

# xCAT2 Top Doc

05/08/2009

## Table of Contents

<a href="#">1.0 Overview of xCAT</a>	3
<a href="#">1.1 xCAT Architecture</a>	3
<a href="#">1.1.1 Stateless and Stateful Choices</a>	4
<a href="#">1.2 xCAT Features</a>	4
<a href="#">1.3 xCAT license</a>	5
<a href="#">1.4 xCAT support</a>	5
<a href="#">1.5 xCAT Commands</a>	5
<a href="#">1.5.1 xCAT quick reference guide</a>	5
<a href="#">1.5.2 Database support</a>	5
<a href="#">1.5.3 Hardware Control</a>	6
<a href="#">1.5.4 Monitoring</a>	6
<a href="#">1.5.5 Inventory</a>	7
<a href="#">1.5.6 Parallel Commands</a>	7
<a href="#">1.5.7 Deployment</a>	7
<a href="#">1.5.8 Others</a>	7
<a href="#">2.0 Installing a xCAT Management Node</a>	8
<a href="#">2.1 Install a Linux Management Node with xCAT</a>	8
<a href="#">2.1.1 Install the OS of Management Node</a>	8
<a href="#">2.1.2 Setup Your Networks</a>	9
<a href="#">2.1.3 Install the prerequisite packages for Management Node</a>	9
<a href="#">2.1.4 [RH] Disable the SELinux</a>	9
<a href="#">2.1.5 [RH] Disable the Firewall</a>	9
<a href="#">2.1.6 Configure Cluster-Facing NICS</a>	9
<a href="#">2.1.7 Prevent DHCP client from overwriting DNS configuration</a>	10
<a href="#">2.1.8 Configure Hostname</a>	10
<a href="#">2.1.9 Setup the TimeZone</a>	10
<a href="#">2.1.10 Configure DNS Resolution</a>	10
<a href="#">2.1.11 Set up basic hosts file</a>	10
<a href="#">2.1.12 Restart Management Node (optional)</a>	11
<a href="#">2.1.13 Configure Ethernet Switches (optional)</a>	11
<a href="#">2.1.14 [RH] Remove the package tftp-server</a>	11
<a href="#">2.1.15 [RH] Remove the package OpenIPMI-tools</a>	11
<a href="#">2.1.16 Download and Install xCAT 2 From an MN That Has Internet Access</a>	11
<a href="#">2.1.16.1 [RH] Setup Yum</a>	12
<a href="#">2.1.16.2 [SLES] Setup Zypper</a>	12
<a href="#">2.1.17 Download and Install xCAT 2 For an MN That Does Not Have Internet Access</a>	12
<a href="#">2.1.17.1 Download the tarballs</a>	12
<a href="#">2.1.17.2 [RH] Setup YUM repositories for xCAT and Dependencies</a>	12
<a href="#">2.1.17.3 [SLES] Setup Zypper repositories for xCAT and Dependencies</a>	12
<a href="#">2.1.18 Get the Requisite Packages From the Distro</a>	13

2.1.18.1	<a href="#">[FEDORA 8/9] Setup the repository</a>	13
2.1.18.2	<a href="#">[RHEL] Setup repository</a>	14
2.1.18.3	<a href="#">[SLES] Setup repository</a>	15
2.1.19	<a href="#">Install xCAT and Dependencies on the Management Node</a>	15
2.1.20	<a href="#">Install Yaboot on the Management Node for pLinux</a>	16
2.1.21	<a href="#">Test xCAT Installation</a>	16
2.1.22	<a href="#">Update xCAT Software after Installation</a>	16
2.2	<a href="#">Install an AIX Management Node with xCAT</a>	17
2.2.1	<a href="#">Setup xCAT Management Node</a>	17
2.2.2	<a href="#">Download and install the prerequisite Open Source Software (OSS)</a>	17
2.2.3	<a href="#">Verify that the following basic AIX services needed</a>	17
2.2.4	<a href="#">Download and Install the xCAT software</a>	18
2.2.5	<a href="#">Verify the xCAT install</a>	19
2.3	<a href="#">Setup Alternate Databases</a>	19
2.3.1	<a href="#">SQLite</a>	19
2.3.2	<a href="#">PostgreSQL</a>	19
2.3.3	<a href="#">MySQL</a>	19
2.3.4	<a href="#">DB2 (TBD)</a>	20
3.0	<a href="#">Deploying and Maintaining Cluster Nodes</a>	20
3.1	<a href="#">Linux Nodes</a>	20
3.1.1	<a href="#">XCAT2 Linux Advanced Cookbook</a>	20
3.1.2	<a href="#">pLinux Cookbook</a>	20
3.1.3	<a href="#">Linux BladeCenter How-To</a>	20
3.1.4	<a href="#">IdataPlex How-To</a>	20
3.1.5	<a href="#">SLES 10.1 notes</a>	20
3.2	<a href="#">AIX Nodes</a>	20
3.2.1	<a href="#">AIX diskfull nodes</a>	20
3.2.2	<a href="#">AIX diskless nodes</a>	20
3.2.3	<a href="#">AIX on JS blade installation</a>	20
3.3	<a href="#">Updating the xCAT Cluster</a>	21
4.0	<a href="#">Node Discovery</a>	21
5.0	<a href="#">Using Hierarchy</a>	21
5.1	<a href="#">Linux</a>	21
5.2	<a href="#">AIX</a>	21
6.0	<a href="#">Monitoring</a>	21
7.0	<a href="#">xCAT imaging</a>	22
8.0	<a href="#">xCAT IB Support</a>	22
9.0	<a href="#">Customize your installation methods</a>	22
10.0	<a href="#">Uninstalling xCAT on Linux</a>	22
11.0	<a href="#">Migrating from xCAT 1.3 to 2.x</a>	22
12.0	<a href="#">xCAT for CSM Admin</a>	22
13.0	<a href="#">xCAT How-To(s)</a>	22
14.0	<a href="#">xCAT on Windows</a>	22
15.0	<a href="#">xCAT and Xen</a>	22
16.0	<a href="#">xCAT Developer's Guide</a>	22
17.0	<a href="#">References</a>	23
17.1	<a href="#">xCAT Summary Commands and Database Tables</a>	23

<a href="#">17.2 Stateless GPFS</a> .....	23
<a href="#">17.3 Maui</a> .....	23
<a href="#">17.4 Torque</a> .....	23
<a href="#">17.5 Ganglia</a> .....	23
<a href="#">17.6 LDAP</a> .....	23
<a href="#">17.7 XCAT Developer Guide (TBD)</a> .....	23
<a href="#">18.0 Known Bugs</a> .....	23
<a href="#">19.0 Feature requests</a> .....	23
<a href="#">20.0 References</a> .....	23

## 1.0 Overview of xCAT

xCAT (Extreme Cluster Administration Tool) is a toolkit that provides support for the deployment and administration of large cluster environments.

