

Bright Cluster Manager 7.2

Developer Manual

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Preface

Welcome to the *Developer Manual* for Bright Cluster Manager 7.2.

0.1 About This Manual

This manual is aimed at helping developers who would like to program the Bright Cluster Manager in order to enhance or alter its functionality. It is not intended for end users who simply wish to submit jobs that run programs to workload managers, which is discussed in the *User Manual*. The developer is expected to be reasonably familiar with the parts of the *Administrator Manual* that is to be dealt with—primarily CMDaemon, of which `cmsh` and `cmgui` are the front ends.

This manual discusses the Python API to CMDaemon, and also covers how to program for metric collections.

0.2 About The Manuals In General

Regularly updated versions of the Bright Cluster Manager 7.2 manuals are available on updated clusters by default at `/cm/shared/docs/cm`. The latest updates are always online at `http://support.brightcomputing.com/manuals`.

- The *Administrator Manual* describes the general management of the cluster.
- The *Installation Manual* describes installation procedures for a basic cluster.
- The *User Manual* describes the user environment and how to submit jobs for the end user.
- The *Cloudbursting Manual* describes how to deploy the cloud capabilities of the cluster.
- The *Developer Manual* has useful information for developers who would like to program with Bright Cluster Manager.
- The *OpenStack Deployment Manual* describes how to deploy OpenStack with Bright Cluster Manager.
- The *Hadoop Deployment Manual* describes how to deploy Hadoop with Bright Cluster Manager.
- The *UCS Deployment Manual* describes how to deploy the Cisco UCS server with Bright Cluster Manager.

If the manuals are downloaded and kept in one local directory, then in most pdf viewers, clicking on a cross-reference in one manual that refers to a section in another manual opens and displays that section in the second manual. Navigating back and forth between documents is usually possible with keystrokes or mouse clicks.

For example: `<Alt>-<Backarrow>` in Acrobat Reader, or clicking on the bottom leftmost navigation button of `xpdf`, both navigate back to the previous document.

The manuals constantly evolve to keep up with the development of the Bright Cluster Manager environment and the addition of new hardware and/or applications. The manuals also regularly incorporate customer feedback. Administrator and user input is greatly valued at Bright Computing. So any comments, suggestions or corrections will be very gratefully accepted at `manuals@brightcomputing.com`.

0.3 Getting Administrator-Level Support

If the reseller from whom Bright Cluster Manager was bought offers direct support, then the reseller should be contacted.

Otherwise the primary means of support is via the website <https://support.brightcomputing.com>. This allows the administrator to submit a support request via a web form, and opens up a trouble ticket. It is a good idea to try to use a clear subject header, since that is used as part of a reference tag as the ticket progresses. Also helpful is a good description of the issue. The followup communication for this ticket goes via standard e-mail. Section 11.2 of the *Administrator Manual* has more details on working with support.

0.4 Getting Developer-Level Support

Developer support is given free, within reason. For more extensive support, Bright Computing can be contacted in order to arrange a support contract.

1

Bright Cluster Manager Python API

This chapter introduces the Python API of Bright Cluster Manager. For a head node `bright72`, the API reference documentation for all available objects is available in a default cluster via browser access to the URL:

```
https://bright72/userportal/downloads/python
```

The preceding access is via the User Portal (section 10.9 of the *Administrator Manual*).

The documentation is also available directly on the head node itself at:

```
file:///cm/local/docs/cmd/python/index.html
```

1.1 Installation

The Python cluster manager bindings are pre-installed on the head node.

1.1.1 Windows Clients

For windows clients, Python version 2.5.X is needed. Newer versions of Python do not work with the API.

For Windows a redistributable package is supplied in the `pythoncm-dist` RPM package installed on the cluster. The file at

```
/cm/shared/apps/pythoncm/dist/windows-pythoncm.7.2.r15673.zip
```

—the exact version number may differ—is copied to the Windows PC and unzipped.

A Windows shell (`cmd.exe`) is opened to the directory where the Python bindings are. The `headnodeinfo.py` example supplied with the unzipped files has a line that has the following format:

```
cluster = clustermanager.addCluster(<parameters>);
```

where `<parameters>` is either:

```
'<URL>', '<PEMauth1>', '<PEMauth2>'
```

or

```
'<URL>', '<PFXauth>', '"', '<password>'
```

The `<parameters>` entry is edited as follows:

- the correct hostname is set for the `<URL>` entry. By default it is set to `https://localhost:8081`
- If PEM key files are to be used for client authentication,

- `<PEMauth1>` is set to path of `cert.pem`
- `<PEMauth2>` is set to the path of `cert.key`
- If a PFX file is used for client authentication,
 - `<PFXauth>` is set to path of `admin.pfx`
 - `<password>` is set to the password

To verify everything is working, it can be run as follows:

```
c:\python25\python headnodeinfo.py
```

1.1.2 Linux Clients

For Linux clients, a redistributable source package is supplied in the `pythoncm-dist` package installed on the cluster. The file at `/cm/shared/apps/pythoncm/dist/pythoncm-7.2-r18836-src.tar.bz2`—the exact version number may differ—is copied and untarred to any directory.

The `build.sh` script is then run to compile the source. About 4GB of memory is usually needed for compilation, and additional packages may be required for compilation to succeed. A list of packages needed to build Python cluster manager bindings can be found in the `README` file included with the package.

The `headnodeinfo.py` example supplied with the untarred files is edited as for in the earlier windows client example, for the `clustermanager.addCluster` line.

The path to the remote cluster manager library is added:

```
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:remotecm
```

To verify everything is working, the following can be run:

```
python ./headnodeinfo.py
```

1.2 Examples

A set of examples can be found in `/cm/local/examples/cmd/python/` on the head node of the cluster.

1.2.1 First Program

A Python script is told to use the cluster manager bindings by importing `pythoncm` at the start of the script:

```
import pythoncm
```

If not working on the cluster, the administrator needs to set the path where the shared libraries can be found (`pythoncm.so` in Linux, or `python.pyd` in windows). This is done by adding the following to the start of the script:

```
import sys
sys.path.append(".") # path to pythoncm.so/python.pyd
```

Python cluster manager bindings allow for simultaneous connections to several clusters. For this reason the first thing to do is to create a `ClusterManager` object:

```
clustermanager = pythoncm.ClusterManager()
```

A connection to a cluster can now be made. There are two possible ways of connecting.

