

A Quick Guide to iSCSI on Linux

Cuddletech TekRef Series

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A quick and gentle overview of iSCSI on Linux. Setting up both an iSCSI initiator and iSCSI target on a Linux system are covered with a quick overview of essential iSCSI terms and ideas.

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Introduction

More and more it appears that iSCSI isn't going away, but might just be here to stay for awhile. In a nutshell, iSCSI is simply the pairing of the "best" of both NAS (using NFS or CIFSs over IP Ethernet networks) and SAN (Fibre Channel Fabrics) technologies. What you ultimately get is a protocol that allows you to use SCSI commands like Fibre Chan-

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nels FCP, yet does it over an IP network instead of a costly Fibre Channel Fabric. Instead of buying an expensive Brocade or McData switch and costly Fibre Channel HBAs from companies like JNI, Adaptec and Emulex, you can use any IP switch (NetGear, 3Com, Extreme, Foundry, etc) and normal Ethernet cards. Because SCSI is CPU intensive during high I/O loads iSCSI Host Bus Adapters (HBA) have arrived which act just like a FC HBA except that it uses Ethernet instead of FC Fabric; the idea being that the SCSI requests are offloaded from your primary CPU onto the ASIC on your iSCSI HBA.

SCSI uses a client-server architecture. A "client" (ie: your system) is an initiator, it initiates requests. A "server" (ie: your storage device) is a target, it has something you want and answers requests from the initiator(s). Initiators come in two varieties: software and hardware. A software initiator is just a driver that handles all requests and pairs the network interfaces driver and the SCSI drivers together to make it all work. Using a software initiator any system with an ethernet card can act as an iSCSI initiator. A hardware initiator is an iSCSI HBA, which is basically just an ethernet card with a SCSI ASIC on-board to offload all the work from the system CPU. Because there is no cost involved in using a software initiator we'll look at that. Adaptec is currently selling iSCSI HBA's which have Linux drivers available if you choose to go that route.

There are three very interesting projects in the Linux community regarding iSCSI at the moment. The first is a project from the University of New Hampshire's Inter-op Labs (legendary in Fibre Channel circles). Their iSCSI implementation provides both software initiator and target code for use with a Linux kernel. While it's an interesting project, they admit that their target code is really only around for testing their initiator code, and documentation and tools for the UNH iSCSI code is confusing. Even when you get UNH iSCSI running it's unclear what it's doing and how. So we look at 2 other projects which complement each other: The Linux iSCSI Target Implementation from Ardis Technologies and the Linux-iSCSI Project (software initiator). We will look at these 2 projects for testing and playing with iSCSI.

The Basics

Before we actually build anything, you need to understand a couple things. Lets look at how iSCSI addresses are formed and how iSCSI is used, some general terms, and overall methodology.

It's important to understand that iSCSI, unlike NAS, makes block devices available via the network. Effectively, you can mount block devices (disks) across an IP network to your local system and then use them like any other block device. Generally when you first use an iSCSI device your going to need to partition it, label it, and create a filesystem on it. Unlike NAS your kernel will be able to read and write to your new iSCSI device just as if it were a local hard disk and therefore you can use any filesystem you like (EXT2/3, JFS, XFS, ReiserFS, etc). Also, because it is being handled as a block device only one (1) system can use the iSCSI device at a time! (This changes if you use a global filesystem, or read-only filesystem.) So just like Fibre Channel your not making 4

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machines access 1 filesystem, but instead your allocating 4 chunks of disk on one large device and making it available via an iSCSI target so that 4 initiators can access it.

All devices in an iSCSI environment will have addresses. Think of addresses in iSCSI as being the iSCSI equivalent to a Fibre Channel WWN. Every address must be unique. Initiators will have addresses, and targets will have addresses. When you define a target you can specify the address yourself. When you use an initiator the address is typically defined for you. For instance, on my test setup used for this tutorial I have the following addresses:

On Nexus, Linux System:

```
iqn.1987-05.com.cisco:01.54197b8f9a8 -> Linux Initiator Address
iqn.1997-06.com.homestead:storage.disk1.nexus -> iSCSI Target Disk on Nexus
iqn.1997-06.com.homestead:storage.disk2.drew -> iSCSI Target Disk for Drew
iqn.1997-06.com.homestead:storage.raid.stripe0 -> iSCSI Target RAID
```

On Blade, Solaris System:

```
iqn.1987-05.com.cisco:01.f554845210af -> Solaris Initiator Address
```

iSCSI uses the following form for addresses, as found documented in IETF iSCSI Protocol Draft 20.

iSCSI Address Form:

The following are examples of iSCSI qualified names that might be generated by "EXAMPLE Storage Arrays, Inc."

