

# Moab Web Services 7.2.8 Reference Guide

## Table of Contents

- 1** Introduction
  - 1.1** Moab Web Services Overview
  - 1.2** Upgrading from Previous Versions
  - 1.3** Installation Guide
  - 1.4** Troubleshooting
  - 1.5** Configuration
  - 1.6** Security
  - 1.7** Version and Build Information
- 2** Access Control
  - 2.1** Application Accounts
- 3** API Documentation
  - 3.1** RESTful Web Services
  - 3.2** Data Format
  - 3.3** Global URL Parameters
  - 3.4** Requesting Specific API Versions
  - 3.5** Responses and Return Codes
  - 3.6** Error Messages
  - 3.7** Pre and Post-Processing Hooks
  - 3.8** Authentication
- 4** Resources
  - 4.1** Access Control Lists
  - 4.2** Accounts
  - 4.3** Credentials
  - 4.4** Diagnostics
  - 4.5** Events
  - 4.6** Funds
  - 4.7** Images
  - 4.8** Jobs
  - 4.9** Job Arrays
  - 4.10** Job Templates
  - 4.11** Metric Types
  - 4.12** Nodes

- 4.13** Pending Actions
- 4.14** Permissions
- 4.15** Plugins
- 4.16** Plugin Types
- 4.17** Policies
- 4.18** Principals
- 4.19** Quotes
- 4.20** Reports
- 4.21** Reservations
- 4.22** Resource Types
- 4.23** Roles
- 4.24** Services
- 4.25** Service Templates
- 4.26** Standing Reservations
- 4.27** Usage Records
- 4.28** Virtual Containers
- 4.29** Virtual Machines
- 5** Reporting Framework
  - 5.1** Overview
  - 5.2** Example Report (CPU Utilization)
- 6** MWS Plugins (Beta)
  - 6.1** Plugin Overview
  - 6.2** Plugin Developer's Guide
  - 6.3** MWM Resource Manager Integration
  - 6.4** Plugin Type Management
  - 6.5** Plugin Management

# 1 Introduction

## 1.1 Moab® Web Services Overview

Moab Web Services (MWS) is a component of Adaptive Computing Suites that enables programmatic interaction with Moab Workload Manager via a RESTful interface. MWS allows you to create and interact with Moab objects and properties such as jobs, nodes, virtual machines, and reservations. MWS is the preferred method for those wishing to create custom user interfaces for Moab and is the primary method by which Moab Viewpoint communicates with Moab.

MWS communicates with the Moab Workload Manager (MWM) server using the same wire protocol as the Moab command-line interface. By publishing a standard interface into Moab's intelligence, MWS significantly reduces the amount of work required to integrate MWM into your solution.

This documentation is intended for developers performing such integrations. If you are a Moab administrator, and for conceptual information about MWM, see the Moab Administrator's Guide.

## 1.2 Upgrading from Previous Versions

In order to upgrade from previous versions of MWS, the following steps must be completed. MWS is capable of detecting and performing necessary database updates, but this process must be triggered manually (see steps 3 and 4 below) by the admin user. It is not always necessary to perform database updates even when MWS is upgraded to a new version.



It is **highly** recommended to perform a full database backup before performing database updates. This may be done using the `mongodump` utility documented in the [MongoDB documentation](#).

### 1) Stop Tomcat, re-deploy mws.war, remove exploded mws directory, and start Tomcat.

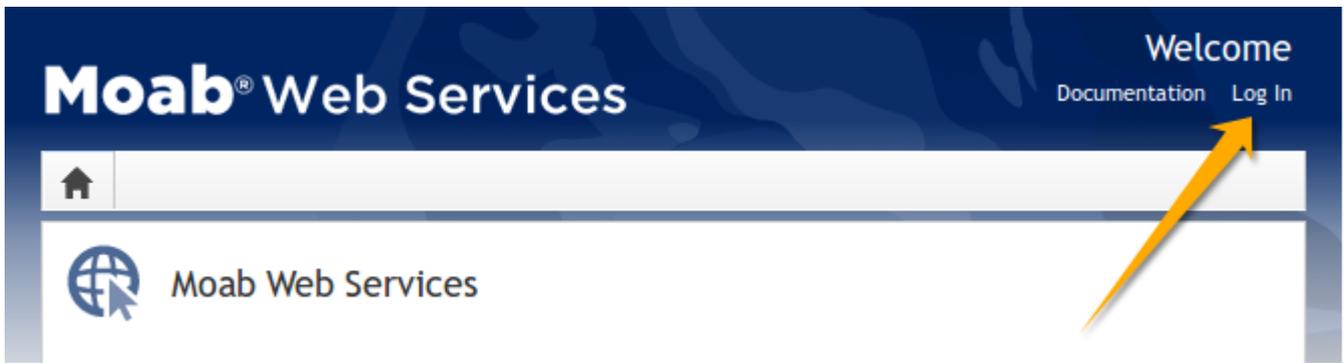
```
# CentOS 6 example
service tomcat6 stop
cp /tmp/mws-install/mws-<VERSION>/mws.war /var/lib/tomcat6/webapps
rm -rf /var/lib/tomcat6/webapps/mws
service tomcat6 start
```

### 2) Visit <http://localhost:8080/mws/> in a web browser to verify that MWS is running again.

You will see some sample queries and a few other actions.

### 3) Log into MWS to verify configuration and check for required database updates.

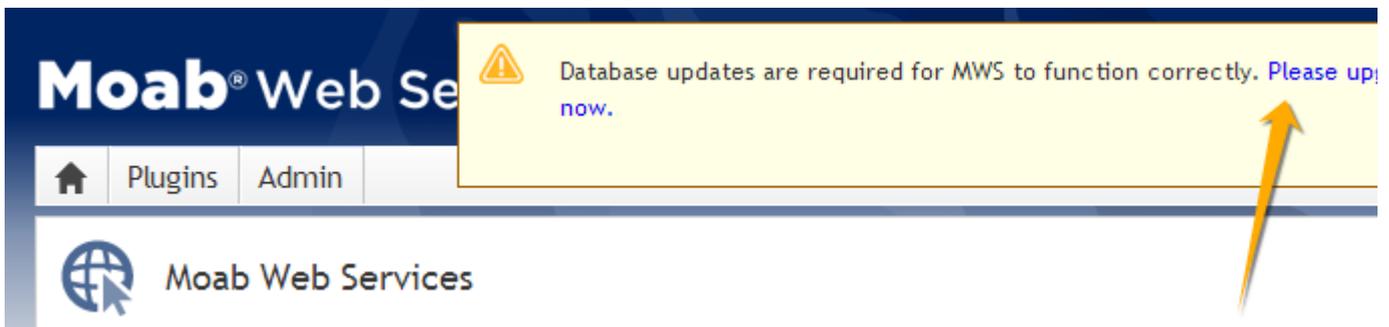
The credentials are the values of `auth.defaultUser.username` and `auth.defaultUser.password` set in the MWS configuration file.



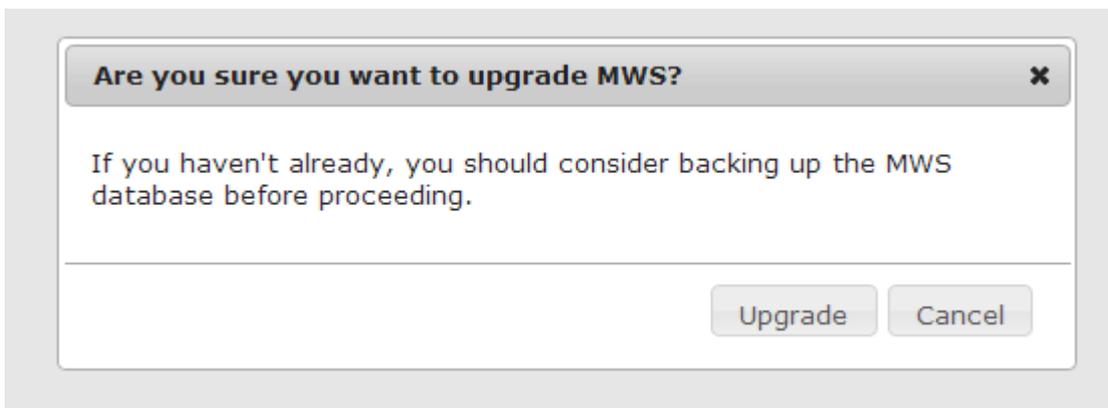
 If you encounter problems, or if MWS does not seem to be running, see the steps in the [Troubleshooting](#) section.

#### 4) Perform database updates.

If database updates are required, a warning box will be shown at the top of the MWS home page. Click "Please upgrade now" to continue.



A dialog will appear confirming if the upgrade should be applied or not.



When the upgrade is completed, a confirmation notice will be displayed. MWS is then ready for normal usage.

## 1.3 Installation Guide

These instructions describe how to install Moab® Web Services (MWS).

### 1.3.1 Requirements

#### Hardware Requirements

- Dual-core Intel/AMD x86-64 processor
- At least 4 GB of RAM

## Software Requirements

- Moab® Workload Manager (version must match exactly the version of MWS)
- Oracle® Java® 6 Runtime Environment
- Apache Tomcat™ 6
- MongoDB® 2.0.2 - 2.0.8

 Oracle Java 6 Runtime Environment is the **only** supported Java environment. All other versions of Java, including Oracle Java 7, OpenJDK/IcedTea, GNU Compiler for Java, and so on, are not supported.

 Microsoft Active Directory or OpenLDAP (must support the LDAPv3 protocol) is required if you want the **Principal** resource functionality in Moab Web Services, or if you are going to install Moab Viewpoint. For a basic tutorial on how to set up OpenLDAP, see [Setting up OpenLDAP on Centos 6](#) in the Viewpoint Management and User Guide.

## 1.3.2 Quickstart Guide

### 1) Install MongoDB version 2.0.8.

 MWS does not yet support MongoDB 2.2 or later. Be sure to install the **2.0.8** packages. The RPM package names are `mongo20-10gen-2.0.8-mongodb_1.x86_64.rpm` and `mongo20-10gen-server-2.0.8-mongodb_1.x86_64.rpm`.

- [Install MongoDB on RedHat Enterprise, CentOS, or Fedora Linux](#)
- [Install MongoDB on Debian or Ubuntu Linux](#)

### 2) Start MongoDB.

```
# CentOS 6 example
chkconfig mongod on
service mongod start
```

 The instructions provided above for installing MongoDB describe a base installation only. See the MongoDB section of the [security](#) page.

### 3) Install and configure Moab Workload Manager (MWM).



- You must deploy Moab Web Services (MWS) on the same server as Moab Workload Manager (MWM).
- The version of MWS must match exactly the version of MWM. For example, MWS 7.1.1 works **only** with MWM 7.1.1.

#### 4) Generate a secret key to be used for communication between MWM and MWS.

```
# All these steps are required. Do not skip any steps.
service moab stop
dd if=/dev/urandom count=18 bs=1 2>/dev/null | base64 > /opt/moab/etc/.moab.key
chown root:root /opt/moab/etc/.moab.key
chmod 400 /opt/moab/etc/.moab.key
service moab start
```

#### 5) Install Apache Tomcat 6.

```
# CentOS 6 example
yum install tomcat6
```

#### 6) Install the 64-bit RPM version of the [Oracle Java SE 6 JRE](#).



Oracle Java 6 Runtime Environment is the **only** supported Java environment. All other versions of Java, including Oracle Java 7, OpenJDK/IcedTea, GNU Compiler for Java, and so on, are not supported.

```
# CentOS 6 example
sh jre-6u45-linux-x64-rpm.bin
```

#### 7) Create the [MWS home directory](#) and its subdirectories etc, hooks, plugins, and log.



The default location for the MWS home directory is `/opt/mws`. These instructions assume the default location.

- Give the Tomcat user read access to these directories and write access to the `plugins` and `log` directories.
- Here is a sample script for these steps:

```
mkdir -p /opt/mws/etc /opt/mws/hooks /opt/mws/plugins /opt/mws/log
chown -R tomcat:tomcat /opt/mws # Depending on your OS, the Tomcat username might be
tomcat6.
chmod -R 555 /opt/mws
chmod u+w /opt/mws/plugins /opt/mws/log
```

## 8) Extract the contents of the MWS tarball into a temporary directory.

```
mkdir /tmp/mws-install
cd /tmp/mws-install
tar xvzf $HOME/Downloads/mws-<VERSION>.tar.gz
cd /tmp/mws-install/mws-<VERSION>
```

## 9) Set up the MWS configuration file.

- In the extracted MWS directory are two sample configuration files:  
`mws-config-cloud.groovy` and `mws-config-hpc.groovy`.
  - `mws-config-cloud.groovy` provides sample configuration for the Moab Cloud Suite.
  - `mws-config-hpc.groovy` provides sample configuration for the Moab HPC Suites.
- Choose the correct file for your suite, rename it to `mws-config.groovy`, and copy it to `/opt/mws/etc`.
- Give the Tomcat user read access to `/opt/mws/etc/mws-config.groovy`.
- In the `/opt/mws/etc/mws-config.groovy` file, change these settings:
  - `moab.secretKey`: needs to match the MWM secret key you generated earlier (contained in `/opt/moab/etc/.moab.key`)
  - `auth.defaultUser.username`: any value you like, or leave as is
  - `auth.defaultUser.password`: any value you like, but choose a good password

```
vi /opt/mws/etc/mws-config.groovy
...
moab.secretKey = "<ENTER-KEY-HERE>"
moab.server = "localhost"
moab.port = 42559

// Change these to be whatever you like.
auth.defaultUser.username = "admin"
auth.defaultUser.password = "adminpw"
```



If you do not change `auth.defaultUser.password`, then your MWS is not secure, since anyone reading these instructions can log into your MWS. Here are some [tips](#) for choosing a good password.

## 10) Add the following lines to the end of `/etc/tomcat6/tomcat6.conf`:

```
CATALINA_OPTS="-DMWS_HOME=/opt/mws -Xms256m -Xmx3g -XX:MaxPermSize=384m"
JAVA_HOME="/usr/java/latest"
```

⚠ Some Linux distributions use `/etc/default/tomcat6` or `/etc/sysconfig/tomcat6` instead of `/etc/tomcat6/tomcat6.conf`.

## 11) Start Tomcat and deploy `mws.war`.

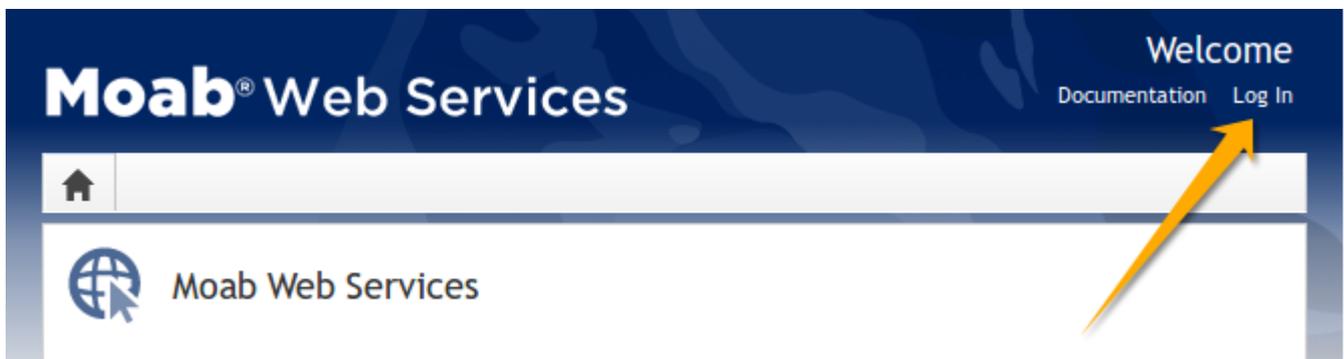
```
# CentOS 6 example
chkconfig tomcat6 on
service tomcat6 stop
cp /tmp/mws-install/mws-<VERSION>/mws.war /var/lib/tomcat6/webapps
service tomcat6 start
```

## 12) Visit <http://localhost:8080/mws/> in a web browser to verify that MWS is running.

You will see some sample queries and a few other actions.

## 13) Log into MWS to verify that the MWS credentials are working.

The credentials are the values of `auth.defaultUser.username` and `auth.defaultUser.password` that you set above.



⚠ If you encounter problems, or if MWS does not seem to be running, see the steps below in the Troubleshooting section.

## 1.4 Troubleshooting

If something goes wrong with MWS, look in the following files:

1. The MWS log file. By default this is `/opt/mws/log/mws.log`.
2. The Tomcat `catalina.out` file, usually in `/var/log/tomcat6` or `$CATALINA_HOME/logs`.



If you remove the `log4j` configuration from `mws-config.groovy`, MWS will write its log files to `java.io.tmpdir`. For Tomcat, `java.io.tmpdir` is generally set to `$CATALINA_BASE/temp` or `CATALINA_TMPDIR`.

Here is a list of some errors and their fixes:

## MongoDB: Errors during MWS startup

If the application fails to start and gives error messages such as these:

```
Error creating bean with name 'mongoDatastore'
can't say something; nested exception is com.mongodb.MongoException
```

MongoDB is most likely not running, or the host and port are misconfigured. Start MongoDB or reconfigure MWS and restart MWS.

## MongoDB: Out of semaphores to get db connection

To resolve this error, adjust the values of `connectionsPerHost` or `threadsAllowedToBlockForConnectionMultiplier` by adding them to `mws-config.groovy`. Example:

```
grails.mongo.options.connectionsPerHost = 60
grails.mongo.options.threadsAllowedToBlockForConnectionMultiplier = 10
```

For more information on these options, refer to these documents:

- The [Configuration](#) page under Moab Web Services in the Quick Reference menu, which briefly discusses a few MongoDB driver options.
- The [MongoOptions](#) documentation, which contains full details on all MongoDB driver options.



- You must restart Tomcat after adding, removing, or changing `grails.mongo.options` parameters.
- As shipped, `mws-config.groovy` does not contain any `grails.mongo.options` parameters. To adjust their values, you need to add them to `mws-config.groovy`.
- The default value of `connectionsPerHost` is normally 10, but MWS sets it internally to 50.
- The default value of `threadsAllowedToBlockForConnectionMultiplier` is 5.
- Any of the options listed in [MongoOptions](#) can be specified in `mws-config.groovy`. Just use the prefix `grails.mongo.options` as shown above.

## MongoDB: Connection wait timeout after 120000 ms

See the section "MongoDB: Out of semaphores to get db connection" above.

## java.lang.OutOfMemoryError: Java heap space

Increase the size of the heap using JVM options `-Xms` and `-Xmx`. Here are the suggested values from the [Quickstart Guide](#):

```
CATALINA_OPTS="-DMWS_HOME=/opt/mws -Xms256m -Xmx3g -XX:MaxPermSize=384m"
```

- `-Xms`: Set initial Java heap size.
- `-Xmx`: Set maximum Java heap size.

## java.lang.OutOfMemoryError: PermGen space

Increase the size of the permanent generation using JVM option `-XX:MaxPermSize`. Here are the suggested values from the [Quickstart Guide](#):

```
CATALINA_OPTS="-DMWS_HOME=/opt/mws -Xms256m -Xmx3g -XX:MaxPermSize=384m"
```

## SEVERE: Context [/mws] startup failed due to previous errors

If `catalina.out` contains this error, look in `/opt/mws/log/mws.log` and `/opt/mws/log/stacktrace.log` for more details on the error.

## Moab Reached Maximum Number of Concurrent Client Connections

When this error message is encountered, simply add a new line to the `moab.cfg` file:

```
CLIENTMAXCONNECTIONS 256
```

This will change the Moab configuration when Moab is restarted. Run the following command to immediately use the new setting:

```
changeparam CLIENTMAXCONNECTIONS 256
```



The number 256 above may be substituted for the desired maximum number of MWM client connections.

## 1.5 Configuration

This section describes the location of the Moab Web Services configuration files. It also shows some examples of how to configure logging.

 To see a full reference to all configuration and logging parameters available in MWS, see the [Configuration](#) page under Moab Web Services in the Quick Reference menu.

## Home Directory

The MWS home directory contains configuration files, log files, and files that serve features of MWS such as hooks and plugins. You should set the location of the MWS home directory using the `MWS_HOME` property as shown in the [Quickstart Guide](#). If you do not set `MWS_HOME` as a Java property or as an environment variable, then MWS will use `/opt/mws` as the default `MWS_HOME`.

## Configuration Files

The primary configuration file is `MWS_HOME/etc/mws-config.groovy`. If this file is missing or contains errors, MWS will not start. If `MWS_HOME/etc/log4j.properties` exists, MWS will load it as well.

## Logging Configuration Using `mws-config.groovy`

Shown below is an example that logs all error messages and fatal messages to `/opt/mws/log/mws.log`. It also logs all stack traces to `/opt/mws/log/stacktrace.log`. Note that this example is not configured to log [events](#).

### Minimal Logging Configuration

```
log4j = {
  appenders {
    rollingFile name: 'stacktrace',
      file: '/opt/mws/log/stacktrace.log',
      maxFileSize: '1GB'
    rollingFile name: 'rootLog',
      file: '/opt/mws/log/mws.log',
      threshold: org.apache.log4j.Level.ERROR,
      maxFileSize: '1GB'
  }
  root {
    debug 'rootLog'
  }
}
```

Alternatively, you may configure a console appender instead of a rolling file as shown below.

## Console Logging Configuration

```
log4j = {
  appenders {
    rollingFile name: 'stacktrace',
      file: '/opt/mws/log/stacktrace.log',
      maxFileSize: '1GB'
    console name: 'consoleLog',
      threshold: org.apache.log4j.Level.ERROR
  }
  root {
    debug 'consoleLog'
  }
}
```



- You may configure logging using either `MWS_HOME/etc/mws-config.groovy` or `MWS_HOME/etc/log4j.properties`.
- If you do not define any `log4j` configuration, MWS will write its log files to `java.io.tmpdir`. For Tomcat, `java.io.tmpdir` is generally set to `$CATALINA_BASE/temp` or `CATALINA_TMPDIR`.

## LDAP Configuration Using `mws-config.groovy`

### Using a Supported LDAP Directory Type

To configure an MWS connection to an LDAP server, add the following parameters to `mws-config.groovy`:



Throughout the following examples in this topic, you will see `dc=acme,dc=com`. "acme" is only used as an example to illustrate what you would use as your own domain controller if your domain name was "acme.com." You should replace any references to "acme" with your own organization's domain name.

- **ldap.server**: The hostname or IP address of the LDAP server.
- **ldap.port**: The port the LDAP server is listening on.
- **ldap.baseDNs**: A list of distinguished names that are the root entries for LDAP searches.
- **ldap.bindUser**: The distinguished name of the bind user.
- **ldap.password**: The password of the `ldap.bindUser`.
- **ldap.directory.type**: The type of LDAP directory (e.g. "Microsoft Active Directory").

The **ldap.directory.type** parameter can have the following values:

- Microsoft Active Directory
- OpenLDAP Using InetOrgPerson Schema
- OpenLDAP Using NIS Schema
- OpenLDAP Using Samba Schema

Here is a sample configuration for OpenLDAP.



If you followed the Adaptive Computing tutorial "Setting up OpenLDAP on CentOS 6" your `ldap.directory.type` should be set to "OpenLDAP Using InetOrgPerson Schema".

### Sample OpenLDAP Configuration

```
ldap.server = "192.168.0.5"
ldap.port = 389
ldap.baseDNs = [ "dc=acme,dc=com" ]
ldap.bindUser = "cn=Manager,dc=acme,dc=com"
ldap.password = "*****"
ldap.directory.type = "OpenLDAP Using InetOrgPerson Schema"
```

Here is a sample configuration for Microsoft Active Directory.

### Sample Active Directory Configuration

```
ldap.server = "192.168.0.5"
ldap.port = 389
ldap.baseDNs = [ "CN=Users,DC=acme,DC=com", "OU=Europe,DC=acme,DC=com" ]
ldap.bindUser = "cn=Administrator,cn=Users,DC=acme,DC=com"
ldap.password = "*****"
ldap.directory.type = "Microsoft Active Directory"
```



To see how to configure a secure connection to the LDAP server, see **Connection to LDAP** in the [Security](#) section.

## Using an Unsupported LDAP Directory Type

If you are not using one of the supported directory types, you can explicitly configure MWS to work with your LDAP schema by using the following parameters:

- **ldap.user.objectClass:** The name of the class used for the LDAP user object. Example:
  - user
  - person
  - inetOrgPerson
  - posixAccount
- **ldap.group.objectClass:** The name of the class used for the LDAP group object. Example:
  - group
  - groupOfNames
  - posixGroup
- **ldap.ou.objectClass:** The name of the class used for the LDAP organizational unit object. Example:
  - organizationalUnit
- **ldap.user.membership.attribute:** The attribute field in a user entry to use when loading the user's groups (optional if **ldap.group.membership.attribute** is defined). Example:
  - memberOf
- **ldap.group.membership.attribute:** The attribute field in a group entry to use when loading the group's members (optional if **ldap.user.membership.attribute** is defined). Example:
  - member
  - memberUid
- **ldap.user.name.attribute:** The attribute field to use when loading the username. This field **must** uniquely identify a user. Example:
  - sAMAccountName
  - uid

For example:

```

Advanced Active Directory Configuration
-----
ldap.server = "myldaphostname"
ldap.port = 389
ldap.baseDNs = [ "CN=Users,DC=acme,DC=com", "OU=Europe,DC=acme,DC=com" ]
ldap.bindUser = "cn=Administrator,cn=Users,DC=acme,DC=com"
ldap.password = "*****"
ldap.user.objectClass = "person"
ldap.group.objectClass = "group"
ldap.ou.objectClass = "organizationalUnit"
ldap.user.membership.attribute = "memberof"
ldap.group.membership.attribute = "member"
ldap.user.name.attribute = "sAMAccountName"

```

Here is a similar example for OpenLDAP. Note there is no user membership attribute in the OpenLDAP InetOrgPerson schema and thus **ldap.user.membership.attribute** is set to null. This is allowable because the **ldap.group.membership.attribute** is set.

## Advanced OpenLDAP Configuration

```
ldap.server = "myldaphostname"
ldap.port = 389
ldap.baseDNs = [ "dc=acme,dc=com" ]
ldap.bindUser = "cn=Manager,dc=acme,dc=com"
ldap.password = "*****"
ldap.user.objectClass = "inetOrgPerson"
ldap.group.objectClass = "groupOfNames"
ldap.ou.objectClass = "organizationalUnit"
ldap.user.membership.attribute = null
ldap.group.membership.attribute = "memberUid"
ldap.user.name.attribute = "uid"
```

## Overriding Attributes in a Supported LDAP Directory Type

You can also override attributes in supported directory types. For example, say you are using OpenLDAP with an NIS Schema. The group objectClass for NIS defaults to "groupOfNames," but you want to use "groupOfUniqueNames" instead while retaining all other defaults for NIS. You can do this by setting **ldap.directory.type** to "OpenLDAP Using NIS Schema" and overriding the **ldap.group.objectClass** attribute as follows:

## Advanced OpenLDAP Configuration

```
ldap.directory.type = "OpenLDAP Using NIS Schema"
ldap.group.objectClass = "groupOfUniqueNames"
```



- LDAP is **not** currently used to authenticate users to MWS. LDAP is only used to map principals to roles, as explained in [Principals](#).
- The user class in your LDAP schema must have an attribute that uniquely identifies a user (e.g. uid, sAMAccountName).

## 1.6 Security

When running MWS in production environments, security is a major concern. This section focuses on securing the three kinds of connections with MWS:

1. The connection between MWS and Moab Workload Manager (MWM)
2. The connection between MWS and MongoDB
3. The connections between clients and MWS

### Connection with MWM

MWS communicates with MWM via the Moab Wire Protocol, which uses a direct connection between the two applications. The communication over this connection uses a shared secret key, which is discussed in the [Quickstart Guide](#). However, the communication is not encrypted and is therefore susceptible to eavesdropping and replay attacks. For this reason, MWS is supported only when running on the same machine as MWM. This assures that any connections between the two applications occur internally on the server and are not exposed to external users.

### Connection with MongoDB

By default, the connection between MWS and MongoDB is not authenticated. To enable authentication, follow the instructions below. For further reading, see the MongoDB tutorial [Control Access to MongoDB Instances with Authentication](#).

- Add an administrative user to the `admin` database.
- Add an MWS user to the `mws` database.
- To support MWS API version 2, add an MWS user with read-only rights to the `moab` database.
  - Here is an example of how to create all the required users. The users in the `moab` database are required only for MWS API version 2.

```
[root]# service mongod start
[root]# mongo
> use admin;
> db.addUser("admin_user", "secret1");
> use moab;
> db.addUser("moab_user", "secret2");
> db.addUser("mws_user", "secret3", true);
> use mws;
> db.addUser("mws_user", "secret3");
> exit;
```

- Add the MWS user credentials (the ones you just created) to the `mws-config.groovy` file. Example:

```
grails.mongo.username = "mws_user"
grails.mongo.password = "secret3"
```

- Enable authentication in the MongoDB configuration file.
  - The file is called `/etc/mongodb.conf` on many Linux distributions.
  - In that file, look for `#auth = true` and uncomment it.
- Restart MongoDB.
- Restart Tomcat.

 The passwords used here (secret1, secret2, and secret3) are examples. Choose your own passwords for these users.

If authentication is enabled in MongoDB, but the MWS user was not properly created or configured, MWS will not start. See the log file(s) for additional information in this case.

## Client Connections to MWS

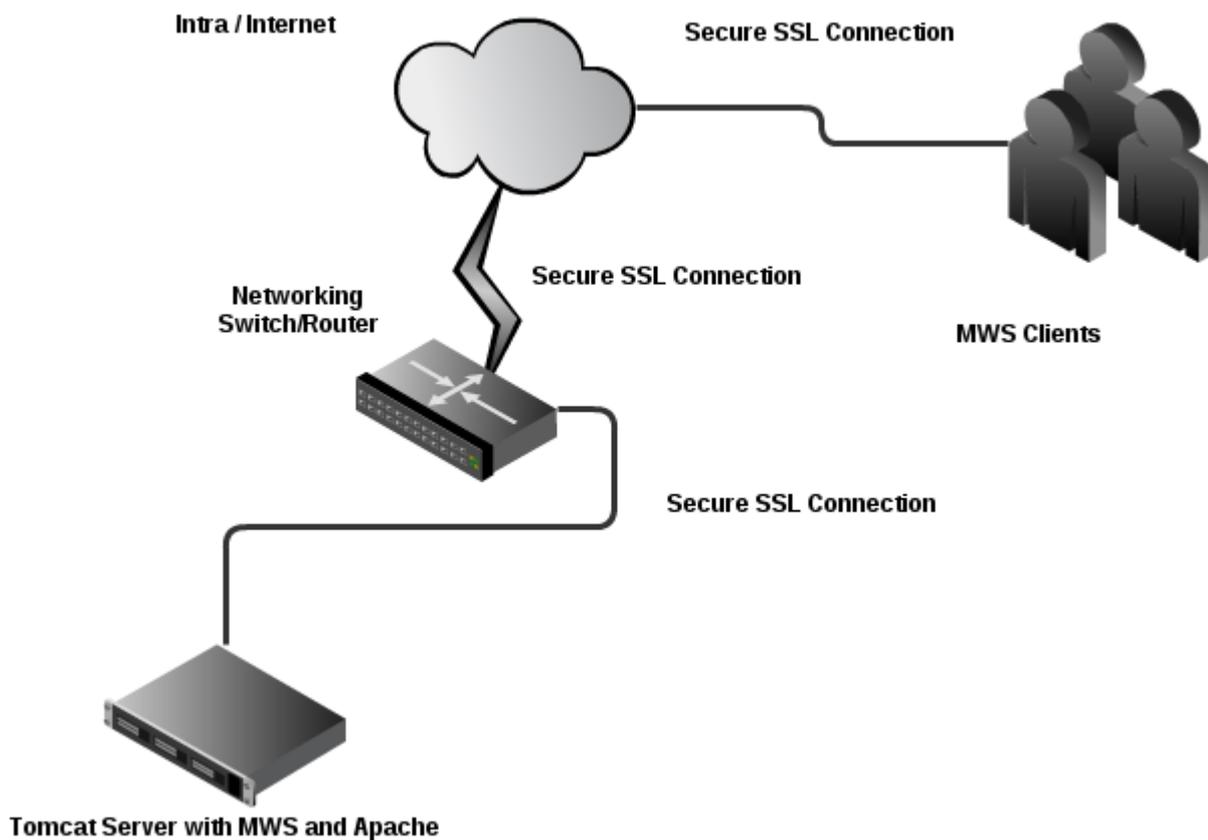
All connections to MWS, except those requesting the documentation or the main page, must be authenticated properly. MWS uses a single-trusted-user authentication model, meaning a single user exists that has access to all aspects of MWS. The username and password for this user are configured with the `auth.defaultUser` properties in the configuration file. See the [Configuration](#) reference guide for more information.

When using the MWS user interface in a browser, the user will be prompted for username and password. For information on how to authenticate requests when not using a browser, see the [Authentication](#) section in the user guide.

**⚠** The username and password in the Basic Authentication header are encoded but not encrypted. Therefore, it is **strongly** recommended that MWS be run behind a proxy (like Apache) with SSL enabled. The instructions below provide an example of how to do this.

## Encrypting Client Connections using Apache and SSL

This section shows how to encrypt client connections to MWS using Apache and SSL. These instructions have been tested on CentOS™ 6.2 with the "Web Server" software set installed. The same ideas are applicable to other operating systems, but the details might be different. As shown in the diagram below, these instructions assume that Tomcat and Apache are running on the same server.



- **Create a self-signed certificate.** See <http://www.openssl.org/docs/HOWTO/certificates.txt> for more details if desired.

**⚠** Instead of creating a self-signed certificate, you can buy a certificate from a certificate vendor. If you do, then the vendor will provide instructions on how to configure Apache with your certificate.

- Run these commands:

```
cd /etc/pki/tls/certs
cp -p make-dummy-cert make-dummy-cert.bak
cp -p localhost.crt localhost.crt.bak
```

- Edit `make-dummy-cert` and replace the `answers()` function with code similar to this:

```
answers() {
    echo US
    echo Utah
    echo Provo
    echo Adaptive Computing Enterprises, Inc.
    echo Engineering
    echo test1.adaptivecomputing.com
    echo
}
```

- Run this command:

```
./make-dummy-cert localhost.crt
```

- **Configure Apache to use the new certificate and to redirect MWS requests to Tomcat. To do so, edit `/etc/httpd/conf.d/ssl.conf`.**

- Comment out this line:

```
SSLCertificateKeyFile /etc/pki/tls/private/localhost.key
```

- Add these lines near the end, just above `</VirtualHost>`:

```
ProxyPass /mws http://127.0.0.1:8080/mws retry=5
ProxyPassReverse /mws http://127.0.0.1:8080/mws
```

- **Configure Apache to use SSL for all MWS requests.**

- Add these lines to the end of `/etc/httpd/conf/httpd.conf`:

```
RewriteEngine On
RewriteCond %{HTTPS} off
RewriteRule (/mws.*) https://%{HTTP_HOST}%{REQUEST_URI}
```

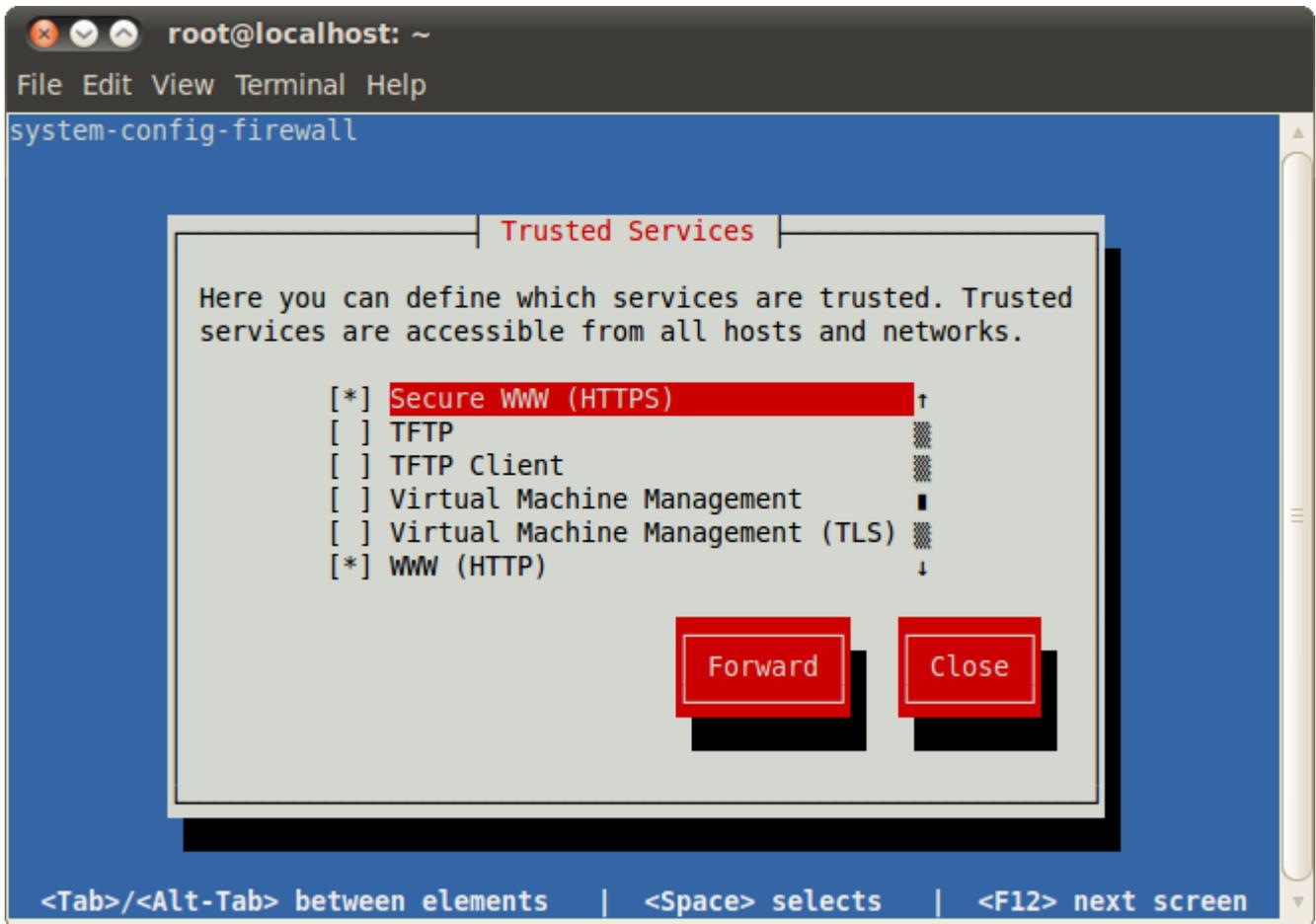
- **Give Apache permission to connect to Tomcat.**

```
setsebool -P httpd_can_network_connect 1
```

- **Turn on Apache.**

```
chkconfig httpd on
service httpd start
```

- Using `system-config-firewall-tui`, enable "Secure WWW (HTTPS)" and "WWW (HTTP)" as trusted services.



## Encrypting Client Connections using Tomcat and SSL

This section shows how to encrypt client connections to MWS using Tomcat and SSL but without requiring the use of Apache. These instructions have been tested on CentOS™ 6.2 with Tomcat 6.0.

### Generate a Certificate

First you must generate a certificate. To do so, use the `keytool` utility that is shipped with the Oracle Java Runtime Environment. As the Tomcat user, run the following

```
keytool -genkey -alias tomcat -keyalg RSA
```

Specify a password value of "changeit". This will create a `.keystore` file that contains the new certificate in the user's home directory.

### Enable the Tomcat SSL Connector

Open the server.xml file, usually located in \$CATALINA\_HOME/conf/ (\$CATALINA\_HOME represents the directory where Tomcat is installed). Verify the SSL HTTP/1.1 Connector entry is enabled. To do so locate the SSL HTTP/1.1 Connector entry and uncomment it.

```
<Connector port="8443" protocol="HTTP/1.1" SSLEnabled="true" maxThreads="150" scheme="https" secure="true" clientAuth="false" sslProtocol="TLS" />
```

Save the server.xml file.



The code above enables SSL access on port 8443. The default for HTTPS is 443, but just as Tomcat uses 8080 instead of 80 to avoid conflicts, 8443 is used instead of 443.

Verify that server.xml is owned by the Tomcat user.

```
chown -R tomcat:tomcat server.xml
```

Next modify the MWS web.xml file. Add a security-constraint section to the \$CATALINA\_HOME/webapps/mws/WEB-INF/web.xml file found in your Tomcat directory.

```
<web-app>
...
  <security-constraint>
    <web-resource-collection>
      <web-resource-name>MWS Secure URLs</web-resource-name>
      <url-pattern>/*</url-pattern>
    </web-resource-collection>
    <user-data-constraint>
      <transport-guarantee>CONFIDENTIAL</transport-guarantee>
    </user-data-constraint>
  </security-constraint>
</web-app>
```

Now restart tomcat.

## Connection to LDAP

MWS supports using SSL/TLS to secure connections to an LDAP server. Typically, LDAP servers reserve port 636 for SSL/TLS connections. In order to use SSL/TLS you need to place the PEM-encoded LDAP server security certificate in the MWS\_HOME/etc/ssl.crt folder, and make sure the user running Tomcat either owns or has permission to read this certificate.

```
mkdir $MWS_HOME/etc/ssl.crt
cp ldapServerCert.pem $MWS_HOME/etc/ssl.crt
cd $MWS_HOME/etc/ssl.crt
chown tomcat:tomcat ldapServerCert.pem
```

To configure MWS to use SSL/TLS add the following to mws-config.groovy. (Note that ldap.security.server.certificate is the filename of a server certificate found in the MWS\_HOME/etc/ssl.crt folder.)

### Configuring an SSL/TLS connection to LDAP

```
ldap.port = 636
ldap.security.type = "SSL"
ldap.security.server.certificate = "ldapServerCert.pem"
```

Many LDAP servers also support the StartTLS protocol. StartTLS allows a client to connect to the standard insecure port, usually 389, and upgrade to a secure SSL/TLS connection. To configure StartTLS, set the `ldap.security.type` parameter to `StartTLS` as follows:

### Configuring a StartTLS connection to LDAP

```
ldap.port = 389
ldap.security.type = "StartTLS"
ldap.security.server.certificate = "ldapServerCert.pem"
```

The following table lists the possible values for `ldap.security.type`.

<code>ldap.security.type</code>	Default Port	Notes
None	389	This is the default if no security type is configured. All data is sent in plain text.
SSL	636	Requires server certificate. All data is encrypted.
StartTLS	389	Starts as an insecure connection and is upgraded to an SSL/TLS connection. Requires server certificate. After upgrade all data is encrypted.

By default, MWS looks for SSL certificates in the `MWS_HOME/etc/ssl.crt` folder. You can change this location by setting the `mws.certificates.location` parameter in `mws-config.groovy`. If the path specified is relative, MWS will resolve this path relative to the `MWS_HOME` directory. For example, if you set the `mws.certificates.location` to `"etc/someOtherCertsFolder"` MWS will look for certificates in `MWS_HOME/etc/someOtherCertsFolder`.

### Changing the SSL/TLS security certificates location

```
mws.certificates.location = "etc/someOtherCertsFolder"
```

## 1.7 Version and Build Information

To get detailed version information about MWS, use one of the following three methods:

### Browser

Using a browser, visit the MWS home page (for example, <http://localhost:8080/mws/>). At the bottom of the page is the MWS version information. See the screenshot below:

## Migrate a VM:

VM:

```
{"node": {"id": "hv1"}}
```

Migrate VM

Moab Web Services 7.0.0-beta-3, Build 993 (2012-02-04\_16-15-33), Revision 79f9da5b00e8a36e5cf40b5c96b61a04e9813fi

## REST Request

Using a REST client or other HTTP client software, send a GET request to the `rest/diag/about` resource. Here is an example:

```
curl -u username:password http://localhost:8080/mws/rest/diag/about
```

This resource is also described under [Diagnostics](#).

## MANIFEST.MF File

If MWS fails to start, version and build information can be found in the `META-INF/MANIFEST.MF` file inside the MWS WAR file. The version properties begin with `Implementation`. Below is an excerpt of a `MANIFEST.MF` file:

```
Implementation-Build: 26
Implementation-Build-Date: 2012-06-19_14-18-59
Implementation-Revision: 376079a5e5f552f2fe25e6070fd2e84c646a98fd

Name: Grails Application
Implementation-Title: mws
Implementation-Version: 7.1.0-rc2
Grails-Version: 2.0.3
```

## 2 Access Control

This section describes how to manage access control in Moab Web Services.

### 2.1 Application Accounts

Applications are the consumers of MWS. They include Moab Viewpoint and other applications that need the resources provided by MWS. An application account consists of four editable fields and resource specific access control settings:

Field	Required	Default Value	Value Type	Maximum Length	Description
Application Name	Yes	-	String	32	The name of the application. Must start with a letter and may contain letters, digits, underscores, periods, hyphens, apostrophes, and spaces.
Username	Yes	-	String	32	Used for authentication. Must start with a letter and may contain letters, digits, underscores, periods, and hyphens.
Description	No	-	String	1000	The description of the application.
Enabled	-	true	Boolean	-	Controls whether the application is allowed to access MWS.
Access Control Settings	Yes	All Permissions	-	-	The permissions granted to the application. This is controlled by selecting specific check boxes in a grid.

An application account also contains an auto-generated password that is visible only when creating the account or when resetting its password. Whenever an application sends a REST request to MWS, it needs to pass its credentials (username and password) in a Basic Authentication header. See the [Authentication](#) section for more information.

The **Application Name** is a human-friendly way to identify an application account, but MWS does not use it during authentication (or at any other time, for that matter).

The **Enabled** field is set to true automatically when an application account is created. To change the value of this field, see [Modifying an Application Account](#).

Here is an example of how you might set the fields when creating an application account:

- **Application Name:** Moab Viewpoint
- **Username:** viewpoint
- **Description:** This application account grants access to Moab Viewpoint for Moab Cloud Suite.

The permissions granted to an application account may be customized while creating or modifying the account. See [Creating an Application Account](#) and [Modifying an Application Account](#).

## 2.1.1 Managing Application Accounts

Application accounts are used to grant access to MWS. Every application with an application account must be granted at least one access control permission to a resource in MWS. To manage application accounts, start with [Listing Application Accounts](#).

## 2.1.2 Listing Application Accounts

To list all applications accounts, browse to the MWS home page (<https://servername/mws> for example). Log in as the admin user, then click **Admin** and then **Application Accounts**.

