

xCAT 2 on AIX

Using xCAT Service Nodes with AIX

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1.0 Overview

Note: The support described below requires xCAT version 2.2 or greater.

In an xCAT cluster the single point of control is the xCAT *management node*. However, in order to provide sufficient scaling and performance for large clusters, it may also be necessary to have additional servers to help handle the deployment and management of the cluster nodes. In an xCAT cluster these additional servers are referred to as *service nodes*.

For an xCAT on AIX cluster there is a primary NIM master which is typically on the management node. The service nodes are configured as additional NIM masters. All commands are run on the management node. The xCAT support automatically handles the setup of the low level service nodes and the distribution of the NIM resources. All installation resources for the cluster are managed from the primary NIM master. The NIM resources are automatically replicated on the low level masters when they are needed.

You can set up one or more service nodes in an xCAT cluster. The number you need will depend on many factors including the number of nodes in the cluster, the type of node deployment, the type of network etc. (As a general “rule of thumb” you should plan on having at least 1 service node per 128 cluster nodes.)

A service node may also be used to run user applications in most cases.

An xCAT service node must be installed with xCAT software as well as additional prerequisite software. See the section “Contents of xCATaixSN.bnd and xCATaixSSH.bnd” below for a list of the software that is required for AIX service nodes.

When using service nodes you must switch to a database that supports remote access. As a convenience, version 5.0 of the MySQL database is included in the `xcat-mysql-<version>.tar.gz` tar file that is available from the xCAT download site. This and other versions of MySQL are also available directly from the MySQL web site. (See <http://dev.mysql.com/downloads/mysql/5.1.html#aix>)

This document describes the process for setting up AIX service nodes and using them to deploy cluster nodes. The cluster nodes will be System p logical partitions.

AIX service nodes must be diskfull systems. Diskless xCAT service nodes are not currently supported for AIX.

In the process described below the service nodes will be deployed using a standard AIX/NIM “rte” network installation. If you are using multiple service nodes you may want to consider creating a “golden” **mksysb** image that you can use as a common image for all the service nodes. See the xCAT document named “Cloning AIX nodes (using an AIX mksysb image)” for more information on using **mksysb** images. (<http://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2onAIXmksysb.pdf>)

In this document it is assumed that the cluster nodes will be diskless. The cluster nodes will be deployed using a common diskless image. It is also possible to deploy the cluster nodes using “rte” or “mksysb” type installs.

Before starting this process it is assumed you have configured an xCAT management node by following the process described in the “xCAT2onAIX” overview document. (<http://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2onAIX.pdf>)

The process described below also assumes that System p LPARs for the cluster have already been defined using the standard HMC interfaces. At a minimum you need to define the partitions to use for your diskfull service nodes and at least one diskless partition (per CEC). The additional diskless partitions can be defined later in the process using the xCAT **mkvm** command if desired.

When defining the LPARs there are a couple things to keep in mind that may help with the rest of the cluster deployment.

1. When configuring an LPAR it would be advisable to use the host name you will want to use for the node as the LPAR name. When you run the xCAT **rscan** command in the process described below the default host name used for the node definitions will be the LPAR names.

2. It would also be advisable to use an LPAR naming convention that is representative of the cluster organization. For example, you might want to use “sn” in the names of the service node LPARs or “cn” in the cluster node LPARs or some other naming convention that helps keep track of a nodes characteristics etc.

2.0 Additional configuration of the management node

2.1 Switch to the MySQL database

The xCAT support for Service Nodes requires a database with remote access capabilities. The MySQL database is provided for this purpose.

See the “xCAT 2.1 MySQL Setup” document for details on installing, configuring and migrating to MySQL.

<http://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2.SetupMySQL.pdf>

Note: Make sure you add MySQL access for each of your service nodes.

3.0 Install the Service Nodes

3.1 Define the HMCs as xCAT nodes

The xCAT hardware control support requires that the hardware control point for the nodes also be defined as a cluster node.

The following example will create an xCAT node definition for an HMC with a host name of “hmc01”. The *groups*, *nodetype*, *mgt*, *username*, and *password* attributes must be set.

```
mkdef -t node -o hmc01 groups="all" nodetype=hmc mgt=hmc
username=hscroot password=abc123
```

3.2 Discover the LPARs managed by the HMCs

This step assumes that the partitions are already created using the standard HMC interfaces.

Use the **rscan** command to gather the LPAR information. This command can be used to display the LPAR information in several formats and can also write the LPAR information directly to the xCAT database. In this example we will use the “-z” option to create a stanza file that contains the information gathered by **rscan** as well as some default values that could be used for the node definitions.

To write the stanza format output of **rscan** to a file called “*mystanzafile*” run the following command.

```
rscan -z hmc01 > mystanzafile
```

The file will contain stanzas for all the LPARs that have been configured as well as some additional information that must also be defined in the xCAT database. It is not necessary to modify the non-LPAR stanzas in any way.

This file can then be checked and modified as needed. For example you may need to add a different name for the node definition or add additional attributes and values.

Since we are using service nodes there are several values that **must be set** for the node definitions. **You can set these values later, after the nodes have been defined, or you can modify the stanzas to include the values now.** (If you have many nodes it would be easier to do this later.)

For service nodes:

- Add “service” to the “groups” attribute of all the service nodes.
- The “setupnameserver” attribute of the service nodes must be explicitly set to “yes” or “no”. (Ex. “setupnameserver=no”)

For non-service nodes:

- Add the name of the service node for a node to the node definition. (Ex. “servicenode=xcatSN01”) This is the name of the service node as it is known by the management node.
- Set the “xcatmaster” attribute. This must be the name of the service node as it is known by the node. This may or may not be the same value as the “servicenode “ attribute.

Note: if the “servicenode” and “xcatmaster” values are not set then xCAT will default to use the value of the “master” attribute in the xCAT “site” definition.

