Pacemaker

Clusters from Scratch - Apache, DRBD and GFS2

Creating Active/Passive and Active/Active Clusters on Fedora 12

by Andrew Beekhof

pacemaker@clusterlabs.org

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Read-Me-First

The Scope of this Document

The purpose of this document is to provide a start-to-finish guide to building an example active/passive cluster with Pacemaker and show how it can be converted to an active/active one.

The example cluster will use:

- Fedora 11 as the host operating system
- OpenAIS to provide messaging and membership services,
- Pacemaker to perform resource management,
- DRBD as a cost-effective alternative to shared storage,
- GFS2 as the cluster filesystem (in active/active mode)
- The crm shell for displaying the configuration and making changes

Given the graphical nature of the Fedora install process, a number of screenshots are included. However the guide is primarily composed of commands, the reasons for executing them and their expected outputs.

Formatting conventions used in this document

command to be executed

```
[root@pcmk-1 ~]# command to be executed
Sample output
Part of the output to look for in particular
More output
```

If a command is listed and not followed by any output, then it should be assumed that the command does not produce any.

What Is Pacemaker?

Pacemaker is a cluster resource manager. It achieves maximum availability for your cluster services (aka. resources) by detecting and recovering from node and resource-level failures by making use of the messaging and membership capabilities provided by your preferred cluster infrastructure (either OpenAIS or Heartbeat).

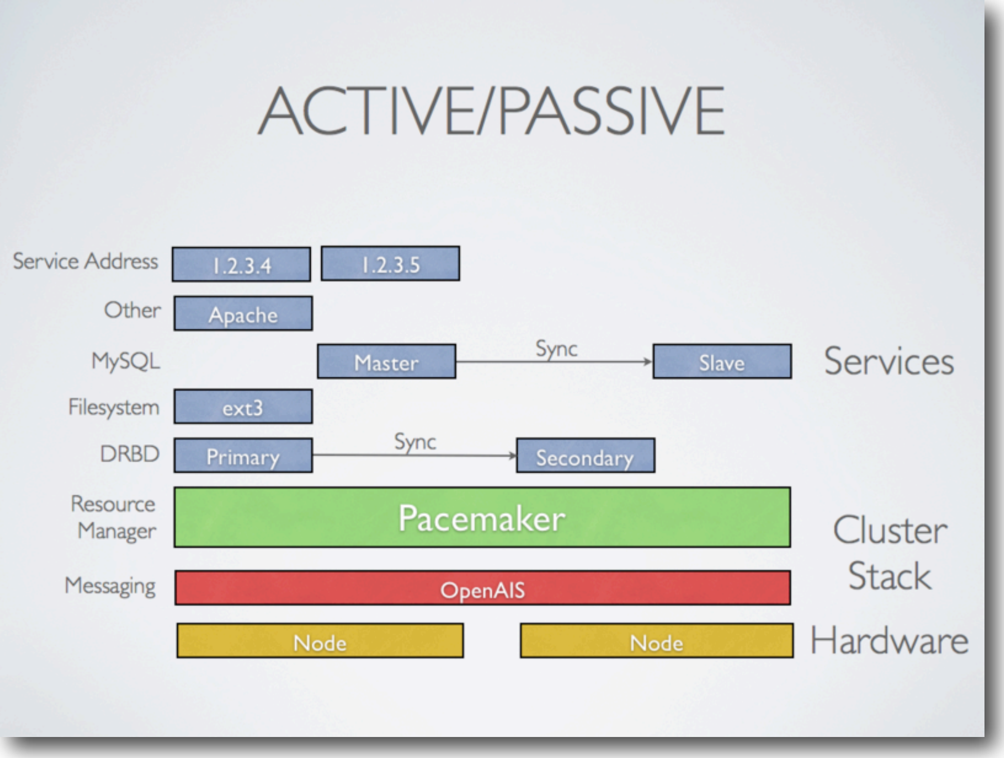
Pacemaker's key features include:

- Detection and recovery of node and service-level failures
- Storage agnostic, no requirement for shared storage
- Resource agnostic, anything that can be scripted can be clustered
- Support for both large and small clusters
- Optionally ensure data integrity with STONITH
- Ability to specify cluster-wide service ordering, colocation and anti-colocation
- Support for services which need to be active on multiple nodes
- Support for services with multiple modes (eg. master/slave, primary/secondary)
- Unified, scriptable, cluster shell

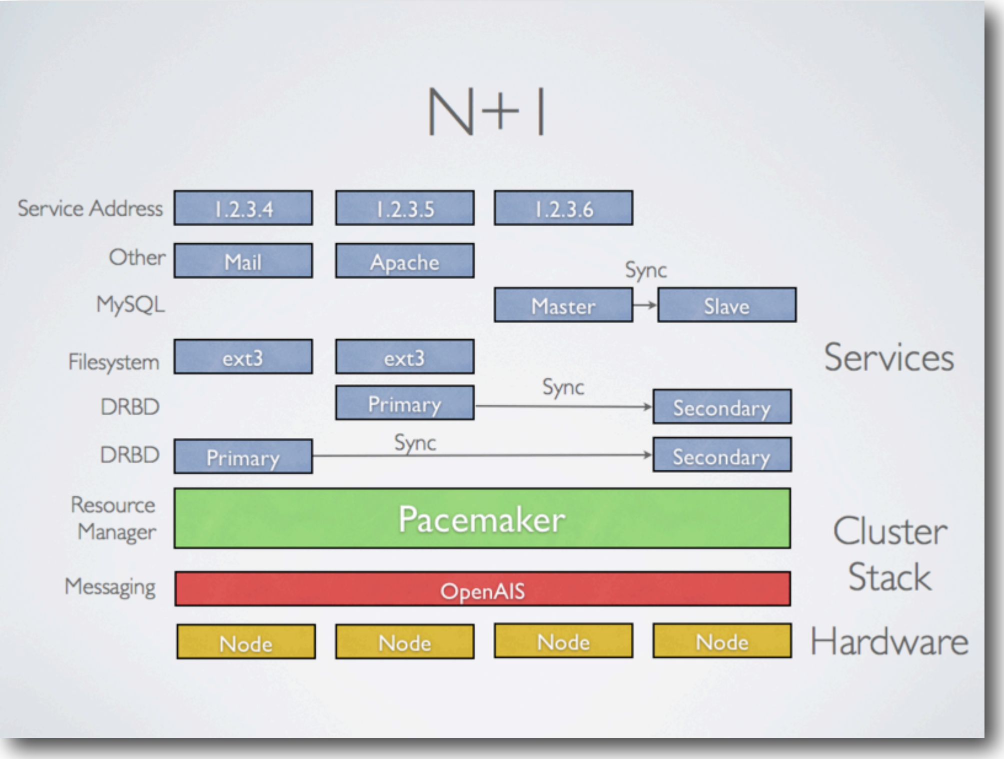
Types of Pacemaker Clusters

Pacemaker makes no assumptions about your environment, this allows it to support practically any redundancy configuration including Active/Active, Active/Passive, N+1, N+M, N-to-1 and N-to-N.

Two-node Active/Passive clusters using Pacemaker and DRBD are a cost-effective solution for many High Availability situations.



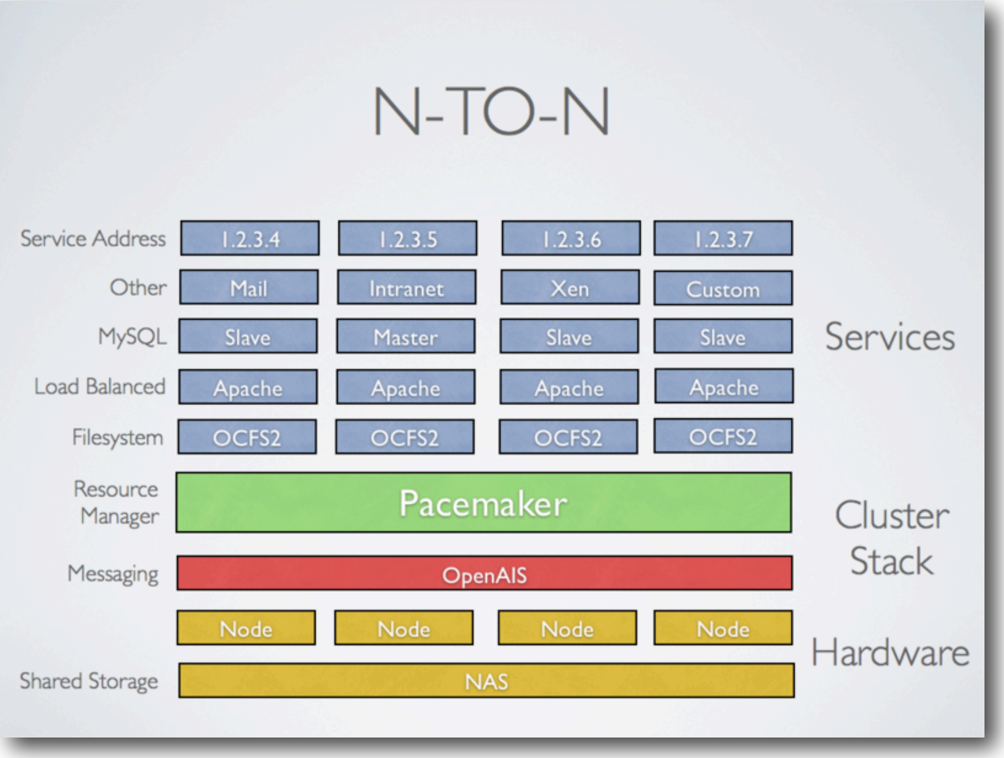
By supporting many nodes, Pacemaker can dramatically reduce hardware costs by allowing several active/passive clusters to be combined and share a common backup node



N+1

Service Address	1.2.3.4	1.2.3.5	1.2.3.6		Services
Other	Mail	Apache			
MySQL			Master	Sync → Slave	
Filesystem	ext3	ext3			
DRBD		Primary	Sync →	Secondary	
DRBD	Primary	Sync →		Secondary	
Resource Manager	Pacemaker				Cluster Stack
Messaging	OpenAIS				
	Node	Node	Node	Node	Hardware

When shared storage is available, every node can potentially be used for failover. Pacemaker can even run multiple copies of services to spread out the workload.



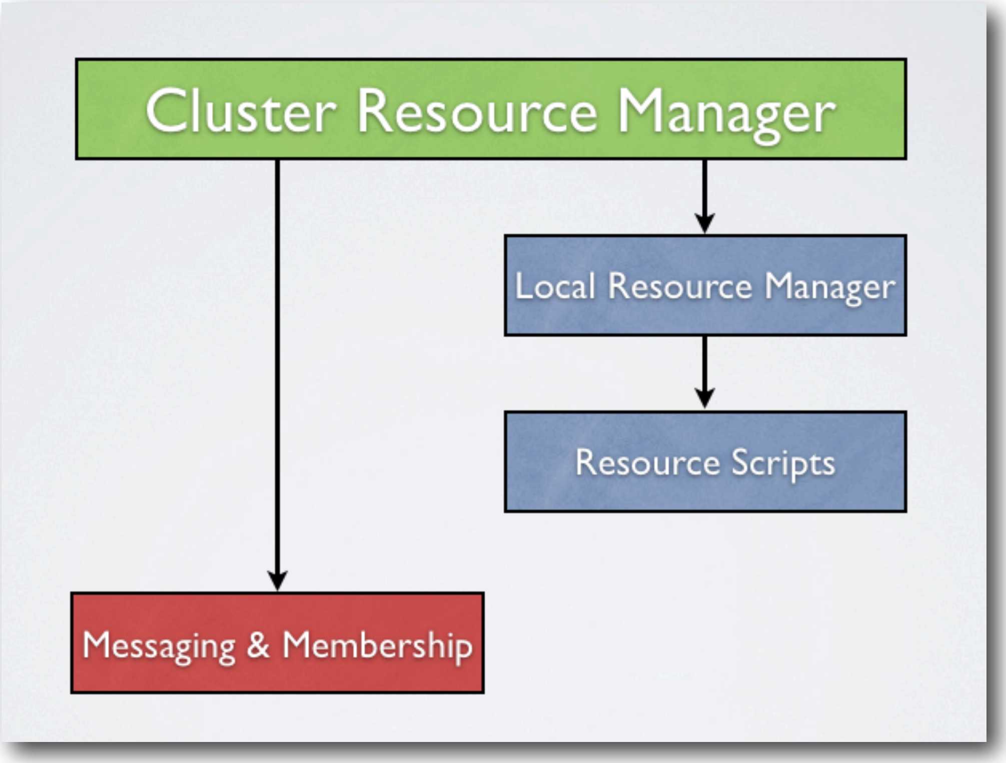
N-TO-N

Service Address	1.2.3.4	1.2.3.5	1.2.3.6	1.2.3.7	Services
Other	Mail	Intranet	Xen	Custom	
MySQL	Slave	Master	Slave	Slave	
Load Balanced	Apache	Apache	Apache	Apache	
Filesystem	OCFS2	OCFS2	OCFS2	OCFS2	
Resource Manager	Pacemaker				Cluster Stack
Messaging	OpenAIS				
	Node	Node	Node	Node	Hardware
Shared Storage	NAS				