Type	Date	Naming Auth	String defined by "example.com" naming authority
iqn.2001-04.com.example:storage:diskarrays-sn-a8675309			
iqn.2001-04.com.example			
iqn.2001-04.com.example:storage.tape1.sys1.xyz			
iqn.2001-04.com.example:storage.disk2.sys1.xyz			

In the above examples, you can see the form. There are two different address types, iqn (iSCSI Qualified Name) and eui (IEEE EUI-64 format). The date field is the date of the first full month that your naming authority domain name was registered. The Naming Auth is the naming authority (domain name) for this target, reversed. Following the naming authority is a colon, after which you can put anything you want to help you better organize your resources. In the example above (#2) this field is left off completely which is legal. In examples 1 and 3 above you can see different naming conventions being used to clarify the target resources type. But in both cases the date and naming authority are the same. Cuddletech was registered on Jan 30th, 1999, so if I shared a 20G target I might use the target address: "iqn.1999-02.com.cuddletech:public.dump.20g-Seagate.jfs". So far I have not seen an implementation that actually used the naming authority for resolution, so it doesn't really matter what the naming authority is. Most Cisco targets and initi-

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ators will get the naming authority of cisco.com, and that's not a problem. You'll almost always be asked for the IP address of the iSCSI target, so feel free to name your targets anything you want so long as it follows the convention above.

Some other terms you may want to know include "portals" and "discovery". An iSCSI portal is a target's IP and TCP port number pair. Typically, if the port number is not specified it is defaulted to 3260. Discovery, or auto-discovery, is the process of an initiator asking a target portal for a list of its targets and thus making those available to the initiator for use. Most of the time using discovery on a target portal is the best way to get connected, and you'll see this done when we setup an initiator later. You can, however, alternately specify specifically the portal and target you wish to use. You can also use iSNS (the Internet Storage Name Service) for discovery instead of contacting a specific portal. iSNS is effectively like DNS for network storage devices. Finally, one cool thing you can do, especially if you're using iSCSI as a method to extend your FC-SAN, is to allow multipathing for fault-tolerance. In such a case, a storage device would be available as a target on 2 or more target portals (or specified as such in your iSNS directory) and if one server died, you could continue to access the device through the other portals. But doing such is beyond the scope of this tutorial.

Setting up a Target

Using the Linux iSCSI Target Implementation from Ardis Technologies [<http://www.ardistech.com/iscsi/>] we can create iSCSI targets on any Linux system which can be accessed from the iSCSI initiator we'll set up in the next section. A system that will make targets available only needs some partition to be available for export, and it does not need to be a SCSI disk.

The following are the steps to setup an iSCSI target.

Procedure 1. Setting up an iSCSI Target

1. Download the iSCSI Target code from: <http://www.ardistech.com/iscsi/>

Warning

I had problems with the 20040211 release, when loading the modules I'd get unresolved symbols. Using the January release worked fine.

2. Download and configure (make menuconfig) a Linux 2.4.22 kernel. Patch the kernel with the diff in the target code (ie: kernel.2.4.22.diff).

```
[benr@nexus linux-2.4.22]$ patch -p0 <
```

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```
    ../linux-iscsi-target-20040116/kernel.2.4.22.diff
patching file include/linux/mm.h
patching file include/linux/pagemap.h
patching file kernel/ksyms.c
patching file mm/filemap.c
[benr@nexus linux-2.4.22]$
```

3. There are no iSCSI options you need to select except to have the normal SCSI driver built. Just build and install your kernel in the usual way. Then boot it.
4. Next, build the target module and tools source. You'll need to define the environmental variable `KERNELSRC` to point to the location of the kernel tree you patched and installed.

```
[benr@nexus linux-iscsi-target-20040116]$ make
set $KERNELSRC!
[benr@nexus linux-iscsi-target-20040116]$ export KERNELSRC=../linux-2.4.22
[benr@nexus linux-iscsi-target-20040116]$ make
( ... Removed for clarity ... )
[benr@nexus linux-iscsi-target-20040116]$ make install
( ... Removed for clarity ... )
```

This will install the iSCSI target module (`iscsi_trgt_mod.o`) into `/lib/modules` and the target daemon (`iscsi_trgt`) into `/usr/sbin`.

5. Copy the `iscsid.config` file to `/etc`, and edit it to meet your needs.

```
[benr@nexus /etc]$ cat iscsid.config
## iSCSI Target Configuration File
User benr

Target iqn.1997-06.com.homestead:storage.disk1.nexus
    User
    # Lun definition
    # (right now only block devices are possible)
    Lun 0 /dev/sdb
    # Alias name for this target
    Alias Test

Target iqn.1997-06.com.homestead:storage.disk2.drew
    User
    # Lun definition
    # (right now only block devices are possible)
    Lun 0 /dev/sdc
    # Alias name for this target
    Alias NTFS
```

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6. Copy the `iscsid.rc` to `/etc/init.d/iscsid` and make it executable.
7. Now, you should be able to start the iSCSI Targets.

