r/o	Server is configured in a high availabilitly cluster.
`matrix.datagrid.root`	String	dynamic, r/o	The root directory of the datagrid.
`matrix.date`	Date	dynamic, r/o	The date of this server.
`matrix.date.dayofmonth`	Integer	dynamic, r/o	The numerical representation of the current day of the month.
`matrix.date.dayofweek`	String	dynamic, r/o	The string representation of the current week day.
`matrix.date.dayofweek.number`	Integer	dynamic, r/o	The numerical representation of the current week day.
`matrix.date.month`	String	dynamic, r/o	The string representation of the current month.
`matrix.date.month.number`	Integer	dynamic, r/o	The numerical representation of the current month.
`matrix.date.year`	Integer	dynamic, r/o	The current year.
`matrix.groups.job`	String[]	dynamic, r/o	List of Group Names of type Job.

Fact Name	Fact Type	Mode	Description
`matrix.groups.repository`	String[]	dynamic, r/o	List of Group Names of type Repository.
`matrix.groups.resource`	String[]	dynamic, r/o	List of Group Names of type Resource.
`matrix.groups.user`	String[]	dynamic, r/o	List of Group Names of type User.
`matrix.groups.vbridge`	String[]	dynamic, r/o	List of Group Names of type Vbridge.
`matrix.hostname`	String	dynamic, r/o	The server hostname.
`matrix.hostname.full`	String	dynamic, r/o	The fully qualified server hostname.
`matrix.id`	String	r/o	The name of the matrix
`matrix.loadaverage`	Real		Indicates the average load of the grid server. A value less than 1.0 is unloaded.
`matrix.maxactive`	Integer		The hard limit for the maximum number of active jobs (including child jobs) allowed on this server at one time. Jobs exceeding this value will be queued.
`matrix.maxqueued`	Integer		The maximum number of queued jobs that will be accepted by this matrix server
`matrix.maxtopjobs`	Integer		The maximum number of active jobs after which new top-level jobs will be queued (child jobs may be be able to start). Should be less than `matrix.maxactive`.
`matrix.physical.hostname`	String	dynamic, r/o	The physical server hostname
`matrix.physical.hostname.full`	String	dynamic, r/o	The fully qualified physical server hostname.
`matrix.queuedjobs`	Integer	dynamic, r/o	The number of queued jobs for this matrix server.
`matrix.time`	Time	dynamic, r/o	The time of this server.
`matrix.timeout.jobfinishing`	Integer		The approximate number of seconds to wait for a job to complete its finishing state. That is, to run any failed/canceled/completed JDL event handlers.
`matrix.timezone`	String	dynamic, r/o	The string description of the time zone in which this matrix server resides.
`matrix.uptime`	String	dynamic, r/o	The time since the last server restart.

Fact Name	Fact Type	Mode	Description
`matrix.version`	String	dynamic, r/o	The version of this server in form *<major>.<minor>.<point>_<buildNumber>*

4.2 Computed Facts

Computed facts are derived from a value, like that generated from the cell of a spreadsheet. Computed facts have some kind of logic behind them which derives 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 are not necessarily available in the default set, or are not static to anything that might impact other dynamic 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 236)
- ComputedFactContext (page 236)

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 PlateSpin Orchestrate Development Client).

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 ZOC 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).

The PlateSpin Orchestrate Datagrid

5

This section explains concepts related to the datagrid of the PlateSpin Orchestrate Server datagrid and specifies many of the objects and facts that are managed in the grid environment:

- Section 5.1, "Defining the Datagrid," on page 109
- Section 5.2, "Datagrid Communications," on page 112
- Section 5.3, "datagrid.copy Example," on page 113

5.1 Defining the Datagrid

Within the PlateSpin Orchestrate environment, the datagrid has three primary functions:

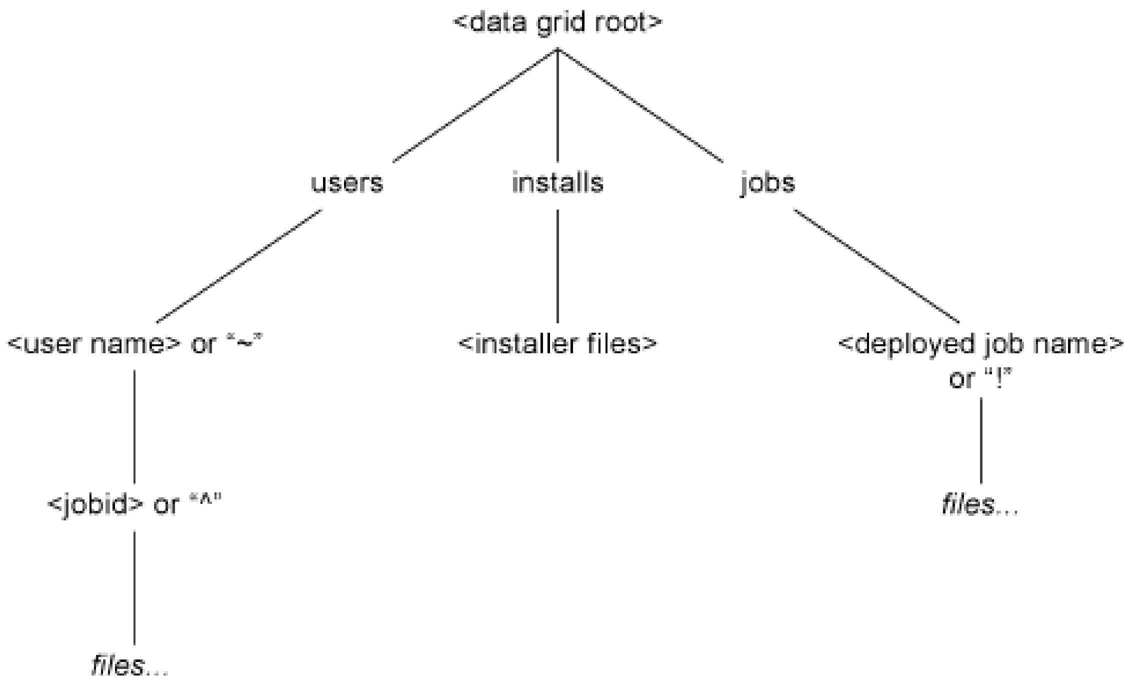
- Section 5.1.1, "PlateSpin Orchestrate Datagrid Filepaths," on page 109
- Section 5.1.2, "Distributing Files," on page 111
- Section 5.1.3, "Simultaneous Multicasting to Multiple Receivers," on page 111

5.1.1 PlateSpin Orchestrate Datagrid Filepaths

The PlateSpin Orchestrate datagrid provides a file naming convention that is used in JDL code and by the PlateSpin Orchestrate CLI for accessing files in the datagrid. The naming convention is in the form of a URL. For more information, see "Jobs"in the *PlateSpin Orchestrate 2.6 Administrator Reference*.

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

Figure 5-1 File Structure of Data Nodes in a Datagrid



The grid URL naming convention is the form `grid://<gridID>/<file path>`. Including the grid ID is optional and its absence means the host default grid.When writing jobs and configuring a datagrid, you can use the symbol ^ 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 Orchestrate Server you are using:

- "Directory Listing of the Datagrid Root Example" on page 110
- "Directory Listing of the Jobs Subdirectory Example" on page 111

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

```
$ 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
```

5.1.2 Distributing Files

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

5.1.3 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 5.2, “Datagrid Communications,” on page 112.

5.1.4 PlateSpin Orchestrate Datagrid Commands

The following datagrid commands can be used when creating job files. To see where these commands are applied in the PlateSpin Orchestrate Development Client, 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 datagrid.
`delete`	Deletes files and directories in the datagrid.
`dir`	Lists files and directories in the datagrid.
`head`	Displays the first of a datagrid file.
`log`	Displays the log for the specified job.
`mkdir`	Makes a new directory in the datagrid.
`move`	Moves files and directories in the datagrid.
`tail`	Displays the end of a datagrid file.

5.2 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 Orchestrate Server. Currently this is the same server that is running the grid.

With the exception of multicast file transfers, all datagrid 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 datagrid operations function.

5.2.1 Multicast Example

Multicast transfers are currently only supported through JDL code on the agents. 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 minimum of five receivers must request multicast within 30 seconds, but if 30 receivers connect, then start right away, use the following JDL:

```
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.

5.2.2 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 “Interface ClientAgent” on page 218.

5.2.3 Plan for Datagrid Expansion

When planning your datagrid, you need to consider where you want the Orchestrate 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 addition, 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`.

5.3 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 datagrid to a resource, then read the lines of the file:

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

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

```
datagrid = DataGrid()
datagrid.setRecursive(True)
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:

```
datagrid = DataGrid()
datagrid.copy("grid:///!myJob/myFile","myLocalFile")
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:

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

6 Virtual Machine Job Development

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

6.1 VM Job Best Practices

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

6.1.1 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 Orchestrate 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.

6.1.2 Managing VM Systems

A series of VMs must typically be provisioned in order to run system-wide 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.

6.1.3 Managing VM Images

Similar to how the job `installagent` searches for virtual machine grid objects using specified Constraints and runs a VM operation (`installAgent`) on the VMs that are returned, a PlateSpin Orchestrate image must be modified when the VM is not running. Preferably, this should occur without having to provision the VM itself.

6.1.4 Managing VM Hypervisors

The management engine (“hypervisor”) underlying 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 Development Client action.

6.1.5 VM Job Considerations

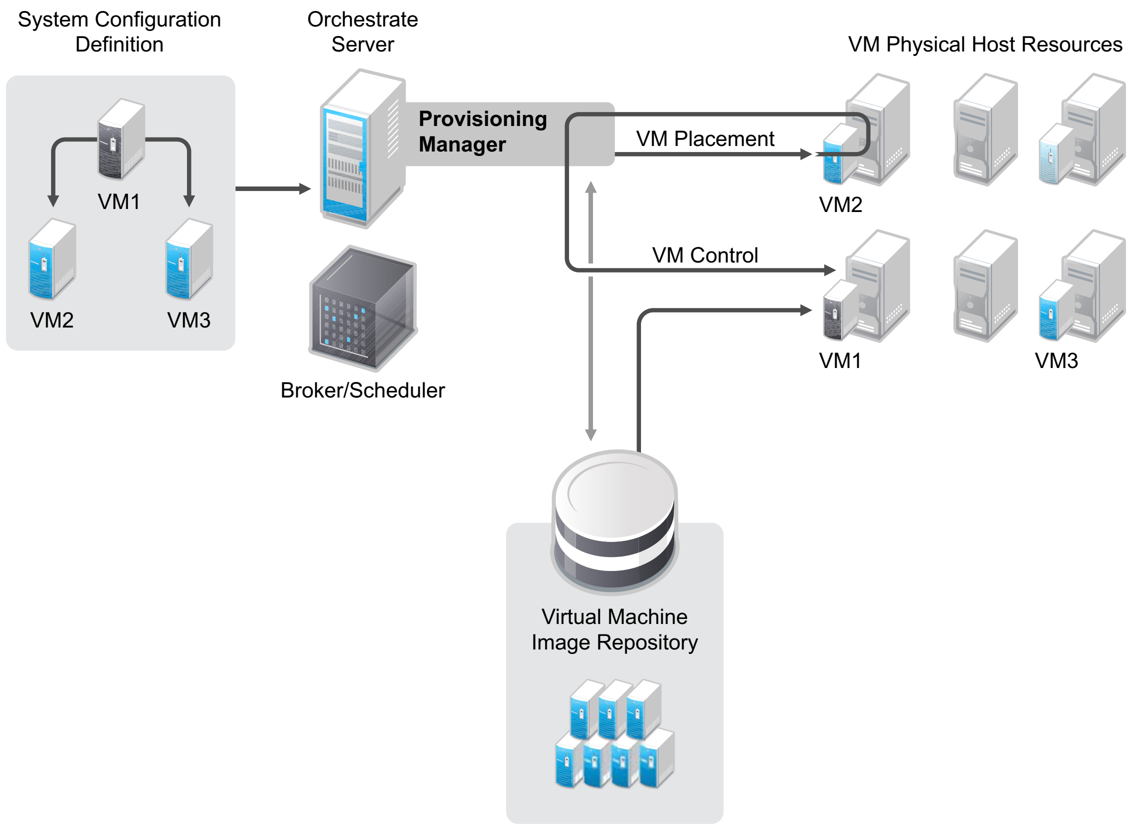
In some instances, some managed resources might host VMs that do not contain an Orchestrate Agent. Such VMs can only be controlled by administrators interacting directly with them.

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.

6.2 Virtual Machine Management

The PlateSpin Orchestrate provisioning manager provides the ability to manage the use of virtual machines, as shown in the following figure:

***Figure 6-1** VM Management*



For more information about managing virtual machines, see the *PlateSpin Orchestrate 2.6 VM Client Guide and Reference*.

While PlateSpin Orchestrate enables 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 create 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 121 and "VM Template:" on page 121).
- **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.
- **Provide checkpoints, restoration, and re-synchronization of VMs:** Snapshots of the virtual machine image can be taken and used to restore the environment if needed. For more information, refer to the documentation for your hypervisor or contact technical support organization for that hypervisor.
- **Monitor VM operations:** Jobs can start, shut down, suspend and restart VMs.
- **Manage on, off, suspend, and restart operations.**

6.3 VM Life Cycle Management

The life cycle of a VM includes its creation, testing, modifications, use in your environment, and removal when it's no longer needed.

For example, in setting up your VM environment, you might want to first create basic VMs from which you can create templates. Then, to enable the most efficient use of your current hardware capabilities, you can use those templates to create the many different specialized VMs that you need to perform the various jobs. You can create and manage VM-related jobs through the Development Client interface.

Life cycle functions are performed one at a time per given VM in order to prevent conflicts in using the VM. Life cycle events include:

- Creating a VM
- Starting and stopping a VM
- Pausing and resuming a VM
- Suspending and provisioning a VM
- Installing the Orchestrate Agent on a VM
- Creating a template from a VM
- Using the VM (starting, stopping, pausing, suspending, restarting, and shutting down)
- Running jobs for the VM
- Editing a VM
- Editing a template
- Moving a stopped VM to another host server
- Migrating a running VM to another host server
- Resynchronizing a VM to ensure that the state of the VM displayed in the Development Client is accurate
- Cloning a VM

6.4 Manual Management of a VM Lifecycle

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 PlateSpin Orchestrate 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. For an example of a provision job JDL, see Section 6.4.3, “Provision Job JDL,” on page 119.

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

1. Create your VMs and follow the discovery process in the Development Client so that the VMs are contained in the PlateSpin Orchestrate inventory.
2. In the Development Client, 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 Orchestrate Server using either the Development Client or the `zosadmin` command line.

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

- Section 6.4.1, "Manually Using the zos Command Line," on page 119
- Section 6.4.2, "Automatically Using the Development Client Job Scheduler," on page 119

6.4.1 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 *PlateSpin Orchestrate 2.6 Command Line Reference*.

6.4.2 Automatically Using the Development Client Job Scheduler

1 In the Development Client, create a *New* schedule.

2 Fill in the job name (`provision`), user, and 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 Job Scheduler, see "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference*. You can also refer to Section 6.6, "Automatically Provisioning a VM," on page 124 in this guide.

6.4.3 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 241). See also ProvisionSpec (page 246).

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>
```

6.5 Provisioning Virtual Machines

VM provisioning adapters run just like regular jobs on PlateSpin Orchestrate. 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, CPU, 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 (also called "provisioning adapters"):

- **Xen Adapter:** For more information, see XenSource* (http://www.xensource.com/).
- **VMware vSphere 4.*x*:** For more information, see VMware (http://www.vmware.com).
- **Hyper-V:** For more information, see Microsoft* Windows Server 2008 Virtualization with Hyper-V (http://www.microsoft.com/windowsserver2008/en/us/hyperv.aspx).

For more information, see "Provisioning a Virtual Machine" in the *PlateSpin Orchestrate 2.6 Virtual Machine Management Guide*.

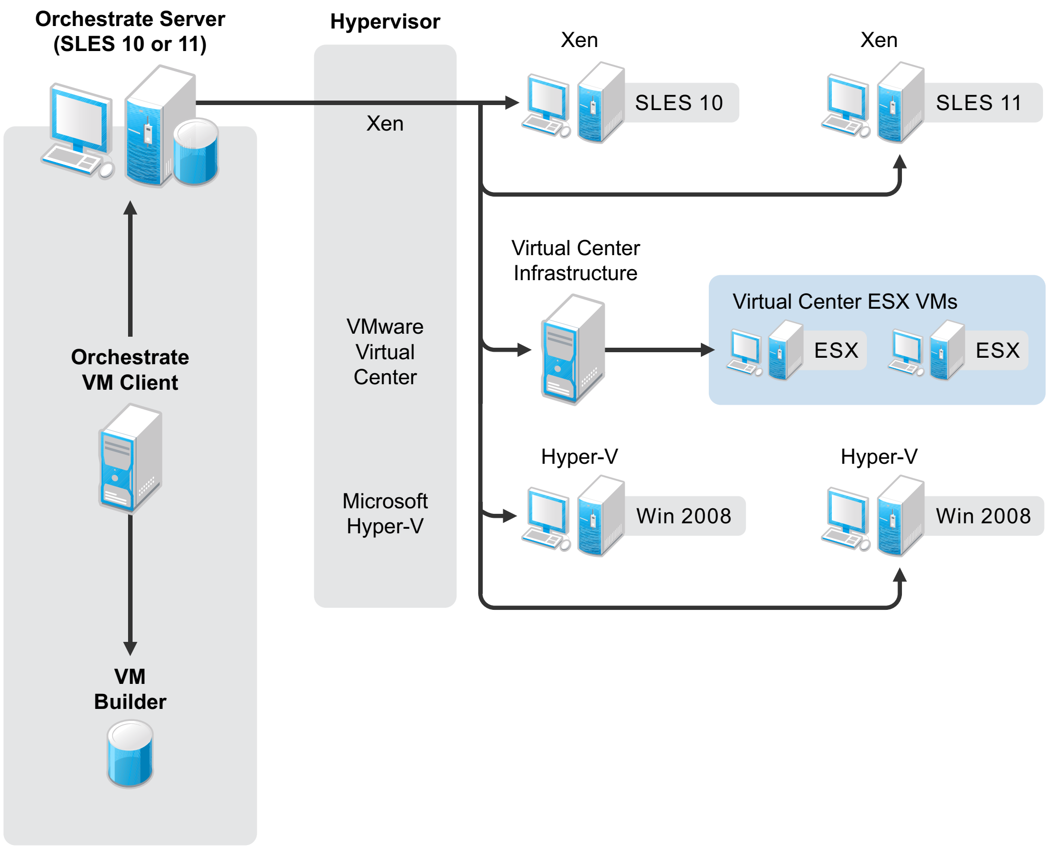
There are two types of VMs that can be provisioned:

- **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 cloned. 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.

The following graphic is a representation of the provisioning adapters and the way they function to communicate joblets to VMs:

Figure 6-2 *VM Management Provisioning Communications*



NOTE: The Xen VM Monitor can support more than just SUSE Linux Enterprise (SLE) 10 (which uses Xen 3.0.4) and Red Hat Enterprise Linux (RHEL) 5 (which uses Xen 3.0.3) VMs. For a complete list of supported guest operating systems, see the Xen Web site (http://www.xen.org/).

The following sections provide more information on provision of VMs:

- Section 6.5.1, "Provisioning VMs Using Jobs," on page 122

* Section 6.5.2, “VM Placement Policy,” on page 123
* Section 6.5.3, “Provisioning Example,” on page 123

6.5.1 Provisioning VMs Using Jobs

The following actions can be performed by jobs:

* 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
* 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 programmatically (using a job), manually (through the Development Client), 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.