Pacemaker Architecture

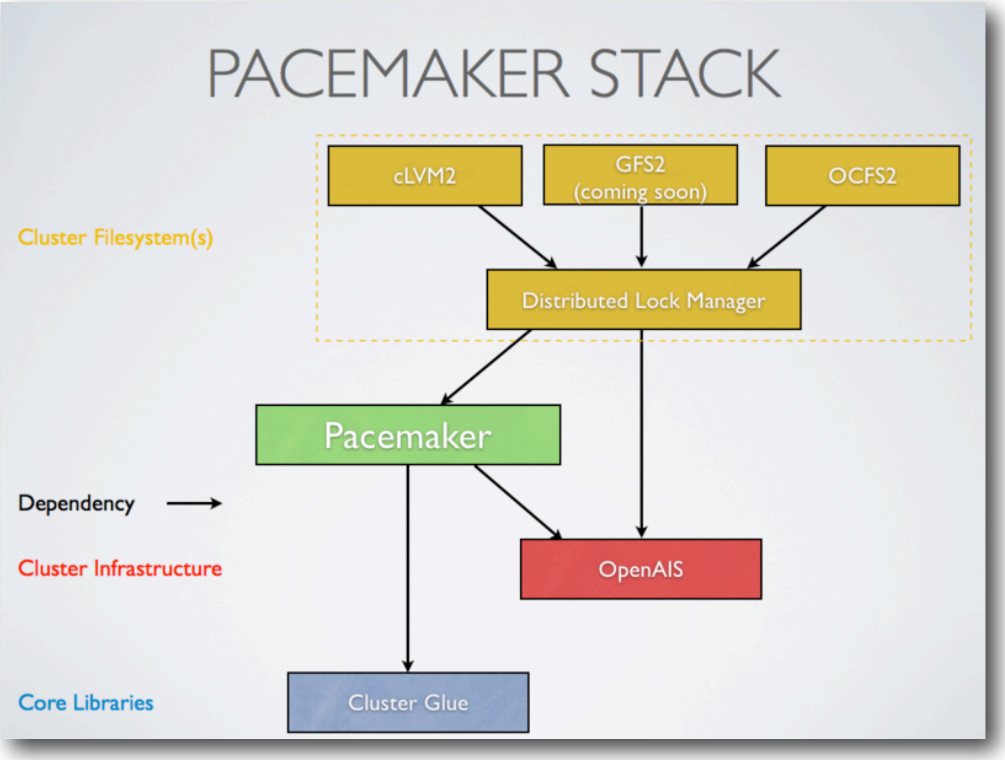
At the highest level, the cluster is made up of three pieces:

- Core cluster infrastructure providing messaging and membership functionality (illustrated in red)
- Non-cluster aware components (illustrated in blue). In a Pacemaker cluster, these pieces include not only the scripts that knows how to start, stop and monitor resources, but also a local daemon that masks the differences between the different standards these scripts implement.
- A brain (illustrated in green) that processes and reacts to events from the cluster (nodes leaving or joining) and resources (eg. monitor failures) as well as configuration changes from the administrator. In response to all of these events, Pacemaker will compute the ideal state of the cluster and plot a path to achieve it. This may include moving resources, stopping nodes and even forcing them offline with remote power switches.



Conceptual overview of the cluster stack

When combined with OpenAIS, Pacemaker also supports popular open source cluster filesystems [1]. Due to recent standardization in the cluster filesystem community, they make use of a common distributed lock manager which makes use of OpenAIS for its messaging capabilities and Pacemaker for its membership (which nodes are up/down) and fencing services.



PACEMAKER STACK

The Pacemaker stack when running on OpenAIS

[1] Even though Pacemaker also supports Heartbeat, the filesystems need to use the stack for messaging and membership and OpenAIS seems to be what they're standardizing on. Technically it would be possible for them to support Heartbeat as well, however there seems little interest in this.

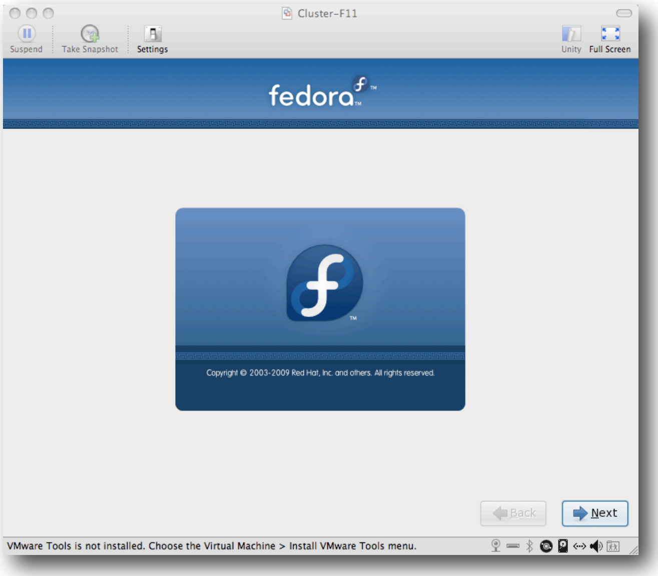
Installation

OS Installation

Detailed instructions for installing Fedora are available at http://docs.fedoraproject.org/install-guide/f11/ in a number of languages. The abbreviated version is:

Point your browser to http://fedoraproject.org/en/get-fedora-all, locate the **Install Media** section and download the install DVD that matches your hardware.

Burn the disk image to a DVD[2] and boot from it. Or use the image to boot a virtual machine as I have done here. After clicking through the welcome screen, select your language and keyboard layout[3]



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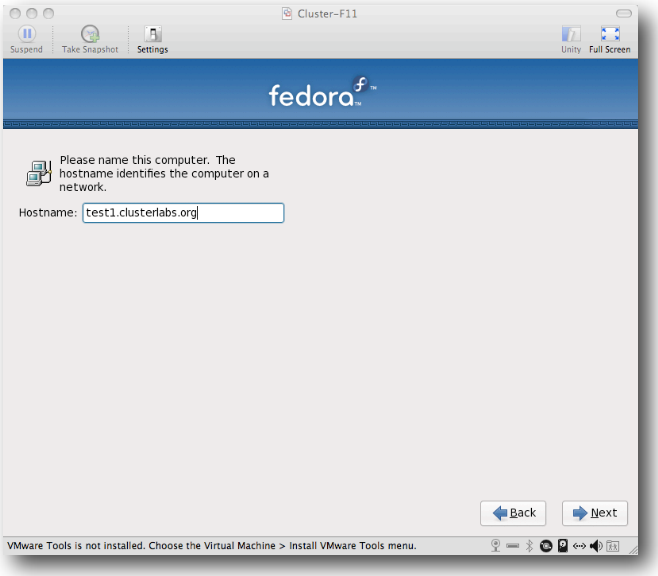
VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

[2] http://docs.fedoraproject.org/readme-burning-isos/

[3] http://docs.fedoraproject.org/install-guide/f11/en-US/html/s1-langselection-x86.html

Assign your machine a host name.[4] I happen to control the clusterlabs.org domain name, so I will use that here.



Please name this computer. The hostname identifies the computer on a network.

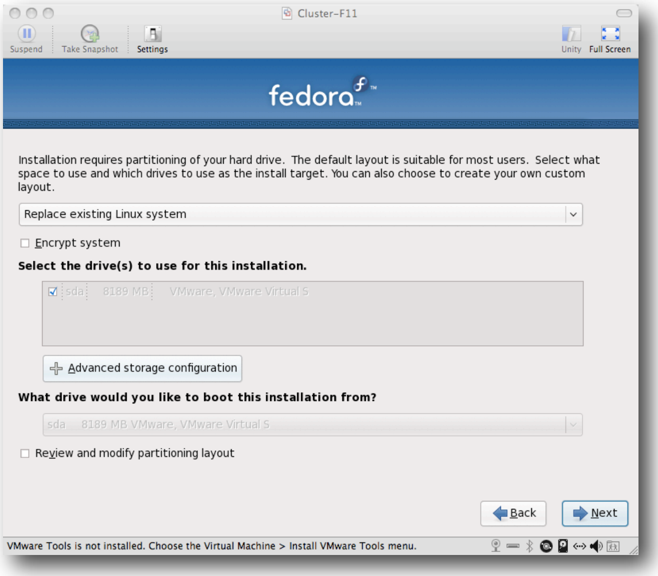
Hostname: test1.clusterlabs.org

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

You will then be prompted to indicate the machine's physical location and to supply a root password[5].

Now select where you want Fedora installed.[6] As I don't care about any existing data, I will accept the default and allow Fedora to use the complete drive.

IMPORTANT: If you plan on following the DRBD or GFS2 portions of this guide, you should reserve at least 1Gb of space on each machine from which to create a shared volume.



Installation requires partitioning of your hard drive. The default layout is suitable for most users. Select what space to use and which drives to use as the install target. You can also choose to create your own custom layout.

Replace existing Linux system

☐ Encrypt system

Select the drive(s) to use for this installation.

☑ sda 8189 MB VMware, VMware Virtual S

What drive would you like to boot this installation from?

sda 8189 MB VMware, VMware Virtual S

☐ Review and modify partitioning layout

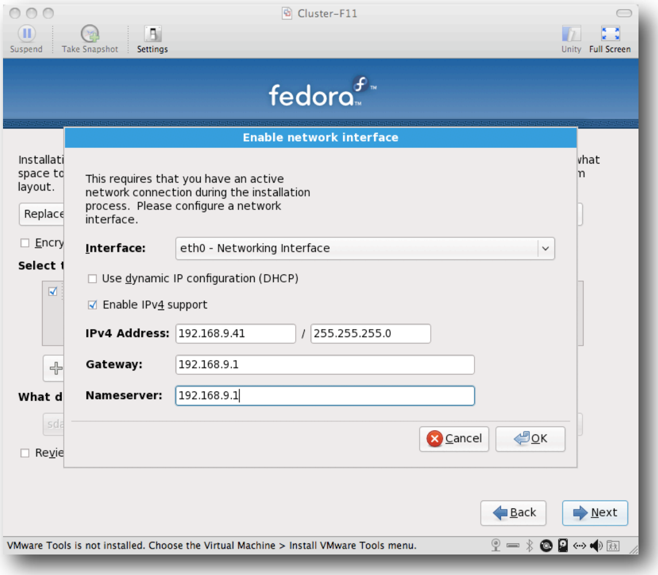
VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

[4] http://docs.fedoraproject.org/install-guide/f11/en-US/html/sn-networkconfig-fedora.html

[5] http://docs.fedoraproject.org/install-guide/f11/en-US/html/sn-account_configuration.html

[6] http://docs.fedoraproject.org/install-guide/f11/en-US/html/s1-diskpartsetup-x86.html

The next step is to configure networking. Do not accept the default. Cluster machines should **never** obtain an ip address via DHCP. Here I will use the **internal** addresses for the clusterlab.org network.



Enable network interface

This requires that you have an active network connection during the installation process. Please configure a network interface.

Interface: eth0 - Networking Interface

□ Use dynamic IP configuration (DHCP)

☑ Enable IPv4 support

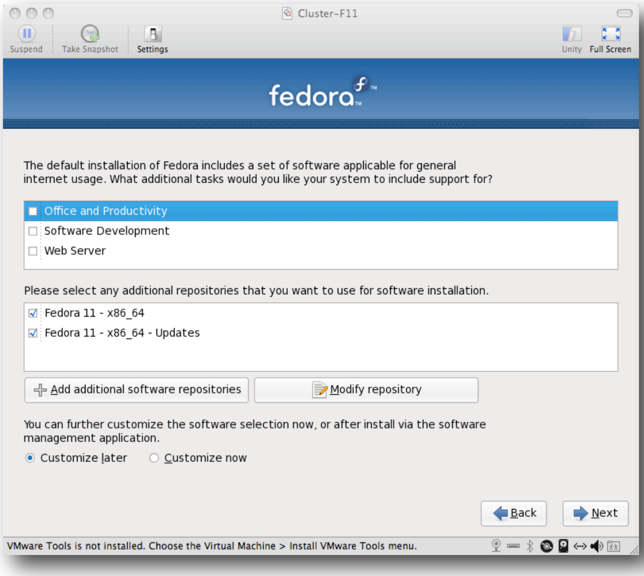
IPv4 Address: 192.168.9.41 / 255.255.255.0

Gateway: 192.168.9.1

Nameserver: 192.168.9.1

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

Next choose which software should be installed. Deselect the default "Office and Productivity" as its not appropriate for a cluster node. We'll install any needed software later. After you click next, Fedora will begin installing.



The default installation of Fedora includes a set of software applicable for general internet usage. What additional tasks would you like your system to include support for?

□ Office and Productivity
□ Software Development
□ Web Server

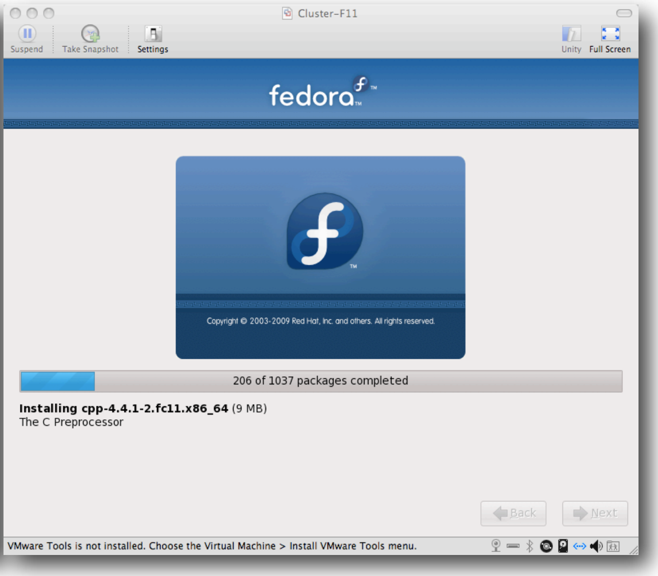
Please select any additional repositories that you want to use for software installation.

☑ Fedora 11 - x86_64
☑ Fedora 11 - x86_64 - Updates

You can further customize the software selection now, or after install via the software management application.

● Customize later ○ Customize now

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.



Cluster-F11
Suspend
Take Snapshot
Settings
Unity
Full Screen
fedora
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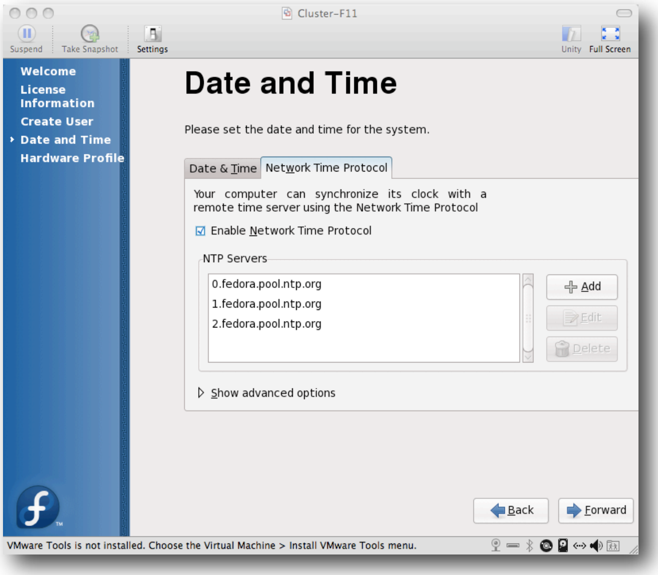
206 of 1037 packages completed

Installing cpp-4.4.1-2.fc11.x86_64 (9 MB)
The C Preprocessor

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

Once the node reboots, follow the on screen instructions[7] to create a system user and configure the time. It is highly recommended to enable NTP on your cluster nodes. Doing so ensures all nodes agree on the current time and makes reading log files significantly easier.