The first is using the certificate and private key file that `cmsh` uses by default when it authenticates from the head node.

```
cluster = clustermanager.addCluster('https://mycluster:8081', \
'/root/.cm/admin.pem', '/root/.cm/admin.key');
```

The second way uses the password protected `admin.pfx` file, which is generated with the `cmd -c` command. A Python script could ask for the password and store it in a variable for increased security.

```
cluster = clustermanager.addCluster('https://mycluster:8081', \
'/root/.cm/cmgui/admin.pfx', '', '<password>');
```

Having defined the cluster, a connection can now be made to it:

```
isconnected = cluster.connect()
if !isconnected:
    print "Unable to connect"
    print cluster.getLastError()
    exit(1)
```

If a connection cannot be made, the function `cluster.connect()` returns false. The function `cluster.getLastError()` shows details about the problem. The two most likely problems are due to a wrong password setting or a firewall settings issue.

Similar to `cmgui` and `cmsh`, the cluster object contains a local cache of all objects. This cache will be filled automatically when the connection is established. All changes to properties will be done on these local copies and will be lost after the Python scripts exits, unless a `commit` operation is done.

The most common operation is finding specific objects in the cluster.

```
active = cluster.find('active')
if active == None:
    print "Unable to find active head node"
    exit(1)
else:
    print "Hostname of the active head node is %s" % active.hostname
```

If creating an automated script that runs at certain times, then it is highly recommended to check if objects can be found. During a failover, for instance, there will be a period over a few minutes in which the active head node will not be set.

It is good practice to disconnect from the cluster at the end of the script.

```
cluster.disconnect()
```

When connecting to a cluster with a failover setup, it is the shared IP address that should be connected to, and not the fixed IP address of either of the head nodes.

1.3 Methods And Properties

1.3.1 Viewing All Properties And Methods

All properties visible in `cmsh` and `cmgui` are also accessible from Python cluster manager bindings. The easiest way to get an overview of the methods and properties of an object is to define the following function:

```
import re
def dump(obj):
    print "--- DUMP ---"
    for attr in dir(obj):
        p = re.compile('^__.*__$')
        if not p.match(attr):
            print "%s = %s" % (attr, getattr(obj, attr))
```

An overview of all properties and methods for the active head node can be obtained with:

```
active = cluster.find('active')
dump(active)
```

1.3.2 Property Lists

Most properties are straightforward and their names are almost identical to the `cmsh` equivalent.

For instance:

```
node.mac = '00:00:00:00:00:00'
category.softwareimage = cluster.find('testimage')
```

Properties that contain lists, like `node.roles`, `node.interfaces`, `category.fsmounts` and several others, are trickier to deal with. While iterating over a list property is simple enough:

```
for role in node.roles:
    print role.name
```

because of an implementation restriction, adding a new role requires that a local copy of the roles list be made:

```
roles = node.roles
provisioningrole = pythoncm.ProvisioningRole() # Create a new pro\
                                              visioning role object
roles.append(provisioningrole)
node.roles = roles # This will update the internal\
                  roles list with the local copy
```

1.3.3 Creating New Objects

Creating a new node can be done with:

```
node = pythoncm.Node()
```

This is valid command, but fairly useless because a node has to be a `MasterNode`, `PhysicalNode` or `VirtualSMPNode`. So to create a normal compute or login node, the object is created as follows:

```
node = pythoncm.PhysicalNode()
```

The first thing to do after creating a new object is to add it to a cluster.

```
cluster.add(node)
```

It is impossible to add one node to more than one cluster.

After the node has been added its properties can be set. In `cmsh` and `cmgui` this is semi-automated, but in Python cluster manager bindings it has to be done by hand.

```
node.hostname = 'node001'
node.partition = cluster.find('base')
node.category = cluster.find('default')
```

Similar to the `node` object, a `NetworkInterface` object has several subtypes: `NetworkPhysicalInterface`, `NetworkVLANInterface`, `NetworkAliasInterface`, `NetworkBondInterface`, and `NetworkIPMIInterface`.

```
interface = pythoncm.NetworkPhysicalInterface()
interface.name = 'eth0'
interface.ip = '10.141.0.1'
interface.network = cluster.find('internalnet')
node.interfaces = [interface]
node.provisioningInterface = interface
```

Having set the properties of the new node, it can now be committed.

```
cr = node.commit()
```

If a commit fails for some reason, the reason can be found:

```
if not cr.result:
    print "Commit of %s failed:" % node.resolveName()
    for j in range(cr.count):
        print cr.getValidation(j).msg
```

1.3.4 List Of Objects

In the following lists of objects:

- Objects marked with (*) cannot be used
- Trees marked with (+) denote inheritance

Roles

```
Role (*)
+ BackupRole
+ BootRole
+ DatabaseRole
+ EthernetSwitch
+ LoginRole
+ LSFClientRole
+ LSFServerRole
+ MasterRole
+ PbsProClientRole
+ PbsProServerRole
+ ProvisioningRole
+ SGEClientRole
+ SGEServerRole
+ SlurmClientRole
+ SlurmServerRole
+ SubnetManagerRole
+ TorqueClientRole
+ TorqueServerRole
```

Devices

```
Device (*)
+ Chassis
+ GpuUnit
+ GenericDevice
+ PowerDistributionUnit
+ Switch (*)
  + EthernetSwitch
  + IBSwitch
  + MyrinetSwitch
Node (*)
+ FSExport
+ FSMount
+ MasterNode
+ SlaveNode (*)
  + PhysicalNode
  + VirtualSMPNode
```

Network Interfaces

```
NetworkInterface (*)
+ NetworkAliasInterface
+ NetworkBondInterface
```

- + NetworkIpmiInterface
- + NetworkPhysicalInterface
- + NetworkVLANInterface

Information Objects

- ClusterSetup
- GuiClusterOverview
- GuiCephOverview
- GuiHadoopHDFSOverview
- GuaOpenStackOverview
- GuiOpenStackTenantOverview
- GuiGpuUnitOverview
- GuiNodeOverview
- GuiNodeStatus
- LicenseInfo
- SysInfoCollector
- VersionInfo

Monitoring Configuration Objects

- MonConf
- ConsolidatorConf
- MonHealthConf
- HealthCheck
- MonMetricConf
- ThreshActionConf
- ThreshAction
- Threshold