Earlier versions of xCAT have been used to deploy and manage many high end Linux clusters since 1999. The new xCAT version 2.X is a complete rewrite of xCAT that includes many architectural changes and functional enhancements.

xCAT is a scalable distributed computing management and provisioning tool that provides a unified interface for hardware control, discovery, and OS diskful/diskless deployment. Now xCAT 2 is open source on the [Source Forge Website](#) , so you can use it with confidence and participate in making it even better.

### 1.1 xCAT Architecture

xCAT 2 is a complete rewrite of xCAT 1.3 that includes many architectural changes and functional enhancements. All commands are client/server, authenticated, logged and policy driven. XCAT 2 supports roll base authentication. The clients can be run on any OS with Perl, including Windows. All communication is SSL encrypted. The code has been completely rewritten in Perl, and table data is now stored in a relational database and with the plug-in architecture you can chose your database from SQLite, MySQL, PostgreSQL with more options coming.

In the xCAT client/server application, flow between the client and server is controlled by the xCAT daemon (xcatd) on the Management Node. When xcatd receives the command which has been packaged as (XML), it determines whether the sender has authority to execute the command by evaluating the ACL's in the policy table. The daemon also receives status and inventory information from the nodes as they are deployed. See [xCAT 2 Architecture](#) for more details.

xCAT 2 was designed to scale for extremely large clusters. See xCAT on the [world's fastest know supercomputer](#). With the Hierarchical support, a single management node may have any number of stateless or statefull service nodes to increase the provisioning throughput and management of the largest clusters. All cluster services such as LDAP, DNS, DHCP, NTP, Syslog, etc... can be automatically configured throughout the cluster. Outbound cluster management commands such as rpower, xdsh, xdcpc, etc...utilize this hierarchy for scalable systems management.

### 1.1.1 Stateless and Stateful Choices

Stateless nodes are an important concept in xCAT 2. A stateless node is defined as one that has no “state” (configuration changes, software updates, etc.) stored permanently on it. This is extremely useful in a cluster for the following reasons:

- All nodes will have a much greater likelihood of staying consistent. And if the administrator does suspect that a node is out of sync with the rest of the cluster, they can simply reboot it and know that it is back in its original, pristine state.
- If a node experiences a hardware problem, the hardware can be pulled from the rack and replaced with new hardware and the node booted again and it will come up with the same state as before.
- In a provisioning environment, new nodes can be provisioned or moved without the worry of them losing state.

xCAT 2 provides the choice of either stateless or stateful nodes. A stateful node is one that has the OS installed on its local hard disk and therefore, changes to the node (configuration changes, software updates, etc.) can be made over time and those changes will persist.

Stateless nodes in xCAT 2 are implemented by not putting the OS on the local disk of the node. There are 3 choices for stateless:

1. **RAM-root** – The entire OS image is contained in a RAM file system that is sent to the node when it boots. Typical size for a minimal compute node for Linux is 75-160 MB of memory.
2. **Compressed RAM-root** – The OS image is in a compressed tar file. Individual files are extracted and cached when read. File writes are done to the cached copy. Typical size for a minimal compute node for Linux is 30-64 MB of memory.
3. **NFS Hybrid** – This is more accurately called NFS-root with copy-on-write. A minimal boot kernel is sent to the node, which readonly NFS mounts the OS image from the server. Files read are cached in memory. File writes are done to the cached copy. Typical size for a minimal compute node for Linux is 5 MB of memory.

## 1.2 xCAT Features

Features provided by xCAT for AIX or Linux clusters include the following:

- Deploying diskless and diskfull nodes.
- Node discovery
- Operating system image management.
- Support for user-provided customization scripts.
- xCAT data store in plug-in relational database (SQLite, MySQL, Postgres, TBD)
- Hardware control commands for discovering hardware, gathering MAC addresses, VPD, and environments, power control, initiating a network boot, and LPAR creation/deletion.
- Hierarchical support to allow large system to distribute the management of the cluster to service nodes.
- Remote console support.
- Parallel remote shell and remote copy commands.

- Monitoring plug-in infrastructure (RMC, Ganglia)
- Notification infrastructure which lets users monitor xCAT database table changes.
- Predefined conditions, responses and sensors.
- Software and firmware inventory
- Xen support
- Windows support
- GUI for initial cluster setup
- Allow continuous operation during cluster software updates using plug-in job scheduler (LoadLeveler, Moab).
- Automatic setup for syslog, remote shell, DNS, DHCP, and ntp for both the xCAT management node and the cluster nodes.
- Documentation and “**man**” pages.

### 1.3 xCAT license

xCAT 2 Open Source License: [Eclipse Public License](#)

### 1.4 xCAT support

Support for xCAT may now be [purchased](#). Other support is offered through the xCAT public mailing list. You can also open a new feature request or a bug report using Tracker on Source Forge. Check out the Support section on the [xCAT Source Forge Home page](#).

### 1.5 xCAT Commands

Note: some of these commands run on Linux and AIX, some are targeted only for AIX or Linux.

#### 1.5.1 xCAT quick reference guide

For the expert user, we have provided a quick reference guide to keep in your pocket.

The [xCAT compact handout](#).

#### 1.5.2 Database support

- [DB Tables](#)– Complete list of xCAT database tables descriptions.
- [chdef](#) - Change xCAT data object definitions.
- [chtab](#) - Add, delete or update rows in the database tables.
- [dumpxCATdb](#) – dumps entire xCAT database.
- [gettab](#) – searches through tables with keys and return matching attributes.
- [lsdef](#) - used to display xCAT object definitions which are stored in the xCAT database.
- [mkdef](#) – used to create xCAT data object definitions.
- [mkrrbc](#) - Adds or deletes BladeCenter management module and switch node definitions in the xCAT cluster database.
- [mkrrnodes](#) – adds or deletes nodes in the xCAT cluster database. Allows creation/deletion of many nodes at once.
- [nodeadd](#) - Adds nodes to the xCAT cluster database.