Date and Time

Please set the date and time for the system.

Your computer can synchronize its clock with a remote time server using the Network Time Protocol

☑ Enable Network Time Protocol

NTP Servers

0.fedora.pool.ntp.org
1.fedora.pool.ntp.org
2.fedora.pool.ntp.org

VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

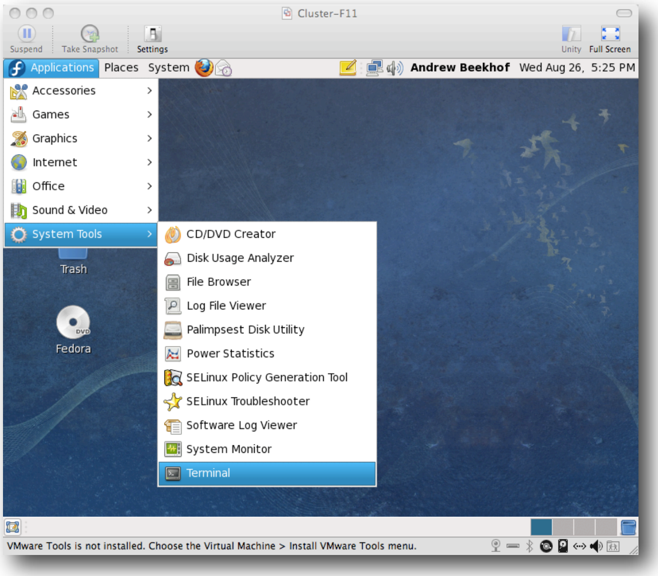
Click through the next screens until you reach the login window. Click on the user you created and supply the password you indicated earlier.

[7] http://docs.fedoraproject.org/install-guide/f11/en-US/html/ch-firstboot.html

Cluster Software Installation

NOTE: Installing the cluster in future versions of Fedora will be significantly easier now that the entire stack has been accepted into the distribution. However for now there are still some hoops to jump through.

Start a terminal by going to Applications -> System Tools -> Terminal



VMware Tools is not installed. Choose the Virtual Machine > Install VMware Tools menu.

That was the last screenshot by the way, from here on in we're going to be working from the terminal.

Switch to the super user account. You will need to supply the password you entered earlier during the installation process.

```
su -
```

```
[beekhof@pcmk-1 ~]$ su -
Password:
[root@pcmk-1 ~]#
```

Note that the username (the text before the @ symbol) now indicates we're running as the super user "root".

Install the Cluster Software

The tricky part here is to make yum install openais from the *server_ha-clustering* repository by specifying the exact version to install. This is necessary as the version that comes with Fedora is incompatible with the one upstream currently uses to build Pacemaker packages.

yum install -y pacemaker

```
[root@pcmk-1 ~]# yum install -y pacemaker
Setting up Install Process
Resolving Dependencies
--> Running transaction check
---> Package pacemaker.x86_64 0:1.1.0-1.fc12 set to be updated
--> Processing Dependency: heartbeat >= 3.0.0 for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: resource-agents for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: corosync for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libgnutls.so.26(GNUTLS_1_4)(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: cluster-glue for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libcrmcluster.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libcib.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libltdl.so.7()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libccmclient.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libesmtp.so.5()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libxslt.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libpils.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libpengine.so.3()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: liblrm.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libtransitioner.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libstonithd.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libcrmcommon.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libplumb.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libnetsnmp.so.15()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libnetsnmpagent.so.15()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libnetsnmpmibs.so.15()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libpe_status.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libsensors.so.4()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libnetsnmphelpers.so.15()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libstonith.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libcoroipcc.so.4()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libpe_rules.so.2()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libgnutls.so.26()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Processing Dependency: libhbclient.so.1()(64bit) for package: pacemaker-1.1.0-1.fc12.x86_64
--> Running transaction check
---> Package cluster-glue.x86_64 0:1.0-0.11.b79635605337.hg.fc12 set to be updated
--> Processing Dependency: perl-TimeDate for package: cluster-glue-1.0-0.11.b79635605337.hg.fc12.x86_64
--> Processing Dependency: libOpenIPMIutils.so.0()(64bit) for package: cluster-
   glue-1.0-0.11.b79635605337.hg.fc12.x86_64
--> Processing Dependency: libOpenIPMIposix.so.0()(64bit) for package: cluster-
   glue-1.0-0.11.b79635605337.hg.fc12.x86_64
--> Processing Dependency: libopenhpi.so.2()(64bit) for package: cluster-
   glue-1.0-0.11.b79635605337.hg.fc12.x86_64
--> Processing Dependency: libOpenIPMI.so.0()(64bit) for package: cluster-
   glue-1.0-0.11.b79635605337.hg.fc12.x86_64
---> Package cluster-glue-libs.x86_64 0:1.0-0.11.b79635605337.hg.fc12 set to be updated
---> Package corosync.x86_64 0:1.1.2-1.fc12 set to be updated
---> Package corosynclib.x86_64 0:1.1.2-1.fc12 set to be updated
--> Processing Dependency: librdmacm.so.1(RDMACM_1.0)(64bit) for package: corosynclib-1.1.2-1.fc12.x86_64
--> Processing Dependency: libibverbs.so.1(IBVERBS_1.0)(64bit) for package: corosynclib-1.1.2-1.fc12.x86_64
--> Processing Dependency: libibverbs.so.1(IBVERBS_1.1)(64bit) for package: corosynclib-1.1.2-1.fc12.x86_64
--> Processing Dependency: libibverbs.so.1()(64bit) for package: corosynclib-1.1.2-1.fc12.x86_64
--> Processing Dependency: librdmacm.so.1()(64bit) for package: corosynclib-1.1.2-1.fc12.x86_64
---> Package gnutls.x86_64 0:2.8.5-1.fc12 set to be updated
--> Processing Dependency: libtasn1.so.3(LIBTASN1_0_3)(64bit) for package: gnutls-2.8.5-1.fc12.x86_64
--> Processing Dependency: libtasn1.so.3()(64bit) for package: gnutls-2.8.5-1.fc12.x86_64
---> Package heartbeat.x86_64 0:3.0.0-0.5.0daab7da36a8.hg.fc12 set to be updated
--> Processing Dependency: PyXML for package: heartbeat-3.0.0-0.5.0daab7da36a8.hg.fc12.x86_64
---> Package heartbeat-libs.x86_64 0:3.0.0-0.5.0daab7da36a8.hg.fc12 set to be updated
---> Package libesmtp.x86_64 0:1.0.4-12.fc12 set to be updated
---> Package libtool-ltdl.x86_64 0:2.2.6-15.fc12 set to be updated
---> Package libxslt.x86_64 0:1.1.26-1.fc12 set to be updated
---> Package lm_sensors-libs.x86_64 0:3.1.1-4.fc12 set to be updated
---> Package net-snmp-libs.x86_64 1:5.4.2.1-18.fc12 set to be updated
---> Package pacemaker-libs.x86_64 0:1.1.0-1.fc12 set to be updated
---> Package resource-agents.x86_64 0:3.0.5-1.fc12 set to be updated
--> Running transaction check
---> Package OpenIPMI-libs.x86_64 0:2.0.16-4.fc12 set to be updated
---> Package PyXML.x86_64 0:0.8.4-15 set to be updated
---> Package libibverbs.x86_64 0:1.1.3-3.fc12 set to be updated
--> Processing Dependency: libibverbs-driver for package: libibverbs-1.1.3-3.fc12.x86_64
---> Package librdmacm.x86_64 0:1.0.10-1.fc12 set to be updated
---> Package libtasn1.x86_64 0:2.3-1.fc12 set to be updated
---> Package openhpi-libs.x86_64 0:2.14.0-5.fc12 set to be updated
---> Package perl-TimeDate.noarch 1:1.16-11.fc12 set to be updated
--> Running transaction check
---> Package libmlx4.x86_64 0:1.0.1-3.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

=======================================================================================
 Package              Arch       Version                            Repository   Size
=======================================================================================
Installing:
 pacemaker            x86_64     1.1.0-1.fc12                       custom      545 k
Installing for dependencies:
 OpenIPMI-libs        x86_64     2.0.16-4.fc12                      fedora      434 k
 PyXML                x86_64     0.8.4-15                           fedora      808 k
 cluster-glue         x86_64     1.0-0.11.b79635605337.hg.fc12      fedora      222 k
 cluster-glue-libs    x86_64     1.0-0.11.b79635605337.hg.fc12      fedora      114 k
 corosync             x86_64     1.1.2-1.fc12                       fedora      144 k
 corosynclib          x86_64     1.1.2-1.fc12                       fedora      138 k
 gnutls               x86_64     2.8.5-1.fc12                       fedora      350 k
 heartbeat            x86_64     3.0.0-0.5.0daab7da36a8.hg.fc12     fedora      172 k
 heartbeat-libs       x86_64     3.0.0-0.5.0daab7da36a8.hg.fc12     fedora      265 k
 libesmtp             x86_64     1.0.4-12.fc12                      fedora       54 k
 libibverbs           x86_64     1.1.3-3.fc12                       updates      42 k
 libmlx4              x86_64     1.0.1-3.fc12                       updates      26 k
 librdmacm            x86_64     1.0.10-1.fc12                      updates      22 k
 libtasn1             x86_64     2.3-1.fc12                         fedora      232 k
 libtool-ltdl         x86_64     2.2.6-15.fc12                      fedora       44 k
 libxslt              x86_64     1.1.26-1.fc12                      fedora      397 k
 lm_sensors-libs      x86_64     3.1.1-4.fc12                       updates      36 k
 net-snmp-libs        x86_64     1:5.4.2.1-18.fc12                  fedora      1.3 M
 openhpi-libs         x86_64     2.14.0-5.fc12                      fedora      128 k
 pacemaker-libs       x86_64     1.1.0-1.fc12                       custom      250 k
 perl-TimeDate         noarch     1:1.16-11.fc12                    fedora       33 k
 resource-agents       x86_64     3.0.5-1.fc12                      updates     251 k

Transaction Summary
=======================================================================================
Install      23 Package(s)
Upgrade       0 Package(s)

Total download size: 5.9 M
Downloading Packages:
(1/23): OpenIPMI-libs-2.0.16-4.fc12.x86_64.rpm                  | 434 kB     00:00
(2/23): PyXML-0.8.4-15.x86_64.rpm                               | 808 kB     00:00
(3/23): cluster-glue-1.0-0.11.b79635605337.hg.fc12.x86_64.rpm   | 222 kB     00:00
(4/23): cluster-glue-libs-1.0-0.11.b79635605337.hg.fc12.x86_64. | 114 kB     00:00
(5/23): corosync-1.1.2-1.fc12.x86_64.rpm                        | 144 kB     00:00
(6/23): corosynclib-1.1.2-1.fc12.x86_64.rpm                     | 138 kB     00:00
(7/23): gnutls-2.8.5-1.fc12.x86_64.rpm                          | 350 kB     00:00
(8/23): heartbeat-3.0.0-0.5.0daab7da36a8.hg.fc12.x86_64.rpm     | 172 kB     00:00
(9/23): heartbeat-libs-3.0.0-0.5.0daab7da36a8.hg.fc12.x86_64.rp | 265 kB     00:00
(10/23): libesmtp-1.0.4-12.fc12.x86_64.rpm                      |  54 kB     00:00
(11/23): libibverbs-1.1.3-3.fc12.x86_64.rpm                     |  42 kB     00:00
(12/23): libmlx4-1.0.1-3.fc12.x86_64.rpm                        |  26 kB     00:00
(13/23): librdmacm-1.0.10-1.fc12.x86_64.rpm                     |  22 kB     00:00
(14/23): libtasn1-2.3-1.fc12.x86_64.rpm                         | 232 kB     00:00
(15/23): libtool-ltdl-2.2.6-15.fc12.x86_64.rpm                  |  44 kB     00:00
(16/23): libxslt-1.1.26-1.fc12.x86_64.rpm                       | 397 kB     00:00
(17/23): lm_sensors-libs-3.1.1-4.fc12.x86_64.rpm                |  36 kB     00:00
(18/23): net-snmp-libs-5.4.2.1-18.fc12.x86_64.rpm               | 1.3 MB     00:00
(19/23): openhpi-libs-2.14.0-5.fc12.x86_64.rpm                  | 128 kB     00:00
(20/23): pacemaker-1.1.0-1.fc12.x86_64.rpm                      | 545 kB     00:00
(21/23): pacemaker-libs-1.1.0-1.fc12.x86_64.rpm                 | 250 kB     00:00
(22/23): perl-TimeDate-1.16-11.fc12.noarch.rpm                  |  33 kB     00:00
(23/23): resource-agents-3.0.5-1.fc12.x86_64.rpm                | 251 kB     00:00
---------------------------------------------------------------------------------------
Total                                                  894 kB/s | 5.9 MB     00:06
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : libtool-ltdl-2.2.6-15.fc12.x86_64                              1/23
  Installing     : lm_sensors-libs-3.1.1-4.fc12.x86_64                            2/23
  Installing     : 1:net-snmp-libs-5.4.2.1-18.fc12.x86_64                         3/23
  Installing     : libxslt-1.1.26-1.fc12.x86_64                                   4/23
  Installing     : openhpi-libs-2.14.0-5.fc12.x86_64                              5/23
  Installing     : PyXML-0.8.4-15.x86_64                                          6/23
  Installing     : libesmtp-1.0.4-12.fc12.x86_64                                  7/23
  Installing     : OpenIPMI-libs-2.0.16-4.fc12.x86_64                             8/23
  Installing     : libtasn1-2.3-1.fc12.x86_64                                     9/23
  Installing     : gnutls-2.8.5-1.fc12.x86_64                                    10/23
  Installing     : 1:perl-TimeDate-1.16-11.fc12.noarch                           11/23
  Installing     : cluster-glue-libs-1.0-0.11.b79635605337.hg.fc12.x86_64        12/23
  Installing     : cluster-glue-1.0-0.11.b79635605337.hg.fc12.x86_64             13/23
  Installing     : libibverbs-1.1.3-3.fc12.x86_64                                14/23
  Installing     : resource-agents-3.0.5-1.fc12.x86_64                           15/23
  Installing     : librdmacm-1.0.10-1.fc12.x86_64                                16/23
  Installing     : corosynclib-1.1.2-1.fc12.x86_64                               17/23
  Installing     : corosync-1.1.2-1.fc12.x86_64                          18/23
  Installing     : libmlx4-1.0.1-3.fc12.x86_64                           19/23
  Installing     : heartbeat-libs-3.0.0-0.5.0daab7da36a8.hg.fc12.x86_64  20/23
  Installing     : heartbeat-3.0.0-0.5.0daab7da36a8.hg.fc12.x86_64       21/23
  Installing     : pacemaker-1.1.0-1.fc12.x86_64                         22/23
  Installing     : pacemaker-libs-1.1.0-1.fc12.x86_64                    23/23

Installed:
  pacemaker.x86_64 0:1.1.0-1.fc12

Dependency Installed:
  OpenIPMI-libs.x86_64 0:2.0.16-4.fc12
  PyXML.x86_64 0:0.8.4-15
  cluster-glue.x86_64 0:1.0-0.11.b79635605337.hg.fc12
  cluster-glue-libs.x86_64 0:1.0-0.11.b79635605337.hg.fc12
  corosync.x86_64 0:1.1.2-1.fc12
  corosynclib.x86_64 0:1.1.2-1.fc12
  gnutls.x86_64 0:2.8.5-1.fc12
  heartbeat.x86_64 0:3.0.0-0.5.0daab7da36a8.hg.fc12
  heartbeat-libs.x86_64 0:3.0.0-0.5.0daab7da36a8.hg.fc12
  libesmtp.x86_64 0:1.0.4-12.fc12
  libibverbs.x86_64 0:1.1.3-3.fc12
  libmlx4.x86_64 0:1.0.1-3.fc12
  librdmacm.x86_64 0:1.0.10-1.fc12
  libtasn1.x86_64 0:2.3-1.fc12
  libtool-ltdl.x86_64 0:2.2.6-15.fc12
  libxslt.x86_64 0:1.1.26-1.fc12
  lm_sensors-libs.x86_64 0:3.1.1-4.fc12
  net-snmp-libs.x86_64 1:5.4.2.1-18.fc12
  openhpi-libs.x86_64 0:2.14.0-5.fc12
  pacemaker-libs.x86_64 0:1.1.0-1.fc12
  perl-TimeDate.noarch 1:1.16-11.fc12
  resource-agents.x86_64 0:3.0.5-1.fc12

Complete!
[root@pcmk-1 ~]#
```