LDAP Objects

- User
- Group

Category Objects

- Category
- FSExport
- FSMount

Miscellaneous Objects

- SoftwareImage

- KernelModule

- Network

- NodeGroup

- Partition
- + BurnConfig
- Rack

1.3.5 Useful Methods

For The Cluster Object:

Name	Description
<code>find(<name>)</code>	Find the object with a given name, <i><name></i>
<code>find(<name>, <type>)</code>	Because it is possible to give a category and node the same name, sometimes the type <i><type></i> of the object needs to be specified too
<code>getAll(<type>)</code>	Get a list of all objects of a given type: e.g. device, category
<code>activeMaster()</code>	Get the active master object
<code>passiveMaster()</code>	Get the active master object
<code>overview()</code>	Get all the data shown in the <code>cmgui</code> cluster overview
<code>add(<object>)</code>	Add a newly created object <i><object></i> to the cluster. Only after an object is added can it be used
<code>pexec(<nodes>, <command>)</code>	Execute a command <i><command></i> on one or more nodes

For Any Object:

Name	Description
<code>commit()</code>	Save changes to the cluster
<code>refresh()</code>	Undo all changes and restore the object to its last saved state
<code>remove()</code>	Remove an object from the cluster
<code>clone()</code>	Make an identical copy. The newly created object is not added to a cluster yet

For Any Device:

Name	Description
<code>close()</code>	Close a device
<code>open()</code>	Open a device
<code>powerOn()</code>	Power on a device
<code>powerOff()</code>	Power off a device
<code>powerReset()</code>	Power reset a device
<code>latestMonitoringData()</code>	Return a list of the most recent monitoring data

For Any Node:

Name	Description
<code>overview()</code>	Get the data displayed in the <code>cmgui</code> node overview tab
<code>sysinfo()</code>	Get the data displayed in the <code>cmgui</code> node system information tab
<code>pexec(<command>)</code>	Execute a command

1.3.6 Useful Example Program

In the directory `/cm/local/examples/cmd/python` are some example programs using the python API.

One of these is `printall.py`. It displays values for objects in an easily viewed way. With `all` as the argument, it displays resource objects defined in a list in the program. The objects are 'Partition', 'MasterNode', 'SlaveNode', 'Category', 'SoftwareImage', 'Network', 'NodeGroup'. The output is displayed something like (some output elided):

Example

```
[root@bright72 ~]# cd /cm/local/examples/cmd/python
[root@bright72 python]# ./printall all
Partition base
+- revision .....
| name ..... base
| clusterName ..... Bright 7.2 Cluster
...
| burnConfigs
| +- revision .....
| | name ..... default
| | description ..... Standard burn test.
| | configuration ..... < 2780 bytes >
| +- revision .....
| | name ..... long-hpl
...
| provisioningInterface ..... None
| fsmounts ..... < none >
| fsexports
| +- revision .....
| | name ..... /cm/shared@internalnet
| | path ..... /cm/shared
| | hosts ..... !17179869185!
...
Category default
+- revision .....
| name ..... default
| softwareImage ..... default-image
| defaultGateway ..... 10.141.255.253
| nameServers ..... < none >
...
```

The values of a particular resource-level object, such as `softwareimage`, can be viewed by specifying it as the argument:

Example

```
[root@bright72 python]# ./printall.py softwareimage
softwareimage default-image
+- revision .....
| name ..... default-image
| path ..... /cm/images/default-image
| originalImage ..... 0
| kernelVersion ..... 2.6.32-431.11.2.el6.x86_64
| kernelParameters ..... rdblacklist=nouveau
| creationTime ..... 1398679806
| modules
| +- revision .....
| | name ..... xen-netfront
...
```

```
| +- revision .....
| | name ..... hpilo
| | parameters .....
| enableSOL ..... False
| SOLPort ..... ttyS1
| SOLSpeed ..... 115200
| SOLFlowControl ..... True
| notes .....
| fspart ..... 98784247812
| bootfspart ..... 98784247813
...
[root@bright72 python]#
```


2

Metric Collections

This chapter gives details on metric collections.

Section 10.4.4 of the *Administrator Manual* introduces metric collections, and describes how to add a metric collections script with `cmgui`.

This chapter covers how to add a metric collections script with `cmsh`. It also describes the output specification of a metric collections script, along with example outputs, so that a metric collections script can be made by the administrator.

2.1 Metric Collections Added Using `cmsh`

A metric collections script, `responsiveness`, is added in the `monitoring metrics` mode just like any other metric.

Example

```
[bright72]% monitoring metrics
[bright72->monitoring->metrics]% add responsiveness
[...[responsiveness]]% set command /cm/local/apps/cmd/scripts/metrics/s\
ample_responsiveness
[...*[responsiveness*]]% set classofmetric prototype; commit
```

For `classofmetric`, the value `prototype` is the class used to distinguish metric collections from normal metrics.

2.2 Metric Collections Initialization

When a metric collections script is added to CMDaemon for the first time, CMDaemon implicitly runs it with the `--initialize` flag. The output is used to define the collections table header structure. The structure is composed of the component metrics in the collections script, and the resulting structure is placed in the CMDaemon monitoring database. After the initialization step, data values can be added to the collections table during regular use of the script.

The displayed output of a metric collections script when using the `--initialize` flag is a list of available metrics and their parameter values. The format of each line in the list is:

```
metric <name[:parameter]> <unit> <class> "<description>" <cumulative> <min> <max>
```

where the items in the line are:

- `metric`: A bare word.
- `<name[:parameter]>`: The name of the metric, with for certain metrics a parameter value. For example, the metric `AlertLevel` can have the parameter `sum` assigned to it with the ":" character.

- `<unit>`: The unit of measurement that the metric uses.
- `<class>`: Any of: misc cpu disk memory network environmental operatingsystem internal workload cluster.
- `<description>`: This can contain spaces, but should be enclosed with quotes.
- `<cumulative>`: Either `yes` or `no`. This indicates whether the metric increases monotonically (e.g., bytes received) or not (e.g., temperature).
- `<min>` and `<max>`: The minimum and maximum numeric values of this metric are determined dynamically based on the values so far.