```
[root@nexus /root]# /etc/init.d/iscsid start
Starting iSCSI target.
[root@nexus /root]#
```

As defined in the above procedure, according to my `iscsid.conf`, I'm offering 2 iSCSI targets. I can use these target names later when I connect to them with an initiator.

Keep an eye on the `syslog` when you start the iSCSI Target Daemon (`tail -f /var/log/messages`) to watch for startup messages and any warnings.

Setting up an Initiator

The Linux-iSCSI Project [<http://linux-iscsi.sourceforge.net/>] provides a driver, daemon, and tools for their iSCSI software initiator. This project is the Open Source version of the Cisco iSCSI driver intended for use with the Cisco SN 5428-2 Storage Router, but can be used with any iSCSI target. This driver is also available in a closed form for Solaris and HP-UX from Cisco.

The following are the steps to set up a software initiator.

Procedure 2. Setting up an iSCSI Initiator

1. Download the appropriate tarball from http://sourceforge.net/project/showfiles.php?group_id=26396. Make sure that the version you download corresponds with the kernel you are using, otherwise you'll have all types of strange problems. If you are also running an iSCSI target on this system you'll want to use the 2.4 Production Source (3.4.2 as of this writing).
2. Untar the source tarball and edit the Makefile. Change `KERNEL_CONFIG` and `TOPDIR` to match the location of your kernel source tree if your kernel tree isn't in the "usual place" (`/usr/src/linux`).
3. Compile the source with "make" and then as root install with "make install". This will install all the tools, daemons, init script, sample config file, and modules into place.

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```
[root@nexus linux-iscsi-3.4.2]# make install
```

```
Note: using kernel source from /lib/modules/2.4.22/build containing kernel version 2.4.22
```

```
Note: using kernel config from /lib/modules/2.4.22/build/.config
```

```
Installing iSCSI driver for Linux 2.4.22
```

```
The initialization script has been installed as /etc/rc.d/init.d/iscsi.
```

```
iSCSI has been set up to run automatically when you reboot.
```

```
InitiatorName iqn.1987-05.com.cisco:01.9c871ac985a was generated and written to /etc/initiatorname.iscsi.
```

```
Make sure you check and edit the /etc/iscsi.conf file!
```

4. Edit your `/etc/iscsi.conf`. If you aren't sure how to configure your initiator you can specify any username and password (assuming your not using authentication on your target) and use the `DiscoveryAddress` keyword to define an address to discover. If you created a target on this machine, specify it's address to discover.

```
[root@nexus /etc]# cat iscsi.conf
Username=benr
Password=fakepass

DiscoveryAddress=10.10.1.100
  Username=benr
  Password=somepass
```

5. Now start the initiator using the RC script. Watch syslog (`tail -f /var/log/messages`) while you do this.

```
[root@nexus /]# /etc/init.d/iscsi start
Starting iSCSI: iscsi iscsid fsck/mount
[root@nexus /]#
```

My syslog output is below. You may see errors and warnings during the startup, I have removed warnings and dates from the output below for clarity.

```
[root@nexus /]# tail -f /var/log/messages

iscsid[30112]: version 3.4.2 (16-Feb-2004)
iscsid[30112]: INBP boot check returned this_is_inbp_boot = 0
kernel: iSCSI: bus 0 target 1 = iqn.1997-06.com.homestead:storage.disk2.drew
kernel: iSCSI: bus 0 target 1 portal 0 = address 10.10.1.100 port 3260 group 1
kernel: iSCSI: bus 0 target 1 trying to establish session df2dc000 to portal 0,
```

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```
address 10.10.1.100 port 3260 group 1
kernel: iSCSI: bus 0 target 1 established session df2dc000 #1, portal 0,
address 10.10.1.100 port 3260 group 1
kernel: iSCSI: bus 0 target 0 = iqn.1997-06.com.homestead:storage.disk1.nexus
kernel: iSCSI: bus 0 target 0 portal 0 = address 10.10.1.100 port 3260 group 1
kernel: iSCSI: bus 0 target 0 trying to establish session ca4ee000 to portal 0,
address 10.10.1.100 port 3260 group 1
kernel: iSCSI: bus 0 target 0 established session ca4ee000 #1, portal 0,
address 10.10.1.100 port 3260 group 1
kernel: scsi singledevice 1 0 0 0
kernel: Vendor: LINUX Model: ISCSI Rev: 0
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: Attached scsi disk sdh at scsil, channel 0, id 0, lun 0
kernel: SCSI device sdh: 35566480 512-byte hdwr sectors (18210 MB)
kernel: sdh: unknown partition table
kernel: scsi singledevice 1 0 1 0
kernel: Vendor: LINUX Model: ISCSI Rev: 0
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: Attached scsi disk sdi at scsil, channel 0, id 1, lun 0
kernel: SCSI device sdi: 35566480 512-byte hdwr sectors (18210 MB)
kernel: sdi: sdil
```

6. If everything goes properly, your initiator should have auto-discovered the targets from your target daemon. You can use the command "iscsi-ls" to see which targets your connected to.