Security Shortcuts

To simplify this guide and focus on the aspects directly connected to clustering, we will now disable the machine's firewall and SELinux installation. Both of these actions create significant security issues and should not be performed on machines that will be exposed to the outside world.

```
sed -i.gres "s/SELINUX=enforcing/SELINUX=permissive/g" /etc/selinux/config
/sbin/chkconfig --del iptables
```

Now reboot all nodes so the new security settings take effect.

Setup

Before You Continue

Repeat the Installation steps so that you have 2 Fedora nodes with the cluster software installed.

For the purposes of this document, the additional node is called *pcmk-2* with address 19.168.9.42.

Finalize Node Configuration

Finalize Networking

Confirm that you can communicate with the two new nodes:

ping -c 3 192.168.122.102

```
[root@pcmk-1 ~]# ping -c 3 192.168.122.102
PING 192.168.122.102 (192.168.122.102) 56(84) bytes of data.
64 bytes from 192.168.122.102: icmp_seq=1 ttl=64 time=0.343 ms
64 bytes from 192.168.122.102: icmp_seq=2 ttl=64 time=0.402 ms
64 bytes from 192.168.122.102: icmp_seq=3 ttl=64 time=0.558 ms

--- 192.168.122.102 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2000ms
rtt min/avg/max/mdev = 0.343/0.434/0.558/0.092 ms
```

Now we need to make sure we can communicate with the machines by their name. If you have a DNS server, add additional entries for the three machines. Otherwise, you'll need to add the machines to /etc/hosts . Below are the entries for my cluster nodes:

grep test /etc/hosts

```
[root@pcmk-1 ~]# grep test /etc/hosts
192.168.122.101 pcmk-1.clusterlabs.org pcmk-1
192.168.122.102 pcmk-2.clusterlabs.org pcmk-2
```

We can now verify the setup by again using ping:

ping pcmk-2

```
[root@pcmk-1 ~]# ping -c 3 pcmk-2
PING pcmk-2.clusterlabs.org (192.168.122.101) 56(84) bytes of data.
64 bytes from pcmk-1.clusterlabs.org (192.168.122.101): icmp_seq=1 ttl=64 time=0.164 ms
64 bytes from pcmk-1.clusterlabs.org (192.168.122.101): icmp_seq=2 ttl=64 time=0.475 ms
64 bytes from pcmk-1.clusterlabs.org (192.168.122.101): icmp_seq=3 ttl=64 time=0.186 ms

--- pcmk-2.clusterlabs.org ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 0.164/0.275/0.475/0.141 ms
```

Configure SSH

SSH is a convenient and secure way to copy files and perform commands remotely. For the purposes of this guide, we will create a key without a password (using the -N “” option) so that we can perform remote actions without being prompted.

NOTE: Unprotected SSH keys, those without a password, are not recommended for servers exposed to the outside world.

Create a new key and allow anyone with that key to log in:

ssh-keygen -t dsa -f ~/.ssh/id_dsa -N “”

cp .ssh/id_dsa.pub .ssh/authorized_keys

```
[root@pcmk-1 ~]# ssh-keygen -t dsa -f ~/.ssh/id_dsa -N ""
Generating public/private dsa key pair.
Your identification has been saved in /root/.ssh/id_dsa.
Your public key has been saved in /root/.ssh/id_dsa.pub.
The key fingerprint is:
91:09:5c:82:5a:6a:50:08:4e:b2:0c:62:de:cc:74:44 root@pcmk-1.clusterlabs.org
The key's randomart image is:
+--[ DSA 1024]----+
|==.ooEo..        |
|X O + .o o       |
| * A    +        |
|  +      .       |
| .      S        |
|                 |
|                 |
|                 |
|                 |
+-----------------+
[root@pcmk-1 ~]# cp .ssh/id_dsa.pub .ssh/authorized_keys
```

Install the key on the other nodes and test that you can now run commands remotely, without being prompted

scp -r .ssh pcmk-2:

ssh pcmk-2 -- uname -n

```
[root@pcmk-1 ~]# scp -r .ssh pcmk-2:
The authenticity of host 'pcmk-2 (192.168.122.102)' can't be established.
RSA key fingerprint is b1:2b:55:93:f1:d9:52:2b:0f:f2:8a:4e:ae:c6:7c:9a.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'pcmk-2,192.168.122.102' (RSA) to the list of known hosts.
root@pcmk-2's password:
id_dsa.pub                                                      100%  616     0.6KB/s   00:00
id_dsa                                                          100%  672     0.7KB/s   00:00
known_hosts                                                     100%  400     0.4KB/s   00:00
authorized_keys                                                 100%  616     0.6KB/s   00:00
[root@pcmk-1 ~]# ssh pcmk-2 -- uname -n
pcmk-2
[root@pcmk-1 ~]#
```

Short Node Names

During installation, we filled in the machine's fully qualifier domain name (FQDN) which can be rather long when it appears in cluster logs and status output. See for yourself how the machine identifies itself:

```
uname -n
dnsdomainname
```

```
[root@pcmk-1 ~]# uname -n
pcmk-1.clusterlabs.org
[root@pcmk-1 ~]# dnsdomainname
clusterlabs.org
```

The output from the second command is fine, but we really don't need the domain name included in the basic host details. To address this, we need to update */etc/sysconfig/network*. This is what it should look like before we start.

```
cat /etc/sysconfig/network
```

```
NETWORKING=yes
HOSTNAME=pcmk-1.clusterlabs.org
GATEWAY=192.168.9.1
```

All we need to do now is strip off the domain name portion, which is stored elsewhere anyway.

```
sed -i.gres 's/\.[a-z].*//g' /etc/sysconfig/network
```

```
[root@pcmk-1 ~]# sed -i.gres 's/\.[a-z].*//g' /etc/sysconfig/network
```

Now confirm the change was successful. The revised file contents should look something like this.

```
cat /etc/sysconfig/network
```

```
[root@pcmk-1 ~]# cat /etc/sysconfig/network
NETWORKING=yes
HOSTNAME=pcmk-1
GATEWAY=192.168.9.1
```

However we're not finished. The machine wont normally see the shortened host name until about it reboots, but we can force it to update

```
source /etc/sysconfig/network
hostname $HOSTNAME
```

```
[root@pcmk-1 ~]# source /etc/sysconfig/network
[root@pcmk-1 ~]# hostname $HOSTNAME
```

Now check the machine is using the correct names

```
uname -n
dnsdomainname
```

```
[root@pcmk-1 ~]# uname -n
pcmk-1
[root@pcmk-1 ~]# dnsdomainname
clusterlabs.org
```

Now repeat on *pcmk-2*.

Configuring OpenAIS

Choose a port number and multi-cast[8] address[9].

Be sure that the values you chose do not conflict with any existing clusters you might have. For advice on choosing a multi-cast address, see http://www.29west.com/docs/THPM/multicast-address-assignment.html

For this document, I have chosen port 4000 and used 226.94.1.1 as the multi-cast address.

```
export ais_port=4000
export ais_mcast=226.94.1.1
```

Next we automatically determine the hosts address. By not using the full address, we make the configuration suitable to be copied to other nodes.

```
export ais_addr=`ip addr | grep "inet " | tail -n 1 | awk '{print $4}' | sed s/255/0/`
```

Display and verify the configuration options

```
env | grep ais_
```

```
[root@pcmk-1 ~]# env | grep ais_
ais_mcast=226.94.1.1
ais_port=4000
ais_addr=192.168.9.0
```

Once you’re happy with the chosen values, update the OpenAIS configuration

```
cp /etc/corosync/corosync.conf.example  /etc/corosync/corosync.conf
sed -i.gres "s/.*mcastaddr:.*/mcastaddr:\ $ais_mcast/g" /etc/corosync/corosync.conf
sed -i.gres "s/.*mcastport:.*/mcastport:\ $ais_port/g" /etc/corosync/corosync.conf
sed -i.gres "s/.*bindnetaddr:.*/bindnetaddr:\ $ais_addr/g" /etc/corosync/corosync.conf
```

Tell Corosync to run as the root user

```
cat <<-END >>/etc/corosync/corosync.conf
aisexec {
        user:   root
        group:  root
}
END
```

Finally, tell Corosync to start Pacemaker

```
cat <<-END >>/etc/corosync/corosync.conf
service {
```

[8] http://en.wikipedia.org/wiki/Multicast

[9] http://en.wikipedia.org/wiki/Multicast_address

```
        # Load the Pacemaker Cluster Resource Manager
        name: pacemaker
        ver:  0
    }
    END
```

The final configuration should look something like the sample in the appendix.

Propagate the Configuration

Now we need to copy the changes so far to the other node:

```
for f in /etc/corosync/corosync.conf /etc/hosts; do scp $f pcmk-2:$f ; done
```

```
[root@pcmk-1 ~]# for f in /etc/ais/openais.conf /etc/hosts; do scp $f pcmk-2:$f ; done
corosync.conf                                                   100% 1528     1.5KB/s   00:00
hosts                                                          100%  281     0.3KB/s   00:00
[root@pcmk-1 ~]#
```

Verify OpenAIS Installation

Start OpenAIS on the first node

```
/etc/init.d/corosync start
```

```
[root@pcmk-1 ~]# /etc/init.d/corosync start
Starting Corosync Cluster Engine (corosync):               [  OK  ]
```

Check the cluster started correctly and that an initial membership was able to form

```
grep -e "Corosync Cluster Engine" -e "configuration file" /var/log/messages
grep TOTEM /var/log/messages
```

```
[root@pcmk-1 ~]# grep -e "corosync.*network interface" -e "Corosync Cluster Engine" -e "Successfully read
   main configuration file" /var/log/messages
Aug 27 09:05:34 pcmk-1 corosync[1540]: [MAIN  ] Corosync Cluster Engine ('1.1.0'): started and ready to
   provide service.
Aug 27 09:05:34 pcmk-1 corosync[1540]: [MAIN  ] Successfully read main configuration file '/etc/corosync/
   corosync.conf'.

[root@pcmk-1 ~]# grep TOTEM /var/log/messages
Aug 27 09:05:34 pcmk-1 corosync[1540]: [TOTEM ] Initializing transport (UDP/IP).
Aug 27 09:05:34 pcmk-1 corosync[1540]: [TOTEM ] Initializing transmit/receive security: libtomcrypt
   SOBER128/SHA1HMAC (mode 0).
Aug 27 09:05:35 pcmk-1 corosync[1540]: [TOTEM ] The network interface [192.168.122.101] is now up.
Aug 27 09:05:35 pcmk-1 corosync[1540]: [TOTEM ] A processor joined or left the membership and a new
   membership was formed.
```

With one node functional, its now safe to start OpenAIS on the second node as well.

```
ssh pcmk-2 -- /etc/init.d/corosync start
```

```
[root@pcmk-1 ~]# ssh pcmk-2 -- /etc/init.d/corosync start
Starting Corosync Cluster Engine (corosync):               [  OK  ]
```

```
[root@pcmk-1 ~]#
```