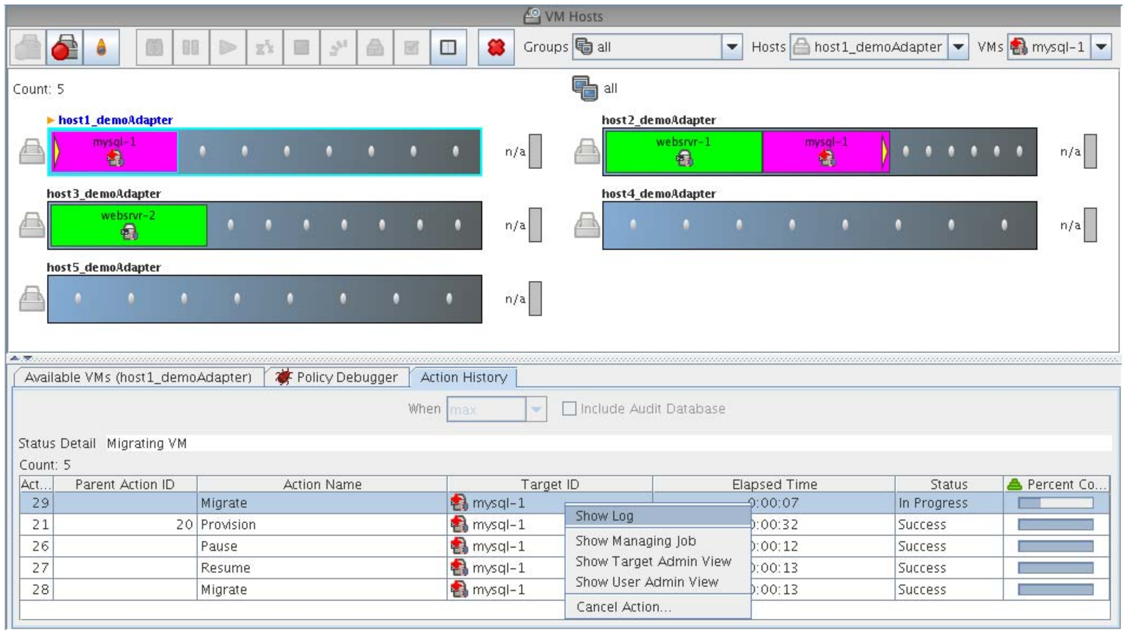
For an example of this job, see sweeper.job (page 174).

VM operations are available on the ResourceInfo (page 246) grid object, and VmHost operations are available on the VMHostClusterInfo (page 248) grid object. In addition, as shown in Section 6.5.3, “Provisioning Example,” on page 123, three provisioner events are fired when a provision action has completed, failed, or cancelled.

The API is equivalent to the actions available within the Development Client. 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 Orchestrate 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 Development Client.

Figure 6-3 *VM Hosts Management*



Status Detail Migrating VM

Count: 5

Act...	Parent Action ID	Action Name	Target ID	Elapsed Time	Status	Percent Co...
29		Migrate	mysql-1	0:00:07	In Progress	
21	20	Provision	mysql-1	0:00:32	Success	
26		Pause	mysql-1	0:00:12	Success	
27		Resume	mysql-1	0:00:13	Success	
28		Migrate	mysql-1	0:00:13	Success	

6.5.2 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>
```

6.5.3 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.

```
class provision(Job):

    def job_started_event(self):
        vm = getMatrix().getGridObject(TYPE_RESOURCE,"webserver")
        vm.provision()
        self.setFact("job.autoterminate",False)

    def provisioner_completed_event(self,params):
        print "provision completed successfully"
        self.setFact("job.autoterminate",True)

    def provisioner_failed_event(self,params):
        print "provision failed"
        self.setFact("job.autoterminate",True)

    def provisioner_cancelled_event(self,params):
        print "provision cancelled"
        self.setFact("job.autoterminate",True)
```

See additional provisioning examples in Section 6.4, “Manual Management of a VM Lifecycle,” on page 118 and Section 6.6, “Automatically Provisioning a VM,” on page 124.

6.6 Automatically Provisioning a VM

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

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

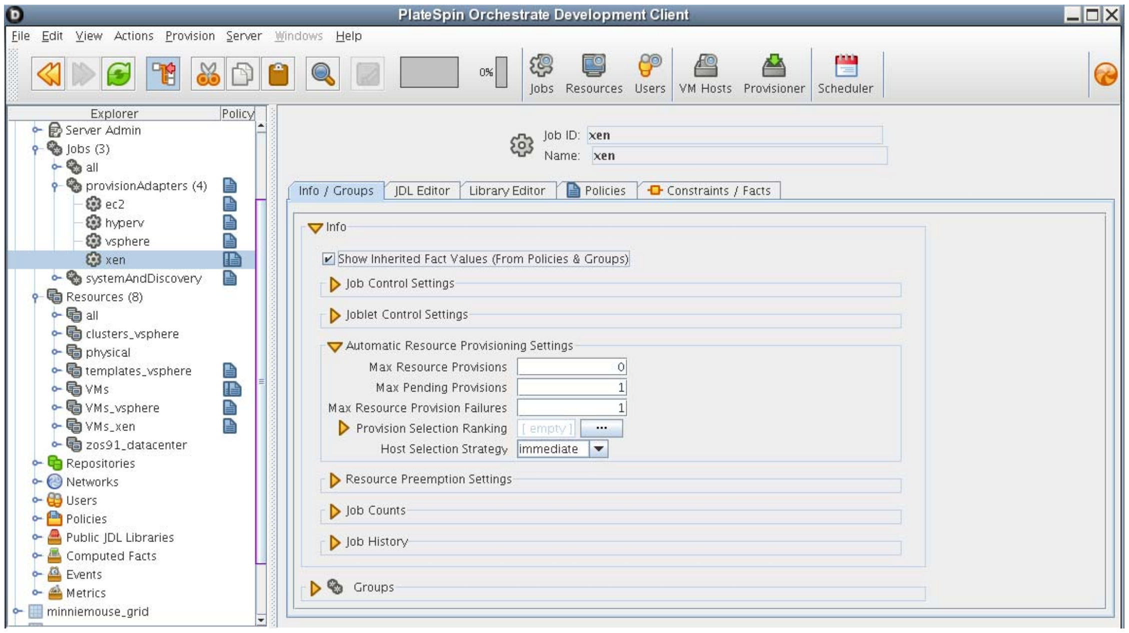
These are the job facts to enable and configure the usage of virtual machines for resource allocation. These facts can be set in a job’s policy.

For example, setting the `provision.maxcount` fact 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’s Development Client settings that are used to automatically provision VMs:

Figure 6-4 *Job Settings for Automatic VM Provisioning*



Job ID: xen
Name: xen

Info
Show Inherited Fact Values (From Policies & Groups) [✓]
Job Control Settings
Joblet Control Settings
Automatic Resource Provisioning Settings
Max Resource Provisions: 0
Max Pending Provisions: 1
Max Resource Provision Failures: 1
Provision Selection Ranking: [empty]
Host Selection Strategy: immediate
Resource Preemption Settings
Job Counts
Job History
Groups

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

When the job that reserved the resource has finished its work (joblet has completed) on the provisioned resource, the reservation is relaxed allowing other jobs to 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 246) class.

7 Job Examples

The following sections demonstrate some practical ways to use PlateSpin Orchestrate and should help you better understand how to write your own jobs:

- Section 7.1, “Simple Job Examples,” on page 127
- Section 7.2, “BuildTest Job Examples,” on page 129
- Section 7.3, “Using Deployable Job Examples Included with Platespin Orchestrate,” on page 134
- Section 7.4, “Deployable Job Examples: Parallel Computing,” on page 136
- Section 7.5, “Deployable Job Examples: General Purpose,” on page 148
- Section 7.6, “Job Examples: Miscellaneous Code-Only,” on page 186

7.1 Simple Job Examples

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

- Section 7.1.1, “provisionBuildTestResource.job,” on page 127
- Section 7.1.2, “Workflow Job Example,” on page 128

To learn about other job examples that are packaged with PlateSpin Orchestrate, see Chapter 7, “Job Examples,” on page 127.

7.1.1 provisionBuildTestResource.job

The following job example illustrates simple scripting to ensure that each of three desired OS platforms might be available in the grid and, if not, it tries to provision them (provided that a VM image matching the OS type exists). The resource Constraint object is created programmatically, so there is no need for external policies.

```
class provisionBuildTestResource(Job):

    def job_started_event(self):
        oslist = ["Windows XP", "Windows 2000", "Windows 2003 Server"]
        for os in oslist:
            constraint = EqConstraint()
            constraint.setFact("resource.os.name")
            constraint.setValue(os)
            resources = getMatrix().getGridObjects("resource",constraint)
            if len(resources) == 0:
                print "No resources were found to match constraint. \
os:%s" % (os)
            else:
              #
              # Find an offline vm instance or template.
              #
              instance = None
              for resource in resources:
                  if resource.getFact("resource.type") != "Fixed Physical"
```

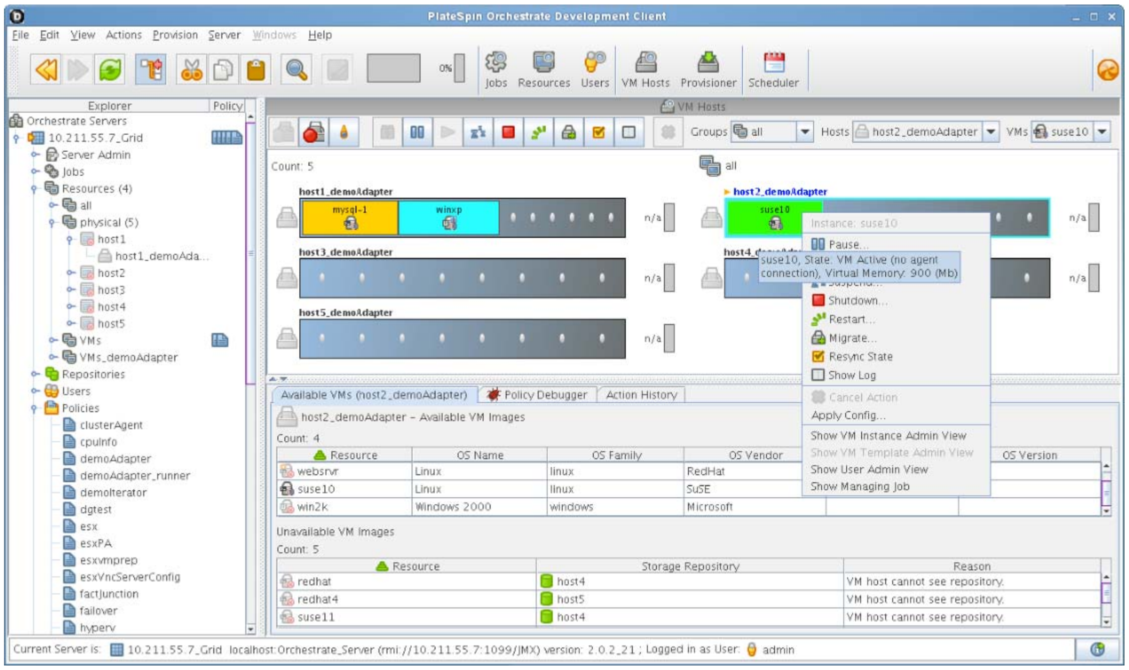
```
and \
                        resource.getFact("resource.online") == False:
                        # Found a vm or template. provision it for job.
                        print "Submitting provisioning request for vm %s." %
(resource)
                        instance = resource.provision()
                        print "Provisioning successfully submitted."
                        break
                 if instance == None:
                       print "No offline vms or templates found for os: %s" %
(os)
```

It is not necessary to always script resource provisioning. Automatic resource provisioning ("on demand") is one of the built-in functions of the Orchestrate 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 Orchestrate Development Client; that is, `job.provision.maxcount` is enabled.

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

All provisioned virtual machines and the status of the various hosts are visible in the following view of the Orchestrate Development Client.

***Figure 7-1** The PlateSpin Orchestrate Development Client Showing Virtual Machine Management*



host2_demoAdapter – Available VM Images

Count: 4

Resource	OS Name	OS Family	OS Vendor	OS Version
websrvr	Linux	linux	RedHat	
suse10	Linux	linux	SuSE	
win2k	Windows 2000	windows	Microsoft	

Unavailable VM Images

Count: 5

Resource	Storage Repository	Reason
redhat	host4	VM host cannot see repository.
redhat4	host5	VM host cannot see repository.
suse11	host4	VM host cannot see repository.

Current Server is: 10.211.55.7_Grid localhost:Orchestrate_Server (rmi://10.211.55.7:1099/JMX) version: 2.0.2_21 ; Logged in as User: admin

7.1.2 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 7.2, "BuildTest Job Examples," on page 129.

```
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 127) to ensure all the necessary resources are available, and then starts the buildTest.jdl Example (page 131). This workflow job does not complete until the two subjobs are complete, as defined in lines 3 and 4.

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

7.2 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 creating a `<fact>` element in the job policy. You can also create a fact directly in the JDL job code.

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 name.

This section shows an example of a relatively simple working job that performs a set (100) of 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. PlateSpin Orchestrate has multiple methods to specify parameters. This (`/QA/testlists/nightly.dat`) is just one example:

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

To demonstrate the possible functionality for this example, here are some policies that might apply to this example:

- Only users running tests can use resources owned by their group.
- To conserve resources, terminate the test after 50 failures.
- Because the system under test requires a license, prevent more than three of these regression tests from running at one time.

* To prevent a job backlog, limit the number of queued jobs in the system.
* To allow the regression test run to tolerate resource failures (for example, unexpected network disconnections, unexpected reboots, and so on), enable automatic failover without affecting the regression run.

The section includes the following information:

* Section 7.2.1, "buildTest.policy Example," on page 130
* Section 7.2.2, "buildTest.jdl Example," on page 131

7.2.1 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"            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.

```
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>
```

7.2.2 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 the PlateSpin Orchestrate Development Client.

This section includes the following information:

- Setting Resource Constraints
- Creating a Memo Field
- Joblet Definition

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 PlateSpin Orchestrate operations that allow interaction with the Orchestrate 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.

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.

```
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 the Orchestrate Development Client, 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 executed on a remote resource employed by a job, as defined in lines 56-80, below. The `joblet_started_event` in line 60 mirrors the `job_started_event` (line 6) but 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 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 job 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
```

```
            else:
                failed +=1
            run += 1
self.sendEvent("test_results_event",{"passed":passed,"failed":failed,"run":ru
n})
    def run_cmd(self,cmd):
        e = Exec()
        e.setCommand(cmd)
        return e.execute()
```

7.3 Using Deployable Job Examples Included with Platespin Orchestrate

The basic examples delivered with PlateSpin Orchestrate 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 `<path>/examples/<example>.job` file or view jobs using the details panel and the JDL and Policy tabs in PlateSpin Orchestrate Development Client, you should see the `.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: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

This section includes the following information:

- Section 7.3.1, "Preparing to Deploy Job Examples," on page 134
- Section 7.3.2, "Summary of PlateSpin Orchestrate Deployable Job Examples," on page 135

You can find the detailed deployable job example documentation in the following sections:

- Section 7.4, "Deployable Job Examples: Parallel Computing," on page 136
- Section 7.5, "Deployable Job Examples: General Purpose," on page 148
- Section 7.6, "Job Examples: Miscellaneous Code-Only," on page 186

7.3.1 Preparing to Deploy Job Examples

To run the PlateSpin Orchestrate jobs described in this section, use the following guidelines:

- Install and configure PlateSpin Orchestrate properly (see "Installing and Configuring All PlateSpin Orchestrate Components Together" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

- Unless otherwise indicated, install at least one agent on a managed resource and have it running (see "Installing the PlateSpin Orchestrate Agent on Other Supported Operating Systems" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*).
- Before running zosadmin or zos commands, you must log into the Orchestrate Server.

  The zosadmin command is required for administrating jobs. This includes deploying and undeploying a job to the server. The zos command is for job control, including starting a job and viewing a job's log. As you learn about the PlateSpin Orchestrate job samples, you will use the zosadmin command for deploying a sample job and the zos command for running the sample.

  - For an explanation of the zosadmin commands, see "The zosadmin Command Line Tool" in the *PlateSpin Orchestrate 2.6 Command Line Reference*.

    ```
    > zosadmin login --user psoadmin
    Login to server: skate
    Please enter current password for 'psoadmin':
    Logged into grid on server 'skate'
    ```

  - For an explanation of zos commands, see "The zos Command Line Tool" in the *PlateSpin Orchestrate 2.6 Command Line Reference*.

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

  You should create a user (see "Walkthrough: Creating a User Account" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*) before logging in.

7.3.2 Summary of PlateSpin Orchestrate Deployable Job Examples

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

Table 7-1 *PlateSpin Orchestrate Job Development Examples*

Example Name	Job Function Capabilities
demoIterator.job (page 136)	◆ Using policy constraints and job arguments to restrict joblet execution to specific resources. ◆ Scheduling joblets using a ParameterSpace. ◆ Provides an example of executing a command on a resource.
dgtest.job (page 148)	◆ Downloading files stored on grid management servers to networked nodes.
failover.job (page 157)	◆ Managing how joblets failover to enhance the robutsness of your jobs.
instclients.job (page 163)	◆ Installing an PlateSpin Orchestrate client on multiple machines. ◆ Provides an example of executing a command on a resource.

Example Name	Job Function Capabilities
jobargs.job (page 186)	◆ 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 170)	◆ Understanding how to launch specific applications on specified resources.
quickie.job (page 143)	◆ Understanding how jobs can start multiple instances of a joblet on one or more resources.
sweeper.job (page 174)	◆ Understanding how poll all resources on the grid.an ordered serialized scheduling of the joblets
whoami.job (page 180)	◆ 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`.

7.4 Deployable Job Examples: Parallel Computing

The following examples demonstrate high performance or parallel computing concepts:

- "demoIterator.job" on page 136
- "quickie.job" on page 143

demoIterator.job

Reference implementation for a simple test iterator. Several concepts are demonstrated: 1) Using policy constraints and job arguments to restrict joblet execution to a specific resource, 2) Scheduling joblets using a ParameterSpace, and 3) An example of executing a command on a resource.

Usage

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

> 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.