- [nodech](#) - Changes nodes' attributes in the xCAT cluster database.
- [nodels](#) - lists the nodes, and their attributes, from the xCAT database.
- [noderm](#) - removes the nodes in the noderange from all database table.
- [restoreCATdb](#) – restore the xCAT database.
- [rmdf](#) - remove xCAT data object definitions.
- [tabdump](#) - isplay an xCAT database table in CSV format.
- [tabedit](#) - view an xCAT database table in an editor and make changes.
- [tabgrep](#) - list table names in which an entry for the given node appears.
- [tabrestore](#) - replaces the contents of an xCAT database table with the contents in a csv file.
- [xcatstanzafile](#) - Format of a stanza file that can be used with xCAT data object definition commands.

### 1.5.3 Hardware Control

- [getmacs](#) - Collects node MAC address.
- [lsslp](#) - Discovers selected networked services information within the same subnet.
- [lsvm](#) - Lists partition profile information for HMC- and IVM-managed nodes.
- [nodestat](#) - display the running status of a noderange
- [rbeacon](#) - Turns beacon on/off/blink or gives status of a node or noderange.
- [rcons](#) - remotely accesses the serial console of a node.
- [replaycons](#) - replay the console output for a node
- [reventlog](#) - retrieve or clear remote hardware event logs
- [rflash](#) - Performs Licensed Internal Code (LIC) update support for HMC-attached P5/P6
- [rmigrate](#) - Execute migration of a guest VM between hosts/hypervisors .
- [rmvm](#) - Removes HMC- and IVM-managed partitions.
- [rnetboot](#) - Cause the range of nodes to boot to network.
- [rpower](#) - remote power control of nodes
- [rscan](#) - Collects node information from one or more hardware control points.
- [rsetboot](#) - Sets the boot device to be used for BMC-based servers for the next boot only.
- [rspconfig](#) - configures various settings in the nodes' service processors.
- [rspreset](#) - resets the service processors associated with the specified nodes
- [switchblade](#) - reassign the BladeCenter media tray and/or KVM to the specified blade
- [wcons](#) – windowed remote console
- [wkill](#) – kill windowed remote consoles

### 1.5.4 Monitoring

- [monadd](#) - Registers a monitoring plug-in to the xCAT cluster.
- [moncfg](#) - Configures a 3rd party monitoring software to monitor the xCAT cluster.
- [mondecfg](#) - Deconfigures a 3rd party monitoring software from monitoring the xCAT cluster.
- [monls](#) - Lists monitoring plug-in modules that can be used to monitor the xCAT cluster.
- [monrm](#) - Unregisters a monitoring plug-in module from the xCAT cluster.
- [monstart](#) - Starts a plug-in module to monitor the xCAT cluster.
- [monstop](#) - Stops a monitoring plug-in module to monitor the xCAT cluster.
- [regnotif](#) - Registers a Perl module or a command that will get called when changes occur in the desired xCAT database tables.
- [unregnotif](#) - unregister a Perl module or a command that was watching for the changes of the desired xCAT database tables.

### 1.5.5 Inventory

- [rinv](#) - remote hardware inventory.
- [rvitals](#) – retrieves remote hardware vitals information.
- [sinv](#) - Checks the software configuration of the nodes in the cluster.

### 1.5.6 Parallel Commands

- [pcons](#) - runs a command on the noderange using the out-of-band console.
- [pping](#) - parallel ping.
- [ppping](#) – parallel ping between nodes in a cluster.
- [prsync](#) – parallel rsync
- [pscp](#) – parallel remote copy ( supports scp and not hierarchy)
- [psh](#) – parallel remote shell ( supports ssh and not hierarchy)
- [xcdp](#) – concurrently copies files too and from multiple nodes. ( scp/rcp and hierarchy)
- [xdsh](#) – concurrently runs commands on multiple nodes. ( supports ssh/rsh and hierarchy)
- [xdshbak](#)- formats the output of the xdsh command.
- [xcoll](#) – Formats command output of the psh, xdsh, rinv command

### 1.5.7 Deployment

- [copycds-cdrom](#) - client side wrapper for copycds supporting physical drives.
- [copycds](#) - Copies Linux distributions and service levels from CDs to install directory.
- [genimage](#) - Generates a stateless image to be used for a diskless install.
- [geninitrd](#) - Regenerates the initrd for a stateless image to be used for a diskless install.
- [mkdsklsnode](#) - xCAT command to define and initialize AIX/NIM diskless machines.
- [mknimage](#) - xCAT command to create AIX image definitions.
- [mknb](#) - creates a network boot root image for node discovery and flashing
- [nimnodecust](#) - xCAT command to customize AIX/NIM standalone machines.
- [nimnodeset](#) - xCAT command to initialize AIX/NIM standalone machines.
- [nodeset](#) - set the boot state for a noderange
- [packimage](#) - Packs the stateless image from the chroot file system.
- [rbootseq](#) - Persistently sets the order of boot devices for BladeCenter blades.
- [rinstall](#) - Begin installation on a noderange
- [rmdsklsnode](#) - Use this xCAT command to remove AIX/NIM diskless machine definitions.
- [rmnimage](#) - xCAT command to remove an xCAT osimage definition and the associated NIM resources.
- [setupiscsidev](#) - creates a LUN for a node to boot up with, using iSCSI.
- [updateSNimage](#) – (No longer used) Adds the needed Service Node configuration files to the install image.
- [updatenode](#) - Reruns postscripts or runs additional scripts on the nodes.
- [winstall](#) - Begin installation on a noderange and display in wcons
- [xcat2nim](#) - Use this command to create and manage AIX NIM definitions based on xCAT object definitions.

### 1.5.8 Others

- [csm2xcat](#) - Migrates a CSM database to a xCAT database.