Check the cluster formed correctly

grep TOTEM /var/log/messages

```
[root@pcmk-1 ~]# grep TOTEM /var/log/messages
Aug 27 09:05:34 pcmk-1 corosync[1540]: [TOTEM ] Initializing transport (UDP/IP).
Aug 27 09:05:34 pcmk-1 corosync[1540]: [TOTEM ] Initializing transmit/receive security: libtomcrypt
   SOBER128/SHA1HMAC (mode 0).
Aug 27 09:05:35 pcmk-1 corosync[1540]: [TOTEM ] The network interface [192.168.122.101] is now up.
Aug 27 09:05:35 pcmk-1 corosync[1540]: [TOTEM ] A processor joined or left the membership and a new
   membership was formed.
Aug 27 09:12:11 pcmk-1 corosync[1540]: [TOTEM ] A processor joined or left the membership and a new
   membership was formed.
```

Verify Pacemaker Installation

Now that we have confirmed that OpenAIS is functional we can check the rest of the stack.

grep pcmk_startup /var/log/messages

```
[root@pcmk-1 ~]# grep pcmk_startup /var/log/messages
Aug 27 09:05:35 pcmk-1 corosync[1540]:   [pcmk  ] info: pcmk_startup: CRM: Initialized
Aug 27 09:05:35 pcmk-1 corosync[1540]:   [pcmk  ] Logging: Initialized pcmk_startup
Aug 27 09:05:35 pcmk-1 corosync[1540]:   [pcmk  ] info: pcmk_startup: Maximum core file size is:
   18446744073709551615
Aug 27 09:05:35 pcmk-1 corosync[1540]:   [pcmk  ] info: pcmk_startup: Service: 9
Aug 27 09:05:35 pcmk-1 corosync[1540]:   [pcmk  ] info: pcmk_startup: Local hostname: pcmk-1
```

Now verify the Pacemaker processes have been started

ps axf

```
[root@pcmk-1 ~]# ps axf
  PID TTY      STAT   TIME COMMAND
    2 ?        S<     0:00 [kthreadd]
    3 ?        S<     0:00  \_ [migration/0]
... lots of processes ...
 2166 pts/0    SLl    0:01 /usr/sbin/corosync
 2172 ?        SLs    0:00  \_ /usr/lib64/heartbeat/stonithd
 2173 pts/0    S      0:00  \_ /usr/lib64/heartbeat/cib
 2174 pts/0    S      0:00  \_ /usr/lib64/heartbeat/lrmd
 2175 pts/0    S      0:00  \_ /usr/lib64/heartbeat/attrd
 2176 pts/0    S      0:00  \_ /usr/lib64/heartbeat/pengine
 2177 pts/0    S      0:00  \_ /usr/lib64/heartbeat/crmd
```

And finally, check for any ERRORs during startup, there shouldn’t be any, and display the cluster’s status.

grep ERROR: /var/log/messages | grep -v unpack_resources

crm_mon

```
[root@pcmk-1 ~]# grep ERROR: /var/log/messages | grep -v unpack_resources
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Aug 27 16:54:55 2009
```

```
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
0 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]
```

Using Pacemaker Tools

In the dark past, configuring Pacemaker required the administrator to read and write XML. In true UNIX style, there were also a number of different commands that specialized in different aspects of querying and updating the cluster.

Since Pacemaker 1.0, this has all changed and we have an integrated, scriptable, cluster shell that hides all the messy XML scaffolding. It even allows you to queue up several changes at once and commit them atomically.

Take some time to familiarize yourself with what it can do.

crm --help

```
[root@pcmk-1 ~]# crm --help

usage:
    crm [-D display_type]
    crm [-D display_type] args
    crm [-D display_type] [-f file]

    Use crm without arguments for an interactive session.
    Supply one or more arguments for a "single-shot" use.
    Specify with -f a file which contains a script. Use '-' for
    standard input or use pipe/redirection.

    crm displays cli format configurations using a color scheme
    and/or in uppercase. Pick one of "color" or "uppercase", or
    use "-D color,uppercase" if you want colorful uppercase.
    Get plain output by "-D plain". The default may be set in
    user preferences (options).

Examples:

    # crm -f stopapp2.cli
    # crm < stopapp2.cli
    # crm resource stop global_www
    # crm status
```

The primary tool for monitoring the status of the cluster is crm_mon (also available as crm status). It can be run in a variety of modes and has a number of output options. To find out about any of the tools that come with Pacemaker, simply invoke them with the --help option or consult the included man pages. Both sets of output are created from the tool, and so will always be in sync with each other and the tool itself.

Additionally, the Pacemaker version and supported cluster stack(s) is available via the --version option.

crm_mon --version

crm_mon --help

```
[root@pcmk-1 ~]# crm_mon --version
crm_mon 1.0.5 for OpenAIS and Heartbeat (Build: 462f1569a43740667daf7b0f6b521742e9eb8fa7)

Written by Andrew Beekhof
[root@pcmk-1 ~]# crm_mon --help
crm_mon - Provides a summary of cluster's current state.

Outputs varying levels of detail in a number of different formats.

Usage: crm_mon mode [options]
Options:
 -?, --help            This text
 -$, --version         Version information
 -V, --verbose         Increase debug output

Modes:
 -h, --as-html=value   Write cluster status to the named file
 -w, --web-cgi         Web mode with output suitable for cgi
 -s, --simple-status   Display the cluster status once as a simple one line output (suitable for nagios)
 -S, --snmp-traps=value Send SNMP traps to this station
 -T, --mail-to=value   Send Mail alerts to this user.  See also --mail-from, --mail-host, --mail-prefix

Display Options:
 -n, --group-by-node   Group resources by node
 -r, --inactive  Display inactive resources
 -f, --failcounts      Display resource fail counts
 -o, --operations      Display resource operation history
 -t, --timing-details  Display resource operation history with timing details



Additional Options:
 -i, --interval=value         Update frequency in seconds
 -1, --one-shot        Display the cluster status once on the console and exit
 -N, --disable-ncurses        Disable the use of ncurses
 -d, --daemonize              Run in the background as a daemon
 -p, --pid-file=value         (Advanced) Daemon pid file location
 -F, --mail-from=value        Mail alerts should come from the named user
 -H, --mail-host=value        Mail alerts should be sent via the named host
 -P, --mail-prefix=value      Subjects for mail alerts should start with this string
 -E, --external-agent=value   A program to run when resource operations take place.
 -e, --external-recipient=value      A recipient for your program (assuming you want the program to send
   something to someone).

Examples:

Display the cluster´s status on the console with updates as they occur:

   # crm_mon

Display the cluster´s status on the console just once then exit:

   # crm_mon

Display your cluster´s status, group resources by node, and include inactive resources in the list:

   # crm_mon --group-by-node --inactive
```

```
Start crm_mon as a background daemon and have it write the cluster´s status to an HTML file:

   # crm_mon --daemonize --as-html /path/to/docroot/filename.html

Start crm_mon as a background daemon and have it send email alerts:

   # crm_mon --daemonize --mail-to user@example.com --mail-host mail.example.com

Start crm_mon as a background daemon and have it send SNMP alerts:

   # crm_mon --daemonize --snmp-traps snmptrapd.example.com


Report bugs to pacemaker@oss.clusterlabs.org
```

Create an Active/Passive Cluster

Exploring the Existing Configuration

When Pacemaker starts up, it automatically records the number and details of the nodes in the cluster as well as which stack is being used and the version of Pacemaker being used.

This is what the base configuration should look like.

crm configure show

```
[root@pcmk-2 ~]# crm configure show
node pcmk-1
node pcmk-2
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2"
```

For those that are not of afraid of XML, you can see the raw configuration by appending “xml” to the previous command.

crm configure show xml

```
[root@pcmk-2 ~]# crm configure show xml
<?xml version="1.0" ?>
<cib admin_epoch="0" crm_feature_set="3.0.1" dc-uuid="pcmk-1" epoch="13" have-quorum="1" num_updates="7"
    validate-with="pacemaker-1.0">
  <configuration>
    <crm_config>
      <cluster_property_set id="cib-bootstrap-options">
        <nvpair id="cib-bootstrap-options-dc-version" name="dc-version"
    value="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7"/>
        <nvpair id="cib-bootstrap-options-cluster-infrastructure" name="cluster-infrastructure"
    value="openais"/>
        <nvpair id="cib-bootstrap-options-expected-quorum-votes" name="expected-quorum-votes" value="2"/>
      </cluster_property_set>
    </crm_config>
    <rsc_defaults/>
    <op_defaults/>
    <nodes>
      <node id="pcmk-1" type="normal" uname="pcmk-1"/>
      <node id="pcmk-2" type="normal" uname="pcmk-2"/>
    </nodes>
    <resources/>
    <constraints/>
  </configuration>
</cib>
```

The last XML you'll see in this document

Before we make any changes, its a good idea to check the validity of the configuration.

crm_verify -L

```
[root@pcmk-1 ~]# crm_verify -L
crm_verify[2195]: 2009/08/27_16:57:12 ERROR: unpack_resources: Resource start-up disabled since no STONITH
    resources have been defined
crm_verify[2195]: 2009/08/27_16:57:12 ERROR: unpack_resources: Either configure some or disable STONITH with
    the stonith-enabled option
crm_verify[2195]: 2009/08/27_16:57:12 ERROR: unpack_resources: NOTE: Clusters with shared data need STONITH
    to ensure data integrity
Errors found during check: config not valid
  -V may provide more details
[root@pcmk-1 ~]#
```

As you can see, the tool has found some errors.

In order to guarantee the safety of your data[10], Pacemaker ships with STONITH[11] enabled. However it also knows when no STONITH configuration has been supplied and reports this as a problem (since the cluster would not be able to make progress if a situation requiring node fencing arose).

For now, we will disable this feature and configure it later in the Configuring STONITH section. It is important to note that the use of STONITH is highly encouraged, turning it off tells the cluster to simply pretend that failed nodes are safely powered off. Some vendors will even refuse to support clusters that have it disabled.

To disable STONITH, we set the stonith-enabled cluster option to false.

crm configure property stonith-enabled=false

crm_verify -L

```
[root@pcmk-1 ~]# crm configure property stonith-enabled=false
[root@pcmk-1 ~]# crm_verify -L
[root@pcmk-1 ~]#
```

With the new cluster option set, the configuration is now valid.

[10] If the data is corrupt, there is little point in continuing to make it available

[11] A common node fencing mechanism. Used to ensure data integrity by powering off "bad" nodes.

Adding a Resource

The first thing we should do is configure an IP address. Regardless of where the cluster service(s) are running, we need a consistent address to contact them on. Here I will choose and add 192.168.9.101 as the floating address, give it the imaginative name *ClusterIP* and tell the cluster to check that its running every 30 seconds.

Important: The chosen address must not be one already associated with a physical node

```
crm configure primitive ClusterIP ocf:heartbeat:IPaddr2  \
          params ip=192.168.9.101 cidr_netmask=32 \
          op monitor interval=30s
```

The other important piece of information here is *ocf:heartbeat:IPaddr2*. This tells Pacemaker three things about the resource you want to add. The first field, *ocf*, is the standard to which the resource script conforms to and where to find it. The second field is specific to OCF resources and tells the cluster which namespace to find the resource script in, in this case *heartbeat*. The last field indicates the name of the resource script.

To obtain a list of the available resource classes, run

```
crm ra classes
```

```
[root@pcmk-1 ~]# crm ra classes
heartbeat
lsb
ocf / heartbeat pacemaker
stonith
```

To then find all the OCF resource agents provided by Pacemaker and Heartbeat, run

```
crm ra list ocf heartbeat
crm ra list ocf pacemaker
```

```
[root@pcmk-1 ~]# crm ra list ocf pacemaker
ClusterMon     Dummy          Stateful       SysInfo        SystemHealth   controld
ping           pingd
[root@pcmk-1 ~]# crm ra list ocf heartbeat
AoEtarget                AudibleAlarm             ClusterMon               Delay
Dummy                    EvmsSCC                  Evmsd                    Filesystem
ICP                      IPaddr                   IPaddr2                  IPsrcaddr
LVM                      LinuxSCSI                MailTo                   ManageRAID
ManageVE                 Pure-FTPd                Raid1                    Route
SAPDatabase              SAPInstance              SendArp                  ServeRAID
SphinxSearchDaemon       Squid                    Stateful                 SysInfo
VIPArip                  VirtualDomain            WAS                      WAS6
WinPopup                 Xen                      Xinetd                   anything
apache                   db2                      drbd                     eDir88
iSCSILogicalUnit         iSCSITarget              ids                      iscsi
ldirectord               mysql                    mysql-proxy              nfsserver
oracle                   oralsnr                  pgsql                    pingd
portblock                rsyncd                   scsi2reservation         sfex
tomcat                   vmware
[root@pcmk-1 ~]#
```

Now verify that the IP resource has been added and display the cluster's status to see that it is now active.

```
crm configure show
crm_mon
```

```
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 15:23:48 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-1
```

Perform a Failover

Being a high-availability cluster, we should test failover of our new resource before moving on.

First, find the node on which the IP address is running.

```
crm resource status ClusterIP
```

```
[root@pcmk-1 ~]# crm resource status ClusterIP
resource ClusterIP is running on: pcmk-1
[root@pcmk-1 ~]#
```

Shut down OpenAIS on that machine.

```
ssh pcmk-1 -- /etc/init.d/corosync stop
```

```
[root@pcmk-1 ~]# ssh pcmk-1 -- /etc/init.d/corosync stop
Stopping Corosync Cluster Engine (corosync):               [  OK  ]
Waiting for services to unload:                            [  OK  ]
[root@pcmk-1 ~]#
```

Once OpenAIS is no longer running, go to the other node and check the cluster status with crm_mon.

```
[root@pcmk-2 ~]# crm_mon
============
Last updated: Fri Aug 28 15:27:35 2009
Stack: openais
Current DC: pcmk-2 - partition WITHOUT quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-2 ]
OFFLINE: [ pcmk-1 ]
```

There are three things to notice about the cluster's current state. The first is that, as expected, pcmk-1 is now offline. However we can also see that *ClusterIP* isn't running anywhere!