The updated stanzas might look something like the following.

```
cl2sn01:
  objtype=node
  nodetype=lp,osi
  id=9
  hcp=hmc01
  pprofile=lp,9
  parent=Server-9117-MMA-SN10F6F3D
  groups=all,service
  setupnameserver=no
  mgt=hmc
```

```
cl2cn27:
  objtype=node
  nodetype=lp,osi
  servicenode=cl2sn01           # name of service node as
known by the                   #management node
  xcatmaster=cl2sn01-en1       # name of the service node as
known by the                   #node
  id=7
  hcp=hmc01
```

```
pprofile=lpar6
parent=Server-9117-MMA-SN10F6F3D
groups=all
mgt=hmc
```

```
Server-9117-MMA-SN10F6F3D:
objtype=node
nodetype=fsp
id=5
model=9118-575
serial=02013EB
hcp=hmc01
pprofile=
parent=Server-9458-10099201WM_A
groups=fsp,all
mgt=hmc
```

Note: The **rscan** command supports an option to automatically create node definitions in the xCAT database. To do this the LPAR name gathered by **rscan** is used as the node name and the command sets several default values. If you use the “-w” option make sure the LPAR name you defined will be the name you want used as your node name.

3.3 Define xCAT service nodes

The information gathered by the **rscan** command can be used to create xCAT node definitions.

Since we have put all the node information in a stanza file we can now pass the contents of the file to the **mkdef** command to add the definitions to the database. The stanza file will include any LPARs that were already created so it may include nodes other than just the service nodes.

```
cat mystanzafile | mkdef -z
```

You can use the xCAT **lsdef** command to check the definitions (ex. “**lsdef -l node01**”). After the node has been defined you can use the **chdef** command to make additional updates to the definitions, if needed.

Make sure the node attributes required for service nodes support are set as mentioned in the previous step. For example to set the required attributes for service node “cl2sn01” you could run the following.

```
chdef -t node -o cl2sn01 -p groups=service setupnameserver=no
```

3.4 Add IP addresses and hostnames to /etc/hosts

Make sure all node hostnames are added to /etc/hosts. Refer to the section titled “Add cluster nodes to the /etc/hosts file” in the following document for details.

<https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2onAIX.odt>)

3.5 Create a Service Node operating system image

Use the xCAT **mknimimage** command to create an xCAT *osimage* definition as well as the required NIM installation resources.

An xCAT *osimage* definition is used to keep track of a unique operating system image and how it will be deployed.

In order to use NIM to perform a remote network boot of a cluster node the NIM software must be installed, NIM must be configured, and some basic NIM resources must be created.

The **mknimimage** will handle all the NIM setup as well as the creation of the xCAT *osimage* definition. It will not attempt to reinstall or reconfigure NIM if that process has already been completed. See the **mknimimage man** page for additional details.

Note: If you wish to install and configure NIM manually you can run the AIX **nim_master_setup** command (Ex. “*nim_master_setup -a mk_resource=no -a device=<source directory>*”).

By default, the **mknimimage** command will create the NIM resources in subdirectories of `/install`. Some of the NIM resources are quite large (1-2G) so it may be necessary to increase the file size limit.

For example, to set the file size limit to “unlimited” for the user “root” you could run the following command.

```
/usr/bin/chuser fsize=-1 root
```

When you run the command you must provide a source for the installable images. This could be the AIX product media, a directory containing the AIX images, or the name of an existing NIM *lpp_source* resource. You must also provide a name for the *osimage* you wish to create. This name will be used for the NIM SPOT resource that is created as well as the name of the xCAT *osimage* definition. The naming convention for the other NIM resources that are created is the *osimage* name followed by the NIM resource type, (ex. “*61cosi_lpp_source*”).

In this example we need resources for installing a NIM “standalone” type machine using the NIM “rte” install method. (This type and method are the defaults for the **mknimimage** command but you can specify other values on the command line.)

For example, to create an *osimage* named “610SNimage” using the images contained in the `/myimages` directory you could issue the following command.

```
mknimimage -s /myimages 610SNimage
```

(Creating the NIM resources could take a while!)

Note: To populate the */myimages* directory you could copy the software from the AIX product media using the AIX *gencopy* command. For example you could run “*gencopy -U -X -d /dev/cd0 -t /myimages all*”.

By default the command will create NIM *lpp_source*, *spot*, and *bosinst_data* resources. You can also specify alternate or additional resources on the command line using the “*attr=value*” option, (“<nim resource type>=<resource name>”).

For example:

```
mknimimage -s /dev/cd0 610SNimage resolv_conf=my_resolv_conf
```

Any additional NIM resources specified on the command line must be previously created using NIM interfaces. (Which means NIM must already have been configured previously.)

Note: Another alternative is to run **mknimimage** without the additional resources and then simply add them to the xCAT *osimage* definition later. You can add or change the *osimage* definition at any time. When you initialize and install the nodes xCAT will use whatever resources are specified in the *osimage* definition.

When the command completes it will display the *osimage* definition which will contain the names of all the NIM resources that were created. The naming convention for the NIM resources that are created is the *osimage* name followed by the NIM resource type, (ex. “*610SNimage_lpp_source*”), except for the SPOT name. The default name for the SPOT resource will be the same as the *osimage* name.

The xCAT *osimage* definition can be listed using the **lsdef** command, modified using the **chdef** command and removed using the **rmnimimage** command. See the man pages for details.

In some cases you may also want to modify the contents of the NIM resources. For example, you may want to change the *bosinst_data* file or add to the *resolv_conf* file etc. For details concerning the NIM resources refer to the NIM documentation.

You can list NIM resource definitions using the AIX **lsnim** command. For example, if the name of your SPOT resource is “*610SNimage*” then you could get the details by running:

```
lsnim -l 610SNimage
```

To see the actual contents of a NIM resource use “*nim -o showres <resource name>*”. For example, to get a list of the software installed in your SPOT you could run:

```
nim -o showres 610SNimage
```

Note: The **mknimimage** command will take care of the NIM installation and configuration automatically, however, you can also do this using the standard AIX support. See the AIX documentation for details on using the **nim_master_setup** command or the SMIT “*eznim*” interface.

3.6 Add required service node software

An xCAT AIX service node must also be installed with additional software.

To simplify this process xCAT includes the required xCAT and open source software in the `core-aix-<version>.tar.gz` and `dep-aix-<version>.tar.gz` tar files. You will also need the `openssl` and `openssh` software that was installed on the management node.

The required software must be copied to the NIM `lpp_source` that is being used for this OS image. The easiest way to do this is to use the “`nim -o update`” command.

For example, assume all the required software has been copied and unwrapped in the `/tmp/images` directory.

To add all the packages to our `lpp_source` resource, you can run the following:

```
nim -o update -a packages=all -a source=/tmp/images 610SNimage_lpp_source
```

The NIM command will find the correct directories and update the `lpp_source` resource.