```
[root@nexus /]# iscsi-ls
*****
Cisco iSCSI Driver Version ... 3.4.2 (16-Feb-2004)
*****
TARGET NAME           : iqn.1997-06.com.homestead:storage.disk1.nexus
TARGET ALIAS          :
HOST NO                : 1
BUS NO                 : 0
TARGET ID              : 0
TARGET ADDRESS        : 10.10.1.100:3260
SESSION STATUS        : ESTABLISHED AT Mon Apr 12 15:13:32 2004
NO. OF PORTALS        : 1
PORTAL ADDRESS 1      : 10.10.1.100:3260,1
SESSION ID             : ISID 00023d000001 TSID 100
*****
TARGET NAME           : iqn.1997-06.com.homestead:storage.disk2.drew
TARGET ALIAS          :
HOST NO                : 1
BUS NO                 : 0
TARGET ID              : 1
TARGET ADDRESS        : 10.10.1.100:3260
SESSION STATUS        : ESTABLISHED AT Mon Apr 12 15:13:32 2004
NO. OF PORTALS        : 1
PORTAL ADDRESS 1      : 10.10.1.100:3260,1
SESSION ID             : ISID 00023d000001 TSID 100
*****
[root@nexus /]#
```

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You'll notice in the above output that these 2 targets are using the names I defined in the Target daemon config file.

7. You can now partition and create a filesystem on the target in the usual ways. Use the syslog output to figure out the mapping from iSCSI target to Linux device name.

```
[root@nexus /]# fdisk /dev/sdh
Command (m for help): n
Command action
  e   extended
  p   primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-17366, default 1):
Using default value 1
Last cylinder or +size or +sizeM or +sizeK (1-17366, default 17366):
Using default value 17366

Command (m for help): p

Disk /dev/sdh: 64 heads, 32 sectors, 17366 cylinders
Units = cylinders of 2048 * 512 bytes

   Device Boot      Start         End      Blocks   Id  System
/dev/sdh1                1         17366    17782768    83  Linux

Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.

WARNING: If you have created or modified any DOS 6.x
partitions, please see the fdisk manual page for additional
information.
Syncing disks.
[root@nexus /]# mkfs -t jfs /dev/sdh1
mkfs.jfs version 1.1.0, 20-Nov-2002
Warning!  All data on device /dev/sdh1 will be lost!

Continue? (Y/N) y
\

Format completed successfully.

17782768 kilobytes total disk space.
[root@nexus /]# mount -t jfs /dev/sdh1 /iscsi
[root@nexus /]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/hda1        4.8G  4.3G  286M  94% /
/dev/hda5        13G   11G   2.0G  85% /home
/dev/sdh1        17G   2.3M   16G   1% /iscsi
[root@nexus /]#
```

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This should get your target mounted and ready to use!

A word about initiator device paths on Linux

There are 2 paths available for use, the standard Linux block device (ie: `/dev/sdx`, `/dev/sdx1`, etc) and the iSCSI device path (the `/dev/iscsi` tree). The devices in the iSCSI tree are just symlinks back to the standard Linux paths, however the iSCSI paths provide more clarity which is useful for troubleshooting. Specifically, because the iSCSI commands shown above do not report the Linux block device name, they do however show the bus number, target id, and lun. An iSCSI device path looks like this:

```
[root@nexus /]# ls -l /dev/iscsi/bus0/target0/lun0
total 0
lrwxrwxrwx  1 root    root          8 Apr 13 12:25 disk -> /dev/sdh
lrwxrwxrwx  1 root    root          8 Apr 13 12:25 generic -> /dev/sg7
lrwxrwxrwx  1 root    root          9 Apr 13 12:25 part1 -> /dev/sdh1
...
```

In this tutorial I have utilized the Linux block device name instead of the full iSCSI device path primarily due to formatting concerns (iSCSI paths run off the page). I *do not* recommend that you use the Linux block device directly for any reason. Failing to utilize the iSCSI paths will only create confusion and impair troubleshooting.

Notes for using a Linux Initiator with NetApp Filer Targets

If you expect to use the initiator to connect to a NetApp Filer at some point you will need to add some extra parameters to your `/etc/iscsi.conf`. Here is the configuration file I use for connecting to a NetApp 840 Filer:

```
Username=benr
Password=nopassneeded

### NetApp 940 iSCSI Portal
DiscoveryAddress=10.10.2.240

### These lines are required for NetApp Filers
### If you do not add them you will not be able
### to communicate with the filer!
Continuous=no
HeaderDigest=never
DataDigest=never
ImmediateData=yes
```

If the four parameters listed here are not present you'll get all sorts of strange timeouts

and warning, and you'll even connect but never be able to access the LUNs. For further information about iSCSI on NetApp Filers, head over to now.netapp.com.

Accessing iSCSI Targets from non-Linux Hosts

You can obtain obtain iSCSI software initiators for a variety of different operating systems. You can get the a Windows initiator from Microsoft and other initiators (HP-UX, Solaris, etc) from Cisco. The Cisco initiator uses the exact same syntax as the Linux client. For Windows clients just have the client software try to auto-discover your system hosting the targets and go from there.

If you do plan to use targets on Solaris initiators, take note of disk settings (heads, disks, cylinders) on the Linux host before you setup the Solaris system. On Solaris you'll need to install the Cisco package, edit your `/etc/iscsi.conf` just like you did on your Linux initiator (the syntax is identical) and then start the initiator (`/etc/init.d/iscsi start`). Once the targets are available to your Solaris system you'll need to create the device paths (**devfsadm**) and then repartition and label the device (the **format** command). When you select the iSCSI target in the format tool you'll be told that it can't be recognized as a Solaris disk and will want you to configure it, and auto-layout won't work. You'll need to take the values that your linux system saw and use those. Most of the values can be defaulted. You can find the values you need in the `/proc` filesystem on your linux initiator, but it's probly easier to just look at the partition map on the device using **fdisk** and then use those values. At that point you can actually partition slices on the disk and label it for use.

Here is a quick look at adding an initiator on Solaris:

Procedure 3. Setting up a Solaris Initiator

1. Start by installing the Cisco iSCSI package for Solaris

```
# gzcat solaris-iscsi-3.3.5.tar.Z | tar xfv -
(Lines removed)
# pkgadd -d .
```

```
The following packages are available:
 1  CSCOiscsi      Cisco iSCSI device driver
                        (sparc) 3.3.5
```

```
Select package(s) you wish to process (or 'all' to process
all packages). (default: all) [?,??,q]: 1
(Lines removed)
```

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2. Now check the initiator name so that you can configure your targets as needed.

```
# cat /etc/initiatorname.iscsi
InitiatorName=iqn.1987-05.com.cisco:01.7fcfb3a9ad78
```

3. After setting up your targets, start up the iSCSI initiator and see whats available.

```
# cat /etc/initiatorname.iscsi
InitiatorName=iqn.1987-05.com.cisco:01.7fcfb3a9ad78
# /etc/init.d/iscsi start
iSCSI is starting.
#
# iscsi-ls
*****
TARGET NAME iqn.1992-08.com.netapp:sn.33582139
TARGET ID 0:
  ADDRESS = 10.10.2.240:3260, 1
  STATUS = Connected 10.10.2.244:38784<->10.10.2.240:3260 6/6/2004 22:19:50
  SESSION = ISID 00023d000001 TSID 351 PID 6440
*****
```

4. If you take a look at **format** you won't see our iSCSI block device because it hasn't been added to the devfs yet. Use **devfsadm** to create the devices. Note: I use the **-vC** options to **devfsadm** to show me what it does (**-v**: verbose) and to clean any old or unneeded entries from the tree (**-C**: Cleanup).

```
# format
Searching for disks...done
```

```
AVAILABLE DISK SELECTIONS:
  0. c0t0d0 <SUN18G cyl 7506 alt 2 hd 19 sec 248>
     /sbus@1f,0/SUNW,fas@e,8800000/sd@0,0
```

```
Specify disk (enter its number): ^D
```

```
# devfsadm -vC
```

```
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:a 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s0 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:a
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:b 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s1 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:b
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:c 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s2 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:c
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:d 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s3 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:d
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:e 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s4 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:e
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:f 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s5 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:f
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:g 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s6 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:g
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:h 01/31/60640
devfsadm[6456]: verbose: symlink /dev/dsk/clt0d0s7 -> ../../devices/iscsipseudo/iscsi@0/sd@0,0:h
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:a,raw 01/31/20640
```

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```
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s0 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:b,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s1 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:c,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s2 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:d,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s3 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:e,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s4 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:f,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s5 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:g,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s6 -> ../../devices/iscsipseudo/iscsi
devfsadm[6456]: verbose: mknod /devices/iscsipseudo/iscsi@0/sd@0,0:h,raw 01/31/20640
devfsadm[6456]: verbose: symlink /dev/rdisk/ctl0d0s7 -> ../../devices/iscsipseudo/iscsi
```