Example

```
[root@myheadnode metrics]# ./sample_responsiveness --initialize
metric util_sda % internal "Percentage of CPU time during which I/O
requests were issued to device sda" no 0 100
metric await_sda ms internal "The average time (in milliseconds) for
I/O requests issued to device sda to be served" no 0 500
```

2.3 Metric Collections Output During Regular Use

The output of a metric collection script without a flag is a list of outputs from the available metrics. The format of each line in the list is:

```
metric <name[:parameter]> <value> [infomessage]
```

where the parameters to the `metric` bare word are:

- `<name[:parameter]>`: The name of the metric, with optional parameter for some metrics.
- `<value>`: The numeric value of the measurement.
- `[infomessage]`: An optional infomessage.

Example

```
[root@myheadnode metrics]# ./sample_responsiveness
metric await_sda 0.00
metric util_sda 0.00
[root@myheadnode metrics]#
```

If the output has more metrics than that suggested by when the `--initialize` flag is used, then the extra sampled data is discarded. If the output has fewer metrics, then the metrics are set to NaN (not a number) for the sample.

A metric or health check inside a metric collection appears as a check when viewing metrics or healthcheck lists. Attempting to remove such a check specifically using `cmsh` or `cmgui` only succeeds until the node is updated or rebooted. It is the metric collection itself that should have the check removed from within it, in order to remove the check from the list of checks permanently.

Setting a node that is UP to a CLOSED state, and then bringing it out of that state with the `open` command (section 5.5.4 of the *Administrator Manual*) also has CMDaemon run the metric collections script with the `--initialize` flag. This is useful for allowing CMDaemon to re-check what metrics in the collections can be sampled, and then re-configure them.

2.4 Metric Collections Error Handling

If the exit code of the script is 0, CMDaemon assumes that there is no error. So, with the `--initialize` flag active, despite no numeric value output, the script does not exit with an error.

If the exit code of the script is non-zero, the output of the script is assumed to be a diagnostic message and is passed to the head node. This shows up as an event in `cmsh` or `cmgui`.

For example, the `sample_ipmi` script uses the `ipmi-sensors` binary internally. Calling the binary directly returns an error code if the device has no IPMI configured. However, the `sample_ipmi` script in this case simply returns 0, and no output. The rationale here being that the administrator is aware of this situation and would not expect data from that IPMI anyway, let alone an error.

2.5 Metric Collections Consolidator Syntax

Metric collections can have a consolidator format defined per metric. The consolidator definition must be placed as an output in the line immediately preceding the corresponding metric initialization output line. The consolidator definition line can take the following forms:

```
consolidators default
consolidators none
consolidators CONSOLIDATORNAME FORMAT SPECIFICATION
```

The meanings of the texts after `consolidators` are as follows:

- `default`: The metrics follow the default consolidator names and interval values (section 10.7.4, page 409 of the *Administrator Manual*). That is, consolidator names take the value of `Hour`, `Day`, `Week`, while the interval values are the corresponding durations in seconds.
- `consolidators none`: No consolidation is done, only raw data values are collected for the metrics.
- `CONSOLIDATORNAME FORMAT SPECIFICATION`: This has the form:
`<name: interval [:kind [:tablelength]]> . . .`
 - `name`: the consolidator name. A special feature here is that it can also define a new consolidator if the name does not already exist. Multiple consolidators can be defined in each consolidator definition line, with `name` separated from any preceding definition on the same line by a space.
 - `interval`: the duration in seconds, between consolidation, for the consolidator.
 - `kind`: an optional value of `min`, `max`, or `average`. By default it is `average`.
 - `tablelength`: an optional value for the length of the table, if `kind` has been specified. By default it is 1000.

2.6 Metric Collections Environment Variables

The following environment variables are available for a metric collection script, as well as for custom scripts, running from CMDaemon:

On all devices:

`CMD_HOSTNAME`: name of the device. For example:

```
CMD_HOSTNAME=myheadnode
```

Only on non-node devices:

CMD_IP: IP address of the device. For example:

```
CMD_IP=192.168.1.33
```

Only on node devices:

Because these devices generally have multiple interfaces, the single environment variable CMD_IP is often not enough to express these. Multiple interfaces are therefore represented by these environment variables:

- CMD_INTERFACES: list of names of the interfaces attached to the node. For example:

```
CMD_INTERFACES=eth0 eth1 ipmi0 BOOTIF
```

- CMD_INTERFACE_<interface>_IP: IP address of the interface with the name <interface>. For example:

```
CMD_INTERFACE_eth0_IP=10.141.255.254
CMD_INTERFACE_eth1_IP=0.0.0.0
```

- CMD_INTERFACE_<interface>_TYPE: type of interface with the name <interface>. For example:

```
CMD_INTERFACE_eth1_TYPE=NetworkPhysicalInterface
CMD_INTERFACE_ipmi0_TYPE=NetworkBmcInterface
```

Possible values are:

- NetworkBmcInterface
- NetworkPhysicalInterface
- NetworkVLANInterface
- NetworkAliasInterface
- NetworkBondInterface
- NetworkBridgeInterface
- NetworkTunnelInterface
- NetworkNetMapInterface

- CMD_BMCUSERNAME: username for the BMC device at this node (if available).
- CMD_BMCPASSWORD: password for the BMC device at this node (if available).

To parse the above information to get the BMC IP address of the node for which this script samples, one could use (in Perl):

```
my $ip;
my $interfaces = $ENV{"CMD_INTERFACES"};
foreach my $interface ( split( " ", $interfaces ) ) {
    if( $ENV{"CMD_INTERFACE_" . $interface . "_TYPE"} eq
"NetworkBmcInterface" ) {
        $ip = $ENV{"CMD_INTERFACE_" . $interface . "_IP"};
        last;
    }
}
# $ip holds the bmc ip
```


A list of environment variables available under the CMDaemon environment can be found by running a script under CMDaemon and exporting the environment variables to a file for viewing. For example, the `/cm/local/apps/cmd/scripts/healthchecks/testhealthcheck` script can be modified and run to sample on the head node, with the added line: `set>/tmp/environment`. The resulting file `/tmp/environment` that is generated as part of the healthcheck run then includes the `CMD_*` environment variables.