To get this additional software installed we need a way to tell NIM to include it. To facilitate this, xCAT provides two AIX installp bundle files. The files are included in the `core-aix-<version>.tar.gz` file.

To use the bundle files you need to define them as NIM resources and add them to the xCAT `osimage` definition.

Copy the bundle files (`xCATaixSN.bnd` and `xCATaixSSH.bnd`) to a location where they can be defined as a NIM resource, for example “`/install/nim/installp_bundle`”.

Note: AIX has recently started shipping `expect`, `tcl`, and `tk` software with base AIX. If the version of AIX you are using has these installed you should not attempt to install the corresponding RPM packages contained in the xCAT `dep-aix-<version>.tar.gz` file. You can check for this by running “`lspp -i expect.base`”. If it is installed then you should either remove the `tcl`, `tk`, and `expect` rpms from the `xCATaixSN.bnd` file or use the `xCATaixSN2.bnd` file.

To define the NIM resources you can run the following commands.

```
nim -o define -t installp_bundle -a server=master -a  
location= /install/nim/installp_bundle/xCATaixSN.bnd  
xCATaixSN
```

```
nim -o define -t installp_bundle -a server=master -a  
location=  
/install/nim/installp_bundle/xCATaixSSH.bnd  
xCATaixSSH
```

To add these bundle resources to your xCAT `osimage` definition run:

```
chdef -t osimage -o 610SNimage  
installp_bundle="xCATaixSN,xCATaixSSH"
```

Note: Make sure the xCATaixSN comes first! There is a temporary issue with the AIX openssh installp package that requires that it be done in a separate bundle file that comes after the xCATaixSN bundle (which contains the openssh dependency.).

3.7 Define xCAT networks

Create an xCAT network definition for each network that contains cluster nodes. You will need a name for the network and values for the following attributes.

net The network address.
mask The network mask.
gateway The network gateway.

In our example we will assume that all the cluster node management interfaces and the xCAT management node interface are on the same network. You can use the xCAT **mkdef** command to define the network.

For example:

```
mkdef -t network -o net1 net=9.114.0.0 mask=255.255.255.224  
gateway=9.114.113.254
```

Note: The xCAT definition should correspond to the NIM network definition. If multiple cluster subnets are needed then you will need an xCAT and NIM network definition for each one.

3.8 Create additional NIM network definitions (optional)

For the processes described in this document we are assuming that the xCAT management node and the LPARs are all on the same network.

However, depending on your specific situation, you may need to create additional NIM network and route definitions.

NIM network definitions represent the networks used in the NIM environment. When you configure NIM, the primary network associated with the NIM master is automatically defined. You need to define additional networks only if there are nodes that reside on other local area networks or subnets. If the physical network is changed in any way, the NIM network definitions need to be modified.

The following is an example of how to define a new NIM network using the NIM command line interface.

Step 1

Create a NIM network definition. Assume the NIM name for the new network is “clstr_net”, the network address is “10.0.0.0”, the network mask is “255.0.0.0”, and the default gateway is “10.0.0.247”.

```
nim -o define -t ent -a net_addr=10.0.0.0 -a snm=255.0.0.0 -a  
routing1='default 10.0.0.247' clstr_net
```

Step 2

Create a new interface entry for the NIM “master” definition. Assume that the next available interface index is “2” and the hostname of the NIM master is “xcataixmn”. This must be the hostname of the management node interface that is connected to the “clstr_net” network.

```
nim -o change -a if2='clstr_net xcataixmn 0' -a cable_type2=N/A master
```

Step 3

Create routing information so that NIM knows how to get from one network to the other. Assume the next available routing index is “2”, and the IP address of the NIM master on the “master_net” network is “8.124.37.24”. Assume the IP address on the NIM master on the “clstr_net” network is “10.0.0.241”. This command will set the route from “master_net” to “clstr_net” to be “10.0.0.241” and it will set the route from “clstr_net” to “master_net” to be “8.124.37.24”.

```
nim -o change -a routing2='master_net 10.0.0.241 8.124.37.24'  
clstr_net
```

Step 4

Verify the definitions by running the following commands.

```
lsnim -l master
```

```
lsnim -l master_net
```

```
lsnim -l clstr_net
```

See the NIM documentation for details on creating additional network and route definitions. (*IBM AIX Installation Guide and Reference*. <http://www-03.ibm.com/servers/aix/library/index.html>)

3.9 Define an xCAT “service” group

If you did not already create the xCAT “service” group when you defined your nodes then you can do it now using the **mkdef** or **chdef** command.

There are two basic ways to create xCAT node groups. You can either set the “groups” attribute of the node definition or you can create a group directly.

You can set the “groups” attribute of the node definition when you are defining the node with the **mkdef** command or you can modify the attribute later using the **chdef** command. For example, if you want to create the group called “service” with the members *sn01* and *sn02* you could run **chdef** as follows.

```
chdef -t node -p -o sn01,sn02 groups=service
```

The “-p” option specifies that “service” be added to any existing value for the “groups” attribute.

The second option would be to create a new group definition directly using the **mkdef** command as follows.

```
mkdef -t group -o service members="sn01,sn02"
```

These two options will result in exactly the same definitions and attribute values being created.

3.10 Include customization scripts

xCAT supports the running of customization scripts on the nodes when they are installed.

This support includes:

- The running of a set of default customization scripts that are required by xCAT.

You can see what scripts xCAT will run by default by looking at the “xcatdefaults” entry in the xCAT “postscripts” database table. (I.e. Run “tabdump postscripts”). You can change the default setting by using the xCAT **chtab** or **tabedit** command. The scripts are contained in the /install/postscripts directory on the xCAT management node.

- The optional running of customization scripts provided by xCAT.

There is a set of xCAT customization scripts provided in the /install/postscripts directory that can be used to perform optional tasks such as additional adapter configuration.

- The optional running of user-provided customization scripts.

To have your script run on the nodes:

1. Put a copy of your script in /install/postscripts on the xCAT management node. (Make sure it is executable.)
2. **When using service nodes make sure the postscripts are copied to the /install/postscripts directories on each service node.**
3. Set the “postscripts” attribute of the node definition to include the comma separated list of the scripts that you want to be executed on the nodes. The order of the scripts in the list determines the order in which they will be run. For example, if you want to have your two scripts called “foo” and “bar” run on node “node01” you could use the **chdef** command as follows.

```
chdef -t node -o node01 -p postscripts=foo,bar
```

(The “-p” means to add these to whatever is already set.)