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

    os             Desc: Regular expression match for Operating System
                   Type: String
```

```
            Default: .*

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

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

Description

The files that make up the DemoIterator job include:

```
demoIterator                                 # Total: 156 lines
|-- demoIterator.jdl                         #   79 lines
`-- demoIterator.policy                      #   77 lines
```

demoIterator.jdl

```
# -----------------------------------------------------------------------------
#  Copyright (C) 2010 Novell, Inc. All Rights Reserved.
#
#  NOVELL PROVIDES THE SOFTWARE "AS IS," WITHOUT ANY EXPRESS OR IMPLIED
#  WARRANTY, INCLUDING WITHOUT THE IMPLIED WARRANTIES OF MERCHANTABILITY,
#  FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGMENT.  NOVELL, THE AUTHORS
#  OF THE SOFTWARE, AND THE OWNERS OF COPYRIGHT IN THE SOFTWARE ARE NOT LIABLE
#  FOR ANY CLAIM, DAMAGES, OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT,
#  TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: demoIterator.jdl 10344 2009-11-20 21:46:43Z jastin $
# ------------------------------------------------------------------------------

import time, random

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
   try:
       jobgroupname = "examples"
       jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
       if jobgroup == None:
           jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
       jobgroup.addMember(__jobname__)
   except:
       exc_type, exc_value, exc_traceback = sys.exc_info()
       print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)

```

```

class demoIteratorJob(Job):

     def job_started_event(self):
          print 'job_started_event'
          self.completed = 0

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

          pspace = ParameterSpace()
          i = 1
          while i <= numJoblets:
             pspace.appendRow({'name':'joblet'+str(i)})
             i += 1
         pspace.maxJobletSize = 1
         self.schedule(demoIteratorJoblet,pspace,{})

     def joblet_completed_event(self, jobletnumber, node):
         self.completed += 1
         self.setFact("jobinstance.memo", "Tests run: %s" % (self.completed))


class demoIteratorJoblet(Joblet):

     def joblet_started_event(self):
         print "Hi from joblet ", self.getFact("joblet.number")
         time.sleep(random.random() * 15)

         cmd = self.getFact("jobargs.cmd")
         if len(cmd) > 0:
             system(cmd)



             # Example of more sophisticated exec
             # e.g.  e.signal("SIGUSR1")
             """
             e = Exec()
             e.setCommand(cmd)
             #e.setStdoutFile("cmd.out")
             e.writeStdoutToLog()
             e.writeStderrToLog()
             #try:
             e.execute()
             #except:
                 #self.retry("retryable example error")
             """
```

demoIterator.policy

```
<!--
 *=============================================================================
 * Copyright (C) 2010 Novell, Inc. All Rights Reserved.
 *
 * NOVELL PROVIDES THE SOFTWARE "AS IS," WITHOUT ANY EXPRESS OR IMPLIED
 * WARRANTY, INCLUDING WITHOUT THE IMPLIED WARRANTIES OF MERCHANTABILITY,
 * FITNESS FOR A PARTICULAR PURPOSE, AND NON INFRINGMENT.  NOVELL, THE AUTHORS
 * OF THE SOFTWARE, AND THE OWNERS OF COPYRIGHT IN THE SOFTWARE ARE NOT LIABLE
 * FOR ANY CLAIM, DAMAGES, OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT,
 * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
 *=============================================================================
 * $Id: demoIterator.policy 10344 2009-11-20 21:46:43Z jastin $
 *=============================================================================
 -->

<policy>
   <constraint type="accept" reason="Too busy for more work. Try again later!">
      <or>
         <lt fact="job.instances.queued" value="4" />
         <contains fact="user.groups" value="superuser" />
      </or>
   </constraint>

   <constraint type="start" reason="Waiting on queue">
     <or>
       <lt fact="job.instances.active" value="2" />
       <contains fact="user.groups" value="superuser" />
     </or>
   </constraint>

   <jobargs>
     <fact name="numJoblets"
           type="Integer"
           description="joblets to run"
           value="100"
           visible="true" />

     <fact name="cmd"
           type="String"
          description="Simple command to execute"
           value="" />

     <fact name="os"
           type="String"
           description="Regular expression match for Operating System"
           value=".*" />

     <fact name="cpu"
           type="String"
           description="Regular expression match for CPU architecture"
           value=".*" />
   </jobargs>

  <constraint type="resource" reason="Does not match">
    <and>
      <eq fact="resource.os.family" factvalue="jobargs.os" match="regexp" />
      <eq fact="resource.cpu.architecture" factvalue="jobargs.cpu" match="regexp"/>

      <or>
        <and>
             <defined fact="env.VENDOR" />
           <eq fact="resource.os.vendor" factvalue="env.VENDOR" match="regexp" />
        </and>
        <undefined fact="env.VENDOR" />
      </or>
    </and>
  </constraint>

  <job>
    <fact name="description"
          type="String"
         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." />
  </job>

</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 141
- "job_started_event" on page 141
- "joblet_started_event" on page 142

zosadmin deploy

The deployment for the DemoIterator job is performed by lines 20-29 of demoIterator.jdl (page 137). When jobs are deployed into the grid, they can optionally be organized for grouping. In this case, the demoIterator job is added to the group named examples, and can be displayed in the PlateSpin Orchestrate Development Client in the Explorer view at the location:

```
/Orchestrate Servers/Grid_Name/Jobs/examples
```

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the "*PlateSpin Orchestrate 2.6 Installation and Configuration Guide*."

job_started_event

When the DemoIterator job receives a job_started_event, it creates a ParameterSpace JDL class and adds the number of rows as indicated by the value of the argument `numJoblets` (see lines 42-46 in demoIterator.jdl (page 137)). 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 47), meaning a joblet instance is created for each row in the ParameterSpace during job scheduling (see line 48).

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 245).

The resource that runs the joblet is determined from the resource constraint specified in lines 18-30 and 55-68 of demoIterator.policy (page 139), 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 18-30 in demoIterator.policy (page 139) 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 "Job Arguments and Parameter Lists in Policies" on page 19.

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 50-52 in demoIterator.jdl (page 137)). You can see the text for the memo displayed on the Job Log tab in the list of running jobs in the PlateSpin Orchestrate Development Client.

For more information, see "Starting and Stopping the PlateSpin Orchestrate Development Client" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

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=dir os=windows cpu=i386
   ```

NOTE: If a resource with the matching OS is not available, the job remains in the "waiting" state.

Here is an example that runs the `pwd` command on three joblets on the Linux operating system:

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

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

See Also

- Setting Constraints Using Policies (see Section 2.3, “Policies,” on page 18 and Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53).
- quickie.job (page 143) 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 5.1.1, “PlateSpin Orchestrate Datagrid Filepaths,” on page 109)
- Facts provided by the PlateSpin Orchestrate system that can be referenced within a JDL file
- Using the zos command line tool (see “The zos Command Line Tool” in the *PlateSpin Orchestrate 2.6 Command Line Reference*.
- 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 zenuser
Please enter current password for 'zenuser':
Logged into grid as zenuser

> 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: 88 lines
|-- quickie.jdl                             #   48 lines
`-- quickie.policy                          #   40 lines
```

quickie.jdl

```
# -----------------------------------------------------------------------------
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#  TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: quickie.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

import time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class quickieJob(Job):

     def job_started_event(self):

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

          self.schedule(quickieJoblet, numJoblets)


class quickieJoblet(Joblet):

     def joblet_started_event(self):
          self.setFact("joblet.memo", "quickie's memo - joblet started")
          sleeptime = self.getFact("jobargs.sleeptime")
          time.sleep(sleeptime)
```

quickie.policy

```
<!--
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 *
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 * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
 *=============================================================================
 * $Id: quickie.policy 10344 2009-11-20 21:46:43Z jastin $
 *=============================================================================
 -->

<policy>

    <jobargs>
        <fact name="numJoblets"
              type="Integer"
              description="joblets to run"
              value="100"
              visible="true" />

        <fact name="sleeptime"
              type="Integer"
              description="time to sleep (in seconds)"
              value="0"
```

```
30                  visible="true" />
31       </jobargs>
32
33       <job>
34            <fact name="description"
35                  type="String"
36                  value="This example job does absolutely nothing. It just
returns immediately. For testing network latency." />
37       </job>
38
39   </policy>
40
```

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 146
- "job_started_event" on page 147
- "joblet_started_event" on page 147

zosadmin deploy

The job is first deployed into the grid, as shown in lines 20-29 of quickie.jdl (page 144). When jobs are deployed into the grid, they can optionally be organized for grouping. In this example, the Quickie job is added to the group named `examples` and displays in the PlateSpin Orchestrate Development Client in the Explorer view at the location:

`/Orchestrate Servers/`*`Grid_Name`*`/Jobs/examples`

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

job_started_event

As shown in line 37 of quickie.jdl (page 144), 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 20-24 in quickie.policy (page 145)).

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 48 in quickie.jdl (page 144)), 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: zenuser.quickie.418

   > zos status zenuser.quickie.418
   Completed

   > zos log zenuser.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 (see Section 2.3, "Policies," on page 18 and Chapter 4, "Understanding Grid Object Facts and Computed Facts," on page 53).
- Scheduling multiple instances of a joblet

7.5 Deployable Job Examples: General Purpose

The following examples demonstrate general purpose job concepts:

- "dgtest.job" on page 148
- "failover.job" on page 157
- "instclients.job" on page 163
- "notepad.job" on page 170
- "sweeper.job" on page 174
- "whoami.job" on page 180

dgtest.job

This job demonstrates downloading a file from the datagrid.

Usage

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

> 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 PlateSpin Orchestrate Server to a node. For additional background information, see Section 5.1, "Defining the Datagrid," on page 109.

Because it typically grows quite large, the physical location of the PlateSpin Orchestrate root directory is important. Use the following procedure to determine the location of the datagrid in the Orchestrate Development Client:

1. Select the grid id on the left in the PlateSpin Orchestrate 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 PlateSpin Orchestrate can be seen with the command:

```
> zos dir grid:///
     <DIR>        Feb-17-2010 15:10 installs
     <DIR>        Feb-17-2010 15:10 jobs
     <DIR>        Feb-17-2010 15:10 lib
     <DIR>        Feb-24-2010 15:59 users
     <DIR>        Feb-17-2010 15:10 vms
```

Job Filesdg

The files that make up the Dgtest job include:

```
dgtest                                                # Total: 238 lines
|-- dgtest.jdl                                        #  172 lines
`-- dgtest.policy                                     #   66 lines
```

dgtest.jdl

```
# -----------------------------------------------------------------------------
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#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: dgtest.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

"""
Example usage of DataGrid to download a file stored on the Server to a node.

Setup:
    Before running the job, you must:
        (1) Create a dgtest resource group using the management console.
        (2) Copy a suitable file into the Server DataGrid
        (3) Modify the dgtest policy with the filename to download
                (to not use the default test file).

    For example, use the following command to copy the file 'suse-10-flat.vmdk'
    into the deployment area for the job 'dgtest'
        >zos mkdir grid:///images

        >zos copy suse-10-flat.vmdk grid:///images/

    To verify the file is there:
        >zos dir grid:///images


To start the job after the above setup steps are complete:
        >zos run dgtest filename=suse-10-flat.vmdk

"""
import os,time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class test(Job):

     def job_started_event(self):
          filename = self.getFact("jobargs.filename")
          print "Starting Datagrid Test Job."
          print "Filename: %s" % (filename)

          rg = None
          try:
             rg = getMatrix().getGroup("resource","dgtest")
          except:
             # no such group
             pass

          if rg == None:
            self.fail("The resource group 'dgtest' was not found. It is required for this job.")
             return

          members = rg.getMembers()
          count = 0
          for resource in members:
              if resource.getFact("resource.online") == True and \
                    resource.getFact("resource.enabled") == True:
                   count += 1

          memo = "Scheduling Datagrid Test on %d Joblets" % (count)
          self.setFact("jobinstance.memo",memo)
          print memo
          self.schedule(testnode,count)


class testnode(Joblet):

     def joblet_started_event(self):
          jobletnum = self.getFact("joblet.number")
          print "Running datagrid test joblet #%d" % (jobletnum)
          filename = self.getFact("jobargs.filename")
          multicast = self.getFact("jobargs.multicast")

          # Test download a file from server job directory
          dg_url = "grid:///images/" + filename

          # Create an intance of the JDL DataGrid object
          # This object is used to manage DataGrid operations
          dg = DataGrid()

          # Set to always force a download.
          dg.setCache(False)

          # Set whether to use multicast or unicast
          # If set to True, then the following  4 multicast
          # options are applicable
          dg.setMulticast(multicast)

          # how long to wait for a quorom (milliseconds)
          #dg.setMulticastWait( 10000 )

          # Number of receivers that constitute a quorum
          #dg.setMulticastQuorum(4)

          # Requested data rate in bytes per second. 0 means use default
          #dg.setMulticastRate(0)

          # Min number of receivers
          #dg.setMulticastMin(1)

          if multicast:
              mode = "multicast"
          else:
              mode = "unicast"

          memo = "Starting %s download of file: %s" % (mode,dg_url)
          self.setFact("joblet.memo",memo)
          print memo

          # Destination defaults to Node's Joblet dir.
          # Change this path to go to any other local filesystem.
          # e.g. to store in /tmp:
          #     dest = "/tmp/" + filename
          dest = filename
          try:
              dg.copy(dg_url,dest)
          except:
              exc_type, exc_value, exc_traceback = sys.exc_info()
              retryUnicast = False
              if multicast == True:
                  # If node's OS and/or NIC does not fully support multicast,
                  # then the node will timeout waiting for broadcasts.
                  # Note the error and fallback to unicast
                  if exc_type != None and len(str(exc_type)) > 0:
                      msg = str(exc_type)
                      index = msg.find("Multicast receive timed out")
                      retryUnicast = index != -1

              if retryUnicast:
                  memo = "Multicast timeout. Fallback to unicast"
                  self.setFact("joblet.memo",memo)
                  print memo
                  dg.setMulticast(False)
                  dg.copy(dg_url,dest)
              else:
                  raise exc_type,exc_value

          if os.path.exists(dest):
               print dg_url + " downloaded successfully."

               # Show directory listing of downloaded file to job log
               if self.getFact("resource.os.family") == "windows":
                   cmd = "dir %s" % (dest)
               else:
                   cmd = "ls -lsart %s" % (dest)

               system(cmd)
          else:
               raise RuntimeError, "Datagrid copy() failed"

          print "Datagrid test completed"
```

dgtest.policy

```
<!--
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 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
*=============================================================================
 * $Id: dgtest.policy 10344 2009-11-20 21:46:43Z jastin $
*=============================================================================
 -->

<policy>

     <jobargs>
```

```

          <!--
             Name of file that is stored in the Datagrid area to
             download to the resource.

             A value for this fact the 'zos run' is assigned when
             using the 'zos run' command.
          -->
          <fact name="filename"
                type="String"
                description="The filename to download from the Datagrid"
                />

          <fact name="multicast"
                type="Boolean"
              description="Whether to download using multicast or unicast"
                value="false" />

     </jobargs>

     <job>
          <fact name="description"
                type="String"
              value="This job demonstrates downloading from the Datagrid" />

          <!-- limit to one per host -->
          <fact name="joblet.maxperresource"
                type="Integer"
                value="1" />
     </job>


     <!--
       This job will only run on resources in the "dgtest" resource group.

        You must create a Resource Group named 'dgtest' using the management
       console and populate the new group with resources that you wish to have
        participate in the datagrid test.
     -->
     <constraint type="resource" reason="No resources are in the dgtest group" >

          <contains fact="resource.groups" value="dgtest"
            reason="Resource is not in the dgtest group" />

     </constraint>

</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 56 in dgtest.jdl (page 149) is derived from the Job class.

testnode

Class testnode (line 87 in dgtest.jdl (page 149) is derived from the Joblet (page 241) class.

Job Details

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

- "Policy" on page 154
- "zosadmin deploy" on page 155
- "job_started_event" on page 155
- "joblet_started_event" on page 155

Policy

In addition to describing the `filename` and `multicast` jobargs and the default settings for `multicast` (lines 19-38) in the dgtest.policy (page 152) file, there is the <job/> section (lines 40-49), which describes static facts. You must assign the `filename` argument when executing this example. This is only the name of the file in the "images" area of PlateSpin Orchestrate. For example, for `grid:///images/disk.img`, just assign `disk.img` to the argument. This file must be in the PlateSpin Orchestrate file system for fetching and delivering to remote nodes used in this example.

To populate the PlateSpin Orchestrate, use the `zos copy` command. For example, for a file named `suse-10-flat.vmd` in the current directory, use the following command:

```
> zos mkdir grid:///images
> zos copy suse-10-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 also describes a `resource.groups` constraint.This requires a resource group named `dgtest` (lines 52-64 in dgtest.policy (page 152)) and that group should have member nodes. Consequently, you must create this resource group using the Orchestrate Server Development Client and assign it some nodes to run this example successfully.

zosadmin deploy

When the Orchestrate Server deploys a job for the first time (see Section 3.5, “Deploying Jobs,” on page 40), the job JDL files are executed in a special deploy mode. Looking at dgtest.jdl (page 149), you might notice that when the job is deployed (line 44), either through the Orchestrate Development Client or the zosadmin deploy command, that it attempts to find the `examples` jobgroup (lines 46-47), create it if missing (lines 48-49), and add the dgtest job to the group (line 50).

If this deployment fails for some reason, an exception is thrown (line 51), which prints (line 53) the job name, group name, exception type, and value.

job_started_event

In dgtest.jdl (page 149), the `test` class (line 56) defines only the required job_started_event (line 58) 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 59-61). It then tries to find the resource group named `dgtest`. If the resource group does not exist, the member `fail` string is set to inform the user and returns without scheduling the joblet(s) (lines 63-72).

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 74-79. After setting the memo line in the Orchestrate Development Client (81-82), the job schedules `count` number of `testnode` joblets (line 84).

joblet_started_event

In dgtest.jdl (page 149), the `testnode` class (line 87) defines only the required joblet_started_event (line 89) method. This method runs on the Orchestrate Agent nodes when scheduled by a Job (page 241) class.

The joblet_started_event prints some trace information (lines 90-91), gets the name of the file to transfer (line 92) and the mode of transfer (line 93), and creates the grid URL for the file (line 96).

A DataGrid (page 238) is instantiated (line 100), set not to cache (line 103), and set to use the multicast jobarg (line 108). The next four settings control multicast behavior are commented out (lines 111, 114, 117, and 120).

The joblet prints a memo line for the Orchestrate Development Client (lines 122-128), sets the location for the file on the local node (line 135), and tries to transfer the file from the datagrid (line 137).

If the datagrid copy at line 137 fails for some reason, we have a retry mechanism in the exception handler (lines 138-157). The information for why the exception occurred is fetched (line 139).

The variable `retryUnicast` (line 140) 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 140-148). 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 150 from a failed multicast copy, a memo for the Orchestrate Development Client is set and printed to the log (151-152), `setMulticast` is set to `false` (154), and another copy from the datagrid is attempted.

If we get to line 150 from a failed unicast copy, an exception is raised (line 157) and we’re done.

Configure and Run

```
> zos run dgtest filename=suse-10-flat.vmd
JobID: zenuser.dgtest.323
```

Looks like it ran successfully; let’s see what the log says:

```
> zos log zenuser.dgtest.323
Starting Datagrid Test Job.
Filename: suse-10-flat.vmd
Job 'zenuser.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 Orchestrate Development Client, create the resource group `dgtest`:

```
> zos run dgtest filename=suse-10-flat.vmd
JobID: zenuser.dgtest.324

> zos log zenuser.dgtest.324
Starting Datagrid Test Job.
Filename: suse-10-flat.vmd
Scheduling Datagrid Test on 0 Joblets
```

NOTE: No joblets were scheduled because we have no active nodes in the group.