5. Now the device exists. Use **format** to label and if needbe partition the device.

```
# format
Searching for disks...done

ctl0d0: configured with capacity of 19.99GB

AVAILABLE DISK SELECTIONS:
  0. c0t0d0 <SUN18G cyl 7506 alt 2 hd 19 sec 248>
     /sbus@1f,0/SUNW,fas@e,8800000/sd@0,0
  1. clt0d0 <NETAPP-LUN-0.2 cyl 5118 alt 2 hd 16 sec 512>
     /iscsipseudo/iscsi@0/sd@0,0
Specify disk (enter its number): 1
selecting clt0d0
[disk formatted]
Disk not labeled. Label it now? y
    (blah blah blah)
format> quit
```

6. If everything looks good so far, create your filesystem(s) and mount it.

```
# newfs /dev/rdisk/ctl0d0s2
newfs: construct a new file system /dev/rdisk/ctl0d0s2: (y/n)? y
/dev/rdisk/ctl0d0s2:      41926656 sectors in 5118 cylinders of 16 tracks, 512 sectors
      20472.0MB in 394 cyl groups (13 c/g, 52.00MB/g, 6336 i/g)
super-block backups (for fsck -F ufs -o b=#) at:
   32, 107040, 214048, 321056, 428064, 535072, 642080, 749088, 856096, 963104,
Initializing cylinder groups:
.....
super-block backups for last 10 cylinder groups at:
   40894496, 41001504, 41108512, 41215520, 41322528, 41429536, 41536544,
   41643552, 41750560, 41857568,
# mount /dev/dsk/ctl0d0s2 /iscsi/
# df -h
Filesystem                size  used  avail capacity  Mounted on
/dev/dsk/c0t0d0s0          16G   2.4G   13G    16%      /
/proc                      0K     0K     0K     0%      /proc
```

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```
mnttab          0K      0K      0K      0%    /etc/mnttab
fd              0K      0K      0K      0%    /dev/fd
swap           487M    40K    487M    1%    /var/run
swap           487M    40K    487M    1%    /tmp
/dev/dsk/clt0d0s2 20G     9K     19G     1%    /iscsi
#
```

7. Lastly, if you want the iSCSI share automatically mounted at boot when the `iscsi init` script runs, update your `/etc/vfstab` like you usually would, but in the "Mount at Boot" column instead of "yes" or "no", place the identifier "iscsi" to note that it's an iSCSI share. My line looks like this:

```
/dev/dsk/clt0d0s2 /dev/rdisk/clt0d0s2 /iscsi    ufs    1    iscsi    -
```

8. You're done! Read and write stuff to the share to make sure everything is working properly and possibly even pull out a benchmark to see what throughput you're getting. I personally recommend IOzone [<http://www.iozone.org/>].

Using Volumes as iSCSI Targets

The target implementation used earlier can be used only on block devices at the present. This means that we can create block devices and use those, allowing us to use Linux RAID, LVM, Vinum, EVMS or any other volume manager in order to create more efficient storage solutions. In the following procedure we'll use the Linux RAID tools to create a 4 disk RAID0 (striped) volume and then make it available as an iSCSI target.

Warning

I am personally not a fan of the Linux RAID tools. I use them here simply because it's quick and easy, and so that this procedure is about iSCSI and not an LVM or EVMS tutorial. I highly suggest that if you plan to seriously use volumes for iSCSI that you consider using LVM, Vinum, or EVMS.

Procedure 4. Setting up RAID Targets

1. Ensure that Linux RAID (and LVM if you want it) are compiled into your kernel, and that the **mkraid** tool is installed.

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2. Create a raidtab for your volume, such as the following.

```
[root@nexus /etc]# cat raidtab
raiddev /dev/md0
raid-level 0
nr-raid-disks 4
persistent-superblock 1
chunk-size 8

device /dev/sdd1
raid-disk 0
device /dev/sde1
raid-disk 1
device /dev/sdf1
raid-disk 2
device /dev/sdg1
raid-disk 3
[root@nexus /etc]#
```

3. Create the volume.

```
[root@nexus /etc]# mkraid /dev/md0
handling MD device /dev/md0
analyzing super-block
disk 0: /dev/sdd1, 17782768kB, raid superblock at 17782656kB
disk 1: /dev/sde1, 17782768kB, raid superblock at 17782656kB
disk 2: /dev/sdf1, 17782768kB, raid superblock at 17782656kB
disk 3: /dev/sdg1, 17782768kB, raid superblock at 17782656kB
[root@nexus /etc]#
```

4. Add the metadvice to your /etc/iscsid.conf.