Note: The customization scripts are run during the boot process (out of /etc/inittab).

3.10.1 Add “servicnode” script for service nodes

You must add the “servicnode” script to the *postscripts* attribute of all the service node definitions. To do this you could modify each node definition individually or you could simply modify the definition of the “service” group.

For example, to have the “servicnode” postscript run on all nodes in the group called “service” you could run the following command.

```
chdef -p -t group service postscripts=servicnode
```

3.10.2 Add NTP setup script (optional)

To have xCAT automatically set up ntp on the cluster nodes you must add the **setupntp** script to the list of postscripts that are run on the nodes.

To do this you can either modify the “postscripts” attribute for each node individually or you can just modify the definition of a group that all the nodes belong to.

For example, if all your nodes belong to the group “compute” then you could add **setupntp** to the group definition by running the following command.

```
chdef -p -t group -o compute postscripts=setupntp
```

3.10.3 Add secondary adapter configuration script

It is possible to have additional adapter interfaces automatically configured when the nodes are booted. XCAT provides sample configuration scripts for both Ethernet and IB adapters. These scripts can be used as-is or they can be modified to suit your particular environment. The Ethernet sample is `/install/postscript/configeth`. When you have the configuration script that you want you can add it to the “postscripts” attribute as mentioned above. Make sure your script is in the `/install/postscripts` directory and that it is executable.

If you wish to configure IB interfaces please refer to: “xCAT 2 InfiniBand Support” <https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2IBsupport.odt>

3.11 Gather MAC information for the install adapters.

Use the xCAT **getmacs** command to gather adapter information from the nodes. This command will return the MAC information for each Ethernet adapter available on the target node. The command can be used to either display the results or write the information directly to the database. If there are multiple adapters the first one will be written to the database.

The command can also be used to do a ping test on the adapter interfaces to determine which ones could be used to perform the network boot. In this case the first adapter that can be successfully used to ping the server will be written to the database.

Before running **getmacs** you must first run the **makeconsvercf** command. You need to run **makeconsvercf** any time you add new nodes to the cluster.

makeconsvercf

Shut down all the nodes that you will be querying for MAC addresses.

rpower aixnodes off

To retrieve the MAC address for all the nodes in the group “*aixnodes*” and write the first adapter MAC to the xCAT database you could issue the following command.

getmacs aixnodes

To display all adapter information but not write anything to the database.

getmacs -d aixnodes

To retrieve the MAC address and do a ping test to determine which adapter MAC to use for the node you could issue the following command. (The ping operation may take a while to complete.)

getmacs -d aixnodes -S 10.14.0.2 -G 10.14.0.2 -C 10.14.0.4

The output would be similar to the following.

```
# Type Location Code MAC Address Full Path Name Ping Result Device Type
ent U9125.F2A.024C362-V6-C2-T1 fe9dfb7c602 /vdevice/l-lan@30000002 successful
virtual
ent U9125.F2A.024C362-V6-C3-T1 fe9dfb7c603 /vdevice/l-lan@30000003 unsuccessful virtual
```

From this result you can see that “*fe9dfb7c602*” should be used for this nodes MAC address.

For more information on using the **getmacs** command see the man page.

3.12 Create NIM client & group definitions

You can use the xCAT **xcat2nim** command to automatically create NIM machine and group definitions based on the information contained in the xCAT database. By doing this you synchronize the NIM and xCAT names so that you can use the same target names when running either an xCAT or NIM command.

To create NIM machine definitions for your service nodes you could run the following command.

```
xcat2nim -t node service
```

To create NIM group definition for the group “service” you could run the following command.

```
xcat2nim -t group -o service
```

To check the NIM definitions you could use the NIM **lsnim** command or the xCAT **xcat2nim** command. For example, the following command will display the NIM definitions of the nodes contained in the xCAT group called “service”, (from data stored in the NIM database).

```
xcat2nim -t node -l service
```

3.13 Initialize the AIX/NIM nodes

You can use the xCAT **nimnodeset** command to initialize the AIX standalone nodes. This command uses information from the xCAT *osimage* definition and default values to run the appropriate NIM commands.

For example, to set up all the nodes in the group “service” to install using the *osimage* named “610SNimage” you could issue the following command.

```
nimnodeset -i 610SNimage service
```

To verify that you have allocated all the NIM resources that you need you can run the “**lsnim -l**” command. For example, to check the node “clstrn01” you could run the following command.

```
lsnim -l clstrn01
```

The command will also set the “*profile*” attribute in the xCAT node definitions to “610SNimage”. Once this attribute is set you can run the **nimnodeset** command without the “-i” option.

Note: To verify that NIM has properly initialized the nodes you can also check the contents of the */etc/bootptab* or */var/lib/dhcp/db/dhcpd.leases*, */etc/exports*, and the node “info” file in the */ftpboot* directory.

3.14 Open a remote console (optional)

You can open a remote console to monitor the boot progress using the xCAT **rcons** command. This command requires that you have **conserver** installed and configured.

If you wish to monitor a network installation you must run rcons before initiating a network boot.

To configure conserver run:

```
makeconservercf
```

To start a console:

```
rcons node01
```

Note: You must always run `makeconservercf` after you define new cluster nodes.

3.15 Initiate a network boot

Initiate a remote network boot request using the xCAT `rnetboot` command. For example, to initiate a network boot of all nodes in the group “`service`” you could issue the following command.

```
rnetboot service
```

Note: If you receive timeout errors from the `rnetboot` command, you may need to increase the default 60-second timeout to a larger value by setting `ppctimeout` in the site table:

```
chdef -t site -o clustersite ppctimeout=180
```

3.16 Verify the deployment

- If you opened a remote console using `rcons` you can watch the progress of the installation.
- For p6 lpar, it may be helpful to bring up the HMC web interface in a browser and watch the lpar status and reference codes as the node boots.
- You can use the AIX `lsnim` command to see the state of the NIM installation for a particular node, by running the following command on the NIM master:

```
lsnim -l <clientname>
```

- When the node is booted you can log in and check if it is configured properly. For example, is the password set?, is the timezone set?, can you xdsh to the node etc.