Each column (except Password) can be sorted in ascending or descending order by clicking on the column heading.

## 2.1.3 Creating an Application Account

To create an application account, go to the **Application List** page and click **Add Application**. The **Application Name** and **Username** are required fields. See [Application Accounts](#) for more information on the fields.

Access to specific resources and plugin custom web services is granted or revoked by checking or unchecking the check boxes in the respective resources or plugin web services access control sections. For each resource, access may be granted to a resource for each method supported by MWS, including GET, POST, PUT, and DELETE. See the figure below for an example.

<input type="checkbox"/> Select All	<input checked="" type="checkbox"/> GET	<input type="checkbox"/> POST	<input checked="" type="checkbox"/> PUT	<input checked="" type="checkbox"/> DELETE
<input checked="" type="checkbox"/> Access Control Lists			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/> Accounts	<input checked="" type="checkbox"/>			
<input type="checkbox"/> Events	<input checked="" type="checkbox"/>	<input type="checkbox"/>		

In this example, the application has access to all available methods for the Access Control Lists and Accounts resources as well as to retrieve the Events resource through the GET method, but is denied the permission to create new events through the POST method.

Access may also be granted to each plugin type's custom web service(s). When new plugin types or plugin web services are added to MWS, applications must be updated with the new access control settings. See below for an example.

Plugin Type	<input checked="" type="checkbox"/> Can Access
<input checked="" type="checkbox"/> Test	
customService	<input checked="" type="checkbox"/>
unsecuredService (Unsecured)	<input checked="" type="checkbox"/>

In this example, the application has access to all the custom web services defined for the "Test" plugin type. Note that though Unsecured Web Services are listed, access to them cannot be denied (see [Exposing Web Services](#) for more information).

## 2.1.4 Displaying an Application Account

To show information about an application account, go to the **Application List** page and click the desired application name.

In addition to displaying the values for fields, grids are also displayed which represent the application's access control permissions defined for resources and plugin custom web services. Examples of the resources and the plugin web services access control displays are shown below.

	GET	POST	PUT	DELETE
<b>Access Control Lists</b>			✓	✓
<b>Accounts</b>	✓			
<b>Events</b>	✓	✗		

Plugin Type	Can Access
<b>Test</b>	
<code>customService</code>	✓
<code>unsecuredService (Unsecured)</code>	✓

### 2.1.5 Modifying an Application Account

To modify an application account, go to the **Application List** page, click the desired application name, and then click **Edit**. See [Creating an Application Account](#) for more information on available fields and access control settings.

### 2.1.6 Resetting an Application Password

To reset an application password, go to the **Application List** page and click the **Reset** link for the desired application. Alternatively, go to the **Display Application** page for the desired application and click the **Reset** link.

### 2.1.7 Deleting an Application Account

To delete an application account, go to the **Application List** page, click the desired application name, and then click **Delete**. A confirmation message is shown. If the **OK** button is clicked, the application account is deleted from the system and cannot be recovered.

## 3 API Documentation

### Introduction

The Moab® Web Services (MWS) provide a set of RESTful resources that can be used to create, read, update, and delete various objects in the Moab® Workload Manager.

#### 3.1 RESTful Web Services

In order to understand how to use Moab Web Services, it is first necessary to give a brief introduction to REST. REST (Representational State Transfer) is a set of guidelines which utilizes the full HTTP (Hypertext Transfer Protocol) specification along with endpoint URLs that describe **resources**. The HTTP methods used in REST are composed of the following:

Method	Description
GET	Query for a list or a single resource.
POST	Creating a resource.
PUT	Modifying a resource.
DELETE	Deleting a resource.

In comparison to other architectures of web services which use a single HTTP method and service endpoint to perform multiple types of operations (such as a POST operation to a URL), REST utilizes all of the available HTTP methods and URLs that directly correlate to resources. For example, RESTful web services for books in a library may expose many URL endpoints and the HTTP methods available for each such as GET, POST, PUT, and DELETE. The list below gives the methods, URLs, and descriptions for a sample set of services. The number 1 represents a unique identifier for books in each case.

Method	URL	Description
GET	/books	Retrieves a list of all books in the library.
POST	/books	Creates a new book.
GET	/books/1	Retrieves a single book.
PUT	/books/1	Modifies a single book.
DELETE	/books/1	Deletes a single book.



Note that in the cases of the POST and PUT operations, additional information may be needed to describe the resource to be created or the fields that should be modified.

Moab Web Services provides RESTful web services for many resources. The methods and URLs available are documented in the [Resources](#) section.

## 3.2 Data Format

JSON (JavaScript Object Notation) is the data format used for all communication with MWS. This format makes use of two main structures: collections of key/value pairs called *objects* and ordered lists of values called *arrays*. Objects are defined by using curly braces (`{ }`), and arrays are defined by using square brackets (`[ ]`). A JSON object or array may contain several different types of values including numbers, booleans (`true/false`), strings, objects, arrays, or the keyword `'null'` representing no value. For example, a simple JSON object might be defined as:

```
{
  "number": 1,
  "decimalNumber": 1.2,
  "boolean": true,
  "string": "Any string",
  "dateString": "2013-05-23 17:32:02 UTC",
  "object": {
    "key": "value"
  },
  "array": [
    "value1",
    "value2"
  ],
  "nullValue": null
}
```

Dates in MWS, for both input and output, use the pattern `"yyyy-MM-dd HH:mm:ss ZZZ"`. For more details on that pattern, see [Joda-Time DateTimeFormat](#). For a list of valid time zone IDs, see [Joda-Time Available Time Zones](#).

For more information on JSON, see [json.org](http://json.org).

The data format of MWS is defined as follows:

- Input for a POST or PUT must be in JSON format. Set the `Content-Type` header to `application/json`.
- Output is in JSON format and always consists of an object with zero or more key/value pairs.
- The output may also be "pretty-printed" or formatted for human viewing by sending a URL parameter. See [Global URL Parameters](#) for more information.

## 3.3 Global URL Parameters

 All URL parameters are optional.

Parameter	Valid Values	Description
api-version	Integer	Requests a specific API version
pretty	<i>true</i>	Controls pretty printing of output
fields	Comma-Separated String	Includes only specified fields in output
exclude-fields	Comma-Separated String	Excludes specified fields from output
max	Integer	The maximum number of items to return
offset	Integer	The index of the first item to return

## API Version (api-version)

See [Requesting Specific API Versions](#) for information on this parameter and how it should be used.

## Pretty (pretty)

By default, the output is easy for a machine to read but difficult for humans to read. The *pretty* parameter formats the output so that it is easier to read.

## Field Selection (fields)

The *fields* parameter will include **only** the specified fields in the output. For list queries, the field selection acts on the objects in *results* and not on the *totalCount* or *results* properties themselves.

The format of the *fields* parameter is a comma-separated list of properties that should be included, as in `id, state`. Using periods, sub-objects may also be specified, and fields of these objects may be included as well. This is done with the same syntax for both single sub-objects and lists of sub-objects, as in `id, requirements.requiredNodeCountMinimum, blockReason.message`.

## Example for a job query

### Request

```
GET /rest/jobs?api-version=2&fields=name,flags,requirements.taskCount,dates.createdDate
```

### Response

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "dates": { "createdDate": "2012-10-17 01:11:54 UTC" },
    "flags": [ "GLOBALQUEUE" ],
    "name": "Moab.24",
    "requirements": [ { "taskCount": 1 } ]
  } ]
}
```

## Field Exclusion (exclude-fields)

The *exclude-fields* parameter is the opposite of the *fields* parameter. All fields will be included in the output **except** those that are specified. For list queries, the field exclusion acts on the objects in *results* and not on the *totalCount* or *results* properties themselves.

The format of the *exclude-fields* parameter is a comma-separated list of properties that should be excluded from the output, as in `id, state`. Using periods, sub-objects may also be specified, and fields of these objects may be excluded as well. This is done with the same syntax for both single sub-objects and lists of sub-objects, as in `id, requirements.requiredNodeCountMinimum, blockReason.message`.

## Example

Suppose a query returns the following JSON:

### Request with No Field Exclusion

```
GET /objects
```

### Response

```
{
  "id": "1",
  "listOfStrings": [
    "string1",
    "string2"
  ],
  "listOfObjects": [ {
    "item1": "value1",
    "item2": "value2"
  } ],
  "singleObject": {
    "id": "obj1",
    "field1": "value1"
  }
}
```

The same query with *exclude-fields* would return the following output:

### Request with Field Exclusion

```
GET /objects?exclude-fields=id,listOfObjects.item2,singleObject.field1,listOfStrings
```

### Response

```
{
  "listOfObjects": [{"item1": "value1"}],
  "singleObject": {"id": "obj1"}
}
```

## Sorting (sort)

[Services](#), [Service Templates](#), [Images](#), and [Events](#) support sorting based on [MongoDB syntax](#) by using the *sort* parameter. To sort in ascending order, specify a 1 for the sorting field. To sort in descending order, specify a -1. Objects can also be sorted on nested fields by using dot notation to separate the sub-fields, such as `field.subfield1.subfield2`.

## Examples

To sort services in ascending order by account:

```
http://localhost/mws/rest/services?sort={"account":1}
```

To sort services in descending order by account:

```
http://localhost/mws/rest/services?sort={"account":-1}
```

To sort services in descending order by processors:

```
http://localhost/mws/rest/services?sort={"attributes.moab.job.resources.procs":-1}
```

To sort service templates in ascending order by name:

```
http://localhost/mws/rest/service-templates?sort={"name":1}
```

To sort service templates in descending order by name:

```
http://localhost/mws/rest/service-templates?sort={"name":-1}
```

To sort service templates in ascending order by the nested field template:

```
http://localhost/mws/rest/service-templates?sort={"attributes.moab.job.template":1}
```

### 3.4 Requesting Specific API Versions

Because of significant changes in the API introduced in 7.2, MWS possesses a versioned API. The `api-version` URL parameter may be used to change the requested API version for any call to MWS. The current valid API versions with their corresponding MWS versions are shown in the table below:

API Version	MWS Version	Documentation
1	7.0 and 7.1	<a href="#">MWS 7.1.1 Documentation</a>
2	7.2	Contained within this document
latest	Latest	Contained within this document

Additionally, several points should be noted:

- If no API version is requested, it will default to version 1.
- The [Resources](#) documentation contains information for the latest API version. For documentation of previous API versions, please see the table above.
- When the `latest` API version is requested, it resolves to the latest API version of MWS, such as 2 for MWS 7.2.

### Examples

```
GET http://localhost:8080/mws/rest/nodes
// Data returned uses API version 1

GET http://localhost:8080/mws/rest/nodes?api-version=1
// Data returned uses API version 1

GET http://localhost:8080/mws/rest/nodes?api-version=2
// Data returned uses API version 2

GET http://localhost:8080/mws/rest/nodes?api-version=latest
// Data returned uses API version 2
```

## 3.5 Responses and Return Codes

Various HTTP responses and return codes are generated from MWS operations. These are documented below according to the operation that they are associated with.

### Listing and Showing Resources

For any successful list or show operation (GET), a 200 OK response code is always returned. No additional headers beyond those typical of a HTTP response are given in the response.

The body of this response consists of the results of the list or show operation. For a list operation, the results are wrapped in metadata giving total and result counts. The result count represents the number of resource records returned in the current request, and the total count represents the number of all records available. These differ when querying or the `max` and `offset` parameters are used. The following is an example of a list operation response:

#### JSON List Response Body

```
{
  "resultCount":1,
  "totalCount":5,
  "results":[
    {
      "id":"Moab.1",
      ...
    }
  ]
}
```

For a show operation, the result is given as a single object:

#### JSON Show Response Body

```
{
  "id":"Moab.1",
  ...
}
```

### Creating Resources

A successful creation (POST) of a resource has two potential response codes:

- If the resource was created immediately, a 201 Created response code is returned.
- If the resource is still being created, a 202 Accepted response code is returned.

In either case, a `Location` header is added to the response with the full URL which can be used to get more information about the newly created resource or the task associated with creating the resource (if a 202 is returned).

Additionally, the body of the response will contain the unique identifier of the newly created resource or the unique identifier for the task associated with creating the resource (if a 202 is returned).

For example, during creation or submission of a job, a 201 response code is returned with the following response headers and body:

#### Job Creation Response Headers

```
HTTP/1.1 201 Created
Server: Apache-Coyote/1.1
Location: /mws/rest/jobs/Moab.21
X-Moab-Status: Success
X-Moab-Code: 000
Content-Type: application/json;charset=utf-8
Content-Length: 16
Date: Wed, 21 Dec 2011 23:04:47 GMT
```

#### Job Creation Response Body

```
{ "id": "Moab.21" }
```

For another resource that is not immediately created, such as virtual machines, the response headers and body are shown below. In this case, a job is submitted to track the progress of the VM creation. This job contains information pertaining to the VM that is being created.

#### VM Creation Response Headers

```
HTTP/1.1 202 Accepted
Server: Apache-Coyote/1.1
Location: /mws/rest/jobs/vmcreate-1
X-Moab-Status: Success
X-Moab-Code: 000
Content-Type: application/json;charset=utf-8
Content-Length: 23
Date: Wed, 21 Dec 2011 23:12:50 GMT
```

#### VM Creation Response Body

```
{ "jobId": "vmcreate-1" }
```

As can be seen, the body of the response contains only a job ID and not the ID of the virtual machine.

## Modifying Resources

For any successful resource modification operation (PUT), a 200 OK or 202 Accepted response code is returned. A 200 response code signifies that the modification was immediately completed. No additional headers are returned in this case. A 202 response code is used again to signify that the modification is not yet complete and additional actions are taking place. In this case, a Location header is also returned with the full URL of the resource describing the additional actions.

In the case of a 200 response code, the body of this response typically consists of an object with a single messages property containing a list of statuses or results of the modification(s). However, a few exceptions to this rule exist as documented in the [Resources](#) section. In the case of a 202 response code, the format is the same as for a 202 during a creation operation, in that the body consists of an object with the unique identifier for the task associated with the additional action(s).

For example, when modifying a job, several messages may be returned as follows with the associated 200 response code.

#### Job Modification Response Headers

```
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
X-Moab-Status: Success
X-Moab-Code: 000
X-Moab-Message:
Content-Type: application/json;charset=utf-8
Content-Length: ...
Date: Thu, 22 Dec 2011 16:49:43 GMT
```

#### JSON Modify Response Body

```
{
  "messages": [
    "gevent processed",
    "variables successfully modified"
  ]
}
```

When modifying a virtual machine, however, the action sometimes does not occur immediately, such as when migrating the VM to another hypervisor as described in the [VM documentation](#). In this case, the headers and response body are as follows:

#### VM Modification Response Headers

```
HTTP/1.1 202 Accepted
Server: Apache-Coyote/1.1
Location: /mws/rest/jobs/vmmigrate-1
X-Moab-Status: Success
X-Moab-Code: 000
Content-Type: application/json;charset=utf-8
Content-Length: 22
Date: Wed, 21 Dec 2011 23:12:50 GMT
```

#### VM Modification Response Body

```
{ "jobId": "vmmigrate-1" }
```

## Deleting Resources

For any successful resource deletion operation (DELETE), a 200 OK or 202 Accepted response code is returned. A 200 response code signifies that the deletion was immediately completed. No additional headers are returned in this case. A 202 response code is used again to signify that the deletion is not yet complete and additional actions are taking place. In this case, a Location header is also returned with the full URL of the resource describing the additional actions.

In the case of a 200 response code, the body of this response is empty. In the case of a 202 response code, the format is the same as for a 202 during a creation operation, in that the body consists of an object with the unique identifier for the task associated with the additional action(s).

For example, when deleting a job, a 200 response code is returned with an empty body as shown below.

#### Job Deletion Response

```
HTTP/1.1 200 OK
Server: Apache-Coyote/1.1
X-Moab-Status: Success
X-Moab-Code: 000
X-Moab-Message:
Content-Type: application/json;charset=utf-8
Content-Length: 0
Date: Thu, 22 Dec 2011 16:49:43 GMT
```

When deleting a virtual machine, however, the action does not occur immediately. In this case, the headers and response body are as follows:

#### VM Deletion Response Headers

```
HTTP/1.1 202 Accepted
Server: Apache-Coyote/1.1
Location: /mws/rest/jobs/vmdestroy-1
X-Moab-Status: Success
X-Moab-Code: 000
Content-Type: application/json;charset=utf-8
Content-Length: 22
Date: Wed, 21 Dec 2011 23:12:50 GMT
```

#### VM Deletion Response Body

```
{ "jobId": "vmdestroy-1" }
```

## Moab Response Headers

In addition to the typical HTTP headers and the Location header described above, several headers are returned if the operations directly interact with Moab. These headers are described in the following table:

Name	Description
X-Moab-Status	One of <code>Success</code> , <code>Warning</code> , or <code>Failure</code> . Describes the overall status of the Moab request.
X-Moab-Code	A three digit code specifying the exact error encountered, used only in debugging.
X-Moab-Message	An optional message returned by Moab during the request.

## 3.6 Error Messages

Below is an explanation of what error message format to expect when an HTTP status code other than 20x is returned. All error codes have a response code of 400 or greater.

### 400 Bad Request

This response code is returned when the request itself is at fault, such as when trying to modify a resource with an empty PUT request body or when trying to create a new resource with invalid parameters. The response body is as follows:

```
{
  "messages": [
    "Message describing error",
    "Possible prompt to take action"
  ]
}
```

### 401 Unauthorized

This response code is returned when authentication credentials are not supplied or are invalid. The response body is as follows:

```
{
  "messages": [
    "You must be authenticated to access this area"
  ]
}
```

### 403 Forbidden

This response code is returned when the credentials supplied are valid, but the permissions granted are insufficient for the operation. This occurs when using [Application Accounts](#) with limited access.

```
{
  "messages": [
    "You are not authorized to access this area"
  ]
}
```

## 404 Not Found

This response code is returned when the request specifies a resource that does not exist. The response body is as follows:

```
{
  "messages": [
    "The resource with id 'uniqueId' was not found"
  ]
}
```

## 405 Method Not Allowed

This response code is returned when a resource does not support the specified HTTP method as an operation. The response body is as follows:

```
{
  "messages": [
    "The specified HTTP method is not allowed for the requested resource"
  ]
}
```

## 500 Internal Server Error

This indicates that there was an internal server error while performing the request, or that an operation failed in an unexpected manner. These are the most serious errors returned by MWS. If additional information is needed, the MWS log may contain further error data. The response body is as follows:

```
{
  "messages": [
    "A problem occurred while processing the request",
    "A message describing the error"
  ]
}
```

## 3.7 Pre and Post-Processing Hooks

MWS provides functionality to intercept and modify data sent to and returned from web services for all available resources. This is done by creating hooks in Groovy files located in a sub-directory of the MWS\_HOME directory (/opt/mws/hooks by default).



The full reference for available hooks and methods available to them can be found on the [Hooks](#) page in the reference guide.

## Configuring Hooks

The directory of the hooks folder may be changed by providing a value for `mws.hooks.location` in the configuration file. If the directory starts with a path separator (ie `/path/to/hooks`), it will be treated as an absolute path. Otherwise, it will be used relative to the location of the [MWS home directory](#).

For example, if the MWS home directory is set to `/opt/mws`, the hooks directory by default would be in `/opt/mws/hooks`. Changing the `mws.hooks.location` property to `myhooks` would result in the hooks directory being located at `/opt/mws/myhooks`. Due to the default location of the MWS home directory, the default directory of the hooks directory is `/opt/mws/hooks`.

On startup, if the hooks directory does not exist, it will be created with a simple `README.txt` file with instructions on how to create hooks, the objects available, and the hooks available. If the folder or file is unable to be created, a message will be printed on the log with the full location of a `README` file, copied into a temporary directory.

## Defining Hooks for a Resource

Hooks are defined for resources by creating groovy class files in the hooks directory (`MWS_HOME/hooks` by default). Each groovy file must be named by the resource URL it is associated with and end in `.groovy`. The following table shows some possible hook files that may be created. Notice that the virtual machines hook file is abbreviated as `vms`, just as the URL for virtual machines is `/rest/vms`. In all cases, the hook file names will match the URLs.

Resource	Hook Filename
Jobs	<code>jobs.groovy</code>
Nodes	<code>nodes.groovy</code>
Virtual Machines	<code>vms.groovy</code>
Pending Actions	<code>pending-actions.groovy</code>
<i>url</i>	<i><code>url.groovy</code></i>

A complete example of a hook file is as follows:

## Complete Hook File

```
// Example before hook
def beforeList = {
    // Perform actions here
    // Return true to allow the API call to execute normally
    return true
}

def beforeShow = {
    // Perform actions here
    // Render messages to the user with a 405 Method Not Allowed
    // HTTP response code
    renderMessages("Custom message here", 405)
    // Return false to stop normal execution of the API call
    return false
}

// Example after hook
def afterList = { o ->
    if (!isSuccess()) {
        // Handle error here
        return false
    }
    // Perform actions here
    return o
}
```

As the specific format for the hooks for `before` and `after` are different, each will be explained separately.

### Before Hooks

As shown above, `before` hooks require no arguments. They can directly act on several properties, objects, and methods as described in the [Hooks](#) reference guide. The return value is one of the most important aspects of a `before` hook. If it is `false`, a `renderMessages`, `renderObject`, `renderList`, `render`, or `redirect` method **must** first be called. This signifies that the API call should be interrupted and the render or redirect action specified within the hook is to be completed immediately.

A return value of `true` signifies that the API call should continue normally. Parameters, session variables, request and response variables may all be modified within a `before` hook.

 If no return value is explicitly given, the result of the last statement in the `before` hook to be executed will be returned. This may cause unexpected behavior if the last statement resolves to `false`.

For all methods available to `before` hooks as well as specific examples, see the [Hooks](#) page in the reference guide.

### After Hooks

`After` hooks are always passed one argument: the object or list that is to be rendered as JSON. This may be modified as desired, but note that the object or list value is either a [JSONArray](#) or [JSONObject](#). Therefore, it may not be accessed and modified as a typical groovy Map.

Unlike `before` hooks, `after` hooks should not call the `render*` methods directly. This method will automatically be called on the resulting object or list returned. The `redirect` and `render` methods should also not be called at this point. Instead, if a custom object or list is desired to be used, the `serializeObject` and `serializeList` methods are available to create suitable results to return.

The return value of an `after` hook may be one of two possibilities:

1. The potentially modified object or list passed as the first argument to the hook. In this case, this value will override the output object or list unless it is null.
2. Null or false. In this case, the original, unmodified object or list will be used in the output.



The return value of the `after` hook, if not null or false, **must** be the modified object passed into the hook or an object or list created with the `serialize*` methods.

For all methods available to `after` hooks as well as specific examples, see the [Hooks](#) page in the reference guide.

## Error Handling

`After` hooks, unlike the `before` hooks, have the possibility of handling errors encountered during the course of the request. Handling errors is as simple as adding a one-line check to the hook as shown above or in the following code:

```
if (!isSuccess()) {  
    // Handle error  
    return false  
}
```

It is recommended that each `after` hook contain at least these lines of code to prevent confusion on what the input object or list represents or should look like.

The `isSuccess()` function is false if and only if the HTTP response code is 400 or higher, such as a 404 Not Found, 400 Bad Request, or 500 Internal Server Error and the cause of the error state was not in the associated `before` hook. In other words, objects and lists rendered in the `before` hook with any HTTP response code will never run the associated `after` hook.

When handling errors, the passed in object will always contain a `messages` property containing a list of Strings describing the error(s) encountered.

## Defining Common Hooks

Sometimes it is beneficial to create hooks which are executed for all calls of a certain type, such as a `beforeList` hook that is executed during the course of listing any resource. These are possible using an `all.groovy` file. The format of this file is exactly the same as other hook files. The order of execution is as follows:

1. Before common hook executed
2. Before resource-specific hook executed
3. Normal API call executed
4. After resource-specific hook executed
5. After common hook executed

## 3.8 Authentication

MWS uses Basic Authentication for all REST API requests. This means that a username and password must be provided for each call to resources. There are two types of accounts that can be granted access: **Users** and **Applications**.

- For instructions on how to set the credentials for the default **User** account, see the "Client Connections to MWS" section in [Security](#).
- For instructions on how to manage **Application** accounts, see [Application Accounts](#).

To use Basic Authentication, each client request must contain a header that looks like this:

```
Authorization: Basic YWRhcHRpdmU6YzNVU3R1bkU=
```

The string after the word `Basic` is the base64 encoding of `username : password`. In the example above, `YWRhcHRpdmU6YzNVU3R1bkU=` is the base64 encoding of `adaptive:c3UStunE`. See section 2 of [RFC 2617](#) for more details.



The username and password in the Basic Authentication header are encoded but not encrypted. Therefore, it is **strongly** recommended that MWS be run behind a proxy (like Apache) with SSL enabled. See the section "Encrypting Client Connections using Apache and SSL" under [Security](#).

## 4 Resources

The sections below show the MWS resources and the HTTP methods defined on them. The prefix for these resources depends on how the `mws.war` file is deployed. A typical prefix would be `http://localhost:8080/mws`. Using this example, one absolute resource URI would be `http://localhost:8080/mws/rest/jobs`.

 This section only contains documentation for the latest API version. Please see the table in the [Requesting Specific API Versions](#) section for links to documentation for previous versions.

### 4.1 Access Control Lists

This section describes behavior of the **ACL Rules** (Access Control List Rules) object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [ACL API](#) contains the type and description of all fields in the **ACL Rules** object. It also contains details regarding which fields are valid during PUT and POST actions.

### Supported Methods

 ACLs are not directly manipulated through a single URL, but with sub-URLs of the other objects such as Virtual Containers and Reservations.

Resource	GET	PUT	POST	DELETE
<code>/rest/reservations/rsvId/acl-rules/aclId</code>		<a href="#">Create or Update ACLs</a>		<a href="#">Delete ACL</a>
<code>/rest/vcs/vcId/acl-rules/aclId</code>		<a href="#">Create or Update ACLs</a>		<a href="#">Delete ACL</a>

#### 4.1.1 Getting ACLs

Although **ACL Rules** cannot be retrieved directly using the GET method on any of the `acl-rules` resources, **ACL Rules** are attached to supported objects when querying for them. Each supported object contains a field named `aclRules`, which is a collection of the **ACL Rules** defined on that object.

### Supported Objects

The following is a list of objects that will return **ACL Rules** when queried:

- [Reservations](#)
- [Standing Reservations](#)
- [Virtual Containers](#)

## 4.1.2 Creating or Updating ACLs

The HTTP PUT method is used to create or update **ACL Rules**. The request body can contain one or more **ACL Rules**. If an **ACL Rule** with the same type and value exists, then it will be overwritten.

### Quick Reference

```
PUT http://localhost/mws/rest/reservations/<rsvId>/acl-rules
PUT http://localhost/mws/rest/vcs/<vcId>/acl-rules
```

### 4.1.2.1 Create or Update ACL

#### URLs and Parameters

```
PUT http://localhost/mws/rest/reservations/<objectId>/acl-rules
PUT http://localhost/mws/rest/vcs/<objectId>/acl-rules
```

Parameter	Required	Type	Valid Values	Description
objectId	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

#### Request Body

The request body below shows all the fields that are available for the PUT method, along with some sample values.

##### JSON Request Body

```
{
  "aclRules": [
    {
      "affinity": "POSITIVE",
      "comparator": "LEXIGRAPHIC_EQUAL",
      "type": "USER",
      "value": "ted"
    }
  ]
}
```

#### Sample Response



This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

## JSON Response

```
{"messages":["Virtual container 'vc1' successfully modified"]}
```

## Samples

Create or update multiple ACLs on a single object:

PUT `http://localhost/mws/rest/reservations/system.21/acl-rules`

```
{ "aclRules": [
  {
    "affinity": "POSITIVE",
    "comparator": "LESS_THAN_OR_EQUAL",
    "type": "DURATION",
    "value": "3600"
  },
  {
    "affinity": "POSITIVE",
    "comparator": "LEXIGRAPHIC_EQUAL",
    "type": "USER",
    "value": "ted"
  }
]}
```

## Restrictions

- **ACL Rules** cannot be added to or updated on **Standing Reservations**.
- The **affinity** and **comparator** fields are ignored for **Virtual Containers**.

### 4.1.3 Deleting ACLs

The HTTP DELETE method is used to remove **ACL Rules**.

## Quick Reference



**ACL Rules** cannot be removed from **Standing Reservations**.

```
DELETE http://localhost/mws/rest/reservations/<rsvId>/acl-rules/<aclId>
DELETE http://localhost/mws/rest/vcs/<vcId>/acl-rules/<aclId>
```

#### 4.1.3.1 Delete ACL

### URLs and Parameters

```
DELETE http://localhost/mws/rest/reservations/<objectId>/acl-rules/<aclId>
DELETE http://localhost/mws/rest/vcs/<objectId>/acl-rules/<aclId>
```

Parameter	Required	Type	Valid Values	Description
objectId	Yes	String	-	The unique identifier of the object from which to remove the <b>ACL Rule</b> .
aclId	Yes	String	-	A string representing the <b>ACL Rule</b> , with the format <code>type:value</code> .

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

 This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

### JSON Response

```
{"messages":["Successfully modified virtual container 'vc1'"]}
```

## Restrictions

- **ACL Rules** cannot be removed from **Standing Reservations**.

## 4.2 Accounts

This section describes behavior of the **Accounts** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 This resource refers to Moab Accounting Manager accounts, not Moab Workload Manager accounts.

 The [Account API](#) contains the type and description of fields that all **Accounts** have in common.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/accounts	<a href="#">Get all accounts</a>			
/rest/accounts/ <b>id</b>	<a href="#">Get specified account</a>			

## 4.2.1 Getting Accounts

The HTTP GET method is used to retrieve **Accounts** information.

### Quick Reference

```
GET http://localhost/mws/rest/accounts
```

#### 4.2.1.1 Get All Accounts

##### URLs and Parameters

```
GET http://localhost/mws/rest/accounts?proxy-user=<USER>
[&custom-fields=Department][&query={"deleted":false}][&sort={"requestId":-1}]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
custom-fields	No	Comma-Separated String	Includes custom MAM account attributes.	custom-fields=Department
query	No	JSON	Query for specific results.	query={"deleted":false}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"requestId":-1}



The `query` parameter does not support the full Mongo query syntax. Only querying for a simple, non-nested JSON object is allowed.

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

GET http://localhost/mws/rest/accounts?proxy-user=amy&fields=name,description

```
{
  "totalCount": 2,
  "resultCount": 2,
  "results": [
    {
      "id": "biology",
      "description": "Biology Dept."
    },
    {
      "id": "chemistry",
      "description": "Chemistry Dept."
    }
  ]
}
```

## 4.2.1.2 Get Single Account

### URLs and Parameters

GET http://localhost/mws/rest/accounts/<id>

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

### Sample Responses

GET http://localhost/mws/rest/accounts/chemistry?proxy-user=amy

```
{
  "id": "chemistry",
  "active": true,
  "organization": "",
  "description": "Chemistry Dept",
  "creationTime": "2012-04-11 06:56:11 UTC",
  "modificationTime": "2012-04-11 06:56:11 UTC",
  "deleted": false,
  "requestId": 94,
  "transactionId": 283,
  "users": [
    {
      "id": "amy",
      "active": true,
      "admin": false
    },
    {
      "id": "bob",
      "active": true,
      "admin": false
    },
    {
      "id": "dave",
      "active": true,
      "admin": false
    }
  ]
}
```

## 4.3 Credentials

This section describes behavior of the **Credential** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The Credential API is new with **API version 2**. The supported methods table below requires each resource to be accessed with a URL parameter of `api-version=2`.

See [Requesting Specific API Versions](#) for more information.

 The [Credential API](#) contains the type and description of all fields in the **Credential** object.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/credentials/accounts	<a href="#">Get all account credentials</a>	
/rest/credentials/classes	<a href="#">Get all class credentials</a>	
/rest/credentials/groups	<a href="#">Get all group credentials</a>	
/rest/credentials/qoses	<a href="#">Get all QoS credentials</a>	
/rest/credentials/users	<a href="#">Get all user credentials</a>	

### 4.3.1 Getting Credentials

The HTTP GET method is used to retrieve **Resource Type** information.

#### Quick Reference

```
GET http://localhost/mws/rest/credentials/accounts
GET http://localhost/mws/rest/credentials/classes
GET http://localhost/mws/rest/credentials/groups
GET http://localhost/mws/rest/credentials/qoses
GET http://localhost/mws/rest/credentials/users
```

#### 4.3.1.1 Get All Account Credentials

##### URLs and Parameters

```
GET http://localhost/mws/rest/credentials/accounts
```

See [Global URL Parameters](#) for available URL parameters.

##### Sample Response

```
GET http://localhost/mws/rest/credentials/accounts?fields=name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    { "name": "account1" }
  ]
}
```

### 4.3.1.2 Get All Class Credentials

#### URLs and Parameters

```
GET http://localhost/mws/rest/credentials/classes
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/credentials/classes?fields=name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    { "name": "class1" }
  ]
}
```

### 4.3.1.3 Get All Group Credentials

#### URLs and Parameters

```
GET http://localhost/mws/rest/credentials/groups
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/credentials/groups?fields=name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    { "name": "group1" }
  ]
}
```

### 4.3.1.4 Get All QoS Credentials

#### URLs and Parameters

```
GET http://localhost/mws/rest/credentials/qoses
```

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```
GET http://localhost/mws/rest/credentials/qoses?fields=name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    { "name": "qos1" }
  ]
}
```

### 4.3.1.5 Get All User Credentials

#### URLs and Parameters

```
GET http://localhost/mws/rest/credentials/users
```

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```
GET http://localhost/mws/rest/credentials/users?fields=name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    { "name": "user1" }
  ]
}
```

## 4.4 Diagnostics

This section describes additional REST calls that are available for performing diagnostics on Moab Web Services.

### Supported Methods

Resource	GET	PUT POST DELETE
/rest/diag/about	<a href="#">Get version information</a>	
/rest/diag/auth	<a href="#">Diagnose authentication</a>	
/rest/diag/health/summary	<a href="#">Get health information summary</a>	
/rest/diag/health/detail	<a href="#">Get health information detail</a>	
/rest/diag/ldap	<a href="#">Get LDAP connection information</a>	

## 4.4.1 Version and Build Information

The HTTP GET method is used to retrieve version and build information.

### Quick Reference

```
GET http://localhost/mws/rest/diag/about
```

### URLs and Parameters

```
GET http://localhost/mws/rest/diag/about
```

### Sample Response

The response contains the application version, build number, build date, and revision.

```
{
  "suite": "Cloud",
  "pluginCommonsVersion": "0.9.3",
  "version": "7.1",
  "build": "100",
  "buildDate": "2012-01-01_16-00-00",
  "revision": "1000"
}
```

## 4.4.2 Diagnose Authentication

The HTTP GET method is used to test for proper authentication. This resource is designed to be used as a simple validation of credentials and gives no output besides the response code.

### Quick Reference

```
GET http://localhost/mws/rest/diag/auth
```

### URLs and Parameters

```
GET http://localhost/mws/rest/diag/auth
```

## Sample Response



A successful result is indicated by the 200 response code while a failure is indicated by a 401 response code.

```
{}
```

## 4.4.3 Connection Health Information

The HTTP GET method is used to retrieve health or status information for connections to external systems or software. There are two available resources for health, one that returns simple summary information and another that returns detailed information.

### Quick Reference

```
GET http://localhost/mws/rest/diag/health  
GET http://localhost/mws/rest/diag/health/detail
```

### 4.4.3.1 Get Health Summary

#### URLs and Parameters

```
GET http://localhost/mws/rest/diag/health/summary
```



If the MongoDB connection is down, authenticated resources are not available. While this resource does not possess much detail beyond that of simple connection information, it is still useful as it does not require authentication and therefore can be used to determine connection problems with MongoDB.

## Sample Response

The response contains the connection health for Moab Workload Manager (MWM), Moab Accounting Manager (MAM), and MongoDB. A `true` response value indicates that the connection is healthy and available, and a `false` response indicates that the connection is currently down. Likewise, the `mongoConnected` property for MWM signifies the state of the MWM to MongoDB connection. The possible values of this state are `UP`, `DOWN`, `NOT_CONFIGURED` when the MongoDB server is not configured in MWM, `NOT_SUPPORTED` when MWM is not compiled with MongoDB support, and `UNKNOWN` when MWS cannot communicate with MWM.

```
{
  "mam": {
    "connected": true
  },
  "mongo": {
    "connected": false
  },
  "mwm": {
    "connected": true,
    "mongoConnected": "UP"
  }
}
```

### 4.4.3.2 Get Health Detail

#### URLs and Parameters

```
GET http://localhost/mws/rest/diag/health/detail
```



If the MongoDB connection is down, authenticated resources such as this are not available. In this case, using the [Get Health Summary](#) instead may be required.

#### Sample Response

The response contains the connection health and information for Moab Workload Manager (MWM), Moab Accounting Manager (MAM), and MongoDB. A `"connected": true` response value indicates that the connection is healthy and available, and a `false` response indicates that the connection is currently down. Likewise, the `mongoConnected` property for MWM signifies the state of the MWM to MongoDB connection. The possible values of this state are `UP`, `DOWN`, `NOT_CONFIGURED` when the MongoDB server is not configured in MWM, `NOT_SUPPORTED` when MWM is not compiled with MongoDB support, and `UNKNOWN` when MWS cannot communicate with MWM. A message is also present for all down connections except MWM to MongoDB giving a reason for the error state.

```

{
  "mam": {
    "connected": false,
    "host": "localhost",
    "message": "There was an error connecting to MAM at 'localhost', the secret key
does not match.",
    "port": 7112,
    "version": null
  },
  "mongo": {
    "connected": true,
    "databaseName": "mws",
    "host": "127.0.0.1",
    "message": null,
    "port": 27017,
    "replicaSet": null,
    "username": "mws",
    "version": "2.0.1"
  },
  "mwm": {
    "connected": true,
    "host": "localhost",
    "message": null,
    "port": 42559,
    "licensedFeatures": ["vm", "provision"],
    "state": "RUNNING",
    "mongoConnected": "DOWN",
    "mongoCredentialsSet": false,
    "mongoHost": "localhost",
    "mongoPort": 27017,
    "version": "7.2"
  }
}

```

#### 4.4.4 LDAP Information

The HTTP GET method is used to retrieve LDAP information.

#### Quick Reference

```
GET http://localhost/mws/rest/diag/ldap
```

#### URLs and Parameters

```
GET http://localhost/mws/rest/diag/ldap
```

#### Sample Response

```

{
  "server": "openldapsambaserver",
  "port": 389,
  "securityType": "SSL",
  "baseDNs": ["dc=testldap,dc=ac"],
  "bindUser": "cn=admin,dc=testldap,dc=ac",
  "userObjectClass": "posixAccount",
  "userNameAttribute": "uid"
}

```

### 4.5 Events

This section describes the URLs, request bodies, and responses delivered to and from Moab Web Services for handling events

 The [Event API](#) contains the type and description of all fields in the **Event** object. It also contains details regarding which fields are valid during POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/events	<a href="#">Get all events</a>		<a href="#">Create event</a>	
/rest/events/ <b>id</b>	<a href="#">Get specified event</a>			

## Configuration

Logging events to a flat file requires that you make a few changes to the configuration in the log4j section of the mws-config.groovy file so that events will be logged to the events.log file, and all other Moab Web Services logging information will be sent to the mws.log file.

### Causing events.log to Roll Based on a Time Window

You can specify how often the events.log file rolls. The following example illustrates the configuration changes you will need make to mws-config.groovy to cause the events.log file to roll based on a time window. (In this example, mws-config.groovy is configured so that events.log rolls daily at midnight.)

#### Daily rolling events.log configuration in mws-config.groovy

```
log4j = {
  def eventAppender = new org.apache.log4j.rolling.RollingFileAppender(name: 'events',
  layout: pattern(conversionPattern: "%m%n"))
  def rollingPolicy = new
org.apache.log4j.rolling.TimeBasedRollingPolicy(fileNamePattern:
'/tmp/events.%d{yyyy-MM-dd}', activeFileName: '/tmp/events.log')
  rollingPolicy.activateOptions()
  eventAppender.setRollingPolicy(rollingPolicy)

  appenders {
    appender eventAppender

    rollingFile name: 'rootLog',
      file: '/tmp/mws.log',
      maxFileSize: '1GB'
  }

  root {
    warn 'rootLog'
  }

  trace additivity: false, events: 'com.ace.mws.events.EventFlatFileWriter'
}
```

Note the **RollingFileAppender** and the **TimeBasedRollingPolicy** lines. These lines configure Moab Web Services to write the event log to the events.log file.

Rolled log files will have a date appended to their name in this format: 'yyyy-MM-dd' (for example, events.log.2012-02-28).

If you want the event log file to roll at the beginning of each month, change the **TimeBasedRollingPolicy** "fileNamePattern" date format to 'yyyy-MM'. For example:

#### Monthly event logs

```
def rollingPolicy = new
org.apache.log4j.rolling.TimeBasedRollingPolicy(fileNamePattern:
'/tmp/events.%d{yyyy-MM}', activeFileName: '/tmp/events.log')
```

If you want the event log file to roll at the beginning of each hour, change the date format to 'yyyy-MM-dd\_HH:00'. For example:

#### Hourly event logs

```
def rollingPolicy = new
org.apache.log4j.rolling.TimeBasedRollingPolicy(fileNamePattern:
'/tmp/events.%d{yyyy-MM-dd_HH:00}', activeFileName: '/tmp/events.log')
```

## Configuring events.log to Roll Based on File Size Threshold

You can also configure the events.log file to roll when the log size exceeds a specified threshold. The following example illustrates the configuration changes you will need to make to mws-config.groovy to cause the events.log file to roll on a size threshold. (In this example, mws-config.groovy is configured so that events.log rolls when its size exceeds 50 MB.)

#### mws-config.groovy configuration that rolls events.log based on file size

```
log4j = {
  appenders {
    rollingFile name: 'events',
      file: '/tmp/events.log',
      maxFileSize: '50MB',
      maxBackupIndex: 10

    rollingFile name: 'rootLog',
      file: '/tmp/mws.log',
      maxFileSize: '1GB'
  }
  root {
    warn 'rootLog'
  }

  trace additivity: false, events: 'com.ace.mws.events.EventFlatFileWriter'
}
```

Note that **maxFileSize** is set to '50MB'. This means that when the events.log file exceeds 50 MB, it will roll.

The name for the rolled log will be "events.log.1". When the new events.log file exceeds 50 MB, it will roll and be named "events.log.1", while the old "events.log.1" file will be renamed "events.log.2". This process will continue until the optional **maxBackupIndex** value is met. In the example above, **maxBackupIndex** is set to 10. This means that Moab Web Services will delete all but the ten most recent events.log files. Using this feature helps prevent hard drives from filling up.

## Additivity

The **additivity** attribute of the EventFlatFileWriter logger can be either "true" or "false". If you specify "true", events will be logged to the events.log file and the mws.log file. If you specify "false", events will be logged to the events.log file only. (All other Moab Web Services logging information will be logged to the mws.log file, as configured by the rootLog appender.)

To log events to the mws.log file in addition to the events.log file, make this configuration: **additivity:true**. For example:

### Logging events to both events.log and mws.log

```
trace additivity:true, events:'com.ace.mws.events.EventFlatFileWriter'
```

For more configuration options, see [Apache Extras Companion for log4j](#).

## Deleting Old Events

By default, MWS will hold event data in MongoDB indefinitely. However, if disk space is limited, you may want to regularly delete old, unneeded events from MongoDB. This section contains some examples of how you can do this.

Let's say that you want to delete events that are older than 90 days. You could run this script. (There are 86,400,000 milliseconds in a day, so in this example,  $90 * 86400000$  corresponds to 90 days in milliseconds.)

### Delete events older than 90 days

```
$ mongo
MongoDB shell version: 2.0.1
connecting to: test
> use mws
> db.event.remove({eventTime:{$lt:new Date(new Date()).getTime()-90*86400000}})
> exit
```

To create a script to perform this task:

### deleteOldEvents.sh

```
#!/bin/bash
printf 'use mws_dev\ndb.event.remove({eventTime:{$lt:new Date(new
Date()).getTime()-90*86400000}})\nexit' | mongo
```

Now say that you want to set up a [cron job](#) (`crontab -e`) so that old events are automatically deleted on a certain day of the week (for example, every Sunday at 2:00 a.m.), you would add an entry like this:

### cron table entry to delete old events

```
00 02 * * 0 /root/deleteOldEvents.sh
```

## 4.5.1 Getting Events

The HTTP GET method is used to retrieve **Event** information. Queries for all objects and a single object are available.