Example

```
CMD_BMCPASSWORD
CMD_BMCUSERNAME
CMD_CLUSTERNAME
CMD_CMDSTARTEDTIME
CMD_DEVICE_TYPE
CMD_EXPORTS
CMD_FSEXPOR__SLASH_cm_SLASH_shared_AT_internalnet_ALLOWWRITE
CMD_FSEXPOR__SLASH_cm_SLASH_shared_AT_internalnet_HOSTS
CMD_FSEXPOR__SLASH_cm_SLASH_shared_AT_internalnet_PATH
CMD_FSEXPOR__SLASH_home_AT_internalnet_ALLOWWRITE
CMD_FSEXPOR__SLASH_home_AT_internalnet_HOSTS
CMD_FSEXPOR__SLASH_home_AT_internalnet_PATH
CMD_FSEXPOR__SLASH_var_SLASH_spool_SLASH_burn_AT_internalnet_ALLOWWRITE
CMD_FSEXPOR__SLASH_var_SLASH_spool_SLASH_burn_AT_internalnet_HOSTS
CMD_FSEXPOR__SLASH_var_SLASH_spool_SLASH_burn_AT_internalnet_PATH
CMD_HOSTNAME
CMD_INTERFACES
CMD_INTERFACE_eth0_IP
CMD_INTERFACE_eth0_MTU
CMD_INTERFACE_eth0_SPEED
CMD_INTERFACE_eth0_STARTIF
CMD_INTERFACE_eth0_TYPE
CMD_INTERFACE_eth1_IP
CMD_INTERFACE_eth1_MTU
CMD_INTERFACE_eth1_SPEED
CMD_INTERFACE_eth1_STARTIF
CMD_INTERFACE_eth1_TYPE
CMD_IP
CMD_MAC
CMD_METRICNAME
CMD_METRICPARAM
CMD_MOUNTS
CMD_NODEGROUPS
CMD_PARTITION
CMD_PORT
CMD_PROTOCOL
CMD_ROLES
CMD_SCRIPTTIMEOUT
CMD_STATUS
CMD_STATUS_CLOSED
CMD_STATUS_HEALTHCHECK_FAILED
CMD_STATUS_HEALTHCHECK_UNKNOWN
CMD_STATUS_MESSAGE
CMD_STATUS_RESTART_REQUIRED
CMD_STATUS_STATEFLAPPING
CMD_STATUS_USERMESSAGE
CMD_SYSINFO_SYSTEM_MANUFACTURER
```

```
CMD_SYSINFO_SYSTEM_NAME
CMD_USERDEFINED1
CMD_USERDEFINED2
```

2.7 Metric Collections Examples

Bright Cluster Manager has several scripts in the `/cm/local/apps/cmd/scripts/metrics` directory. Among them are the metric collections scripts `testmetriccollection` and `sample_responsiveness`. A glance through them while reading this chapter may be helpful.

2.8 Metric Collections On iDataPlex And Similar Units

IBM's iDataPlex is a specially engineered dual node rack unit. When the term iDataPlex is used in the following text in this section, it also implies any other dual node units that show similar behavior.

This section gives details on configuring an iDataPlex if IPMI metrics retrieval seems to skip most IPMI values from one of the nodes in the unit.

When carrying out metrics collections on an iDataPlex unit, Bright Cluster Manager should work without any issues. However, it may be that due to the special paired node design of an iDataPlex unit, most IPMI metrics of one member of the pair are undetectable by the `sample_ipmi` script sampling on that particular node. The missing IPMI metrics can instead be retrieved from the second member in the pair (along with the IPMI metrics of the second member).

The output may thus look something like:

Example

```
[root@master01 ~]# cmsh
[master01]% device latestmetricdata node181 | grep Domain
Metric                               Value
-----
Domain_A_FP_Temp                     23
Domain_A_Temp1                       39
Domain_A_Temp2                       37
Domain_Avg_Power                     140
Domain_B_FP_Temp                     24
Domain_B_Temp1                       40
Domain_B_Temp2                       37
[master01]% device latestmetricdata node182 | grep Domain
Metric                               Value
-----
Domain_A_FP_Temp                     no data
Domain_A_Temp1                       no data
Domain_A_Temp2                       no data
Domain_Avg_Power                     170
Domain_B_FP_Temp                     no data
Domain_B_Temp1                       no data
Domain_B_Temp2                       no data
[master01]%
```

Because there are usually many iDataplex units in the rack, the metrics retrieval response of each node pair in a unit should be checked for this behavior.

The issue can be dealt with by Bright Cluster Manager by modifying the configuration file for the `sample_ipmi` script in `/cm/local/apps/cmd/scripts/metrics/configfiles/sample_ipmi.conf`. Two parameters that can be configured there are `chassisContainsLeadNode` and `chassisContainsLeadNodeRegex`.

- Setting `chassisContainsLeadNode` to `on` forces the `sample_ipmi` script to treat the unit as an iDataPlex unit.

In particular:

- `auto` (recommended) means the unit is checked by the IPMI metric sample collection script for whether it behaves like an iDataPlex unit.
 - `on` means the unit is treated as an iDataPlex node pair, with one node being a lead node that has all the IPMI metrics.
 - `off` means the unit is treated as a non-iDataPlex node pair, with each node having normal behavior when retrieving IPMI metrics. This setting may need to be used in case the default value of `auto` ever falsely detects a node as part of an iDataPlex pair.
- The value of `chassisContainsLeadNodeRegex` can be set to a regular expression pattern that matches the system information pattern for the name, as obtained by `CMDaemon` for an iDataPlex unit (or similar clone unit). The pattern that it is matched against is the output of:

```
cmsh -c 'device ; sysinfo master | grep "^System Name"'
```

If the pattern matches, then the IPMI sample collection script assumes the unit behaves like an iDataPlex dual node pair. The missing IPMI data values are then looked for on the lead node.

The value of `chassisContainsLeadNodeRegex` is set to `iDataPlex` by default.

3

Bright Cluster Manager JSON API

This chapter gives an alphabetical list of the JSON API services and entities available for Bright Cluster Manager. The API reference documentation for all available services and entities is available on the head node at:

`/cm/local/docs/cmd/json/index.html`.