- [makedhcp](#) - Creates new dhcp configuration files and updates live dhcp configuration using omapi.
- [makedns](#) - sets up domain name services (DNS) from the entries in /etc/hosts.
- [makehosts](#) - sets up /etc/hosts from the xCAT hosts table.
- [makeconserveref](#) - creates the conserver.cf configuration file and stops and starts conserver.
- [makeknownhosts](#) – creates a ssh known\_hosts file from the input node range.
- [makenetworks](#) - populates the xCAT networks table, using network information from the local system
- [noderange](#) – Supported syntax for compactly expressing a list of node names.
- [pbstop](#) - Monitors your cluster in a terminal window.
- [xcatconfig](#) – setups up MN during install. Can be used to reinitialize keys, credentials, site table after install.
- [xcatstart](#) - Starts the xCAT daemon (xcatd) on AIX.
- [xcatstop](#) - Stops the xCAT daemon (xcatd) on AIX.
- [xCATWorld](#) – Sample client program for xCAT.
- [xpbsnodes](#) - PBS pbsnodes front-end for a noderange.
- [Summary of xCAT Commands](#)

## 2.0 Installing a xCAT Management Node

To install the xCAT Management Node (MN), the following steps are taken:

1. Install the MN with the OS. Install all rpms from the OS. You will probably be missing dependencies for xCAT later, if you do not.
2. Configure Cluster-Facing NICS
3. Configure NTP
4. Configure Hostname
5. Configure DNS or some hostname resolution method.
6. Setup basic /etc/hosts file
7. Configure Ethernet switches

**Convention:** *In order to distinguish the operation among different OS or distros, the mark likes [OS+distro+release] will be used before an operation to specify the applicable range of the operation.*

**[RH]** – applicable for all releases of RHEL and Fedora

**[RHEL]** – applicable for distro RHEL

**[FEDORA]** – applicable for distro Fedora

**[SLES]** – applicable for distro SLES

**[SLES11]** – applicable for distro SLES11

## 2.1 Install a Linux Management Node with xCAT

### 2.1.1 Install the OS of Management Node

xCAT 2 management nodes are supported on the following Linux distributions:

**[RHEL]:** rhels5.2, rhels5.3

**[FEDORA]:** fedora8, fedora9

**[SLES]:** sles10, sles11

### 2.1.2 Setup Your Networks

xCAT install process will scan and populate certain settings from the running configuration. Having the networks configured ahead of time will aid in correct configuration. All the networks in the cluster must be defined in the xCAT networks table before start installing cluster nodes. When xCAT is installed, it will run makenetworks to create an entry in the network table for each of the networks the management node is on. Additional network configuration can be added to the xCAT networks table manually later if needed.

### 2.1.3 Install the prerequisite packages for Management Node

As mentioned earlier, it is recommended to install all the RPMs on the management node from the OS repository, in case not all the RPMs are installed, we need to make sure that dhcp, bind (not bind-chroot), expect, httpd, nfs-utils, vsftpd, and perl-XML-Parser were installed before installing the xCAT. Please be aware that the packages names may vary slightly between different operating systems, setting up the operating system repository for YUM/zypper is a good practice, when the operating system repository for YUM/zypper is setup correctly, these xCAT prerequisite packages will be installed automatically when installing the xCAT.

### 2.1.4 [RH] Disable the SELinux

The RedHat SELinux (Secure Enterprise Linux) must be disabled on the xCAT 2 management node, various xCAT 2 functions will be affected if the SELinux feature is enabled.

One method for disabling the SELinux is the following:

1. In the /etc/selinux/config file, set SELINUX=disabled.
2. Reboot the node.

### 2.1.5 [RH] Disable the Firewall

The management node provides many services to the cluster nodes, but the firewall on the management node can interfere with this. If your cluster is on a secure network, the easiest thing to do is to disable the firewall on the management node:

```
service iptables stop
chkconfig iptables off
```

If disabling the firewall completely isn't an option, configure iptables to allow the following services on the NIC that faces the cluster: DHCP, TFTP, NFS, HTTP, FTP, DNS.

### 2.1.6 Configure Cluster-Facing NICs

The cluster-facing NICs should be configured before installing xCAT 2 management node. There are a number of methods to configure the NICs such as updating Linux ifcfg-\* files, using Linux ifconfig command or Linux Graphic User Interface. Here is an example of using ifcfg-\* files to configure the NICs:

The location of the ifcfg-\* files:

**[RH]:** /etc/sysconfig/network-scripts/ifcfg-\*

**[SLES]:** /etc/sysconfig/network/ifcfg-\*

An example of the content of ifcfg-\* file:

```
DEVICE=eth1
ONBOOT=yes
BOOTPROTO=static
IPADDR=11.16.0.1
NETMASK=255.255.0.0
```

## 2.1.7 Prevent DHCP client from overwriting DNS configuration

If the management node will be used to install any service node or compute node, the DHCP service needs to be configured on the management mode through the cluster-facing network interfaces, to prevent DHCP client from overwriting DNS configuration, the line “PEERDNS=no” is needed in the ifcfg-\* files relevant to any cluster-facing network interfaces .

**[RH]:** /etc/sysconfig/network-scripts/ifcfg-\*

**[SLES]:** /etc/sysconfig/network/ifcfg-\*

## 2.1.8 Configure Hostname

The xCAT 2 management node hostname must be configured before setting up the xCAT 2 management node. If the management node hostname is already configured, this step can be skipped. The Linux command “hostname” or the Linux GUI can be used to configure the hostname. Editing the hostname configuration file /etc/sysconfig/network on RedHat systems or /etc/HOSTNAME on SuSE systems is another method.

**[RH]:** Edit the /etc/sysconfig/network and add entry 'HOSTNAME=(desired hostname)'.

**[SLES]:** Edit the /etc/HOSTNAME and add the proper hostname.

## 2.1.9 Setup the TimeZone

When using management node to install service nodes or compute nodes, the timezone configuration on the management node will be inherited by the service nodes or compute nodes. So it is recommended to setup the correct timezone on the management node.

## 2.1.10 Configure DNS Resolution

/etc/resolv.conf should contain the DNS for management node itself.

```
search cluster
nameserver 11.16.0.1
```

## 2.1.11 Set up basic hosts file

Ensure the /etc/hosts has the entries of localhost and management node itself.

```
127.0.0.1          localhost.localdomain localhost
::1               localhost6.localdomain6 localhost6
```

```
11.16.9.1      xcat20mn.clusters.com xcat20mn
11.16.9.2      .....
```

Note: Name resolution is required by xCAT 2. You can use a simple /etc/hosts mechanism or you can optionally set up a DNS name server. You can refer to section 4.3 **Configuring name resolution (optional)** in xCAT2onAIX for more details on how to setup DNS resolution and /etc/hosts.

### 2.1.12 Restart Management Node (optional)

Though it is possible to restart the correct services for all settings except SELinux, the simplest step would be to reboot the management server at this point.