## Quick Reference

```
GET http://localhost/mws/rest/events[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/events/<id>
```

### 4.5.1.1 Get All Events

#### URLs and Parameters

```
GET http://localhost/mws/rest/events[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Query for specific results.	query={"status":"failure"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"id":-1}

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

GET http://localhost:8080/mws/rest/events

```
{
  "totalCount":3,
  "resultCount":3,
  "results":[
    {
      "details":{
        "errorMessage":{
          "errorCode":"542",
          "message":"Cannot communicate with XCAT resource manager",
          "originator":"XCAT"
        },
        "eventCategory":"failure",
        "eventTime":"2012-01-27 15:18:32 UTC",
        "eventType":"rmfailure",
        "facility":"rm",
        "primaryObject":{
          "serialization":null,
          "type":"rm",
          "id":"xcat"
        },
        "sourceComponent":"MWM",
        "status":"failure",
        "id":"4faddab8c4aa264506f8ac3d"
      },
      "details":{
        "eventCategory":"start",
        "eventTime":"2012-01-27 15:18:31 UTC",
        "eventType":"schedcyclestart",
        "facility":"scheduler",
        "sourceComponent":"MWM",
        "status":"success",
        "id":"4faddab8c4aa264506f8ac3c"
      },
      "details":{
        "alpha":"lorem ipsum dolor sit amet",
        "bravo":"2",
        "charlie":"consectetur adipisicing elit, sed do"
      },
      "eventCategory":"start",
      "eventTime":"2012-01-27 15:18:30 UTC",
      "eventType":"jobstart",
      "facility":"job",
      "initiatedBy":{
        "proxyUser":"bob",
        "user":"tomcat6"
      },
      "primaryObject":{
        "serialization":"\n          <job JobID=\"moab.849\"
ReqAWDDuration=\"100000\" User=\"bob\" />\n          ",
        "type":"job",
        "id":"moab.849"
      },
      "relatedObjects":[
        {
          "type":"vm",
          "id":"vm56"
        },
        {
          "type":"service",
          "id":"lamp.211"
        }
      ],
      "sourceComponent":"MWM",
      "status":"success",
      "id":"4faddab8c4aa264506f8ac3b"
    }
  ]
}
```

## Querying Events

It is possible to query events by one or more fields based on [MongoDB query syntax](#). The following contains examples of simple and complex event queries and event queries by date.

## Simple Queries

To see only events that are of type "jobsubmit":

```
http://localhost/mws/rest/events?query={"eventType":"jobsubmit"}
```

To see only events of type "jobsubmit" with the status of "failure":

```
http://localhost/mws/rest/events?query={"eventType":"jobsubmit","status":"failure"}
```

To see only events with the "job" facility:

```
http://localhost/mws/rest/events?query={"facility":"job"}
```

To see only events in the "start" event category:

```
http://localhost/mws/rest/events?query={"eventCategory":"start"}
```

## More Complex Queries

You can query on embedded JSON objects within the event JSON. For example, to see events associated with proxyUser bob:

```
http://localhost/mws/rest/events?query={"initiatedBy.proxyUser":"bob"}
```

To see only events that are NOT associated with bob:

```
http://localhost/mws/rest/events?query={"initiatedBy.proxyUser":{"$ne":"bob"}}
```

When the field values of the desired events are a finite set, you can use the \$in operator. For example, to see events that relate to either alice, bob, or charlie:

```
http://localhost/mws/rest/events?query={"initiatedBy.proxyUser":{"$in":["alice","bob","charlie"]}}
```

## Querying Events by Date

To see events created before January 27, 2012 at 12:08 a.m. UTC:

```
http://localhost/mws/rest/events?query={"eventTime":{"$lt":"2012-01-27 12:08:00 UTC"}}
```

To see events created before or on January 27, 2012 at 12:08 a.m. UTC:

```
http://localhost/mws/rest/events?query={"eventTime":{"$lte":"2012-01-27 12:08:00 UTC"}}
```

To see all events created after January 27, 2012 at 12:04 a.m. UTC:

```
http://localhost/mws/rest/events?query={"eventTime":{"$gt":"2012-01-27 12:04:00 UTC"}}
```

To see all events created after or on January 27, 2012 at 12:04 a.m. UTC:

```
http://localhost/mws/rest/events?query={"eventTime":{"$gte":"2012-01-27 12:04:00 UTC"}}
```

To see events created between 12:04 a.m. and 12:08 a.m. UTC inclusive:

```
http://localhost/mws/rest/events?query={"eventTime":{"$gte":"2012-01-27 12:04:00 UTC",
"$lte":"2012-01-27 12:08:00 UTC"}}
```

To see events created between 12:04 a.m. and 12:08 a.m. UTC inclusive that are associated with proxyUser bob:

```
http://localhost/mws/rest/events?query={"initiatedBy.proxyUser":"bob", "eventTime":{"
"$gte":"2012-01-27 12:04:00 UTC", "$lte":"2012-01-27 12:08:00 UTC"}}
```

To see events created between 12:04 a.m. and 12:08 a.m. UTC inclusive, that are associated with proxyUser bob, and that are of type "jobsubmit":

```
http://localhost/mws/rest/events?query={"initiatedBy.proxyUser":"bob", "eventType":
"jobsubmit", "eventTime":{"$gte":"2012-01-27 12:04:00 UTC", "$lte":"2012-01-27 12:08:00
UTC"}}
```

## Sorting

See the sorting section of [Global URL Parameters](#)

## Limiting the Number of Results

If you want to limit the number of results of events, you can use the max parameter. For example, to see only 10 "vmmigrate" events:

```
http://localhost/mws/rest/events?query={"eventType":"vmmigrate"}&sort={"eventTime":1}&max=10
```

To see "vmcreate" events 51-60 when sorted by eventTime in descending order, you can combine max with offset, as follows:

```
http://localhost/mws/rest/events?query={"eventType":"vmcreate"}&sort={"eventTime":
:-1}&max=51&offset=60
```

## Retrieving a Subset of Fields

To cause only certain fields to return for each event, use the `fields` parameter. For example, to show only the `eventTime` field for each event:

```
http://localhost/mws/rest/events?max=3&fields=eventTime
```

This returns:

```
{
  "totalCount": 187,
  "resultCount": 3,
  "results": [
    { "eventTime": "2012-03-05 10:01:59 UTC" },
    { "eventTime": "2012-03-05 10:02:00 UTC" },
    { "eventTime": "2012-03-05 10:02:01 UTC" }
  ]
}
```

To show the name, type, and status:

```
http://localhost/mws/rest/events?fields=name,type,status
```

This returns:

```
{
  "totalCount": 187,
  "resultCount": 3,
  "results": [
    {
      "eventTime": "2012-03-05 10:01:59 UTC",
      "eventType": "jobsubmit",
      "status": "failure"
    },
    {
      "eventTime": "2012-03-05 10:02:00 UTC",
      "eventType": "jobstart",
      "status": "success"
    },
    {
      "eventTime": "2012-03-05 10:02:01 UTC",
      "eventType": "vmmigrate",
      "status": "success"
    }
  ]
}
```

### 4.5.1.2 Get Single Event

#### URLs and Parameters

```
GET http://localhost/mws/rest/events/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

### JSON Response

```
{
  "details": {
    "attribute": "walltime",
    "modifier": "increase",
    "value": "200000"
  },
  "eventCategory": "job",
  "eventTime": "2012-01-27 00:07:00 UTC",
  "eventType": "jobmodify",
  "facility": "baseline",
  "initiatedBy": {
    "proxyUser": "bob",
    "user": "viewpoint"
  },
  "primaryObject": {
    "serialization": null,
    "type": "job",
    "id": "moab.900"
  },
  "sourceComponent": "MWM",
  "status": "success",
  "id": "4fa46081c4aa5b896ac4b757"
}
```

## 4.5.2 Creating Events

The HTTP POST method is used to create an **Event**.

### Quick Reference

```
POST http://localhost/mws/rest/events
```

#### 4.5.2.1 Create Event

##### URLs and Parameters

```
POST http://localhost/mws/rest/events
```

### Request Body

Unlike most other URLs, the events URL accepts both JSON and XML. Be sure to set the Content-Type HTTP header to either `application/json` or `application/xml`.

POST http://localhost/mws/rest/events Content-Type:application/json

```
[
  {
    "eventTime":"2012-01-27 15:18:30 UTC",
    "eventType":"jobstart",
    "eventCategory":"start",
    "sourceComponent":"MWM",
    "status":"success",
    "facility":"job",
    "initiatedBy":{"
      "proxyUser":"bob",
      "user":"tomcat6"
    },
    "primaryObject":{"
      "serialization":"<job JobID=\"moab.849\" ReqAWDDuration=\"100000\" User=\"bob\"
/>",
      "type":"job",
      "id":"moab.849"
    },
    "relatedObjects":[
      {
        "type":"vm",
        "id":"vm56"
      },
      {
        "type":"service",
        "id":"lamp.211"
      }
    ],
    "details":{"
      "alpha":"lorem ipsum dolor sit amet",
      "bravo":"2",
      "charlie":"consectetur adipisicing elit, sed do"
    }
  },
  {
    "eventTime":"2012-01-27 15:18:32 UTC",
    "eventType":"rmfailure",
    "eventCategory":"failure",
    "sourceComponent":"MWM",
    "status":"failure",
    "facility":"rm",
    "primaryObject":{"
      "serialization":null,
      "type":"rm",
      "id":"xcat"
    },
    "errorMessage":{"
      "errorCode":"542",
      "message":"Cannot communicate with XCAT resource manager",
      "originator":"XCAT"
    }
  },
  {
    "eventTime":"2012-01-27 15:18:31 UTC",
    "eventType":"schedcyclestart",
    "eventCategory":"start",
    "sourceComponent":"MWM",
    "status":"success",
    "facility":"scheduler"
  }
]
```

POST http://localhost/mws/rest/events Content-Type:application/xml

```
<Events>
<Event eventTime="2012-01-27T15:18:30.000-07:00" eventType="jobstart" eventCategory=
"start" sourceComponent="MWM" status="success" facility="job">
  <InitiatedBy user="tomcat6" proxyUser="bob" />
  <PrimaryObject objectType="job" objectID="moab.849">
    <Serialization>
      <![CDATA[<job JobID="moab.849" ReqAWDDuration="100000" User="bob" />]]>
    </Serialization>
  </PrimaryObject>
  <RelatedObjects>
    <RelatedObject objectType="vm" objectID="vm56" />
    <RelatedObject objectType="service" objectID="lamp.211" />
  </RelatedObjects>
  <Details>
    <Detail name="alpha">lorem ipsum dolor sit amet</Detail>
    <Detail name="bravo">2</Detail>
    <Detail name="charlie">consectetur adipiscing elit, sed do</Detail>
  </Details>
</Event>

<Event eventTime="2012-01-27T15:18:31.000-07:00" eventType="schedcyclestart"
eventCategory="start" sourceComponent="MWM" status="success" facility="scheduler" />

<Event eventTime="2012-01-27T15:18:32.000-07:00" eventType="rmfailure" eventCategory=
"failure" sourceComponent="MWM" status="failure" facility="rm">
  <PrimaryObject objectType="rm" objectID="xcat" />
  <ErrorMessage originator="XCAT" errorCode="542">Cannot communicate with XCAT
resource manager</ErrorMessage>
</Event>

</Events>
```

## Sample Response

If the request was successful, the response will be an object with an id property containing the ID of the newly created events. On failure, the response is an error message.

### JSON Response

```
[{"id": "4fadd83bc4aa366464599e1a"}, {"id": "4fadd83bc4aa366464599e1b"}, {"id": "4fadd83bc4aa366464599e1c"}]
```

Below is an example of events.log output for a successful event request:

```
2012-01-27T15:18:30.000-07:00 type="jobstart" category="start" sourceComponent="MWM"
status="success" facility="job" initiatedBy.user="tomcat6" initiatedBy.proxyUser="bob"
primaryObject.type="job" primaryObject.id="moab.849" relatedObject.0.type="service"
relatedObject.0.id="lamp.211" relatedObject.1.type="vm" relatedObject.1.id="vm56"
detail.alpha="lorem ipsum dolor sit amet" detail.bravo="2" detail.charlie="consectetur
adipiscing elit, sed do" primaryObject.serialization="<job JobID="moab.849"
ReqAWDDuration="100000" User="bob" />"
2012-01-27T15:18:31.000-07:00 type="schedcyclestart" category="start" sourceComponent=
"MWM" status="success" facility="scheduler"
2012-01-27T15:18:32.000-07:00 type="rmfailure" category="failure" sourceComponent="MWM"
status="failure" facility="rm" primaryObject.type="rm" primaryObject.id="xcat"
error.originator="XCAT" error.code="542" error.message="Cannot communicate with XCAT
resource manager"
```



Note that " (double quote) characters in the input have been replaced by \" characters in the output. (For other character restrictions, see the "Restrictions" section below.)

## Restrictions

Special characters, such as newline, carriage return, and " (double quote) are encoded in the output of events.log to make events.log easy to parse with scripts and third party tools. For example, if the input XML contains:

```
<ErrorMessage>RM says, "Cannot provision vm21"</ErrorMessage>
```

Then the following will be output to events.log:

```
error.message="RM says, \"Cannot provision vm21\""
```

Notice that " has been replaced with \". This table contains the most common encodings.

Character	Escape Sequence
" (double quote)	\"
\ (backslash)	\\
newline	\n
carriage return	\r
tab	\t

(For more information see [escape sequences for Java Strings](#).)

Other restrictions include:

- Detail names can only contain alpha-numeric characters, colons (:), underscores (\_), and dashes (-).
- **primaryObject.serialization**, **error.message**, and **detail values** (for example detail.someName="some value") can contain any printable ASCII character. Single quotes (') and double quotes (") cannot be contained in any other field.
- A single event cannot contain more than more than 50 details. If an event has more than 50 details, the excess details will be ignored.

## 4.6 Funds

This section describes behavior of the **Fund** object and all related objects in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Fund API](#), [FundBalance API](#), [FundStatement API](#), and [FundStatementSummary API](#) contain the type and description of all fields in the **Fund** object as well as related objects and reports given in the URLs below.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/funds	<a href="#">Get all funds</a>	
/rest/funds/id	<a href="#">Get specified fund</a>	
/rest/funds/balances	<a href="#">Get all fund balances</a>	
/rest/funds/reports/statement	<a href="#">Get fund statement</a>	
/rest/funds/reports/statement/summary	<a href="#">Get fund statement summary</a>	

## 4.6.1 Getting Funds

The HTTP GET method is used to retrieve **Fund** information.

### Quick Reference

```
GET http://localhost/mws/rest/funds?proxy-user=<USER>
[&active=true][&custom-fields=health][&filter={"account"
:"chemistry"}][&filter-type=NonExclusive][&query={"priority":"2"}][&sort={"id":-1}]
GET http://localhost/mws/rest/funds/<id>?proxy-user=<USER>
[&active=true][&custom-fields=health][&filter={"account"
:"chemistry"}][&filter-type=NonExclusive]
GET http://localhost/mws/rest/funds/balances?proxy-user=<USER>
[&custom-fields=health][&filter={"account":"chemistry"}][&filter-type=NonExclusive]
GET http://localhost/mws/rest/funds/reports/statement?proxy-user=<USER>[&filter=
<FILTER>][&filter-type=<FILTER-TYPE>][&start-time=<DATE-STRING>][&end-time=
<DATE-STRING>][&context=<CONTEXT>]
GET http://localhost/mws/rest/funds/reports/statement/summary?proxy-user=<USER>
[&filter=<FILTER>][&filter-type=<FILTER-TYPE>][&start-time=<DATE-STRING>][&end-time=
<DATE-STRING>]
```

### 4.6.1.1 Get All Funds

#### URLs and Parameters

```
GET http://localhost/mws/rest/funds?proxy-user=<USER>
[&active=true][&custom-fields=health][&filter={"account"
:"chemistry"}][&filter-type=NonExclusive][&query={"priority":"2"}][&sort={"id":-1}]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
active	No	Boolean	Lists only active or non-active allocations of the fund. The fund amount becomes the sum of the active/inactive allocations.	active=true
custom-fields	No	Comma-Separated String	Includes custom MAM fund attributes.	custom-fields=health
filter	No	JSON	Query funds based on defined MAM filter.	filter={"account":"chemistry"}
filter-type	No	String	Query funds based on defined MAM filter type.	filter-type=NonExclusive
query	No	JSON	Query for specific results.	query={"priority":"2","allocation.active":"fa
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"id":-1}



The query parameter does not support the full Mongo query syntax. Only querying for a simple, non-nested JSON object is allowed.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

GET

http://localhost/mws/rest/funds?proxy-user=amy&fields=id,name,allocations,constraints

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "id": 2,
    "name": 1204,
    "allocations": [ {
      "id": 2,
      "startTime": "-infinity",
      "endTime": "2012-02-02 09:34:42 UTC",
      "amount": 9060000,
      "creditLimit": 0,
      "deposited": 9060000,
      "active": true,
      "description": ""
    } ],
    "fundConstraints": [ {
      "id": 2,
      "name": "CostCenter",
      "value": 1204
    } ]
  } ]
}
```

## 4.6.1.2 Get Single Fund

### URLs and Parameters

```
GET http://localhost/mws/rest/funds/<id>?proxy-user=<USER>
[&active=true][&custom-fields=health][&filter={"account"
:"chemistry"}][&filter-type=NonExclusive]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
active	No	Boolean	Lists only active or non-active allocations of the fund. The fund amount becomes the sum of the active/inactive allocations.	active=true
custom-fields	No	Comma-Separated String	Includes custom MAM fund attributes.	custom-fields=health
filter	No	JSON	Query funds based on defined MAM filter.	filter={"account":"chemistry"}
filter-type	No	String	Query funds based on defined MAM filter type.	filter-type=NonExclusive

See [Global URL Parameters](#) for available URL parameters.

## Sample Responses

Fund sample response
<pre> {   "id": 2,   "name": 1204,   "priority": 0,   "description": "R&amp;D for Manufacturing",   "creationTime": "2012-02-02 09:34:42 UTC",   "amount": 9060000,   "deposited": 9060000,   "creditLimit": 0,   "allocations": [ {     "id": 2,     "startTime": "-infinity",     "endTime": "infinity",     "amount": 9060000,     "creditLimit": 0,     "deposited": 9060000,     "active": true,     "description": ""   } ],   "fundConstraints": [ {     "id": 2,     "name": "CostCenter",     "value": 1204   } ] } </pre>

### 4.6.1.3 Get All Fund Balances

## URLs and Parameters

```
GET http://localhost/mws/rest/funds/balances?proxy-user=<USER>
[&custom-fields=health][&filter={"project":"chemistry"}][&filter-type=NonExclusive]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
custom-fields	No	Comma-Separated String	Includes custom MAM fund attributes.	custom-fields=health
filter	No	JSON	Query funds based on defined MAM filter.	filter={"account":"chemistry"}
filter-type	No	String	Query funds based on defined MAM filter type.	filter-type=NonExclusive

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

The fund balances resource is an aggregation of fund data. See the [FundBalance API](#) page for more details.

GET http://localhost/mws/rest/funds/balances?proxy-user=amy

```
{
  "totalCount": 2,
  "resultCount": 2,
  "results": [
    {
      "id": 2,
      "name": 1204,
      "priority": 0,
      "description": "R&D for Manufacturing",
      "creationTime": "2012-02-02 09:34:42 UTC",
      "amount": 9060000,
      "deposited": 9060000,
      "creditLimit": 0,
      "reserved": 0,
      "allocations": [
        {
          "id": 2,
          "amount": 9060000,
          "creditLimit": 0,
          "deposited": 9060000
        }
      ],
      "fundConstraints": [
        {
          "id": 2,
          "name": "CostCenter",
          "value": 1204
        }
      ],
      "balance": 9060000,
      "available": 9060000,
      "allocated": 9060000,
      "used": 0,
      "percentRemaining": 100,
      "percentUsed": 0
    },
    {
      "id": 5,
      "name": "",
      "priority": 0,
      "description": "",
      "creationTime": "2012-04-03 09:25:47 UTC",
      "amount": 901290219001,
      "deposited": 901290219021,
      "creditLimit": 30,
      "reserved": 84018308897.68,
      "allocations": [
        {
          "id": 6,
          "amount": 901290219001,
          "creditLimit": 30,
          "deposited": 901290219021
        }
      ],
      "fundConstraints": [],
      "balance": 817271910103.32,
      "available": 817271910133.32,
      "allocated": 901290219051,
      "used": 20,
      "percentRemaining": 100,
      "percentUsed": 0
    }
  ]
}
```

## 4.6.1.4 Get Fund Statement

### URLs and Parameters

```
GET http://localhost/mws/rest/funds/reports/statement?proxy-user=<USER>[&filter=
<FILTER>][&filter-type=<FILTER-TYPE>][&start-time=<DATE-STRING>][&end-time=
<DATE-STRING>][&context=<CONTEXT>]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
filter	No	JSON	Query funds based on defined MAM filter.	filter={"account":"chemistry"}
filter-type	No	String	Query funds based on defined MAM filter type.	filter-type=NonExclusive
start-time	No	Date, -infinity, or now	Filter allocations and transaction after a start time.	start-time=2012-04-03 15:24:39 UTC
end-time	No	Date, -infinity, or now	Filter allocations and transactions before an end time.	end-time=2012-04-03 15:24:39 UTC
context	No	hpc or cloud	The context to use in Moab Accounting Manager.	context=hpc



The `context` parameter overrides the default context set for MAM using the `mam.context` configuration parameter. See the [Configuration](#) page for more information on this parameter.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

The fund statement report provides a snapshot of the current funds. See the [FundStatement API](#) for more details.

GET

`http://localhost/mws/rest/funds/reports/statement?proxy-user=amy&fields=startBalance,endBalance`

```
{
  "startBalance":1234.01,
  "endBalance":1000
}
```

### 4.6.1.5 Get Fund Statement Summary

#### URLs and Parameters

```
GET http://localhost/mws/rest/funds/reports/statement/summary?proxy-user=<USER>
[&filter=<FILTER>][&filter-type=<FILTER-TYPE>][&start-time=<DATE-STRING>][&end-time=
<DATE-STRING>]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
filter	No	JSON	Query funds based on defined MAM filter.	filter={"account":"chemistry"}
filter-type	No	String	Query funds based on defined MAM filter type.	filter-type=NonExclusive
start-time	No	Date, -infinity, or now	Filter allocations and transaction after a start time.	start-time=2012-04-03 15:24:39 UTC
end-time	No	Date, -infinity, or now	Filter allocations and transactions before an end time.	end-time=2012-04-03 15:24:39 UTC

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

The fund statement summary is slightly different from the typical fund statement in that the transactions are provided as summaries grouped by `object` and `action`. See the [FundStatementSummary API](#) for more details.

```

GET
http://localhost/mws/rest/funds/reports/statement/summary?proxy-user=amy&fields=totalCredits,totalD

{
  "totalCredits":200.02,
  "totalDebits":-100,
  "transactions":[ {
    "action": "Deposit",
    "amount":200.02,
    "count":2
  }, {
    "action": "Charge",
    "amount":-100,
    "count":1
  }
]
}

```

## 4.7 Images

This section describes behavior of the **Image** resource in Moab Web Services. An image resource is used to track the different types of operating systems and hypervisors available in the data center. It also tracks which virtual machines are available on the hypervisors. This section describes the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Image API](#) contains the type and description of all fields in the **Image** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/images	<a href="#">Get All Images</a>		<a href="#">Create Image</a>	
/rest/images/id	<a href="#">Get Specified Image</a>	<a href="#">Modify Image</a>		<a href="#">Delete Image</a>
/rest/images/name	<a href="#">Get Specified Image</a>	<a href="#">Modify Image</a>		<a href="#">Delete Image</a>

### 4.7.1 Getting Images

The HTTP GET method is used to retrieve **Image** information. You can query all objects or a single object.

#### Quick Reference

```
GET http://localhost/mws/rest/images[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/images/<id>
GET http://localhost/mws/rest/images/<name>
```

#### 4.7.1.1 Get All Images

##### URLs and Parameters

```
GET http://localhost/mws/rest/images[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"type":"stateful","osType":"linux"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query images by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/images?fields=id,name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "id": "4fa197e68ca30fc605dd1cf0",
    "name": "centos5-stateful"
  } ]
}
```

## Sorting and Querying

See the sorting and querying sections of [Global URL Parameters](#).

### 4.7.1.2 Get Single Image

#### URLs and Parameters

```
GET http://localhost/mws/rest/images/<id>
GET http://localhost/mws/rest/images/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Image.
name	Yes	String	-	The name of the Image.

See [Global URL Parameters](#) for available URL parameters.



You must specify either **id** or **name**, but you do not have to specify both.

## Sample Response

Virtual machine image example:

GET http://localhost/mws/rest/images/centos5-compute-stateful

```
{
  "active":true,
  "extensions":{
    "xcat":{
      "os":"centos",
      "architecture":"x86_64",
      "profile":"compute"
    }
  },
  "features":[],
  "hypervisor":false,
  "hypervisorType":null,
  "id":"4fa197e68ca30fc605dd1cf0",
  "name":"centos5-compute-stateful",
  "osType":"linux",
  "supportsPhysicalMachine":false,
  "supportsVirtualMachine":true,
  "templateName":"",
  "type":"stateful",
  "version":0,
  "virtualizedImages":[]
}
```

Hypervisor image example:

GET http://localhost/mws/rest/images/esxi-4.1-stateful

```
{
  "active":true,
  "extensions":{
    "xcat":{
      "hvGroupName":"hvGroup",
      "vmGroupName":"vmGroup",
      "os":"esxi-4.1",
      "architecture":"x86_64",
      "profile":"hv"
    }
  },
  "features":[],
  "hypervisor":true,
  "hypervisorType":"ESX",
  "id":"4fa197e68ca30fc605dd1cf0",
  "name":"centos5-compute-stateful",
  "osType":"linux",
  "supportsPhysicalMachine":true,
  "supportsVirtualMachine":false,
  "templateName":"",
  "type":"stateful",
  "version":0,
  "virtualizedImages":[]
}
```



The `version` field contains the current version of the database entry and does **not** reflect the version of the operating system. See [Modify Image](#) for more information.

## 4.7.2 Creating Images

The HTTP POST method is used to submit **Images**.

### Quick Reference

POST http://localhost/mws/rest/images

## 4.7.2.1 Create Single Image

### URLs and Parameters

```
POST http://localhost/mws/rest/images
```

See [Global URL Parameters](#) for available URL parameters.

### Request Body

Three fields are required to submit an image: **name**, **hypervisor**, and **osType**. Each image must also support provisioning to either a physical machine or a virtual machine by using the **supportsPhysicalMachine** or **supportsVirtualMachine** fields.

 The **name** field must contain only letters, digits, periods, dashes, and underscores.

The array of virtualized images are themselves objects that contain image IDs or names. For more information on available fields and types, see the [Image API](#).

The following is an example of the most basic image that can be created:

```
POST http://localhost/mws/rest/images
```

```
{
  "name": "centos5-stateful",
  "osType": "linux",
  "hypervisor": false,
  "supportsVirtualMachine": true
}
```

Note that this example does not provide any information for a provisioning manager (such as xCAT) to actually provision the machine. In order to provide this, you must add an entry to the **extensions** field that contains provisioning manager-specific information. Each key in the extensions field corresponds to the provisioning manager, and certain properties are required based on this key. For example, the xCAT extension key must be named `xcat` and must contain certain fields. These extension keys are documented in the [Image API](#). See the following examples of creating images with xCAT-specific provisioning information below.

### Sample Response

If the request was successful, the response body is the new image that was created exactly as shown in [Get Single Image](#). On failure, the response is an error message.

### Samples

The **virtualizedImages** field only accepts input when the image is a hypervisor and expects an array of image IDs **or** names, as shown in the following example:

### Example payload of hypervisor with 2 vms

```
{
  "hypervisor": true,
  "name": "esx5-stateful",
  "osType": "linux",
  "supportsPhysicalMachine": true,
  "type": "stateful",
  "hypervisorType": "ESX",
  "virtualizedImages": [
    { "id": "4fa197e68ca30fc605dd1cf0" },
    { "name": "centos5-stateful" }
  ]
}
```

The following example shows how to create an image that utilizes a cloned template for a virtual machine. (Note that the **type** must be set to `linkedclone` in order to set the **templateName** field.)

### VM Utilizing a Cloned Template

```
{
  "active": true,
  "hypervisor": false,
  "name": "centos5-compute-stateful",
  "osType": "linux",
  "type": "linkedclone",
  "supportsVirtualMachine": true,
  "templateName": "centos5-compute"
}
```

The following are samples of a virtual machine and a hypervisor image that can be provisioned with xCAT:

### xCAT Virtual Machine Image

```
{
  "active": true,
  "features": [],
  "hypervisor": false,
  "name": "centos5-compute-stateful",
  "osType": "linux",
  "type": "stateful",
  "supportsVirtualMachine": true,
  "extensions": {
    "xcat": {
      "os": "centos",
      "architecture": "x86_64",
      "profile": "compute"
    }
  }
}
```

## xCAT Hypervisor Image

```
{
  "active": true,
  "features": [],
  "hypervisor": true,
  "name": "esxi5-base-stateless",
  "osType": "linux",
  "virtualizedImages": [
    { "name": "centos5-compute-stateless" }
  ],
  "type": "stateless",
  "hypervisorType": "ESX",
  "supportsPhysicalMachine": true,
  "extensions": {
    "xcat": {
      "os": "esxi5",
      "architecture": "x86_64",
      "profile": "base",
      "hvType": "esx",
      "hvGroupName": "esx5hv",
      "vmGroupName": "esx5vm"
    }
  }
}
```

### 4.7.3 Modifying Images

The HTTP PUT method is used to modify **Images**.

#### Quick Reference

```
PUT http://localhost/mws/rest/images/<id>
PUT http://localhost/mws/rest/images/<name>
```

#### 4.7.3.1 Modify Single Image

##### URLs and Parameters

```
PUT http://localhost/mws/rest/images/<id>
PUT http://localhost/mws/rest/images/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Image.
name	Yes	String	-	The name of the Image.

See [Global URL Parameters](#) for available URL parameters.



- You must specify either **id** or **name**, but you do not have to specify both.
- The **name** field must contain only letters, digits, periods, dashes, and underscores.

## Example Request

```
PUT http://localhost/mws/rest/images/centos5-stateful
```

```
{
  "name": "centos5-stateful",
  "type": "stateful",
  "hypervisor": false,
  "osType": "linux",
  "virtualizedImages": []
}
```



The **version** field contains the current version of the database entry and does **not** reflect the version of the operating system. This field cannot be updated directly. However, if **version** is included in the modify request, it will be used to verify that another client did not update the object in between the time the data was retrieved and the modify request was delivered.

## Sample Response

If the request was successful, the response body is the modified image as shown in [Get Single Image](#). On failure, the response is an error message.

## 4.7.4 Deleting Images

The HTTP DELETE method is used to delete **Images**.

### Quick Reference

```
DELETE http://localhost/mws/rest/images/<id>
DELETE http://localhost/mws/rest/images/<name>
```

### 4.7.4.1 Delete Single Image

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/images/<id>
DELETE http://localhost/mws/rest/images/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Image.
name	Yes	String	-	The name of the Image.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

## Sample Response

JSON Response

```
{}
```

## 4.8 Jobs

This section describes behavior of the **Job** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The Job API has changed with **API version 2**. The supported methods table below requires each resource to be accessed with a URL parameter of `api-version=2` in order to behave as documented.

In order to access documentation for previous API versions, see [Requesting Specific API Versions](#).

 The [Job API](#) contains the type and description of all fields in the **Job** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/jobs	<a href="#">Get all jobs</a>		<a href="#">Submit job</a>	
/rest/jobs/name	<a href="#">Get single job</a>	<a href="#">Modify job</a>		<a href="#">Cancel job</a>

### 4.8.1 Getting Job Information

The HTTP GET method is used to retrieve **Job** information.

## Quick Reference

```
GET http://localhost/mws/rest/jobs/<name>?api-version=2
```

#### 4.8.1.1 Get All Jobs

### URLs and Parameters

```
GET http://localhost/mws/rest/jobs?api-version=2
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"isActive":true}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

## How to Get All Jobs

```
GET http://localhost/mws/rest/jobs?api-version=2&fields=name,flags&max=3
```

```
{
  "totalCount": 8,
  "resultCount": 3,
  "results": [
    {
      "flags": [ "GLOBALQUEUE" ],
      "name": "Moab.1"
    },
    {
      "flags": [ "GLOBALQUEUE" ],
      "name": "Moab.2"
    },
    {
      "flags": [ "GLOBALQUEUE" ],
      "name": "Moab.4"
    }
  ]
}
```

## How to Get a Subset of Jobs

Here are a few examples of how to query for jobs.

### Get Active Jobs

```
http://localhost/mws/rest/jobs?api-version=2&query={"isActive":true}
```

### Get Completed Jobs

```
http://localhost/mws/rest/jobs?api-version=2&query={"isActive":false}
```

### Get Jobs Owned by a Particular User

```
http://localhost/mws/rest/jobs?api-version=2&query={"credentials.user":"fred"}
```

## Known Issues

- Some jobs are not returned if `DisplayFlags UseBlocking` is set in the `moab.cfg` file.

### 4.8.1.2 Get Single Job

#### URLs and Parameters

```
GET http://localhost/mws/rest/jobs/<name>?api-version=2
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

##### JSON Response

```
{
  "arrayIndex": null,
  "arrayMasterName": null,
  "attributes": [],
  "blocks": [ {
    "category": "jobBlock",
    "message": null,
    "type": null
  } ],
  "bypassCount": 0,
  "cancelCount": 0,
  "commandFile": "/tmp/test.sh",
  "commandLineArgs": null,
  "completionCode": null,
  "cpuTime": 0,
  "credentials": {
    "account": null,
    "group": "adaptive",
    "jobClass": null,
    "qos": "NONE",
    "qosRequested": null,
    "user": "adaptive"
  },
  "customName": null,
  "dates": {
    "completedDate": null,
    "createdDate": "2012-10-11 17:58:16 UTC",
    "deadlineDate": "2037-10-24 12:26:40 UTC",
    "dispatchedDate": null,
    "earliestRequestedStartDate": null,
    "earliestStartDate": "2012-10-11 17:58:18 UTC",
    "eligibleDate": "2012-10-11 17:59:19 UTC",
    "lastCanceledDate": null,
    "lastChargedDate": null,
    "lastPreemptedDate": null,
    "lastUpdatedDate": "2012-10-11 17:59:19 UTC",
    "startDate": null,
    "submitDate": "2012-10-11 17:58:16 UTC",
    "terminationDate": "2037-10-24 12:26:40 UTC"
  },
  "deferCount": 0,
  "dependencies": [],
  "description": null,
  "duration": 8639999,
  "durationActive": 0,
  "durationQueued": 31,
```

```

"durationRemaining": 0,
"durationSuspended": 0,
"emailNotifyAddresses": [],
"emailNotifyTypes": [],
"environmentRequested": false,
"environmentVariables": {},
"epilogScript": null,
"flags": ["GLOBALQUEUE"],
"holdDate": null,
"holdReason": null,
"holds": [],
"initialWorkingDirectory": "/tmp",
"isActive": true,
"jobGroup": null,
"masterNode": null,
"memorySecondsDedicated": 0,
"memorySecondsUtilized": 0,
"messages": [],
"migrateCount": 0,
"minimumPreemptTime": 0,
"mwmName": "Moab",
"name": "Moab.15",
"nodesExcluded": [],
"nodesRequested": [],
"nodesRequestedPolicy": null,
"partitionAccessList": [
  "msm",
  "SHARED"
],
"partitionAccessListRequested": [
  "msm",
  "SHARED"
],
"preemptCount": 0,
"priorities": {
  "run": 0,
  "start": 1,
  "system": 0,
  "user": 0
},
"processorSecondsDedicated": 0,
"processorSecondsLimit": 0,
"processorSecondsUtilized": 0,
"prologScript": null,
"queueStatus": "blocked",
"rejectPolicies": [],
"requirements": [ {
  "architecture": null,
  "attributes": [],
  "features": [],
  "index": 0,
  "featuresRequested": [],
  "featuresRequestedMode": "AND",
  "featuresExcluded": [],
  "featuresExcludedMode": "AND",
  "metrics": {},
  "nodeAccessPolicy": null,
  "nodeAllocationPolicy": null,
  "nodeCount": 0,
  "nodes": [],
  "nodeSet": null,
  "image": null,
  "reservation": null,
  "resourcesPerTask": {
    "processors": {
      "dedicated": 1,
      "utilized": 0
    },
    "memory": {
      "dedicated": 0,
      "utilized": 0
    },
    "disk": {
      "dedicated": 0,
      "utilized": null
    },
    "swap": {
      "dedicated": 0,
      "utilized": null
    }
  }
},
"taskCount": 4,
"tasksPerNode": 0
}],
"reservationRequested": null,
"resourceFailPolicy": null,
"resourceManagerExtension": null,
"resourceManagers": [ {
  "isDestination": false,
  "isSource": true,
  "jobName": "Moab.15",

```

```
"name": "internal"
}],
"rmStandardErrorFilePath": null,
"rmStandardOutputFilePath": null,
"standardErrorFilePath": null,
"standardOutputFilePath": null,
"startCount": 0,
"states": {
  "state": "Idle",
  "stateExpected": "Idle",
  "stateLastUpdatedDate": null,
  "subState": null
},
"submitHost": "0:0:0:0:0:0:1",
"systemJobAction": null,
"systemJobType": null,
"targetedJobAction": null,
"targetedJobName": null,
"templates": [{"name": "DEFAULT"}],
"triggers": [],
"variables": {},
"virtualContainers": [],
```

```
"virtualMachines": [],
"vmUsagePolicy": null
}
```

## Job Arrays

If a job is the master of a job array, the response will have some additional fields set as shown in the following example. The name field is chosen by the Moab Workload Manager, and the customName field comes from the job array [name](#) field.

### Job Array Master

```
{
  "name": "Moab.5",
  "customName": "myarray",
  "flags": [
    "ARRAYMASTER",
    "GLOBALQUEUE",
    "CANCELONFIRSTFAILURE",
    "CANCELONANYSUCCESS"
  ]
}
```

If a job is a sub-job of an array, the response will have other fields set as shown in the following example.

### Array Sub-Job

```
{
  "name": "Moab.5[21]",
  "customName": "myarray",
  "arrayIndex": 21,
  "arrayMasterName": "Moab.5",
  "flags": [
    "ARRAYJOB",
    "GLOBALQUEUE",
    "CANCELONFIRSTFAILURE",
    "CANCELONANYSUCCESS"
  ]
}
```

## 4.8.2 Submitting Jobs

The HTTP POST method is used to submit **Jobs**.

### Quick Reference

```
POST http://localhost/mws/rest/jobs?api-version=2[&proxy-user=<username>]
```

## Restrictions

- MWS must have read access to the file given in `commandFile`.
- No more than one virtual container can be specified in the request. The virtual container must already exist.
- The `credentials.user` and `credentials.group` properties are used to submit a job as the specified user belonging to the specified group.
- Job variables have the following restrictions:
  - Variable names cannot contain equals (=), semicolon (;), colon (:), plus (+), question mark (?), caret (^), backslash (\), or white space.
  - Variable values cannot contain semicolon (;), colon (:), plus (+), or caret (^).
- When submitting jobs, the only supported hold type is User.
- The proxy-user parameter is ignored unless you set `ENABLEPROXY=TRUE` in the `moab.cfg` file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

## 4.8.2.1 Submit Job

### URLs and Parameters

```
POST http://localhost/mws/rest/jobs?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

To submit a job, only one field is required: `commandFile`.

The request body below shows all the fields that are available during job submission. This is a very contrived example; its purpose is simply to show sample values in the correct format.

#### JSON Request Body (specified host list)

```
{
  "attributes": [
    "attr1",
    "attr2"
  ],
  "commandFile": "/tmp/test.sh",
  "commandLineArguments": "-x -v",
  "credentials": {
    "account": "account",
    "group": "group",
    "jobClass": "BATCH",
    "qosRequested": "QOS1",
    "user": "saadmin"
  },
  "customName": "custom name for job",
  "dates": {
    "earliestRequestedStartDate": "2012-11-08 13:18:47 UTC",
```

```

"deadlineDate": "2014-02-17 14:00:00 UTC"
},
"dependencies": [
  {
    "type": "set",
    "name": "vc1.varA"
  },
  {
    "type": "set",
    "name": "vc2.varB"
  },
  {
    "type": "set",
    "name": "vc3.varC"
  }
],
"duration": 600,
"emailNotifyAddresses": [
  "user3@ac.com",
  "user4@ac.com"
],
"emailNotifyTypes": [
  "JobStart",
  "JobEnd"
],
"environmentRequested": true,
"environmentVariables": {
  "var1": "val1",
  "var2": "val2"
},
"epilogScript": "/tmp/epilog.sh",
"flags": [
  "RESTARTABLE",
  "SUSPENDABLE"
],
"holds": ["User"],
"initialWorkingDirectory": "/tmp",
"jobGroup": "job_group",
"nodesExcluded": [
  { "name": "node07" },
  { "name": "node08" }
],
"nodesRequested": [
  { "name": "node01" },
  { "name": "node02" }
],
"nodesRequestedPolicy": "SUBSET",
"partitionAccessListRequested": [
  "p1",
  "p2"
],
"priorities": {"user": 5},
"prologScript": "/tmp/prolog.sh",
"requirements": [ {
  "architecture": "x86_64",
  "attributes": [
    {
      "name": "matlab",
      "comparator": "<=",
      "value": "7.1"
    },
    {
      "name": "soffice",
      "comparator": "=",
      "value": "3.1"
    }
  ]
}
],
"featuresRequested": [
  "a",
  "b",
  "c"
],
"featuresRequestedMode": "OR",
"featuresExcluded": [
  "d",
  "e",
  "f"
],
"featuresExcludedMode": "AND",
"nodeAccessPolicy": "SINGLEJOB",
"nodeAllocationPolicy": "PRIORITY",
"nodeCount": 6,
"image": "linux",
"resourcesPerTask": {
  "disk": {"dedicated": 1024},
  "memory": {"dedicated": 512},
  "processors": {"dedicated": 2},
  "swap": {"dedicated": 4096},
  "matlab": {"dedicated": 6},
  "intellij": {"dedicated": 2}
}
},

```

```
    "taskCount": 4,  
    "tasksPerNode": 14  
  }],  
  "reservationRequested": {"name": "rsv.1"},  
  "resourceFailPolicy": "RETRY",  
  "resourceManagerExtension": "x=PROC=4",  
  "standardErrorFilePath": "/tmp/error",  
  "standardOutputFilePath": "/tmp/out",  
  "submitHost": "admin-node",  
  "templates": [  
    {"name": "template1"},  
    {"name": "template2"}  
  ],  
  "variables": {  
    "var1": "val1",  
    "var2": "val2"  
  },  
}
```

```
"virtualContainers": [{ "name": "vc1" }],  
"vmUsagePolicy": "CREATEVM"  
}
```

## Sample Response

The response of this task is one of three possibilities:

- An object with a single `messages` property containing a list of error messages on failure

```
{ "messages": [ "Could not create job - invalid requirements" ] }
```

- An object with a `name` property containing the name of the newly created job

```
{ "name": "Moab.1" }
```

- An object with a `name` property and a `virtualContainers` list containing the name of the newly created virtual container

```
{ "name": "Moab.1", "virtualContainers": [ { "name": "vc1" } ] }
```



The virtual container will only be reported when a *new* virtual container has been created by Moab for the job.

## 4.8.2.2 Examples of Job Submission

This section includes some sample job submission requests.

### Submit job to run on node2 and node3

POST <http://localhost/mws/rest/jobs?api-version=2>

```
{  
  "commandFile": "/tmp/test.sh",  
  "credentials": {  
    "group": "adaptive",  
    "user": "adaptive"  
  },  
  "initialWorkingDirectory": "/tmp",  
  "nodesRequested": [  
    { "name": "node2" },  
    { "name": "node3" }  
  ]  
}
```

### Submit job that requires 20 processors

POST http://localhost/mws/rest/jobs?api-version=2

```
{
  "commandFile": "/tmp/test.sh",
  "credentials": {
    "group": "adaptive",
    "user": "adaptive"
  },
  "initialWorkingDirectory": "/tmp",
  "requirements": [{"taskCount": 20}]
}
```

## Submit job to run after a certain time

POST http://localhost/mws/rest/jobs?api-version=2

```
{
  "commandFile": "/tmp/test.sh",
  "credentials": {
    "group": "adaptive",
    "user": "adaptive"
  },
  "dates": {"earliestRequestedStartDate": "2012-10-11 18:36:35 UTC"},
  "initialWorkingDirectory": "/tmp",
  "requirements": [{"taskCount": 20}]
}
```

## Submit job based on msub example

Given this msub command:

```
msub -l nodes=3:ppn=2,walltime=1:00:00,pmem=100 script2.pbs.cmd
```

Here is an equivalent MWS request:

POST http://localhost/mws/rest/jobs?api-version=2

```
{
  "duration": 3600,
  "commandFile": "/home/adaptive/script2.pbs.cmd",
  "credentials": {
    "group": "adaptive",
    "user": "adaptive"
  },
  "initialWorkingDirectory": "/home/adaptive",
  "requirements": [ {
    "resourcesPerTask": {"memory": {"dedicated": 100}},
    "taskCount": 6,
    "tasksPerNode": 2
  } ]
}
```



- To emulate what msub does, make `commandFile` an absolute path, and add `credentials.user`, `credentials.group`, and `initialWorkingDirectory`.
- As shown above, `nodes=3:ppn=2` is equivalent to setting `taskCount` to 6 and `tasksPerNode` to 2.

## Submit a Job Array

See the [Submitting Job Arrays](#) section for details on how to submit a job array.

### 4.8.3 Modifying Jobs

The HTTP PUT method is used to modify **Jobs**.

#### Quick Reference

```
PUT http://localhost/mws/rest/jobs/<name>[/<modifyAction>]?api-version=2[&proxy-user=
<username>]
```

#### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

#### 4.8.3.1 Modify Job Attributes

##### URLs and Parameters

```
PUT http://localhost/mws/rest/jobs/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

#### Request Body

The request body below shows all the fields that are available when modifying a Job, along with some sample values.

## JSON Request Body

```
{
  "credentials": {
    "account": "account",
    "jobClass": "BATCH",
    "qosRequested": "QOS1"
  },
  "customName": "custom name for job",
  "dates": {"earliestRequestedStartDate": "2012-11-08 13:18:47 UTC"},
  "duration": 600,
  "flags": [
    "RESTARTABLE",
    "SUSPENDABLE"
  ],
  "holds": ["User"],
  "messages": [
    {"message": "Message one"},
    {"message": "Message two"}
  ],
  "partitionAccessListRequested": [
    "p1",
    "p2"
  ],
  "priorities": {"user": 5},
  "reservationRequested": {"name": "rsv.1"},
  "variables": {
    "var1": "val1",
    "var2": "val2"
  }
}
```

## Sample Response



These messages may not match the messages returned from Moab exactly, but are given as an example of the structure of the response.



Not all messages are shown for the above request body.

## JSON Response

```
{
  "messages": [
    "Account modified successfully",
    "Messages modified successfully",
    "Variables modified successfully"
  ]
}
```

## Restrictions

- Old messages are not removed from jobs; only new messages are added.
- Job variables have the restrictions documented in [Submitting Jobs](#)

## 4.8.3.2 Perform Actions on Job

### URLs and Parameters

```
PUT http://localhost/mws/rest/jobs/<name>/<modifyAction>?api-version=2[&proxy-user=
<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
modifyAction	Yes	String	cancel	Attempts to cancel the job.
			checkpoint	Attempts to checkpoint the job. Note that the OS must support checkpointing for this to work.
			execute	Executes the job if possible.
			hold	Attempts to hold the job using the holds set in the request body.
			requeue	Attempts to requeue the job.
			resume	Attempts to resume the job.
			suspend	Attempts to suspend the job.
			unhold	Attempts to release the holds set in the request body.
proxy-user	No	String	-	Perform the action as this user.

 Performing a cancel function on a job is equivalent to deleting a job.

See [Global URL Parameters](#) for available URL parameters.

## Request Body

Request bodies are only required for holding or unholding jobs. All other actions do not require request bodies of any kind.

### JSON Request Body to Add Holds to a Job

```
{"holds": ["User"]}
```

### JSON Request Body to Remove Holds from a Job

```
{"holds": ["User"]}
```

 If no holds are specified when unholding a job, all holds will be removed. This is equivalent to specifying holds as a list with a single element of All.

## Sample Response



This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

#### JSON Response

```
{ "messages": [ "Job modified successfully" ] }
```

## 4.8.4 Deleting (Canceling) Jobs

The HTTP DELETE method is used to cancel **Jobs**.

### Quick Reference

```
DELETE http://localhost/mws/rest/jobs/<name>?api-version=2[&proxy-user=<username>]
```

### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

### 4.8.4.1 Cancel Job

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/jobs/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

#### JSON Response for successful DELETE

```
{ }
```

 Additional information about the DELETE can be found in the HTTP response header X-MWS-Message.

## 4.9 Job Arrays

This section describes behavior of the **Job Array** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [JobArray API](#) contains the type and description of all fields in the **Job Array** object.

### Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/job-arrays			<a href="#">Submit new job array</a>	

#### 4.9.1 Submitting Job Arrays

The HTTP POST method is used to submit **Job Arrays**.

### Quick Reference

```
POST http://localhost/mws/rest/job-arrays?api-version=2[&proxy-user=<username>]
```

 While the **Job Array** resource only gives access to create job arrays, job arrays are retrieved using the operations in the [Getting Job Information](#) section.

### Restrictions

All restrictions present for [Submitting Jobs](#) are present for job arrays. In addition, job arrays are *only* supported if the ENABLEJOBARRAYS parameter is set to TRUE in the moab.cfg file.

Example:

```
ENABLEJOBARRAYS    TRUE
```

#### 4.9.1.1 Submit Job Array

### URLs and Parameters

```
POST http://localhost/mws/rest/job-arrays?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

## Request Body

To submit a job array, only two fields are required: `jobPrototype` and one of `indexValues` or `indexRanges`. Both index ranges and values may be specified if desired.