3.16.1 Retry and troubleshooting tips:

- If a node did not boot up:
 - Verify network connections. Try a ping test using the HMC console.
 - For bootp, check `/etc/bootptab` to make sure an entry exists for the node.
For dhcp, check `/var/lib/dhcp/db/dhcpd.leases` to make sure an entry exists for the node
 - Verify that the information in `/tftpboot/<node>.info` is correct.

- Stop and restart inetd:
 - stopsrc -s inetd*
 - startsrc -s inetd*
- Stop and restart tftp:
 - stopsrc -s tftpd*
 - startsrc -s tftpd*
- Verify NFS is running properly and mounts can be performed with this NFS server:
 - View */etc/exports* for correct mount information.
 - Run the **showmount** and **exportfs** commands.
 - Stop and restart the NFS and related daemons:
 - stopsrc -g nfs*
 - startsrc -g nfs*
 - Attempt to mount a filesystem from another system on the network.
- You may need to reset the NIM client definition and start over.
 - nim -Fo reset node01*
 - nim -o deallocate -a subclass=all node01*
- If the node booted but one or more customization scripts did not run correctly:
 - You can check the */var/log/messages* file on the management node and the *var/log/xcat/xcat.log* file on the node (if it is up) to see if any error messages were produced during the installation.
 - Restart the **xcatd** daemon (**xcatstop & xcatstart (xCAT2.4 restartxcatd)**) and then re-run the customization scripts either manually or by using **updatenode**.

3.17 Configure additional adapters on the service nodes (optional)

If additional adapter configuration is required on the service nodes you could either use the **xdsh** command to run the appropriate AIX commands on the nodes or you may want to use the **updatenode** command to run a configuration script on the nodes.

XCAT provides sample adapter interface configuration scripts for Ethernet and IB. The Ethernet sample is */install/postscripts/configeth*. It illustrates how to use a specific naming convention to automatically configure interfaces on the node. You can modify this script for your environment and then run it on the node using **updatenode**. First copy your script to the */install/postscripts* directory and make sure it is executable. Then run a command similar to the following.

```
updatenode clstrn01 myconfigeth
```

If you wish to configure IB interfaces please refer to: “xCAT 2 InfiniBand Support”
- <https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2IBsupport.odt>

3.18 Verify Service Node configuration

During the node boot up there are several xCAT post scripts that are run that will configure the node as an xCAT service node. It is advisable to check the service nodes to make sure they are configured correctly before proceeding.

There are several things that can be done to verify that the service nodes have been configured correctly.

1. Check if NIM has been installed and configured by running “**lsnim**” or some other basic NIM command on the service node.
2. Check to see if all the additional software has been installed. For example, Run “**rpm -qa**” to see if the xCAT and dependency software is installed.
3. Try running some xCAT commands such as “**lsdef -a**” to see if the xcatd daemon is running and if data can be retrieved from the xCAT database on the management node.
4. If using SSH for your remote shell try to **ssh** to the service nodes from the management node.
5. Check the system services, as mentioned earlier in this document, to make sure the service node can respond to a network boot request.

4.0 Install the cluster nodes

4.1 Create a diskless image

In order to boot a diskless AIX node using xCAT and NIM you must create an xCAT *osimage* definition as well as several NIM resources.

You can use the xCAT **mknimimage** command to automate this process.

There are several NIM resources that must be created in order to deploy a diskless node. The main resource is the NIM SPOT (Shared Product Object Tree). An AIX diskless image is essentially a SPOT. It provides a **/usr** file system for diskless nodes and a root directory whose contents will be used for the initial diskless nodes root directory. It also provides network boot support.

When you run the command you must provide a source for the installable images. This could be the AIX product media, a directory containing the AIX images, or the name of an existing NIM *lpp_source* resource. You must also provide a name for the *osimage* you wish to create. This name will be used for the NIM SPOT resource that

is created as well as the name of the xCAT *osimage* definition. The naming convention for the other NIM resources that are created is the *osimage* name followed by the NIM resource type, (ex. “*61cosi_lpp_source*”).

For example, to create a diskless image called “*61cosi*” using the images contained in the */myimages* directory you could issue the following command.

```
mknimimage -t diskless -s /myimages 61cosi
```

(Note that this operation could take a while to complete!)

Note: To populate the */myimages* directory you could copy the software from the AIX product media using the AIX **gencopy** command. For example you could run “*gencopy -U -X -d /dev/cd0 -t /myimages all*”.

The command will display a summary of what was created when it completes.

The NIM resources will be created in a subdirectory of */install/nim* by default. You can use the “-l” option to specify a different location.

You can also specify alternate or additional resources on the command line using the “attr=value” option, (“<nim resource type>=<resource name>”). For example, if you want to include a “*resolv_conf*” resource named “*61cosi_resolv_conf*” you could run the command as follows.

```
mknimimage -t diskless -s /dev/cd0 61cosi resolv_conf=61cosi_resolv_conf
```

Any additional NIM resources specified on the command line must be previously created using NIM interfaces. (Which means NIM must already have been configured previously.)

Note: Another alternative is to run **mknimimage** without the additional resources and then simply add them to the xCAT *osimage* definition later. You can add or change the *osimage* definition at any time. When you initialize and install the nodes xCAT will use whatever resources are specified in the *osimage* definition.

The xCAT *osimage* definition can be listed using the **lsdef** command, modified using the **chdef** command and removed using the **rnmimimage** command. See the **man** pages for details.

To get details for the NIM resource definitions use the AIX **lsnim** command. For example, if the name of your SPOT resource is “*61cosi*” then you could get the details by running:

```
lsnim -l 61cosi
```

To see the actual contents of a NIM resource use “*nim -o showres <resource name>*”. For example, to get a list of the software installed in your SPOT you could run:

```
nim -o showres 61cosi
```

4.2 Update the SPOT

The SPOT created in the previous step should be considered the basic minimal diskless AIX operating system image. It does not contain all the software that would normally be installed as part of AIX, if you were installing a standalone system from the AIX product media. (The “nim -o showres ...” command mentioned above will display what software is contained in the SPOT.)

You must install any additional software you need and make any customizations to the image before you boot the nodes.

It would also be good to add other configuration files such as /etc/passwd etc. These files will be then be available to every node that boots with this image.