```
# 4 Disk Linux RAID Stripe
Target ign.1997-06.com.homestead:storage.raid.stripe0
User
Lun 0 /dev/md0
Alias RAID0
```

5. If iSCSI is in use, stop both the initiator and the target daemons now.

```
[root@nexus /etc]# /etc/init.d/iscsi stop
Stopping iSCSI: sync umount sync iscsid iscsi
[root@nexus /etc]# /etc/init.d/iscsid stop
Stopping iSCSI target.
```

6. Start the target daemon and then the initiator. Watch syslog while you do this to

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make sure your new target is auto-discovered.

```
[root@nexus /etc]# /etc/init.d/iscsid start
Starting iSCSI target.
[root@nexus /etc]# /etc/init.d/iscsi start
Starting iSCSI: iscsi iscsid fsck/mount
```

In syslog (/var/log/messages) we see a new target auto-discovered.

```
kernel: scsi singledevice 1 0 2 0
kernel: Vendor: LINUX Model: ISCSI Rev: 0
kernel: Type: Direct-Access ANSI SCSI revision: 03
kernel: Attached scsi disk sdj at scsil, channel 0, id 2, lun 0
kernel: SCSI device sdj: 142261248 512-byte hdwr sectors (72838 MB)
kernel: sdj: unknown partition table
```

7. Now partition, label and create a filesystem on the new target.

```
[root@nexus /etc]# fdisk /dev/sdj
( Removed for Clarity )
Command (m for help): p

Disk /dev/sdj: 64 heads, 32 sectors, 69463 cylinders
Units = cylinders of 2048 * 512 bytes

   Device Boot      Start         End      Blocks   Id  System
Command (m for help): n
Command action
   e   extended
   p   primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-69463, default 1):
Using default value 1
Last cylinder or +size or +sizeK (1-69463, default 69463):
Using default value 69463

Command (m for help): p

Disk /dev/sdj: 64 heads, 32 sectors, 69463 cylinders
Units = cylinders of 2048 * 512 bytes

   Device Boot      Start         End      Blocks   Id  System
 /dev/sdj1          1           69463    71130096   83  Linux
Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.

( Removed for Clarity )
Syncing disks.
```

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```
[root@nexus /etc]# mkfs -t jfs /dev/sdj1
mkfs.jfs version 1.1.0, 20-Nov-2002
Warning! All data on device /dev/sdj1 will be lost!

Continue? (Y/N) y
\

Format completed successfully.

71130096 kilobytes total disk space.
```

8. Now mount it.

```
[root@nexus /]# mkdir /iscsi_raid
[root@nexus /]# mount -t jfs /dev/sdj1 /iscsi_raid
[root@nexus /]# df -h
```

Filesystem	Size	Used	Avail	Use%	Mounted on
/dev/hda1	4.8G	4.3G	286M	94%	/
/dev/hda5	13G	11G	2.0G	85%	/home
/dev/sdj1	68G	8.7M	67G	1%	/iscsi_raid

9. Done! Put some data on the new device and watch all the lights blink while you do writes, run some benchmarks, or just watch iostat data while you copy data onto the device.

```
[root@nexus benr]# iostat -kt
Linux 2.4.22 (nexus.homestead.com)      04/13/2004

( Removed for Clarity )

avg-cpu:  %user   %nice    %sys %iowait    %idle
           7.00    0.00   50.00    0.00   43.00

Device:            tps    kB_read/s    kB_wrtn/s    kB_read    kB_wrtn
dev3-0              205.00      8488.00      2248.00      8488      2248
dev8-0               0.00         0.00         0.00         0         0
dev8-1               0.00         0.00         0.00         0         0
dev8-2               0.00         0.00         0.00         0         0
dev8-3              122.00         0.00      3604.00         0      3604
dev8-4              120.00         0.00      3596.00         0      3596
dev8-5              121.00         0.00      3604.00         0      3604
dev8-6              122.00         0.00      3600.00         0      3600
dev8-7               0.00         0.00         0.00         0         0
dev8-8               0.00         0.00         0.00         0         0
dev8-9              126.00         0.00     14404.00         0     14404
```

Cisco iSCSI Initiator Command Reference

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As mentioned earlier, the Linux-iSCSI Initiator implementation is simply the Open Source version of the Cisco closed source driver available for several platforms. Here is a quick overview of its different tools.