### 2.1.13 Configure Ethernet Switches (optional)

xCAT can use the ethernet switches for automatic hardware discovery and initial configuration, this is useful especially for large clusters. In general, this requires that the user in advance set up an ip address and basic snmp functionality. Allowing the snmp version 1 community string “public” read access will allow xCAT to communicate without further customization. It is also recommended that spanning tree be set to portfast or edge-port for faster boot performance. Please see the relevant switch documentation as to how to configure these items.

### 2.1.14 [RH] Remove the package tftp-server

xCAT ships the package tftp\* package with its dependencies. This package conflicts with the tftp-server that is by default installed with the OS.

In order to install the xCAT successfully, you have to remove any tftp-server package that is installed first.

```
yum erase tftp-server.*
```

or if tftp-server depended by other packages:

```
rpm -e --nodeps tftp-server
```

### 2.1.15 [RH] Remove the package OpenIPMI-tools

The xCAT software ships its own ipmi-tools\* package with its dependencies. This package conflicts with the OpenIPMI-tools packages of the OS, which must be removed before xCAT is installed.

### 2.1.16 Download and Install xCAT 2 From an MN That Has Internet Access

XCAT can be downloaded and installed using YUM on RedHat systems or zypper on SuSE systems. To download and install xCAT2 on RedHat systems, go to the [xCAT Download](#) site in the section titled “**RPMs in directories, structured for YUM download** “. This allows you to get a repo file to put on your management node that will point YUM to the proper place to get the xCAT RPMs. Then follow the instructions in section “**Open Source Package Dependencies that xCAT Requires**” to download the correct repo file for the xcat-dep packages.

**For SLES systems, just simply use the zypper command to add the xCAT download site into the zypper repository and then use the zypper command to download and install xCAT2.**

*Note: disable any firewalls that could prevent the download.*

*Note: We have chosen ppc64 as our architecture and sles10, modify to suit your needs.*

### 2.1.16.1 [RH] Setup Yum

Download Repository Files into the /etc/yum.repos.d.

```
cd etc/yum.repos.d
wget http://xcat.sourceforge.net/yum/xcat-core/xCAT-core.repo
wget http://xcat.sourceforge.net/yum/xcat-dep/<release>/<arch>/xCAT-dep.repo
```

### 2.1.16.2 [SLES] Setup Zypper

[SLES11]:

```
zypper ar http://xcat.sf.net/yum/xcat-core xCAT-core
zypper ar http://xcat.sf.net/yum/xcat-dep/<release>/<arch> xCAT-dep
```

[SLES10.2+]:

```
zypper sa http://xcat.sf.net/yum/xcat-core xCAT-core
zypper sa http://xcat.sf.net/yum/xcat-dep/<release>/<arch> xCAT-dep
```

## 2.1.17 Download and Install xCAT 2 For an MN That Does Not Have Internet Access

Go to the [xCAT Download](#) site in the section titled **RPMs in tarball - download tarball ...** Download the level of xCAT tarball you desired. Go to the [xCAT Dependencies Download](#) page and get the latest xCAT dependency tarball.

### 2.1.17.1 Download the tarballs

Download and copy the files to the Management Node (MN) and untar them:

```
mkdir /root/xcat2
cd /root/xcat2

tar jxvf core-rpms-snap.tar.bz2
tar jxvf xcat-dep-2*.tar.bz2
```

### 2.1.17.2 [RH] Setup YUM repositories for xCAT and Dependencies

On Red Hat related distros point YUM to the local repositories for xCAT and its dependencies:

```
cd /root/xcat2/xcat-dep/<release>/<arch>
./mklocalrepo.sh
cd /root/xcat2/core-snap
./mklocalrepo.sh
```

### 2.1.17.3 [SLES] Setup Zypper repositories for xCAT and Dependencies

[SLES 10.2+]:

```
zypper sa file:///root/xcat2/xcat-dep/sles10/<arch> xCAT-dep
zypper sa file:///root/xcat2/core-snap core-snap
```

[SLES 11]:

```
zypper ar file:///root/xcat2/xcat-dep/sles11/<arch> xCAT-dep
```

```
zypper ar file:///root/xcat2/core-snap core-snap
```

You can check status of zypper using command `zypper sl` and remove the zypper repository using command `zypper sd` on SLES 10.2+ or `zypper rr` on SLES 11.

To update xCAT:

```
zypper update --type package xCAT
```

## 2.1.18 Get the Requisite Packages From the Distro

xCAT depends on several packages that come from the Linux distro. Follow this section to create the repository of the OS of the Management Node.

### 2.1.18.1 [FEDORA 8/9] Setup the repository

If your management node has access to the internet, you can simply create a file called `/etc/yum.repos.d/fedora-internet.repo` that contains:

```
[fedora-everything]
name=Fedora $releasever - $basearch
failovermethod=priority
#baseurl=http://download.fedora.redhat.com/pub/fedora/linux/releases/
$releasever/Everything/$basearch/os/
mirrorlist=http://mirrors.fedoraproject.org/mirrorlist?repo=fedora-
$releasever&arch=$basearch
enabled=1
gpgcheck=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-fedora file:///etc/pki/rpm-gpg/RPM-GPG-
KEY
```

If your management node does not have internet access, then download the necessary fedora RPMs, copy them to the MN, and create a local YUM repository:

**Note:** you can use this example for Fedora 9, just go to the Fedora 9 website by substituting “9” in for “8” in the below link and wget the equivalent Fedora 9 rpms.

```
cd /root/xcat2/xcat-dep/rh5/x86_64
export
BASEURL=http://download.fedora.redhat.com/pub/fedora/linux/releases/8/Everything/x
86_64/os/Packages/

wget $BASEURL/perl-Net-SNMP-5.2.0-1.fc8.1.noarch.rpm
wget $BASEURL/perl-XML-Simple-2.17-1.fc8.noarch.rpm
wget $BASEURL/perl-Crypt-DES-2.05-4.fc7.x86_64.rpm
wget $BASEURL/net-snmp-perl-5.4.1-4.fc8.x86_64.rpm
wget $BASEURL/ksh-20070628-1.1.fc8.x86_64.rpm
wget $BASEURL/perl-IO-Socket-INET6-2.51-2.fc8.1.noarch.rpm
wget $BASEURL/dhcp-3.0.6-10.fc8.x86_64.rpm
wget $BASEURL/syslinux-3.36-7.fc8.x86_64.rpm
wget $BASEURL/mtools-3.9.11-2.fc8.x86_64.rpm
wget $BASEURL/expect-5.43.0-9.fc8.x86_64.rpm
wget $BASEURL/perl-DBD-SQLite-1.12-2.fc8.1.x86_64.rpm
wget $BASEURL/perl-Expect-1.20-1.fc8.1.noarch.rpm
```

```
wget $BASEURL/perl-IO-Tty-1.07-2.fc8.1.x86_64.rpm
wget $BASEURL/scsi-target-utils-0.0-1.20070803snap.fc8.x86_64.rpm
wget $BASEURL/perl-Net-Telnet-3.03-5.1.noarch.rpm
wget $BASEURL/perl-TimeDate-1.16.6.fc8.noarch.rpm
wget $BASEURL/perl-DateTime-0.41-1.fc8.x86_64.rpm
wget $BASEURL/perl-DateTime-Set-0.25-4.fc7.noarch.rpm
wget $BASEURL/perl-MailTools-1.77-2.fc8.noarch.rpm
wget $BASEURL/perl-Set-Infinite-0.61-3.fc7.noarch.rpm
wget $BASEURL/perl-MIME-Lite-3.01-5.fc8.1.noarch.rpm
wget $BASEURL/perl-version-0.7203-2.fc8.x86_64.rpm
wget $BASEURL/perl-SOAP-Lite-0.68-5.fc8.noarch.rpm

createrepo .
```

**Note: if using Fedora 9, you must have at least this version of net-snmp-perl: net-snmp-5.4.1-19.fc9**

### 2.1.18.2 [RHEL] Setup repository

To make the necessary RHEL RPM prereqs available to the xCAT install process, mount the RHEL CD/DVD or ISO and then create a repo file in /etc/yum.repos.d that points to it.

**If you have the RHEL CD(s) or DVD(s):**

**If the RHEL distro only has one CD or DVD:**

1. Insert the RHEL CD or DVD into the CD or DVD drive.
2. Mount the disk into some directory, for example, /media/cdrom/.
3. Create a YUM repository file, for example, rhel-dvd.repo, under directory /etc/yum.repos.d. The YUM repository contents should look like:

```
name=RHEL 5.3 from DVD
baseurl=file:///media/cdrom/Server
enabled=1
gpgcheck=1
```

Note: To make the YUM repository work persistently after management node reboot, the CD/DVD drive mount needs to be added into the /etc/fstab, or add the mount command into Linux startup scripts.

**If the RHEL distro has more than one CDs or DVDs:**

1. Insert the RHEL CD or DVD into the CD or DVD drive one by one.
2. Copy the CD or DVD disk contents into one directory, for example, /rhels5.2/.
3. Create a YUM repository file, for example, rhel-dvd.repo, under directory /etc/yum.repos.d. The YUM repository contents should look like:

```
name=RHEL 5.3 from directory
baseurl=file:///rhels5.2/Server
enabled=1
gpgcheck=1
```

**If you have the RHEL iso files:**

**If the RHEL distro only has one iso file:**

1. Copy the iso file to any directory, such as /iso
 

```
mkdir /iso
cp RHEL5.2-Server-20080430.0-ppc-DVD.iso /iso/
```
2. Mount the iso file to a directory such as /iso/rhels5.2

```
cd /iso
mount -o loop RHEL5.2-Server-20080430.0-ppc-DVD.iso /iso/rhels5.2
```

3. Create a YUM repository file, for example, `rhel-dvd.repo`, under directory `/etc/yum.repos.d`. The YUM repository contents should look like:

```
[rhe-5-server]
name=RHEL 5 SERVER packages
baseurl=file:///iso/rhels5.2/Server
enabled=1
gpgcheck=1
```

Note: To make the YUM repository work persistently after management node reboot, the iso mount needs to be added into the `/etc/fstab`, or add the mount command into Linux startup scripts.

#### **If the RHEL distro has more than one iso files**

1. Copy the iso files to any directory, such as `/iso`
2. Mount the iso files to some specific directory such as `/iso/mnt/` one by one
3. Copy the the isos contents to any directory such as `/iso/rhels5.2`
4. Create a YUM repository file, for example, `rhel-dvd.repo`, under directory `/etc/yum.repos.d`. The YUM repository contents should look like:

```
[rhe-5-server]
name=RHEL 5 SERVER packages
baseurl=file:///iso/rhels5.2/Server
enabled=1
gpgcheck=1
```

#### **For either case above:**

change directory to where the RHEL CD image is and run  
`rpm --import RPM-GPG-KEY-redhat-release`

#### **2.1.18.3 [SLES] Setup repository**

If you have a SLES ISO:

```
mkdir /iso
copy SLES11-DVD-ppc-GM-DVD1.iso to /iso/
mkdir /iso/1
cd /iso
mount -o loop SLES11-DVD-ppc-GM-DVD1.iso 1
```

```
zypper ar file:///iso/1 sles11
```

#### **2.1.19 Install xCAT and Dependencies on the Management Node**

**[RH]:**

```
yum clean metadata
yum install xCAT
```

**[SLES]:**

```
zypper install xCAT
```

## 2.1.20 Install Yaboot on the Management Node for pLinux

Note: it is only necessary to install yaboot-xcat on releases earlier than 2.2.

If using yum/zypper it will automatically be installed for you in xCAT 2.2.

On pre-2.2 releases of xCAT, it is only necessary to manually install yaboot-xcat, if you are planning to manage any ppc nodes.

**[RHEL]:**

```
yum install yaboot-xcat.noarch
```

## 2.1.21 Test xCAT Installation

Add command to the path:

```
source /etc/profile.d/xcat.sh
```

Check to see the database is initialized:

```
tabdump site
```

The output should similar to the following:

```
key,value,comments,disable
"xcatdport","3001",,,
"xcatiport","3002",,,
"tftpdir","/tftpboot",,,
"installdir","/install",,
```

## 2.1.22 Update xCAT Software after Installation

If you need to update the xCAT 2 rpms later:

- If the management node does not have access to the internet: download the new version of <http://xcat.sf.net/yum/core-rpms-snap.tar.bz2> and untar it in the same place as before.
- If the management node has access to the internet, the yum/zypper command below will pull the updates directly from the xCAT site.