For more information on updating a diskless image see the document called “Updating AIX cluster nodes” (<https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2onAIXUpdates.odt>)

See the section titled “Updating diskless nodes”

4.2.1 Updating a SPOT with SSH software

You will have to install *openssl* and *openssh* along with several additional requisite software packages.

To help facilitate this task xCAT ships two AIX installp_bundle files. They are called xCATaixSSL.bnd and xCATaixSSH.bnd, and they are included in the xCAT tar file.

The basic process is:

- Copy the required software to the lpp_source resource that you used to create you SPOT.
- Install the software in the SPOT.

Copy the software.

You will need the openssl and openssh packages that you installed on the management server earlier in this process. You will also need some prerequisite RPM packages that were included in the xCAT for AIX dependency tar file. The easiest way to copy the software to the correct locations is to use the “nim -o update ..” command. Just provide the directory that contains your software and the NIM lpp_source resource name. (ie. “61cosi_lpp_source”).

For example:

```
nim -o update -a packages=all -a source=/tmp/myimages  
61cosi_lpp_source
```

Install the software into the SPOT.

To install additional software in the SPOT you can use the “**nim -o cust**” command.

To use the bundle files with this command you must first define them as NIM resources.

Copy the bundle files (xCATaixSSL.bnd and xCATaixSSH.bnd) to a location where they can be defined as a NIM resource, for example “/install/nim/installp_bundle”.

To define the NIM resources you can run the following commands.

```
nim -o define -t installp_bundle -a server=master -a  
location=  
/install/nim/installp_bundle/xCATaixSSL.bnd  
xCATaixSSL
```

```
nim -o define -t installp_bundle -a server=master -a  
location=  
/install/nim/installp_bundle/xCATaixSSH.bnd  
xCATaixSSH
```

Note: You cannot update a SPOT that is currently allocated. To check to see if the SPOT is allocated you could run the following command.

```
lsnim -l <spot name>
```

Run the “nim -o cust ...” command to install the software in the SPOT.

```
nim -o cust -a lpp_source= 61cosi_lpp_source -a installp_flags=agcXY -a  
installp_bundle=xCATaixSSL 61cosi
```

```
nim -o cust -a lpp_source= 61cosi_lpp_source -a installp_flags=agcXY -a  
installp_bundle=xCATaixSSH 61cosi
```

Refer to the NIM documentation for more information on how to use the NIM commands mentioned above.

4.3 Define xCAT networks

Create a network definition for each network that contains cluster nodes. You will need a name for the network and values for the following attributes.

net	The network address.
mask	The network mask.
gateway	The network gateway.

This “How-To” assumes that all the cluster node management interfaces and the xCAT management node interface are on the same network. You can use the xCAT **mkdef** command to define the network.

For example:

```
mkdef -t network -o net1 net=9.114.113.224 mask=255.255.255.224  
gateway=9.114.113.254
```

4.4 Define the LPARs currently managed by the HMC

This step assumes that LPARs were already created using the standard HMC interfaces.

Use the xCAT **rscan** command to gather the LPAR information. In this example we will use the “-z” option to create a stanza file that contains the information gathered by **rscan** as well as some default values that could be used for the node definitions.

To write the stanza format output of **rscan** to a file called “*mystanzafile*” run the following command.

```
rscan -z hmc01 > mystanzafile
```

This file can then be checked and modified as needed. For example you may need to add a different name for the node definition or add additional attributes and values etc.

Note: The stanza file will contain stanzas for objects other than the LPARs. This information must also be defined in the xCAT database. It is not necessary to modify the non-LPAR stanzas in any way

The information gathered by the **rscan** command can be used to create xCAT node definitions.

Since we have put all the node information in a stanza file we can now pass the contents of the file to the **mkdef** command to add the definitions to the database.

```
cat mystanzafile | mkdef -z
```

You can use the xCAT **lsdef** command to check the definitions (ex. “*lsdef -l node01*”). After the node has been defined you can use the **chdef** command to make any additional updates to the definitions, if needed.

4.5 Create and define additional logical partitions (optional)

You can use the xCAT **mkvbm** command to create additional logical partitions for diskless nodes in some cases.

This command can be used to create new partitions based on an existing partition or it can replicate the partitions from a source CEC to a destination CEC.

The first form of the **mkvbm** command creates new partition(s) with the same profile/resources as the partition specified on the command line. The starting numeric partition number and the *noderange* for the newly created partitions must also be provided. The LHEA port numbers and the HCA index numbers will be automatically increased if they are defined in the source partition.

The second form of this command duplicates all the partitions from the specified source CEC to the destination CEC. The source and destination CECs can be managed by different HMCs.

The nodes in the *noderange* must already be defined in the xCAT database. The “mgt” attribute of the node definitions must be set to “hmc”.

For example, to create a set of new nodes. (The “groups” attribute is required.)

```
mkdef -t node -o clstrn04-clstrn10 groups=all,aixnodes mgt=hmc
```

To create several new partitions based on the partition for node clstrn01.

```
mkvm -V clstrn01 -i 4 -n clstrn04-clstrn10
```

See the **mkvm** man page for more details.

4.6 Gather MAC information for the node boot adapters.

Use the xCAT **getmacs** command to gather adapter information from the nodes. This command will return the MAC information for each Ethernet adapter available on the target node. The command can be used to either display the results or write the information directly to the database. If there are multiple adapters the first one will be written to the database and used as the install adapter for that node.

The command can also be used to do a ping test on the adapter interfaces to determine which ones could be used to perform the network boot. In this case the first adapter that can be successfully used to ping the server will be written to the database.

Before running **getmacs** you must first run the **makeconsvercf** command. You need to run **makeconsvercf** any time you add new nodes to the cluster.

```
makeconsvercf
```

Shut down all the nodes that you will be querying for MAC addresses.

```
rpower aixnodes off
```

To retrieve the MAC address for all the nodes in the group “*aixnodes*” and write the first adapter MAC to the xCAT database you could issue the following command.

```
getmacs aixnodes
```

To display all adapter information but not write anything to the database.

getmacs -d aixnodes

To retrieve the MAC address and do a ping test to determine which adapter MAC to use for the node you could issue the following command. (The ping operation may take a while to complete.)

```
getmacs -d aixnodes -S 10.14.0.2 -G 10.14.0.2 -C 10.14.0.4
```

The output would be similar to the following.

```
# Type Location Code MAC Address Full Path Name Ping Result Device Type
ent U9125.F2A.024C362-V6-C2-T1 fef9dfb7c602 /vdevice/l-lan@30000002 successful
virtual
ent U9125.F2A.024C362-V6-C3-T1 fef9dfb7c603 /vdevice/l-lan@30000003 unsuccessful virtual
```

From this result you can see that “*fef9dfb7c602*” should be used for this nodes MAC address.