The request body below shows all the fields that are available during job array submission, although the `jobPrototype` shown is a simple example and does not utilize all fields of a job submission.

 The `jobPrototype` field has the same properties as a typical job submission. Examples of this can be seen in the [Submitting Jobs](#) section.

### JSON Request Body

```
{
  "name": "myarray",
  "indexRanges": [ {
    "startIndex": 11,
    "endIndex": 25,
    "increment": 2
  } ],
  "indexValues": [ 2, 4, 6, 8, 10 ],
  "slotLimit": 2,
  "cancellationPolicy": {
    "firstJob": "FAILURE",
    "anyJob": "SUCCESS"
  },
  "jobPrototype": {
    "commandFile": "/tmp/test.sh",
    "initialWorkingDirectory": "/tmp",
    "requirements": [ {"taskCount": 4} ]
  }
}
```

## Sample Response

The response of this task is the same as [submitting a job](#).

## 4.10 Job Templates

This section describes behavior of the **Job Template** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Job Template API](#) contains the type and description of all fields in the **Job Template** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/job-templates	<a href="#">Get all job templates</a>	
/rest/job-templates/id	<a href="#">Get specified job template</a>	

### 4.10.1 Getting Job Templates

The HTTP GET method is used to retrieve **Job Template** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/job-templates/<id>
```

#### 4.10.1.1 Get All Job Templates

##### URLs and Parameters

```
GET http://localhost/mws/rest/job-templates
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/job-templates?fields=id
```

```
{
  "totalCount": 14,
  "resultCount": 14,
  "results": [
    {"id": "DEFAULT"},
    {"id": "genericVM"},
    {"id": "genericVM-setup"},
    {"id": "genericVM-destroy"},
    {"id": "genericVM-migrate"},
    {"id": "genericPM"},
    {"id": "genericPM-setup"},
    {"id": "genericPM-destroy"},
    {"id": "OSStorage"},
    {"id": "OSStorage-setup"},
    {"id": "OSStorage-destroy"},
    {"id": "extraStorage"},
    {"id": "extraStorage-setup"},
    {"id": "extraStorage-destroy"}
  ]
}
```

## 4.10.1.2 Get Single Job Template

### URLs and Parameters

```
GET http://localhost/mws/rest/job-templates/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

#### JSON Response

```
{
  "account": "account",
  "args": "arg1 arg2",
  "commandFile": "/tmp/script",
  "description": "description",
  "genericSystemJob": true,
  "id": "genericVM",
  "inheritResources": false,
  "jobDependencies": [ {
    "name": "genericVM-setup",
    "type": "JOBSUCCESSFULCOMPLETE"
  } ],
  "jobFlags": ["VMTRACKING"],
  "jobTemplateFlags": ["SELECT"],
  "jobTemplateRequirements": [ {
    "architecture": "x86_64",
    "diskRequirement": 500,
    "genericResources": { "tape": 3 },
    "nodeAccessPolicy": "SINGLEJOB",
    "operatingSystem": "Ubuntu 10.04.3",
    "requiredDiskPerTask": 200,
    "requiredFeatures": ["dvd"],
    "requiredMemoryPerTask": 1024,
    "requiredProcessorsPerTask": 2,
    "requiredSwapPerTask": 512,
    "taskCount": 4
  } ],
  "priority": 20,
  "qos": "qos",
  "queue": "queue",
  "durationRequested": 600,
  "select": true,
  "trigger": null,
  "version": 0,
  "vmUsagePolicy": "REQUIREPM"
}
```

## 4.11 Metric Types

This section describes behavior of the **Metric Type** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [MetricType API](#) contains the type and description of all fields in the **Metric Type** object.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/metric-types	<a href="#">Get all metric types</a>	

### 4.11.1 Getting Metric Types

The HTTP GET method is used to retrieve **Metric Type** information.

#### Quick Reference

```
GET http://localhost/mws/rest/metric-types
```

#### 4.11.1.1 Get All Metric Types

##### URLs and Parameters

```
GET http://localhost/mws/rest/metric-types
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/metric-types?fields=id
```

```
{
  "totalCount": 9,
  "resultCount": 9,
  "results": [
    {"id": "vmcount"},
    {"id": "watts"},
    {"id": "pwatts"},
    {"id": "temp"},
    {"id": "cpu"},
    {"id": "mem"},
    {"id": "io"},
    {"id": "ccores"},
    {"id": "threads"}
  ]
}
```

## 4.12 Nodes

This section describes behavior of the **Node** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The Node API has changed with **API version 2**. The supported methods table below requires each resource to be accessed with a URL parameter of `api-version=2` in order to behave as documented.

In order to access documentation for previous API versions, see [Requesting Specific API Versions](#).



The [Node API](#) contains the type and description of all fields in the **Node** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/nodes	<a href="#">Get all nodes</a>			
/rest/nodes/ <b>name</b>	<a href="#">Get specified node</a>	<a href="#">Modify node</a>		

### 4.12.1 Getting Nodes

The HTTP GET method is used to retrieve **Node** information.

#### Quick Reference

```
GET http://localhost/mws/rest/nodes/<name>?api-version=2
```

#### 4.12.1.1 Get All Nodes

##### URLs and Parameters

```
GET http://localhost/mws/rest/nodes?api-version=2
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"type":"compute"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.



This query will not return the DEFAULT or GLOBAL nodes from Moab Workload Manager. However, the [Get Single Node](#) task may be used to retrieve them individually if desired.

## Sample Response

GET <http://localhost/mws/rest/nodes?api-version=2&fields=name>

```
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    { "name": "node1" },
    { "name": "node2" },
    { "name": "node3" }
  ]
}
```

## 4.12.1.2 Get Single Node

### URLs and Parameters

GET <http://localhost/mws/rest/nodes/<name>?api-version=2>

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

JSON Response

```
{
  "name": "hv2",
  "architecture": null,
  "classes": ["class1"],
  "featuresReported": [],
  "index": 2,
  "ipAddress": "10.0.0.4",
  "isHypervisor": true,
  "lastUpdatedDate": "2012-10-11 17:42:24 UTC",
  "migrationDisabled": false,
  "partition": "msm",
  "processorSpeed": null,
  "profilingEnabled": false,
  "rack": null,
  "resourceManagerMessages": {
    "torque": null,
    "mws": null
  },
  "slot": null,
  "type": "compute",
  "messages": [ {
    "count": 11,
    "createdDate": "2012-10-24 04:06:04 UTC",
    "expireDate": "2037-10-24 12:26:40 UTC",
    "message": "This is a message"
  } ],
  "metrics": {
```

```

    "watts": 200,
    "pwatts": 200,
    "temp": 103,
    "vmcount": 4
  },
  "variables": {},
  "states": {
    "powerState": "On",
    "powerStateExpected": null,
    "state": "Idle",
    "stateExpected": "Idle",
    "stateLastUpdatedDate": "2012-10-11 17:15:01 UTC",
    "subState": null,
    "subStateLast": null,
    "subStateLastUpdatedDate": null
  },
  "operatingSystem": {
    "hypervisorType": "KVM",
    "image": "hyper",
    "imageExpected": null,
    "imageLastUpdatedDate": null,
    "imagesAvailable": ["hyper"],
    "virtualMachineImages": [
      "stateless1",
      "stateless2"
    ]
  },
  "resources": {
    "processors": {
      "configured": 8,
      "real": 8,
      "dedicated": 0,
      "available": 8,
      "utilized": -1
    },
    "memory": {
      "configured": 1048576,
      "real": 1048576,
      "dedicated": 0,
      "available": 1048576,
      "utilized": 0
    },
    "disk": {
      "configured": 1048576,
      "real": 1048576,
      "dedicated": 0,
      "available": 1048576,
      "utilized": 0
    },
    "swap": {
      "configured": 4096,
      "real": 4096,
      "dedicated": 0,
      "available": 4096,
      "utilized": 0
    }
  },
  "resourceManagers": [ {
    "name": "msm",
    "isMaster": true,
    "stateReported": "Active"
  } ],
  "jobs": [],
  "reservations": [
    {
      "name": "system.5",
      "type": "user"
    },
    {
      "name": "system.17",
      "type": "user"
    }
  ],
  "virtualContainers": [],
  "virtualMachines": [
    { "name": "vm3" },
    { "name": "vm4" }
  ]
}

```

```
  ],
  "triggers": []
}
```

## 4.12.2 Modifying Nodes

The HTTP PUT method is used to modify **Nodes**.

### Quick Reference

```
PUT http://localhost/mws/rest/nodes/<name>?api-version=2[&proxy-user=<username>]
```

### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

#### 4.12.2.1 Modify Node

### URLs and Parameters

```
PUT http://localhost/mws/rest/nodes/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows all the fields that are available when modifying a Node, along with some sample values.

## Sample JSON Request Body to Modify a Node

```
{
  "messages": [
    { "message": "Message one" },
    { "message": "Message two" }
  ],
  "metrics": { "pwatts": 211 },
  "operatingSystem": { "image": "esx4.1" },
  "partition": "part1",
  "states": {
    "powerState": "On",
    "state": "Running"
  },
  "variables": {
    "key": "value",
    "arbitrary text key": "more value"
  }
}
```

## Sample Response

 This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

## JSON Response

```
{ "messages": [
  "Successfully modified os to 'linux'",
  "Successfully powered node off"
]}
```

## 4.13 Pending Actions

This section describes behavior of the **Pending Action** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Pending Action API](#) contains the type and description of all fields in the **Pending Action** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/pending-actions	<a href="#">Get all pending actions</a>	

### 4.13.1 Getting Pending Actions

The HTTP GET method is used to retrieve **Pending Action** information.

## Quick Reference

```
GET http://localhost/mws/rest/pending-actions
```

## 4.13.1.1 Get All Pending Actions

### URLs and Parameters

```
GET http://localhost/mws/rest/pending-actions
```

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

```
GET http://localhost/mws/rest/pending-actions
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "failureDetails": "",
    "hosts": ["hv3"],
    "id": "vmcreate-27",
    "maxDurationInSeconds": 3600,
    "migrationDestination": "",
    "migrationSource": "",
    "motivation": "requested by root",
    "pendingActionState": "RUNNING",
    "pendingActionType": "VMCREATE",
    "requester": "root",
    "serviceId": "Rhel55Vm.200",
    "startTime": "2011-11-15 21:57:55 UTC",
    "substate": "installing",
    "targetOS": "",
    "topLevelServiceId": "Lamp.132",
    "vmId": "vm8"
  } ]
}
```

## Generic vs Non-Generic Types

If generic job templates are used in Moab, MWS may be configured to translate pending actions with the generic type to the proper type such as VMCREATE. This is done in the configuration file. The [Quickstart Guide](#) provides the default mappings for this feature, as well as an example of adding a custom mapping from a custom template name to the correct type.

The default mappings are shown in the table below. The available pending action types may be seen on the [PendingActionType API](#) page.

Template Name	Mapped Type
genericVM-setup	VMCREATE
genericVM-migrate	VMMIGRATE
genericVM-destroy	VMDESTROY
OSStorage-setup	VMSTORAGE
OSStorage-destroy	VMSTORAGEDESTROY
extraStorage-setup	STORAGE
extraStorage-destroy	STORAGEDESTROY
genericPM-setup	OSPROVISION

 When generic mappings are used, MWS will match the first template mapping that the pending action ID ends with. For example, an ID of `Moab.1.genericVM-setup` will map the type to `VMCREATE`.

To enable mapping for a custom template name such as `myCustomVM-setup`, simply add the following line to the MWS configuration file. The value of the pending action type is case insensitive.

```
mws.pendingActions.mappings["myCustomVM-setup"] = "vmcreate"
```

MWS also provides the ability to enable or disable the display of generic pending actions (or those pending actions that are not mapped). This behavior is controlled by the `mws.pendingActions.displayGeneric` setting as shown below. A `false` value will prevent generic pending actions from being displayed, while a `true` value will display all pending actions. By default this value is `true`.

```
mws.pendingActions.displayGeneric = false
```

## 4.14 Permissions

This section describes behavior of the **Permissions** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Permission API](#) contains the type and description of fields that all **Permissions** have in common.

## Supported Methods

Resource	GET	PUT POST	DELETE
/rest/permissions	<a href="#">Get all Permissions</a>	<a href="#">Create Permission</a>	
/rest/permissions/ <b>id</b>	<a href="#">Get specified Permissions</a>		<a href="#">Delete Permission</a>
/rest/permissions/users/ <b>id</b>	<a href="#">Get users Permissions</a>		

## 4.14.1 Getting Permissions

The HTTP GET method is used to retrieve **Permission** information. You can query all objects or a single object.

### Quick Reference

```
GET http://localhost/mws/rest/permissions
GET http://localhost/mws/rest/permissions/<id>
```

### 4.14.1.1 Get All Permissions

#### URLs and Parameters

```
GET http://localhost/mws/rest/permissions[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"type":"CUSTOM"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query permissions by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

```
GET http://localhost/mws/rest/permissions?fields=resource,action,description
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [{
    "resource" : "chart",
    "action" : "read",
    "description" : "The permission to view all charts."
  } ]
}
```

## Sorting and Querying

See the sorting and querying sections of [Global URL Parameters](#).

### 4.14.1.2 Get a User's Permissions

#### URLs and Parameters

```
GET http://localhost/mws/rest/permissions/users/<name>
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the user

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

GET http://localhost/mws/rest/permissions/users/bob

```
[
  {
    "action": "read",
    "description": "The permission to read all charts",
    "id": "5033b842e4b09cc61bedb818",
    "label": "",
    "resource": "chart",
    "resourceFilter": null,
    "type": "custom",
    "version": 1
  },
  {
    "action": "read",
    "description": "The permission to read all pages",
    "id": "5033b8a5e4b09cc61bedb82d",
    "label": "",
    "resource": "page",
    "resourceFilter": null,
    "type": "custom",
    "version": 1
  },
  {
    "action": "update",
    "description": "The permission to update all pages",
    "id": "5033b8a5e4b09cc61bedb82f",
    "label": "",
    "resource": "page",
    "resourceFilter": null,
    "type": "custom",
    "version": 1
  }
]
```

### 4.14.1.3 Get Single Permission

#### URLs and Parameters

GET http://localhost/mws/rest/permissions/<id>

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Permission.

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

GET http://localhost/mws/rest/permissions/

```
{
  "action" : "create",
  "description" : "The permission to create all charts.",
  "id" : "50296335e4b0011b0f8394ec",
  "label" : "Create Chart",
  "resource" : "chart",
  "resourceFilter" : null,
  "type" : "custom",
  "version" : 0
}
```

## 4.14.2 Creating Permissions

The HTTP POST method is used to create **Permissions**.

### Quick Reference

```
POST http://localhost/mws/rest/permissions
```

### 4.14.2.1 Create Single Permission

#### URLs and Parameters

```
POST http://localhost/mws/rest/permissions
```

See [Global URL Parameters](#) for available URL parameters.

#### Request Body



- The **resource**, **action**, and **type** are required on each Permission.
- Api permissions are permissions with the type 'api' and are the only permissions enforced by MWS.
- Api permissions must map to a valid resource. For example 'services' is valid because there is a resource /mws/rest/services.
- Api permissions must have create, read, update, or delete as the action.

The following is an example request body to create a permission:

```
POST http://localhost/mws/rest/permissions
```

```
{
  "resource" : "Chart",
  "action" : "read",
  "type" : "custom",
  "label" : "Read all charts",
  "description" : "The permissions to view all charts."
}
```

#### Sample Response

If the request was successful, the response body is the new permission that was created exactly as shown in [Get Single Permission](#). On failure, the response is an error message.

## 4.14.3 Deleting Permissions

The HTTP DELETE method is used to delete **Permissions**.

## Quick Reference

```
DELETE http://localhost/mws/rest/permissions/<id>
```

### 4.14.3.1 Delete Single Permission

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/permission/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Permission.

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

JSON Response

```
{}
```

## 4.15 Plugins

This section describes behavior of the **Plugin** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [PluginInstance API](#) page contains the type and description of all fields in the **Plugin** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/plugins	<a href="#">Get all plugins</a>		<a href="#">Create new plugin</a>	
/rest/plugins/id	<a href="#">Get specified plugin</a>	<a href="#">Modify plugin</a>		<a href="#">Delete plugin</a>
/rest/plugins/id/poll			<a href="#">Trigger Plugin Poll</a>	
/rest/plugins/id/services/ serviceName	<a href="#">Access Web Service</a>	<a href="#">Access Web Service</a>	<a href="#">Access Web Service</a>	<a href="#">Access Web Service</a>

## 4.15.1 Getting Plugins

The HTTP GET method is used to retrieve **Plugin** information. Queries for all objects and a single object are available.

### Quick Reference

```
GET http://localhost/mws/rest/plugins
GET http://localhost/mws/rest/plugins/<id>
```

### 4.15.1.1 Get All Plugins

#### URLs and Parameters

```
GET http://localhost/mws/rest/plugins
```

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

```
GET http://localhost/mws/rest/plugins?fields=id
```

```
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    { "id": "plugin1" },
    { "id": "plugin2" },
    { "id": "plugin3" }
  ]
}
```

### 4.15.1.2 Get Single Plugin

#### URLs and Parameters

```
GET http://localhost/mws/rest/plugins/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```

JSON Response
{
  "id": "plugin1",
  "pluginType": "Native",
  "pollInterval": 30,
  "autoStart": true,
  "config": {
    "getJobs": "exec:///opt/moab/tools/workload.query.pl"
  },
  "state": "STARTED",
  "nextPollDate": "2011-12-02 17:28:52 UTC",
  "lastPollDate": "2011-12-02 17:28:22 UTC"
}

```

## 4.15.2 Creating Plugins

The HTTP POST method is used to create **Plugins**.

### Quick Reference

```

POST http://localhost/mws/rest/plugins

```

### 4.15.2.1 Create Plugin

#### URLs and Parameters

```

POST http://localhost/mws/rest/plugins

```

See [Global URL Parameters](#) for available URL parameters.

### Request Body

When creating a plugin, the `id` and `pluginType` fields are required. The request body below shows all fields that are available when creating a Plugin, along with some sample values.

## JSON Request Body

```
{
  "id": "plugin1",
  "pluginType": "Native",
  "pollInterval": 30,
  "autoStart": true,
  "config": {
    "getJobs": "exec:///opt/moab/tools/workload.query.pl"
  }
}
```

## Sample Response

### JSON Response for successful POST

```
{"id": "plugin1"}
```

## Restrictions

While it is *possible* to create a plugin with arbitrary nested configuration, such as:

```
...
"config": {
  "nestedObject": {
    "property1": "value1",
    "property2": "value2"
  },
  "nestedList": ["listItem1", "listItem2"]
}
```

It is **not** recommended as the [user interface](#) does not support editing or viewing any configuration data values other than strings.

### 4.15.3 Modifying Plugins

The HTTP PUT method is used to modify **Plugins**. Additionally, the POST method may be used to trigger an immediate poll of a **Plugin**.

## Quick Reference

```
PUT http://localhost/mws/rest/plugins/<id>
POST http://localhost/mws/rest/plugins/<id>/poll
```

#### 4.15.3.1 Modify Plugin

### URLs and Parameters

```
PUT http://localhost/mws/rest/plugins/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Request Body

The request body below shows all the fields that are available when modifying a Plugin, along with some sample values.

```

JSON Request Body for Plugin Modification
{
  "state": "STARTED",
  "pollInterval": 30,
  "autoStart": true,
  "config": {
    "getJobs": "exec:///opt/moab/tools/workload.query.pl"
  },
  "state": "STARTED"
}

```

## Sample Response

```

JSON Response
{"messages": ["Plugin plugin1 updated", "Started Plugin 'plugin1'"]}

```

### 4.15.3.2 Trigger Plugin Poll

#### URLs and Parameters

```

POST http://localhost/mws/rest/plugins/<id>/poll

```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Trigger Poll

This resource call will trigger an immediate poll of the specified plugin. It is equivalent to the same operation on the [Monitoring and Lifecycle Controls](#) page.

## Request Body

No request body is required.

## Sample Response

JSON Response

```
{ "messages": [ "Polled Plugin with ID 'myPlugin' ] }
```

## 4.15.4 Deleting Plugins

The HTTP DELETE method is used to delete **Plugins**.

### Quick Reference

```
DELETE http://localhost/mws/rest/plugins/<id>
```

### 4.15.4.1 Delete Plugin

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/plugins/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

JSON Response for successful DELETE

```
{ }
```



Additional information about a successful DELETE can be found in the HTTP response header X-MWS-Message.

JSON Response for an unsuccessful DELETE

```
{ "messages": [ "Plugin plugin1 could not be deleted", "Error message describing the problem" ] }
```

## 4.15.5 Accessing Plugin Web Services

All HTTP methods can be used to access **Plugin Web Services**. However, some services only support specific methods. Check the specific plugin type documentation for more information.

## Quick Reference

```
GET http://localhost/mws/rest/plugins/<id>/services/<serviceName>
POST http://localhost/mws/rest/plugins/<id>/services/<serviceName>
PUT http://localhost/mws/rest/plugins/<id>/services/<serviceName>
DELETE http://localhost/mws/rest/plugins/<id>/services/<serviceName>
```

### 4.15.5.1 Access a Plugin Web Service

#### URLs and Parameters

```
GET http://localhost/mws/rest/plugins/<id>/services/<serviceName>
POST http://localhost/mws/rest/plugins/<id>/services/<serviceName>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
serviceName	Yes	String	-	The name of the web service, either in CamelCase or hyphenated.

See [Global URL Parameters](#) for available URL parameters.

#### Web Service IDs

Translation is done to map [CamelCase](#) web service names to hyphenated names in the URL. For example, a web service method named `notifyEvent` on a plugin with a name of `notifications` may be called with the following URLs:

```
// CamelCase
/rest/plugins/notifications/services/notifyEvent

// Hyphenated
/rest/plugins/notifications/services/notify-event
```

#### HTTP Method and Request Body

Because plugin [Custom Web Services](#) do not need to distinguish which HTTP method is used, it is recommended to use GET and POST when making requests to access web services unless documented otherwise. The request body and output may vary for each web service called. See the plugin type documentation for the requested plugin for available web services, request parameters, and expected output.

## 4.16 Plugin Types

This section describes behavior of the **Plugin Type** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [PluginType API](#) page contains the type and description of all fields in the **Plugin Type** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST DELETE
/rest/plugin-types	<a href="#">Get all plugin types</a>	<a href="#">Create or update plugin type</a>	
/rest/plugin-types/id	<a href="#">Get specified plugin type</a>		

### 4.16.1 Getting Plugin Types

The HTTP GET method is used to retrieve **Plugin Type** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/plugin-types/<id>
```

#### 4.16.1.1 Get All Plugin Types

##### URLs and Parameters

```
GET http://localhost/mws/rest/plugin-types
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/plugin-types?fields=id
```

```
{
  "totalCount": 2,
  "resultCount": 2,
  "results": [
    { "id": "vCenter" },
    { "id": "Native" }
  ]
}
```

#### 4.16.1.2 Get Single Plugin Type

##### URLs and Parameters

```
GET http://localhost/mws/rest/plugin-types/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

### JSON Response

```
{
  "author": "Adaptive Computing Enterprises, Inc.",
  "commonsVersion": "0.9.3 > *",
  "description": "Polls a VMware® vCenter™ Server for information on the hypervisors
and virtual machines it manages.",
  "documentationLink": "",
  "email": "",
  "id": "VCenter",
  "initialPlugins": { },
  "instances": [
    {"id": "vcenter"}
  ],
  "issueManagementLink": "",
  "license": "APACHE",
  "mwsVersion": "7.1.2 > *",
  "pollMethod": true,
  "scmLink": "",
  "title": "VCenter",
  "version": "1.0",
  "webServices": [ ],
  "website": "http://www.adaptivecomputing.com"
}
```

## 4.16.2 Creating or Updating Plugin Types

The HTTP PUT method is used to create or update **Plugin Types**. The Content-Type HTTP header is used to determine if the request contains a single class file as plaintext or the binary data of a JAR file. Each request is explained in the following sections.

### Quick Reference

```
PUT http://localhost/mws/rest/plugin-types[?reload-plugins=false]
```



There is a known issue with dynamically updating plugin types with typed field injection. See the [Add or Update Plugin Types](#) section for more information.

### 4.16.2.1 Update Plugin Type (File)

#### URLs and Parameters

```
PUT http://localhost/mws/rest/plugin-types[?reload-plugins=false]
```

Parameter	Required	Valid Values	Description
reload-plugins	No	true or false	Reloads all plugins of this type on successful update. Defaults to true.

See [Global URL Parameters](#) for available URL parameters.

## Request Body

This function is idempotent, meaning it will create the Plugin Type if it does not exist or update it if it does. The request body is the actual contents of the class file to upload. This web service is an exception to most as it **requires** a content type of `application/x-groovy` or `text/plain`.



If the `application/x-groovy` or `text/plain` content types are not used in the request, it will be interpreted as JSON, resulting in a failure.

### Plaintext upload

```
package test
import com.adaptc.mws.plugins.*
class UploadPlugin {
    static author = "Adaptive Computing"
    static description = "A sample plugin class"
    String id
    public void configure() throws InvalidPluginConfigurationException {
        def myConfig = config
        def errors = []
        if (!myConfig.arbitraryKey)
            errors << "Missing arbitraryKey!"
        if (errors)
            throw new InvalidPluginConfigurationException(errors)
    }
    public def customService(Map params) {
        return params
    }
}
```



If using the [curl](#) library to perform plugin type uploading, the equivalent of the command-line option `--data-binary` must be used to send the request body. Otherwise compilation errors may be encountered when uploading the plugin type.

## Sample Response

The response of this task is the same as the [Get All Plugin Types](#) task. The reason that the return of this task is a list is to accommodate the possibility of uploading multiple plugin types in a single JAR file as explained in the next section.

## 4.16.2.2 Update Plugin Type (JAR)

### URLs and Parameters

```
PUT http://localhost/mws/rest/plugin-types?jar-filename=<filename.jar>
[&reload-plugins=false]
```

Parameter	Required	Valid Values	Description
jar-filename	Yes	String	The filename of the JAR file that is being uploaded.
reload-plugins	No	true or false	Reloads all plugins of this type on successful update. Defaults to true.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

This function is idempotent, meaning it will create the Plugin Types if they do not exist or update them if they do. The request body is the binary contents of the JAR file to upload. This web service is an exception to most as it **requires** a content type of `application/x-jar`.

 If the `application/x-jar` content type is not used in the request, it will be interpreted as JSON, resulting in a failure.

 If using the [curl](#) library to perform plugin type uploading, the equivalent of the command-line option `--data-binary` must be used to send the request body. Otherwise compilation errors may be encountered when uploading the plugin type.

### Sample Response

The response of this task is the same as the [Get All Plugin Types](#) task. Note that when using a JAR file, multiple plugin types may be uploaded in the same request.

## 4.17 Policies

This section describes behavior of the **Policies** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Policy API](#) contains the type and description of fields that all **Policies** have in common.

## Supported Policies

Name	Id
<a href="#">Auto VM Migration</a>	auto-vm-migration
<a href="#">Hypervisor Allocation Overcommit</a>	hv-allocation-overcommit
<a href="#">Node Allocation</a>	node-allocation
<a href="#">Migration Exclusion List</a>	migration-exclusion-list

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/policies	<a href="#">Get all policies</a>			
/rest/policies/ <b>id</b>	<a href="#">Get specified policy</a>	<a href="#">Modify specified policy</a>		

### 4.17.1 Getting Policies

The HTTP GET method is used to retrieve **Policies** information.

#### Quick Reference

```
GET http://localhost/mws/rest/policies
```

#### 4.17.1.1 Get All Policies

##### URLs and Parameters

```
GET http://localhost/mws/rest/policies
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Query for specific results.	query={"state":"DISABLED","conflicted":"false"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"id":-1}

It is possible to query policies by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```
GET http://localhost/mws/rest/policies?fields=id,state,conflicted

{
  "totalCount": 2,
  "resultCount": 2,
  "results": [
    {
      "conflicted": false,
      "state": "DISABLED",
      "id": "auto-vm-migration"
    },
    {
      "conflicted": false,
      "state": "DISABLED",
      "id": "hv-allocation-overcommit"
    },
    {
      "conflicted": false,
      "state": "DISABLED",
      "id": "node-allocation"
    },
    {
      "conflicted": false,
      "state": "DISABLED",
      "id": "migration-exclusion-list"
    }
  ]
}
```

### 4.17.1.2 Get Single Policy

#### URLs and Parameters

```
GET http://localhost/mws/rest/policies/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Responses

## Auto VM Migration

```
{
  "conflicted": false,
  "description": "Configure thresholds to control how and when virtual machines are
moved from one hypervisor to another.",
  "id": "auto-vm-migration",
  "name": "Automatic Virtual Machine Migration",
  "potentialConflicts": [],
  "priority": 1,
  "state": "DISABLED",
  "tags": [],
  "types": [],
  "version": 0,
  "genericMetricThresholds":{
    "GMETRIC1":1.3
  },
  "processorUtilizationThreshold":0.5,
  "memoryUtilizationThreshold":0.4,
  "migrationAlgorithmType": "NONE"
}
```

## Hypervisor Allocation Overcommit

```
{
  "conflicted": false,
  "description": "Controls how hypervisors are overallocated with regards to processors
and memory.",
  "id": "hv-allocation-overcommit",
  "name": "Hypervisor Allocation Overcommit",
  "potentialConflicts": [],
  "priority": 2,
  "state": "DISABLED",
  "tags": [],
  "types": [],
  "version": 0,
  "processorAllocationLimit":29.5,
  "memoryAllocationLimit":1.2
}
```

## Node Allocation

```
{
  "conflicted": false,
  "description": "Controls how nodes are selected for workload placement.",
  "id": "node-allocation",
  "name": "Node Allocation",
  "potentialConflicts": [],
  "priority": 3,
  "state": "DISABLED",
  "tags": [],
  "types": [],
  "version": 0,
  "nodeAllocationAlgorithm": "CustomPriority",
  "customPriorityFunction": "100*RSVAFFINITY - GMETRIC[numvms]"
}
```

## Migration Exclusion List

```
{
  "conflicted": false,
  "description": "Controls which machines are excluded from automatic live migration
operations.",
  "hvExclusionList": ["blade05", "blade02"],
  "name": "Migration Exclusion List",
  "potentialConflicts": [],
  "priority": 100,
  "state": "DISABLED",
  "tags": [],
  "types": [],
  "version": 1,
  "vmExclusionList": ["vm1", "vm5"],
  "id": "migration-exclusion-list"
}
```

## 4.17.2 Modifying Policies

The HTTP PUT method is used to modify **Policies**.

### Quick Reference

```
PUT http://localhost/mws/rest/policies/<id>
```

### 4.17.2.1 Modify Policy

#### URLs and Parameters

```
PUT http://localhost/mws/rest/policies/<id>[?change-mode=set]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

#### Additional URL parameters

URL parameters for modifying a Migration Exclusion Lists Policy.

Migration Exclusion Lists Parameter	Required	Valid Values	Description
change-mode	No	set(Default)	Replace the existing exclusion list(s) with the given one.
		add	Add the given VMs/HVs to the existing exclusion list(s).
		remove	Remove the given VMs/HVs from the existing exclusion list(s).

## Request Body

In general, the fields shown in the [Policy API](#) are **not** available for modification. However, the state field may be modified to a valid [Policy State](#). All other fields listed in the specific API pages may be modified unless documented otherwise.

The request body below shows all the fields that are available when modifying a Auto VM Migration Policy, along with some sample values.

```

JSON Request Body for Auto VM Migration Policy
{
  "genericMetricThresholds": {
    "GENERICTHRESHOLD": 5
  },
  "memoryUtilizationThreshold": 0.5,
  "processorUtilizationThreshold": 0.4
}

```

The request body below shows all the fields that are available when modifying a Node Allocation Policy, along with some sample values.

```

JSON Request Body for Auto VM Migration Policy
{
  "nodeAllocationAlgorithm" : "CustomPriority",
  "customPriorityFunction" : "100*RSVAFFINITY - GMETRIC[numvms]"
}

```

The request body below shows all the fields that are available when modifying a Migration Exclusion Lists Policy, along with some sample values.

```

JSON Request Body for Migration Exclusion Lists Policy
{
  "vmExclusionList" : [ "vm1", "vm3", "vm5" ],
  "hvExclusionList" : [ "hv2", "hv3", "hv6" ]
}

```

## Sample Response

## JSON Response

```
{
  "messages": ["Policy auto-vm-migration updated"]
}
```

## Samples

Enable the Auto VM Migration Policy and set values.

### PUT <http://localhost/mws/rest/policies/auto-vm-migration>

```
{
  "state": "enabled",
  "migrationAlgorithmType": "overcommit",
  "processorUtilizationThreshold": 0.5,
  "memoryUtilizationThreshold": 0.4
}
```



As noted in the [Auto VM Migration API](#) documentation, if the state is set to ENABLED, then the migrationAlgorithmType must **not** be set to NONE.

## Restrictions

### All Policies

- Fields cannot be modified while the policy is disabled. Enable the policy to modify the field.

### Auto VM Migration

- Arbitrary metrics can be added to **genericMetricThresholds**, but they cannot be removed once added.
- The **migrationAlgorithmType** field cannot be modified while the policy is disabled. Enable the policy to modify the field.
- Moab is configured with a default limit of 10 generic metrics. If this limit is reached, such as when arbitrary metrics are added to **genericMetricThresholds**, the metric will not be reported.
  - To increase this limit, set the MAXGMETRIC property in the Moab configuration file.

## 4.18 Principals

This section describes behavior of the **Principal** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Principal API](#) contains the type and description of all fields in the **Principal** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/principals	<a href="#">Get All Principals</a>		<a href="#">Create Principal</a>	
/rest/principals/ <b>id</b>	<a href="#">Get Specified Principal</a>	<a href="#">Modify Principal</a>		<a href="#">Delete Principal</a>
/rest/principals/ <b>name</b>	<a href="#">Get Specified Principal</a>	<a href="#">Modify Principal</a>		<a href="#">Delete Principal</a>

### 4.18.1 Getting Principals

The HTTP GET method is used to retrieve **Principal** information. You can query all objects or a single object.

#### Quick Reference

```
GET http://localhost/mws/rest/principals[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/principals/<id>
GET http://localhost/mws/rest/principals/<name>
```

#### 4.18.1.1 Get All Principals

##### URLs and Parameters

```
GET http://localhost/mws/rest/principals[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"name":"Acme Principal"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query principals by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

GET http://localhost/mws/rest/principals?fields=name,description

```
{
  "totalCount": 2,
  "resultCount": 2,
  "results": [
    {
      "groups": [
        {
          "name": "CN=Engineering,CN=Users,DC=corp,DC=cloud,DC=dev",
          "type": "LDAPGROUP"
        }
      ],
      "name": "Engineering-Principal"
    },
    {
      "groups": [
        {
          "name": "CN=Marketing,CN=Users,DC=corp,DC=cloud,DC=dev",
          "type": "LDAPGROUP"
        }
      ],
      "name": "Marketing-Principal"
    }
  ]
}
```

## Sorting and Querying

See the sorting and querying sections of [Global URL Parameters](#).

### 4.18.1.2 Get Single Principal

#### URLs and Parameters

```
GET http://localhost/mws/rest/principals/<id>
GET http://localhost/mws/rest/principals/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Principal.
name	Yes	String	-	The name of the Principal.

See [Global URL Parameters](#) for available URL parameters.



You must specify either **id** or **name**, but you do not have to specify both.

## Sample Response

GET http://localhost/mws/rest/principals/principal8

```
{
  "attachedRoles": [ {
    "description": "This is a role for normal users in the Acme BU Group.",
    "id": "5033b8eae4b09cc61bedb895",
    "name": "Acme-User-Role",
    "permissions": [
      {
        "action": "read",
        "description": "The permission to read all nodes",
        "id": "5033b842e4b09cc61bedb818",
        "label": "",
        "resource": "nodes",
        "resourceFilter": null,
        "type": "api",
        "version": 1
      },
    ],
    "version": 2
  } ],
  "description": "Principal 8",
  "groups": [ {
    "name": "CN=Engineering,CN=Users,DC=corp,DC=cloud,DC=dev",
    "type": "LDAPGROUP"
  } ],
  "id": "5033d33fe4b018b28745fecb",
  "name": "principal8",
  "users": [
    {
      "name": "jhammon",
      "type": "LDAP"
    },
    {
      "name": "bjones",
      "type": "LDAP"
    }
  ],
  "version": 0
}
```

## 4.18.2 Creating Principals

The HTTP POST method is used to submit **Principals**.

### Quick Reference

```
POST http://localhost/mws/rest/principals
```

#### 4.18.2.1 Create Single Principal

##### URLs and Parameters

```
POST http://localhost/mws/rest/principals
```

See [Global URL Parameters](#) for available URL parameters.

### Request Body



- The **name** field is required and must contain only letters, digits, periods, dashes, and underscores.
- The **attachedRoles** field expects an array of Role IDs **or** names:

The following is an example request body to create a principal:

POST http://localhost/mws/rest/principals

```
{
  "name" : "Acme-Principal",
  "attachedRoles" : [{"name": "Acme-User-Role"}],
  "description" : "A cool principal",
  "groups" : [{"name": "CN=Engineering,CN=Users,DC=corp,DC=cloud,DC=dev", "type":
"LDAPGROUP"}],
  "users" : [{
    "name" : "john",
    "type" : "LDAP"
  } ]
}
```

## Sample Response

If the request was successful, the response body is the new principal that was created, exactly as shown in [Get Single Principal](#). On failure, the response is an error message.

## 4.18.3 Modifying Principals

The HTTP PUT method is used to modify **Principals**.

### Quick Reference

```
PUT http://localhost/mws/rest/principals/<id>
PUT http://localhost/mws/rest/principals/<name>
```

### 4.18.3.1 Modify Single Principal

URLs and Parameters

```
PUT http://localhost/mws/rest/principal/<id>
PUT http://localhost/mws/rest/principal/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Principal.
name	Yes	String	-	The name of the Principal.
change-mode	Yes	String	add	Add the given objects (ldapGroups, ldapOUs, etc) to the objects that already exist.
			remove	Delete the given objects from the objects that already exist.
			set	Add the given objects (ldapGroups, ldapOUs, etc) and remove the objects that already exist.

See [Global URL Parameters](#) for available URL parameters.



- The change-mode **set** is the default if no change-mode parameter is given.
- You must specify either **id** or **name**, but you do not have to specify both.
- The **name** field must contain only letters, digits, periods, dashes, and underscores.
- The **attachedRoles** field expects an array of Role IDs **or** names:

## Example Request

```

PUT http://localhost/mws/rest/principals/Acme-Principal"
{
  "groups" : [ {
    "name" : "CN=Marketing,CN=Users,DC=mycompany,DC=com",
    "type" : "LDAPGROUP"
  }, {
    "name" : "CN=Sales,CN=Users,DC=mycompany,DC=com",
    "type" : "LDAPGROUP"
  } ],
  "users" : [ {
    "name" : "jhammon",
    "type" : "LDAP"
  } ]
}

```



The **version** field contains the current version of the database entry. This field cannot be updated directly. However, if **version** is included in the modify request, it will be used to verify that another client did not update the object between the time that the data was retrieved and the modify request was delivered.

## Sample Response

If the request was successful, the response body is the modified principal as shown in [Get Single Principal](#). On failure, the response is an error message.

## 4.18.4 Deleting Principals

The HTTP DELETE method is used to delete **Principals**.

### Quick Reference

```
DELETE http://localhost/mws/rest/principals/<id>
DELETE http://localhost/mws/rest/principals/<name>
```

### 4.18.4.1 Delete Single Principal

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/principal/<id>
DELETE http://localhost/mws/rest/principal/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Principal.
name	Yes	String	-	The name of the Principal.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

### Sample Response

JSON Response

```
{}
```

## 4.19 Quotes

This section describes behavior of the **Quotes** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Quote API](#) contains the type and description of fields that all **Quotes** have in common.

## Supported Methods

Resource	GET PUT POST	DELETE
/rest/quotes/standard/quote	<a href="#">Quoting resources</a>	

## 4.19.1 Quoting Resources

### Quick Reference

```
POST http://localhost/mws/rest/quotes/standard/quote?object-type=<OBJECTTYPE>
&proxy-user=<USER>&charge-duration=<CHARGEDURATION>
```

### 4.19.1.1 Quote Single Job or Service

#### URLs and Parameters

```
POST http://localhost/mws/rest/quotes/standard/quote?object-type=<OBJECTTYPE>
&proxy-user=<USER>&charge-duration=<CHARGEDURATION>
```

Parameter	Required	Type	Valid Values	Description
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
charge-duration	Yes	Integer	The charge duration of the job in seconds.	charge-duration=6400
object-type	Yes	String	The object to quote. It can be job or service.	object-type=job
itemize	No	Boolean	Returns the composite charge information in the response data.	itemize=true

rate	No	JSONArray	<p>Uses the specified charge rates in the quote. The specified rates override the standard and quote rates. If the guarantee field is set to true, these charge rates will be saved and used when this quote is referenced in a charge action.</p>	rate=[{"type":"VBR","name":"Memory","rate":1}
guarantee	No	Boolean	<p>Guarantees the quote and returns a quote id to secure the current charge rates. This results in the creation of a quote record and a permanent usage record. This parameter is mutually exclusive with the cost-only parameter.</p>	guarantee=true

grace-duration	No	Integer	The guaranteed quote grace period in seconds. If the quote duration is specified but not the quote end time, the quote endtime will be calculated as the quote start time plus the quote duration plus the grace duration.	grace-duration=6400
cost-only	No	Integer	Returns the cost, ignoring all balance and validity checks. This parameter is mutually exclusive with the guarantee parameter.	cost-only=true
description	No	String	The guaranteed quote description.	description="ABC Coupon Rate"
start-time	No	Date	The guaranteed quote start time in the format yyyy-MM-dd HH:mm:ss z, -Infinity, Infinity, or Now.	start-time="2012-04-09 13:49:40 UTC"

end-time	No	Date	The guaranteed quote end time in the format yyyy-MM-dd HH:mm:ss z, -Infinity, Infinity, or Now.	end-time="2012-04-09 14:49:40 UTC"
----------	----	------	---	------------------------------------

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows all of the fields in a Job that could affect the quote.