**[RH]:**

```
yum update '*xCAT*'
```

**[SLES]:**

```
zypper refresh
zypper update -t package '*xCAT*'
```

*Note: If you have a service node stateless image in a hierachical configuration , don't forget to update the image with the new xCAT rpms to keep the service node at the same level as the management Node.*

## 2.2 Install an AIX Management Node with xCAT

### 2.2.1 Setup xCAT Management Node

- Follow AIX documentation and procedures to install and configure the base AIX operating system. (Typically by using the product media.)
- Apply the latest software updates and fixes if needed.
- Install the latest versions of OpenSSL & OpenSSH from the AIX Expansion Pack. This software can also be downloaded from the following sites.

OpenSSH:

<http://sourceforge.net/projects/openssh-aix>

OpenSSL:

<https://www14.software.ibm.com/webapp/iwm/web/preLogin.do?source=aixbp>

**Since these are installp file sets you should run /usr/sbin/updtvpkg to make sure that the RPM reflection of what was installed by installp is updated.** This makes it possible for RPM packages with a dependency on OpenSSL to recognize that the dependency is satisfied.

NOTE: For easier downloading without a web browser, you may want to download and install the wget tool from the AIX Toolkit for Linux.

### 2.2.2 Download and install the prerequisite Open Source Software (OSS)

- Download the dep-aix-2.1.tar.gz tar file from <http://xcat.sourceforge.net/aix/download.html> and copy it to a convenient location on your xCAT management node.
- Unwrap the tar file.
- `gunzip dep-aix-2.1.tar.gz`
- `tar -xvf dep-aix-2.1.tar`
- Read the README file.
- Run the instoss script (contained in the tar file) to install the OSS packages.

### 2.2.3 Verify that the following basic AIX services needed

- **inetd**

inetd includes services such as telnet, ftp, bootp, and others. Edit the /etc/inetd.conf file to turn on all services that are needed. Ftp and bootp are required for pSeries node installations. Stop and restart the inetd service after any changes:

```
stopsrc -s inetd
```

```
startsrc -s inetd
```

- **NFS**

NFS is required for all NIM installs. Ensure the NFS daemons are running:

```
lssrc -g nfs
```

If any NFS services are inoperative, you can stop and restart the entire group of services:

```
stopsrc -g nfs
```

```
startsrc -g nfs
```

There are other system services that NFS depends on such as inetd, portmap, biod, and others. A handy trouble-shooting guide listing the required services can be found at:

[http://publib.boulder.ibm.com/infocenter/systems/index.jsp?topic=/com.ibm.aix.commadmn/doc/commadmndita/nfs\\_troublesh.htm](http://publib.boulder.ibm.com/infocenter/systems/index.jsp?topic=/com.ibm.aix.commadmn/doc/commadmndita/nfs_troublesh.htm)

- **DNS ( name resolution)**

Name resolution is required by xCAT. You can use a simple /etc/hosts mechanism, but setting up DNS would also work. You will need to have an accurate /etc/hosts file to use the xCAT makedns command. See Set up basic hosts file.

Make sure to verify and update the contents of both /etc/hosts (you may wish to use the xCAT makehosts command to do this after your nodes have been defined) and /etc/resolv.conf (for domain name and external name servers).

## 2.2.4 Download and Install the xCAT software

- Download the latest xCAT for AIX tar file from <http://xcat.sourceforge.net/aix/download.html> and copy it to a convenient location on your xCAT management node.
- Unwrap the xCAT tar file. For example,
  - *gunzip core-aix-2.1.tar.gz*
  - *tar -xvf core-aix-2.1.tar*
- Run the **instxcat** script (contained in the tar file) to install the xCAT software. The post processing provided by the xCAT packages will perform some basic xCAT configuration. (This includes initializing the SQLite database and starting **xcatd** daemon processes.)
- Execute the system profile file to set the xCAT paths. This file was updated during the xCAT post install processing. (“*/etc/profile*”). ( **Note**: Make sure you don't have a .profile file that overwrites the “PATH” environment variables.)

## 2.2.5 Verify the xCAT install

- Run the “*lsdef-h*” to check if the xCAT daemon is working. If you get a correct response then you should be ok.
- Check to see if the initial xCAT definitions have been created. For example, you can run “*lsdef-t site -l*” to get a listing of the default site definition. You should see output similar to the following.

-----  
*Setting the name of the site definition to 'clustersite'.*

*Object name: clustersite*

*domain=abc.foo.com*

*installdir=/install*

*tftpdire=/tftpboot*

*master=7.104.46.27*

*useSSHonAIX=no*

*xcatdport=3001*

*xcatiport=3002*

## 2.3 Setup Alternate Databases

XCAT supports a pluggable interface which allow you to choose the relational database you wish to use. The following are the currently supported databases, with SQLite being the default when xCAT is installed on the Management Node for the first time.

### 2.3.1 SQLite

XCAT will automatically perform the initial setup of an SQLite Database when the Management Node is first installed. This database is sufficient for small to moderate size systems ( less than 1000 nodes for Linux, 300 for AIX) , if you are not using hierarchy ( service nodes). SQLite cannot be used for hierarchy, because the service nodes require access to the database from the service node and this SQLite does not support remote access to the database. For hierarchy, you need to setup PostgreSQL or MySQL, see below.

### 2.3.2 PostgreSQL

Instructions for setting up a PostgreSQL database on Linux, go to the . [xCAT2 Linux Advanced Cookbook](#)

### 2.3.3 MySQL

Instructions for setting up a MySQL data base for xCAT on AIX or Linux are found in the [xCAT2 MySQL setup](#) documentation.

## 2.3.4 DB2 (TBD)

# 3.0 Deploying and Maintaining Cluster Nodes

## 3.1 Linux Nodes

xCAT supports deployment of diskfull and diskless Linux nodes in the cluster.

### 3.1.1 XCAT2 Linux Advanced Cookbook

The [xCAT2 Linux Advanced Cookbook](#) provides information on setting up diskfull and diskless Linux clusters.

### 3.1.2 pLinux Cookbook

The [xCAT2 pLinux Cookbook](#) provides information on setting up diskfull and diskless pLinux clusters.

### 3.1.3 Linux BladeCenter How-To

Instructions for installation of a BladeCenter configuration are contained in the [BladeCenter How-to](#).

### 3.1.4 IdataPlex How-To

An example of an iDataPlex configuration, and instructions for installation are contained in the [iDataPlex How-to](#).

### 3.1.5 SLES 10.1 notes

Some helpful notes on installing SLES 10 SP1 are contained in the “[SLES 10 SP 1 notes](#)”.