Some examples of JSON use are given in section 3.3

3.1 Services

- 3.1.1 **auth**
- 3.1.2 **ceph**
- 3.1.3 **cert**
- 3.1.4 **cloud**
- 3.1.5 **device**
- 3.1.6 **gui**
- 3.1.7 **hadoop**
- 3.1.8 **job**
- 3.1.9 **keyvalue**
- 3.1.10 **lustre**
- 3.1.11 **main**
- 3.1.12 **mon**
- 3.1.13 **net**
- 3.1.14 **openstack**
- 3.1.15 **part**
- 3.1.16 **proc**
- 3.1.17 **prov**
- 3.1.18 **puppet**
- 3.1.19 **serv**
- 3.1.20 **session**
- 3.1.21 **test**
- 3.1.22 **ticket**
- 3.1.23 **user**

3.2 Entities

- 3.2.1 **BackupRole**

- 3.2.2 **BadEntityManagers**
- 3.2.3 **BasicResource**
- 3.2.4 **BillingHistory**
- 3.2.5 **BootRole**
- 3.2.6 **BurnConfig**
- 3.2.7 **BurnStatus**
- 3.2.8 **BurnTestStatus**
- 3.2.9 **Category**
- 3.2.10 **Ceph**
- 3.2.11 **CephMonitorRole**
- 3.2.12 **CephOSDAssociation**
- 3.2.13 **CephOSDPool**
- 3.2.14 **CephOSDRole**
- 3.2.15 **CephState**
- 3.2.16 **Certificate**
- 3.2.17 **CertificateRequest**
- 3.2.18 **Chassis**
- 3.2.19 **CloudDirectorRole**
- 3.2.20 **CloudGatewayRole**
- 3.2.21 **CloudImage**
- 3.2.22 **CloudJobDescription**
- 3.2.23 **CloudJobSubmissionStatus**
- 3.2.24 **CloudNode**
- 3.2.25 **CloudPrivateCloud**
- 3.2.26 **CloudProvider**
- 3.2.27 **CloudRegion**
- 3.2.28 **CloudSettings**
- 3.2.29 **CloudStaticIP**
- 3.2.30 **CloudStorageAction**
- 3.2.31 **CloudStorageNodeState**
- 3.2.32 **CloudType**
- 3.2.33 **CloudVirtualNetworkInterface**
- 3.2.34 **ClusterSetup**
- 3.2.35 **CMDaemonBackgroundTask**
- 3.2.36 **CMDaemonFailover**
- 3.2.37 **CMDaemonFailoverGroup**
- 3.2.38 **CMDaemonFailoverGroupStatus**
- 3.2.39 **CMDaemonFailoverPeer**
- 3.2.40 **CMDaemonFailoverStatus**
- 3.2.41 **CMDaemonStatus**
- 3.2.42 **CMService**
- 3.2.43 **CondorClientRole**
- 3.2.44 **CondorJob**
- 3.2.45 **CondorJobQueue**
- 3.2.46 **CondorJobQueueStat**
- 3.2.47 **CondorServerRole**
- 3.2.48 **ConfigSum**

- 3.2.49 ConfigurationOverlay
- 3.2.50 ConsolidatorConf
- 3.2.51 DatabaseRole
- 3.2.52 DellClustat
- 3.2.53 DellClustatGroup
- 3.2.54 DellClustatNode
- 3.2.55 DellDiskGroupInfo
- 3.2.56 DellPhysicalDiskDriveInfo
- 3.2.57 DellRAIDControllerInfo
- 3.2.58 DellSettings
- 3.2.59 DellSettingsFirmware
- 3.2.60 DellSettingsNicDevice
- 3.2.61 DellStorageInfo
- 3.2.62 DellVirtualDiskInfo
- 3.2.63 Device
- 3.2.64 DevStatus
- 3.2.65 DiskAssertion
- 3.2.66 DiskDevice
- 3.2.67 DiskInfo
- 3.2.68 DiskPartition
- 3.2.69 DiskRaid
- 3.2.70 DiskSetup
- 3.2.71 DiskVolume
- 3.2.72 DiskVolumeGroup
- 3.2.73 DrainResult
- 3.2.74 EBSattachAction
- 3.2.75 EBSdetachAction
- 3.2.76 EC2AMI
- 3.2.77 EC2AvailabilityZone
- 3.2.78 EC2EBSStorage
- 3.2.79 EC2EphemeralStorage
- 3.2.80 EC2PrivateCloud
- 3.2.81 EC2Provider
- 3.2.82 EC2Region
- 3.2.83 EC2RegionAMI
- 3.2.84 EC2Settings
- 3.2.85 EC2StaticIP
- 3.2.86 EC2Storage
- 3.2.87 EC2Type
- 3.2.88 EC2VirtualNetworkInterface
- 3.2.89 EntityManagersMD5
- 3.2.90 EthernetSwitch
- 3.2.91 FailoverRole
- 3.2.92 FakeData
- 3.2.93 FSExport
- 3.2.94 FSMount
- 3.2.95 FSPart

- 3.2.96 FSPartAssociation
- 3.2.97 FSPartBasicAssociation
- 3.2.98 FSPartProviderAssociation
- 3.2.99 GenericDevice
- 3.2.100 GenericResource
- 3.2.101 GPUInfo
- 3.2.102 GPUSettings
- 3.2.103 GpuUnit
- 3.2.104 GPUUnitInfo
- 3.2.105 GridEngineJob
- 3.2.106 GridEngineJobQueue
- 3.2.107 GridEngineJobQueueStat
- 3.2.108 GridEngineParallelEnvironment
- 3.2.109 Group
- 3.2.110 GuiCephOsdPoolInfo
- 3.2.111 GuiCephOverview
- 3.2.112 GuiCephPgslInfo
- 3.2.113 GuiClusterOverview
- 3.2.114 GuiCompleteOpenStackOverview
- 3.2.115 GuiDiskUsage
- 3.2.116 GuiGpuUnitOverview
- 3.2.117 GuiHadoopHDFSDetailHBase
- 3.2.118 GuiHadoopHDFSDetailHDFS
- 3.2.119 GuiHadoopHDFSDetailMapreduce
- 3.2.120 GuiHadoopHDFSDetailSpark
- 3.2.121 GuiHadoopHDFSDetailYarn
- 3.2.122 GuiHadoopHDFSDetailZooKeeper
- 3.2.123 GuiHadoopHDFSOverview
- 3.2.124 GuiJob
- 3.2.125 GuiNetSwitchStatus
- 3.2.126 GuiNetworkInterface
- 3.2.127 GuiNodeOverview
- 3.2.128 GuiNodeStatus
- 3.2.129 GuiOpenStackOverview
- 3.2.130 GuiOpenStackProjectOverview
- 3.2.131 GuiOpenStackTenantOverview
- 3.2.132 GuiPDUBank
- 3.2.133 GuiPDUOutlet
- 3.2.134 GuiWorkload
- 3.2.135 HadoopBaseConfiguration
- 3.2.136 HadoopDataNodeHDFSConfiguration
- 3.2.137 HadoopDataNodeRole
- 3.2.138 HadoopHBaseClientHDFSConfiguration
- 3.2.139 HadoopHBaseClientRole
- 3.2.140 HadoopHBaseServerHDFSConfiguration
- 3.2.141 HadoopHBaseServerRole
- 3.2.142 HadoopHDFS