Using the Orchestrate Development Client, populate the `dgtest` group with nodes that are both online and enabled:

```
> zos run dgtest filename=suse-10-flat.vmd
JobID: zenuser.dgtest.325

> zos log zenuser.dgtest.325
Starting Datagrid Test Job.
Filename: suse-10-flat.vmd
Scheduling Datagrid Test on 2 Joblets
[freeze] Running datagrid test joblet #0
[freeze] Starting unicast download of file: grid:///images/suse-10-flat.vmd
[freeze] Traceback (innermost last):
[freeze]   File "dgtest.jdl", line 170, in joblet_started_event
[freeze] copy() failed: DataGrid file "/images/suse-10-flat.vmd" does not
exist.
```

```
Job 'zenuser.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-10-flat.vmd
[melt] Traceback (innermost last):
[melt]   File "dgtest.jdl", line 170, in joblet_started_event
[melt] copy() failed: DataGrid file "/images/suse-10-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-10-flat.vmd grid:///images/
suse-10-flat.vmd copied.

> zos run dgtest filename=suse-10-flat.vmd
JobID: zenuser.dgtest.326

> zos log zenuser.dgtest.326
Starting Datagrid Test Job.
Filename: suse-10-flat.vmd
Scheduling Datagrid Test on 2 Joblets
[melt] Running datagrid test joblet #1
[melt] Starting unicast download of file: grid:///images/suse-10-flat.vmd
[melt] grid:///images/suse-10-flat.vmd downloaded successfully.
[melt] 16732 -rw-r--r-- 1 root root 17108462 Dec 21 21:32 suse-10-flat.vmd
[melt] Datagrid test completed
[freeze] Running datagrid test joblet #0
[freeze] Starting unicast download of file: grid:///images/suse-10-flat.vmd
[freeze] grid:///images/suse-10-flat.vmd downloaded successfully.
[freeze] 16732 -rw-r--r-- 1 root root 17108462 Dec 21 21:31 suse-10-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/zenuser.dgtest.326.0
```

So, for a more permanent demonstration, see lines 132-134 in dgtest.jdl (page 149). Uncomment line 134 and comment out line 135 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 zenuser
Please enter current password for 'zenuser':
 Logged into grid as zenuser

> 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 3.11, “Improving Job and Joblet Robustness,” on page 47.

The files that make up the Failover job include:

```
failover                                    # Total: 94 lines
|-- failover.jdl                            #   64 lines
`-- failover.policy                         #   30 lines
```

failover.jdl

```
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#  TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: failover.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

# Test job to illustrate joblet failover and max retry limits
#
# Job args:
#    numJoblets - specify number of Joblets to run
#    sleeptime -- specify the execute length of joblet before failure in seconds
#

import sys,os,time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class failover(Job):

     def job_started_event(self):
          numJoblets = self.getFact("jobargs.numJoblets")
          print 'Launching ', numJoblets, ' joblets'
          self.schedule(failoverjoblet,numJoblets)


class failoverjoblet(Joblet):

     def joblet_started_event(self):
          print "------------------ joblet_started_event"
          print "node=%s joblet=%d" % (self.getFact("resource.id"), self.getFact("joblet.number"))
          print "self.getFact(joblet.retrynumber)=%d" % (self.getFact("joblet.retrynumber"))
          print "self.getFact(job.joblet.maxretry)=%d" % (self.getFact("job.joblet.maxretry"))

          sleeptime = self.getFact("jobargs.sleeptime")
          print "sleeping for %d seconds" % (sleeptime)
          time.sleep(sleeptime)

          # This will cause joblet failure and thus retry
          raise RuntimeError, "Artifical error in joblet. node=%s" % (self.getFact("resource.id"))
```

failover.policy

```
<!--
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 *
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 * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
*=============================================================================
 * $Id: failover.policy 10344 2009-11-20 21:46:43Z jastin $
*=============================================================================
 -->

<policy>
    <jobargs>
         <fact name="sleeptime" description="specify the execute length of joblet before failure in seconds" value="7" type="Integer"  />
          <fact name="numJoblets" description="joblets to run" value="1" type="Integer" />
    </jobargs>

    <job>
          <fact name="description" value="This test jobs can be used to demonstrate joblet failover handling." type="String" />

         <!-- Number of times to retry joblet on failure -->
         <fact name="joblet.maxretry" type="Integer" value="3" />
    </job>
</policy>

```

Classes and Methods

Definitions:

Class failover in line 25 of failover.jdl (page 158) is derived from the Job (page 241) class; and the class failoverjoblet in line 33 of failover.jdl (page 158) is derived from the Joblet (page 241) 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.

failover

Class failover (line 39 in dgtest.jdl (page 149) is derived from the Job class.

failoverjoblet

Class failoverjoblet (line 47 in dgtest.jdl (page 149) is derived from the Joblet (page 241) class.

Job Details

The following sections describe the Failover job:

- "zosadmin deploy" on page 161
- "job_started Event" on page 161
- "job_started Event" on page 162

zosadmin deploy

In failover.policy (page 160), in addition to describing the jobargs and default settings for `sleeptime` and `numJoblets` (lines 18-21), the <job/> section (lines 23-28) describes static facts. Note that the `joblet.maxretry` attribute in line 27 has a default setting of 0 but is set here to 3. This attribute can also be modified in the failover.jdl (page 158) file by inserting a line between line 41 and 42, as shown in the following example:

```
41      def job_started_event(self):
++           self.setFact("job.joblet.maxretries", 3)
42           numJoblets = self.getFact("jobargs.numJoblets")
```

job_started Event

After the Orchestrate Server deploys a job for the first time (see Section 3.5, "Deploying Jobs," on page 40), the job JDL files are executed in a special "deploy" mode. When the job is deployed (line 27, failover.jdl (page 158), it attempts to find the `examples` jobgroup (lines 29-30), creates it if is missing (lines 31-32), and adds the failover job to the group (line 33).

Jobs can be deployed using either the Orchestrate Development Client or the `zosadmin deploy` command. If the deployment fails for some reason, an exception is thrown (line 34), which prints the job name (line 36), group name, exception type, and value.

job_started Event

In failover.jdl (page 158), the failover class (line 39) defines only the required `job_started_event` (line 41) method. This method runs on the Orchestrate 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 42), then schedules that specified number of instances (line 44) of the `failoverjoblet class.failoverjoblet`. The failoverjoblet class (lines 47-60) defines only the required `joblet_started_event` (line 49) method.

When executed on an agent node, the `joblet_started_event` prints some helpful information for tracking execution (lines 50-53). The first output is where the joblet is running and which instance is running (line 51). The current joblet retry number (line 52) is displayed, followed by the job's static `joblet.maxretry` (line 53) that was specified in the policy file.

The joblet then sleeps for `jobargs.sleeptime` seconds (lines 55-57) and on waking raises an exception of type `RuntimeError` (line 60).

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 Orchestrate Server before you run `zosadmin` or `zos` commands.

1. Deploy failover.job into the grid:

   ```
   > zosadmin deploy failover.job
   JobID: zenuser.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: zenuser.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 zenuser.failover.269Launching  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 60, 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 60, 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 60, 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 60, 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 60, 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 60, in joblet_started_event
[freeze] RuntimeError: Artifical error in joblet. node=freeze
```

See Also

- Setting Constraints Using Policies (Section 2.3, "Policies," on page 18 and Chapter 4, "Understanding Grid Object Facts and Computed Facts," on page 53).
- Executing Commands Using Exec (page 239)

instclients.job

Installs the PlateSpin Orchestrate 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 (either `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 zenuser
Please enter current password for 'zenuser':
 Logged into grid as zenuser

> zos jobinfo --detail instclients
Jobname/Parameters    Attributes
------------------    ----------
instclients          Desc: This job installs the 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: 138 lines
|-- instclients.jdl                         #   97 lines
`-- instclients.policy                      #   41 lines
```

instclients.jdl

```
# -----------------------------------------------------------------------
-----
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```
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#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: instclients.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

"""

Run install clients on a resource

Setup:
    Before running the job, you must copy installers into DataGrid of
    server.

    >zos copy zosclients_windows_1_3_0_with_jre.exe grid:///\!instclients/

"""
import os,time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class InstClients(Job):

     def job_started_event(self):
          print "Scheduling joblet"
          self.schedule(InstClientsJoblet)


class InstClientsJoblet(Joblet):

     def joblet_started_event(self):
          print "Launching Installer"
          windowsInstaller = "zosclients_windows_2_0_0_with_jre.exe"
          linuxInstaller = "zosclients_linux_2_0_0_with_jre.sh"
          if self.getFact("resource.os.family") == "windows":
               print "Downloading Windows install"
               dg = DataGrid()
               dg.copy("grid:///!instclients/" + windowsInstaller,windowsInstaller)

               print "Starting install"
               cmd = self.getcwd() + "/" + windowsInstaller + " -q "
               e = Exec()
```

```
                 e.setCommand(cmd)
                 e.setRunAsJobUser(False)
                 e.writeStdoutToLog()
                 e.writeStderrToLog()
                 result = e.execute()
            else:
                 print "Downloading Linux install"
                 dg = DataGrid()
                 dg.copy("grid:///!instclients/" + linuxInstaller,linuxInstaller)

                 print "Starting install"
                 cmd = "chmod +x " + self.getcwd() + "/" + linuxInstaller
                 print "cmd=%s" % (cmd)
                 e = Exec()
                 e.setCommand(cmd)
                 e.setRunAsJobUser(False)
                 e.writeStdoutToLog()
                 e.writeStderrToLog()
                 result = e.execute()

                 cmd = self.getcwd() + "/" + linuxInstaller + " -q"
                 print "cmd=%s" % (cmd)
                 e = Exec()
                 e.setRunAsJobUser(False)
                 e.setCommand(cmd)
                 e.writeStdoutToLog()
                 e.writeStderrToLog()
                 result = e.execute()

            if result == 0:
                 print "Install complete"
            else:
                 print "result=%d" % (result)

```

instclients.policy

```
  <!--
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*============================================================================
   * $Id: instclients.policy 10344 2009-11-20 21:46:43Z jastin $
   *=============================================================================
   -->

  <policy>

       <jobargs>

            <fact name="host"
                  type="String"
                  description="The host name of resource to install on"
                   />

       </jobargs>

       <job>
            <fact name="description"
                  type="String"
                  value="This job installs the clients on a resource" />
       </job>

       <constraint type="resource" >

            <eq fact="resource.id" factvalue="jobargs.host" />

       </constraint>

  </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 datagrid. Operations include copying files from the datagrid down to the resource for joblet usage and uploading files from a resource to the datagrid.

Job Details

The following sections describe the instclients job:

- "zosadmin deploy" on page 168
- "job_started_event" on page 168
- "joblet_started_event" on page 168

zosadmin deploy

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 (lines 31-40), and will show up in the PlateSpin Orchestrate Development Client in the Explorer view at the location:

`/Orchestrate Servers/`*`Grid_Name`*`/Jobs/examples`

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

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 45 of instclients.jdl (page 164)). The resource that runs the joblet is determined from the resource constraint specified in instclients.policy (page 166), lines 21-24, 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 Orchestrate Client installation file to download, and the commands to execute on the operating system by checking the value of `resource.os.family` (see line 56 of instclients.jdl (page 164)). The `resource.os.family` fact does not exist in the `instclients.policy` file, but is instead provided by the PlateSpin Orchestrate system.

After deciding which operating system the joblet is being run on, the `Instclients` joblet uses the DataGrid class to download the appropriate client installation file to the current working directory of the running joblet (see lines 58-59 and 71-72 in instclients.jdl (page 164)). 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 63-68 and 86-91 in instclients.jdl (page 164)). As indicated by lines 66, 67, 80, 81, 89 and 90, 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 3.5.2, "Using the zosadmin Command Line Tool to Deploy Jobs," on page 40. See the Exec class in PlateSpin Orchestrate Job Classes and JDL Syntax 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 datagrid of the Orchestrate Server:

   ```
   zos copy zosclients_linux_2_1_0_with_jre.sh grid:///\!instclients/
   ```

   NOTE: Replace "linux" with windows, linux, solaris, etc. for your given operating system, and replace 2_1_0 with your version of the product.

   This command copies the file `zosclients_linux_2_1_0_with_jre.sh` into the datagrid job directory for instclients.

   For more information about using PlateSpin Orchestrate Development Client 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 Orchestrate clients onto the resource with the host: my_resource_host.

See Also

- Setting Constraints Using Policies (Section 2.3, "Policies," on page 18 and Chapter 4, "Understanding Grid Object Facts and Computed Facts," on page 53).
- Scheduling multiple instances of a joblet
- Setting default parameter values using policies
- Configuring constraints in a policy file

- Naming conventions for policy facts (Section 5.1.1, “PlateSpin Orchestrate Datagrid Filepaths,” on page 109.Section 5.1.1, “PlateSpin Orchestrate Datagrid Filepaths,” on page 109)
- Facts provided by the PlateSpin Orchestrate system that can be referenced within a JDL file
- Using the PlateSpin Orchestrate Development Client (“How Do I Interact with PlateSpin Orchestrate?”)
- Running commands using the Exec class.

notepad.job

Launches the Notepad application on a Windows resource.

Usage

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

> zos jobinfo --detail notepad
Jobname/Parameters    Attributes
------------------    ----------
notepad              Desc: No description available.
```

Description

The files that make up the Notepad job include:

```
notepad                                     # Total: 86 lines
|-- notepad.jdl                             #   54 lines
`-- notepad.policy                          #   32 lines
```

notepad.jdl

```
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# -----------------------------------------------------------------------------
#  $Id:  notepad.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------
```

```

"""

Run Notepad Application on windows resoure

"""
import os,time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class Notepad(Job):

     def job_started_event(self):
          print "Scheduling joblet"
          self.schedule(NotepadJoblet)


class NotepadJoblet(Joblet):

     def joblet_started_event(self):
          print "Starting Notepad"
          cmd = "notepad"
          e = Exec()
          e.setCommand(cmd)
          e.writeStdoutToLog()
          e.writeStderrToLog()
          result = e.execute()

```

notepad.policy

```
<!--
*=============================================================================
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 *
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 * FITNESS FOR A PARTICULAR PURPOSE, AND NON INFRINGMENT.  NOVELL, THE AUTHORS
 * OF THE SOFTWARE, AND THE OWNERS OF COPYRIGHT IN THE SOFTWARE ARE NOT LIABLE
 * FOR ANY CLAIM, DAMAGES, OR OTHER LIABILITY, WHETHER IN AN ACTION OF
```

```
CONTRACT,
 * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE
SOFTWARE
 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

*=========================================================================
=
 * $Id: notepad.policy 10344 2009-11-20 21:46:43Z jastin $

*=========================================================================
=
 -->

<policy>

     <constraint type="accept" >

          <gt fact="jobinstance.matchingresources" value="0" reason="No
Windows's resources are available to run Notepad" />

     </constraint>

     <constraint type="resource" >

          <eq fact="resource.os.family" value="windows" reason="Notepad
only runs on Windows OS" />

     </constraint>

</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 173
- "job_started_event" on page 173
- "joblet_started_event" on page 173

zosadmin deploy

In notepad.jdl (page 170), lines 25-34 places the job into the "examples" job group. 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 PlateSpin Orchestrate Development Client in the Explorer view at the location:

/Orchestrate Servers/*Grid_Name*/Jobs/examples

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

job_started_event

Scheduling the Notepad joblet to run immediately is the second operation performed by the Notepad job in line 41 of notepad.jdl (page 170). 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 21 and 27 of notepad.policy (page 171), there must be at least one Windows machine available in the grid for the Notepad job to run. The `accept` constraint in lines 19-23 prevents the Notepad job from being accepted for running if there are no Windows resources available.

The `resource` constraint in lines 25-29 constrain the Orchestrate Job Scheduler to choose a resource that is running a Windows OS only.

For more information on setting constraints using policies, see Section 2.3, "Policies," on page 18 and Chapter 4, "Understanding Grid Object Facts and Computed Facts," on page 53.

joblet_started_event

As specified in lines 49-53 in notepad.jdl (page 170), 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 PlateSpin Orchestrate API class named Exec 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. You will see the following error if there are no Windows resources.

   ```
   No Windows resources available to run Notepad
   ```

See Also

- Setting Constraints Using Policies see Section 2.3, “Policies,” on page 18 and Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53.
- Executing Commands Using Exec (page 239)

sweeper.job

This example job illustrates how to schedule a "sweep," which is an ordered, serialized scheduling of the joblets across all matching resources.

Usage

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

> 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: 140 lines
|-- sweeper.jdl                                       #   66 lines
`-- sweeper.policy                                    #   74 lines
```

The ScheduleSpec (page 247) utility class is also related to this example.

sweeper.jdl

```
# ---------------------------------------------------------------------------
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#  TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# ---------------------------------------------------------------------------
#  $Id: sweeper.jdl 10344 2009-11-20 21:46:43Z jastin $
# ---------------------------------------------------------------------------

import time

#
# Add to the 'examples' group on deployment
#
```

```
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class sweeperJob(Job):

     def job_started_event(self):
         self.setFact("jobinstance.memo", self.getFact("job.description"))

          sp = ScheduleSpec()

          # Optionally a constraint can be specified to further limit matching
          # resources from the job's default 'resource' constraint. Could also
          # compose an object Constraint.
          # For example, uncomment to restrict to resource group 'sweeper'
          #sp.setConstraint("<contains fact='resource.groups' value='sweeper' />")

          # Specify the joblet to run on each resource
          sp.setJobletClass(sweeperJoblet)

          # Specify the sweep across active nodes
          sp.setUseNodeSet(sp.ACTIVE_NODE_SET)

          # Schedule a sweep (creates preassigned joblets)
          self.scheduleSweep(sp)

          # Now the ScheduleSpec contains the number of joblets created
          print 'Launched', sp.getCount(), 'joblets'


class sweeperJoblet(Joblet):

     def joblet_started_event(self):
          msg = "run on resource %s" % (self.getFact("resource.id"))
          self.setFact("joblet.memo", msg)
          print "Sweep", msg
          sleeptime = self.getFact("jobargs.sleeptime")
          time.sleep(sleeptime)

```

sweeper.policy

```
<!--
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 * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
 * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
 *=============================================================================
 * $Id: sweeper.policy 10344 2009-11-20 21:46:43Z jastin $
 *=============================================================================
 -->

<policy>

     <jobargs>
          <!--
           -  Defines and sets the length of time the joblet should pretend
            -  it is doing something important
            -->
          <fact name="sleeptime"
                type="Integer"
                description="time to sleep (in seconds)"
                value="1"
                visible="true" />
     </jobargs>


     <job>
          <!--
            -  Give the job a description for GUI's
            -->
          <fact name="description"
                type="String"
              value="This example job ilustrates how to schedule a 'sweep' accross all matching resources." />

          <!--
            -  This activates a built in throttle to limit the number of
            -  resources this job will run on at a time
            -->
          <fact name="maxresources"
                type="Integer"
                value="3" />

          <!--
            -  Rank resources from least loaded to the highest loaded. The
            -  idea is to run the joblets on the least loaded node first
            -  and hopefully by the time we get to the higher loaded machines
            -  their load may have gone down
            -->
          <!--
          <fact name="resources.rankby">
            <array>
              <string>resource.loadaverage/a</string>
            </array>
          </fact>
           -->

          <!--
            -  Alternative ranking that is easier to see:
            -  decending alphabetic of node name
            -->
          <fact name="resources.rankby">
            <array>
              <string>resource.id/d</string>
            </array>
          </fact>
     </job>