```

POST http://localhost/mws/rest/quotes/standard/quote?object-type=job

{
  "id": "Moab.1",
  "user": "amy",
  "group": "group",
  "rmName": "machine1",
  "templateList": [
    "genericVm"
  ],
  "account": "biology",
  "qosRequested": "QOS1",
  "variables": {
    "imageName": "centos5.5-stateless",
    "topLevelServiceId": "myService.1",
    "serviceId": "vmService.1",
    "vmid": "VmService.1",
    "pmid": "VmService.1"
  },
  "requirements": [
    {
      "requiredProcessorsPerTask": 2,
      "genericResources": {
        "gold": 100,
        "os": 500
      },
      "requiredNodeCountMinimum": 1,
      "requiredMemoryPerTask": 1024,
      "requiredClass": "batch"
    }
  ]
}

```

The request body below shows all of the fields in a Service that affect the quote in a default MAM installation.

POST http://localhost/mws/rest/quotes/standard/quote?object-type=service

```
{
  "name": "service.1",
  "user": "amy",
  "account": "chemistry"
  "attributes": {
    "moab": {
      "job": {
        "resources": {
          "procs": 1,
          "mem": 2048,
          "OS": 500,
          "gold": 100
        },
        "variables": {
          "Var1": 1524
        },
        "image": "centos5.5-stateless",
        "template": "genericVM",
      }
    }
  }
}
```

## Sample Responses

**If the quote is not guaranteed**

JSON Response

```
{
  "instance": "Moab.1",
  "amount": 600
}
```

**If the quote is guaranteed**

JSON Response

```
{
  "id": 1,
  "usageRecord": 2,
  "instance": "Moab.1",
  "amount": 600
}
```

**If the quote is guaranteed and itemized**

## JSON Response

```
{
  "details": [
    {
      "name": "Processors",
      "value": "2",
      "duration": 300,
      "rate": 1,
      "scalingFactor": 1,
      "amount": 600,
      "details": "2 [Processors] * 1 [ChargeRate{VBR}{Processors}] * 300 [Duration]"
    },
    {
      "name": "Memory",
      "value": "1024",
      "duration": 300,
      "rate": 1,
      "scalingFactor": 1,
      "amount": 307200,
      "details": "1024 [Memory] * 1 [ChargeRate{VBR}{Memory}] * 300 [Duration]"
    }
  ],
  "id": 20,
  "instance": "Moab.1",
  "usageRecord": 20,
  "amount": 307800
}
```

**If the quote is on a service**

## JSON Response

```
{
  "services": [
    {
      "details": [
        {
          "name": "Processors",
          "value": "22",
          "duration": 30,
          "rate": 1,
          "scalingFactor": 1,
          "amount": 660,
          "details": "22 [Processors] * 1 [ChargeRate{VBR}{Processors}] * 30 [Duration]"
        },
        {
          "name": "Memory",
          "value": "32343242",
          "duration": 30,
          "rate": 1,
          "scalingFactor": 1,
          "amount": 970297260,
          "details": "32343242 [Memory] * 1 [ChargeRate{VBR}{Memory}] * 30 [Duration]"
        }
      ],
      "id": 120,
      "instance": "myVmWorkflow",
      "usageRecord": 157,
      "amount": 970297920
    },
    {
      "details": [
        {
          "name": "Storage",
          "value": "2500",
          "duration": 30,
          "rate": 1.157E-7,
          "scalingFactor": 1,
          "amount": 0,
          "details": "2500 [Storage] * 1.157e-07 [ChargeRate{VBR}{Storage}] * 30 [Duration]"
        }
      ],
      "id": 122,
      "instance": "myExtraStorageWorkflow",
      "usageRecord": 159,
      "amount": 0
    },
    {
      "details": [
        {
          "name": "Processors",
          "value": "0",
          "duration": 30,
          "rate": 1,
          "scalingFactor": 1,
          "amount": 0,
          "details": "0 [Processors] * 1 [ChargeRate{VBR}{Processors}] * 30 [Duration]"
        },
        {
          "name": "Memory",
          "value": "0",
          "duration": 30,
          "rate": 1,
          "scalingFactor": 1,
          "amount": 0,
          "details": "0 [Memory] * 1 [ChargeRate{VBR}{Memory}] * 30 [Duration]"
        }
      ],
      "id": 123,
      "instance": "myPmWorkflow",
      "usageRecord": 160,
      "amount": 0
    }
  ],
  "amount": 970297920
}
```

## Restrictions

- The details field is only available with MAM version 7.1.0 or later.

## 4.20 Reports

This section describes behavior of the reporting framework in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Report](#), [Sample](#), and [Datapoint](#) API contains the type and description of all fields in the **Report**, **Sample**, and **Datapoint** objects. They also contains details regarding which fields are valid during PUT and POST actions.

### Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/reports	<a href="#">Get all reports</a>		<a href="#">Create Reports</a>	<a href="#">Deleting Reports</a>
/rest/reports/ <b>name</b>	<a href="#">Get single report with data</a>			
/rest/reports/ <b>id</b>	<a href="#">Get single report with data</a>			
/rest/reports/ <b>name</b> /datapoints	<a href="#">Get datapoints for report</a>			
/rest/reports/ <b>id</b> /datapoints	<a href="#">Get datapoints for report</a>			
/rest/reports/ <b>name</b> /samples	<a href="#">Get samples for report</a>		<a href="#">Create sample(s) for report</a>	
/rest/reports/ <b>id</b> /samples	<a href="#">Get samples for report</a>		<a href="#">Create sample(s) for report</a>	

### 4.20.1 Getting Reports

The HTTP GET method is used to retrieve **Report** information. Queries for all reports with no attached data and a single report with associated data are available.

#### Quick Reference

```
GET http://localhost/mws/rest/reports[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/reports/<id>
GET http://localhost/mws/rest/reports/<name>
```

#### 4.20.1.1 Get All Reports (No Data Included)

##### URLs and Parameters

```
GET http://localhost/mws/rest/reports[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"reportSize":4}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query reports by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```

JSON Response
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "id": "3efe5c670be86ba8560397ff",
    "name": "cpu-util"
  } ]
}

```

 No datapoints are returned when querying for all reports. To view the consolidated datapoints, the [Get Single Report](#) API call must be used.

## Samples

```

GET http://localhost/mws/rest/reports?fields=id,name
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    {
      "id": "3efe5c670be86ba8560397ff",
      "name": "cpu-util"
    },
    {
      "id": "3efe5c670be86ba856039800",
      "name": "cpu-temp"
    },
    {
      "id": "3efe5c670be86ba856039801",
      "name": "cpu-load"
    }
  ]
}

```

### 4.20.1.2 Get Single Report (Includes Data)

#### URLs and Parameters

```
GET http://localhost/mws/rest/reports/<id>
GET http://localhost/mws/rest/reports/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the report.
name	Yes	String	-	The name of the report.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

## Sample Response

In the example below, the first datapoint has a `null` data element, which means that the `minimumSampleSize` configured for the report was not met when consolidating the datapoint. The second datapoint contains actual data.

### JSON Response

```
{
  "consolidationFunction": "average",
  "datapointDuration": 15,
  "datapoints": [
    {
      "endDate": "2011-12-02 17:28:22 UTC",
      "startDate": "2011-12-02 17:28:22 UTC",
      "firstSampleDate": null,
      "lastSampleDate": null,
      "data": null
    },
    {
      "endDate": "2011-12-02 17:28:23 UTC",
      "startDate": "2011-12-02 17:28:37 UTC",
      "firstSampleDate": "2011-12-02 17:28:23 UTC",
      "lastSampleDate": "2011-12-02 17:28:30 UTC",
      "data": {
        "utilization": 99.89,
        "time": 27.433333333333337
      }
    }
  ],
  "description": "Example of CPU utilization reporting",
  "id": "3efe5c670be86ba8560397ff",
  "keepSamples": false,
  "minimumSampleSize": 1,
  "name": "cpu-util",
  "reportSize": 2
}
```

## 4.20.1.3 Get Datapoints For Single Report

### URLs and Parameters

```
GET http://localhost/mws/rest/reports/<id>/datapoints[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/reports/<name>/datapoints[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the report.
name	Yes	String	-	The name of the report.
query	No	JSON	Queries for specific results.	query={"data.test":true}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"startDate":-1}

It is possible to query datapoints by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

## Sample Response

This function is exactly the same as requesting a [single report](#) with only the datapoints returned. No report metadata (i.e. description, minimumSampleSize, etc.) is returned.

### JSON Response

```
{
  "resultCount":1,
  "totalCount":1,
  "results":[
    {
      "endDate": "2011-12-02 17:28:22 UTC",
      "startDate": "2011-12-02 17:28:22 UTC",
      "firstSampleDate": null,
      "lastSampleDate": null,
      "data": null
    },
    {
      "endDate": "2011-12-02 17:28:37 UTC",
      "startDate": "2011-12-02 17:28:37 UTC",
      "firstSampleDate": "2011-12-02 17:28:23 UTC",
      "lastSampleDate": "2011-12-02 17:28:23 UTC",
      "data": {
        "utilization": 99.89,
        "time": 27.433333333333337
      }
    }
  ]
}
```

## 4.20.2 Getting Samples For Reports

The HTTP GET method is used to retrieve **Sample** information.

### Quick Reference

```
GET http://localhost/mws/rest/reports/<id>/samples[?query={"field":"value"}&sort={
"field":<1|-1>}]
GET http://localhost/mws/rest/reports/<name>/samples[?query={"field":"value"}&sort={
"field":<1|-1>}]
```

## 4.20.2.1 Get Samples For Report

### URLs and Parameters

```
GET http://localhost/mws/rest/reports/<id>/samples[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/reports/<name>/samples[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the report.
name	Yes	String	-	The name of the report.
query	No	JSON	Queries for specific results.	query={"agent":"cpu-monitor"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"agent":-1}

It is possible to query samples by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

### Sample Response

#### JSON Response

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "timestamp": "2011-12-02 17:28:37 UTC"
    "data": {
      "cpu1": 2.3,
      "cpu2": 1.2,
      "cpu3": 0.0,
      "cpu4": 12.1
    }
  },
  ...
]
}
```

## 4.20.3 Creating Reports

The HTTP POST method is used to create **Reports**. Operations are available to create reports with or without historical datapoints.

### Quick Reference

```
POST http://localhost/mws/rest/reports
```

## 4.20.3.1 Create Report

### URLs and Parameters

```
POST http://localhost/mws/rest/reports
```

See [Global URL Parameters](#) for available URL parameters.

### Request Body

To create a report, several fields are required as documented in the [Report API](#).

The request body below shows all the fields that are available during report creation.

#### JSON Request Body

```
{
  "name": "cpu-util",
  "description": "An example report on cpu utilization",
  "consolidationFunction": "average",
  "datapointDuration": 15,
  "minimumSampleSize": 1,
  "reportSize": 2,
  "keepSamples": true,
  "datapoints": [
    {
      "startDate": "2011-12-01 19:16:57 UTC",
      "endDate": "2011-12-01 19:16:57 UTC",
      "data": {
        "time": 30,
        "util": 99.98
      }
    }
  ]
}
```

### Sample Response

```
{
  "messages": ["Report cpu-util created"],
  "id": "3efe5c670be86ba8560397ff",
  "name": "cpu-util"
}
```

### Samples

#### POST http://localhost/mws/rest/reports (Minimal report without datapoints)

```
{
  "name": "cpu-util",
  "datapointDuration": 15,
  "reportSize": 2
}
```

## 4.20.4 Creating Samples

The HTTP POST method is used to create **Samples** for Reports.

### Quick Reference

```
POST http://localhost/mws/rest/reports
```

### 4.20.4.1 Create Samples For Report

#### URLs and Parameters

```
GET http://localhost/mws/rest/reports/<id>/samples
GET http://localhost/mws/rest/reports/<name>/samples
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the report.
name	Yes	String	-	The name of the report.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

### Request Body

To create samples for a report, simply send data and an optional timestamp to the URL above.

The request body below shows all the fields that are available during sample creation. Note that the data field can contain arbitrary JSON.

#### JSON Request Body

```
{
  "timestamp": "2011-12-01 19:16:57 UTC",
  "agent": "my agent",
  "data": {
    "cpu1": 2.3,
    "cpu2": 1.2,
    "cpu3": 0.0,
    "cpu4": 12.1
  }
}
```

### Sample Response

```
{"messages":["1 sample(s) created for report cpu-util"]}
```

## 4.20.5 Deleting Reports

The HTTP DELETE method is used to delete **Reports**.

### Quick Reference

```
DELETE http://localhost/mws/rest/reports/<id>  
DELETE http://localhost/mws/rest/reports/<name>
```

### 4.20.5.1 Delete Report

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/reports/<id>  
DELETE http://localhost/mws/rest/reports/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the report.
name	Yes	String	-	The name of the report.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

### Sample Response

JSON Response

```
{"messages":["Report cpu-util deleted"]}
```

## 4.21 Reservations

This section describes behavior of the **Reservation** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Reservation API](#) contains the type and description of all fields in the **Reservation** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/reservations	<a href="#">Get all reservations</a>		<a href="#">Create reservation</a>	
/rest/reservations/ id	<a href="#">Get specified reservation</a>	<a href="#">Modify reservation</a>		<a href="#">Release reservation</a>

### 4.21.1 Getting Reservations

The HTTP GET method is used to retrieve **Reservation** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/reservations/<id>
```

#### Restrictions

- Only admin or user reservations are returned with this call.

#### 4.21.1.1 Get All Reservations

##### URLs and Parameters

```
GET http://localhost/mws/rest/reservations
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/reservations?fields=id
```

```
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    { "id": "system.1" },
    { "id": "system.2" },
    { "id": "system.3" }
  ]
}
```

#### 4.21.1.2 Get Single Reservation

##### URLs and Parameters

```
GET http://localhost/mws/rest/reservations/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

## JSON Response

```
{
  "accountingAccount": "",
  "accountingGroup": "",
  "accountingQOS": "",
  "accountingUser": "root",
  "aclRules": [ {
    "affinity": "NEUTRAL",
    "comparator": "LEXIGRAPHIC_EQUAL",
    "type": "RESERVATION_ID",
    "value": "system.43"
  } ],
  "allocatedNodeCount": 1,
  "allocatedProcessorCount": 8,
  "allocatedTaskCount": 1,
  "allocatedNodes": [
    { "id": "node001" }
  ],
  "comments": "",
  "creationDate": null,
  "duration": 200000000,
  "endDate": "2018-03-17 16:49:10 UTC",
  "excludeJobs": [
    "job1",
    "job2"
  ],
  "expireDate": null,
  "flags": [
    "REQFULL",
    "ISACTIVE",
    "ISCLOSED"
  ],
  "globalId": "",
  "hostListExpression": "",
  "id": "system.43",
  "idPrefix": "",
  "isActive": true,
  "isTracked": false,
  "label": "",
  "maxTasks": 0,
  "messages": [],
  "owner": {
    "name": "adaptive",
    "type": "USER"
  },
  "partitionId": "switchB",
  "profile": "",
  "requirements": {
    "architecture": "",
    "featureList": [
      "feature1",
      "feature2"
    ],
    "featureMode": "",
    "memory": 0,
    "nodeCount": 0,
    "nodeIds": ["node001:1"],
    "os": "",
    "taskCount": 1
  },
  "reservationGroup": "",
  "resources": { "PROCS": 0 },
  "startDate": "2011-11-14 20:15:50 UTC",
  "statistics": {
    "caps": 0,
    "cips": 2659.52,
    "taps": 0,
    "tips": 0
  },
  "subType": "Other",
  "taskCount": 0,
  "trigger": null,
  "triggerIds": [],
  "uniqueIndex": "",
  "variables": {}
}
```

### 4.21.2 Creating Reservations

The HTTP POST method is used to create **Reservations**.

## Quick Reference

```
POST http://localhost/mws/rest/reservations
```

### 4.21.2.1 Create Reservation

#### URLs and Parameters

```
POST http://localhost/mws/rest/reservations
```

See [Global URL Parameters](#) for available URL parameters.

#### Request Body

The request body below shows all the fields that are available when creating a Reservation, along with some sample values.

## JSON Request Body

```
{
  "accountingAccount": "",
  "accountingGroup": "",
  "accountingQOS": "",
  "accountingUser": "root",
  "aclRules": [ {
    "affinity": "POSITIVE",
    "comparator": "LEXIGRAPHIC_EQUAL",
    "type": "GROUP",
    "value": "staff"
  } ],
  "comments": "",
  "duration": 200000000,
  "endDate": "2018-03-17 16:49:10 UTC",
  "excludeJobs": [
    "job1",
    "job2"
  ],
  "flags": [
    "SPACEFLEX",
    "ACLOVERLAP",
    "SINGLEUSE"
  ],
  "hostListExpression": "",
  "idPrefix": "",
  "label": "myreservation",
  "owner": {
    "name": "adaptive",
    "type": "USER"
  },
  "partitionId": "",
  "profile": "",
  "requirements": {
    "architecture": "",
    "featureList": [
      "feature1",
      "feature2"
    ],
    "memory": 0,
    "os": "",
    "taskCount": 1
  },
  "reservationGroup": "",
  "resources": {
    "PROCS": 2,
    "MEM": 1024,
    "DISK": 1024,
    "SWAP": 1024,
    "other1": 17,
    "other2": 42
  },
  "startDate": "2011-11-14 20:15:50 UTC",
  "subType": "Other",
  "trigger": {
    "eventType": "START",
    "actionType": "EXEC",
    "action": "date"
  },
  "variables": {
    "var1": "val1",
    "var2": "val2"
  }
}
```

**Create reservation if no conflicting reservations are found.**

This is equivalent to `mrsvctl -c -h node01 -E`.

## JSON Request Body

```
{
  "flags": [
    "DEDICATEDRESOURCE"
  ],
  "hostListExpression": "node01"
}
```

## Sample Response

JSON Response for successful POST

```
{ "id": "system.44" }
```

## 4.21.3 Modifying Reservations

The HTTP PUT method is used to modify **Reservations**.

### Quick Reference

```
PUT http://localhost/mws/rest/reservations/<id>?change-mode=<add|remove|set>
```

### 4.21.3.1 Modify Reservation

#### URLs and Parameters

```
PUT http://localhost/mws/rest/reservations/<id>?change-mode=<add|remove|set>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
change-mode	Yes	String	add	Add the given variables to the variables that already exist.
			remove	Delete the given variables from the variables that already exist.
			set	Replace all existing variables with the given variables.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows all the fields that are available when modifying a Reservation, along with some sample values.

JSON Request Body for Reservation Modify

```
{  "variables": {    "var1": "val1",    "var2": "val2"  } }
```

## Sample Response



This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

### JSON Response

```
{"messages":["reservation 'system.43' attribute 'Variable' changed."]}
```

## Restrictions

- You can change the ACL Rules on a reservation, but not using this resource. See [Create or Update ACLs](#).

## 4.21.4 Releasing Reservations

The HTTP DELETE method is used to release **Reservations**.

### Quick Reference

```
DELETE http://localhost/mws/rest/reservations/<id>
```

### 4.21.4.1 Release Reservation

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/reservations/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

### JSON Response for successful DELETE

```
{}
```

## 4.22 Resource Types

This section describes behavior of the **Resource Type** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [ResourceType API](#) contains the type and description of all fields in the **Resource Type** object.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/resource-types	<a href="#">Get all resource types</a>	

### 4.22.1 Getting Resource Types

The HTTP GET method is used to retrieve **Resource Type** information.

#### Quick Reference

```
GET http://localhost/mws/rest/resource-types
```

#### 4.22.1.1 Get All Resource Types

##### URLs and Parameters

```
GET http://localhost/mws/rest/resource-types
```

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/resource-types?fields=id
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [
    {"id": "throttle_migrate"}
  ]
}
```

## 4.23 Roles

This section describes behavior of the **Role** resource in Moab Web Services. The role resource is used to control access to MWS resources based on the proxy-user. Each role is attached to a principal and contains a list of proxy-user permissions that the group can use in MWS. This section describes the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Role API](#) contains the type and description of all fields in the **Role** object. It also contains details regarding which fields are valid during PUT and POST actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/roles	<a href="#">Get All Roles</a>		<a href="#">Create Role</a>	
/rest/roles/id	<a href="#">Get Specified Role</a>	<a href="#">Modify Role</a>		<a href="#">Delete Role</a>
/rest/roles/name	<a href="#">Get Specified Role</a>	<a href="#">Modify Role</a>		<a href="#">Delete Role</a>

### 4.23.1 Getting Roles

The HTTP GET method is used to retrieve **Role** information. You can query all objects or a single object.

#### Quick Reference

```
GET http://localhost/mws/rest/roles[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/roles/<id>
GET http://localhost/mws/rest/roles/<name>
```

#### 4.23.1.1 Get All Roles

##### URLs and Parameters

```
GET http://localhost/mws/rest/roles[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"name":"Acme-User-Role"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query roles by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

```
GET http://localhost/mws/rest/roles?fields=id,name
```

```
{
  "totalCount": 1,
  "resultCount": 1,
  "results": [ {
    "id": "4fa197e68ca30fc605dd1cf0",
    "name": "Acme-User-Role"
  } ]
}
```

## Sorting and Querying

See the sorting and querying sections of [Global URL Parameters](#).

### 4.23.1.2 Get Single Role

#### URLs and Parameters

```
GET http://localhost/mws/rest/roles/<id>
GET http://localhost/mws/rest/roles/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Role.
name	Yes	String	-	The name of the Role.

See [Global URL Parameters](#) for available URL parameters.



You must specify either **id** or **name**, but you do not have to specify both.

## Sample Response

GET http://localhost/mws/rest/roles/Acme-User-Role

```
{
  "description" : "This is a role for normal users in the Acme BU Group.",
  "id" : "5022e695e4b073f54e47c28d",
  "name" : "Acme-User-Role",
  "permissions" : [ {
    "action" : "create",
    "description" : "The permission to create all charts.",
    "id" : "5022e695e4b073f54e47c28e",
    "label" : "Create Chart",
    "resource" : "chart",
    "resourceFilter" : null,
    "type" : "custom",
    "version" : 0
  }, {
    "action" : "read",
    "description" : "The permission to view all charts.",
    "id" : "5022e695e4b073f54e47c28f",
    "label" : "View Chart",
    "resource" : "chart",
    "resourceFilter" : null,
    "type" : "custom",
    "version" : 0
  }, {
    "action" : "update",
    "description" : "The permission to modify the africa chart.",
    "id" : "5022e695e4b073f54e47c290",
    "label" : "Modify Africa Chart",
    "resource" : "chart",
    "resourceFilter" : {
      "name" : "africa"
    },
    "type" : "custom",
    "version" : 0
  }, {
    "action" : "read",
    "description" : "The permissions to view John's services.",
    "id" : "5022e695e4b073f54e47c291",
    "label" : "Read John's services",
    "resource" : "services",
    "resourceFilter" : {
      "user" : "john"
    },
    "type" : "api",
    "version" : 0
  } ],
  "version" : 2
}
```

## 4.23.2 Creating Roles

The HTTP POST method is used to submit **Roles**.

### Quick Reference

```
POST http://localhost/mws/rest/roles
```

#### 4.23.2.1 Create Single Role

##### URLs and Parameters

```
POST http://localhost/mws/rest/roles
```

See [Global URL Parameters](#) for available URL parameters.

### Request Body



The **name** field is required and must contain only letters, digits, periods, dashes, and underscores.

The following is an example of a request body to create a role:

POST <http://localhost/mws/rest/roles>

```
{
  "name" : "Acme-User-Role",
  "description" : "This is a role for normal users in the Acme BU Group.",
  "permissions" :
  [
    {
      "id" : "4fa197e68ca30fc605dd1cf0"
    },
    {
      "id" : "4fa197e68ca30fc605dd1df2"
    }
  ]
}
```

## Sample Response

If the request was successful, the response body is the new role that was created, exactly as shown in [Get Single Role](#). On failure, the response is an error message.

## Samples

The **permissions** field only expects an array of permission IDs, as shown in the following example:

Example payload of role with 2 permissions

```
{
  "name" : "Acme-User-Role",
  "description" : "This is a role for normal users in the Acme BU Group.",
  "permissions" :
  [
    {
      "id" : "4fa197e68ca30fc605dd1cf0"
    }
  ]
}
```

## 4.23.3 Modifying Roles

The HTTP PUT method is used to modify **Roles**.

## Quick Reference

```
PUT http://localhost/mws/rest/roles/<id>
PUT http://localhost/mws/rest/roles/<name>
```

### 4.23.3.1 Modify Single Role

#### URLs and Parameters

```
PUT http://localhost/mws/rest/role/<id>
PUT http://localhost/mws/rest/role/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Role.
name	Yes	String	-	The name of the Role.
change-mode	No	String	add	Adds the given permissions to the permissions that already exist.
			remove	Deletes the given permissions from the permissions that already exist.
			set	Adds the given permissions and deletes the permissions that already exist.



- If you do not specify a change-mode value, the system automatically assumes **set** as the default.
- You must specify either **id** or **name**, but you do not have to specify both.
- The **name** field must contain only letters, digits, periods, dashes, and underscores.

See [Global URL Parameters](#) for available URL parameters.

## Example Request

```
PUT http://localhost/mws/rest/role/Acme-User-Role?change-mode=add
```

```
{
  "permissions": [ { "id": "4fa197e68ca30fc605dd1cf0" } ]
}
```

## Sample Response

If the request was successful, the response body is the modified role as shown in [Get Single Role](#). On failure, the response is an error message.

## 4.23.4 Deleting Roles

The HTTP DELETE method is used to delete **Roles**.

## Quick Reference

```
DELETE http://localhost/mws/rest/roles/<id>
DELETE http://localhost/mws/rest/roles/<name>
```

## 4.23.4.1 Delete Single Role

### URLs and Parameters

```
DELETE http://localhost/mws/rest/role/<id>
DELETE http://localhost/mws/rest/role/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Role.
name	Yes	String	-	The name of the Role.

See [Global URL Parameters](#) for available URL parameters.

 You must specify either **id** or **name**, but you do not have to specify both.

### Sample Response

JSON Response

```
{}
```

## 4.24 Services

This section describes the behavior of a **Service** (an interdependent collection of workflows). It is possible for a **Service** to be composed of multiple Services. This section describes the URLs, request bodies, and responses delivered to and from Moab Web Services for each approach.

 The [Service API](#) contains the type and description of all fields in the **Service** object. It also contains details regarding which fields are valid during PUT and POST actions.

### Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/services	<a href="#">Get all Services</a>		<a href="#">Create Service</a>	
/rest/services/ <b>id</b>	<a href="#">Get specified Service</a>	<a href="#">Modify Service</a>		<a href="#">Delete Service</a>

## 4.24.1 Getting Service Information

The HTTP GET method is used to retrieve **Service** information. Queries for all objects and a single object are available.

### Quick Reference

```
GET http://localhost/mws/rest/services[?query={"field":"value"}&sort={"field":<1|-1>}[&[show-recursive-vc|show-vc]=true]]
GET http://localhost/mws/rest/services/<id>[?[show-recursive-vc|show-vc]=true]
GET http://localhost/mws/rest/services/<name>[?[show-recursive-vc|show-vc]=true]
```

### 4.24.1.1 Get All Services

#### URLs and Parameters

```
GET http://localhost/mws/rest/services[?query={"field":"value"}&sort={"field":<1|-1>}[&[show-recursive-vc|show-vc]=true]]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Query for specific results.	query={"type":"storage","label":"exlabel"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"account":-1}
show-recursive-vc	No	<i>true</i>	Show extended details about the service's virtual container including nested virtual containers and nested jobs.	show-recursive-vc=true
show-vc	No	<i>true</i>	Show details about the service's virtual container.	show-vc=true

## Sample Response

```

GET http://localhost:8080/mws/rest/services?query={user:"bob"}

{
  "totalCount": 9,
  "resultCount": 3,
  "results": [
    {
      "dateCreated": "2011-12-07 16:03:40 UTC",
      "lastUpdated": "2011-12-07 16:03:40 UTC",
      "name": "bobService.1",
      "version": 1,
      "type": "container",
      "label": null,
      "user": "bob",
      "account": "bamboo",
      "startDateRequested": "2012-14-10 20:51:07 UTC",
      "startDateScheduled": "2012-14-10 20:51:07 UTC",
      "status": "A custom status message",
      "statusCode": 0,
      "includedServices": [
        "machine0.1",
        "OSStoremachine0.1"
      ],
      "parent": null,
      "serviceTemplate": {

```

```

    "id": "4fbd42cfc4aa4c444cc54112",
    "name": "CentosVmPlusStorage"
  },
  "attributes": { "moab": {
    "vc": { "id": "vc56" },
    "dependencies": [
      {
        "service": "machine0.1",
        "dependency": ["OSStoremachine0.1"]
      }
    ]
  }
},
  "id": "4edff0cc6852f709fa777826"
},
{
  "dateCreated": "2011-12-07 16:03:40 UTC",
  "lastUpdated": "2011-12-07 16:03:40 UTC",
  "name": "machine0.1",
  "version": 1,
  "type": "vm",
  "label": "bobs machine",
  "user": "bob",
  "account": "bamboo",
  "startDateRequested": "2012-14-10 20:51:07 UTC",
  "startDateScheduled": "2012-14-10 20:51:07 UTC",
  "status": "A custom status message",
  "statusCode": 0,
  "includedServices": [],
  "parent": "bobService.1",
  "serviceTemplate": {
    "id": "4fbd42cfc4aa4c444cc54113",
    "name": "CentosVm"
  },
  "attributes": { "moab": {
    "vc": { "id": "vc57" },
    "job": {
      "id": "Moab.24",
      "template": "genericVM",
      "image": "centos5.5-stateless",
      "features": ["vlan3"],
      "variables": {"QOS": "High"},
      "resources": {
        "mem": 2,
        "procs": 2,
        "disk": 2
      }
    }
  }
},
  "id": "4edff0cc6852f709fa777827"
},
{
  "dateCreated": "2011-12-07 16:03:40 UTC",
  "lastUpdated": "2011-12-07 16:03:40 UTC",
  "name": "OSStoremachine0.1",
  "version": 1,
  "type": "storage",
  "label": null,
  "user": "bob",
  "account": "bamboo",
  "startDateRequested": "2012-14-10 20:51:07 UTC",
  "startDateScheduled": "2012-14-10 20:51:07 UTC",
  "status": "A custom status message",
  "statusCode": 0,
  "includedServices": [],
  "parent": "bobService.1",
  "serviceTemplate": {
    "id": "4fbd42cfc4aa4c444cc54114",
    "name": "OpSysStorage"
  },
  "attributes": { "moab": {
    "vc": { "id": "vc58" },
    "job": {
      "id": "Moab.23",
      "template": "OSStorage",
      "resources": {"OS": 200}
    }
  }
},
  "id": "4edff0cc6852f709fa777828"
}

```

```
} ] }  
}
```

## Querying Services

It is possible to query services by one or more fields based on [MongoDB query syntax](#).

### Simple Queries

To see only services that are associated with the user "bob" you can use a query such as the following:

```
http://localhost/mws/rest/services?query={"user":"bob"}
```

To see only services that are of type "vm":

```
http://localhost/mws/rest/services?query={"type":"vm"}
```

To see only bob's vm services:

```
http://localhost/mws/rest/services?query={"user":"bob","type":"vm"}
```

To see only services that are NOT associated with bob:

```
http://localhost/mws/rest/services?query={"user":{"$ne":"bob"}}
```

### More Complex Queries

When the field values of the desired services are a finite set, you can use the `$in` operator. For example, to see services that belong to either bob, alice, or charlie, you can do the following:

```
http://localhost/mws/rest/services?query={"user":{"$in":["alice","bob","charlie"]}}
```

You can also query on embedded JSON objects within the service JSON. For example, to see services requesting 3 processors you can use:

```
http://localhost/mws/rest/services?query={"attributes.moab.job.resources.procs":3}
```

### Conditional Operators

You can perform `<`, `<=`, `>`, `>=` comparisons using the `$lt`, `$lte`, `$gt`, `$gte` operators.

Operator Comparison	
\$lt	<
\$lte	<=
\$gt	>
\$gte	>=

To see services requesting < 2 processors:

```
http://localhost/mws/rest/services?query={"attributes.moab.job.resources.procs":{"$lt":2}}
```

To see services requesting >= 1024 memory:

```
http://localhost/mws/rest/services?query={"attributes.moab.job.resources.mem":{"$gte":1024}}
```

### Querying Services by Date

To see all services created after February 8, 2012 at 1:00 PM Mountain Standard Time (MST):

```
http://localhost/mws/rest/services?query={"dateCreated":{"$gt":"2012-02-08 13:00:00 MST"}}
```

To see services created before or on February 8, 2012 at 1:00 PM Pacific Standard Time (PST):

```
http://localhost/mws/rest/services?query={"dateCreated":{"$lte":"2012-02-08 13:00:00 PST"}}
```

To see services created between 12:00 PM and 1:00 PM Eastern Standard Time (EST) on February 8, 2012:

```
http://localhost/mws/rest/services?query={"dateCreated":{"$lte":"2012-02-08 13:00:00 EST","$gte":"2012-02-08 12:00:00 EST"}}
```

### Querying Services by Containing Service

Services can contain other services. When a service is contained within another service, you can find out what its container is by looking at the parent field. A service that is not contained in any other service is called a top level service. If you want to see only top level services you need to query for services with a null parent.

In MongoDB syntax you query for services whose parent field have a \$type of **10** (with 10 representing null). The following query shows all of bob's top level services:

```
http://localhost/mws/rest/services?query={"user":"bob","parent":{"$type":10}}
```

Once you have the top level service, you can find the direct child services:

```
http://localhost/mws/rest/services?query={"user":"bob","parent":"bobService.1"}
```

Once you have the direct children, you can find the children of those children with a similar query.

## Sorting

See the sorting section of [Global URL Parameters](#)

## Limiting the Number of Results

If you want to limit the number of results of services you can use the `max` parameter. For example, to see only 10 of bob's services:

```
http://localhost/mws/rest/services?query={"user":"bob"}&sort={"name":1}&max=10
```

To see bob's services 91-100 when sorted by name in ascending order you can combine `max` with `offset` as follows:

```
http://localhost/mws/rest/services?query={"user":"bob"}&sort={"name":1}&max=10&offset=90
```

## Retrieving a Subset of Fields

To cause only certain fields to return for each service, use the `fields` parameter. For example, to show only the name field for each service:

```
http://localhost/mws/rest/services?fields=name
```

This returns:

```
{
  "totalCount": 9,
  "resultCount": 3,
  "results": [
    { "name": "aliceService.1" },
    { "name": "machine0.1" },
    { "name": "OSStoremachine0.1" }
  ]
}
```

To show the name, type, and user:

```
http://localhost/mws/rest/services?fields=name,type,user
```

This returns:

```
{
  "totalCount": 9,
  "resultCount": 3,
  "results": [
    {
      "name": "aliceService.1",
      "type": "container",
      "user": "alice"
    },
    {
      "name": "machine0.1",
      "type": "vm",
      "user": "alice"
    },
    {
      "name": "OSStoremachine0.1",
      "type": "storage",
      "user": "alice"
    }
  ]
}
```

## 4.24.1.2 Get Single Service

### URLs and Parameters

```
GET http://localhost/mws/rest/services/<id>[?[show-recursive-vc|show-vc]=true]
GET http://localhost/mws/rest/services/<name>[?[show-recursive-vc|show-vc]=true]
```

Parameter	Required	Valid Values	Description	Example
id	Yes	String	The unique identifier of the service.	
name	Yes	String	The name of the service.	
show-recursive-vc	No	<i>true</i>	Show extended details about the service's virtual container including nested virtual containers and nested jobs.	show-recursive-vc=true
show-vc	No	<i>true</i>	Show details about the service's virtual container.	show-vc=true

Parameter	Required	Type	Valid Values	Description
-----------	----------	------	--------------	-------------

See [Global URL Parameters](#) for available URL parameters.



Only one of **id** or **name** are required.

## Samples

GET <http://localhost/mws/rest/services/bobService.1?>

```
{
  "dateCreated": "2011-12-07 16:03:40 UTC",
  "lastUpdated": "2011-12-07 16:03:40 UTC",
  "name": "bobService.1",
  "version": 1,
  "type": "container",
  "label": null,
  "user": "bob",
  "account": "bamboo",
  "startDateRequested": "2012-14-10 20:51:07 UTC",
  "startDateScheduled": "2012-14-10 20:51:07 UTC",
  "durationRequested": 86400,
  "status": "A custom status message",
  "statusCode": 0,
  "includedServices": [
    "machine0.1",
    "OSStoremachine0.1"
  ],
  "parent": null,
  "serviceTemplate": {
    "id": "4fbd42cfc4aa4c444cc54112",
    "name": "CentosVmPlusStorage"
  },
  "attributes": {
    "moab": {
      "vc": {
        "id": "vc56"
      },
      "dependencies": [
        {
          "service": "machine0.1",
          "dependency": ["OSStoremachine0.1"]
        }
      ]
    }
  },
  "id": "4edff0cc6852f709fa777826"
}
```

### 4.24.2 Creating Services

The HTTP POST method is used to create a **Service**.

#### Quick Reference

POST <http://localhost/mws/rest/services>

#### 4.24.2.1 Create Service From Service Template

##### URLs and Parameters

POST [http://localhost/mws/rest/services\[?proxy-user=bob\]](http://localhost/mws/rest/services[?proxy-user=bob])

Parameter	Required	Valid Values	Description	Example
proxy-user	No	String	The name of the user creating the service.	proxy-user=bob

##### Simple Case

To create a service from the template named "Rhel54VmPlusStorage":

POST http://localhost/mws/rest/services

```
{
  "user": "steve",
  "account": "cloud",
  "startDateRequested": "2011-11-08 13:18:47 MST",
  "durationRequested": 86400,
  "data": [
    {
      "name": "MyRhel54VmPlusStorage",
      "serviceTemplate": "Rhel54VmPlusStorage",
    }
  ]
}
```

Alternatively you can submit:

POST http://localhost/mws/rest/services

```
{
  "user": "steve",
  "account": "cloud",
  "data": [
    {
      "name": "MyRhel54VmPlusStorage",
      "serviceTemplate": {
        "name": "Rhel54VmPlusStorage"
      }
    }
  ]
}
```

To create a service based on the service template with id "4fbd2d90c4aa4996400bsa5m"

POST http://localhost/mws/rest/services

```
{
  "user": "steve",
  "account": "cloud",
  "data": [
    {
      "name": "MyRhel54VmPlusStorage",
      "serviceTemplate": {
        "id": "4fbd2d90c4aa4996400bsa5m"
      }
    }
  ]
}
```

## Extending a Service Template

If you want to create a service from a service template, but wish to extend the service template with some additional variables or generic resources, you can use the **extends** field. Extending a service template is also helpful when you wish to override certain values, such as the amount of memory or processors the service requires.

To extend a service template, you will need to determine the extends path for the service you wish to override. The extends path is the name of the top level service, followed by one or more localNames as described in the includedServices field. All but the last <localName> are nested containers inside the top level container. For example:

```
<top level service name>::<localName>[:<localName>]+
```

For example, suppose you want to create a new service from the "Rhel54VmPlusStorage" service template, and you want to name this new service "MyRhel54VmPlusStorage". In this example, "Rhel54VmPlusStorage" contains a service template named "SubContainer1". The localName for "SubContainer1" in the "Rhel54VmPlusStorage" **includedServices** field is "sc1".

#### Rhel54VmPlusStorage Service Template

```
{
  "name": "Rhel54VmPlusStorage",
  "type": "container",
  ...
  "includedServices": [
    {
      "localName": "sc1",
      "serviceTemplate": "SubContainer1"
    }
  ]
}
```

The extends path for the instance of "SubContainer1" in your "MyRhel54VmPlusStorage" is:

```
MyRhel54VmPlusStorage::sc1
```

Let's say inside "SubContainer1" is another service template called "SubContainer2". The localName for "SubContainer2" as defined in the includedServices field for "SubContainer1" is "sc2".

#### SubContainer1 Service Template

```
{
  "name": "SubContainer1",
  "type": "container",
  ...
  "includedServices": [
    {
      "localName": "sc2",
      "serviceTemplate": "SubContainer2"
    }
  ]
}
```

The extends path for the instance of "SubContainer2" in "MyRhel54VmPlusStorage" is:

```
MyRhel54VmPlusStorage::sc1:sc2
```

Now let's say that "SubContainer2" contains two service templates, "Rhel54Vm" and "OpsysStorage" with localNames "rvm" and "oss" respectively.

## SubContainer1 Service Template

```
{
  "name": "SubContainer2",
  "type": "container",
  ...
  "includedServices": [
    {
      "localName": "rvm",
      "serviceTemplate": "Rhel54Vm"
    },
    {
      "localName": "oss",
      "serviceTemplate": "OpSysStorage"
    }
  ]
}
```

The extends paths for the instances of "Rhel54Vm" and "OpSysStorage" in "MyRhel54VmPlusStorage" are:

```
MyRhel54VmPlusStorage::sc1:sc2:rvm
MyRhel54VmPlusStorage::sc1:sc2:oss
```

Now that we have the extends paths for all the services that will be created from the "Rhel54VmPlusStorage" template, we can add variables to these services that were not in the service templates.

## POST http://localhost/mws/rest/services

```
{
  "user": "steve",
  "account": "cloud",
  "data": [
    {
      "name": "MyRhel54VmPlusStorage",
      "serviceTemplate": "Rhel54VmPlusStorage",
      "attributes": {
        "sharedData": { "extraAttribute": "some attribute not in the Rhel54VmPlusStorage
template" }
      }
    },
    {
      "name": "MyRhel54Vm",
      "extends": "MyRhel54VmPlusStorage::sc1:sc2:rvm",
      "attributes": {
        "moab": { "job": { "variables": { "extraVar": "An additional variable not in the
Rhel54Vm template" } } },
        "sharedData": { "extraAttribute": "some attribute not in the Rhel54Vm template"
      }
    }
  ],
  {
    "name": "MyOsStorage",
    "extends": "MyRhel54VmPlusStorage::sc1:sc2:oss",
    "attributes": {
      "moab": { "job": { "variables": { "extraVar2": "An additional variable not in
the OpSysStorage template" } } },
      "sharedData": { "extraAttribute": "some attribute not in the OpSysStorage
template" }
    }
  ]
}
```

When the "MyRhel54Vm" service is created, it will have a variable named "extraVar" even though this variable was not defined in the "Rhel54Vm" service template. Likewise, when the "MyOsStorage" service is created, it will have a variable named "extraVar2", even though no such variable was defined in the "OsStorage" service template. All three services will have an attribute named "extraAttribute" in their attributes.sharedData sections though "extraAttribute" does not appear in any service template.

## Extending Services and Dependencies in a Container Service

To add a services to a container service that were not in the container's service template you first define the new services in the service request. Then you extend the includedServices field of the container with the newly defined services. This will add the new services to any that are already in the container as defined in the service template. It is only possible to add services to a container. It is not possible to remove services from a container that were defined in the container's service template.

For example, say the CentosVmPlusStorage service template contains an OpSysStorage service template and a CentosVm service template.

### CentosVmPlusStorage Service Template

```
{
  "name": "CentosVmPlusStorage",
  "type": "container",
  ...
  "includedServices": [
    {
      "localName": "oss",
      "serviceTemplate": "OpSysStorage"
    },
    {
      "localName": "cvm",
      "serviceTemplate": "CentosVm"
    }
  ]
}
```

To add two storage services to the service created from the CentosVmPlusStorage service template submit the following service request:

### POST http://localhost/mws/rest/services

```
{
  "user": "bob",
  "account": "cloud",
  "data": [
    {
      "name": "BobsCentosVmPlusStorage",
      "serviceTemplate": "CentosVmPlusStorage",
      "includedServices": [
        "NewStorageToAdd1",
        "NewStorageToAdd2"
      ]
    },
    {
      "name": "NewStorageToAdd1",
      "serviceTemplate": "ExtraStorage"
    },
    {
      "name": "NewStorageToAdd2",
      "serviceTemplate": "ExtraStorage"
    }
  ]
}
```

The resulting service BobsCentosVmPlusStorage will contain NewStorageToAdd1, NewStorageToAdd2, a service created from the OpSysStorage template, and a service created from the CentosVm template. To add a dependency such that the CentosVm service will not be able to start until both NewStorageToAdd1 and NewStorageToAdd2 have been set up:

POST http://localhost/mws/rest/services

```
{
  "user": "bob",
  "account": "cloud",
  "data": [
    {
      "name": "BobsCentosVmPlusStorage",
      "serviceTemplate": "CentosVmPlusStorage",
      "includedServices": [
        "NewStorageToAdd1",
        "NewStorageToAdd2"
      ],
      "attributes": {
        "moab": {
          "dependencies": [
            {
              "service": "BobsCentosVm",
              "dependency": [
                "NewStorageToAdd1",
                "NewStorageToAdd2"
              ]
            }
          ]
        }
      }
    },
    {
      "name": "BobsCentosVm",
      "extends": "CentosVmPlusStorage:cvm"
    },
    {
      "name": "NewStorageToAdd1",
      "serviceTemplate": "ExtraStorage"
    },
    {
      "name": "NewStorageToAdd2",
      "serviceTemplate": "ExtraStorage"
    }
  ]
}
```

## Extendable Fields

You can only extend certain fields. Below is a table of fields that can be extended:

Extendable Fields	Notes
attributes.moab.dependencies	Dependencies can be added but not removed. Only applicable to containers.
attributes.moab.job.features	Features can be added but not removed.
attributes.moab.job.requestedHosts	Hosts can be added but not removed.
attributes.moab.job.resources	Including procs, mem, disk, and any generic resource.
attributes.moab.job.variables	Can either change the value of variables in the template or add new variables.
attributes.sharedData	A place for arbitrary, site-specific data.
image	
includedServices	Services can be added but not removed. Only applicable to containers.
label	

## Sample Response

If the request was successful, the response includes the unique ID of the new Service. On failure, the response is an error message.

```
JSON Response
{ "name" : "MyRhe154VmPlusStorage.1" }
```

## 4.24.2.2 Create Custom Service

### URLs and Parameters

```
POST http://localhost/mws/rest/services[?proxy-user=bob]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	No	String	The name of the user creating the service.	proxy-user=bob

### Request Body

The payload below shows all the fields that are available during service submission.

```
POST http://localhost/mws/rest/services
```

```

{
  "user": "adaptive",
  "account": "cloud",
  "startDateRequested": "2011-11-08 13:18:47 MST",
  "durationRequested": 86400,
  "data": [
    {
      "name": "myNewService",
      "type": "container",
      "label": "My New Service",
      "includedServices": [
        "myVmContainer",
        "myNetworkStorageWorkflow",
        "myPmContainer"
      ],
      "attributes": {
        "moab": {
          "dependencies": [
            {
              "dependency": [
                "myNetworkStorageWorkflow"
              ],
              "service": "myVmWorkflow"
            }
          ]
        }
      },
      "sharedData": {
        "extraAttribute": "Some arbitrary value",
        "extraAttribute2": "Another arbitrary value"
      }
    },
    {
      "name": "myVmContainer",
      "type": "container",
      "includedServices": [
        "myVmWorkflow",
        "myOsStorageWorkflow"
      ],
      "attributes": {
        "moab": {
          "dependencies": [
            {
              "dependency": [
                "myOsStorageWorkflow"
              ],
              "service": "myVmWorkflow"
            }
          ]
        }
      }
    },
    {
      "name": "myVmWorkflow",
      "type": "vm",
      "includedServices": [
        "myVmContainer",
        "myVmContainer",
        "myVmContainer"
      ],
      "attributes": {
        "moab": {
          "job": {
            "resources": {
              "procs": 2,
              "mem": 2048,
              "disk": 80
            },
            "variables": {
              "QOS": "Premium"
            }
          },
          "image": "centos5.5-stateless",
          "template": "genericVM",
          "requestedHosts": ["il6"],
          "features": ["vlan3"]
        }
      }
    },
    {
      "name": "myOsStorageWorkflow",
      "type": "storage",
      "includedServices": [
        "myVmWorkflow",
        "myVmWorkflow",
        "myVmWorkflow"
      ],
      "attributes": {
        "moab": {
          "dependencies": [
            {
              "dependency": [
                "myVmWorkflow"
              ],
              "service": "myVmWorkflow"
            }
          ]
        }
      }
    }
  ],
  "attributes": {
    "moab": {
      "job": {
        "resources": {
          "procs": 2,
          "mem": 2048,
          "disk": 80
        },
        "variables": {
          "QOS": "Premium"
        }
      },
      "image": "centos5.5-stateless",
      "template": "genericVM",
      "requestedHosts": ["il6"],
      "features": ["vlan3"]
    }
  }
}

```

```

],
  "attributes":{
    "moab":{
      "job":{
        "template":"OSStorage",
        "resources":{
          "OS":2500
        }
      }
    }
  },
  "name":"myNetworkStorageWorkflow",
  "type":"storage",
  "includedServices":[]
],
  "attributes":{
    "moab":{
      "job":{
        "template":"extraStorage",
        "resources":{
          "gold":500
        },
        "variables":{
          "mount":"/path/to/mount"
        }
      }
    }
  },
  "name":"myPmContainer",
  "type":"container",
  "includedServices":[
    "myPmWorkflow"
  ]
},
  "name":"myPmWorkflow",
  "type":"pm",
  "includedServices":[]
],
  "attributes":{
    "moab":{
      "job":{
        "resources":{
          "procs":2,
          "mem":2048,
          "disk":100
        },
        "variables":{
          "QOS":"Premium"
        },
        "image":"centos5.5-stateless",
        "template":"genericPM"
      }
    }
  }
}
]
}

```

## Sample Response

If the request was successful, the response includes the unique ID of the new Service. On failure, the response is an error message.