For more information on using the **getmacs** command see the man page.

To add the MAC value to the node definition you can use the **chdef** command. For example:

```
chdef -t node node01 mac=fef9dfb7c603
```

4.7 Define xCAT groups (optional)

XCAT supports both *static* and *dynamic* node groups. See the section titled “xCAT node group support” in the “xCAT2 Top Doc” document for details on using xCAT groups. (<https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2top.odt>)

Note: The *dynamic* node group support is only available in xCAT 2.3 and beyond.

4.8 Add IP addresses and hostnames to /etc/hosts

Make sure all node hostnames are added to /etc/hosts. Refer to the section titled “Add cluster nodes to the /etc/hosts file” in the following document for details. (<https://xcat.svn.sourceforge.net/svnroot/xcat/xcat-core/trunk/xCAT-client/share/doc/xCAT2onAIX.odt>)

4.9 Verify the node definitions

Verify that the node definitions include the required information.

To get a listing of the node definition you can use the **lsdef** command. For example to display the definitions of all nodes in the group “aixnodes” you could run the following command.


```
lsdef -t node -l -o aixnodes
```

The output for one diskless node might look something like the following:

```
Object name: clstrn02
cons=hmc
groups=lpar,all
servicenode=clstrSN1
xcamaster=clstrSN1-en1
hcp=clstrhmc01
hostnames=clstrn02.mycluster.com
id=2
ip=10.1.3.2
mac=001a64f9bfc9
mgt=hmc
nodetype=lpar,osi
os=AIX
parent=clstr1fsp03-9125-F2A-SN024C352
pprofile=compute
```

Most of these attributes should have been filled in automatically by xCAT.

Note: xCAT supports many different cluster environments and the attributes that may be required in a node definition will vary. For diskless nodes using a `servicenode`, the node definition should include at least the attributes listed in the above example.

Make sure “`servicenode`” is set to the name of the service node as known by the management node and “`xcatmaster`” is set to the name of the service node as known by the node.

To modify the node definitions you can use the **chdef** command.

For example to set the `xcatmaster` attribute for node “`clstrn01`” you could run the following.

```
chdef -t node -o clstrn01 xcatmaster=clstrSN1-en1
```

4.10 Set up post boot scripts (optional)

xCAT supports the running of user-provided customization scripts on the nodes when they are deployed. For diskless nodes these scripts are run when the `/etc/inittab` file is processed during the node boot up.

To have your script run on the nodes:

1. Put a copy of your script in `/install/postscripts` on the xCAT management node. (Make sure it is executable.)
2. **When using service nodes make sure the postscripts are copied to the `/install/postscripts` directories on each service node.**
3. Set the “postscripts” attribute of the node or group definition to include the comma separated list of the scripts that you want to be executed on the nodes. For example, if you want to have your two scripts called “foo” and “bar” run on node “node01” you could use the `chdef` command as follows.

```
chdef -t node -o node01 postscripts=foo,bar
```

The order of the scripts in the list determines the order in which they will be run.

XCAT also runs some scripts to do default node configuration. You can see what scripts xCAT will run by looking at the “`xcatdefaults`” entry in the xCAT “postscripts” database table. (I.e. Run “`tabdump postscripts`”). You can change the default setting by using the xCAT **chtab** or **tabedit** command.

4.11 Initialize the AIX/NIM diskless nodes

You can set up NIM to support a diskless boot of nodes by using the xCAT **mkdsklsnode** command. This command uses information from the xCAT database and default values to run the appropriate NIM commands.

For example, to set up all the nodes in the group “`aixnodes`” to boot using the SPOT (COSI) named “`61cosi`” you could issue the following command.

```
mkdsklsnode -i 61cosi aixnodes
```

The command will define and initialize the NIM machines. It will also set the “`profile`” attribute in the xCAT node definitions to “`61cosi`”.

To verify that NIM has allocated the required resources for a node and that the node is ready for a network boot you can run the “**lsnim -l**” command. For example, to check node “`node01`” you could run the following command.

```
lsnim -l node01
```

Note:

The NIM initialization of multiple nodes is done sequentially and takes approximately three minutes per node to complete. If you are planning to initialize multiple nodes you should plan accordingly. The NIM development team is currently working on a solution for this scaling issue.

4.11.1 Verifying the node initialization before booting (optional)

Once the **mkdsklnode** command completes you can log on to the service node and verify that it has been configured correctly.

- The `/etc/bootptab` or `/var/lib/dhcp/db/dhcpd.leases`, `/etc/exports` files.
- The node info file in the `/tftpboot` directory.
- The NIM node definition for the node.

4.12 Open a remote console (optional)

You can open a remote console to monitor the boot progress using the xCAT **rcons** command. This command requires that you have **conserver** installed and configured.

If you wish to monitor a network installation you must run rcons before initiating a network boot.

To configure **conserver** run:

```
makeconservercf
```

To start a console:

```
rcons node01
```

Note: You must always run **makeconservercf** after you define new cluster nodes.

4.13 Initiate a network boot

Initiate a remote network boot request using the xCAT **rnetboot** command. For example, to initiate a network boot of all nodes in the group “*aixnodes*” you could issue the following command.

```
rnetboot aixnodes
```

Note: If you receive timeout errors from the **rnetboot** command, you may need to increase the default 60-second timeout to a larger value by setting `ppctimeout` in the site table:

```
chdef -t site -o clustersite ppctimeout=180
```

4.14 Verify the deployment

- Retry and troubleshooting tips:
 - For p6 lpar, it may be helpful to bring up the HMC web interface in a browser and watch the lpar status and reference codes as the node boots.
 - Verify network connections
 - If the **rnetboot** returns “unsuccessful” for a node, verify that bootp and tftp is configured and running properly on the .