- 3.2.143 HadoopHiveHDFSConfiguration
- 3.2.144 HadoopHiveRole
- 3.2.145 HadoopJob
- 3.2.146 HadoopJobQueue
- 3.2.147 HadoopJobQueueStat
- 3.2.148 HadoopJobTrackerHDFSConfiguration
- 3.2.149 HadoopJobTrackerRole
- 3.2.150 HadoopJournalHDFSConfiguration
- 3.2.151 HadoopJournalRole
- 3.2.152 HadoopKMServerHDFSConfiguration
- 3.2.153 HadoopKMServerRole
- 3.2.154 HadoopNameNodeHDFSConfiguration
- 3.2.155 HadoopNameNodeRole
- 3.2.156 HadoopNFSGatewayHDFSConfiguration
- 3.2.157 HadoopNFSGatewayRole
- 3.2.158 HadoopSecondaryNameNodeHDFSConfiguration
- 3.2.159 HadoopSecondaryNameNodeRole
- 3.2.160 HadoopSparkMasterHDFSConfiguration
- 3.2.161 HadoopSparkMasterRole
- 3.2.162 HadoopSparkWorkerHDFSConfiguration
- 3.2.163 HadoopSparkWorkerRole
- 3.2.164 HadoopSparkYARNHDFSConfiguration
- 3.2.165 HadoopSparkYARNRole
- 3.2.166 HadoopSqoopHDFSConfiguration
- 3.2.167 HadoopSqoopRole
- 3.2.168 HadoopTaskTrackerHDFSConfiguration
- 3.2.169 HadoopTaskTrackerRole
- 3.2.170 HadoopYARNClientHDFSConfiguration
- 3.2.171 HadoopYARNClientRole
- 3.2.172 HadoopYARNServerHDFSConfiguration
- 3.2.173 HadoopYARNServerRole
- 3.2.174 HadoopZooKeeperHDFSConfiguration
- 3.2.175 HadoopZooKeeperRole
- 3.2.176 HAProxyBackendInformation
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- 3.2.179 HAProxyFrontendInformation
- 3.2.180 HAProxyNodeInformation
- 3.2.181 HAProxyRole
- 3.2.182 HAProxyServer
- 3.2.183 HAProxySharedSettings
- 3.2.184 HealthCheck
- 3.2.185 HeatMapData
- 3.2.186 IBSwitch
- 3.2.187 IniConfigFileCustomizationEntry
- 3.2.188 IPCPerm
- 3.2.189 IPResource

3.2.190 Job
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3.2.192 JobQueuePlaceholder
3.2.193 JobQueueStat
3.2.194 KernelModule
3.2.195 KeyValuePair
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3.2.199 LSFBaseJob
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3.2.201 LSFBaseJobQueueStat
3.2.202 LSFClientRole
3.2.203 LSFJob
3.2.204 LSFJobQueue
3.2.205 LSFJobQueueStat
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3.2.233 MonGlobalConf
3.2.234 MonHealthConf
3.2.235 MonitoringRole
3.2.236 MonMetricConf

- 3.2.237 **MsgQueue**
- 3.2.238 **MyrinetSwitch**
- 3.2.239 **Network**
- 3.2.240 **NetworkAliasInterface**
- 3.2.241 **NetworkBmcInterface**
- 3.2.242 **NetworkBondInterface**
- 3.2.243 **NetworkBridgeInterface**
- 3.2.244 **NetworkInterface**
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- 3.2.249 **NewNode**
- 3.2.250 **NFSexportAction**
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- 3.2.255 **NodeCategory**
- 3.2.256 **NodeGroup**
- 3.2.257 **OpenLavaClientRole**
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3.2.308 **OpenStackImageBackendFS**
3.2.309 **OpenStackImageRegistryRole**
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3.2.311 **OpenStackNetworkApiRole**
3.2.312 **OpenStackNetworkRole**
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3.2.316 **OpenStackNovalImageBackendCow**
3.2.317 **OpenStackObjectAccountRole**
3.2.318 **OpenStackObjectApiRole**
3.2.319 **OpenStackObjectContainerRole**
3.2.320 **OpenStackObjectStoreRole**
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- 3.2.356 **OsapiSecurityGroupRule**
- 3.2.357 **OsapiSubnetAllocationPool**
- 3.2.358 **OSService**
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- 3.2.360 **OSServiceConfig**
- 3.2.361 **Partition**
- 3.2.362 **PBSJob**
- 3.2.363 **PBSJobQueue**
- 3.2.364 **PBSJobQueueStat**
- 3.2.365 **PbsProClientRole**
- 3.2.366 **PbsProJob**
- 3.2.367 **PbsProJobQueue**
- 3.2.368 **PbsProJobQueueStat**
- 3.2.369 **PbsProServerRole**
- 3.2.370 **PDUPort**
- 3.2.371 **PhysicalNode**
- 3.2.372 **PowerDistributionUnit**
- 3.2.373 **PowerStatus**
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- 3.2.375 **Processor**
- 3.2.376 **Profile**
- 3.2.377 **ProgramRunnerInput**

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3.2.380 ProgramRunnerStatus
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3.2.385 ProvisioningStatus
3.2.386 Puppet
3.2.387 PuppetApplyResult
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3.2.397 ReadMonDataOutput
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3.2.413 Sensor
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3.2.416 SGEJob
3.2.417 SGEJobQueue
3.2.418 SGEJobQueueStat
3.2.419 SGEParallelEnvironment
3.2.420 SGEServerRole
3.2.421 SharedMemory
3.2.422 SlaveMonotonicElem
3.2.423 SlaveMonSnapshot
3.2.424 SlaveNode