### JSON Response

```
{ "name": "myNewService.1" }
```

## 4.24.3 Modifying Services

The HTTP PUT method is used to modify **Services**.

## Quick Reference

```
PUT http://localhost/mws/rest/services/<id>
PUT http://localhost/mws/rest/services/<name>
```

### 4.24.3.1 Modify Service

#### URLs and Parameters

```
PUT http://localhost/mws/rest/services/<id>
PUT http://localhost/mws/rest/services/<name>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the Service.
name	Yes	String	-	The name of the Service .

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

#### Example Request

Only the `attributes`, `status`, and `statusCode` fields may be modified in services. Note that the `status` field must be a valid string, and the `statusCode` field must be a valid number (long). Any arbitrary string and number may be used to represent the current state of the service through `status` and `statusCode` respectively.

```
PUT http://localhost:8080/mws/rest/services/myStorageService
```

```
{
  "status": "Done provisioning!",
  "statusCode": 200,
  "attributes": {
    "mount": "/mnt/myMount",
    "size": "2500",
    "sharedData": {
      "extraAttribute": "Some arbitrary value",
      "extraAttribute2": "Another arbitrary value"
    }
  }
}
```

 The moab element of `attributes` cannot be modified. An error will be returned if this is attempted.

#### Sample Response

## JSON Response

```
{
  "name": "myStorageService",
  "dateCreated": "2012-02-01 14:54:52 UTC",
  "lastUpdated": "2012-02-01 14:54:52 UTC",
  "type": "storage",
  "label": null,
  "user": "john",
  "account": "corp",
  "status": "Done provisioning!",
  "statusCode": 200,
  "includedServices": [],
  "parent": "myVmWithStorage",
  "attributes": {
    "moab": {
      "vc": {
        "id": "vc3"
      },
      "job": {
        "id": "Moab.1",
        "template": "extraStorage",
        "resources": {
          "gold": 2500
        }
      }
    },
    "sharedData": {
      "extraAttribute": "Some arbitrary value",
      "extraAttribute2": "Another arbitrary value"
    },
    "mount": "/mnt/myMount",
    "size": "2500"
  },
  "id": "4f29b4abe4b03c2f8e3a1a40"
}
```

## 4.24.4 Deleting Services

The HTTP DELETE method is used to delete **Services**.

### Quick Reference

```
DELETE http://localhost/mws/rest/services/<id>
DELETE http://localhost/mws/rest/services/<name>
```

### 4.24.4.1 Delete Service

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/services/<id>[?proxy-user=bob]
DELETE http://localhost/mws/rest/services/<name>[?proxy-user=bob]
```

Parameter	Required	Type	Valid Values	Description
force-delete	No	Boolean	-	If true MWS will not check service dependencies before deleting it.
id	Yes	String	-	The unique identifier of the Service.
name	Yes	String	-	The name of the Service.
proxy-user	No	String	The name of the user deleting the service.	proxy-user=bob

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** are required.

## Sample Response

JSON Response

```
{}
```

## 4.25 Service Templates

This section describes the behavior of the **Service Template** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Service Template API](#) contains the type and description of all fields in the **ServiceTemplate** object. It also contains details regarding which fields are valid during PUT and POST actions.

 See [Create Service From Service Template](#) to create Services from Service Templates.

 The Service Template name has the following constraints:

- It must contain only letters, digits, spaces, and these special characters: underscore, comma, hyphen, period, question mark, at sign, tilde, pound sign, square brackets, angle brackets, vertical bar, equals sign, ampersand, parentheses, asterisk, curly braces, grave accent, and dollar sign.
- It cannot have the same form as a MongoDB ID (24 characters of 0-9 and a-f)
- It must be unique in the database.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/service-templates	<a href="#">Get all Service Templates</a>		<a href="#">Create ServiceTemplate</a>	
/rest/service-templates/ id or name	<a href="#">Get specified Service Template</a>	<a href="#">Modify ServiceTemplate</a>		<a href="#">Cancel Service Template</a>

### 4.25.1 Getting Service Templates

The HTTP GET method is used to retrieve **Service Template** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/service-templates[?query={"field":"value"}&sort={"field":<1|-1>}]
GET http://localhost/mws/rest/service-templates/<id>
GET http://localhost/mws/rest/service-templates/<name>
```

#### 4.25.1.1 Get All Service Templates

##### URLs and Parameters

```
GET http://localhost/mws/rest/service-templates[?query={"field":"value"}&sort={"field":<1|-1>}]
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Query for specific results.	query={"type":"vm","createdBy":"name"}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":1}

See [Global URL Parameters](#) for available URL parameters.

#### Sample Response

##### JSON Response

```
{
  "totalCount": 4,
  "resultCount": 4,
```

```

"results": [
  {
    "attributes": {
      "moab": {"job": {
        "resources": {"OS": 100},
        "template": "OSStorage",
        "variables": {"var1": "variable to be attached to tracking job"}
      }},
      "sharedData": {
        "custom1": "Custom data to be attached to service",
        "custom2": "More custom data to be attached to service"
      }
    },
    "createdBy": "bob",
    "includedServices": [],
    "label": "Operating System Storage",
    "modified": null,
    "name": "OpSysStorage",
    "tags": [
      "tag1",
      "tag2",
      "tag3"
    ],
    "type": "storage",
    "version": 0,
    "id": "50d4dalac4aaceecaf386452"
  },
  {
    "attributes": {
      "moab": {"job": {
        "resources": {"gold": 100},
        "template": "extraStorage",
        "variables": {"var1": "variable to be attached to tracking job"}
      }},
      "sharedData": {
        "custom1": "Custom data to be attached to service",
        "custom2": "More custom data to be attached to service"
      }
    },
    "createdBy": "bob",
    "includedServices": [],
    "label": "Network Storage",
    "modified": null,
    "name": "NetworkStorage",
    "tags": [
      "tag1",
      "tag2",
      "tag3"
    ],
    "type": "storage",
    "version": 0,
    "id": "50d4dalac4aaceecaf386453"
  },
  {
    "attributes": {
      "moab": {"job": {
        "image": "centos5.5-stateless",
        "resources": {
          "procs": 1,
          "mem": 1024,
          "disk": 20480
        },
        "template": "genericVM",
        "variables": {"var1": "variable to be attached to tracking job"}
      }},
      "sharedData": {
        "custom1": "Custom data to be attached to service",
        "custom2": "More custom data to be attached to service"
      }
    },
    "createdBy": "bob",
    "includedServices": [],
    "label": "Centos 5.5 VM",
    "modified": null,
    "name": "Centos55Vm",
    "tags": [
      "tag1",
      "tag2",
      "tag3"
    ],
    "type": "vm",
    "version": 0,
    "id": "50d4dalac4aaceecaf386454"
  },
  {
    "attributes": {
      "moab": {"dependencies": [
        "oss",
        "ns"
      ]}
    },

```

```
    "localName": "cvm"
  }]],
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
},
"createdBy": "bob",
"includedServices": [
  {
    "localName": "cvm",
    "serviceTemplate": "Centos55Vm"
  },
  {
    "localName": "oss",
    "serviceTemplate": "OpSysStorage"
  },
  {
    "localName": "ns",
    "serviceTemplate": "NetworkStorage"
  }
],
"label": "Centos 5.5 VM Plus OS and Network Storage",
"modified": null,
"name": "Centos55VmPlusStorage",
"tags": [
  "tag1",
  "tag2",
  "tag3"
],
"type": "container",
"version": 0,
"id": "50d4dalac4aaceecaf386455"
```

```
} ] }  
}
```

## Querying Service Templates

It is possible to query service templates by one or more fields based on the [MongoDB query syntax](#).

### Simple Queries

To see only service templates that are associated with the user "bob", use a query like the following:

```
http://localhost/mws/rest/service-templates?query={"user":"bob"}
```

To see only service templates that are of type "vm":

```
http://localhost/mws/rest/service-templates?query={"type":"vm"}
```

To see only bob's vm service templates:

```
http://localhost/mws/rest/service-templates?query={"user":"bob","type":"vm"}
```

To see only service templates that are NOT associated with bob:

```
http://localhost/mws/rest/service-templates?query={"user":{"$ne":"bob"}}
```

### More Complex Queries

When the field values of the desired service templates are a finite set, use the `$in` operator. For example, to see service templates that belong to either bob, alice, or charlie, do the following:

```
http://localhost/mws/rest/service-templates?query={"user":{"$in":["alice","bob","charlie"]}}
```

You can also query on embedded JSON objects within the service template JSON. For example, to see service templates requesting 3 processors, do the following:

```
http://localhost/mws/rest/service-templates?query={"attributes.moab.job.resources.procs":3}
```

### Conditional Operators

You can perform <, <=, >, >= comparisons using the \$lt, \$lte, \$gt, \$gte operators.

Operator	Comparison
\$lt	<
\$lte	<=
\$gt	>
\$gte	>=

To see service templates requesting < 2 processors:

```
http://localhost/mws/rest/service-templates?query={
  "attributes.moab.job.resources.procs":{"$lt":2}}
```

To see service templates requesting >= 1024 memory:

```
http://localhost/mws/rest/service-templates?query={"attributes.moab.job.resources.mem"
:{"$gte":1024}}
```

### Querying Service Templates by Date

To see all service templates modified after July 4, 2011 at 10:30:00 PM Mountain Standard Time (MST):

```
http://localhost/mws/rest/service-templates?query={"modified":{"$gt":"2011-07-04
22:30:00 MST"}}
```

To see service templates modified before July 6, 2011 at 12:00 AM Pacific Standard Time (PST):

```
http://localhost/mws/rest/service-templates?query={"modified":{"$lt":"2011-07-06
00:00:00 PST"}}
```

To see service templates modified between 12:00 AM and 11:59 PM (inclusive) Eastern Standard Time (EST) on July 5, 2011

```
http://localhost/mws/rest/service-templates?query={"modified":{"$gte":"2011-07-05
00:00:00 EST","$lte":"2011-07-05 23:59:00 EST"}}
```

## Sorting

See the sorting section in [Global URL Parameters](#).

## Limiting the Number of Results

To limit the size of the result set, use the `max` parameter. For example, to see only 10 of bob's services:

```
http://localhost/mws/rest/service-templates?query={"user":"bob"}&sort={"name":1}&max=10
```

To see bob's service templates 91-100 when sorted by name in ascending order, combine `max` with `offset` as follows:

```
http://localhost/mws/rest/service-templates?query={"user":"bob"}&sort={"name":1}&max=10&offset=90
```

## Retrieving a Subset of Fields

To retrieve only certain fields, use the `fields` parameter. For example, to show only the name field for each service:

```
http://localhost/mws/rest/service-templates?fields=name
```

This returns:

```
{
  "totalCount": 9,
  "resultCount": 3,
  "results": [
    { "name": "aliceService.1" },
    { "name": "machine0.1" },
    { "name": "OSStoremachine0.1" }
  ]
}
```

To show the name, type, and user:

```
http://localhost/mws/rest/service-templates?fields=name,type,user
```

This returns:

```

{
  "totalCount": 9,
  "resultCount": 3,
  "results": [
    {
      "name": "aliceService.1",
      "type": "container",
      "user": "alice"
    },
    {
      "name": "machine0.1",
      "type": "vm",
      "user": "alice"
    },
    {
      "name": "OSStoremachine0.1",
      "type": "storage",
      "user": "alice"
    }
  ]
}

```

## 4.25.1.2 Get Single Service Template

### URLs and Parameters

```

GET http://localhost/mws/rest/service-templates/<id>
GET http://localhost/mws/rest/service-templates/<name>

```

Parameter	Required	Valid Values	Description
id	Yes	String (24 character alphanumeric)	The unique identifier of the service template.
name	Yes	String	The name of the service template.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** is required.

### Response

GET http://localhost/mws/rest/service-templates/Centos55Vm

```
{
  "attributes": {
    "moab": {"job": {
      "image": "centos5.5-stateless",
      "resources": {
        "procs": 1,
        "mem": 1024,
        "disk": 20480
      }
    }},
    "template": "genericVM",
    "variables": {"var1": "variable to be attached to tracking job"}
  },
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
},
"createdBy": "bob",
"id": "50d4dalac4aaceecaf386454",
"includedServices": [],
"label": "Centos 5.5 VM",
"modified": null,
"name": "Centos55Vm",
"tags": [
  "tag1",
  "tag2",
  "tag3"
],
"type": "vm",
"version": 0
}
```

GET http://localhost/mws/rest/service-templates/OpSysStorage

```
{
  "attributes": {
    "moab": {"job": {
      "resources": {"OS": 100},
      "template": "OSStorage",
      "variables": {"var1": "variable to be attached to tracking job"}
    }},
    "sharedData": {
      "custom1": "Custom data to be attached to service",
      "custom2": "More custom data to be attached to service"
    }
  },
  "createdBy": "bob",
  "id": "50d4dalac4aaceecaf386452",
  "includedServices": [],
  "label": "Operating System Storage",
  "modified": null,
  "name": "OpSysStorage",
  "tags": [
    "tag1",
    "tag2",
    "tag3"
  ],
  "type": "storage",
  "version": 0
}
```

## GET http://localhost/mws/rest/service-templates/NetworkStorage

```
{
  "attributes": {
    "moab": { "job": {
      "resources": { "gold": 100 },
      "template": "extraStorage",
      "variables": { "var1": "variable to be attached to tracking job" }
    } },
    "sharedData": {
      "custom1": "Custom data to be attached to service",
      "custom2": "More custom data to be attached to service"
    }
  },
  "createdBy": "bob",
  "id": "50d4dalac4aaceecaf386453",
  "includedServices": [],
  "label": "Network Storage",
  "modified": null,
  "name": "NetworkStorage",
  "tags": [
    "tag1",
    "tag2",
    "tag3"
  ],
  "type": "storage",
  "version": 0
}
```

## GET http://localhost/mws/rest/service-templates/Centos55VmPlusStorage

```
{
  "attributes": {
    "moab": { "dependencies": [
      {
        "dependency": [
          "oss",
          "ns"
        ]
      }
    ] },
    "localName": "cvm"
  } },
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
},
"createdBy": "bob",
"id": "50d4dalac4aaceecaf386453",
"includedServices": [
  {
    "localName": "cvm",
    "serviceTemplate": "Centos55Vm"
  },
  {
    "localName": "oss",
    "serviceTemplate": "OpSysStorage"
  },
  {
    "localName": "ns",
    "serviceTemplate": "NetworkStorage"
  }
],
"label": "Centos 5.5 VM Plus OS and Network Storage",
"modified": null,
"name": "Centos55VmPlusStorage",
"tags": [
  "tag1",
  "tag2",
  "tag3"
],
"type": "container",
"version": 0
}
```

## 4.25.2 Creating Service Templates

The HTTP POST method is used to create **Service Templates**.

### Quick Reference

```
POST http://localhost/mws/rest/service-templates
```

## 4.25.2.1 Create Service Template

### URLs and Parameters

```
POST http://localhost/mws/rest/service-templates
```

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows some of the fields that are available when creating a Service Template, along with some sample values.

#### JSON Request Body

```
{
  "name": "Centos55Vm",
  "label": "Centos 5.5 VM",
  "type": "vm",
  "createdBy": "bob",
  "tags": ["tag1", "tag2", "tag3"],
  "attributes": {
    "moab": {
      "job": {
        "image": "centos5.5-stateless",
        "resources": {
          "procs": 1,
          "mem": 1024,
          "disk": 20480
        },
        "template": "genericVM",
        "variables": {
          "var1": "variable to be attached to tracking job",
        }
      }
    },
    "sharedData": {
      "custom1": "Custom data to be attached to service",
      "custom2": "More custom data to be attached to service"
    }
  }
}
```

The following payload is an example of a Service Template that can be used to create an OS storage service.

## OS Storage JSON Payload

```
{
  "name": "OpSysStorage",
  "label": "Operating System Storage",
  "type": "storage",
  "createdBy": "bob",
  "tags": ["tag1", "tag2", "tag3"],
  "attributes": {
    "moab": {
      "job": {
        "resources": {
          "OS": 100
        },
        "template": "OSStorage",
        "variables": {
          "var1": "variable to be attached to tracking job"
        }
      }
    }
  },
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
}
```

The following payload is an example of a Service Template that can be used to create an extra storage service.

## Extra Storage JSON Payload

```
{
  "name": "NetworkStorage",
  "label": "Network Storage",
  "type": "storage",
  "createdBy": "bob",
  "tags": ["tag1", "tag2", "tag3"],
  "attributes": {
    "moab": {
      "job": {
        "resources": {
          "gold": 100
        },
        "template": "extraStorage",
        "variables": {
          "var1": "variable to be attached to tracking job"
        }
      }
    }
  },
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
}
```

The following payload is an example of a Service Template that can be used to create a container service that contains a vm service, an OS storage service, and an extra storage service.

## Container JSON Payload

```
{
  "name": "Centos55VmPlusStorage",
  "label": "Centos 5.5 VM Plus OS and Network Storage",
  "type": "container",
  "createdBy": "bob",
  "tags": ["tag1", "tag2", "tag3"],
  "includedServices": [
    {
      "localName": "cvm",
      "serviceTemplate": "Centos55Vm"
    },
    {
      "localName": "oss",
      "serviceTemplate": "OpSysStorage"
    },
    {
      "localName": "ns",
      "serviceTemplate": "NetworkStorage"
    }
  ],
  "attributes": {
    "moab": {
      "dependencies": [
        {
          "dependency": [
            "oss", "ns"
          ],
          "localName": "cvm"
        }
      ]
    }
  },
  "sharedData": {
    "custom1": "Custom data to be attached to service",
    "custom2": "More custom data to be attached to service"
  }
}
```



includedServices is a key-value pair of the internal service name and the serviceTemplate. The service name is unique for each service container.

## Sample Response

### JSON Response for successful POST

```
{"id": "4f06111184ae2bbfa31fa4c7"}
```

### If the Service Template name is not unique:

#### JSON Response

```
{
  "messages": [
    "Service template RHEL54Vm could not be created",
    "Request has a non-unique service template name 'RHEL54Vm'",
    "Please correct the request and try again"
  ]
}
```

### If the Service Template included service local name is not unique to this service template:

### JSON Response

```
{
  "messages": [
    "Service template CentOS5 could not be created",
    "Service template request has a non-unique included service template local name ([SQLServ05])",
    "Please correct the request and try again"
  ]
}
```

### If the Service Template depends on a non-existent included service:

### JSON Response

```
{
  "messages": [
    "Service template NSStor34 could not be created",
    "Service template requires service template(s) [NewRhel54Vm] which do not exist",
    "Please correct the request and try again"
  ]
}
```

### If the Service Template depends on more than one non-existent included service:

### JSON Response

```
{
  "messages": [
    "Service template NSStor34 could not be created",
    "Service template requires service template(s) [NewRhel54Vm, Storage003] which do not exist",
    "Please correct the request and try again"
  ]
}
```

### If the Service Template name contains a colon:

### JSON Response

```
{
  "messages": [
    "Service template Rhel54Vm:C could not be created",
    "Request contains a colon (:) in the service template name 'Rhel54Vm:C'",
    "Please correct the request and try again"
  ]
}
```

### If the Service Template name has the same format as a MongoDB ID (Service Template ID):

## JSON Response

```
{
  "messages": [
    "Service template 4f2049a684ae6e1d4f09bd71 could not be created",
    "Request has a MongoDB Object ID format for the service template name '4f2049a684ae6e1d4f09bd71'",
    "Please correct the request and try again"
  ]
}
```

### 4.25.3 Modifying Service Templates

The HTTP PUT method is used to modify **Service Templates**.

 The modified field is not automatically updated. It will need to be changed by the user.

#### Quick Reference

```
PUT http://localhost/mws/rest/service-templates/<id>
PUT http://localhost/mws/rest/service-templates/<name>
```

#### 4.25.3.1 Modify Service Template

##### URLs and Parameters

```
PUT http://localhost/mws/rest/service-templates/<id>
PUT http://localhost/mws/rest/service-templates/<name>
```

Parameter	Required	Valid Values	Description
id	Yes	String (24 character alphanumeric)	The unique identifier of the service template.
name	Yes	String	The name of the service template.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** is required.

#### Request Body

This is similar to create, except you change the request body to what you need modified.

The request body below shows some of the fields that are available when modifying a Service Template, along with some sample values.

## PUT http://localhost/mws/rest/service-templates/Centos55Vm

```
{
  "label": "Centos 5.5 VM (updated)",
  "createdBy": "newUser",
  "tags": ["newTag", "newTag2"],
  "attributes": {
    "moab": {
      "job": {
        "image": "centos5.5-stateful",
        "resources": {
          "procs": 2,
          "mem": 2048,
          "disk": 22480
        },
        "template": "genericVM",
        "variables": {
          "newVar": "variable to be attached to tracking job",
        }
      }
    },
    "sharedData": {
      "custom3": "Custom data to be attached to service",
      "custom4": "More custom data to be attached to service"
    }
  }
}
```

## Sample Response

### JSON Response for successful PUT

```
{
  "attributes": {
    "moab": {
      "job": {
        "image": "centos5.5-stateful",
        "resources": {
          "procs": 2,
          "mem": 2048,
          "disk": 22480
        },
        "template": "genericVM",
        "variables": {
          "newVar": "variable to be attached to tracking job"
        }
      }
    },
    "sharedData": {
      "custom3": "Custom data to be attached to service",
      "custom4": "More custom data to be attached to service"
    }
  },
  "createdBy": "newUser",
  "id": "50d4de6bc4aa6ca84bbe9be4",
  "includedServices": [
  ],
  "label": "Centos 5.5 VM (updated)",
  "modified": "2012-12-21 15:12:01 MST",
  "name": "Centos55Vm",
  "tags": [
    "newTag",
    "newTag2"
  ],
  "type": "vm",
  "version": 0
}
```

If the Service Template depends on a non-existent included service:

### JSON Response

```
{
  "messages": [
    "Service template NewR could not be updated",
    "Service template requires service template(s) [RhOs045] which do not exist",
    "Please correct the request and try again"
  ]
}
```

If the Service Template depends on more than one non-existent included service:

### JSON Response

```
{
  "messages": [
    "Service template NewR could not be updated",
    "Service template requires service template(s) [Stor45, Stor12] which do not exist",
    "Please correct the request and try again"
  ]
}
```

An attempt to modify the Service Template name to an existing template name:

### JSON Response

```
{
  "messages": [
    "Service template NewR could not be updated",
    "Request has a non-unique service template name 'Stor44'"
  ]
}
```

## 4.25.4 Deleting (Canceling) Service Templates

The HTTP DELETE method is used to delete Service Templates.

### Quick Reference

```
DELETE http://localhost/mws/rest/service-templates/<id>
DELETE http://localhost/mws/rest/service-templates/<name>
```

### 4.25.4.1 Cancel Service Template

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/service-templates/<id|name>
```

Parameter	Required	Valid Values	Description
id	Yes	String (24 character alphanumeric)	The unique identifier of the service template.
name	Yes	String	The name of the service template.

See [Global URL Parameters](#) for available URL parameters.

 Only one of **id** or **name** is required.

## Response

### A successful deletion

#### JSON Response

```
{}
```

### If the Service Template ID does not exist

#### JSON Response

```
{
  "messages": [
    "Service template not found with ID '4f2049a684ae6e1d4f09bd71'"
  ]
}
```

### If the Service Template name does not exist

#### JSON Response

```
{
  "messages": [
    "Service template not found with ID 'Stor44'"
  ]
}
```

### If other Service Templates depend on the one being deleted

#### JSON Response

```
{
  "messages": [
    "Service template Cent5 could not be deleted",
    "Service template 'Cent5' cannot be deleted because Service template '[Cent5]' depends on it "
  ]
}
```

## 4.26 Standing Reservations

This section describes behavior of the **Standing Reservation** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.

 The [Standing Reservation API](#) contains the type and description of all fields in the **Standing Reservation** object. It also contains details regarding which fields are valid during PUT and POST actions.

### Supported Methods

Resource	GET	PUT POST DELETE
/rest/standing-reservations	<a href="#">Get all standing reservations</a>	
/rest/standing-reservations/id	<a href="#">Get specified standing reservation</a>	

### 4.26.1 Getting Standing Reservations

The HTTP GET method is used to retrieve **Standing Reservation** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/standing-reservations/<id>
```

#### 4.26.1.1 Get All Standing Reservations

##### URLs and Parameters

```
GET http://localhost/mws/rest/standing-reservations
```

See [Global URL Parameters](#) for available URL parameters.

##### Sample Response

```
GET http://localhost/mws/rest/standing-reservations?fields=id
```

```
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    { "id": "sr1" },
    { "id": "sr2" },
    { "id": "sr3" }
  ]
}
```

## 4.26.1.2 Get Single Standing Reservation

### URLs and Parameters

```
GET http://localhost/mws/rest/standing-reservations/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

## JSON Response

```
{
  "access": "DEDICATED",
  "accounts": ["account1"],
  "aclRules": [ {
    "affinity": "POSITIVE",
    "comparator": "EQUAL",
    "type": "USER",
    "value": "adaptive",
  } ],
  "chargeAccount": "account2",
  "chargeUser": "user2",
  "classes": ["class1"],
  "clusters": ["cluster1"],
  "comment": "comment",
  "days": ["Monday"],
  "depth": 2,
  "disabled": false,
  "endOffset": 86415,
  "flags": ["ALLOWJOB OVERLAP"],
  "groups": ["group1"],
  "hosts": ["host1"],
  "id": "fast",
  "jobAttributes": ["TEMPLATESAPPLIED"],
  "maxJob": 2,
  "maxTime": 0,
  "messages": ["message1"],
  "nodeFeatures": ["feature1"],
  "os": "Ubuntu 10.04.3",
  "owner": {
    "name": "root",
    "type": "USER"
  },
  "partition": "ALL",
  "period": "DAY",
  "procLimit": {
    "qualifier": "<=",
    "value": 5
  },
  "psLimit": {
    "qualifier": "<=",
    "value": 60
  },
  "qoses": ["qos1"],
  "reservationAccessList": [],
  "reservationGroup": "group2",
  "resources": {
    "PROCS": -1,
    "tapes": 1
  },
  "rollbackOffset": 43200,
  "startOffset": 347040,
  "taskCount": 0,
  "tasksPerNode": 0,
  "timeLimit": -1,
  "triggers": [],
  "type": "type1",
  "users": ["user1"]
}
```

## 4.27 Usage Records

This section describes behavior of the **Usage Record** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Usage Record API](#) contains the type and description of all fields in the **UsageRecord** object.

## Supported Methods

Resource	GET	PUT POST DELETE
/rest/usage-records	<a href="#">Get all usage-records</a>	
/rest/usage-records/ <b>id</b>	<a href="#">Get specified usage-record</a>	

## 4.27.1 Getting Usage Records

The HTTP GET method is used to retrieve **Usage Record** information.

### Quick Reference

```
GET http://localhost/mws/rest/usage-records?proxy-user=<USER>
[&custom-fields=QualityOfService][&query={"id":"2"}][&sort={"Stage":-1}]
GET http://localhost/mws/rest/usage-records/<id>?proxy-user=<USER>
[&custom-fields=QualityOfService]
```

### 4.27.1.1 Get All Usage Records

#### URLs and Parameters

```
GET http://localhost/mws/rest/usage-records?proxy-user=<USER>
[&custom-fields=QualityOfService][&query={"id":"2"}][&sort={"stage":-1}]
```

Parameter	Required	Valid Values	Description	Example
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
custom-fields	No	Comma-Separated String	Includes custom MAM usage-record attributes.	custom-fields=QualityOfService
query	No	JSON	Query for specific results.	query={"priority":"2","allocation.active":"fals
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"stage":-1}



The `query` parameter does not support the full Mongo query syntax. Only querying for a simple, non-nested JSON object is allowed.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```
GET
http://localhost/mws/rest/usage-records?proxy-user=amy&custom-fields=qualityOfService&fields=id,q

{
  "totalCount": 8,
  "resultCount": 2,
  "results": [
    {
      "id": 1,
      "qualityOfService": "premium",
      "type": "Job",
      "instance": "job.123"
    },
    {
      "qualityOfService": "premium",
      "id": 2,
      "type": "Job",
      "instance": "job.1234"
    }
  ]
}
```

### 4.27.1.2 Get Single Usage Record

#### URLs and Parameters

```
GET http://localhost/mws/rest/usage-records/<id>?proxy-user=<USER>
[&custom-fields=QualityOfService]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
proxy-user	Yes	String	Perform action as defined MAM user.	proxy-user=amy
custom-fields	No	Comma-Separated String	Includes custom MAM usage-record attributes.	custom-fields=QualityOfService

See [Global URL Parameters](#) for available URL parameters.

## Sample Responses

GET

http://localhost/mws/rest/usage-records/1?proxy-user=amy&custom-fields=qualityOfService

```
{
  "id": 1,
  "qualityOfService": "premium",
  "type": "Job",
  "instance": "job.123",
  "charge": 0,
  "stage": "Create",
  "quote": "",
  "user": "doug",
}
```

## 4.28 Virtual Containers

This section describes behavior of the **Virtual Container** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The [Virtual Container API](#) contains the type and description of all fields in the **Virtual Container** object. It also contains details regarding which fields are valid during PUT and POST actions.

### Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/vcs	<a href="#">Get all Virtual Containers</a>		<a href="#">Create Virtual Container</a>	
/rest/vcs/ id	<a href="#">Get specified Virtual Container</a>	<a href="#">Modify Virtual Container</a>		<a href="#">Destroy Virtual Container</a>

### 4.28.1 Getting Virtual Containers

The HTTP GET method is used to retrieve **Virtual Container** information. Queries for all objects and a single object are available.

#### Quick Reference

```
GET http://localhost/mws/rest/vcs/<id>
```

#### 4.28.1.1 Get All Virtual Containers

##### URLs and Parameters

```
GET http://localhost/mws/rest/vcs
```

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

```
GET http://localhost/mws/rest/vcs?fields=id
```

```
{
  "totalCount": 5,
  "resultCount": 5,
  "results": [
    { "id": "vc3" },
    { "id": "vc1" },
    { "id": "vc4" },
    { "id": "vc5" },
    { "id": "vc2" }
  ]
}
```

## 4.28.1.2 Get Single Virtual Container

### URLs and Parameters

```
GET http://localhost/mws/rest/vcs/<id>
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

## JSON Response

```
{
  "aclRules": [ {
    "affinity": "POSITIVE",
    "comparator": "LEXIGRAPHIC_EQUAL",
    "type": "USER",
    "value": "root"
  } ],
  "createDate": "2011-11-15 14:01:40 UTC",
  "creator": "root",
  "description": "vc2",
  "flags": ["DESTROYWHENEMPTY"],
  "id": "vc2",
  "jobs": [
    { "id": "Moab.1" }
  ],
  "nodes": [
    { "id": "node1" }
  ],
  "owner": {
    "name": "root",
    "type": "USER"
  },
  "reservations": [
    { "id": "system.1" }
  ],
  "variables": {
    "a": "b",
    "c": "d"
  },
  "virtualContainers": [
    { "id": "vc3" }
  ],
  "virtualMachines": [
    { "id": "vm1" }
  ]
}
```

## 4.28.2 Creating Virtual Containers

The HTTP POST method is used to create **Virtual Containers**.

### Quick Reference

```
POST http://localhost/mws/rest/vcs[?proxy-user=<username>]
```

### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

### 4.28.2.1 Create Virtual Container

#### URLs and Parameters

```
POST http://localhost/mws/rest/vcs[?proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

## Request Body

The request body below shows all the fields that are available when creating a Virtual Container, along with some sample values.

```

JSON Request Body
{
  "description": "ted's vc",
  "owner": {
    "name": "ted",
    "type": "USER"
  },
  "requiredStartDate": "2012-11-08 13:18:47 MST",
  "flags": ["HOLDJOBS"],
  "virtualContainers": [
    { "id": "vc93" },
    { "id": "vc94" }
  ],
}

```

## Sample Response

```

JSON Response for successful POST
{"id": "vc8"}

```

## Restrictions

- When creating a Virtual Container, the `creator` field is set to the value of `proxy-user` (if set) or `owner.name` (if set), with `proxy-user` taking precedence. However, setting the `creator` field works only if you set `ENABLEPROXY=TRUE` in the `moab.cfg` file.

Example:

```

ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE

```

- You can set the `creator` field as shown above, but you can never change it.

## 4.28.3 Modifying Virtual Containers

The HTTP PUT method is used to modify **Virtual Containers**.

## Quick Reference

```
PUT http://localhost/mws/rest/vcs/<id>?change-mode=<add|remove|set>[&proxy-user=
<username>]
```

## Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

### 4.28.3.1 Modify Virtual Container

#### URLs and Parameters

```
PUT http://localhost/mws/rest/vcs/<id>?change-mode=<add|remove|set>[&proxy-user=
<username>]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
change-mode	Yes	String	add	Add the given objects (jobs, VMs, etc) to the objects that already exist.
			remove	Delete the given objects from the objects that already exist.
			set	Modify the attributes of the virtual container itself and <b>not</b> the associated objects.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

#### Request Body

Here are three examples of Virtual Container updates: add objects, remove objects, and update attributes. In each case, the examples below show all the fields that are available, along with some sample values.

### Add objects with /rest/vcs/vc1?change-mode=add

```
{
  "jobs": [
    { "id": "Moab.37" },
    { "id": "Moab.38" }
  ],
  "nodes": [
    { "id": "node1" },
    { "id": "node2" }
  ],
  "reservations": [
    { "id": "system.48" },
    { "id": "system.49" }
  ],
  "virtualContainers": [
    { "id": "vc93" },
    { "id": "vc94" }
  ],
  "virtualMachines": [
    { "id": "vm2" },
    { "id": "vm4" }
  ]
}
```

### Remove objects with /rest/vcs/vc1?change-mode=remove

```
{
  "jobs": [
    { "id": "Moab.37" },
    { "id": "Moab.38" }
  ],
  "nodes": [
    { "id": "node1" },
    { "id": "node2" }
  ],
  "reservations": [
    { "id": "system.48" },
    { "id": "system.49" }
  ],
  "virtualContainers": [
    { "id": "vc93" },
    { "id": "vc94" }
  ],
  "virtualMachines": [
    { "id": "vm2" },
    { "id": "vm4" }
  ]
}
```

### Modify VC attributes with /rest/vcs/vc1?change-mode=set

```
{
  "description": "This is a new description.",
  "flags": ["HOLDJOBS"],
  "owner": {
    "name": "ted",
    "type": "USER"
  },
  "variables": {
    "a": "b",
    "c": "d"
  }
}
```

## Sample Responses



These messages may not match the messages returned from Moab exactly, but they are given as examples of the structure of the responses.

### JSON response for adding objects

```
{
  "messages": [
    "job '147' added to VC 'vc3'",
    "job 'Moab.1' added to VC 'vc3'"
  ]
}
```

### JSON response for removing objects

```
{
  "messages": [
    "job '147' removed from VC 'vc3'",
    "job 'Moab.1' removed from VC 'vc3'"
  ]
}
```

### JSON response for updating attributes

```
{"messages":["VC 'vc3' successfully modified"]}
```

## Restrictions

- You can change the ACL Rules on a Virtual Container, but not using this resource. See [Create or Update ACLs](#).

## 4.28.4 Destroying Virtual Containers

The HTTP DELETE method is used to destroy **Virtual Containers**.

### Quick Reference

```
DELETE http://localhost/mws/rest/vcs/<id>[?proxy-user=<username>]
```

## Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

### 4.28.4.1 Destroy Virtual Container

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/vcs/<id>[?proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
id	Yes	String	-	The unique identifier of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

JSON Response for successful DELETE

```
{}
```

## 4.29 Virtual Machines

This section describes behavior of the **Virtual Machine** object in Moab Web Services. It contains the URLs, request bodies, and responses delivered to and from Moab Web Services.



The Virtual Machine API has changed with **API version 2**. The supported methods table below requires each resource to be accessed with a URL parameter of `api-version=2` in order to behave as documented.

In order to access documentation for previous API versions, see [Requesting Specific API Versions](#).



The [Virtual Machine API](#) contains the type and description of all fields in the **Virtual Machine** object. It also contains details regarding which fields are valid during PUT actions.

## Supported Methods

Resource	GET	PUT	POST	DELETE
/rest/vms	<a href="#">Get all VMs</a>			
/rest/vms/name	<a href="#">Get specified VM</a>	<a href="#">Modify VM</a>		<a href="#">Destroy VM</a>

### 4.29.1 Getting Virtual Machines

The HTTP GET method is used to retrieve **Virtual Machine** information.

## Quick Reference

```
GET http://localhost/mws/rest/vms/<name>?api-version=2
```

## 4.29.1.1 Get All Virtual Machines

### URLs and Parameters

```
GET http://localhost/mws/rest/vms?api-version=2
```

Parameter	Required	Valid Values	Description	Example
query	No	JSON	Queries for specific results.	query={"migrationDisabled":true}
sort	No	JSON	Sort the results. Use 1 for ascending and -1 for descending.	sort={"name":-1}

It is possible to query by one or more fields based on [MongoDB query syntax](#).

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

```
GET http://localhost/mws/rest/vms?api-version=2&fields=name
```

```
{
  "totalCount": 3,
  "resultCount": 3,
  "results": [
    { "name": "vm1" },
    { "name": "vm2" },
    { "name": "vm3" }
  ]
}
```

## 4.29.1.2 Get Single Virtual Machine

### URLs and Parameters

```
GET http://localhost/mws/rest/vms/<name>?api-version=2
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.

See [Global URL Parameters](#) for available URL parameters.

## Sample Response

### JSON Response

```
{
  "name": "vm3",
  "description": null,
  "host": {"name": "hv2"},
  "hostnames": [],
  "ipAddress": "10.0.0.5",
  "migrationDisabled": false,
  "lastUpdatedDate": "2012-10-11 17:46:32 UTC",
  "startDate": "2012-09-25 18:12:23 UTC",
  "trackingJob": null,
  "metrics": {"watts": 200},
  "variables": {},
  "resourceManagers": [ {
    "name": "msm",
    "isMaster": true,
    "stateReported": "Active"
  } ],
  "operatingSystem": {
    "image": "stateless1",
    "imageExpected": null,
    "imageLastUpdatedDate": null,
    "imagesAvailable": []
  },
  "states": {
    "powerState": "On",
    "powerStateExpected": null,
    "powerStateLastUpdatedDate": null,
    "state": "Idle",
    "stateLastUpdatedDate": "2012-10-11 17:15:01 UTC",
    "subState": null,
    "subStateLast": null,
    "subStateLastUpdatedDate": null
  },
  "resources": {
    "processors": {
      "configured": 1,
      "dedicated": 0,
      "available": 1
    },
    "memory": {
      "configured": 512,
      "dedicated": 0,
      "available": 512
    },
    "disk": {
      "configured": 1024,
      "dedicated": 0,
      "available": 1024
    },
    "swap": {
      "configured": 0,
      "dedicated": 0,
      "available": 0
    }
  },
  "triggers": [],
  "virtualContainers": []
}
```

## 4.29.2 Modifying Virtual Machines

The HTTP PUT method is used to modify **Virtual Machines**.

### Quick Reference

```
PUT http://localhost/mws/rest/vms/<name>?api-version=2[&proxy-user=<username>]
```

### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

## 4.29.2.1 Modify Virtual Machine

### URLs and Parameters

```
PUT http://localhost/mws/rest/vms/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows all the fields that are available when modifying a Virtual Machine, along with some sample values.

#### JSON Request Body for VM Modify

```
{
  "metrics": {"pwatts": 211},
  "migrationDisabled": true,
  "operatingSystem": {"image": "esx4.1"},
  "states": {
    "powerState": "On",
    "state": "Running"
  },
  "triggers": [{"name": "trigger_id"}],
  "variables": {
    "key": "value",
    "arbitrary text key": "more value"
  }
}
```

### Sample Response



This message may not match the message returned from Moab exactly, but is given as an example of the structure of the response.

#### JSON Response

```
{"messages":["successfully updated VM variables"]}
```

## 4.29.2.2 Migrate Virtual Machine

### URLs and Parameters

```
PUT http://localhost/mws/rest/vms/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Request Body

The request body below shows how to migrate a Virtual Machine to a host (hypervisor) with name "hv2".

JSON Request Body for VM Migrate to a specific host

```
{"host": {"name": "hv2"}}
```

The request body below shows how to migrate a Virtual Machine to any available host by using the destination name of ANY, which for this operation is a reserved word.

JSON Request Body for VM Migrate to any available host

```
{"host": {"name": "ANY"}}
```

### Sample Response

 The HTTP response code for this operation is 202 Accepted. See the [responses](#) section for more information.

JSON Response

```
{"jobId": "vm-migrate1"}
```

### Restrictions

- If a migration is requested by setting the host as shown in the above examples, any other properties in the same request body will be ignored.

## 4.29.3 Destroying Virtual Machines

The HTTP DELETE method is used to destroy **Virtual Machines**.

### Quick Reference

```
DELETE http://localhost/mws/rest/vms/<name>?api-version=2[&proxy-user=<username>]
```

### Restrictions

- The proxy-user parameter is ignored unless you set ENABLEPROXY=TRUE in the moab.cfg file. Example:

```
ADMINCFG[1]          USERS=root,ted ENABLEPROXY=TRUE
```

### 4.29.3.1 Destroy Virtual Machine

#### URLs and Parameters

```
DELETE http://localhost/mws/rest/vms/<name>?api-version=2[&proxy-user=<username>]
```

Parameter	Required	Type	Valid Values	Description
name	Yes	String	-	The name of the object.
proxy-user	No	String	-	Perform the action as this user.

See [Global URL Parameters](#) for available URL parameters.

### Sample Response

JSON Response for successful DELETE

```
{"jobId": "vmdestroy-26"}
```



The jobId in the response identifies the job that will destroy the virtual machine.

## 5 Reporting Framework

The reporting framework is a set of tools to make time-based reports from numerical data. The following sections will (1) provide an overview of the framework and the concepts related to it, and (2) work through an example report (CPU Utilization) with details regarding which web services to use and with what data.

The REST API reference is located in the [Report Resource](#) section.

### 5.1 Overview

#### 5.1.1 Concepts

The reporting framework uses 3 core concepts: reports, datapoints, and samples.

- **Report** - A report is a time-based view of numerical data.
- **Datapoint** - A datapoint is a consolidated set of data for a certain time period.
- **Sample** - A sample is a snapshot of a certain set of data at a particular point in time.

To illustrate, consider the memory utilization of a virtual machine: at any given point in time, you can get the memory utilization by using your operating system's performance utilities (top for Linux, Task Manager for Windows):

```
2400/12040MB
```

By recording the memory utilization and time constantly for 1 minute, you could gather the following data:

Time	Memory Utilization
3:53:55 PM	2400/12040 MB
3:54:13 PM	2410/12040 MB
3:54:27 PM	2406/12040 MB
3:54:39 PM	2402/12040 MB
3:54:50 PM	2409/12040 MB

Each of the rows in the table above represent a **sample** of data. By averaging the rows we can consolidate them into one or more **datapoints**:

Start time	End Time	Memory Utilization
3:53:30 PM	3:54:00 PM	2400/12040 MB
3:54:00 PM	3:54:30 PM	2408/12040 MB
3:54:30 PM	3:55:00 PM	2406/12040 MB



Note that each datapoint covers exactly the same amount of time, and averages all samples within that period of time.

A **report**, then, is simply a list of datapoints with some additional configuration information:

Field	Value
Name	Memory Utilization Report
Datapoint Duration	30 seconds
Report Size	3 datapoints

#### Datapoints:

Start time	End Time	Memory Utilization
3:53:30 PM	3:54:00 PM	2400/12040 MB
3:54:00 PM	3:54:30 PM	2408/12040 MB
3:54:30 PM	3:55:00 PM	2406/12040 MB

## 5.1.2 Capabilities

While storing simple information like memory utilization is nice, the reporting framework is built to automatically handle much more complex information.

### Consolidating Samples

Samples are JSON documents which are pushed into the report using the [samples API](#). Samples are then stored until the consolidation operation creates a datapoint out of them. The table below shows how different data types are handled in this operation:

Type	Consolidation Function Handling
Numbers	Numerical data is averaged
Strings	Strings are aggregated into an array
Objects	The consolidation function recursively consolidates sub-objects
Lists	Lists are combined into a single flat list containing all elements
Mixed	If samples have different types of data for the same field, the values are aggregated into an array.
Null	These values will be ignored unless all values for a sample field are set to null, resulting in a null result.



If the mixed data types contains at least one number, it will be treated as numerical data. The non-numerical data will be ignored and the result will be averaged.

Below is an example of how the consolidation function works:

Samples:

Time	NumberEx	StringEx	ListEx	MixedEx	MixedNumberEx
3:53:55 PM	2400	"str1"	["elem1"]	"str1"	"str1"
3:54:13 PM	2410	"str2"	["elem2", "elem3"]	["elem1"]	["elem1"]
3:54:27 PM	2405	"str3"	["elem4"]	null	5

Resulting Datapoint after consolidation:

Time	NumberEx	StringEx	ListEx	MixedEx	MixedNumberEx
3:55:00 PM	2405	["str1", "str2", "str3"]	["elem1", "elem2", "elem3", "elem4"]	["str1", "elem1"]	5

## Minimum Number of Samples

If your dataset is highly variable (i.e. values contained in samples are not very close together), converting a single sample into a datapoint may provide misleading information. It may be better to have a datapoint with an "Unknown" value. This can be accomplished by setting the minimum number of samples for a datapoint in the report.

The `minimumSampleSize` field in the [Report API](#) explains that if the specified size of samples is not met when the consolidation function is performed, the datapoint is considered "null" and no data is available for it. When this occurs, the sample data is discarded and the `data` field of the datapoint is set to "null".

For information on how to set this option, see the REST API [Report Resource](#) section in the documentation.

## Report Size

Reports have a predetermined number of datapoints, or size, which sets a limit on the amount of data that can be stored. After the report size has been reached, as newly created datapoints are pushed into the report, the oldest datapoints will automatically be deleted. This is to aid in managing the storage capacity of the server hosting MWS.



On report creation, a Mongo collection will be initialized that is the maximum size of a single entry (currently 16 MB) multiplied by the report size. Be careful in setting a large report size as this will quickly allocate the entire disk if many reports with large report sizes are created.

## 5.2 Example Report (CPU Utilization)

To understand how the behavior and usage of the reporting framework, a sample report covering CPU Utilization will be shown in this section. It will not cover how to gather or display data for reports, but will cover some basic operations that are available with Moab Web Services to facilitate reporting.

## 5.2.1 Creating A Report

Before any data is sent to Moab Web Services, a report must first be created. A JSON request body with a HTTP method of POST must be used to do this.

POST /rest/reports

```
{
  "name": "cpu-util",
  "description": "An example report for cpu utilization",
  "consolidationFunction": "average",
  "datapointDuration": 600,
  "reportSize": 288
}
```

This will result in a report being created which can then be retrieved by sending a GET request to /rest/reports/cpu-util. The datapointDuration of 600 signifies that the datapoint consolidation should occur once every 10 minutes, while the reportSize (i.e. number of the datapoints) shows that the report will retain up to 2 days worth of the latest datapoints.

GET /rest/reports/cpu-util

```
{
  "consolidationFunction": "average",
  "datapointDuration": 600,
  "datapoints": [],
  "description": "An example report for cpu utilization",
  "id": "aef6f6a3a0bz7bf6449537c9d",
  "keepSamples": false,
  "minimumSampleSize": 1,
  "name": "cpu-util",
  "reportSize": 288,
  "version": 0
}
```

Note that an ID has been generated automatically and that no datapoints are associated with the report.

## 5.2.2 Adding Samples

Until samples are added and associated with the report, datapoint consolidation will generate datapoints with a data field equal to null. Once samples are added, however, they will be averaged and inserted into the next datapoint.

Create samples for the `cpu-util` by sending a POST request as follows:

## POST /rest/reports/cpu-util/samples

```
[
  {
    "agent": "cpu-monitor",
    "timestamp": "2012-01-01 12:00:00 UTC",
    "data": {
      "minutes1": 0.5,
      "minutes5": 0,
      "minutes15": 0
    }
  },
  {
    "agent": "cpu-monitor",
    "timestamp": "2012-01-01 12:01:00 UTC",
    "data": {
      "minutes1": 1,
      "minutes5": 0.5,
      "minutes15": 0.05
    }
  },
  {
    "agent": "cpu-monitor",
    "timestamp": "2012-01-01 12:02:00 UTC",
    "data": {
      "minutes1": 1,
      "minutes5": 0.5,
      "minutes15": 0.1
    }
  },
  {
    "agent": "cpu-monitor",
    "timestamp": "2012-01-01 12:03:00 UTC",
    "data": {
      "minutes1": 0.75,
      "minutes5": 1,
      "minutes15": 0.25
    }
  },
  {
    "agent": "cpu-monitor",
    "timestamp": "2012-01-01 12:04:00 UTC",
    "data": {
      "minutes1": 0,
      "minutes5": 1,
      "minutes15": 0.85
    }
  }
]
```

This sample data contains average load for the last 1, 5, and 15 minute intervals. The samples were recorded at one-minute intervals starting at noon on January 1st, 2012.

### 5.2.3 Consolidating Data

A consolidation function must run to generate datapoints from the given samples. This scheduled consolidation will occur at intervals of `datapointDuration` seconds. For each field in the data object in samples, all values will be averaged. If non-numeric values are included, the following strategies will be followed:

1. All fields which contain a single numeric value in any included sample will be averaged and the non-numeric or null values will be ignored.
2. All fields which contain a list will be consolidated into a single, flat list.
3. All fields which contain only non-numeric or null values will be consolidated into a single, flat list.

If no historical datapoints are provided in the creation of a report as in this example, the next consolidation will be scheduled for the current time plus the `datapointDuration`. In this example, the scheduled consolidation is at 10 minutes from the creation date. If historical datapoints are included in the report creation, the latest datapoint's `endDate` plus the `datapointDuration` will be used as the scheduled time. If this date was in the past, the next scheduled consolidation will occur at the appropriate interval from the last `endDate`.

## 5.2.4 Retrieving Report Data

To retrieve the consolidated datapoints, simply perform a GET request on the report once again. Alternatively, the GET for a report's [datapoints](#) may be used.