</policy>

```

Classes and Methods

The class sweeperJob (see line 32, sweeper.jdl (page 175)) is derived from the Job Class.

The class sweeperJoblet (see line 58, sweeper.jdl (page 175)) is derived from the Joblet 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 179
- "zosadmin deploy" on page 179
- "job_started_event" on page 179
- "joblet_started_event" on page 180

Policy

In addition to specifying the jobarg and default settings for `sleeptime` in lines 24-28, sweeper.policy (page 177)), there also is the `<job/>` section in lines 32-71, which describes static facts..

The `resources.rankby` array has two notable setting in this example:

- **resource.loadaverage:** This is the first string assignment (lines 55-59), 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 66-70), 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 Orchestrate Server deploys a job for the first time (see Section 3.5, “Deploying Jobs,” on page 40), the job JDL files are executed in a special deploy mode. When `sweeper.jdl` is run in this way (either through the Development Client or the zosadmin deploy command), lines 20-29 are executed. This attempts to locate the examples jobgroup (lines 22-23), creates the group if it is not found (lines 24-25), and adds the sweeper job to the group (line 26).

If the deployment fails for any reason, then an exception is thrown (line 27), which prints the job name, group name, exception type and value (line 29).

job_started_event

The sweeperJob class (line 32) defines only the required `job_started_event` (line 34) method. This method runs on the Orchestrate 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 Orchestrate Development Client (line 35), via `jobinstance.memo` (see Section 3.10.1, “Creating a Job Memo,” on page 45).

Jumping ahead for a moment, instead of calling `self.schedule()` as most the other examples do to instantiate joblets, sweeperJob calls `self.scheduleSweep()` (line 52). scheduleSweep requires an instance of ScheduleSpec (page 247), so one is created (line 37).

The ScheduleSpec method setConstraint can be used to constrain the available resources to a particular group, as shown with a comment (line 43). 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: Creating a Resource Account” in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*). This constraint would also be ANDed to any existing constraint, including any aggregated policies.

The sweeperJoblet is set to be scheduled (line 52), and setUseNodeSet(intnodeSet) is assigned (line 49) 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 58-65) defines only the required `joblet_started_event` (line 60) method. After this method is executed, it displays a message on the memo line of the Joblet tab within the Jobs view in the Orchestrate Development Client (lines 61-62). It also prints a similar log message (line 63), and then just sleeps for `jobargs.sleeptime` seconds (lines 64-65) 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: zenuser.sweeper.420

> zos status zenuser.sweeper.420
Completed

> zos log zenuser.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 2.3, “Policies,” on page 18 and Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53.

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 zenuser
Please enter current password for 'zenuser':
 Logged into grid as zenuser

~> 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: 118 lines
|-- whoami.jdl                                    #   69 lines
`-- whoami.policy                                 #   49 lines
```

whoami.jdl

```
# -----------------------------------------------------------------------------
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#
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#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: whoami.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

"""

Demonstrate running setuid exec.

"""
import os,time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, 
jobgroupname, exc_type, exc_value)


class Whoami(Job):

    def job_started_event(self):
        # Launch the joblets
        numJoblets = self.getFact("jobargs.numJoblets")
        user = self.getFact("user.id")
        print "Launching %d joblets for user '%s'" % (numJoblets,user)
        self.schedule(WhoamiJoblet,numJoblets)


class WhoamiJoblet(Joblet):

    def joblet_started_event(self):
        if self.getFact("resource.os.family") == "windows":
            cmd = "echo %USERNAME%"
        elif self.getFact("resource.os.family") == "solaris":
            cmd = "echo $USER"
        else:
            cmd = "whoami"
        print "cmd=%s" % (cmd)

        # example using built-in system()
        #result = system(cmd)

        # example using Exec class
        e = Exec()
        e.setShellCommand(cmd)
        e.writeStdoutToLog()
        e.writeStderrToLog()
        result = e.execute()

        print "result=%d" % (result)

```

whoami.policy

```
<!--
*===========================================================================
=
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 *
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```

```
*=============================================================================
 * $Id: whoami.policy 10344 2009-11-20 21:46:43Z jastin $
*=============================================================================
 -->

<policy>

     <jobargs>

          <fact name="numJoblets"
                type="Integer"
                description="The number of joblets to schedule"
                value="1" />

          <fact name="resource"
                type="String"
                description="The resource id to run on"
                value=".*" />

     </jobargs>

     <job>
          <fact name="description"
                type="String"
                value="This is a demo example of enhanced exec" />

          <!-- only allow one run resource at a time so that multiple resources can be visited -->
          <fact name="joblet.maxperresource"
                type="Integer"
                value="1" />
     </job>

     <constraint type="resource" >
       <eq fact="resource.id" factvalue="jobargs.resource" match="regex p" />
     </constraint>

</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 184
- "job_started_event" on page 184
- "joblet_started_event" on page 185

zosadmin deploy

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 is added to the group named "examples" (see lines 25-34 of `whoami.jdl`) and is displayed in the PlateSpin Orchestrate Development Client in the Explorer view at the location:

`/Orchestrate Servers/`*`Grid_Name`*`/Jobs/examples`

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

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 44 in whoami.jdl (page 181)). 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 21-24 in whoami.policy (page 182)).

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 26-29 in whoami.policy (page 182)).

Note that the setting for resource is not 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 45 in whoami.jdl (page 181)).

`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 39-42 in whoami.policy (page 182).

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 5.1.1, "PlateSpin Orchestrate Datagrid Filepaths," on page 109.

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 50-55 in whoami.jdl (page 181)). This setting is not set in the `whoami.policy`, but instead is available from the PlateSpin Orchestrate system.

After the command to get the current username has been decided, the PlateSpin Orchestrate API class named Exec is used to execute the command on the resource where the joblet is running (see lines 62-66 in whoami.jdl (page 181)).

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 64-65 in whoami.jdl (page 181), 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" in the *PlateSpin Orchestrate 2.6 Command Line Reference*. For more information on running commands using the Exec class, see Exec (page 239).

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 2.3, “Policies,” on page 18 and Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53).
- Scheduling multiple instances of a joblet
- Setting default parameter values using policies
- Configuring constraints in a policy file
- Naming conventions for policy facts (Section 5.1.1, “PlateSpin Orchestrate Datagrid Filepaths,” on page 109.Section 5.1.1, “PlateSpin Orchestrate Datagrid Filepaths,” on page 109)
- Facts provided by the PlateSpin Orchestrate system that can be referenced within a JDL file
- Using PlateSpin Orchestrate (“How Do I Interact with PlateSpin Orchestrate?”)
- Running commands using the Exec class.

7.6 Job Examples: Miscellaneous Code-Only

The following examples demonstrate useful, miscellaneous code-only job concepts:

- “jobargs.job” on page 186

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 Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53.

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 zenuser Please enter current password for 'zenuser':
 Logged into grid as zenuser

> zos jobinfo --detail jobargs
Jobname/Parameters    Attributes
------------------    ----------
jobargs                          Desc: This example job tests all fact types.

    OptionalRealArray            Desc: No description available.
```

```
                              Type: Real[]
                           Default: [1.1,2.2]

RequiredRealArg               Desc: No description available.
                              Type: Real
                           Default: None! Value must be specified

RequiredDateArg               Desc: No description available.
                              Type: Date
                           Default: None! Value must be specified

OptionalListArg               Desc: No description available.
                              Type: List
                           Default: [hi, mom, 42]

OptionalIntegerArg            Desc: Optional Integer Arg
                              Type: Integer
                           Default: 123

OptionalStringArg             Desc: Optional String Arg
                              Type: String
                           Default: foo

OptionalDateArray             Desc: No description available.
                              Type: Date[]
                          Default: [Mon Jan 02 12:01:00 MST 2006,Tue Jan 03
                                    12:02:00 MST 2006,Wed Jan 04 00:00:00
                                    MST 2006]

OptionalStringArray           Desc: No description available.
                              Type: String[]
                           Default: [string1,string2]

RequiredBooleanArg            Desc: No description available.
                              Type: Boolean
                           Default: None! Value must be specified

OptionalString2ArgAsTag       Desc: Optional String Arg as tag
                              Type: String
                           Default: bar

RequiredTimeArg               Desc: No description available.
                              Type: Time
                           Default: None! Value must be specified

OptionalBooleanArg            Desc: Optional Boolean Arg
                              Type: Boolean
                           Default: true

OptionalTimeArg               Desc: Optional Time Arg
                              Type: Time
                           Default: 43260000

RequiredStringArg             Desc: No description available.
                              Type: String
                           Default: None! Value must be specified

OptionalRealArg               Desc: Optional Real Arg
                              Type: Real
                           Default: 3.14

OptionalDateArg            Desc: Optional Date Arg
                              Type: Date
                           Default: Mon Jan 02 12:01:00 MST 2006

RequiredIntegerArg         Desc: No description available.
                              Type: Integer
                           Default: None! Value must be specified

OptionalDictArg            Desc: No description available.
                              Type: Dictionary
                          Default: {time=12600000, date=Sat Apr 15 00:00:00
                                    MDT 2006, age=12, name=joe}

OptionalString3ArgAsCDATA    Desc: Optional String Arg as CDATA
                              Type: String
                           Default: this text is part of | a multi-line
                                    cdata section containing | xml
                                    <html>test</html> | <eq fact="foo.bar"
                                    value="qwerty" /> | cool!

OptionalTimeArray          Desc: No description available.
                              Type: Time[]
                           Default: [43260000,43320000]

OptionalIntegerArray       Desc: No description available.
                              Type: Integer[]
                           Default: [1,2]
```

Description

The files that make up the Jobargs job include:

```
jobargs.job                                       # Total: 254 lines
|-- jobargs.jdl                                   #   77 lines
`-- jobargs.policy                                #  177 lines
```

jobargs.jdl

```
# -----------------------------------------------------------------------------
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#  WARRANTY, INCLUDING WITHOUT THE IMPLIED WARRANTIES OF MERCHANTABILITY ,
#  FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGMENT.  NOVELL, THE AUTHORS
#  OF THE SOFTWARE, AND THE OWNERS OF COPYRIGHT IN THE SOFTWARE ARE NOT LIABLE
#  FOR ANY CLAIM, DAMAGES, OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT,
#  TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE SOFTWARE
#  OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
# -----------------------------------------------------------------------------
#  $Id: jobargs.jdl 10344 2009-11-20 21:46:43Z jastin $
# -----------------------------------------------------------------------------

"""
Example job showing all available job argument types.

Example cmd line to run job:

  zos run jobargs RequiredTimeArg="12:01 AM" RequiredRealArg="3.14" RequiredIntegerArg="123" RequiredStringArg="foo" RequiredBooleanArg="true" RequiredDateArg="6/10/08 11:35 AM"

"""

import time

#
# Add to the 'examples' group on deployment
#
if __mode__ == "deploy":
    try:
        jobgroupname = "examples"
        jobgroup = getMatrix().getGroup(TYPE_JOB, jobgroupname)
        if jobgroup == None:
            jobgroup = getMatrix().createGroup(TYPE_JOB, jobgroupname)
        jobgroup.addMember(__jobname__)
    except:
        exc_type, exc_value, exc_traceback = sys.exc_info()
        print "Error adding %s to %s group: %s %s" % (__jobname__, jobgroupname, exc_type, exc_value)


class jobargs(Job):

     def job_started_event(self):

          jobid = self.getFact("jobinstance.id")
          print "*****Dumping %s JobInstance jobargs facts*****" % (jobid)
          keys = self.getFactNames()
          keys.sort()
          for s in keys:
             if s.startswith("jobargs"):
                 v = self.getFact(s)
                 ty = type(v)

                 if str(ty).endswith("Dictionary"):
                     self.dump_dict(s,v)
                 else:
                     if s.endswith("TimeArg") or s.endswith("TimeArgReq"):
                          hrs = v/3600
                          min = (v % 3600)/60
                          sec = (v % 3600) % 60
                          print "%s %s %s  hrs:%d min:%d sec:%d" % (s,type(v),v,hrs,min,sec)

                      elif s.endswith("DateArg") or s.endswith("DateArgReq"):
                          sv = time.ctime(v)
                          print "%s %s %s" % (s,type(v),sv)
```

```

                    else:
                        print "%s %s %s" % (s,type(v),str(v))

            print "*****End %s dump*****" % (jobid)

            #self.schedule(jobargsJoblet)

        def dump_dict(self,name,dict):
            print "Dict: %s" % (name)
            keys = dict.keys()
            for k in keys:
                v = dict[k]
                ty = type(v)
                if k == "dob":
                     v = time.ctime(v/1000)
                print "   %s %s %s" % (k,ty,str(v))


    class jobargsJoblet(Joblet):

        def joblet_started_event(self):
            pass

```

jobargs.policy

```
<!--
*=============================================================================
=
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  *
  * NOVELL PROVIDES THE SOFTWARE "AS IS," WITHOUT ANY EXPRESS OR IMPLIED
 * WARRANTY, INCLUDING WITHOUT THE IMPLIED WARRANTIES OF MERCHANTABILITY,
  * FITNESS FOR A PARTICULAR PURPOSE, AND NON INFRINGMENT.  NOVELL, THE
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  * OF THE SOFTWARE, AND THE OWNERS OF COPYRIGHT IN THE SOFTWARE ARE NOT
LIABLE
  * FOR ANY CLAIM, DAMAGES, OR OTHER LIABILITY, WHETHER IN AN ACTION OF
CONTRACT,
  * TORT, OR OTHERWISE, ARISING FROM, OUT OF, OR IN CONNECTION WITH THE
SOFTWARE
  * OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
*=============================================================================
=
  * $Id: jobargs.policy 10344 2009-11-20 21:46:43Z jastin $
*=============================================================================
=
  -->

<policy>

  <jobargs>

    <!-- Optional job args -->
    <fact name="OptionalDateArg"
          description="Optional Date Arg"
          type="Date"
          value="1/2/06 12:01 PM"/>

    <fact name="OptionalTimeArg"
          description="Optional Time Arg"
          type="Time"
          value="12:01 PM"/>

    <fact name="OptionalRealArg"
          description="Optional Real Arg"
          type="Real"
          value="3.14" />

    <fact name="OptionalIntegerArg"
          description="Optional Integer Arg"
          type="Integer"
          value="123" />

    <fact name="OptionalStringArg"
          description="Optional String Arg"
          type="String"
          value="foo" />

    <fact name="OptionalString2ArgAsTag"
          description="Optional String Arg as tag">
      <string>bar</string>
    </fact>

    <fact name="OptionalString3ArgAsCDATA"
          description="Optional String Arg as CDATA">
      <string>
        <![CDATA[this text is part of
a multi-line cdata section containing
xml <html>test</html>
<eq fact="foo.bar" value="qwerty" />
cool!
]]>
      </string>
    </fact>

    <fact name="OptionalBooleanArg"
          description="Optional Boolean Arg"
          type="Boolean"
          value="true" />

    <fact name="OptionalListArg">
      <list>
        <listelement value="hi" type="String" />
        <listelement value="mom" />
        <listelement value="42" type="Integer" />
      </list>
    </fact>

    <fact name="OptionalDictArg">
      <dictionary>
        <dictelement key="name" type="String"  value="joe" />
        <dictelement key="date" type="Date"    value="4/15/06" />
        <dictelement key="time" type="Time"    value="3:30 AM" />
        <dictelement key="age"  type="Integer" value="12" />
      </dictionary>
    </fact>

    <fact name="OptionalDateArray">
      <array>
        <date>1/2/06 12:01 PM</date>
        <date>1/3/06 12:02 PM</date>
        <date>1/4/06</date>
      </array>
    </fact>
    <fact name="OptionalTimeArray">
      <array>
        <time>12:01 PM</time>
        <time>12:02 PM</time>
      </array>
    </fact>
    <fact name="OptionalRealArray">
      <array>
        <real>1.1</real>
        <real>2.2</real>
      </array>
    </fact>
    <fact name="OptionalIntegerArray">
      <array>
        <integer>1</integer>
        <integer>2</integer>
      </array>
    </fact>
    <fact name="OptionalStringArray">
      <array>
        <string>string1</string>
        <string>string2</string>
      </array>
    </fact>
<!-- Arrays of dictionary or list not currently supported
    <fact name="OptionalDictionaryArray">
      <array>
        <dictionary>
          <dictelement key="name" type="String"  value="joe" />
        </dictionary>
      </array>
    </fact>
-->

    <!-- Required job args -->
    <fact name="RequiredDateArg" type="Date" />
    <fact name="RequiredTimeArg" type="Time" />
    <fact name="RequiredRealArg" type="Real" />
    <fact name="RequiredIntegerArg" type="Integer" />
    <fact name="RequiredStringArg" type="String" />
    <fact name="RequiredBooleanArg" type="Boolean" />
  <!-- XXX Ooops, not currently supported without value!
    <fact name="RequiredListArg" type="list" />
    <fact name="RequiredDictArg" type="dictionary" />
    <fact name="RequiredStringArray" type="string">
      <array />
    </fact>
  -->

    <!-- Invisible job args -->
    <fact name="InvisibleDateArg" type="Date" value="1/2/06 12:01 PM" visible="False" />
    <fact name="InvisibleTimeArg" type="Time" value="12:01 PM" visible="False" />
    <fact name="InvisibleRealArg" type="Real" value="3.14" visible="False" />
    <fact name="InvisibleIntegerArg" type="Integer" value="123" visible="False" />
    <fact name="InvisibleStringArg" type="String" value="foo" visible="False" />
    <fact name="InvisibleString2Arg" visible="False" >
      <string>bar</string>
    </fact>
    <fact name="InvisibleBooleanArg" type="Boolean" value="true" visible="False" />
    <fact name="InvisibleListArg" visible="False">
      <list>
        <listelement value="hi" type="String" />
        <listelement value="mom" />
        <listelement value="42" type="integer" />
      </list>
    </fact>
    <fact name="InvisibleDictArg" visible="False">
      <dictionary>
        <dictelement key="name" type="String"  value="joe" />
        <dictelement key="date" type="Date"    value="4/15/06" />
        <dictelement key="time" type="Time"    value="3:30 AM" />
        <dictelement key="age"  type="Integer" value="12" />
      </dictionary>
    </fact>

  </jobargs>

  <job>
    <fact name="description"
          type="String"
          value="This example job tests all fact types." />
  </job>

</policy>

```

Schedule File (optional)

jobargs.sched

```
<schedule name="jobargs" description="Run jobargs" active="true">
<runjob job="jobargs" user="labuser" priority="medium" />
<triggers>
<trigger name="trigger1" />
<trigger name="trigger2" />
</triggers>
</schedule>
```

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 194
- "job_started_event" on page 194
- "joblet_started_event" on page 195

zosadmin deploy

In jobargs.jdl (page 188), lines 27-36 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 PlateSpin Orchestrate Development Client in the Explorer view at the location:

```
/Orchestrate Servers/Grid_Name/Jobs/examples
```

For a general overview of how jobs are added to groups during deployment, see "Walkthrough: Deploying a Sample Job" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.

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 45 of jobargs.jdl (page 188). This list is sorted, filtered according to whether or not it's a jobarg fact, and then enumerated (lines 46-58). Each jobarg fact is printed in a "name type value" format. When the complex Dictionary type is encountered (line 52), a separate method is used to print the values for all the key-value pairs (lines 63-71).

The list of optional and required arguments for this Jobargs example are available as facts within the <jobargs> section (see lines 19-168 in jobargs.policy (page 190)).

For more information about defining job arguments and their types, see Chapter 4, “Understanding Grid Object Facts and Computed Facts,” on page 53 and Section 2.3, “Policies,” on page 18.

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 PlateSpin Orchestrate installed and configured properly. No agents on separate resources are required. You also must be logged into your Orchestrate 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 190) 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

- Defining job arguments and their types
- Using PlateSpin Orchestrate (“How Do I Interact with PlateSpin Orchestrate?”)

Job Scheduling

8

PlateSpin Orchestrate schedules jobs either start manually using the Job Scheduler or to start programatically using the Job Description Language (JDL). This section contains the following topics:

- Section 8.1, "The PlateSpin Orchestrate Job Scheduler Interface," on page 197
- Section 8.2, "Schedule and Trigger Files," on page 198

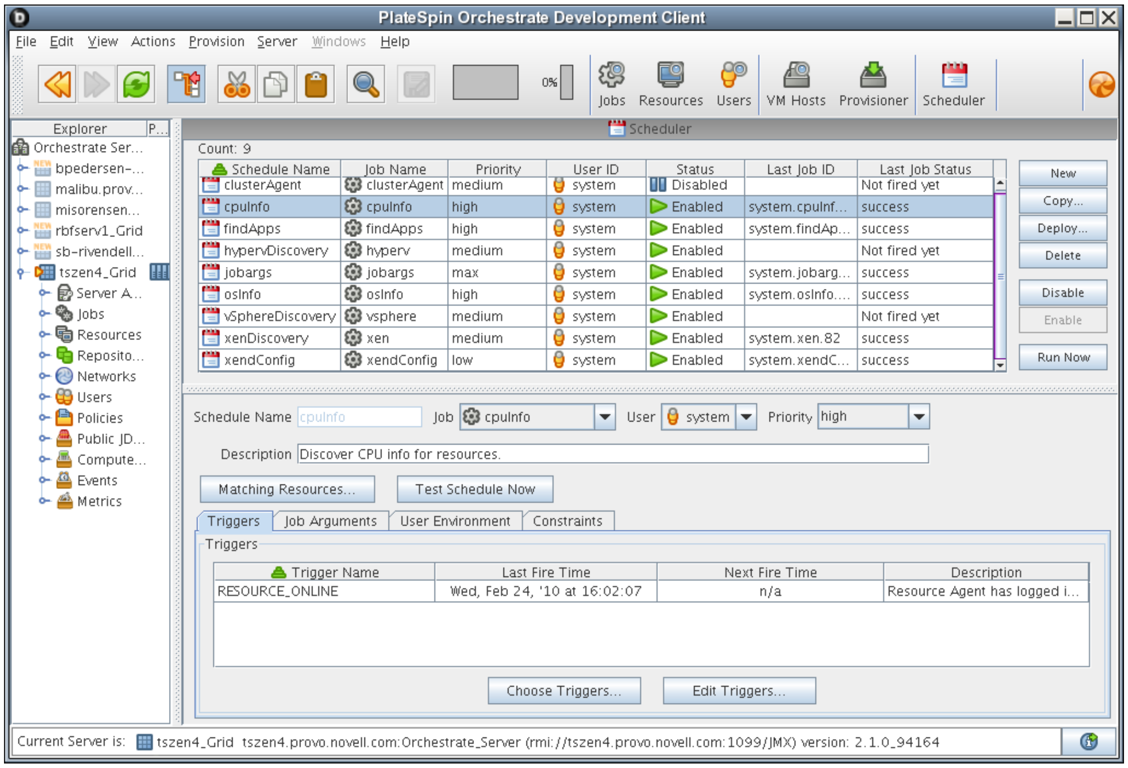
Job scheduling in JDL occurs in the sense that jobs are allocated in priority order (sometimes referred to as "scheduling") by the PlateSpin Resource Allocation Broker. For more information, see "Scheduling with Constraints" on page 26.

8.1 The PlateSpin Orchestrate Job Scheduler Interface

After PlateSpin Orchestrate 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 or user-defined events occur.

The following figure illustrates the Job Scheduler, with nine jobs staged in the main Scheduler panel.

Figure 8-1 *The PlateSpin Orchestrate Scheduler GUI*



Count: 9

Schedule Name	Job Name	Priority	User ID	Status	Last Job ID	Last Job Status
clusterAgent	clusterAgent	medium	system	Disabled		Not fired yet
cpuInfo	cpuInfo	high	system	Enabled	system.cpuInf...	success
findApps	findApps	high	system	Enabled	system.findAp...	success
hypervDiscovery	hyperv	medium	system	Enabled		Not fired yet
jobargs	jobargs	max	system	Enabled	system.jobarg...	success
osInfo	osInfo	high	system	Enabled	system.osInfo....	success
vSphereDiscovery	vsphere	medium	system	Enabled		Not fired yet
xenDiscovery	xen	medium	system	Enabled	system.xen.82	success
xendConfig	xendConfig	low	system	Enabled	system.xendC...	success

Schedule Name cpuInfo Job cpuInfo User system Priority high

Description Discover CPU info for resources.

Triggers

Trigger Name	Last Fire Time	Next Fire Time	Description
RESOURCE_ONLINE	Wed, Feb 24, '10 at 16:02:07	n/a	Resource Agent has logged i...

Current Server is: tszen4_Grid tszen4.provo.novell.com:Orchestrate_Server (rmi://tszen4.provo.novell.com:1099/JMX) version: 2.1.0_94164

Jobs are individually submitted and managed using the Job Scheduler as discussed in "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference* and in "Using the PlateSpin Orchestrate Server Portal" in the *PlateSpin Orchestrate 2.6 Server Portal Reference*.

8.2 Schedule and Trigger Files

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

Everything that you do manually in the Job Scheduler can be automated by creating a `.sched` or `.trig` XML script as part of a job. The XML files enable 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 built-in system events, such as resource startup, user startup (that is, login), or user-defined events that trigger on a rule.

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 "Schedule File Examples" on page 198. See also Section 8.2.2, "Trigger File XML Examples," on page 199.

This section includes the following information:

- Section 8.2.1, "Schedule File Examples," on page 198
- Section 8.2.2, "Trigger File XML Examples," on page 199

8.2.1 Schedule File Examples

A schedule file (`.sched`) can be packaged either within a `.job` archive alongside the `.jdl` file or independently deployed using the zosadmin command line utility. Because the XML file defines the job schedule programmatically outside of the Orchestrate Development Client, packaging these scripts into jobs is typically a developer task.

This section includes the following information:

- "Schedule File Example: osInfo.sched" on page 198
- "Schedule File Example: Multiple Triggers" on page 199

Schedule File Example: osInfo.sched

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:

```
<schedule name="osInfo" description="Discover OS info on resources." active="true" reourcesRequired="false">
  <runjob job="osInfo" user="system" priority="high" />
  <triggers>
    <trigger name="RESOURCE_ONLINE" />
  </triggers>
</schedule>
```

Line 1: 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.

Line 2: Instructs the schedule to run the named job (`osinfo`) by the named user (`system`) using a defined priority (high). If the user (in this case, `system`) does not exist, the deployment returns a `User does not exist` error.

NOTE: Only the PlateSpin Orchestrate users belonging to the `administrators` group can assign priorities higher than `medium`. Assigning a higher priority than specified by the `user.priority.max` fact defaults to a priority equal to `user.priority.max` when the job runs.

Line 3-5: Defines the triggers (in this case only one trigger, an event, `RESOURCE_ONLINE`) that initiates the job.

Schedule File Example: Multiple Triggers

A schedule can include one or more triggers. The following example shows the syntax of a schedule file that has two cron triggers for scheduling a job:

```
1  <schedule name="ReportTwice" active="true">
2    <runjob job="jobargs" user="JohnD" priority="medium" />
3    <triggers>
4      <trigger name="DailyReportTrigger" />
5      <trigger name="NightlyReportTrigger" />
6    </triggers>
7  </schedule>
```

Line 1: Defines the schedule name, deployed condition, and description (if any).

Line 2: Instructs the schedule to run the named job (`jobargs`) by the named user (`JohnD`) using a defined priority (`medium`).

Lines 3-6: Defines the triggers (in this case two occurring time triggers) that initiate the job.

8.2.2 Trigger File XML Examples

Trigger files define when a job and how often a schedule fires. This can happen when a defined event occurs, when a defined amount of time passes, or when a given point in time is reached. so that one or more triggers can be associated with a job schedule (`.sched`). You can create these triggers yourself in XML format and deploy them, or you can edit and choose them in the Job Scheduler, which automatically deploys them. This section includes examples to show you the syntax of different trigger files.

- “XML Example: Event Trigger” on page 200
- “XML Example: Interval Time Trigger” on page 200
- “XML Example: Cron Expression Trigger” on page 201

XML Example: Event Trigger

An event trigger starts a job when a defined event occurs. Several built-in event triggers (such as events that occur when a managed object comes online or offline or has a health status change) are available in the Trigger chooser of the Job Scheduler along with any user-defined Events:

- RESOURCE_ONLINE
- RESOURCE_OFFLINE
- USER_ONLINE
- USER_OFFLINE
- RESOURCE_HEALTH
- USER_HEALTH
- VMHOST_HEALTH
- REPOSITORY_HEALTH

When deployed as triggers in a schedule, built-in events do not generate a `.trig` file, as other triggers do.

You can also associate an Event object with a job schedule (see "Event Triggers" in "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference*). You can define an Event object in an XML document, deploy it to a server, and then manage it with the PlateSpin Orchestrate Development Client.

The following example, `PowerOutage.trig` shows the XML format for a trigger that references an event object.

```
1  <trigger name="PowerOutage" description="Fires when UPS starts at power
outage">
2    <event value="UPS_interrupt"/>
3  </trigger>
```

Line 1: Defines the trigger name and description.

Line 2: Defines the event object chosen for the trigger.

For more information about events, see Section 3.12, "Using an Event Notification in a Job," on page 48.

XML Example: Interval Time Trigger

The following example, `EveryMin1Hr.trig` shows the XML format for a trigger that uses the system clock to define (in seconds) how soon the schedule is to start, how often the schedule is to repeat, and how many times the schedule is to be repeated:

```
1  <trigger name="EveryMin1Hr" description="Fires every minute for one hour">
2    <interval startin="600" interval="60" repeat="60"/>
3  </trigger>
```

Line 1: Defines the trigger name and description.

Lines 2-3: Defines how soon the schedule is to start, how often the schedule is to repeat, and how many times the schedule is to be repeated

XML Example: Cron Expression Trigger

The following example, `NoonDaily.trig` shows the XML format for a trigger that uses a Quartz Cron expression to precisely define when an event is to fire.

```
1  <trigger name="NoonDaily" description="Fires every day at noon">
2    <cron value="0 0 12 * * ?"/>
3  </trigger>
```

Line 1: Defines the trigger name and description.

Lines 2-3: Defines the cron expression to be used by the schedule. Cron expressions are used to precisely define the future point in time when the schedule is to fires. For more information, see "Understanding Cron Syntax in the Job Scheduler" in "The PlateSpin Orchestrate Job Scheduler" in the *PlateSpin Orchestrate 2.6 Development Client Reference*.

Provisioning Adapter Hooks

9

PlateSpin Orchestrate includes a “hooks” facility that lets you make grid events more extensible in the provisioning adapters by adding pre-event or post-event jobs to prepare for and then to clean up after the event.

This section includes the following information:

9.1 Grid Events for VMs That Are Implemented by Provisioning Adapters

The grid events for VMs that are implemented by the respective PlateSpin Orchestrate provisioning adapters are shown in the following table. The actual event names use a “pre_” or “post_” suffix, depending on whether it occurs as a pre-event or post-event.

Table 9-1 *Grid Events Implemented by Provision Adapters*

Event Name	Parameters Passed with the Event	Provisioning Adapters That Support the Event
build_event	◆ vm_host ◆ vm	◆ xen
clone_event	◆ vm_host? ◆ vm ◆ new_vm	◆ xen ◆ vsphere
move_event	◆ vm_host? ◆ vm	◆ xen ◆ vsphere ◆ hyperv
start_event	◆ vm_host? ◆ vm	◆ xen ◆ vsphere ◆ hyperv
shutdown_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv
restart_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv

Event Name	Parameters Passed with the Event	Provisioning Adapters That Support the Event
destroy_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv
suspend_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv
pause_event	◆ vm	◆ xen ◆ hyperv
resume_event	◆ vm	◆ xen ◆ hyperv
personalize_event	◆ vm	◆ xen ◆ vsphere
saveConfig_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv
applyConfig_event	◆ vm	◆ xen
createTemplate_event	◆ vm_host? ◆ vm ◆ new_vm	◆ xen ◆ vsphere
migrate_event	◆ vm ◆ new_vm_host	◆ xen ◆ vsphere ◆ hyperv
checkpoint_event	◆ vm	◆ vsphere ◆ hyperv
restore_event	◆ vm	◆ vsphere ◆ hyperv
installAgent_event	◆ vm	◆ xen
checkStatus_event	◆ vm	◆ xen ◆ vsphere ◆ hyperv
discoverVmHost_event	◆ vm_hosts	◆ xen ◆ vsphere ◆ hyperv
discoverRepository_event	◆ repository	◆ xen ◆ vsphere ◆ hyperv

Event Name	Parameters Passed with the Event	Provisioning Adapters That Support the Event
makeStandalone_event	◆ vm	◆ xen ◆ vsphere

NOTE: A `vm_host` parameter with the (?) annotation signifies that it is passed by the event only if the engine actually has the parameter when the event occurs. If the engine has only a VM but not a VM host, the hooks framework performs an internal lookup for the VM host.

9.2 Customizing Jobs for the Provisioning Adapter Hooks

This section includes the following information:

- Section 9.2.1, "Adding Hooks Jobs to Customize a VM Event," on page 205
- Section 9.2.2, "Customizing Pre- and Post-Job Execution Order," on page 207
- Section 9.2.3, "Customizing Hooks Job Execution Based on Event Type," on page 208

9.2.1 Adding Hooks Jobs to Customize a VM Event

If you want to augment what happens when a VM event occurs, you can do so by adding your custom hooks jobs to run in conjunction with the provisioning adapter. Pre- and Post-VM event jobs are executed synchronously, defined by default sequence, or by custom sequence. The actual VM event is allowed to run synchronously or asynchronously.

PlateSpin Orchestrate includes two example jobs (`paHooks_mount` and `paHooks_simple`) intended as models that you can customize for use by the xen provisioning adapter. These example jobs illustrate some of the implemented xen provisioning adapter pre- and post-hooks. You can use these example jobs can help you to write similar jobs for performing tasks prior to and following a VM event executed by the provisioning adapter.

This section includes the following information:

- "How to Use the paHooks_simple Example to Help Trigger Pre- and Post-Hook Events" on page 205
- "Other Things to Know About Provisioning Adapter Hooks Jobs" on page 207

How to Use the paHooks_simple Example to Help Trigger Pre- and Post-Hook Events

You can use `paHooks_simple` as an example to help you trigger pre- and post-hook events. The following are some requirements you must satisfy when customizing your own paHooks job.

- Your job needs to have an associated `.policy` file. It is standard practice for the policy to have the same name as the job. This policy file must contain these jobargs:

```
  <jobargs>
    <fact name="mode"
          type="String"
          description="The event received by the provision adapter job."
          value="" />
    <fact name="msg"
          type="String"
          description="The job memo describing this child job."
          value="" />
    <fact name="useJoblets"
          type="Boolean"
          description="Schedule joblets or simulation only."
          value="true" />
    <fact name="params"
          type="Dictionary"
          description="The parameters that were passed to the provision
adapter job for the current event (mode)." />
  </jobargs>
```

TIP: To avoid errors, we recommend that you make a copy of the `paHooks_simple.policy` file and and rename it to match the name of your job (or create a new policy and then copy the contents of the `paHooks_simple.policy` file to this file).

- Make sure that the `.jdl` file for your job has the job_started_event defined. The job_started_event is responsible to parse the jobargs.mode argument sent at startup and in turn call the correct pre- or post-event. The `paHooks_simple.jdl` file does this in a generalized way:

```
    def job_started_event(self):
        msg = self.getFact("jobargs.msg")
        if msg:
            print msg
            self.setFact("jobinstance.memo", msg)

        mode = self.getFact('jobargs.mode')
        if not mode:
            self.fail('jobargs.mode not specified!')

        params = self.getFact('jobargs.params')
        params['mode'] = mode
        if self.factExists("job.debug") and self.getFact("job.debug"):
            print 'params=%s' % (params)

        func_name = '%s_event' % (mode)
        try:
            func= getattr(self, func_name)
            func.__call__(params)
        except AttributeError:
            print "Job mode '%s' not implemented" % (mode)
        except TypeError:
            print "Job mode '%s' has invalid signature" % (mode)
```

- Customize the `.jdl` file for your job needs by including the pre_ and post_ events you want to call, for example:

```
    def pre_makeStandalone_event(self, params):
        print "******** pre_makeStandalone_event"
        self.__schedule_vmhost(params)
```

This schedules the joblet for your paHooks job on the vmHost resource that has access to the files for the VM being affected. Your joblet code must then parse the jobletargs mode in order to determine what action to take:

```
def joblet_started_event(self):
        mode = self.getFact("jobletargs.mode")
        if mode.startswith("pre_makeStandalone"):
            """ do something useful here... """
```

- Make sure that the The `job.paHooksVmJob` fact is set in the provisioning adapter job. The `job.paHooksVmJob` standard fact is available for implementation only in provision adapter jobs (xen, vsphere, and hyperv). For information about the location of this fact in the Development Client, see Provision Adapter Hook Jobs in "Job Control Settings" in the *PlateSpin Orchestrate 2.6 Development Client Reference*.

  The `job.paHooksVmJob` fact is a String array that needs to contain the names of the hooks job or jobs that you create and customize for use with the provisioning adapter. By default, the fact specifies that the listed jobs run sequentially as pre-event jobs. Then, after the provision adapter runs, these same hooks jobs execute in reverse sequence.
- Make sure that the policy for the paHooks custom job is associated to the job.

Other Things to Know About Provisioning Adapter Hooks Jobs

- Hyper-V hooks jobs you create can use a job structure similar to the example Xen jobs. For the vsphere provisioning adapter, however, we recommend that you confer with Novell Consulting for assistance in creating your own hooks jobs.
- You can create hooks jobs that implement only one kind of event or many events. The jobs can be configured to be triggered by a single type of event, or that include all of the VM events. Customization options allow flexibility in the role of the job.
- To increase the amount of detail available for hooks job implementation and monitoring, go to the hooks job and set the `job.debug` fact or the `job.tracing` fact to True.

9.2.2 Customizing Pre- and Post-Job Execution Order

If you do not want to use the default execution order for the Pre- and Post-event jobs, you can customize the order of their execution by adding custom facts:

- **job.paHooksPreVmJob:** Use this fact to hard code the implementation order of the hooks jobs prior to a VM event. Make sure the fact is defined as a String array.
- **job.paHooksPostVmJob:** Use this fact to hard code the implementation order of the hooks jobs following a VM event. Make sure the fact is defined as a String array.

IMPORTANT: Make sure you create these custom facts using the exact naming syntax shown above.

For example, if the default order for Pre-event VM jobs was Job 1, Job 2, Job 3 (specified using the `job.paHooksVmJob` fact), you could add the `job.paHooksPostVmJob` custom fact to specify the Post-event VM job execution order as Job 2, Job 1, Job 3.

9.2.3 Customizing Hooks Job Execution Based on Event Type

If you want to make sure that a provisioning adapter is invoked only when certain events occur, you have two options:

- Manually add hooks jobs to the `job.paHooksVmJob` fact that contain only the event types you want (this is always an option).
- Create a custom fact for the hooks jobs that works only for a specific event.

  The naming syntax for a custom fact like this follows the pattern of `job.paHooks<`*`Pre or Post`*`><`*`event_name`*`>VmJob`. For example, if you wanted to invoke a job to execute exclusively prior to a START event, you would add the custom fact `job.paHooksPreStartVmJob`, with the hooks job name or names specified in its String array.

  Each hooks job that you define is called only if it implements the event named, so you can set up a job for the provisioning adapter that implements only the desired event. For example, if you set up a Pre-Start VM hooks job for the Xen provisioning adapter, any other event except Start that occurs in that hooks job is never invoked.

paHooks requires a policy and for the job start event to call the specific methods according to jobargs.mode. For more information, see "How to Use the paHooks_simple Example to Help Trigger Pre- and Post-Hook Events" on page 205.

PlateSpin Orchestrate Client SDK

A

PlateSpin Orchestrate 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, "PlateSpin Orchestrate Client SDK," on page 209. This SDK application can perform the following operations:

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

This section includes the following information:

- Section A.1, "SDK Requirements," on page 209
- Section A.2, "Creating an SDK Client," on page 209
- Section A.3, "Client SDK Reference information," on page 210

A.1 SDK Requirements

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

1. Install the PlateSpin Orchestrate Client package. For instructions, see "Installing and Configuring All PlateSpin Orchestrate Components Together" and "Walkthrough: Launching the PlateSpin Orchestrate Development Client" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*.
2. Install JDK 1.6.*x*.
3. Examine the two example PlateSpin Orchestrate SDK client applications that are included in the examples directory:
    - **extranetDemo:** Provides a sophisticated example of launching 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..

A.2 Creating an SDK Client

Use the following procedure to create an SDK client in conjunction with the sample Java code (see "Interface ClientAgent" on page 218):

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 Orchestrate Server (see "Walkthrough: Logging In to the PlateSpin Orchestrate Server" in the *PlateSpin Orchestrate 2.6 Installation and Configuration Guide*):

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

  clientAgent.login(credential);
```

3 Run the server operations. In this case, it is the `quickie.jdl` 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 PlateSpin Orchestrate Server to receive job events for the job you started.