3.2.425 SlaveRateElem
3.2.426 SlurmClientRole
3.2.427 SlurmJob
3.2.428 SlurmJobQueue
3.2.429 SlurmJobQueueStat
3.2.430 SlurmServerRole
3.2.431 SoftwareImage
3.2.432 SoftwareImageProxy
3.2.433 StartStorageNodeAction
3.2.434 StateElem
3.2.435 StaticRoute
3.2.436 StatisticData
3.2.437 StopStorageNodeAction
3.2.438 StorageNodePolicy
3.2.439 StorageRole
3.2.440 StringListObject
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3.3 JSON Examples

complete.sh

```
#!/bin/bash

URL=https://localhost:2081/json/
user=koen
pass=koen

echo "===== login ====="
curl -c curl.cookiest.txt -i -k -X POST -d '{"service":"login", \
"username":"koen", "password":"' $pass'"}' $URL; echo
echo "===== master ====="
curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"cm\
device", "call":"getNode", "arg":"master"}' $URL; echo
echo "===== logout ====="
curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"lo\
gout"}' $URL; echo
echo "===== denied ====="
curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"cm\
device", "call":"getNode", "arg":"master"}' $URL; echo
rm -f curl.cookiest.txt

echo "===== cert ====="
curl --cert $HOME/.cm/admin.pem --key $HOME/.cm/admin.key -i -k \
-X POST -d '{"service":"cmdevice", "call":"getNode", "arg":"master\
"}' $URL; echo
```

curl.sh

```
#!/bin/bash

source url
if [ -z "$1" ]; then
    pass=koen
else
    pass=$1
fi
read -p "pass: " -s -a $pass

curl -c curl.cookiest.txt -i -k -X POST -d '{"service":"login", \
"username":"koen", "password":"' $pass'"}' $URL

# curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"\
cmsession", "call":"getLastEvents", "args":[0,256]}' $URL

curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"cm\
main", "call":"getProfile"}' $URL
curl --cookie curl.cookiest.txt -i -k -X POST -d '{"service":"cm\
main", "call":"getSubjectName"}' $URL
```

devices.sh

```
#!/bin/bash
source url

if [ "$1" == "gzip" ]; then
```

```

    wget --load-cookies cookie.txt --header='Accept-Encoding: gzip\
' --no-check-certificate --server-response -qO- $URL --post-dat\
a='{"service":"cmdevice","call":"getDevices"}'
else
    wget --load-cookies cookie.txt --no-check-certificate --server\
-response -qO- $URL --post-data='{"service":"cmdevice","call":"g\
etDevices"}'
fi

```

loadone.sh

```

#!/bin/bash
source url

# not perfect but gets the job done
function jsonval {
    temp=`echo $json | sed 's/\\\\\\\\/\\/g' | sed 's/[{}]/g' | awk\
-v k="text" '{n=split($0,a,","); for (i=1; i<=n; i++) print a[i\
]}' | sed 's/\"\\:\\"/\\/g' | sed 's/[\\,]/ /g' | sed 's/\"/\"/g' | g\
rep -w $prop`
    r=$(echo ${temp##*|} | tr ']' ' ' | tr ' ' '\n' | cut -d: -f2 \
| sort -n)
    echo $(echo $r | cut -d' ' -f 1)
}

prop='uniqueKey'

node=master
json=`wget --load-cookies cookie.txt --no-check-certificate --se\
rver-response -qO- $URL --post-data='{"service":"cmdevice","call\
":"getDevice","arg1":"' $node' }'`
nkey=$(jsonval)
if [ -z $nkey ]; then
    echo $json
    exit 1
fi
echo "$node.uniqueKey = $nkey"

json=`wget --load-cookies cookie.txt --no-check-certificate --se\
rver-response -qO- $URL --post-data='{"service":"cmmon","call": "\
getMetric","arg1":"loadOne"}'`
mkey=$(jsonval)
echo "loadone.uniqueKey = $mkey"

now=$(date +%s)
day=$((now-86400))

# echo -----
# wget --load-cookies cookie.txt --no-check-certificate --server\
-response -qO- $URL \
# --post-data='{"service":"cmmon","call":"readDataByIntervalNu\
m",
# "readMonDataIdArray":[{"devId":"' $nkey', "metric\
Id":"' $mkey',

```

```

#                                     "begTime": '$day', "endTi\
me": '$now' }},
#                                     "intervalNum": 0}'
#
# echo
echo -----
wget --load-cookies cookie.txt --no-check-certificate --server-r\
esponse -qO- $URL \
  --post-data='{ "service": "cmmon", "call": "readDataByIntervalNum",
                "args": [ [ { "baseType": "ReadMonDataId", "uniqueKey"\
: 0, "modified": false, "toBeRemoved": false, "childType": "",
                            "devId": '$nkey', "metricId": '$mkey',
                            "begTime": '$day', "endTime": '$now' } ], 0 ] }'

# echo
# echo -----
# data='{ "service": "cmmon", "call": "readDataByIntervalNum",
#        "args": [ [ { "baseType": "ReadMonDataId", "uniqueKe\
y": 0, "modified": false, "toBeRemoved": false, "childType": "",
                    "devId": '$nkey', "metricId": '$mkey',
                    "begTime": '$day', "endTime": '$now' } ], \
0 ] }'
# rm loadone.txt.gz
# echo $data > loadone.txt
# gzip -n loadone.txt
# len=$(wc -c loadone.txt.gz | cut -d" " -f1)
# wget --load-cookies cookie.txt --no-check-certificate --header\
"Content-Length: $len" --header 'Content-Encoding: gzip' --serv\
er-response -O- $URL \
#   --post-file=loadone.txt.gz

```

login.sh

```

#!/bin/bash
source url
user=$USER
pass=$user
wget --keep-session-cookies --save-cookies cookie.txt --no-check\
-certificate --server-response -qO- $URL \
  --post-data='{ "service": "login", "username": "'$user'", "passwor\
d": "'$pass' }'
echo

```

logout.sh

```

#!/bin/bash
source url
wget --load-cookies cookie.txt --no-check-certificate --server-r\
esponse -qO- $URL --post-data='{ "service": "logout" }'
rm cookie.txt
echo

```

node001.sh

```

#!/bin/bash
source url

```

```
if [ -z "$1" ]; then
    node=node001
else
    node=$1
fi

wget --load-cookies cookie.txt --no-check-certificate --server-r\
esponse -qO- $URL --post-data='{ "service": "cmdevice", "call": "get\
Device", "arg1": "' $node' "}'
```