```
GET /rest/reports/cpu-util

{
  "consolidationFunction": "average",
  "datapointDuration": 600,
  "datapoints": [
    {
      "firstSampleDate": null,
      "lastSampleDate": null,
      "data": null,
      "startDate": "2012-01-01 11:49:00 UTC",
      "endDate": "2012-01-01 11:59:00 UTC"
    },
    {
      "firstSampleDate": "2012-01-01 12:00:00 UTC",
      "lastSampleDate": "2012-01-01 12:04:00 UTC",
      "data": {
        "minutes1": 0.65,
        "minutes15": 0.25,
        "minutes5": 0.6
      },
      "startDate": "2012-01-01 11:59:00 UTC",
      "endDate": "2012-01-01 12:09:00 UTC"
    }
  ],
  "description": "An example report for cpu utilization",
  "id": "aef6f6a3a0bz7bf6449537c9d",
  "keepSamples": false,
  "minimumSampleSize": 1,
  "name": "cpu-util",
  "reportSize": 288,
  "version": 0
}
```

Note that of the two datapoints above, only the second actually contains data, while the other is set to null. Only samples lying within the datapoint's duration, or from the `startDate` to the `endDate`, are included in the consolidation. Therefore the first datapoint, which covered the 10 minute period just before the samples' recorded timestamps, contained no data. The second, which covers the 10 minute period matching that of the samples, contains the averaged sample data. This data could be used to display consolidated report data in a custom interface.

## 5.2.5 Possible Configurations

Configuration options may be changed to affect the process of report generation. These are documented in the API for the [Report](#) object and the [Sample](#) object.

## 6 MWS Plugins (Beta)

This section describes MWS Plugins, their use, and their creation in Moab Web Services.

 MWS Plugins are currently in beta. Interfaces may change significantly in future releases.

### 6.1 Plugin Overview

This section provides an overview of the plugin layer in web services. The following areas will be covered:

- An [introduction](#) to the concept of MWS plugins
- How to [configure](#) Moab Workload Manager to interact with MWS plugins
- A description of the plugin [lifecycle](#)
- How plugins are driven by [events](#)
- How to expose [web services](#) from a plugin
- How plugin [utility services](#) may be used
- How data report collisions between plugins are [consolidated](#)
- How calls from MWM are [routed](#) to MWS plugins

#### 6.1.1 Introduction

Moab Web Services plugins provide a highly extensible interface to interact with Moab, MWS, and external resources. Plugins can perform some of the same functions as Moab Resource Managers (RMs), while also providing many other features not available to RMs. This section will discuss the main features of plugins, some basic terminology, and how MWS plugins can interact with Moab.

### Features

Plugins can

- be created, modified, and deleted without restarting Moab Workload Manager or MWS.
- be defined in Groovy and uploaded to MWS without restarting.
- have individual data storage space and configuration.
- access MWS configuration and RESTful web services.
- log to a standard location configured in MWS.
- be polled at a regular interval (configured on a per-plugin basis).
- report current state data to Moab Workload Manager through the Resource Manager interface (see [MWM Resource Manager Integration](#) for more information).
- be informed of important system events.
- be individually stopped, started, paused, and resumed.
- expose secured and unsecured custom web services for external use.
- be manipulated via a full RESTful API (see [Resources](#) for more information).
- be manipulated via a full user interface in a web browser.

## Terminology

There are two distinct terms in the plugin layer: plugin types and plugins (also called plugin instances).

### Plugin Types

Plugin Types can be considered plugin templates with built-in logic. In object-oriented programming languages, this relates to the concept of a class. They possess certain abilities, or methods, that can be called by Moab Web Services to query or update information about certain resources. They also can define methods which will be exposed to external clients as web services. They do not contain any configuration or current data, but they are often tied to a *type* of component, such as components that communicate with Moab's WIKI Protocol or those that are built on a certain product.

They can define several types of methods:

1. **Instance methods** that return information about the current plugin, such as `getState`. While these are defined in the plugin type, the plugin type itself does not have a state.
2. The **poll event method** that is called at a configured interval.
3. **Lifecycle event methods** of plugins created from the plugin type, such as `beforeStart` and `afterStart`.
4. **RM event methods** that are called by Moab when certain events occur.
5. **Web service methods** that expose custom functionality as public web services.

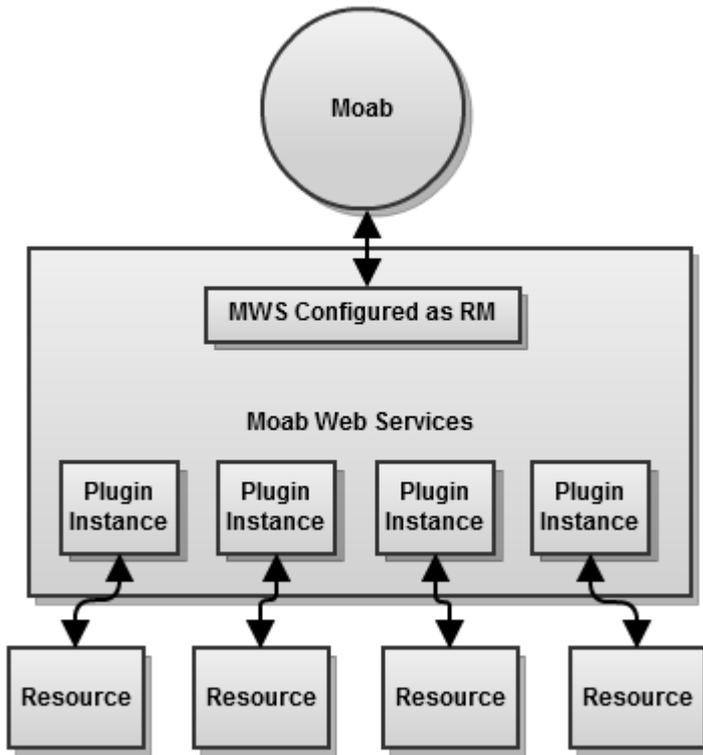
Some examples of plugin types include the [Native](#) and [vCenter](#) plugin types.

### Plugins (Instances)

Plugins (also called plugin instances) are created from plugin types. They contain current data or configuration and use the plugin type methods to interact with resources.

## Interactions with MWM as a Resource Manager

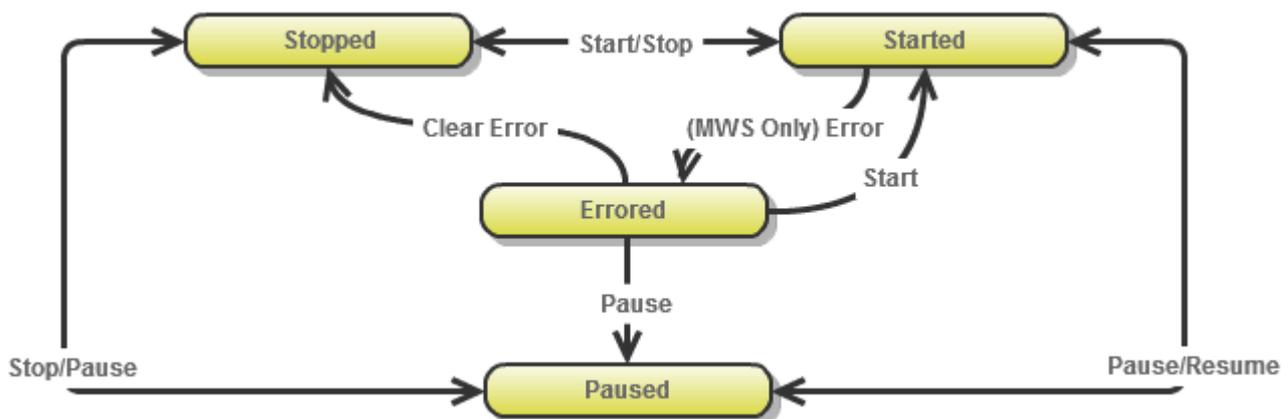
The plugin layer in MWS is integrated with Moab Workload Manager via the Native Resource Manager (RM) interface. When utilizing plugins, MWS is configured as a RM in Moab as explained in the next section. Events from Moab are pushed through the RM interface to MWS which is then pushed to each plugin in turn. The relationship between Moab Web Services, Moab, and plugins is shown in the following image:



See [Consolidating Data](#) and [Reporting State Data](#) for more information.

## 6.1.2 Lifecycle States

During the course of a plugin's use, the state of the plugin may change many times. Plugins have four possible states: Stopped, Started, Paused, and Errored. The flow of a plugin through the states is shown in the following image:



To see descriptions of each state, see the [PluginState API](#).

Events that occur during lifecycle state changes may be found in the [Events](#) section.

## 6.1.3 Events

Plugins use an event based model in that methods are called on the plugin when certain criteria are met or situations arise. Events currently exist for polling, lifecycle state changes, and RM events from Moab. See [Handling Events](#) for more information.

## 6.1.4 Custom Web Services

Although the events interface typically serves most cases, there are some instances where an event is not supported that is desired. This is especially true when an external resource is the source of the event. To address these issues, plugins can expose custom web services to external resources. These web services may be named freely and do anything they wish within the plugin framework.

For example, suppose a resource needs to notify a plugin that provisioning of a virtual machine has been completed. Instead of having the plugin poll the resource to verify that the provisioning was finished, the plugin could expose a custom web service to handle notification from the resource itself.

### Sample custom web service

```
def vmProvisionFinished(Map params) {  
  // Handle event  
  return [messages: ["Event successfully processed"]]  
}
```

Additionally, plugin types may define web services which are unsecured, meaning that a user or application account is not required to access it. A full explanation of the syntax and creation of custom secured and unsecured web services may be seen on the [Exposing Web Services](#) page.

For information how resources can access plugin web services, see [Accessing Plugin Web Services](#).

## 6.1.5 Utility Services

Several features of plugins are only available by utilizing bundled services. These include:

- Accessing the [individual datastore](#).
- [Reporting state data](#) to Moab through the Resource Manager interface.
- Manipulating other plugins and [controlling their lifecycle](#).
- [Accessing REST resources](#) from Moab Web Services.

All bundled services are covered on their respective pages in the Quick Reference guide under "Plugin Services".

It may also be necessary or desired to create additional utility services when creating new plugin types. The easiest way to do this is to create a utility service which is called by convention a [Translator](#), since it typically can "translate" from a specific resource or API to data which can be used by the plugin type.

Finally, [custom components](#) may be used to fulfill use cases not covered by bundled services or custom translators.

## 6.1.6 Data Consolidation

At times, plugins can report differing or even contradictory data for nodes, virtual machines, and jobs. This is called a data "collision". The act of resolving these collisions is called "Consolidation". Plugins also have the concept of "precedence", where the plugins with the lowest precedence value are considered more authoritative than the greater precedence values plugins. For example, a plugin with a precedence value of 1 has a higher precedence and is considered more authoritative than a plugin with a precedence value of 5. If no precedence is provided when creating plugins, the plugin is automatically assigned to the lowest precedence, or 1 greater than the highest precedence value. The precedence value may not be less than 1.

When data from one plugin "collides" with another, the data from the highest precedence plugin will be considered the authoritative source for information. If multiple sets of data (reports) are provided by the same plugin, the latest set of data will take precedence. Additionally, MWS supports the concept of treating node and virtual machine data with state information **optimistically**, **pessimistically**, or **neither**. This is configured using the `plugins.stateConsolidationPolicy` configuration property in the MWS configuration file. If this property is set to `optimistic` and *any* plugin reports the state for a node or VM as "Up", the consolidated state will be "Up". Inversely, if the property is set to `pessimistic` and *any* plugin reports the state as "Down", the consolidated state will be "Down". If it is set to `null` (neither), consolidation will occur for the state field just as with any other field, with higher precedence and later reports being considered authoritative.

 Node, virtual machine, and job unique identifiers (IDs) are all converted to lower-case before consolidation, so the node "NODE1" is equivalent to "node1".

 When MWS is upgraded to a version that supports plugin precedence from an older version, existing plugins will not have the precedence field set. The administrator should assign precedence to each plugin manually through the [REST API](#) or through the [user interface](#) to ensure that the consolidation will occur as expected. By default, data from a plugin without a precedence defaults to a precedence of 1, or the highest precedence.

## Consolidation Examples

Suppose two plugins exist, `pluginA` and `pluginB`. Plugin A has a precedence of 1, and plugin B has a precedence of 2, meaning that plugin A is more authoritative. These plugins both report data for a node with an ID of `node1`. However, each reports a different node power state. Plugin A reports the power as `ON`, while plugin B reports the power as `OFF`. The data collision that occurs due to these two contradictory reports is resolved by the precedence of the plugins. Since plugin A has a higher precedence (lower number), it is considered authoritative and the node will be reported as `ON`.

Now suppose that the plugins also report differing node state for `node1`. In this case, the node state would depend on the `plugins.stateConsolidationPolicy` property. The different combinations of report values compared to the state consolidation policy and the final reported state are shown in the table below.

Plugin A Node State	Plugin B Node State	State Consolidation Policy	Consolidated Node State
ON	OFF	null (neither)	ON
OFF	ON	null (neither)	OFF
ON	OFF	optimistic	ON
OFF	ON	optimistic	ON
ON	OFF	pessimistic	OFF
OFF	ON	pessimistic	OFF

In general, it is recommended that no two plugins report the same resource or that they report different properties of the same resource. For example, if plugin A only modified the power state and plugin B only modified the available disk resource, these two plugins would work in harmony to provide a consistent view of the node resource.

See [Reporting State Data](#) and [RM Queries](#) sections for more information.

## 6.1.7 Routing

Because Moab Web Services is configured as a Resource Manager (RM) in Moab Workload Manager, events are sometimes triggered by Moab through the RM interface. These actions could be migrating a virtual machine, starting a job, submitting a job, modifying a node, and so forth. The decisions regarding which plugins are affected and notified is termed *routing*.

Currently all plugins receive all commands from Moab. This means that each plugin will receive the command to start a job if sent from Moab, even if that plugin does not handle the job. This means that plugins must ensure they handle actions or commands only for resources which they report or handle.

## 6.2 Plugin Developer's Guide

Plugin types comprise the methods by which Moab may communicate with resource managers or other external components. They define all operations that can be performed for a "type" or "class" of plugins, hence the name "plugin type".

Several plugin types are provided with Moab Web Services (see Plugin Types in the Quick Reference), but it is easy to create additional plugin types and add their functionality to web services. This involves using [Groovy](#), which is based on the [Java](#) programming language. This section describes the general guidelines and specifics of implementing new plugin types.

### API Classes and Interfaces

There are several packages and classes available to assist in creating plugin types. These can all be found in the [API documentation](#) under the [com.adaptc.mws.plugins](#) package.

#### 6.2.1 Requirements

This section discusses the requirements to create a basic functional plugin. The `com.adaptc.mws.plugins` package contains the abstract class [AbstractPlugin](#) that should form the basis of any new plugin type. However, this class need not be extended to create a functional plugin type. Only two requirements must be fulfilled for this:

1. The class name must end in `Plugin`.
2. There must exist `id` field getter and setter methods:

```
* public String getId();
* public void setId(String id);
```

The `id` field may be stored in whichever way desired as long as the getter and setter are available as shown above, but will most likely be implemented as follows:

```
class BasicPlugin {
    String id
}
```

In this case, `String id` will be expanded by the Groovy compiler to the full getter and setter method definitions given above. In other words, no explicit method definitions are actually needed. Note that the `BasicPlugin` shown above is able to be uploaded as a plugin type to MWS, but does not actually do anything.

It must also be noted that the `AbstractPlugin` class already implements an `id` field. Therefore, a plugin type that extends this class does not need to define the field as shown in the following example.

```
import com.adaptc.mws.plugins.AbstractPlugin

class BasicPlugin extends AbstractPlugin {
    // No ID field is needed since it exists in AbstractPlugin
}
```

## 6.2.2 Dynamic Methods

Several methods are dynamically inserted onto each plugin. These methods do not need to be included in the plugin class, and will be overwritten if included. Additionally, a logger is inserted into each plugin as discussed in the next section. The inserted methods are shown below (full definitions can be found in [AbstractPlugin](#) and [AbstractPluginInfo](#)):

- `public void start()` throws `PluginStartException`; (Equivalent to the `start` method in the [Plugin Control Service](#))
- `public void stop()` throws `PluginStopException`; (Equivalent to the `stop` method in the [Plugin Control Service](#))
- `public Log getLog()`; (Discussed in [Logging](#))
- `public ConfigObject getAppConfig()`; (Discussed in [Configuration](#))
- `public String message(Map parameters)`; (Discussed in [i18n Messaging](#))
- `public String getPluginType()`;
- `public PluginState getState()`;
- `public Integer getPollInterval()`;
- `public Boolean getAutoStart()`;
- `public Map<String, Object> getConfig()`; (See [Configuration](#))

Many of these methods are provided for convenience and are discussed in the linked pages or the following sections.

## 6.2.3 Logging

Logging in plugin types uses the [Apache Commons Logging](#) and [log4j](#) libraries. Each plugin is injected with a method called `getLog` which can be used to access the configured logger. It returns an instance of [org.apache.commons.logging.Log](#). Examples of using the logger are shown below.

The logger may be used to register messages to the MWS log at several levels (in order of severity):

1. trace
2. debug
3. info
4. warn
5. error
6. fatal

Each of these levels is available as a method on the logger, for example:

```
public void poll() {
    getLog().debug("getLog() is equivalent to just using 'log' in Groovy")
    log.debug("This is a debug message and is used for debugging purposes only")
    log.info("This is a informational message")
    log.warn("This is a warning")
    log.error("This is an error message")
}
```

## Logger Name

Each logger in the MWS logging configuration has a name. In the case of plugins, it is composed of the full class name, including the package, prepended by "plugins.". For example, a plugin class of "example.LoggingPlugin" will have access to a logger configured as "plugins.example.LoggingPlugin".

## Logging Configuration

The logging configuration is done through the MWS configuration file. See the [MWS Configuration](#) page for more information on configuring loggers. A good configuration for developing plugin types may be to add "plugins" at the debug level. Be sure to set the log level threshold down for the desired appender.

```
log4j = {
  ...
  // Appender configuration
  ...
  debug "plugins"
}
```

## 6.2.4 i18n Messaging

Plugins, translators, and custom components all have access to [i18n](#) messages. Utilizing messages requires the two following steps:

1. Including a file (or multiple files) that ends in "messages.properties" in the plugin JAR file.
2. Using the message method on a plugin type, translator, or custom component.

### Including Messages in Plugin JAR File

Messages are defined using property files. These may be named anything as long as they end with "messages.properties" and must be placed at the root or top level of the plugin JAR file. If they are present, they will be loaded automatically. Multiple property files may be used within a single plugin JAR file.

Each property file consists of an arbitrary amount of lines that define a message property (also called a code) with letters, numbers, and periods, associated with a human-readable message that can span multiple lines, have quotes, or contain arguments. These are demonstrated in the following example.

```
first.message.code=This is the first message
second.message=This message can span multiple lines, \\
  and will not show the linebreaks when retrieved
message.with.arguments=This message has arguments: first - {0}, second - {1}, third -
{2}, etc.
message.with.quotes=This message uses single quotes around 'this phrase'.
```

It is recommended to namespace the messages by using the property definitions and multiple property files if necessary. For example, suppose a plugin JAR existed which actually contained two plugin types: `Message1Plugin` and `Message2Plugin`. The first suggestion is to namespace the messages for each plugin by the property definition, such as the following:

```
message1Plugin.first.message=This is a message for Message1Plugin
message2Plugin.first.message=This is a message for Message2Plugin
```

These messages could be stored in a file named "messages.properties" in the root of the plugin JAR file. If there are many messages contained for each plugin type, it may be necessary to split each plugin type's messages into a separate file, such as "message1-messages.properties" and "message2-messages.properties". Note that it is essential that each property file ends with "messages.properties" so that it is registered correctly.



It is important that no two message codes are identical within a single plugin JAR file, even if they are defined in separate property files. If this is done, a conflict will exist with the messages and behavior is undefined.

## Using the Message Method

Each plugin, translator, and custom component is injected with a method named `message`. This method takes a `Map` as its parameter, which can contain one or several of the following properties:

Parameter	Type	Description
<code>code</code>	<code>String</code>	The message property definition (everything before the equals sign in the property file for a single message), i.e. <code>"first.message.code"</code> .
<code>args</code>	<code>List&lt;Object&gt;</code>	A list of arguments to insert into the message.
<code>default</code>	<code>String</code>	A default message to be used when the message code cannot be resolved.
<code>error</code>	<code>org.springframework.context.MessageSourceResolvable</code>	An object that represents a hierarchy of message codes. This is typically used to display errors.

The most utilized parameters are `code` and `args`, as these combined provide great flexibility in generating messages. If a message cannot be resolved, or in other words the message definition does not exist, the `code` will simply be returned as the resolved message. Below are several examples of messages resolved using the property files given above. While these are contained in the `poll` method, the message may be used anywhere within a plugin type.

```

package example
import com.adaptc.mws.plugins.AbstractPlugin
class MessagingPlugin extends AbstractPlugin {
  def poll() {
    assert message(code:"first.message.code")== "This is the first message"
    assert message(code:"message.with.arguments", args:[
      "1st", 2, true
   ])== "This message has arguments: first - 1st, second - 2, third - true,
etc."
    assert message(code:"message.with.quotes")== "This message uses single quotes
around 'this phrase'."
    assert message(code:"invalid.message.code")== "invalid.message.code"
  }
}

```

## 6.2.5 Configuration

Plugin types can access two different kinds of configuration: an individual plugin's configuration, and the global MWS application configuration.

## Individual Plugin Configuration

The individual plugin configuration is separate for each instance of a plugin. This may be used to store current configuration information such as access information for linked resources. It should **not** be used to store cached information or non-configuration related data. The [Individual Datastore](#) should be used instead for these cases.

It is accessed by using the `getConfig` method discussed in [Dynamic Methods](#).

```
public void poll() {
    def configFromMethod = getConfig()
    // OR an even simpler method...
    def configFromMethod = config
}
```

A common case is to retrieve the configuration in the `configure` method, verify that it matches predetermined criteria, and utilize it perform initial setup of the plugin (e.g. initialize libraries needed to communicate with external resources). For example, to verify that the configuration contains the keys "username" and "password", the following code may be used.

```
public void configure() throws InvalidPluginConfigurationException {
    def myConfig = config
    // This checks to make sure the key exists in the configuration Map and that the
    // value is not empty or null
    if (!myConfig.containsKey("username") || !myConfig.username)
        throw new InvalidPluginConfigurationException("The username configuration
parameter must be provided")
    if (!myConfig.containsKey("password") || !myConfig.password)
        throw new InvalidPluginConfigurationException("The password configuration parameter
must be provided")
}
```

## Access MWS Configuration

The MWS application configuration can also be accessed in plugin types. This configuration is global for the entire application and can be modified by the administrator as shown in the [MWS Configuration](#) section.

It is accessed by using the `getAppConfig` method discussed in [Dynamic Methods](#). This is demonstrated below.

```
public void poll() {
    // Retrieve the current MWS_HOME location
    def mwsHome = appConfig.mws.home.location
    // OR an even simpler method...
    def mwsHome = getAppConfig().mws.home.location
}
```

Any of the properties shown in the [Configuration](#) reference may be accessed. Custom properties may also be registered and accessed:

```
mws-config.groovy
```

```
plugins.custom.property = "This is my custom property"
```

```
CustomAppPropertyPlugin
```

```
public void poll() {  
    assert appConfig.plugins.custom.property=="This is my custom property"  
}
```

## 6.2.6 Configuration Constraints

Plugin types can optionally define validation constraints for the polling interval and plugin configuration. These parameters are then checked against the defined constraints during the creation of a new plugin. If the validation fails, meaning the configuration provided does not pass the constraints defined by the plugin type, the plugin will fail to be created with error messages based on the parameters and constraints defined.

### Defining Constraints

To define constraints for a plugin type and therefore for all plugins created using it, use the following syntax:

```
import com.adaptc.mws.plugins.*  
  
class ConstrainedPlugin extends AbstractPlugin {  
    static constraints = {  
        // Set plugin's default polling interval  
        pollInterval defaultValue:60  
        // The "myParam" configuration parameter is automatically required and cannot  
        be blank  
        myParam blank:false  
        // The "myEnum" configuration parameter is not required and must set to one of  
        the values in the list  
        myEnum required:false, inList:["val1", "val2", "val3"]  
        // Insert additional constraints here..  
    }  
}
```

In the table below, all available constraints are shown, as well as the expected value type, an example, the default message code, and the message suffix. The message columns are described in greater detail in the "Messaging" section below.

Constraint	Default Value	Type	Example Value	Default Message Code	Message Suffix
blank	-	Boolean	false	default.blank.message	blank
creditCard	-	Boolean	true	default.invalid.creditCard.message	creditCard.in
defaultValue	-	Object	60	-	-
email	-	Boolean	true	default.invalid.email.message	email.invalid
inList	-	List	[ "first", "second" ]	default.not.inlist.message	not.inList
matches	-	String	"[a-z][A-Z]+"	default.doesnt.match.message	matches.inval
max	-	Integer	10	default.invalid.max.size.message	max.exceedec
*maxSize	-	Integer	10	default.invalid.max.size.message	maxSize.exce
min	-	Integer	1	default.invalid.min.size.message	min.notmet
*minSize	-	Integer	1	default.invalid.min.message	minSize.notr
notEqual	-	Object	"Invalid Value"	default.not.equal.message	notEqual
nullable	true	Boolean	false	default.null.message	nullable
password	-	Boolean	true	-	-
range	-	Range	10..20	default.invalid.range.message	range.toosma
required	true	Boolean	false	default.required.message	required
scale	-	Integer	2	-	-
*size	-	Range	1..10	default.invalid.size.message	size.toosmall/
*type	-	Class	Integer.class	typeMismatch	typeMismatch
url	-	Boolean	true	default.invalid.url.message	url.invalid
scriptableUrl	-	Boolean	true	default.invalid.scriptable.url.message	scriptableUrl.
validator	-	Closure	See below	default.invalid.validator.message	validator.erro



- The user interface (see [Plugin Management](#)) does not support parameters whose type is a subclass of Collection (a List for example). Such parameters are therefore not recommended.
- The polling interval constraints must always apply to Integer types. If this specification is violated, the plugin type cannot be added or updated.

## Messaging

When defined constraints are violated for a plugin, error messages are retrieved based on the configuration parameters and the applied constraints using [i18n Messaging](#) codes. First, the most specific error message will be attempted to be resolved from a message code generated from the plugin type name, the configuration parameter, and the constraint. This code takes the format of "pluginTypeName.parameterName.suffix" where the plugin type's name has a lowercase first letter and the suffix is shown in the table above. If this message code is not defined, the default message code (as shown in the table above) will be used.

For example, if the "url" constraint validation failed for the "ExamplePlugin" plugin type's "endpoint" configuration parameter, the following message codes would be resolved in order:

- examplePlugin.endpoint.url.invalid
- default.invalid.url.message



Plugin types that have two or more uppercase letters at the start of the name will not be converted to have a lowercase first letter for error message codes. i.e. for the example just given using "VCenterPlugin" instead of "ExamplePlugin", the following message codes would be resolved in order:

- VCenterPlugin.endpoint.url.invalid
- default.invalid.url.message

## Default Messages

Default messages may be contained in any `messages.properties` file included in the plugin JAR file as explained in [i18n Messaging](#). Arguments for each constraint vary, but they always include these argument indices:

- {0}: The configuration parameter name (i.e. endpoint)
- {1}: The plugin type class name (i.e. my.package.ExamplePlugin)
- {2}: The value of the configuration parameter

If default messages are not defined in the plugin project, the following messages will be used:

```

default.doesnt.match.message=The ''{0}'' configuration parameter value ({2}) does not
match the required pattern ''{3}''
default.invalid.url.message=The ''{0}'' configuration parameter value ({2}) is not a
valid URL
default.invalid.scriptable.url.message=The ''{0}'' configuration parameter value ({2})
is not a valid scriptable URL
default.invalid.creditCard.message=The ''{0}'' configuration parameter value ({2}) is
not a valid credit card number
default.invalid.email.message=The ''{0}'' configuration parameter value ({2}) is not a
valid e-mail address
default.invalid.range.message=The ''{0}'' configuration parameter value ({2}) does not
fall within the valid range from {3} to {4}
default.invalid.size.message=The ''{0}'' configuration parameter value ({2}) does not
fall within the valid size range from {3} to {4}
default.invalid.max.message=The ''{0}'' configuration parameter value ({2}) is greater
than the maximum value of {3}
default.invalid.min.message=The ''{0}'' configuration parameter value ({2}) is less
than the minimum value of {3}
default.invalid.max.size.message=The ''{0}'' configuration parameter value ({2})
exceeds the maximum size of {3}
default.invalid.min.size.message=The ''{0}'' configuration parameter value ({2}) is
less than the minimum size of {3}
default.invalid.validator.message=The ''{0}'' configuration parameter value ({2}) does
not pass custom validation
default.not.inlist.message=The ''{0}'' configuration parameter value ({2}) is not
contained within the list [{3}]
default.blank.message=The ''{0}'' configuration parameter cannot be blank
default.not.equal.message=The ''{0}'' configuration parameter value ({2}) cannot be
equal to ''{3}''
default.null.message=The ''{0}'' configuration parameter cannot be null
default.required.message=The ''{0}'' configuration parameter is required and cannot be
null
typeMismatch=The ''{0}'' configuration parameter value ({2}) does not match the
required type ''{3}''

```

## Labels and Help Messages

Message codes may also be provided for configuration parameters to aid the admin user with human readable property labels and help messages. Similar to the validation error message codes, labels and help message codes may be defined using the "pluginTypeName.parameterName.label" and "pluginTypeName.parameterName.help" message codes. These values are used only in [Plugin Type Management](#) and are not exposed through the REST API.

## Type Inferencing and Conversion

Due to the dynamic nature of configuration parameters, the expected type or class of values for each parameter are inferred from constraints. The following rules govern how type is inferred, in priority order:

- If the "type" constraint is applied to a parameter, the constraint value will be used as the expected type.
- If the "inList" or "range" constraints are applied to a parameter, the class of the first element in the constraint value array is used as the expected type.
- If the "minSize" or "maxSize" constraints are applied to a parameter, `java.lang.Collection` is used as the expected type.
- If the "max", "min", or "notEqual" constraints are applied to a parameter, the class of the constraint value is used as the expected type.
- If none of the above apply, `java.lang.String` is used as the expected type.



Only the String, Date, Double, Integer, and Boolean classes are supported for the "type" constraint. If Float or Long is desired, use Double and Integer respectively as the type.

If the configuration parameter values can be converted to the expected types, this will occur automatically. Otherwise, the "type" constraint is violated and the applicable error messages will be generated.

## Custom Validator

In cases where the built-in constraints prove inadequate for validation, custom validators may be used. The "validator" constraint expects a Groovy Closure parameter which has one or (optionally) two arguments: the value of the configuration parameter and the plugin object. With these parameters, complex validation logic may be defined. Additionally, custom message codes and arguments may be defined by validator constraints and these will be used in generating error messages when validation fails.

For example, suppose that the parameter "user" cannot be set to the same value as parameter "creator". Additionally, the "creator" parameter must not be equal to either "bob" or "joe". The existing constraints are inadequate to fulfill this use case, but the following code using validators would perform exactly as expected:

```
import com.adaptc.mws.plugins.*

class ConstrainedPlugin extends AbstractPlugin {
    static constraints = {
        user validator:{ val, obj ->
            if (val==obj.config.creator)
                return "invalid.equal.to.creator"
        }
        creator validator:{ val ->
            if ("val"=="joe")
                return ["invalid.equal", "joe"]
            if (val=="bob")
                return ["invalid.equal", "bob"]
        }
    }
}
```

In the examples above, the message codes and output on validation failure is shown below:

### Message Codes

```
constrainedPlugin.user.invalid.equal.to.creator=The user configuration parameter value
({2}) must not be equal to the creator parameter.
constrainedPlugin.creator.invalid.equal=The creator configuration parameter must not be
equal to {3}.
```

### Output Error Messages

```
For user = "jill", creator = "jill"
"The user configuration parameter value (jill) must not be equal to the creator
parameter."

For user = "jill", creator = "bob"
"The creator configuration parameter must not be equal to bob."

For user = "jill", creator = "joe"
"The creator configuration parameter must not be equal to joe."
```

The validator Closure may return:

- Nothing (null) or true if the validation succeeded without errors.
- false if a validation error occurred (in this case the default validator message suffix would be used).
- A string which will be used as the message code suffix in the "pluginTypeName.propertyName.suffix" format.
- A list with the first element being the message code suffix, and all other elements being arguments for the message indexed starting at 3 (as shown in the example above).

All validator constraints automatically have the `appConfig` property available which contains the application configuration as discussed in the [Configuration](#) section. Additionally, services may be retrieved as explained in the next section.

## Retrieving Services

At times it may be necessary to use [Bundled Services](#) in custom validators. A method named `getService` which takes a single string parameter of the name of the service (as used during injection) is provided to be used in these cases. For example, if a plugin needs a valid server certificate file, the [SSL Service](#) may be used as follows:

```
import com.adaptc.mws.plugins.*

class ConstrainedPlugin extends AbstractPlugin {
  static constraints = {
    certificateFile validator:{ val ->
      ISslService sslService = getService("sslService")
      try {
        sslService.getSocketFactory(val)
      } catch(Exception e) {
        // Certificate file is invalid, return an error
        return ["invalid", e.message]
      }
    }
  }
}
```



The `getService` method does not work with [translators](#), [custom components](#), [RM services](#), or the [datastore service](#).

## 6.2.7 Individual Datastore

Each plugin has access to an individual, persistent datastore which may be used for a variety of reasons. The datastore is not designed to store Moab data such as nodes, jobs, or virtual machines, but custom, arbitrary data pertinent only to the individual plugin. This may include storing objects in a persistent cache, state information for currently running processes, or any other arbitrary data. The individual datastore has the following properties:

- Data is persisted to the Mongo database and will be available even if the plugin or MWS is restarted.
- The data must be stored in groups of data called **collections**. These correspond directly to MongoDB collections.
- Each plugin may have an arbitrary number of collections.
- Collections are guaranteed not to collide if there are identically named collections between two plugin types or even two plugin instances.
- Each collection contains multiple objects or **entries**. These correspond directly to MongoDB documents.
- The values of entries may be any object which can be serialized to MongoDB: simple types (int or Integer), Maps, and Lists.
- A collection is automatically created whenever an entry is added to it, it does not need to be specifically initialized.

To utilize the datastore, the [Plugin Datastore Service](#) must be used. Operations are provided to add, query, and remove data from each collection.

 Simple key/value storage is not currently provided with the datastore. It may easily be done, however, by storing data in the format of {name:"key", value:"value"} and then retrieving this entry later by querying on name equals "key".

## Example

The example below demonstrates two [web services](#). The first adds multiple entries containing various types of data to an arbitrarily named collection. The second retrieves the data and returns it to the user.

```
package example
import com.adaptc.mws.plugins.*
class DatastorePlugin extends AbstractPlugin {
  IPluginDatastoreService pluginDatastoreService
def storeData(Map params) {
  def collectionName = params.collectionName
  def data = [[boolVal:true], [stringVal:"String"], [intVal:1], [nullVal:null]]
  if (pluginDatastoreService.addData(collectionName, data))
    log.info("Data successfully added")
  else
    log.info("There was an error adding the data")
  return [success:true]
}
def retrieveData(Map params) {
  def collectionName = params.collectionName
  return pluginDatastoreService.getCollection(collectionName)
}
}
```

## 6.2.8 Exposing Web Services

Any number of methods may be exposed as public, custom web services by satisfying several criteria:

1. The method must declare that it returns `Object` or `def`.
2. The method must define a single argument of type `Map`.
3. The method must actually return a `List` or `Map`.
4. The method must not be declared as `private` or `protected`; only `public` or `unscoped` methods will be recognized as web services.

## Parameters and Request Body

The `Map` argument will contain all parameters passed into the web service by the client. See [Accessing Plugin Web Services](#) for additional details.

Parameters may be passed into the web service call as normal URL parameters such as `?param=value&param2=value2`, as key-value pairs in the POST body of a request, or as JSON in the body.

For the first two cases, the parameters will be available on the `Map` argument passed into the web service call as key value pairs matching those of the request. Note that in these cases all keys and values will be interpreted as strings. However, the parameters object has several helper methods to convert from `Strings` to simple types, such as `booleans`, `integers`, `doubles`, `floats`, and `lists`. If the value is not a valid simple type, `null` is returned.

```
GET <webServiceUrl>?key=value&key2=true&key3=5&list=1&list=2

def serviceMethod(Map params) {
  assert params.key=="value"
  assert params.key2=="true"
  assert params.bool('key2')==true
  assert params.key3=="5"
  assert params.int('key3')==5
  assert params.list('list')==[1, 2]

  // Null is returned if the conversion is invalid
  assert params.int('key')==null
}
```

When the body possesses JSON, the parsed JSON object or array will be available within a parameter called `body` in the `Map` argument. In this scenario, the types of the values are preserved by the JSON format.

```
POST <webServiceUrl> with JSON body of
{"key":"value","key2":true,"key3":5}

def serviceMethod(Map params) {
  assert params.body.key=="value"
  assert params.body.key2==true
  assert params.body.key3==5
}
```

## Unsecured Web Services

There are times when it is desirable to create a plugin with a publicly available web service that does not require a valid [Application Account](#) in order to access it. In these cases, the [Unsecured](#) annotation may be used on the plugin web service method. No authentication will be performed on Unsecured web services. An example of using the annotation is given below.

## Sample unsecured custom web service

```
@Unsecured
def retrievePublicData(Map params) {
  return [data:["data item 1", "data item 2"]]
}
```



Be cautious in using this annotation as it may potentially present a security risk if sensitive data is returned from the web service.

## Returning Errors

In order to signify an error occurred or invalid data was provided, the [WebServiceException](#) class may be thrown from any custom web service. This exception contains constructors and fields for a list of messages and a HTTP response code. For example, suppose that the user provided inadequate information. The web service could use the following code to notify the user and prompt them to take action with custom messages.

```
def service(Map params) {
  // Handle invalid input
  if (!params.int('a'))
    throw new WebServiceException("Invalid parameter 'a' specified, please specify
an integer!", 400)
  // Use params.a correctly ...
}
```

For the example above, a 400 response code (bad request) would be returned with a response body as follows:

```
{
  "messages": [
    "Invalid parameter 'a' specified, please specify an integer!"
  ]
}
```

If any other exception is thrown from a web service (ie Exception, IllegalArgumentException, etc), a 500 response code will be returned with the following response body:

```
{
  "messages": [
    "A problem occurred while processing the request",
    "Message provided in the exception constructor"
  ]
}
```

See the [Responses and Return Codes](#) section for more information on error formats in MWS.

## Accessing the HTTP Request Method

The HTTP method used for the request is available from the Map parameters argument. The key used to access it is stored as a static field in [PluginConstants](#) called `WEB_SERVICES_METHOD`. The value is a string which can be GET, POST, PUT, or DELETE. The following example demonstrates how this could be used with the `WebServiceException` to create a REST API with a plugin.

```
def serviceMethod(Map params) {
  // Check to make sure that this request used the HTTP GET method
  // Throw a 405 error (method not supported) if not
  if (params[PluginConstants.WEB_SERVICES_METHOD]!="GET")
    throw new WebServiceException("Method is not supported", 405)
}
```

## 6.2.9 Reporting State Data

As long as Moab Workload Manager is [configured](#) with MWS as a Resource Manager (RM), plugins may report state information on nodes, virtual machines, and jobs to MWM. This is done through **Reports** that are generated by the plugin and passed to the bundled RM services ([Node RM Service](#), [Virtual Machine RM Service](#), and [Job RM Service](#)). Each report is for a specific type of object: node, virtual machine, or job. Each contains current state information on the specific attributes of the type it is for.

### Generating Reports

To generate a report, simply create a new instance of a report depending on the type of object to be reported:

Object Type	Report Type
Node	<a href="#">NodeReport</a>
Virtual Machine	<a href="#">VirtualMachineReport</a>
Job	<a href="#">JobReport</a>

Each report has a single required parameter for creating a new instance - the ID of the object which is being reported. Once the report instance has been created, any property may be modified as shown in the API documentation links in the table above. The following example shows the creation of a simple node report and modification of a few properties:

```
public void poll() {
  NodeReport node = new NodeReport("node1")
  node.timestamp = new Date()
  node.image = "centos-5.4-stateless"
  ... // Set other properties and persist the report
}
```

### Special Cases in Field Values

All complex types, such as Lists, Maps, and objects (not including Enumerated values such as [NodeReportState](#) and [JobReportState](#)) have default values set for them and are not required to be instantiated before use. For example, the `metrics` property of a node report may be modified as follows:

```

public void poll() {
    NodeReport node = new NodeReport("node1")
    // The following assignments are equivalent in their functionality
    node.features.add("FEAT1")
    node.features << "FEAT2"
    // The following assignments are equivalent in their functionality
    node.metrics.METRIC1 = 4d
    node.metrics["METRIC2"] = 125.5
    ... // Set other properties and persist the report
}

```

For the `resources` and `requirements` (jobs only) properties, assignments may be made easily without checking for previously existing values or null objects. For example, resources may be added to the `resources` property simply by accessing it as a Map:

```

public void poll() {
    NodeReport node = new NodeReport("node1")
    node.resources.RES1.total = 10
    node.resources.RES1.available = 3
    node.resources["RES2"].total = 10
    node.resources["RES2"].available = 10
    ... // Set other properties and persist the report
}

```

The job report's `requirements` property has some additional handling to allow it to be accessed as a single [JobReportRequirement](#) object, such as in the following example:

```

public void poll() {
    JobReport job = new JobReport("job.1")
    job.nodeCountMinimum = 4
    job.processorCountMinimum = 2
    job.requiredNodeFeatures << "FEAT1"
    job.preferredNodeFeatures << "FEAT2"
    ... // Set other properties and persist the report
}

```



Although multiple requirements may be added to the `requirements` list to provide consistency with the MWS [Job](#) resource, only the first requirement object's properties will be reported to MWM through the RM interface.

## Managing Images for Nodes

In order to have Moab Workload Manager recognize a node as a virtual machine hypervisor, it must have a valid associated [Image](#). In particular, the `image` property on a node report must set to a valid image name. The image's `hypervisorType` and `virtualizedImages` properties are then used to report the correct hypervisor type and supported virtual machine images to MWM.

If the image is invalid, it will be ignored and the node will not be recognized as a hypervisor. If the image is valid, but no `hypervisorType` value is present, the `extensions.xcat.hvType` field value will be used. If that is also not present, the configuration parameter for default hypervisor type (See [Configuration](#)) will be used instead.

## Persisting a Report

After a report has been generated and all desired fields have been updated, the report must be sent to one of the three bundled RM services for persisting. If this is not done, the report will be discarded and will not be considered when reporting state information to MWM. The RM services are shown below according to the object type that they handle:

Object Type	RM Service
Node	<a href="#">Node RM Service</a>
Virtual Machine	<a href="#">Virtual Machine RM Service</a>
Job	<a href="#">Job RM Service</a>

Each service has two methods: `save` and `update`. The difference between these is that the `save` method first removes all previous reports from the plugin calling the method, and then persists the new reports, thereby only persisting the latest reports, while the `update` method does not remove any reports before persisting the new reports. Typically, the `save` method will be used while a plugin is being polled, while the `update` method will be used in incremental event based reporting. An example of using the `save` method is shown below.