Quorum and Two-Node Clusters

This is because the cluster no longer has quorum, as can be seen by the text "partition WITHOUT quorum" (highlighted green) in the output above. In order to reduce the possibility of data corruption, Pacemaker's default behavior is to stop all resources if the cluster does not have quorum.

A cluster is said to have quorum when more than half the known or expected nodes are online, or for the mathematically inclined, whenever the following equation is true:

$$total\_nodes - 1 < 2 * active\_nodes$$

Therefore a two-node cluster only has quorum when both nodes are running, which is no longer the case for our cluster. This would normally make the creation of a two-node cluster pointless[12], however it is possible to control how Pacemaker behaves when quorum is lost. In particular, we can tell the cluster to simply ignore quorum altogether.

```
crm configure property no-quorum-policy=ignore
crm configure show
```

```
[root@pcmk-1 ~]# crm configure property no-quorum-policy=ignore
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
```

[12] Actually some would argue that two-node clusters are always pointless, but that is an argument for another time.

After a few moments, the cluster will start the IP address on the remaining node. Note that the cluster still does not have quorum.

```
[root@pcmk-2 ~]# crm_mon
============
Last updated: Fri Aug 28 15:30:18 2009
Stack: openais
Current DC: pcmk-2 - partition WITHOUT quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-2 ]
OFFLINE: [ pcmk-1 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-2
```

Now simulate node recovery by restarting the cluster stack on pcmk-1 and check the cluster's status.

```
/etc/init.d/corosync start
crm_mon
```

```
[root@pcmk-1 ~]# /etc/init.d/corosync start
Starting Corosync Cluster Engine (corosync):               [  OK  ]
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 15:32:13 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-1
```

Here we see something that some may consider surprising, the IP is back running at its original location!

Prevent Resources from Moving after Recovery

In some circumstances it is highly desirable to prevent healthy resources from being moved around the cluster. Move resources almost always requires a period of downtime and for complex services like Oracle databases, this period can be quite long.

To address this, Pacemaker has the concept of resource stickiness which controls how much a service prefers to stay running where it is. You may like to think of it as the "cost" of any downtime. By default, Pacemaker assumes there is zero cost associated with moving resources and will do so to achieve "optimal[13]" resource placement. We can specify a different stickiness for every resource, but it is often sufficient to change the default.

```
crm configure rsc_defaults resource-stickiness=100
crm configure show
```

```
[root@pcmk-2 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness="100"
```

If we now retry the failover test, we see that as expected *ClusterIP* still moves to *pcmk-2* when *pcmk-1* is taken offline.

```
ssh pcmk-1 -- /etc/init.d/corosync stop
ssh pcmk-2 -- crm_mon -1
```

```
[root@pcmk-1 ~]# ssh pcmk-1 -- /etc/init.d/corosync stop
Stopping Corosync Cluster Engine (corosync):               [  OK  ]
Waiting for services to unload:                            [  OK  ]
[root@pcmk-1 ~]# ssh pcmk-2 -- crm_mon -1
============
Last updated: Fri Aug 28 15:39:38 2009
Stack: openais
Current DC: pcmk-2 - partition WITHOUT quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-2 ]
```

[13] It should be noted that Pacemaker's definition of optimal may not always agree with that of a human's. The order in which Pacemaker processes lists of resources and nodes create implicit preferences (required in order to create a stabile solution) in situations where the administrator had not explicitly specified some.

```
OFFLINE: [ pcmk-1 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-2
```

However when we bring *pcmk-1* back online, *ClusterIP* now remains running on *pcmk-2*.

```
[root@pcmk-1 ~]# /etc/init.d/corosync start
Starting Corosync Cluster Engine (corosync):               [  OK  ]
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 15:41:23 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
1 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
```

Apache - Adding More Services

Now that we have a basic but functional active/passive two-node cluster, we're ready to add some real services. We're going to start with Apache because its a feature of many clusters and relatively simple to configure.

Installation

Before continuing, we need to make sure Apache is installed on **both** hosts.

```
yum install -y httpd
```

```
[root@ppcmk-1 ~]# yum install -y httpd
Setting up Install Process
Resolving Dependencies
--> Running transaction check
---> Package httpd.x86_64 0:2.2.13-2.fc12 set to be updated
--> Processing Dependency: httpd-tools = 2.2.13-2.fc12 for package: httpd-2.2.13-2.fc12.x86_64
--> Processing Dependency: apr-util-ldap for package: httpd-2.2.13-2.fc12.x86_64
--> Processing Dependency: /etc/mime.types for package: httpd-2.2.13-2.fc12.x86_64
--> Processing Dependency: libaprutil-1.so.0()(64bit) for package: httpd-2.2.13-2.fc12.x86_64
--> Processing Dependency: libapr-1.so.0()(64bit) for package: httpd-2.2.13-2.fc12.x86_64
--> Running transaction check
---> Package apr.x86_64 0:1.3.9-2.fc12 set to be updated
---> Package apr-util.x86_64 0:1.3.9-2.fc12 set to be updated
---> Package apr-util-ldap.x86_64 0:1.3.9-2.fc12 set to be updated
---> Package httpd-tools.x86_64 0:2.2.13-2.fc12 set to be updated
---> Package mailcap.noarch 0:2.1.30-1.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

=================================================================================================================
 Package                      Arch                   Version                         Repository              Size
=================================================================================================================
Installing:
 httpd                        x86_64                 2.2.13-2.fc12                   rawhide                735 k
Installing for dependencies:
 apr                          x86_64                 1.3.9-2.fc12                    rawhide                117 k
 apr-util                     x86_64                 1.3.9-2.fc12                    rawhide                 84 k
 apr-util-ldap                x86_64                 1.3.9-2.fc12                    rawhide                 15 k
 httpd-tools                  x86_64                 2.2.13-2.fc12                   rawhide                 63 k
 mailcap                      noarch                 2.1.30-1.fc12                   rawhide                 25 k

Transaction Summary
=================================================================================================================
Install       6 Package(s)
Upgrade       0 Package(s)

Total download size: 1.0 M
```

```
Downloading Packages:
(1/6): apr-1.3.9-2.fc12.x86_64.rpm                                                    | 117 kB     00:00
(2/6): apr-util-1.3.9-2.fc12.x86_64.rpm                                               |  84 kB     00:00
(3/6): apr-util-ldap-1.3.9-2.fc12.x86_64.rpm                                          |  15 kB     00:00
(4/6): httpd-2.2.13-2.fc12.x86_64.rpm                                                 | 735 kB     00:00
(5/6): httpd-tools-2.2.13-2.fc12.x86_64.rpm                                           |  63 kB     00:00
(6/6): mailcap-2.1.30-1.fc12.noarch.rpm                                               |  25 kB     00:00
------------------------------------------------------------------------------------------------------------
Total                                                                        875 kB/s | 1.0 MB     00:01
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : apr-1.3.9-2.fc12.x86_64                                                              1/6
  Installing     : apr-util-1.3.9-2.fc12.x86_64                                                         2/6
  Installing     : apr-util-ldap-1.3.9-2.fc12.x86_64                                                    3/6
  Installing     : httpd-tools-2.2.13-2.fc12.x86_64                                                     4/6
  Installing     : mailcap-2.1.30-1.fc12.noarch                                                         5/6
  Installing     : httpd-2.2.13-2.fc12.x86_64                                                           6/6

Installed:
  httpd.x86_64 0:2.2.13-2.fc12

Dependency Installed:
  apr.x86_64 0:1.3.9-2.fc12            apr-util.x86_64 0:1.3.9-2.fc12   apr-util-ldap.x86_64 0:1.3.9-2.fc12
  httpd-tools.x86_64 0:2.2.13-2.fc12   mailcap.noarch 0:2.1.30-1.fc12

Complete!
[root@pcmk-1 ~]#
```

Also, we need the wget tool in order for the cluster to be able to check the status of the Apache server.

```
yum install -y wget
```

```
[root@pcmk-1 ~]# yum install -y wget
Setting up Install Process
Resolving Dependencies
--> Running transaction check
---> Package wget.x86_64 0:1.11.4-5.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

============================================================================================================
 Package              Arch                    Version                          Repository              Size
============================================================================================================
Installing:
 wget                 x86_64                  1.11.4-5.fc12                    rawhide                393 k

Transaction Summary
============================================================================================================
Install       1 Package(s)
Upgrade       0 Package(s)

Total download size: 393 k
Downloading Packages:
```

```
wget-1.11.4-5.fc12.x86_64.rpm                                                   | 393 kB     00:00
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : wget-1.11.4-5.fc12.x86_64                                                     1/1

Installed:
  wget.x86_64 0:1.11.4-5.fc12

Complete!
[root@pcmk-1 ~]#
```

Preparation

First we need to create a page for Apache to serve up. On Fedora the default Apache docroot is */var/www/html*, so we'll create an index file there.

```
cat <<-END >/var/www/html/index.html
<html>
<body>My Test Site - pcmk-1</body>
</html>
END
```

```
[root@pcmk-1 ~]# cat <<-END >/var/www/html/index.html
> <html>
> <body>My Test Site - pcmk-1</body>
> </html>
> END
[root@pcmk-1 ~]#
```

For the moment, we will simplify things by serving up only a static site and manually sync the data between the two nodes. So run the command again on pcmk-2.

```
cat <<-END >/var/www/html/index.html
<html>
<body>My Test Site - pcmk-2</body>
</html>
END
```

```
[root@pcmk-2 ~]# cat <<-END >/var/www/html/index.html
> <html>
> <body>My Test Site - pcmk-2</body>
> </html>
> END
[root@pcmk-2 ~]#
```

Update the Configuration

At this point, Apache is ready to go, all that needs to be done is to add it to the cluster. Lets call the resource WebSite. We need to use an OCF script called ***apache*** in the ***heartbeat*** namespace[14], the only required parameter is the path to the main Apache configuration file and we'll tell the cluster to check once a minute that apache is still running.

```
crm configure primitive WebSite ocf:heartbeat:apache \
        params configfile=/etc/httpd/conf/httpd.conf \
        op monitor interval=1min
crm configure show
crm_mon
```

```
[root@pcmk-1 ~]# crm configure primitive WebSite ocf:heartbeat:apache params configfile=/etc/httpd/conf/
   httpd.conf op monitor interval=1min
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
   params ip="192.168.9.101" cidr_netmask="32" \
   op monitor interval="30s"
property $id="cib-bootstrap-options" \
   dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
   cluster-infrastructure="openais" \
   expected-quorum-votes="2" \
   stonith-enabled="false" \
   no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
   resource-stickiness="100"
```

After a short delay, we should see the cluster start apache

```
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 16:12:49 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
2 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-2
WebSite   (ocf::heartbeat:apache):   Started pcmk-1
```

Wait a moment, the WebSite resource isn't running on the same host as our IP address!

[14] Compare the key used here *ocf:heartbeat:apache* with the one we used earlier for the IP address: *ocf:heartbeat:IPaddr2*

Ensuring Resources Run on the Same Host

To reduce the load on any one machine, Pacemaker will generally try to spread the configured resources across the cluster nodes. However we can tell the cluster that two resources are related and need to run on the same host (or not at all). Here we instruct the cluster that *WebSite* can only run on the host that *ClusterIP* is active on. If *ClusterIP* is not active anywhere, *WebSite* will not be permitted to run anywhere.

crm configure colocation website-with-ip INFINITY: WebSite ClusterIP

crm configure show

crm_mon

```
[root@pcmk-1 ~]# crm configure colocation website-with-ip INFINITY: WebSite ClusterIP
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
colocation website-with-ip inf: WebSite ClusterIP
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness="100"
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 16:14:34 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
2 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-2
WebSite   (ocf::heartbeat:apache):   Started pcmk-2
```

Controlling Resource Start/Stop Ordering

When Apache starts, it binds to the available IP addresses. It doesn't know about any addresses we add afterwards, so not only do they need to run on the same node, but we need to make sure *ClusterIP* is already active before we start *WebSite*. We do this by adding an ordering constraint. We need to give it a name (chose something descriptive like *apache-after-ip*), indicate that its mandatory (so that any recovery for *ClusterIP* will also trigger recovery of *WebSite*) and list the two resources in the order we need them to start.

```
crm configure order apache-after-ip mandatory: ClusterIP WebSite
crm configure show
```

```
[root@pcmk-1 ~]# crm configure order apache-after-ip mandatory: ClusterIP WebSite
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
   params ip="192.168.9.101" cidr_netmask="32" \
   op monitor interval="30s"
colocation website-with-ip inf: WebSite ClusterIP
order apache-after-ip inf: ClusterIP WebSite
property $id="cib-bootstrap-options" \
   dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
   cluster-infrastructure="openais" \
   expected-quorum-votes="2" \
   stonith-enabled="false" \
   no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
   resource-stickiness="100"
```

Specifying a Preferred Location

Pacemaker does not rely on any sort of hardware symmetry between nodes, so it may well be that one machine is more powerful than the other. In such cases it makes sense to host the resources there if it is available. To do this we create a location constraint. Again we give it a descriptive name (*prefer-pcmk-1*), specify the resource we want to run there (*WebSite*), how badly we'd like it to run there (we'll use *50* for now, but in a two-node situation almost any value above 0 will do) and the host's name.

crm configure location prefer-pcmk-1 WebSite rule 50: pcmk-1

crm configure show

crm_mon

```
[root@pcmk-1 ~]# crm configure location prefer-pcmk-1 WebSite 50: pcmk-1
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation website-with-ip inf: WebSite ClusterIP
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness="100"
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 16:17:35 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
2 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-2
WebSite   (ocf::heartbeat:apache):   Started pcmk-2
```

Wait a minute, the resources are still on pcmk-2!

Even though we now prefer pcmk-1 over pcmk-2, that preference is (intentionally) less than the resource stickiness (how much we preferred not to have unnecessary downtime).

To see the current placement scores, you can use a tool called ptest

ptest -sL

There is a way to force them to move though...

Manually Moving Resources Around the Cluster

There are always times when an administrator needs to override the cluster and force resources to move to a specific location. Underneath we use location constraints like the one we created above, happily you don't need to care. Just provide the name of the resource and the intended location, we'll do the rest.

```
crm resource move WebSite pcmk-1
crm_mon
```

```
[root@pcmk-1 ~]# crm resource move WebSite pcmk-1
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 16:19:24 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
2 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-1
WebSite   (ocf::heartbeat:apache):   Started pcmk-1
```

Notice how the colocation rule we created has ensured that *ClusterIP* was also moved to *pcmk-1*.