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

5 Log out of the server:

```
clientAgent.logout()
```

A.3 Client SDK Reference information

This section provides the reference information for the Java classes used by the PlateSpin Orchestrate Client SDK

- Section A.3.1, "Constraint Package," on page 210
- Section A.3.2, "Datagrid Package," on page 215
- Section A.3.3, "Grid Package," on page 217
- Section A.3.4, "TLS Package," on page 224
- Section A.3.5, "Toolkit Package," on page 226

A.3.1 Constraint Package

The Java classes included in the Constraint package form the basis of the PlateSpin Orchestrate infrastructure. For complete documentation of each class, click on the links to access the online documentation javadoc.

- "Interfaces" on page 210
- "Classes" on page 214
- "Exceptions" on page 214

Interfaces

The following Java files form the interfaces for the PlateSpin Orchestrate constraint grid structure:

- "Interface AndConstraint" on page 211

Interface AndConstraint

Perform a logical and-ing of all child constraints.This is a no-op if this constraint contains no children.

For complete documentation of the class, see *AndConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/AndConstraint.html).

Interface 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/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/BetweenConstraint.html).

Interface 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/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/BinaryConstraint.html).

Interface Constraint

Basic Constraint interface that allows traversal and evaluation of a constraint tree.

For complete documentation of the class, see *Constraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/Constraint.html).

Interface ContainerConstraint

Container constraints that perform logical aggregation operations on contained constraints.

For complete documentation of the class, see *ContainerConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/ContainerConstraint.html).

Interface ContainsConstraint

Performs a simple set operation that returns true if 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/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/ContainerConstraint.html).

Interface DefinedConstraint

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.

For complete documentation of the class, see *DefinedConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/DefinedConstraint.html).

Interface EqConstraint

Performs a equality constraint operation. Missing arguments will always result in this constraint evaluating to false.

Supported match modes:

- Strings — MATCH_MODE_REGEXP & MATCH_MODE_GLOB

For complete documentation of the class, see *EqConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/EqConstraint.html).

Interface GeConstraint

Performs a “greater than or equal to” constraint operation. Missing arguments always result in this constraint evaluating to false. The standard lexicographical ordering of values is used to determine result.

For complete documentation of the class, see *GeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/GeConstraint.html).

Interface GtConstraint

Performs a “greater than” constraint operation. Missing arguments will always result in this constraint evaluating to false. The standard lexicographical ordering of values is used to determine result.

For complete documentation of the class, see *GtConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/GtConstraint.html).

Interface IfConstraint

Perform a conditional if,then,else block. If conditional passes, the pass block is run as it would be in an AND constraint. If the the conditional fails, the fail block is run as it would be in an AND constraint.

For complete documentation of the class, see *IfConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/IfConstraint.html).

Interface IncludeConstraint

Extends the class Constraint.

For complete documentation of the class, see *IncludeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/IncludeConstraint.html).

Interface LeConstraint

Performs a "less than or equal to" constraint operation. Missing arguments always result in this constraint evaluating to false. The standard lexicographical ordering of values is used to determine result.

For complete documentation of the class, see *LeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/LeConstraint.html).

Interface LtConstraint

Performs a "'less than" constraint operation. Missing arguments always result in this constraint evaluating to false. The standard lexicographical ordering of values is used to determine result.

For complete documentation of the class, see *LtConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/LtConstraint.html).

Interface NeConstraint

Performs a not equal constraint operation. Missing arguments always result in this constraint evaluating to false.

Supported match modes:

- Strings — MATCH_MODE_REGEXP & MATCH_MODE_GLOB

For complete documentation of the class, see *NeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/NeConstraint.html).

Interface NotConstraint

Perform a logical not operation of all the child constraints. This is a no-op if this constraint contains no children.

For complete documentation of the class, see *NotConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/NotConstraint.html).

Interface OperatorConstraint

Operator constraints that perform comparison operation on facts.

For complete documentation of the class, see *OperatorConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/OperatorConstraint.html).

Interface OrConstraint

Perform a logical or-ing operation of all the child constraints. This is a no-op if this constraint contains no children.

For complete documentation of the class, see *OrConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/OrConstraint.html).

Interface TypedConstraint

Typed constraint must only be used as the outermost wrapper when it is necessary to override the default constraint type of ‘resource.’ It provides the necessary context about where to add the contained constraints.

For complete documentation of the class, see *TypedConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/TypedConstraint.html).

Interface UndefinedConstraint

Evaluates to true only if the left side fact is not defined in the match context. If the left side is not defined, this will evaluate to false.

For complete documentation of the class, see *UndefinedConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/UndefinedConstraint.html).

Classes

The following Java files form the classes for the PlateSpin Orchestrte class structure:

- “Class ContainsConstraint.ContainsMode” on page 214

Class ContainsConstraint.ContainsMode

For complete documentation of the class, see ContainsConstraint.containsMode (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/ContainsConstraint.ContainsMode.html).

Exceptions

The following Java files form the exceptions for the PlateSpin Orchestrate constraint grid structure:

- “Class ConstraintException” on page 214

Class ConstraintException

For exceptions that occur in parsing or executing constraints.

For complete documentation of the class, see *ConstraintException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/constraint/ConstraintException.html).

A.3.2 Datagrid Package

The Java classes included in the Datagrid package form the basis of the PlateSpin Orchestrate infrastructure. For complete documentation of each class, click on the links to access the online documentation javadoc.

- "Interfaces" on page 215
- "Classes" on page 216
- "Exceptions" on page 216

Interfaces

The following Java files form the interfaces for the PlateSpin Orchestrate datagrid structure:

- "Interface GridFile" on page 215
- "Interface GridFileFilter" on page 215
- "Interface GridFileNameFilter" on page 215

Interface GridFile

Specifies the PlateSpin Orchestrate datagrid interface for individual files and directories.

This interface rather closely mirrors `java.io.File`. It does not, however, extend that class, since the standard Java I/O classes would not understand the semantics of this extended version. In particular, path names specified by this class refer to remote files that might not be directly accessible via the file system, as expected by standard Java file I/O classes.

The mirroring of `java.io.File` is done strictly for consistency and familiarity. There are a few methods in `java.io.File` that don't make sense in the context of the datagrid, and have thus been omitted. However, the commonly used methods such as `canWrite`, `mkdir()`, and so on are implemented and provide functionality for datagrid paths that is analogous to that provided by `java.io.File` for local file system paths.

For complete documentation of the class, see *GridFile* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/GridFile.html).

Interface GridFileFilter

Filter for accepting/rejecting file names in a directory list.

Filtering is done by fully qualified `GridFile` objects representing the files and directories contained directly under the parent.

For complete documentation of the class, see *GridFileFilter* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/GridFileFilter.html).

Interface GridFileNameFilter

Filter for accepting/rejecting file names in a directory list.

Filtering is done by simple string path component names relative to the parent.

For complete documentation of the class, see *GridFileNameFilter* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/GridFileNameFilter.html).

Classes

The following Java files form the classes for the PlateSpin Orchestrate datagrid structure:

- "Class DGLogger" on page 216

Class DGLogger

Definitions of the DataGrid Logger options used for multicast.

For complete documentation of the class, see *DGLogger* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/DGLogger.html).

Exceptions

The following Java files form the exceptions for the PlateSpin Orchestrate datagrid structure:

- "Class DataGridException" on page 216
- "Class DataGridNotAvailableException" on page 216
- "Class GridFile.CancelException" on page 216

Class DataGridException

General exception class for datagrid errors.

For complete documentation of the class, see *DataGridException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/DataGridException.html).

Class DataGridNotAvailableException

Exception thrown if the datagrid cannot be reached due to a network error.

For complete documentation of the class, see *DataGridNotAvailableException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/DataGridNotAvailableException.html).

Class GridFile.CancelException

Exception thrown by cancelled requests.

For complete documentation of the class, see *GridFile.CancelException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/dataGrid/GridFile.CancelException.html).

A.3.3 Grid Package

The Java classes included in the Grid package form the basis of the PlateSpin Orchestrate infrastructure. For complete documentation of each class, click on the links to access the online documentation javadoc.

- "Interfaces" on page 217
- "Exceptions" on page 222

Interfaces

The following Java files form the interfaces for the PlateSpin Orchestrate grid structure:

- "Interface AgentListener" on page 218
- "Interface ClientAgent" on page 218
- "Interface Credential" on page 218
- "Interface Fact" on page 218
- "Interface FactSet" on page 218
- "Interface GridObjectInfo" on page 218
- "Interface JobInfo" on page 219
- "Interface Message" on page 219
- "Interface Message.Ack" on page 219
- "Interface Message.AuthFailure" on page 219
- "Interface Message.ClientResponseMessage" on page 219
- "Interface Message.ConnectionID" on page 220
- "Interface Message.Event" on page 220
- "Interface Message.GetGridObjects" on page 220
- "Interface Message.GridObjects" on page 220
- "Interface Message.JobAccepted" on page 220
- "Interface Message.JobError" on page 220
- "Interface Message.JobFinished" on page 220
- "Interface Message.JobIdEvent" on page 220
- "Interface Message.JobInfo" on page 221
- "Interface Message.Jobs" on page 221
- "Interface Message.JobStarted" on page 221
- "Interface Message.JobStatus" on page 221
- "Interface Message.LoginFailed" on page 221
- "Interface Message.LoginSuccess" on page 221
- "Interface Message.LogoutAck" on page 221
- "Interface Message.RunningJobs" on page 222
- "Interface Message.ServerStatus" on page 222
- "Interface Node" on page 222

Interface AgentListener

Provides the interface necessary for processing messages sent from the Orchestrate Server.

The implementation of this interface is registered with the agent using `ClientAgent.addAgentListener()`.

For complete documentation, see *AgentListener* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/AgentListener.html).

Interface ClientAgent

API for client communication with server for job and datagrid operations. This includes retrieving information about available jobs, to start jobs and to manage running jobs.

For complete documentation, see *ClientAgent* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/ClientAgent.html).

Interface Credential

A credential used for identity on the PlateSpin Orchestrate system. Use the `CredentialFactory` to create `Credential` instances.

For complete documentation, see *Credential* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Credential.html).

Interface Fact

The Fact object. This contains accessors for setting and getting fact values and for describing a Fact.

For complete documentation, see *Fact* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Fact.html).

Interface FactSet

Definition of a set of facts. Typically, this represents all facts associated with a particular Grid object.

NOTE: There is also a `FactSetSnapshot` that can hold a read-only, non-dynamic version of the facts.

For complete documentation, see *FactSet* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/FactSet.html).

Interface GridObjectInfo

Client interface to any Grid object. All "Info" objects are serializable.

For complete documentation, see *GridObjectInfo* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridObjectInfo.html).

Interface ID

A unique identifier for an engine or a facility or Grid object.

The default identifiers for the broker, facilities, and an unknown ID are defined here.

For complete documentation, see *ID* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/ID.html).

Interface JobInfo

A client representation of a deployed job.

The interface describes details about a deployed job. This is a simplified interface that is likely to be a subset of Job. It is used in the client API and for management.

For complete documentation, see *JobInfo* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/JobInfo.html).

Interface Message

A base interface for all the messages in the system. It defines the basic methods that must be implemented by a message class, and also defines sub-interfaces for each of the actual messages in the system.

All of these message interfaces are intended to be viewed from the perspective of the consumer, not the producer. Producers are responsible for implementing the concrete classes which will underly these interfaces, and have complete freedom of choice as to how to implement constructors and set methods.

For complete documentation, see *Message* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.html).

Interface Message.Ack

A general acknowledgement of “action” message.

For complete documentation, see *Message.Ack* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.Ack.html).

Interface Message.AuthFailure

Authentication failure messages indicating 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/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.AuthFailure.html).

Interface Message.ClientResponseMessage

All 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/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.ClientResponseMessage.html).

Interface Message.ConnectionID

Messages assigned a connection ID by the session manager.

For complete documentation, see *Message.ConnectionID* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.ConnectionID.html).

Interface Message.Event

An Event is used to signal clients and workflows. A client can receive an Event sent from a workflow. The `ClientAgent.sendEvent()` constructs an Event to send to workflows.

For complete documentation, see *Message.Event* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.Event.html).

Interface Message.GetGridObjects

Client request to retrieve an (optionally ordered) set of grid objects that match a search criteria (constraint).

For complete documentation, see *Message.GetGridObjects* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.GetGridObjects.html).

Interface Message.GridObjects

Server response to client request to retrieve a grid object set.

For complete documentation, see *Message.GridObjects* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.GridObjects.html).

Interface 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 *Message.JobAccepted* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobAccepted.html).

Interface Message.JobError

A JobError message is sent when an unrecoverable error occurs in a job.

For complete documentation, see *Message.JobError* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobError.html).

Interface Message.JobFinished

A JobFinished message is sent when processing of a job completes.

For complete documentation, see *Message.JobFinished* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobFinished.html).

Interface Message.JobIdEvent

Base Event interface for retrieving JobID used for jobid messages.

For complete documentation, see *Message.JobIdEvent* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobIdEvent.html).

Interface Message.JobInfo

A JobInfo message contains information describing a deployed job.

For complete documentation, see *Message.JobInfo* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobInfo.html).

Interface Message.Jobs

A Jobs message contains a list of deployed job names.

For complete documentation, see *Message.Jobs* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.Jobs.html).

Interface Message.JobStarted

A JobStarted message is sent when a job is successfully started.

For complete documentation, see *Message.JobStarted* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobStarted.html).

Interface Message.JobStatus

A JobStatus message contains the state of the specified job. This is used in lieu of JobStatusDetail to get simple state info.

For complete documentation, see *Message.JobStatus* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.JobStatus.html).

Interface Message.LoginFailed

Response message for an unsuccessful login.

For complete documentation, see *Message.LoginFailed* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.LoginFailed.html).

Interface Message.LoginSuccess

Response message for a successful login.

For complete documentation, see *Message.LoginSuccess* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.LoginSuccess.html).

Interface Message.LogoutAck

A LogoutAck indicates success or failure of logout operation. It is a specific message type so error filtering can be applied when the message can't be delivered because the transport has already been closed.

For complete documentation, see *Message.LogoutAck* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.LogoutAck.html).

Interface Message.RunningJobs

A RunningJobs message contains the list of running jobs.

For complete documentation, see *Message.RunningJobs* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.RunningJobs.html).

Interface Message.ServerStatus

A ServerStatus message.

ServerStatus is different from a normal status message from the server because it normally requires an action on the part of the receiver whereas a Status is more informational. ServerStatus can be used for server shutdown, restart, version upgrade, migration to new host, and so on.

For complete documentation, see *Message.ServerStatus* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Message.ServerStatus.html).

Interface Node

Internal interface for Node (Resource) Grid object.

For complete documentation, see *Node* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Node.html).

Interface Priority

Priority information.

For complete documentation, see *Priority* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/Priority.html).

Interface WorkflowInfo

A WorkflowInfo can represent either a snapshot of a running instance or an historical record of an instance. It can be thought of as the client view of a Workflow which is its big sister that is active and runs in the server.

NOTE: `Workflow` extends `WorkflowInfo. LiteWorkflowInfo` implements `WorkflowInfo`.

Setter methods should be put in `Workflow` and not in `WorkflowInfo`.

For complete documentation, see *WorkflowInfo* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/WorkflowInfo.html).

Exceptions

The following Java files form the exceptions for the PlateSpin Orchestrate grid structure:

- "Class ClientOutOfDateException" on page 223
- "Class FactException" on page 223
- "Class GridAuthenticationException" on page 223
- "Class GridAuthorizationException" on page 223
- "Class GridConfigurationException" on page 223

- "Class GridDeploymentException" on page 223
- "Class GridException" on page 224
- "Class GridObjectNotFoundException" on page 224

Class ClientOutOfDateException

Grid exception indicating the client is not compatible with the server.

This exception is thrown if a connection cannot be established with the PlateSpin Orchestrate Sserver because the current client software is either too old or too new to be compatible with the server.

For complete documentation, see *ClientOutOfDateException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/ClientOutOfDateException.html).

Class FactException

For exceptions that occur in accessing or setting facts.

For complete documentation, see *FactException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/FactException.html).

Class GridAuthenticationException

Thrown when authentication is denied by a PlateSpin Orchestrate Server.

For complete documentation, see *GridAuthenticationException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridAuthenticationException.html).

Class GridAuthorizationException

Thrown when credentials are insufficient for the desired grid operation.

For complete documentation, see *GridAuthorizationException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridAuthorizationException.html).

Class GridConfigurationException

Grid exception thrown to indicate a grid configuration error.

This exception is thrown to indicate a severe error in the grid's configuration that prevents it or one of its major components from operating correctly.

For complete documentation, see *GridConfigurationException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridConfigurationException.html).

Class GridDeploymentException

Thrown when credentials are insufficient for the desired grid operation.

For complete documentation, see *GridDeploymentException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridDeploymentException.html).

Class GridException

The base exception for all grid exceptions. This provides an easy way to catch multiple types of related exceptions in the system without needing to explicitly list every one.

For complete documentation, see *GridException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridException.html).

Class GridObjectNotFoundException

Thrown when a Grid object lookup does not find the requested object.

For complete documentation, see *GridObjectNotFoundException* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/grid/GridObjectNotFoundException.html).

A.3.4 TLS Package

The Java classes included in the TLS package form the basis of the PlateSpin Orchestrate infrastructure. For complete documentation of each class, click on the links to access the online documentation javadoc.

- "Interfaces" on page 224
- "Classes" on page 225

Interfaces

Interfaces used for secure authentication to Orchestrate Server include the following:

- "Interface TlsCallbacks" on page 224

Interface TlsCallbacks

Callback interface for TLS certificate exceptions.

An instance of this interface may be passed to `TlsConfiguration.setCallbacks(TlsCallbacks) or to TlsConfiguration.setDefaultCallbacks(TlsCallbacks)` to provide customized handling of missing or mismatched TLS server certicates encountered while attempting to make TLS connections to a PlateSpin Orchestrate Server.

The `TlsCallbacks.onCertificateNotFound(SocketAddress,PemCertificate)` method is invoked when the PlateSpin Orchestrate Server returns a server certificate and there is currently no certificate found for that server. If this method returns false, a certificate exception is thrown on the client; otherwise, the code for this method can "accept" the certificate, possibly with user warnings and a confirmation dialog before returning true to indicate that the certificate is "OK."

The `TlsCallbacks.onCertificateMismatch(SocketAddress,PemCertificate,PemCertificate)` method is invoked when the PlateSpin Orchestrate Server returns a server certificate that does not correctly match the current certificate held by the client. This exception is a more severe error than "not found" because it indicates a possible spoofing attempt by a "man in the middle." We recommend that implementations of this callback method default to returning false unless the user or administrator very specifically indicates a willingness to accept the new certificate.