```
INodeRMService nodeRMService

public void poll() {
    NodeReport node = new NodeReport("node1")
    // Change the state
    node.state = NodeReportState.BUSY
    // Persist
    nodeRMService.save([node])
}
```

Once this is done, the reports will be persisted to MongoDB and will be included in [RM Queries](#) from Moab Workload Manager or users.

## 6.2.10 Controlling Lifecycle

At times a plugin developer may wish to modify the current state of a plugin or even create plugins programmatically. This may be done with the [Plugin Control Service](#). Operations exist on the service to:

- create plugin instances dynamically with specific configuration.
- retrieve plugin instances by ID or based on configuration properties.
- start or stop plugin instances.
- verify plugin instance configuration.

## Creating Plugins

Several methods are provided to allow on-the-fly creation of new plugins. Generally, they allow a plugin with a specific ID and plugin type (as a string or as a Groovy Class) to be created with optional configuration properties. These properties should match the fields in the [Plugin API](#).

If any configuration properties are omitted, the defaults will be used as described in the [Setting Default Plugin Configuration](#) section. A boolean value is also returned indicating whether the creation succeeded or not.

Note that the `createPlugin` methods will initialize the plugin for retrieval or usage and attempt to start the plugin if the `autoStart` property is true.

## Retrieving Plugins

Plugins may be retrieved by using an ID, querying by plugin type, or even querying based on configuration parameters. Several methods are provided to perform these functions as shown on the [Plugin Control Service](#) page.

## Starting and Stopping Plugins

Plugins may also be started or stopped on demand. These two methods are exposed directly as `start` and `stop` on the plugin control service. Although each method does not return any data, exceptions are thrown if errors are encountered.

## Verifying Plugin Configuration

Finally, the plugin control service may be used to verify plugin configuration at any point instead of just when the plugin is started or modified. This may be useful to attempt to modify plugin configuration directly through the `setConfig` [dynamic method](#) and then verify that the new configuration is valid for the plugin. Exceptions are thrown if the plugin or the configuration is invalid.

## Examples

If an error state is detected it may be necessary to stop the current plugin instance until corrective action can be taken. This may be done using the following code:

```
package example
import com.adaptc.mws.plugins.*

class ErrorPlugin {
    IPluginControlService pluginControlService

    public void poll() {
        // Error is detected, stop plugin instance!
        try {
            log.warn("An error was detected, trying to stop the plugin ${id}")
            pluginControlService.stop(id)
            log.warn("The plugin was successfully stopped")
        } catch (PluginStopException e) {
            log.error("Plugin instance ${id} could not be stopped", e)
        }
    }
}
```

### 6.2.11 Accessing MWS REST Resources

Often a plugin type may need to access existing MWS REST Resources in order to extend or complement default MWS functionality. This may be done with the [Moab Rest Service](#), which allows a plugin type developer to utilize the existing [Resources](#) documentation to perform these tasks.

All accesses to resources require a HTTP method to use (such as GET, POST, PUT, or DELETE) and a relative URL (such as `/rest/jobs`). Although it mimics the REST resource interface, no actual requests are made and no data is transmitted through the network.

## Authentication

All resources are available to the Moab REST Service, and no authentication or Application Accounts are needed.

 Caution must be used when developing plugin types, as there are no restrictions to what may be done with the Moab REST Service. This is especially true when not utilizing hooks as discussed below.

## Hooks

If [Pre and Post-Processing Hooks](#) are utilized in MWS, the plugin type developer may choose whether or not they are executed when performing a "request" through the Moab REST service. This is done through the `hooks` option as documented on the [Moab Rest Service](#) page.

## Verifying API Version Support

The Moab REST Service provides a method for easily determining which API versions are supported by the current version of MWS. This method includes checks to make sure that the API version will work as expected, including verifying any configuration or external services are running.

```
moabRestService.isAPIVersionSupported(1)
moabRestService.isAPIVersionSupported(2)
```

## URL Parameters

URL parameters, such as `query`, `sort`, `proxy-user`, and others should be not be appended directly to the URL. Instead, these may be specified with the `params` option:

```
// Query images that are hypervisors
moabRestService.get("/rest/images", params:[query:'{"hypervisor":true}'])
// Sort images by osType
moabRestService.get("/rest/images", params:[sort:'{"osType":1}'])
```

## Examples

This code retrieves a list of all nodes, and is equivalent to the [Get All Nodes](#) task.

```

package example

import com.adaptc.mws.plugins.*
import net.sf.json.*

class RestPlugin {
    IMoabRestService moabRestService

    public void poll() {
        def result = moabRestService.get("/rest/nodes")
        // OR with the hook enabled...
        def result = moabRestService.get("/rest/nodes", hooks:true)

    assert result instanceof MoabRestResponse
    assert nodes instanceof List

    log.debug("Nodes list:")
    nodes.each { JSON node ->
        log.debug(node.id)
    }
}
}

```

This code adds a flag to a job, and is equivalent to the [Modify Job Attributes](#) task. This request also enables the hook (if one is configured) for the "request" and uses a URL parameter. This is the equivalent of making a call to `/rest/jobs/job.1?proxy-user=adaptive`.

```

package example

import com.adaptc.mws.plugins.*
import net.sf.json.*

class RestPlugin {
    IMoabRestService moabRestService

    public void poll() {
        def jobId = "job.1"
        def result = moabRestService.put("/rest/jobs/"+jobId, hooks:true,
params:['proxy-user':'adaptive']) {
            [flags:["RESTARTABLE"]]
        }
        assert result.isSuccess()
    }
}

```

## 6.2.12 Handling Events

Plugin types may handle specific events by containing methods defined by the conventions below. All events are optional.

### The Polling Event

To maintain current information, each plugin is polled at a specified time interval. The following method definition is required to utilize the polling event.

```

void poll() { ... }

```

Typically this polling method is used to report node and virtual machine information. By default, the polling interval is set to 30 seconds, but can be modified for all or individual plugins as explained in [Plugin Management](#).

When a polling event occurs, the `poll` method on the target plugin is called. This method may perform any function desired and should typically make calls to the [Node RM Service](#), the [Virtual Machine RM Service](#), and the [Job RM Service](#) services to report the current state of nodes and virtual machines. For example, the `poll` method in the [Native](#) plugin type is implemented as follows:

 This is an extremely simplified version of what is actually implemented in the Native plugin type.

```
INodeRMService nodeRMService;
IVirtualMachineRMService virtualMachineRMService;

public void poll() {
    nodeRMService.save(getNodes());
    virtualMachineRMService.save(getVirtualMachines());
}
```

This simple poll method calls two other helper methods called `getNodes` and `getVirtualMachines` to retrieve node and virtual machine reports. These reports are then sent to the appropriate RM service. See [Reporting State Data](#) for more information on the RM services, but the objective of this example is to demonstrate one possible use of the poll event handler. Other plugin types, on the other hand, may use the poll event to update internal data from pertinent resources or make calls to external APIs.

## Lifecycle Events

Events are also triggered for certain lifecycle state changes. The following method definitions are required to receive lifecycle events.

```
public void configure() throws InvalidPluginConfigurationException { ... }
public void beforeStart() { ... }
public void afterStart() { ... }
public void beforeStop() { ... }
public void afterStop() { ... }
```

Each event is described in the table below with the associated state change when the event is triggered.

State Change	Event	Description
configure	Configure	Triggered before <code>beforeStart</code> and after the plugin has been configured. May be used to verify configuration and perform any setup needed any time configuration is loaded or modified.
beforeStart	Start	Triggered just before starting a plugin.
afterStart	Start	Triggered just after a plugin has been started.
beforeStop	Stop	Triggered just before stopping a plugin.
afterStop	Stop	Triggered just after stopping a plugin.

Currently, no events are triggered for pausing, resuming, erroring, or clearing errors for plugins.

## RM Events

When MWS is configured as a Moab Resource Manager (see [MWM Resource Manager Integration](#) and more specifically [Configuring MWM](#)), RM events are sent from Moab to each plugin according to the [Routing](#) specification. The following method definitions are required to receive these events.

```
public boolean jobCancel(List<String> jobs) { ... }
public boolean jobModify(List<String> jobs, Map<String, String> properties) { ... }
public boolean jobRequeue(List<String> jobs) { ... }
public boolean jobResume(List<String> jobs) { ... }
public boolean jobStart(String jobId, String taskList, String username) { ... }
public boolean jobStart(String jobId, String taskList, String username, Map<String,
String> properties) { ... }
public boolean jobSubmit(Map<String, String> properties) { ... }
public boolean jobSuspend(List<String> jobs) { ... }
public boolean nodeModify(List<String> nodes, Map<String, String> properties) { ... }
public boolean nodePower(List<String> nodes, NodeReportPower state) { ... }
public boolean resourceCreate(String type, String id, Map<String, String> attributes) {
... }
public boolean systemModify(Map<String, String> properties) { ... }
public List<String> systemQuery(List<String> attributes) { ... }
public boolean virtualMachineMigrate(String vmId, String hypervisorId, String
operationId) { ... }
```

These calls are equivalent to the Moab RM URLs as described in the [Native](#) "Native Plugin Interface Comparison" section. All method definitions are documented in the [AbstractPlugin](#) API documentation.

### 6.2.13 Handling Exceptions

The `com.adaptc.mws.plugins` package contains several exceptions that may be used and in some cases, should be caught. All exceptions end with "Exception", as in [PluginStartException](#).

There are several specific cases where Exceptions should or can be used:

- The `reload` method on the [Plugin Control Service](#) can throw the [InvalidPluginConfigurationException](#) to signify that the configuration contains errors.
- Various methods on the [Plugin Control Service](#) throw plugin exceptions which must be caught to diagnose errors when creating plugin types.
- Any exception (including the Exception class) can be thrown from a custom web service to display a 500 Internal Server Error to the client requesting the service with the given error message.

### 6.2.14 Managing SSL Connections

At times it is desirable to load and use self-signed certificates, certificates generated from a single trusted certificate authority (CA), or even simple server certificates. It may also be necessary to use client certificates to communicate with external resources. To ease this process, the [SSL Service](#) may be utilized. This service provides methods to load client and server certificates from the filesystem. Methods are also present to aid in creating connections which automatically trust all server certificates and connections.

Several points should be noted when using the SSL Service:

- Certificate files may be in the PEM file format and do not need to be in the DER format (as is typical of Java security).
- Each method returns an instance of `SSLConnectionFactory`, which may then be used to create simple sockets or, in combination with another client library of choice, create a connection.
- If the client certificate password is non-null, it will be used to decrypt the protected client certificate.
- This service is **not** needed when performing SSL communications with trusted certificates, such as those for HTTPS enabled websites that do not have a self-signed certificate.
- If the file name of the certificate file (client or server) is relative (no leading '/' character), it will be loaded from the `mws.certificates.location` [Configuration](#) parameter.
  - The default value of `mws.certificates.location` is `MWS_HOME/etc/ssl.crt`.
- Both the client certificate alias and password may be `null`. In this case, the client certificate must not be encrypted and the client certificate's default alias (the first subject CN) will be used.
- The lenient socket factory and hostname verifier automatically trust all server certificates. Because of this, they present a large security hole. Only use these methods in development or in fully trusted environments.

## Example

To create a socket to a server that requires a client certificate, the following code may be used.

```

package example
import com.adaptc.mws.plugins.*

class SSLConnectionPlugin extends AbstractPlugin {
  ISslService sslService

  public void poll() {
    // This certificate is not encrypted and will be the only certificate presented
    to the
    // connecting end of the socket.
    // This file will be loaded from MWS_HOME + mws.certificates.location +
    my-cert.pem.
    String clientCert = "my-cert.pem"

    def socketFactory = sslService.getSocketFactory(clientCert, null, null)
    def socket = socketFactory.createSocket("hostname.com", 443)
    // Write and read from the socket as desired...
  }
}

```

To create a HTTPS URL connection to a server that has a self-signed certificate, the following code may be used. Note that this is very typical of client libraries - they have a method to set the SSL socket factory used when creating connections.

```

package example

import com.adaptc.mws.plugins.*

class SSLConnectionPlugin extends AbstractPlugin {
  ISslService sslService

public void poll() {
  // This certificate represents either the server public certificate or the CA's
  // certificate.
  // Since the path is absolute it will not be loaded from the MWS_HOME
  // directory.
  String serverCert = "/etc/ssl/certs/server-cert.pem"

  def socketFactory = sslService.getSocketFactory(serverCert)

  // Open connection to URL
  HttpURLConnection conn = "https://hostname.com:443/test"
  .toURL().openConnection()
  conn.setSSLSocketFactory(socketFactory)

  // Retrieve page content and do with as desired...
  def pageContent = conn.getInputStream().text
}
}

```

## 6.2.15 Utilizing Services or Custom "Helper" Classes

There are three general types of services available for use in plugins:

1. Bundled services such as the [Moab Rest Service](#).
2. Custom built translators loaded by convention of their name.
3. Other custom built helper classes registered with Annotations.

These will each be described in this section.

### 6.2.15.1 Bundled Services

Bundled services are utility classes that are included and injected by default onto all plugin types. It is not required to use any of these services, but they enable several core features of plugin types as discussed in the [Utility Services](#) section.

More information may be found on each bundled service in the Quick Reference section under "Plugin Services". See especially the "Usage" page under "Plugin Services" to understand generally how they are to be used.

### 6.2.15.2 Using Translators

Often a plugin type class file becomes so complex that it is desirable to split some of its logic into separate utility service classes. The most typical use case for this is to split out the logic for "translating" from a specific resource API to a format of data that the plugin type can natively understand and utilize. For this reason, there is a convention defined to easily add these helper classes called "Translators".

Simply end any class name with "Translator", and it will be automatically injected just as bundled services onto plugin types, other translators, or even [custom registered components](#). The injection occurs only if a field exists on the class matching the name of the translator with the first letter lower-cased. For example, a translator class called "MyTranslator" would be injected on plugin types, other translators, and custom components that define a field called "myTranslator" as `def myTranslator` or `MyTranslator myTranslator`.



Do not use two upper-case letters to start the class name of a Translator. Doing this may cause injection to work improperly. i.e. use RmTranslator instead of RMTranslator as the class name.



Be careful not to declare translator and custom component injection such that a cyclic dependency is created.

## Logging in Translators

All translators automatically have a "getLog" method injected on them which can be used to access the configured logger. It returns an instance of [org.apache.commons.logging.Log](http://org.apache.commons.logging.Log).

```
package example

class ExampleTranslator {
    public void myMethod() {
        // log will be translated to getLog() by the groovy compiler
        log.info("Starting my method")
    }
}
```

See the [Logging](#) section for more information on logging configuration and usage.

## Example

Suppose that a translator needs to be created to handle a connection to access an external REST resource. The translator could be defined as follows:

```
package example

class ExampleTranslator {
    public int getExternalNumber() {
        def number = ... // Make call to external resource
        return number
    }
}
```

A plugin type can then use the translator by defining a field called "exampleTranslator". Note that an instance does not need to be explicitly created.

```
package example

class ExamplePlugin {
    def exampleTranslator
    // OR ...
    //ExampleTranslator exampleTranslator

    public void poll() {
        // Use the translator
        log.info("The current number is "+exampleTranslator.getExternalNumber())
    }
}
```

To extend the example, the translator may also be injected into another translator:

```

package example

class AnotherTranslator {
    def exampleTranslator

    public int modifyNumber(int number) {
        return number + exampleTranslator.getExternalNumber()
    }
}

```

This translator may be used in the plugin type just as the other translator.

### 6.2.15.3 Registering Custom Components

There are cases where the concept of a "Translator" does not fit the desired use of a utility class. In these cases, it is possible to register any arbitrary class as a component to be injected just as a translator would be. This is done using the Spring Framework's annotation `org.springframework.stereotype.Component`. When this annotation is used, the class is automatically registered to be injected just as translators onto plugin types and translators.

 All annotations are available in the dependencies declared by the `plugins-commons` artifact.

 Do not use two upper-case letters to start the class name of a custom component. Doing this may cause injection to work improperly. i.e. use `RmUtility` instead of `RMUtility` as the class name.

## Changing Scope

By default, when a custom component is injected, only a single instance is created for all classes which inject it. This is referred to as the 'singleton' scope. Another scope that is available is 'prototype', which creates a new instance every time it is injected. This is useful when the class contains state data or fields that are modified by multiple methods. To change the scope, use the `org.springframework.context.annotation.Scope` on the class with a single String parameter specifying 'singleton' or 'prototype'.

## Injecting Translators or Components

The need may arise to inject translators or other custom components onto custom components. This is done using the `org.springframework.beans.factory.annotation.Autowired` or `javax.annotation.Resource` annotations. The `Autowired` annotation is used to inject class instances by the type (i.e. `MyTranslator myTranslator`) while the `Resource` annotation is used to inject class instances by the name (i.e. `def myTranslator`). Add the desired annotation to the field that needs to be injected.

 Note that using the `Autowired` annotation does injection by type which differs from translator and plugin type injection. These are done by name just as the `Resource` annotation allows. Due to this fact, a type of "def" cannot be used when doing injection onto custom components using the `Autowired` annotation. See the example below.

Injection of custom components *onto* translators and plugin types are still done by name, only fields injected using the `Autowired` annotation are affected.

 Be careful not to declare translator and custom component injection such that a cyclic dependency is created.

## Logging in Custom Components

Unlike plugins and translators, custom components do **not** automatically have a "getLog" method injected on them. In order to log with custom components, you must use the Apache Commons Logging classes to retrieve a new log. The `PluginConstants` class contains the value of the logger prefix that is used for all plugins and translators. The following is an example of how to retrieve and use a logger correctly in a custom component.

```
package example

import com.adaptc.mws.plugins.PluginConstants
import org.apache.commons.logging.Log
import org.apache.commons.logging.LogFactory
import org.springframework.stereotype.Component

@Component
class ExampleComponent {
    private static final Log log = LogFactory.getLog(PluginConstants.LOGGER_PREFIX+this
.name)

    public void myMethod() {
        log.info("Starting my method")
    }
}
```

See the [Logging](#) for more information on logging configuration and usage.

## Example

Suppose that a custom utility class is needed to perform complex logic. A custom component could be defined as follows (notice the optional use of the `Scope` annotation):

```
package example

import org.springframework.stereotype.Component
import org.springframework.context.annotation.Scope

@Component
@Scope("prototype")
class ComplexLogicHandler {
    def handleLogic() {
        ... // Perform complex logic and return
    }
}
```

A plugin type or translator could then be defined to inject this component:

```
package example

class CustomPlugin {
    def complexLogicHandler

    public void poll() {
        complexLogicHandler.handleLogic()
    }
}
```

Now suppose another custom component needs to use the ComplexLogicHandler in its code. It can inject it using the Autowired annotation:

```
package example

import org.springframework.stereotype.Component
import org.springframework.beans.factory.annotation.Autowired

@Component
class AnotherHandler {
    // Note that this is injected by type, so 'def' may not be used
    @Autowired
    ComplexLogicHandler complexLogicHandler

    def wrapLogic() {
        complexLogicHandler.handleLogic()
    }
}
```

To perform the same injection but by name (as translators and plugin types are injected), use the Resource annotation:

```
package example

import org.springframework.stereotype.Component
import javax.annotation.Resource

@Component
class AnotherHandler {
    // Note that this is injected by name based solely on the name defined in
    // the annotation. The name of the field itself does not affect the injection.
    @Resource(name="complexLogicHandler")
    def complexLogicHandler

    def wrapLogic() {
        complexLogicHandler.handleLogic()
    }
}
```

## 6.2.16 Packaging Plugins

Plugin types may be packaged in two different ways to upload to MWS:

1. A simple Groovy file containing a single plugin type definition.
2. A JAR file containing one or more plugin types, translators, and custom components.

While each may be uploaded to MWS using the REST API or the User Interface as described in [Add or Update Plugin Types](#), using a JAR file is recommended. Using a simple Groovy file is useful for testing and generating proof of concept work, but does not allow the use of several features of plugins.

The principles of packaging a plugin type or set of plugin types in a JAR file are very simple. Simply compile the classes and package in a typical JAR file. All classes ending in "Plugin" are automatically attempted to be loaded as a plugin type, all classes ending in "Translator" are attempted to be loaded as a translator, and all classes annotated as a custom component will be attempted to be loaded. It is recommended that a build framework is used to help with compiling and packaging the JAR file, such as [Gradle](#). This makes it easy to declare a dependency on the necessary JAR files used in plugin development and to debug, compile, and test plugin code.

In addition to using utility services such as translators, packaging plugin types in JAR files allows the creation of a single project for multiple related plugin types and bundling of external dependencies. These two features are discussed in the following sections.

### 6.2.16.1 Plugin Projects and Metadata

Each plugin type has information attached to it, called metadata, which describes the origin and purpose of the plugin type. Additionally, a JAR file may also contain a project file which defines default metadata attributes for all plugin types in the JAR. Initial plugins, or plugins that will be created on loading of the JAR file if they do not exist, are also able to be defined on a project file. In all cases, metadata declared on a plugin type will override the metadata defined on the project file.

To define a project file, simply add a class to JAR file that ends in "Project". This file will be attempted to be loaded as the project file. Every field on a project file, and even the file itself, is optional. All available fields are shown in the example below.

```
class SampleProject {
    // Plugin information
    String title = "Sample"
    String description = "Sample plugin types"
    String author = "Our Company."
    String website = "http://example.com"
    String email = "sample@example.com"

    // Versioning properties
    String version = "0.1"
    String mwsVersion = "7.1 > *"
    String commonsVersion = "0.9 > *"
    String license = "APACHE"

    // Documentation properties
    String issueManagementLink = "http://example.com/ticket-system/sample-plugins"
    String documentationLink = "http://example.com/docs/sample-plugins"
    String scmLink = "http://example.com/git/sample-plugins"

    // Plugins that are to be created with these properties only when they do NOT exist
    // This does not override any existing plugin instance configuration
    def initialPlugins = {
        /*
         * // Multiple instances of plugins may be defined here.
         * // In this case, 'sample' is the id of the plugin
         * sample {
         *     pluginType = "Sample"
         *     // All properties except for "pluginType" are optional
         *     pollInterval = 30
         *     autoStart = true
         *     // Although it is possible to set plugin precedence, it is not
         *     recommended since this precedence
         *     // may already be taken and plugin creation will fail in this case
         *     precedence = 5
         *     config {
         *         configParam = "value"
         *     }
         * }
         * // Another plugin with an ID of 'sample2'
         * sample2 {
         *     ...
         * }
         */
    }
}
```

As can be seen, metadata information about the plugin type(s), versions, and documentation are available. These are displayed when viewing plugin information in the User Interface or through the REST API.

Any of these properties except for `initialPlugins`, `mwsVersion`, and `commonsVersion` may be overwritten by the plugin type class itself by using static properties. A simple example is shown below.

```
package example

class SamplePlugin {
    // Properties may be typed, untyped, final, or otherwise,
    // but they MUST be static
    static version = "0.2"
    static title = "Sample plugin"
    static description = "This sample plugin is used to demonstrate metadata
information"
    static author = "Separate Division"

    ... // Rest of the plugin type definition
}
```

## MWS and Commons Versions

The `mwsVersion` and `commonsVersion` fields are used to restrict the versions of MWS and plugin framework with which the plugin project may be used. Each field is of the format `FIRST_VERSION > LAST_VERSION`, where `FIRST_VERSION` is the first supported MWS or plugin framework version (inclusive), and `LAST_VERSION` is the last supported MWS or plugin framework version (inclusive). Each version must take the format of `##` or `###`, as in `7.1`, or `7.1.2`. An asterisk (`*`) is used to denote any version, and may be used for the first or the last version.

Although support for restricting both the MWS and commons versions are provided, it is recommended to use the commons version restriction always and the MWS version restriction where necessary. Restrictions on the commons version prevent plugin loading errors while restrictions on the MWS version prevent runtime errors such as missing support for certain MWS API versions.

Typically the `mwsVersion` and `commonsVersion` fields are set as shown above, with the first version set to a specific number, and the last version set to any (an asterisk). This is the recommended approach for setting both fields. It is not recommended to use any version (asterisk) for the first version. Some examples of `mwsVersion` and `commonsVersion` values are shown below with explanations of how they behave.

```

String mwsVersion = "7.1 > *" // Any MWS version 7.1.0 and greater is supported
(including 7.2, etc)
String mwsVersion = "7.1.3 > *" // Any MWS version 7.1.3 and greater is supported
(including 7.2, etc)
String mwsVersion = "7.1 > 7.1.3" // Any MWS version between 7.1.0 and 7.1.3 is
supported
String mwsVersion = "*" > "*" // Any MWS version is supported (not recommended!)
String mwsVersion = "*" > 7.2" // Any MWS version up to 7.2 is supported (not
recommended!)

String commonsVersion = "0.9 > *" // Any framework version 0.9.0 and greater is
supported (including 1.0, etc)
String commonsVersion = "0.9.3 > *" // Any framework version 0.9.3 and greater is
supported (including 1.0, etc)
String commonsVersion = "0.9 > 0.9.3" // Any framework version between 0.9.0 and 0.9.3
is supported
String commonsVersion = "*" > "*" // Any framework version is supported (not
recommended!)
String commonsVersion = "*" > 1.0" // Any framework version up to 1.0 is supported (not
recommended!)

```

If the `mwsVersion` or `commonsVersion` fields are formatted incorrectly, the plugin project will fail to load. If a plugin project is uploaded to MWS and the version check fails, the project will fail to load with an error message about the `mwsVersion` or `commonsVersion`.



The `mwsVersion` and `commonsVersion` fields cannot be overridden by a single plugin type, but can be set only at the plugin project level. This prevents mixing of MWS and commons version requirements within a single project.

## Initial Plugins

The initial plugins closure provides the flexibility to insert plugin instances when the JAR is loaded. This occurs at two points: when the plugin JAR is first uploaded to MWS, and when MWS is restarted. As shown in the example above, the ID, pluginType, and other properties may be configured for multiple plugins.

The nature of Groovy closures means that programmatic definition of initial plugins is possible. This may even be based on the MWS application configuration. Two properties are automatically available in the `initialPlugins` closure:

- `appConfig` - Contains the MWS application configuration. Any configuration parameter is available for access as documented on the [Configuration](#) page.
- `suite` - Contains the currently configured suite that MWS is running in. This is equivalent to the `mws.suite` configuration parameter, and is an instance of [Suite](#).

## Native Plugin Case Study

The Native JAR file utilizes many of the features discussed above. In the root of the JAR file, a compiled class called `NativeProject` exists which defines all of the metadata fields, including `initialPlugins`. Trying to create an initial plugin presents two distinct problems:

- The plugin should be initialized only if the suite is CLOUD.
- The plugin type configuration must contain an entry referencing the configured `mws.home.location` parameter, or the configured `MWS_HOME` location.

The `initialPlugins` closure is defined as follows:

```
import com.adaptc.mws.plugins.Suite

class NativeProject {
    ... // Metadata fields

    def initialPlugins = {
        // Initialize the cloud-native plugin only if the suite is CLOUD
        if (suite==Suite.CLOUD) {
            'cloud-native' {
                pluginType = "Native"
                pollInterval = 30
                config {
                    // Use the appConfig property to retrieve the current MWS_HOME
                    location
                    getCluster = "file://${appConfig.mws.home.location}/etc/nodes.txt"
                }
            }
        }
    }
}
```

## 6.2.16.2 Managing External Dependencies

External dependencies (e.g. JAR files) may be included and referenced in JAR files. Certain rules must also be followed in order to have the dependencies loaded from the JAR file correctly:

1. The plugin type must bundle all external dependency JARs in the root of the plugin type JAR file.
2. An entry must be included in the `MANIFEST.MF` file that references each of these bundled JAR files as a space separated list:

```
Class-Path: dependency1.jar dependency2.jar dependency3.jar
```

Assuming that these rules are followed and that the plugin type is uploaded using the REST API or the User Interface, the dependent JARs will first be loaded and then the new plugin type and associated files will be loaded.

## 6.2.17 Example Plugin Types

Several plugin types are provided by Adaptive Computing for use in Moab Web Services. Examples of these include the [Native](#) and [vCenter](#) plugin types.



Please see the Plugin Types item in the Quick Reference menu for all bundled plugin types.

A sample plugin type in Groovy would resemble the following:

```

package sample

import com.adaptc.mws.plugins.*

class SamplePlugin extends AbstractPlugin {
    static author = "Adaptive Computing"
    static description = "A simple plugin in groovy"
    static version = "0.1"

    INodeRMService nodeRMService

    public void configure() throws InvalidPluginConfigurationException {
        def myConfig = config // "config" is equivalent to getConfig() in groovy
        def errors = []
        if (!myConfig.arbitraryKey)
            errors << "Missing arbitraryKey!"
        if (errors)
            throw new InvalidPluginConfigurationException(errors)
    }

    public void poll() {
        NodeReport node = new NodeReport("node1")
        node.resources.RES1.total = 5
        node.resources.RES1.available = 5
        node.state = NodeReportState.IDLE
        nodeRMService.save([node])
    }

    // Access at /rest/plugins/<id>/services/example-service
    public def exampleService(Map params) {
        return [success:true]
    }
}

```

## 6.3 MWM Resource Manager Integration

Moab Workload Manager possesses the concept of Resource Managers (RMs). While plugins can be related to RMs, they often provide greater functionality and serve more purposes than a typical RM. MWS must be represented in MWM as a RM to enable certain plugin features such as state reporting and handling RM events. This section describes the process of configuring MWM and additional details of its queries to MWS.

### 6.3.1 Configuring MWM

Moab Workload Manager must be configured to use MWS as a resource manager. The following lines must be in the `/opt/moab/etc/moab.cfg` file or one of its included files:

```

RMCFG[mws] TYPE=NATIVE
RMCFG[mws] FLAGS=UserSpaceIsSeparate
RMCFG[mws] CLUSTERQUERYURL=exec://$TOOLSDIR/mws/cluster.query.mws.pl
RMCFG[mws] WORKLOADQUERYURL=exec://$TOOLSDIR/mws/workload.query.mws.pl
RMCFG[mws] JOBCANCELURL=exec://$TOOLSDIR/mws/job.cancel.mws.pl
RMCFG[mws] JOBMIGRATEURL=exec://$TOOLSDIR/mws/vm.migrate.mws.pl
RMCFG[mws] JOBMODIFYURL=exec://$TOOLSDIR/mws/job.modify.mws.pl
RMCFG[mws] JOBREQUEUEURL=exec://$TOOLSDIR/mws/job.requeue.mws.pl
RMCFG[mws] JOBRRESUMEURL=exec://$TOOLSDIR/mws/job.resume.mws.pl
RMCFG[mws] JOBSTARTURL=exec://$TOOLSDIR/mws/job.start.mws.pl
RMCFG[mws] JOBSUBMITURL=exec://$TOOLSDIR/mws/job.submit.mws.pl
RMCFG[mws] JOBSUSPENDURL=exec://$TOOLSDIR/mws/job.suspend.mws.pl
RMCFG[mws] NODEMODIFYURL=exec://$TOOLSDIR/mws/node.modify.mws.pl
RMCFG[mws] NODEPOWERURL=exec://$TOOLSDIR/mws/node.power.mws.pl
RMCFG[mws] RESOURCECREATEURL=exec://$TOOLSDIR/mws/resource.create.mws.pl
RMCFG[mws] SYSTEMMODIFYURL=exec://$TOOLSDIR/mws/system.modify.mws.pl
RMCFG[mws] SYSTEMQUERYURL=exec://$TOOLSDIR/mws/system.query.mws.pl

```

The next step is to edit the MWS values in `/opt/moab/etc/cloud.cfg`. Here are the default values:

```

CONFIG[default] MWS_URL=http://localhost:8080/mws
CONFIG[default] MWS_USERNAME=admin
CONFIG[default] MWS_PASSWORD=adminpw

```

 MWS\_USERNAME and MWS\_PASSWORD must match the values of `auth.defaultUser.username` and `auth.defaultUser.password`, respectively, found in `/opt/mws/etc/mws-config.groovy`.

The `*.mws.pl` scripts should be located in the `tools/mws` of the Moab home directory. The `Moab/WebServices.pm` module must also be available to the scripts. All of these files may be found in the `tools/mws` and `lib/perl5` directories of the Moab tar file. They are automatically installed if Moab is configured with the `--with-mws` flag or they can be copied directly from there to the `tools` folder in your Moab home directory.

To enable such actions as submitting jobs as different users, the `ENABLEPROXY=TRUE` option must be present in the `ADMINCFG` configuration line and the `OSCREDLLOOKUP` option must be set to `NEVER` as follows:

```
ADMINCFG[1]          USERS=root      ENABLEPROXY=TRUE
OSCREDLLOOKUP      NEVER
```

### 6.3.2 RM Queries

During each iteration of Moab Workload Manager's cycle, it will query MWS through the RM interface to access current node, virtual machine, and job information. At this point, all reports are loaded from the database and consolidated into a single report of each object as explained in the [Data Consolidation](#) section.

 All unset, or null, values for properties on reports are ignored.

In some cases it may be desired to query MWS directly for the current consolidated node, virtual machine, and job reports. This may be done using the following URLs which return data in the Wiki interface format (see the [Native](#) plugin type for more information). Note that the content type of these URLs is `plain/text`, not `application/json`.

query	Description
<code>/rest/plugins/all/rm/cluster-query</code>	Retrieves consolidated node and virtual machine reports from all plugins. All VMs will have a <code>CONTAINERNODE</code> attribute present.
<code>/rest/plugins/&lt;ID&gt;/rm/cluster-query</code>	Retrieves consolidated node and virtual machine reports for the specified plugin ID. All VMs will have a <code>CONTAINERNODE</code> attribute present.
<code>/rest/plugins/all/rm/workload-query</code>	Retrieves consolidated job reports from all plugins.
<code>/rest/plugins/&lt;ID&gt;/rm/workload-query</code>	Retrieves consolidated job reports for the specified plugin ID.

These queries have no effect on the data itself. In other words, reports are not removed or manipulated when RM queries are performed. These are manipulated only the RM services as described in [Reporting State Data](#).

## Examples

The following example uses [cURL](#) to perform the query.

```

$ curl -u admin:adminpw http://localhost:8080/mws/rest/plugins/all/rm/cluster-query
SC=0 RESPONSE=Success
n1.test
STATE=Up;UPDATETIME=1344488025;CPROC=4;CMEMORY=8191;AMEMORY=7205;CPULOAD=0.0182;POWER=On n2.test
STATE=Up;UPDATETIME=1344488025;CPROC=4;CMEMORY=10239;AMEMORY=9227;CPULOAD=0.0233;POWER=On n3.test
STATE=Up;UPDATETIME=1344488025;CPROC=4;CMEMORY=10239;AMEMORY=9230;CPULOAD=0.019633333333333336;POW
STATE=Up;UPDATETIME=1344488025;CPROC=4;CMEMORY=10239;AMEMORY=9230;CPULOAD=0.020033333333333334;POW
STATE=Up;UPDATETIME=1344488025;CPROC=24;CMEMORY=49150;AMEMORY=39339;CPULOAD=0.23799999999999996;POV
STATE=Up;CONTAINERNODE=management.test;UPDATETIME=1344488025;CPROC=1;CMEMORY=1024;AMEMORY=152;CPULC

```

## 6.4 Plugin Type Management

Plugin types may be managed and accessed with Moab Web Services dynamically, even while running. Operations are provided to upload (add or update) plugin types and to list or show current plugin types. The available fields that are displayed with plugin types are given in the [PluginType API](#). For more information on how these fields are set, see the [Plugin Projects and Metadata](#) section.

 Plugin Type JAR or groovy files should never be manually copied into the `MWS_HOME/plugins` directory. They must be managed using the methods shown in this section or through the [REST API](#).

### 6.4.1 Listing Plugin Types

To list all plugin types, browse to the MWS home page (`https://servername/mws` for example). Log in as the admin user, then click **Plugins** and then **Plugin Types**.



#### Plugin Type List

This list shows all the plugin types that are available in Moab Web Services.

Add or Update Plugin Type

ID	Title	Author	Version	Has Poll
MSM	Moab Services Manager (MSM)	Adaptive Computing Enterprises, Inc.	0.2	Yes
Native	Native	Adaptive Computing Enterprises, Inc.	0.2	Yes

### 6.4.2 Displaying Plugin Types

To show information about a plugin type, go to the **Plugin Type List** page and click the desired plugin type.



## Show Plugin Type

ID	<b>Native</b>						
Title	<b>Native</b>						
Description	<b>Basic implementation of a native plugin</b>						
Author	<b>Adaptive Computing Enterprises, Inc.</b>						
Email	<a href="mailto:mws.plugins@adaptivecomputing.com">mws.plugins@adaptivecomputing.com</a>						
License	<b>APACHE</b>						
Version	<b>0.2</b>						
MWS Version	<b>7.1 &gt; *</b>						
Issues							
Documentation							
Sources							
Has Poll Method	<b>Yes</b>						
Web Services	<table border="1"> <thead> <tr><th>Name</th></tr> </thead> <tbody> <tr><td colspan="2">There are no entries at this time</td></tr> </tbody> </table>	Name	There are no entries at this time				
Name							
There are no entries at this time							
Default Configuration	<table border="1"> <thead> <tr><th>ID</th><th>Poll Interval</th><th>Auto Sta</th></tr> </thead> <tbody> <tr><td>cloud-native</td><td>30</td><td></td></tr> </tbody> </table>	ID	Poll Interval	Auto Sta	cloud-native	30	
ID	Poll Interval	Auto Sta					
cloud-native	30						
Plugins	<table border="1"> <thead> <tr><th>ID</th><th>State</th></tr> </thead> <tbody> <tr><td>cloud-native</td><td>Started</td></tr> </tbody> </table>	ID	State	cloud-native	Started		
ID	State						
cloud-native	Started						

Add Plugin

Plugin Type List

### 6.4.3 Add or Update Plugin Types

Plugin types can be uploaded into Moab Web Services using a Groovy file, a Java Archive ([JAR](#)) file, or pasted Groovy code. To access the plugin type upload page, navigate to the **Plugin Type List** page and click **Add or Update Plugin Type**. The default interface of this page enables the uploading of a single Groovy class file or a JAR file.

When a plugin type is updated, by default all corresponding plugins created from the plugin type will be recreated. If this behavior is not desired, clear the "Do you want to reload all plugins to use this new version?" checkbox before uploading the plugin type.

#### Single Class File

Groovy files containing a single plugin type may be uploaded at the `/mws/admin/plugin-types/create` URL.



## Create Plugin Type

Do you want to reload all plugins to use this new version?

+ Add files...	Start upload	Cancel upload	Clear files
----------------	--------------	---------------	-------------

Cancel

Type or Paste Code

Simply click **Add files...**, select the `.groovy` class file, and click the **Start upload** button. If the plugin type was successfully uploaded and initialized, the size of the file uploaded will be displayed along with the name of the plugin loaded.



## Create Plugin Type

Do you want to reload all plugins to use this new version?

+ Add files...	Start upload	Cancel upload	Clear files
Polling			0.23 KB

Cancel

Type or Paste Code

If the upload failed or an error occurred during initialization of the plugin, an error message will be displayed.



## Create Plugin Type

**Plugin Type with ID 'NotAValidClass' is an invalid plugin: Class name does not end with Plugin**

Do you want to reload all plugins to use this new version?

<b>+ Add files...</b>	<b>Start upload</b>	<b>Cancel upload</b>	<b>Clear files</b>
sample.groovy	0.04 KB	<div style="width: 100%; height: 15px; background-color: orange;"></div>	

Cancel

Type or Paste Code

## JAR File

A JAR file as described in the [Packaging Plugins](#) section containing one or more plugins may also be uploaded using the same process as the Groovy file.

Click **Add files...**, select the `.jar` file, and click the **Start upload** button. If the upload failed or an error occurred during initialization of the plugin(s), an error message will be displayed.

The JAR upload process differs from the single file in that if successful, the name of the JAR file itself is displayed instead of the plugin name(s).



## Create Plugin Type

Do you want to reload all plugins to use this new version?

<b>+ Add files...</b>	<b>Start upload</b>	<b>Cancel upload</b>	<b>Clear files</b>
samples.jar	28.16 KB		

Cancel

Type or Paste Code

## Code

To paste or type code directly into MWS and have it be loaded as a single class file, click **Type or Paste Code** and type or paste the code into the presented text box.



## Create Plugin Type

Upload File(s)

Do you want to reload all plugins to use this new version?

Code

Save

Cancel



## Create Plugin Type

Upload File(s)

Do you want to reload all plugins to use this new version?

Code

```
package sample.polling;

import com.ace.mws.plugins.*

public class PollingPlugin extends AbstractPlugin {
    static final title = "Polling Sample"
    public void poll() {
```

Save

Cancel

When the code is in the box, click **Create**. If the upload succeeded and the code was able to be compiled as Groovy, the browser will be redirected to the **Show Plugin Type** page. If the upload failed or an error occurred during compilation or initialization of the plugin, an error message will be displayed.



The MWS [log file](#) may need to be referred to for additional details and error messages in the case of a failure.

## 6.5 Plugin Management

Plugins may be managed and accessed with Moab Web Services dynamically, even while running. This includes plugin instance and lifecycle management. Additionally, default configuration values may be set for new plugins. In order to access custom web services, the REST API must be utilized as described in the [Accessing Plugin Web Services](#) section. The available fields that are displayed with plugins are given in the [PluginInstance API](#).

## 6.5.1 Listing Plugins

To list all plugins, browse to the MWS home page (<https://servername/mws> for example). Log in as the admin user, then click **Plugins** and then **Plugins**.

### Plugin List

This list shows all the plugins that have been configured in Moab Web Services.

Add Plugin

ID	Plugin Type	State	Poll Interval
<a href="#">cloud-native</a>	Native	Started	30

## 6.5.2 Creating a Plugin

To create a plugin, go to the **Plugin List** page and click **Add Plugin**. First, a **Plugin Type** must be selected to continue to actually create the plugin.

### Create Plugin

Plugin Type \*

VCenter

Continue

Cancel

The page is automatically built to support the [plugin type's constraints](#). The **ID** field will be automatically filled in with a suggested value, and the **Poll Interval** field will be displayed only if the plugin type has a `poll` method. The required configuration fields are displayed by default, and optional fields may be selected and added to the configuration from the drop down at the top of the configuration section. See the [PluginInstance API](#) for more information on the fields.



## Create Plugin

Plugin Type **VCenter**

ID \*

Poll Interval \*

Auto Start

Configuration

Key	Value
* Username	<input type="text"/>
* Password	<input type="text"/>
* URL	<input type="text"/>

### 6.5.3 Displaying a Plugin

To show information about a plugin, go to the **Plugin List** page and click the desired plugin ID.



## Show Plugin

ID **cloud-native**

Plugin Type **Native**

State **Started**

Poll Interval **30**

Auto Start **Yes**

Configuration	Key	Value
	Get Cluster	<b>file:///opt/mws/etc/nodes.txt</b>

Web Services	Name
There are no entries at this time	

## 6.5.4 Modifying a Plugin

To modify a plugin, go to the **Plugin List** page, click the desired plugin ID, and then click **Edit**. See the [PluginInstance API](#) for more information on available fields.

**Edit Plugin**

ID **cloud-native**

Plugin Type **Native**

State **Started**

Poll Interval \*

Auto Start

Configuration

Key	Value
Get Cluster	file:///opt/mws/etc/nodes.txt

## 6.5.5 Deleting a Plugin

To delete a plugin, go to the **Plugin List** page, click the desired plugin ID, and then click **Delete**. A confirmation message is shown. If the **OK** button is clicked, the plugin is deleted from the system and cannot be recovered, including all configuration.

## 6.5.6 Monitoring and Lifecycle Controls

To monitor and control the lifecycle of plugins, browse to the MWS home page (<https://servername/mws> for example). Log in as the admin user, then click **Plugins** and then **Plugin Monitoring**. This page displays the current state of all plugins as well as their polling status.



## Plugin Monitoring

This page monitors the status of all plugins in Moab Web Services.

Tuesday, June 12, 2012

11:28:11 AM

Reload when poll occurs

### Active Plugins

ID	Plugin Type	Last Poll	Next Poll
cloud-native	Native	00:00:08	00:00:21
no-polling	Logging		

### Disabled Plugins

ID	Plugin Type	State	Actions
There are no Disabled Plugins set up at this time			



If plugins are created from plugin types which do not have a poll method, their lifecycle controls will be limited. Any information below which mentions polling does not apply to the 'no-polling' plugin shown in the screenshots.

## Active Plugins

Active plugins are those which are in the Started or Paused states. These are available to receive events such as polling. If paused, a plugin will not receive events but is not actually stopped, therefore no stop events are triggered.

The following images demonstrate the status of plugins in the active states.

### Active Plugins

ID	Plugin Type	Last Poll	Next Poll	Acti
cloud-native	Native	00:00:08	00:00:21	
no-polling	Logging			

Started plugins which can include the relative time of the last poll as well as the time of the next poll in a countdown format. Action buttons are available to stop or pause the plugin as well as trigger an immediate poll event.

## Active Plugins

ID	Plugin Type	Last Poll	Next Poll	Acti
cloud-native	Native	00:00:26		 
no-polling	Logging			 

Paused plugins which can include only the last polling time. Action buttons are available to stop or resume the plugin, as well as trigger an immediate poll event.

## Disabled Plugins

Disabled plugins are those which are in the Stopped or Errored states. These plugins do not receive events such as polling. If errored, a plugin may either be stopped, which represents a "clearing" of the error, or started normally. However, if no action is taken on an errored plugin, it likely will not start due to the fact that most plugins are put into the errored state during startup of the plugin.

The following images demonstrate the representation of plugins in the disabled states.

### Disabled Plugins

ID	Plugin Type	State	Actions
no-polling	Logging	Stopped	

Stopped plugins. A single action button is available to attempt to start the plugin.

### Disabled Plugins

ID	Plugin Type	State	Action
with-error	Logging	Errored	 

An errored plugin. As mentioned previously, action buttons are available to stop the plugin or clear the error as well as attempt to start the plugin. If the start fails, an error message will be displayed.

## 6.5.7 Setting Default Plugin Configuration

Configuration of default values for plugin configuration parameters involves setting fields in the MWS configuration file. These values are used if no values are provided when creating a new plugin. Additionally, the default values will be displayed to the user on the **Create Plugin** page.

The parameters to configure are documented on the MWS [Configuration](#) page and comprise most values starting with `plugins`.