For the curious, we can see the effect of this command by examining the configuration

```
crm configure show
```

```
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
location cli-prefer-WebSite WebSite \
    rule $id="cli-prefer-rule-WebSite" inf: #uname eq pcmk-1
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation website-with-ip inf: WebSite ClusterIP
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness="100"
```

Highlighted is the automated constraint used to move the resources to pcmk-1

Giving Control Back to the Cluster

Once we've finished whatever activity that required us to move the resources to pcmk-1, in our case nothing, we can then allow the cluster to resume normal operation with the unmove command. Since we previously configured a default stickiness, the resources will remain on *pcmk-1*.

crm resource unmove WebSite

crm configure show

```
[root@pcmk-1 ~]# crm resource unmove WebSite
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation website-with-ip inf: WebSite ClusterIP
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes="2" \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness="100"
```

Note that the automated constraint is now gone. If we check the cluster status, we can also see that as expected the resources are still active on *pcmk-1*.

```
[root@pcmk-1 ~]# crm_mon
============
Last updated: Fri Aug 28 16:20:53 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
2 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-1
WebSite   (ocf::heartbeat:apache):   Started pcmk-1
```

Using DRBD for Shared Storage

Even if you're serving up static websites, having to manually synchronize the contents of that website to all the machines in the cluster is not ideal. For dynamic websites, such as a wiki, its not even an option. Not everyone care afford network-attached storage but somehow the data needs to be kept in sync. Enter DRBD which can be thought of as network based RAID-1. See http://www.drbd.org/ for more details.

Install Pre-requisites

DRBD does not currently ship with Fedora 12 and since there is a kernel component, can be sensitive to system updates which may change the kernel's APIs and ABIs. For this reason we'll simply build our own DRBD packages - to be sure they are a perfect match for the machine.

First we need to install a few packages that DRBD needs:

```
yum install -y flex gcc glibc-devel kernel-headers kernel-devel rpm-build
```

```
[root@pcmk-1 ~]# yum install -y flex gcc glibc-devel kernel-headers kernel-devel rpm-build
Setting up Install Process
Resolving Dependencies
--> Running transaction check
---> Package flex.x86_64 0:2.5.35-7.fc12 set to be updated
---> Package gcc.x86_64 0:4.4.2-7.fc12 set to be updated
--> Processing Dependency: libgomp = 4.4.2-7.fc12 for package: gcc-4.4.2-7.fc12.x86_64
--> Processing Dependency: cpp = 4.4.2-7.fc12 for package: gcc-4.4.2-7.fc12.x86_64
--> Processing Dependency: cloog-ppl >= 0.15 for package: gcc-4.4.2-7.fc12.x86_64
--> Processing Dependency: libgomp.so.1()(64bit) for package: gcc-4.4.2-7.fc12.x86_64
---> Package glibc-devel.x86_64 0:2.11-2 set to be updated
--> Processing Dependency: glibc-headers = 2.11-2 for package: glibc-devel-2.11-2.x86_64
--> Processing Dependency: glibc-headers for package: glibc-devel-2.11-2.x86_64
---> Package kernel-devel.x86_64 0:2.6.31.6-162.fc12 set to be installed
---> Package kernel-headers.x86_64 0:2.6.31.6-162.fc12 set to be updated
---> Package rpm-build.x86_64 0:4.7.1-6.fc12 set to be updated
--> Processing Dependency: patch >= 2.5 for package: rpm-build-4.7.1-6.fc12.x86_64
--> Processing Dependency: elfutils >= 0.128 for package: rpm-build-4.7.1-6.fc12.x86_64
--> Processing Dependency: pkgconfig for package: rpm-build-4.7.1-6.fc12.x86_64
--> Processing Dependency: unzip for package: rpm-build-4.7.1-6.fc12.x86_64
--> Running transaction check
---> Package cloog-ppl.x86_64 0:0.15.7-1.fc12 set to be updated
--> Processing Dependency: libppl.so.7()(64bit) for package: cloog-ppl-0.15.7-1.fc12.x86_64
--> Processing Dependency: libgmpxx.so.4()(64bit) for package: cloog-ppl-0.15.7-1.fc12.x86_64
--> Processing Dependency: libppl_c.so.2()(64bit) for package: cloog-ppl-0.15.7-1.fc12.x86_64
--> Processing Dependency: libgmp.so.3()(64bit) for package: cloog-ppl-0.15.7-1.fc12.x86_64
---> Package cpp.x86_64 0:4.4.2-7.fc12 set to be updated
--> Processing Dependency: libmpfr.so.1()(64bit) for package: cpp-4.4.2-7.fc12.x86_64
---> Package elfutils.x86_64 0:0.143-1.fc12 set to be updated
```

```
--> Processing Dependency: elfutils-libs-x86_64 = 0.143-1.fc12 for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libdw.so.1(ELFUTILS_0.127)(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libasm.so.1(ELFUTILS_1.0)(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libdw.so.1(ELFUTILS_0.126)(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libdw.so.1(ELFUTILS_0.138)(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libdw.so.1(ELFUTILS_0.122)(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libdw.so.1()(64bit) for package: elfutils-0.143-1.fc12.x86_64
--> Processing Dependency: libasm.so.1()(64bit) for package: elfutils-0.143-1.fc12.x86_64
---> Package glibc-headers.x86_64 0:2.11-2 set to be updated
---> Package libgomp.x86_64 0:4.4.2-7.fc12 set to be updated
---> Package patch.x86_64 0:2.6-1.fc12 set to be updated
---> Package pkgconfig.x86_64 1:0.23-9.fc12 set to be updated
---> Package unzip.x86_64 0:5.52-11.fc12 set to be updated
--> Running transaction check
---> Package elfutils-libs.x86_64 0:0.143-1.fc12 set to be updated
---> Package gmp.x86_64 0:4.3.1-5.fc12 set to be updated
---> Package mpfr.x86_64 0:2.4.1-3.fc12 set to be updated
---> Package ppl.x86_64 0:0.10.2-10.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

========================================================================================================
 Package                   Arch               Version                        Repository           Size
========================================================================================================
Installing:
 flex                      x86_64             2.5.35-7.fc12                  fedora              274 k
 gcc                       x86_64             4.4.2-7.fc12                   fedora               10 M
 glibc-devel               x86_64             2.11-2                         fedora              951 k
 kernel-devel              x86_64             2.6.31.6-162.fc12              updates             6.0 M
 kernel-headers            x86_64             2.6.31.6-162.fc12              updates             743 k
 rpm-build                 x86_64             4.7.1-6.fc12                   fedora              112 k
Installing for dependencies:
 cloog-ppl                 x86_64             0.15.7-1.fc12                  fedora               82 k
 cpp                       x86_64             4.4.2-7.fc12                   fedora              3.7 M
 elfutils                  x86_64             0.143-1.fc12                   fedora              177 k
 elfutils-libs             x86_64             0.143-1.fc12                   fedora              162 k
 glibc-headers             x86_64             2.11-2                         fedora              580 k
 gmp                       x86_64             4.3.1-5.fc12                   fedora              198 k
 libgomp                   x86_64             4.4.2-7.fc12                   fedora               90 k
 mpfr                      x86_64             2.4.1-3.fc12                   fedora              149 k
 patch                     x86_64             2.6-1.fc12                     updates              79 k
 pkgconfig                 x86_64             1:0.23-9.fc12                  fedora               68 k
 ppl                       x86_64             0.10.2-10.fc12                 fedora              1.1 M
 unzip                     x86_64             5.52-11.fc12                   fedora              125 k

Transaction Summary
========================================================================================================
Install      18 Package(s)
Upgrade       0 Package(s)

Total download size: 24 M
Downloading Packages:
(1/18): cloog-ppl-0.15.7-1.fc12.x86_64.rpm                                       |  82 kB     00:00
(2/18): cpp-4.4.2-7.fc12.x86_64.rpm                                              | 3.7 MB     00:02
(3/18): elfutils-0.143-1.fc12.x86_64.rpm                                         | 177 kB     00:00
(4/18): elfutils-libs-0.143-1.fc12.x86_64.rpm                                    | 162 kB     00:00
```

```
(5/18): flex-2.5.35-7.fc12.x86_64.rpm                                            | 274 kB     00:00
(6/18): gcc-4.4.2-7.fc12.x86_64.rpm                                              |  10 MB     00:06
(7/18): glibc-devel-2.11-2.x86_64.rpm                                            | 951 kB     00:00
(8/18): glibc-headers-2.11-2.x86_64.rpm                                          | 580 kB     00:00
(9/18): gmp-4.3.1-5.fc12.x86_64.rpm                                              | 198 kB     00:00
(10/18): kernel-devel-2.6.31.6-162.fc12.x86_64.rpm                               | 6.0 MB     00:22
(11/18): kernel-headers-2.6.31.6-162.fc12.x86_64.rpm                             | 743 kB     00:01
(12/18): libgomp-4.4.2-7.fc12.x86_64.rpm                                         |  90 kB     00:00
(13/18): mpfr-2.4.1-3.fc12.x86_64.rpm                                            | 149 kB     00:00
(14/18): patch-2.6-1.fc12.x86_64.rpm                                             |  79 kB     00:00
(15/18): pkgconfig-0.23-9.fc12.x86_64.rpm                                        |  68 kB     00:00
(16/18): ppl-0.10.2-10.fc12.x86_64.rpm                                           | 1.1 MB     00:00
(17/18): rpm-build-4.7.1-6.fc12.x86_64.rpm                                       | 112 kB     00:00
(18/18): unzip-5.52-11.fc12.x86_64.rpm                                           | 125 kB     00:00
----------------------------------------------------------------------------------------------------------
Total                                                                   662 kB/s |  24 MB     00:37
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : gmp-4.3.1-5.fc12.x86_64                                                       1/18
  Installing     : mpfr-2.4.1-3.fc12.x86_64                                                      2/18
  Installing     : cpp-4.4.2-7.fc12.x86_64                                                       3/18
  Installing     : ppl-0.10.2-10.fc12.x86_64                                                     4/18
  Installing     : cloog-ppl-0.15.7-1.fc12.x86_64                                                5/18
  Installing     : 1:pkgconfig-0.23-9.fc12.x86_64                                                6/18
  Installing     : libgomp-4.4.2-7.fc12.x86_64                                                   7/18
  Installing     : elfutils-libs-0.143-1.fc12.x86_64                                             8/18
  Installing     : elfutils-0.143-1.fc12.x86_64                                                  9/18
  Installing     : patch-2.6-1.fc12.x86_64                                                      10/18
  Installing     : unzip-5.52-11.fc12.x86_64                                                    11/18
  Installing     : kernel-headers-2.6.31.6-162.fc12.x86_64                                      12/18
  Installing     : rpm-build-4.7.1-6.fc12.x86_64                                                13/18
  Installing     : flex-2.5.35-7.fc12.x86_64                                                    14/18
  Installing     : glibc-headers-2.11-2.x86_64                                                  15/18
  Installing     : glibc-devel-2.11-2.x86_64                                                    16/18
  Installing     : gcc-4.4.2-7.fc12.x86_64                                                      17/18
  Installing     : kernel-devel-2.6.31.6-162.fc12.x86_64                                        18/18

Installed:
  flex.x86_64 0:2.5.35-7.fc12                          gcc.x86_64 0:4.4.2-7.fc12
  glibc-devel.x86_64 0:2.11-2                          kernel-devel.x86_64 0:2.6.31.6-162.fc12
  kernel-headers.x86_64 0:2.6.31.6-162.fc12            rpm-build.x86_64 0:4.7.1-6.fc12

Dependency Installed:
  cloog-ppl.x86_64 0:0.15.7-1.fc12      cpp.x86_64 0:4.4.2-7.fc12       elfutils.x86_64 0:0.143-1.fc12
  elfutils-libs.x86_64 0:0.143-1.fc12   glibc-headers.x86_64 0:2.11-2   gmp.x86_64 0:4.3.1-5.fc12
  libgomp.x86_64 0:4.4.2-7.fc12         mpfr.x86_64 0:2.4.1-3.fc12      patch.x86_64 0:2.6-1.fc12
  pkgconfig.x86_64 1:0.23-9.fc12        ppl.x86_64 0:0.10.2-10.fc12     unzip.x86_64 0:5.52-11.fc12

Complete!
[root@pcmk-1 ~]#
```

Build DRBD Packages

Once the development packages are installed, we can begin building DRBD[15].

```
wget http://oss.linbit.com/drbd/8.3/drbd-8.3.6.tar.gz
tar zxf drbd-8.3.6.tar.gz
cd drbd-8.3.6
./configure --with-km --enable-spec
sed -i.sed s/"devel = %{kernelversion}"/devel/ drbd-km.spec
rpmbuild -ba --define "_sourcedir `pwd`/.." drbd-km.spec
```

```
[root@pcmk-1 ~]# wget http://oss.linbit.com/drbd/8.3/drbd-8.3.6.tar.gz
--2009-12-08 11:04:36--  http://oss.linbit.com/drbd/8.3/drbd-8.3.6.tar.gz
Resolving oss.linbit.com... 212.69.161.111
Connecting to oss.linbit.com|212.69.161.111|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 457469 (447K) [application/x-gzip]
Saving to: “drbd-8.3.6.tar.gz”

100%[==============================================================>] 457,469     1.12M/s   in 0.4s

2009-12-08 11:04:37 (1.12 MB/s) - “drbd-8.3.6.tar.gz” saved [457469/457469]

[root@pcmk-1 ~]# tar zxf drbd-8.3.6.tar.gz
[root@pcmk-1 ~]# cd drbd-8.3.6
[root@pcmk-1 drbd-8.3.6]# make rpm
make: *** No rule to make target `rpm'.  Stop.
[root@pcmk-1 drbd-8.3.6]# ./configure --with-km --enable-spec
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking whether ln -s works... yes
checking for sed... /bin/sed
checking for grep... /bin/grep
checking for flex... /usr/bin/flex
checking for rpmbuild... /usr/bin/rpmbuild
checking for xsltproc... /usr/bin/xsltproc
checking for tar... /bin/tar
checking for git... no
checking for dpkg-buildpackage... no
checking for udevadm... /sbin/udevadm
checking for udevinfo... /usr/bin/udevinfo
configure: WARNING: No dpkg-buildpackage found, building Debian packages is disabled.
configure: WARNING: Cannot update buildtag without git. You may safely ignore this warning when building
   from a tarball.
```