## 3.2 AIX Nodes

xCAT supports deployment of diskfull and diskless AIX nodes and mkysyb installs in the cluster.

### 3.2.1 AIX diskfull nodes

xCAT will install AIX standalone nodes using the NIM (Network Installation Management) “rte” method. NIM is an AIX tool that enables a cluster administrator to centrally manage the installation and configuration of AIX and optional software on machines within a networked environment. XCAT has features that will add you to automatically run the necessary NIM commands. The “[Installing AIX on Standalone Nodes](#)” how-to will guide you in this process.

### 3.2.2 AIX diskless nodes

xCAT supports deploying AIX diskless nodes using NIM. The “[Booting AIX Diskless Nodes](#)” how-to describes the process for deploying AIX diskless nodes.

### 3.2.3 AIX on JS blade installation

The document [xCAT2 AIX on JS blade – Howto](#) focuses on the step by step installation introduction for AIX on a JS blade center.

### 3.3 Updating the xCAT Cluster

You may need to update the nodes in the cluster (OS or applications) updating after the initial install. There are several ways to update depending on the scope of the update. You can use the [updatenode](#) function in xCAT to install additional software on the nodes. Other options are to use `nimnodecust`, rolling update, [xdsh](#), update the diskless image and reboot etc.

### 4.0 Node Discovery

One of the significant features of xCAT 2 is the node discovery approach. It ultimately performs the role of associating node MAC addresses with IP based on some physical cue (ethernet port or BladeCenter slot). It has the same goal as `getmacs` fulfilled historically, except it is node initiated, has more context to enable accommodation of more complex configurations, and automated.

The xCAT wiki section on [Node Discovery](#) contains information on the setup required to use the Discovery function.

### 5.0 Using Hierarchy

In large clusters it is desirable to have more than one node (the Management Node) handle the installation and management of the compute nodes. We call these additional nodes service nodes. You can have one or more service nodes set up to install & manage groups of compute nodes. With xCAT, you have the choice of either having each service node install a distinct set of compute nodes, or, if you are using Linux, having a pool of service nodes, any of which can respond to an installation request from a compute node. This document will cover the former case (distinct sets).

The service nodes need to communicate with the xCAT 2 database on the Management Node and run xCAT commands to install the nodes. The service node will be installed with the xCAT code and requires that the either MySQL or PostgreSQL Database be set up instead of the SQLite Default database. These databases allows a remote client to be set up on the service node such that the service node can access (read/write) the database on the Management Node.

#### 5.1 Linux

For a Linux cluster, setting up hierarchical support is documented in [xCAT2 Cookbook for Linux](#).

#### 5.2 AIX

For an AIX cluster, setting up hierarchical support is documented in (TBD).

### 6.0 Monitoring

There are two monitoring infrastructures in xCAT 2.0. The ***xCAT Monitoring Plug-in Infrastructure*** allows you to plug-in one or more third party monitoring software such as Ganglia, RMC, SNMP etc. to monitor the xCAT cluster. The ***xCAT Notification Infrastructure*** allows you to watch for the changes in xCAT database tables.

How to enable and use the xCAT Monitoring infrastructure is documented in the . [“xCAT 2.0 Monitoring How-to”](#)

## 7.0 xCAT imaging

Steps for imaging with xCAT are documented in [xCAT imaging with Partimage](#).

## 8.0 xCAT IB Support

The [xCAT IB support documents](#) will explain how to configure xCAT for infiniband.

## 9.0 Customize your installation methods

How to setup customized methods of installation are documented in [Boot Targets and Customized Installation methods](#).

## 10.0 Uninstalling xCAT on Linux

Steps for removing xCAT from your Management Node are documented in [Uninstalling xCAT2](#).

## 11.0 Migrating from xCAT 1.3 to 2.x

If you are planning to migrate from xCAT 1.3 to 2.x, read the [xCAT Quick Install Tutorial](#).

## 12.0 xCAT for CSM Admin

The Redbook "[xCAT 2 Guide for the CSM System Administrator](#)" describes the xCAT architecture, Quick deployment, and contains CSM to xCAT transition scenarios.

## 13.0 xCAT How-To(s)

There have been a variety of [How-To's](#) put out on the xCAT Wiki on various subjects and more are constantly being added. Check out the [How-To's](#) for valuable information.

## 14.0 xCAT on Windows

Directions for installing a Windows 2008 Enterprise Server (x86 / x86\_64) node with xCAT 2.1 are being developed. The latest notes are available [on the SourceForge xCAT wiki](#).

## 15.0 xCAT and Xen

xCAT can be configured to work with the Xen hypervisor to install and manage virtual compute nodes. Installing and setting up Xen for xCAT is documented in the [xCAT & Xen How-to](#).

## 16.0 xCAT Developer's Guide

If you would like to develop code for the xCAT project, read the [Developer's Guide](#) for information on the process.

## 17.0 References

### 17.1 xCAT Summary Commands and Database Tables

Select here for [Summary of Commands](#).

Select here for [Summary of Database Tables](#).

### 17.2 Stateless GPFS

GPFS is a premier cluster filesystem. You can run it stateless on nodes. “[How to setup a Stateless GPFS Cluster](#)” documents the process.

### 17.3 Maui

Installing and setting up MAUI for xCAT is documented in the [xCAT How-to for MAUI](#).

### 17.4 Torque

Installing and setting up Torque for xCAT is documented in the [xCAT2 Cookbook for Linux](#).

### 17.5 Ganglia

Installing and setting up Ganglia for xCAT is documented in the [xCAT How-to for Ganglia](#).

### 17.6 LDAP

LDAP can be used for user Management in xCAT. Installing and setting up LDAP for xCAT is documented in the [xCAT How-to for LDAP](#).

### 17.7 XCAT Developer Guide (TBD)

If you would like to develop code for the xCAT project, read the [Developer's Guide](#) for information on the process.

## 18.0 Known Bugs

[https://sourceforge.net/tracker/?group\\_id=208749&atid=1006945](https://sourceforge.net/tracker/?group_id=208749&atid=1006945)

## 19.0 Feature requests

[https://sourceforge.net/tracker/?group\\_id=208749&atid=1006948](https://sourceforge.net/tracker/?group_id=208749&atid=1006948)

## 20.0 References

- xCAT web site: <http://xcat.sf.net/>
- xCAT wiki: <http://xcat.wiki.sourceforge.net/>
- xCAT mailing list: <http://xcat.org/mailman/listinfo/xcat-user>