Cisco iSCSI Initiator Tools

iscsi-iname A iSCSI initiator address generator. Using `/dev/random` and the system clock it creates a (hopefully) unique address that can be used for initiator setup. This tool is used for generating the initial iSCSI initiator address stored in `/etc/initiatorname.iscsi`

```
[root@nexus ~]# iscsi-iname
iqn.1987-05.com.cisco:01.8494d06dc35d
[root@nexus ~]#
```

Warning

Some iSCSI devices implement access control based on the initiators iSCSI address. *Do not* use the address supplied by `iscsi-iname`. Your true initiator address is stored in the file `/etc/initiatorname.iscsi`. The address in this file will be returned to the portal as your valid address, and therefore should always be used. The address in that file can in fact be changed but it must be unique. Using the default is recommended.

iscsi-ls Display details about available targets. With no arguments you can view all the available targets. Using `-l` you can view LUN information for each target. Using `-c` you can view the target configuration information (timeouts, burst lengths, etc). Both `-b` and `-t` provide ways to query a specific target either by the local busId or by the target ID (address) itself.

```
[root@nexus ~]# iscsi-ls
*****
Cisco iSCSI Driver Version ... 3.4.2 (16-Feb-2004 )
*****
TARGET NAME           : iqn.1997-06.com.homestead:stora..
TARGET ALIAS          :
HOST NO                : 1
BUS NO                 : 0
TARGET ID              : 0
TARGET ADDRESS        : 10.10.1.100:3260
SESSION STATUS        : ESTABLISHED AT Tue Apr 13 12:25:..
NO. OF PORTALS        : 1
PORTAL ADDRESS 1      : 10.10.1.100:3260,1
```

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```
SESSION ID : ISID 00023d000001 TSID 100
*****
```

iscsi-device

Display tab delimited output detailing information regarding an iSCSI block device, including target address, target IP and port, LUN number, etc. This is just a different way of getting the same info you can get from **iscsi-ls**.

```
[root@nexus ~]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/hda1       4.8G  4.3G  285M  94% /
/dev/hda5       13G   11G   2.0G  85% /home
/dev/sdj1       68G  391M   67G   1% /iscsi_raid
[root@nexus ~]# iscsi-device /dev/sdj
/dev/sdj: 0 2 0 10.10.1.100 3260
iqn.1997-06.com.homestead:storage.raid.stripe0
```

iscsi-mountall

The iSCSI equivalent to mountall. It attempts to mount all the file systems listed in the `/etc/fstab.iscsi` file, which uses the same syntax as the standard system `fstab`.

```
[root@nexus ~]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/hda1       4.8G  4.3G  285M  94% /
/dev/hda5       13G   11G   2.0G  85% /home
[root@nexus ~]# cat /etc/fstab.iscsi
# /etc/fstab.iscsi file for filesystems built on iscsi devices.
#iSCSI LUN      Mount Point    FS      Options  Dump Pass
#-----
/dev/sdj1      /iscsi_raid    jfs     defaults 0 0
[root@nexus ~]# iscsi-mountall
fsck.jfs version 1.1.0, 20-Nov-2002
The current device is: /dev/sdj1
Block size in bytes: 4096
File system size in blocks: 17782524
Phase 0 - Replay Journal Log
File system is clean.

[root@nexus ~]# df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/hda1       4.8G  4.3G  285M  94% /
/dev/hda5       13G   11G   2.0G  85% /home
/dev/sdj1       68G  391M   67G   1% /iscsi_raid
[root@nexus ~]#
```

iscsi-umountall

The converse of **iscsi-mountall**. It unmounts all filesystems specified in `/etc/fstab.iscsi`.

Resources and Further Reading

- Linux iSCSI Target Implementation [<http://www.ardistech.com/iscsi/>]: A Open Source Linux Target implementation by Ardis Technologies.
- Linux iSCSI Project [<http://linux-iscsi.sourceforge.net/>]: An Open Source driver and daemon for iSCSI on Linux
- UNH-iSCSI [<http://unh-iscsi.sourceforge.net/>]: An Open Source iSCSI target and initiator project by the University of New Hampshire.
- Cisco iSCSI Drivers [<http://www.cisco.com/cgi-bin/tablebuild.pl/sn5420-scsi>]: Official drivers from Cisco. Get the Solaris initiator here. You must have a customer login to download.
- Microsoft iSCSI Home [<http://www.microsoft.com/windows/storage/iscsi.msp>]: Microsoft resources for using iSCSI and iSNS.
- IETF IP Storage Charter [<http://www.ietf.org/html.charters/ips-charter.html>]: The IETF overview of where IP Storage is going and whats in the works. Find all the IETF Drafts here.
- IP Storage Network Trends [<http://www.iscsistorage.com/index.html>]: Your general run of the mill marketing site full of crap, ads, and maybe 1 or 2 useful tidbits.
- Linux iSNS Project [<http://sourceforge.net/projects/linuxisns>]: An Open Source iSNS Server and Client for Linux (and Windows)
- A Technical Overview of iSNS [<http://www.san-ip.com/iSCSI/techoverviewart.htm>]: A decent read on the topic.