For complete documentation of the class, see *TlsCallbacks* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/tls/TlsCallbacks.html).

Classes

Classes used for secure authentication to Orchestrate Server include the following:

- "Class PemCertificate" on page 225
- "Class TlsConfiguration" on page 225

Class PemCertificate

PEM certificate wrapper for X.509 certificates.

This convenience class wraps up an X.509 certificate in an object that allows the certificate to be read from and stored to a standard PEM encoded X.509 certificate file. This allows the Orchestrate Clients to make use of the Sun TLS provider without requiring that the Orchestrate Server certificate be manually installed in the JRE's keystore. The use of standardized PEM certificates allows more portable handling and offline generation of certificates (if desired for security purposes) and enables simplified management of certificates.

For complete documentation of the class, see *PemCertificate* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/tls/PemCertificate.html).

Class TlsConfiguration

TLS Configuration parameters for Orchestrate Clients.

This class holds various TLS-related configuration parameters used by Orchestrate Clients to connect to the server. By passing an instance of this class to the Development Client API upon login, or by setting global defaults, the behavior and usage of Transport Layer Security (TLS) can be modified by client writers.

The factory default behavior for Orchestrate Clients and agents is to enable TLS, with the level of encryption specified by the server upon client connection. By default, "client" (as opposed to "agent") connection mode is assumed.

This class is fully cloneable and serializable. It is recommended that the type-safe `TlsConfiguration.copy()` method be used for cloning.

The following is a simple example of the usage of this class to configure TLS support on a client connection to a PlateSpin Orchestrate Server:

```
    import com.novell.zos.tls.TlsConfiguration;
    import com.novell.zos.grid.ClientAgent;
    import com.novell.zos.grid.Credential;
    import com.novell.zos.toolkit.CredentialFactory;
    ...
    TlsConfiguration tlsConfig = new TlsConfiguration();
    tlsConfig.setCertificatePath("/tmp");
    Credential cred = CredentialFactory.newPasswordCredential("user",
"pass".toCharArray());
    ClientAgent client = ClientAgentFactory.newClientAgent("127.0.0.1");
    client.setTlsConfiguration(tlsConfig);
    client.login(cred);
    System.out.println("Logged In");
```

If custom handling of unknown or mismatched server certificates is required by the client, then add a call to `TlsConfiguration.setCallbacks(TlsCallbacks)` with an instance of `TlsCallbacks` providing methods for handling each of those cases.

If certain TLS parameters will always be the same for all instances (that is, they were specified on a global command line at JVM launch), those parameters can be specified as "global defaults" using the "setDefault*" versions of the various methods of this class. This can be used to avoid passing global configuration parameters among many different objects.

For complete documentation of the class, see *TlsConfiguration* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/tls/TlsConfiguration.html).

A.3.5 Toolkit Package

The Java classes included in the Toolkit package form the basis of the PlateSpin Orchestrate infrastructure. For complete documentation of each class, click on the links to access the online documentation javadoc.

- "Classes" on page 226

Classes

The following Java files form the classes for the PlateSpin Orchestrate toolkit structure:

- "Class ClientAgentFactory" on page 226
- "Class ConstraintFactory" on page 226
- "Class CredentialFactory" on page 227

Class ClientAgentFactory

Factory pattern used to create new clients for connection to a PlateSpin Orchestrate Server. This is the starting point for clients to communicate with the server.

For complete documentation of the class, see *ClientAgentFactory* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/toolkit/ClientAgentFactory.html).

Class ConstraintFactory

Factory pattern used to create constraint objects that can be combined into larger constraint hierarchies for use in searches or other constraint-based matching.

For complete documentation of the class, see *ConstraintFactory* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/toolkit/ConstraintFactory.html).

Class CredentialFactory

Factory pattern used to create a `Credential` used for connection to a PlateSpin Orchestrate Server.

For complete documentation of the class, see *CredentialFactory* (http://www.novell.com/documentation/cloudmanager1/resources/jdldoc/com/novell/zos/toolkit/CredentialFactory.html).

PlateSpin Orchestrate Job Classes and JDL Syntax

B

B.1 Job Class

To review the detailed JDL structure of the joblet class, see Job (page 241).

B.2 Joblet Class

To review the detailed JDL structure of the joblet class, see Joblet (page 241).

B.3 Utility Classes

The following are some of the main utility JDL classes you can use to customize your PlateSpin Orchestrate jobs:

- DataGrid (page 238)
- Exec (page 239)
- MatrixInfo (page 243)
- ResourceInfo (page 246)
- RunJobSpec (page 247)
- ScheduleSpec (page 247)

B.4 Built-in JDL Functions and Variables

The information in this section defines the built-in PlateSpin Orchestrate JDL functions and variables.

- Section B.4.4, "The __agent__ Variable," on page 230
- Section B.4.5, "The __jobname__ Variable," on page 231
- Section B.4.6, "The __mode__ Variable," on page 231

B.4.1 getMatrix()

This function returns the matrix grid object. For more information, see MatrixInfo (page 243).

Purpose: The matrix object is used to retrieve other grid objects in the system.

B.4.2 system(cmd)

This 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: Returns an exit code result of the command execution.

B.4.3 Grid Object TYPE_* Variables

The list of variables are constants for grid object type. For more information, see MatrixInfo (page 243).

Variable Names:

```
TYPE_USER
TYPE_JOB
TYPE_RESOURCE
TYPE_VMHOST
TYPE_REPOSITORY
TYPE_USERGROUP
TYPE_JOBGROUP
TYPE_RESOURCEGROUP
TYPE_REPOSITORYGROUP
TYPE_VNIC
TYPE_VDISK
TYPE_VBRIDGE
TYPE_VBRIDGEGROUP
```

Type: String.

Purpose: Use these in JDL functions for retrieving and creating grid objects.

B.4.4 The __agent__ Variable

Variable Name: `__agent__`

Type: Boolean.

Purpose: Defines whether the JDL is executing on the agent.

B.4.5 The __jobname__ Variable

Variable Name: `__jobname__`

Type: String.

Purpose: Defines the name of the deployed job.

B.4.6 The __mode__ Variable

Variable Name: `__mode__`

Type: String.

Purpose: Defines the execution mode.

Values:

`parse` - JDL is being parsed.

`deploy` - JDL is being deployed.

`undeploy` - JDL is being undeployed.

`runtime` - JDL is being executed.

B.5 Job State Field Values

Here are the job state field values for the Job (page 241) class:

Constant	Value	Description
int CANCELLED_STATE	9	Cancelled end state.
int CANCELLING_STATE	6	Cancelling. Transitions 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. Transitions to: Paused/Completing/ Failing/Cancelling.
int STARTING_STATE	2	Starting. Transitions to: Running/Failing/ Cancelling.
int SUBMITTED_STATE	0	Submitted. Transitions to: Queued/Failing.

Constant	Value	Description
String TERMINATION_TYPE_ADMIN	“Admin"	Indicates Job was cancelled by the admin and only 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.
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.

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.

Constant	Value	Description
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 241).

B.8 Resource Information Values

Use the following values to specify a resource type:

Constant	Value Type	Resource Description
TYPE_BM_INSTANCE	String	Blade server.
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 246).

B.9 JDL Class Definitions

The following PlateSpin Orchestrate 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 235
- “BinaryConstraint” on page 235
- “BuildSpec” on page 235
- “CharRange” on page 236
- “ComputedFact” on page 236
- “ComputedFactContext” on page 236

* "Timer" on page 247
* "UndefinedConstraint" on page 247
* "UserInfo" on page 248
* "VbridgeInfo" on page 248
* "VdiskInfo" on page 248
* "VMHostClusterInfo" on page 248
* "VMHostInfo" on page 249
* "VmSpec" on page 249
* "VnicInfo" on page 249

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()`.

See Also

* ContainerConstraint (page 237)
* Javadoc: *AndConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

* Subclasses: ContainsConstraint (page 237), EqConstraint (page 238), GeConstraint (page 240), GtConstraint (page 240), LeConstraint (page 242), LtConstraint (page 243), NeConstraint (page 244).
* Javadoc: *BinaryConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/BinaryConstraint.html)

BuildSpec

Defines the attributes for building a new VM. An instance of this class is passed to `resource.build()`.

See Also

* Javadoc: *BuildSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/BuildSpec.html)

CharRange

Define lexical character string range of values for ParameterSpace scheduling.

See Also

- Javadoc: *CharRange* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 Also

- ComputedFactContext (page 236)
- Javadoc: *ComputedFact* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ComputedFact.html)

ComputedFactContext

Provides access to the evaluation context.

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, vBridge, and Repository grid objects.

The VM host, vBridge 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.

See Also

- ComputedFact (page 236)
- Javadoc: *ComputedFactContext* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ComputedFactContext.html)

Constraint

Defines the base class for all constraint classes.

See Also

- BinaryConstraint (page 235), ContainerConstraint (page 237), DefinedConstraint (page 238), UndefinedConstraint (page 247).
- Javadoc: *Constraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/Constraint.html)

ContainerConstraint

Representation of a Constraint that contains other Constraints. This is a base class and is not directly constructed.

See Also

- Subclasses: AndConstraint (page 235), NotConstraint (page 244), OrConstraint (page 245)
- Javadoc: *ContainerConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *ContainsConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ContainsConstraint.html)

Credential

Representation of a credital stored in the Credential Manager. Fields contained in this object are:

name: The ID of this credential

type: A string type used to group related credentials (for example, Amazon EC2)

user: The user string.

secret: The secreat associated with this user.

See Also

Javadoc: *Credential* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/Credential.html)

CredentialManager

The interface into the Credential Manager. This class is available only in a joblet context. Also, only users in the administrator group or the system user are allowed access to these methods. From this class you can add, get, update and delete credentials that are stored in an encrypted store on the Orchestrate Server.

See Also

Javadoc: *CredentialManager* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/CredentialManager.html)

DataGrid

General interface to the datagrid. See Chapter 5, "The PlateSpin Orchestrate Datagrid," on page 109.

See Also

- GridObjectInfo (page 240)
- Javadoc: *DataGrid* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

- Constraint (page 236), ContainerConstraint (page 237), and ContainsConstraint (page 237)
- Javadoc: *DefinedConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 235).

See Also

- BinaryConstraint (page 235)
- Javadoc: *EqConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

- BinaryConstraint (page 235) and ExecError (page 239)
- Javadoc: *Exec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/Exec.html)

ExecError

`ExecError` is raised for errors in executing a command line using the Exec (page 239) 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.

See Also

- Exec (page 239)
- Javadoc: *ExecError* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ExecError.html)

FileRange

Define a range of values for a ParameterSpace (page 245) 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 238) file URL.

See Also

- DataGrid (page 238) and ParameterSpace (page 245)
- Javadoc: *FileRange* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 235).

See Also

- Constraint (page 236) and BinaryConstraint (page 235).
- Javadoc: *GeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *GridObjectInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 240).

See Also

- GridObjectInfo (page 240)
- Javadoc: *GroupInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

- Constraint (page 236)
- Javadoc: *GtConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

- JobInfo (page 241), Joblet (page 241), JobletInfo (page 242), JobletParameterSpace (page 242)
- Javadoc: *Job* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 the "job.*" and "jobargs.*" fact namespaces.

See Also

- Job (page 241)
- Javadoc: *JobInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/JobInfo.html)

Joblet

Defines the execution on the resource. A Job writer constructs a subclass of Joblet to define code to run on a resource. The method `joblet_started_event` is required to be implemented. `joblet_started_event` is invoked on the resource. The Job writer invokes the `schedule()` function in the Job subclass to define when and which resource the Joblet is executed. Each Joblet instance has the Job instance (`jobinstance.*`, `job.*`, `jobargs.*`, `user.*`), Resource (`resource.*`) and Joblet (`joblet.*`, `jobletargs.*`) fact sets available using the base `GridObjectInfo` fact functions. For example, you can use `self.getFact()` to retrieve a Joblet fact. Use the `getMatrix()` built-in function to retrieve facts for other Grid Objects that are not in the context of this Joblet instance's fact set.

See Also

- Job, JobInfo
- Javadoc: *Joblet* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *JobletInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *JobletParameterSpace* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *LeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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.

See Also

Javadoc: *LtConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/LtConstraint.html)

MatchContext

The MatchContext defines a context for evaluating a constraint. An instance of this class is supplied to `match()` for evaluating constraints. The `MatchContext` provides a way to setup an evaluation context that the constraint engine is using to evaluate constraints. The `MatchContext` is filled out with the context that is required for evaluating your constraints. This includes assigning a deployed Job, User, Resource, VM Host, vBridge, vNIC, and Repository Grid objects.

See Also

- Javadoc: *MatchContext* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/MatchContext.html)

MatchResult

The MatchResult class defines results of a Constraint `match()`. Instance of `MatchResult` is returned from `match()` operations. From the `MatchResult` you can retrieve a list of the IDs of the matching Grid objects and the non-matching Grid objects.

See Also

- Javadoc: *MatchResult* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/MatchResult.html)

MatrixInfo

The MatrixInfo class is a representation of the matrix grid object (see GridObjectInfo (page 240)). 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.

See Also

- Javadoc: *MatrixInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/MatrixInfo.html)
- Section B.4, “Built-in JDL Functions and Variables,” on page 229.

MigrateSpec

The MigrateSpec class defines the options for the migrate action. An instance of this class is passed to the `resource.migrate()` method.

Example

The following is an example of using `MigrateSpec` to define a migrate action for a Virtual Machine named “sles10” to a VM host named “host2:”

```
vm = getMatrix().getGridObject(TYPE_RESOURCE,"sles10")
spec = MigrateSpec()
spec.setHost('host2')
vm.migrate(spec)
```

See Also

Javadoc: *MigrateSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/MigrateSpec.html)

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.

See Also

Javadoc: *NeConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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()`.

See Also

- See Constraint (page 236) and ContainerConstraint (page 237).
- Javadoc: *NotConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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()`.

See Also

- See Constraint (page 236) and ContainerConstraint (page 237).
- Javadoc: *OrConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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. To limit how many Joblets or the number of rows in a Joblet, use `setMaxJobletSize` or use the `jobletCount` argument to `schedule()` or `SchedulSpec`.

See Also

Javadoc: *ParameterSpace* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ParameterSpace.html)

PolicyInfo

Representation of a Policy Object. This class allows for associating and unassociation of Grid objects using this policy

See Also

Javadoc: *PolicyInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/PolicyInfo.html)

ProvisionJob

This class extends `ProvisionJobBase`.

See Also

Javadoc: *ProvisionJob* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ProvisionJob.html)

ProvisionJoblet

This class extends `Joblet`.

See Also

Javadoc: *ProvisionJoblet* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ProvisionJoblet.html)

ProvisionSpec

Defines the attributes for starting a provision. An instance of this class is passed to the `self.provision()` method. If no reservations are specifed the lifecycle mode is MODE_MANUAL.

See Also

Javadoc: *ProvisionSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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 243) for how to script creation of Repository objects.

See Also

- See GridObjectInfo (page 240) and MatrixInfo (page 243).
- Javadoc: *RepositoryInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/RepositoryInfo.html)

ResourceInfo

ResourceInfo is a representation of a Resource grid object. This class inherits the base fact operations from GridObjectInfo (page 240) and adds the provisioning operations for provisionable resources such as VMs. See MatrixInfo (page 243) for how to script creation of Resource objects.

See Also

- GridObjectInfo (page 240) and MatrixInfo (page 243).
- Javadoc: *ResourceInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ResourceInfo.html)

RunJobSpec

Defines the attributes for starting a child job or a standalone job. An instance of this class is passed to `self.runJob()`.

See Also

Javadoc: *RunJobSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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()` or `scheduleSweep()`. `schedule()` creates the joblets and schedules joblets to run on resources.

See Also

- Joblet (page 241)
- Javadoc: *ScheduleSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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. An active Timer keeps the job or joblet running. You must manually cancel or terminate the job or joblet or invoke the Timer's `cancel()` method.

See Also

Javadoc: *Timer* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/Timer.html)

UndefinedConstraint

Representation of the Undefined Constraint. Evaluates to true only if the left side fact is *not* 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.

See Also

- Constraint (page 236)
- Javadoc: *UndefinedConstraint* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/UndefinedConstraint.html)

UserInfo

UserInfo is a representation of a user grid object. This class provides accessors and setters for User facts.

See Also

Javadoc: *UserInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/UserInfo.html)

VbridgeInfo

VbridgeInfo is a representation of a vBridge grid object. This class provides accessors and setters for vBridge facts. See `VMHostInfo.createVbridge()` (http://www.novell.com/documentation/pso_orchestrate25/resources/jdldoc/com/novell/zos/jdl/VMHostInfo.html#createVbridge(java.lang.String)) for how to script creation of vBridge objects.

See Also

Javadoc: *VbridgeInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/VbridgeInfo.html)

VdiskInfo

VdiskInfo is a representation of a vDisk grid object. This class provides accessors and setters for vDisk facts. See `ResourceInfo.createVdisk()` (http://www.novell.com/documentation/pso_orchestrate25/resources/jdldoc/com/novell/zos/jdl/ResourceInfo.html#createVdisk()) for how to script creation of vDisk objects.

See Also

Javadoc: *VdiskInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/VdiskInfo.html)

VMHostClusterInfo

The VmHostClusterInfo class is a representation of a clustered VM host Grid object. This class provides accessors and setters to the VMHostCluster facts and operations to control the state of the VM host Cluster object.

See Also

Javadoc: *VMHostClusterInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/VmHostClusterInfo.html)

VMHostInfo

The VmHostInfo class is a representation of a VM 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..

See Also

Javadoc: *VMHostInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/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()`.

Example

Example of using `VmSpec` for creating a clone on a named host from a template resource:

```
template = getMatrix().getGridObject(TYPE_RESOURCE,"myTemplate")
spec = VmSpec()
spec.setNewName("newvm")
spec.setHost('vmhost-qa')
template.clone(spec)
```

If the host and repository is not set, the default is to use the source resource object's repository as the destination repository.

See Also

- VMHostClusterInfo (page 248)
- Javadoc: *VmSpec* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/VmSpec.html)

VnicInfo

VnicInfo is a representation of a vNIC grid object. This class provides accessors and setters for vNIC facts. See *ResourceInfo.createVnic()* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/ResourceInfo.html#createVnic()) for how to script creation of vNIC objects.

See Also

Javadoc: *VnicInfo* (http://www.novell.com/documentation/cloudmanager1/resources/javadoc/com/novell/zos/jdl/VnicInfo.html)

C Documentation Updates

This section contains information about documentation content changes that were made in this *PlateSpin Orchestrate Developer Guide and Reference* after the initial release of Novell Cloud Manager 1.1 with PlateSpin Orchestrate 2.6. The changes are listed according to the date they were published.

The documentation for this product is provided on the Web in two formats: HTML and PDF. The HTML and PDF documentation are both kept up-to-date with the changes listed in this section.

If you need to know whether a copy of the PDF documentation that you are using is the most recent, the PDF document includes a publication date on the title page.

The documentation was updated on the following dates:

- Section C.1, “March 29, 2011,” on page 251
- Section C.2, “January 28, 2011,” on page 251

C.1 March 29, 2011

Updates were made to the following sections:

Location	Update Description
Section 4.1.5, “Virtual Disk Object Facts and Fact Junctions,” on page 90	Added a paragraph to clarify that when the `vdisk.moveable` fact is marked as false, the vDisk is not destroyed with its associated VM.

C.2 January 28, 2011

Updates were made to the following sections:

Location	Update Description
“Constraint Types” on page 23	Added more detail about the allocation and provision constraint types.