- For bootp, view */etc/bootptab* to make sure an entry exists for the node.
For dhcp, view */var/lib/dhcp/db/dhcpd.leases* to make sure an entry exists for the node.
- Verify that the information in */tftpboot/<node>.info* is correct.
- Stop and restart inetd:
 - stopsrc -s inetd*
 - startsrc -s inetd*
- Stop and restart tftp:
 - stopsrc -s tftp*
 - startsrc -s tftp*
-
- Verify NFS is running properly and mounts can be performed with this NFS server:
 - View */etc/exports* for correct mount information.
 - Run the **showmount** and **exportfs** commands.
 - Stop and restart the NFS and related daemons:
 - stopsrc -g nfs*
 - startsrc -g nfs*
 - Attempt to mount a file system from another system on the network.
- If that doesn't work, you may need to re-initialize the diskless node and start over. You can use the **rmdsklsnode** command to uninitialized an AIX diskless node. This will deallocate and remove the NIM definition but it will not remove the xCAT node definition.

5.0 Cleanup

The NIM definitions and resources that are created by xCAT commands are not automatically removed. It is therefore up to the system administrator to do some clean up of unused NIM definitions and resources from time to time. (The NIM *lpp_source* and *SPOT* resources are quite large.) There are xCAT commands that can be used to assist in this process.

5.1 Removing NIM machine definitions

Use the xCAT **rmdsklsnode** command to remove all the NIM diskless machine definitions that were created for the specified xCAT nodes. This command will not remove the xCAT node definitions.

For example, to remove the NIM machine definition corresponding to the xCAT diskless node named “node01” you could run the command as follows.

```
rmdsklsnode node01
```

Use the xCAT **xcat2nim** command to remove all the NIM standalone machine definitions that were created for the specified xCAT nodes. This command will not remove the xCAT node definitions.

For example, to remove the NIM machine definition corresponding to the xCAT node named “node01” you could run the command as follows.

```
xcat2nim -t node -r node01
```

The **xcat2nim** and **rmdsklnode** command are intended to make it easier to clean up NIM machine definitions that were created by xCAT. You can also use the AIX **nim** command directly. See the AIX/NIM documentation for details.

5.2 Removing NIM resources

Use the xCAT **rmnimimage** command to **remove all the NIM resources associated with a given xCAT *osimage* definition.** The command will only remove a NIM resource if it is not allocated to a node. You should always clean up the NIM node definitions before attempting to remove the NIM resources. The command will also remove the xCAT *osimage* definition that is specified on the command line.

For example, to remove the “610image” *osimage* definition along with all the associated NIM resources run the following command.

```
rmnimimage 610image
```

If necessary, you can also remove the NIM definitions directly by using NIM commands. See the AIX/NIM documentation for details.

6.0 Contents of xCAT installp bundle files

These are AIX installp bundle files. They can be used with AIX and NIM commands to simplify the process of installing or copying specific sets of software. These two bundle files are included in the xCAT for AIX tar file that is available from the xCAT web site. The xCATaixSN.bnd file contains a list of all the software that is needed on an AIX service node. The xCATaixSSH.bnd file contains a list of openssh and prerequisite software that will be needed to use SSH as your remote shell. The xCATaixSSL.bnd bundle contains the required openssl and related software that will be needed on the cluster nodes.

6.1 xCATaixSN.bnd

```
# Software needed for the xCAT on AIX Service Nodes  
  
# installp packages  
I:openssl.base  
I:openssl.license
```

```
I:bos.sysmgt.nim.master
```

```
# RPMs
```

```
R:popt-1.7-2.aix5.1.ppc.rpm  
R:rsync-2.6.2-1.aix5.1.ppc.rpm  
R:expat-2.0.1-2.aix5.1.ppc.rpm  
R:bash-3.2-1.aix5.2.ppc.rpm  
R:conserver-8.1.16-2.aix5.3.ppc.rpm  
R:expect-5.42.1-3.aix5.1.ppc.rpm  
R:fping-2.4b2_to-1.aix5.3.ppc.rpm  
R:perl-DBI-1.55-1.aix5.3.ppc.rpm  
R:perl-Digest-MD5-2.36-1.aix5.3.ppc.rpm  
R:perl-Expect-1.21-1.aix5.3.ppc.rpm  
R:perl-IO-Socket-SSL-1.06-1.aix5.3.ppc.rpm  
R:perl-IO-Stty-.02-1.aix5.3.ppc.rpm  
R:perl-IO-Tty-1.07-1.aix5.3.ppc.rpm  
R:perl-Net_SSLeay.pm-1.30-1.aix5.3.ppc.rpm  
R:perl-Net-Telnet-3.03-1.2.aix5.3.ppc.rpm  
R:tcl-8.4.7-3.aix5.1.ppc.rpm  
R:tk-8.4.7-3.aix5.1.ppc.rpm  
R:perl-xCAT-2.3*  
R:xCAT-client-2.3*  
R:xCAT-server-2.3*  
R:xCAT-rmc-2.3*  
R:perl-DBD-SQLite-1.13-1.aix5.3.ppc.rpm  
R:net-snmp-5.4.2.1-1.aix5.3.ppc.rpm  
R:net-snmp-devel-5.4.2.1-1.aix5.3.ppc.rpm  
R:net-snmp-perl-5.4.2.1-1.aix5.3.ppc.rpm
```

```
# optional
```

```
R:perl-DBD-mysql-4.007-1.aix5.3.ppc.rpm  
R:xcat-mysql-5.0-1.aix5.3.ppc.rpm
```

6.2 ***xCATaixSSL.bnd***

```
# bundle file for openssl - installp package from AIX
```

```
# installp packages
```

```
I:rpm.rte
```

```
I:openssl.base
```

```
I:openssl.license
```

```
# RPMs
```

```
R:perl-Net_SSLeay.pm-1.30-1.aix5.3.ppc.rpm  
R:perl-IO-Socket-SSL-1.06-1.aix5.3.ppc.rpm
```

6.3 xCATaixSSH.bnd

```
# bundle file for openssh - installp package from AIX  
# Note - openssl must be installed before openssh
```

```
I:openssh.base  
I:openssh.license  
I:openssh.man.en_US  
I:openssh.msg.en_US  
I:openssh.msg.EN_US
```

```
# RPMs  
R:popt-1.7-2.aix5.1.ppc.rpm  
R:rsync-2.6.2-1.aix5.1.ppc.rpm
```