[15] At the time of writing, the latest version was 8.3.6. If a later version is now available it would be advisable to try that first.

```
checking for /Makefile... no
configure: WARNING: Unable to find a kernel Makefile in . You will have to set KDIR correctly when invoking
   make.
checking for /etc/gentoo-release... no
checking for /etc/redhat-release... yes
checking for /etc/slackware-version... no
checking for /etc/debian_version... no
checking for /etc/SuSErelease... no
configure: configured for Red Hat (includes Fedora, RHEL, CentOS).
configure: creating ./config.status
config.status: creating drbd.spec
config.status: creating drbd-km.spec
```

The following build log is quite long and is only included for reference in case it does not work on your machine. Most people can skip to the end.

```
[root@pcmk-1 drbd-8.3.6]# rpmbuild -ba --define "_sourcedir `pwd`/.." drbd-km.spec
Executing(%prep): /bin/sh -e /var/tmp/rpm-tmp.Q7iVhB
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd /root/rpmbuild/BUILD
+ rm -rf drbd-8.3.6
+ /usr/bin/gzip -dc /root/drbd-8.3.6.tar.gz
+ /bin/tar -xf -
+ STATUS=0
+ '[' 0 -ne 0 ']'
+ cd drbd-8.3.6
+ /bin/chmod -Rf a+rX,u+w,g-w,o-w .
+ test -d /lib/modules/2.6.31.6-162.fc12.x86_64/build/.
++ KDIR=/lib/modules/2.6.31.6-162.fc12.x86_64/build
++ scripts/get_uts_release.sh
+ test 2.6.31.6-162.fc12.x86_64 = 2.6.31.6-162.fc12.x86_64
+ exit 0
Executing(%build): /bin/sh -e /var/tmp/rpm-tmp.08bAH0
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd drbd-8.3.6
+ CFLAGS='-O2 -g'
+ export CFLAGS
+ CXXFLAGS='-O2 -g'
+ export CXXFLAGS
+ FFLAGS='-O2 -g'
+ export FFLAGS
+ ./configure --host=x86_64-unknown-linux-gnu --build=x86_64-unknown-linux-gnu --target=x86_64-redhat-linux
   --program-prefix= --prefix=/usr --exec-prefix=/usr --bindir=/usr/bin --sbindir=/usr/sbin --sysconfdir=/
   etc --datadir=/usr/share --includedir=/usr/include --libdir=/usr/lib64 --libexecdir=/usr/libexec --
   localstatedir=/var --sharedstatedir=/var/lib --mandir=/usr/share/man --infodir=/usr/share/info --
   without-utils --with-km --without-udev --without-xen --without-pacemaker --without-heartbeat --without-
   rgmanager --without-bashcompletion
checking for x86_64-unknown-linux-gnu-gcc... no
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking whether ln -s works... yes
checking for sed... /bin/sed
checking for grep... /bin/grep
checking for flex... /usr/bin/flex
checking for rpmbuild... /usr/bin/rpmbuild
checking for xsltproc... /usr/bin/xsltproc
checking for tar... /bin/tar
checking for git... no
checking for dpkg-buildpackage... no
checking for udevadm... /sbin/udevadm
checking for udevinfo... /usr/bin/udevinfo
configure: WARNING: No dpkg-buildpackage found, building Debian packages is disabled.
configure: WARNING: Cannot update buildtag without git. You may safely ignore this warning when building
    from a tarball.
checking for /Makefile... no
configure: WARNING: Unable to find a kernel Makefile in . You will have to set KDIR correctly when invoking
    make.
checking for /etc/gentoo-release... no
checking for /etc/redhat-release... yes
checking for /etc/slackware-version... no
checking for /etc/debian_version... no
checking for /etc/SuSErelease... no
configure: configured for Red Hat (includes Fedora, RHEL, CentOS).
configure: creating ./config.status
config.status: creating Makefile
config.status: creating user/Makefile
config.status: creating scripts/Makefile
config.status: creating documentation/Makefile
+ echo kernelversion=2.6.31.6-162.fc12.x86_64
kernelversion=2.6.31.6-162.fc12.x86_64
+ echo 'kversion=%{kversion}'
kversion=%{kversion}
+ echo krelver=2.6.31.6_162.fc12.x86_64
krelver=2.6.31.6_162.fc12.x86_64
+ make module KDIR=/lib/modules/2.6.31.6-162.fc12.x86_64/build
make[1]: Entering directory `/root/rpmbuild/BUILD/drbd-8.3.6/drbd'

    Calling toplevel makefile of kernel source tree, which I believe is in
    KDIR=/lib/modules/2.6.31.6-162.fc12.x86_64/build

test -f ../scripts/adjust_drbd_config_h.sh && \
     KDIR=/lib/modules/2.6.31.6-162.fc12.x86_64/build O= /bin/bash ../scripts/adjust_drbd_config_h.sh
/lib/modules/2.6.31.6-162.fc12.x86_64/build ~/rpmbuild/BUILD/drbd-8.3.6/drbd
~/rpmbuild/BUILD/drbd-8.3.6/drbd

  Using unmodified drbd_config.h

make -C /lib/modules/2.6.31.6-162.fc12.x86_64/build   SUBDIRS=/root/rpmbuild/BUILD/drbd-8.3.6/drbd  modules
make[2]: Entering directory `/usr/src/kernels/2.6.31.6-162.fc12.x86_64'
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_buildtag.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_bitmap.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_proc.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_worker.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_receiver.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_req.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_actlog.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/lru_cache.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_main.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_strings.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_nl.o
  CC [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_tracing.o
  LD [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd.o
  LD [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_trace.o
  Building modules, stage 2.
  MODPOST 2 modules
  CC      /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd.mod.o
  LD [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd.ko
  CC      /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_trace.mod.o
  LD [M]  /root/rpmbuild/BUILD/drbd-8.3.6/drbd/drbd_trace.ko
make[2]: Leaving directory `/usr/src/kernels/2.6.31.6-162.fc12.x86_64'
mv .drbd_kernelrelease.new .drbd_kernelrelease
Memorizing module configuration ... done.
make[1]: Leaving directory `/root/rpmbuild/BUILD/drbd-8.3.6/drbd'

   Module build was successful.
+ exit 0
Executing(%install): /bin/sh -e /var/tmp/rpm-tmp.sAoLRi
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd drbd-8.3.6
+ rm -rf /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64
+ make install DESTDIR=/root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64
make[1]: Entering directory `/root/rpmbuild/BUILD/drbd-8.3.6/user'
make[1]: Nothing to be done for `install'.
make[1]: Leaving directory `/root/rpmbuild/BUILD/drbd-8.3.6/user'
make[1]: Entering directory `/root/rpmbuild/BUILD/drbd-8.3.6/scripts'
make[1]: Nothing to be done for `install'.
make[1]: Leaving directory `/root/rpmbuild/BUILD/drbd-8.3.6/scripts'
make[1]: Entering directory `/root/rpmbuild/BUILD/drbd-8.3.6/documentation'
set -e; for f in  ; do \
          s=${f##*.}; \
          install -v -D -m 644 $f /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/man/man
   $s/$f ; \
   done
make[1]: Leaving directory `/root/rpmbuild/BUILD/drbd-8.3.6/documentation'
make -C drbd install
make[1]: Entering directory `/root/rpmbuild/BUILD/drbd-8.3.6/drbd'
install -d /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/lib/modules/2.6.31.6-162.fc12.x86_64/
   kernel/drivers/block
install -m 644 drbd.ko /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/lib/modules/
   2.6.31.6-162.fc12.x86_64/kernel/drivers/block
make[1]: Leaving directory `/root/rpmbuild/BUILD/drbd-8.3.6/drbd'
+ cd drbd
+ mv .kernel.config.gz k-config-2.6.31.6-162.fc12.x86_64.gz
+ /usr/lib/rpm/brp-compress
+ /usr/lib/rpm/brp-strip
+ /usr/lib/rpm/brp-strip-static-archive
+ /usr/lib/rpm/brp-strip-comment-note
Processing files: drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64
Executing(%doc): /bin/sh -e /var/tmp/rpm-tmp.ixFNFB
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd drbd-8.3.6
+ DOCDIR=/root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-
   km-2.6.31.6_162.fc12.x86_64-8.3.6
```

```
+ export DOCDIR
+ rm -rf /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6
+ /bin/mkdir -p /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6
+ cp -pr COPYING /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6
+ cp -pr ChangeLog /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6
+ cp -pr drbd/k-config-2.6.31.6-162.fc12.x86_64.gz /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64/usr/share/doc/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6
+ exit 0
Requires(interp): /bin/sh /bin/sh /bin/sh
Requires(rpmlib): rpmlib(CompressedFileNames) <= 3.0.4-1 rpmlib(PayloadFilesHavePrefix) <= 4.0-1
Requires(post): /bin/sh
Requires(preun): /bin/sh
Requires(postun): /bin/sh
Conflicts: drbd-kmod <= 8.3.6_3
Checking for unpackaged file(s): /usr/lib/rpm/check-files /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64
Wrote: /root/rpmbuild/SRPMS/drbd-km-8.3.6-12.fc12.src.rpm
Wrote: /root/rpmbuild/RPMS/x86_64/drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm
Executing(%clean): /bin/sh -e /var/tmp/rpm-tmp.MB9N8D
+ umask 022
+ cd /root/rpmbuild/BUILD
+ cd drbd-8.3.6
+ rm -rf /root/rpmbuild/BUILDROOT/drbd-km-8.3.6-12.fc12.x86_64
+ exit 0
```

Install the DRBD Packages

The completed build process will store the result in the ~/RPMS/x86_64/ directory and all that is required now is to install the ones we need with YUM.

```
yum install -y drbd-utils drbd-pacemaker
```

Now install the kernel module we built

```
cd /root/rpmbuild/RPMS/`uname -m`
yum localinstall -y --nogpgcheck drbd-km-*-8.3.6-*.rpm
```

```
[root@pcmk-1 x86_64]# yum localinstall -y --nogpgcheck drbd-utils-8.3.6-*.rpm drbd-pacemaker-8.3.6-*.rpm
   drbd-km-*-8.3.6-*.rpm
Setting up Local Package Process
Examining drbd-utils-8.3.6-1.fc12.x86_64.rpm: drbd-utils-8.3.6-1.fc12.x86_64
Marking drbd-utils-8.3.6-1.fc12.x86_64.rpm to be installed
custom                                                                           | 1.2 kB     00:00
Examining drbd-pacemaker-8.3.6-1.fc12.x86_64.rpm: drbd-pacemaker-8.3.6-1.fc12.x86_64
Marking drbd-pacemaker-8.3.6-1.fc12.x86_64.rpm to be installed
Examining drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm: drbd-
   km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64
Marking drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm to be installed
Resolving Dependencies
--> Running transaction check
---> Package drbd-km-2.6.31.6_162.fc12.x86_64.x86_64 0:8.3.6-12.fc12 set to be updated
---> Package drbd-pacemaker.x86_64 0:8.3.6-1.fc12 set to be updated
---> Package drbd-utils.x86_64 0:8.3.6-1.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

=======================================================================================================
 Package         Arch    Version          Repository                                               Size
=======================================================================================================
Installing:
 drbd-km-2.6.31.6_162.fc12.x86_64
                 x86_64  8.3.6-12.fc12    /drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64  4.2 M
 drbd-pacemaker  x86_64  8.3.6-1.fc12     /drbd-pacemaker-8.3.6-1.fc12.x86_64                      40 k
 drbd-utils      x86_64  8.3.6-1.fc12     /drbd-utils-8.3.6-1.fc12.x86_64                         580 k

Transaction Summary
=======================================================================================================
Install       3 Package(s)
Upgrade       0 Package(s)

Total size: 4.8 M
Downloading Packages:
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : drbd-utils-8.3.6-1.fc12.x86_64                                                   1/3
  Installing     : drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64                            2/3
  Installing     : drbd-pacemaker-8.3.6-1.fc12.x86_64                                               3/3

Installed:
  drbd-km-2.6.31.6_162.fc12.x86_64.x86_64 0:8.3.6-12.fc12      drbd-pacemaker.x86_64 0:8.3.6-1.fc12
  drbd-utils.x86_64 0:8.3.6-1.fc12

Complete!
[root@pcmk-1 x86_64]#
```

By default DRBD configures itself to start when the machine is powered on, however since we want the cluster to manage it, we will need to disable this behavior:

```
chkconfig --del drbd
```

We could rebuild the drbd package on *pcmk-2*, however if they share the same architecture (x86_64 in this case) we can reuse the ones we built for *pcmk-1*. Assuming this is the case for you, copy them to *pcmk-2* and install:

```
cd /root/rpmbuild/RPMS/`uname -m`
scp drbd-km-*.rpm pcmk-2:
ssh pcmk-2 -- yum install -y drbd-utils drbd-pacemaker
ssh pcmk-2 -- yum localinstall -y --nogpgcheck drbd-km-*-8.3.6-*.rpm
chkconfig --del drbd
```

```
[root@pcmk-1 x86_64]# scp drbd-*.rpm pcmk-2:
drbd-8.3.6-1.fc12.x86_64.rpm                                              100%   21KB  20.7KB/s   00:00
drbd-bash-completion-8.3.6-1.fc12.x86_64.rpm                              100% 5260     5.1KB/s   00:00
drbd-heartbeat-8.3.6-1.fc12.x86_64.rpm                                    100% 6716     6.6KB/s   00:00
drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm                 100% 1271KB   1.2MB/s   00:00
drbd-pacemaker-8.3.6-1.fc12.x86_64.rpm                                    100%   18KB  17.7KB/s   00:00
drbd-udev-8.3.6-1.fc12.x86_64.rpm                                         100% 4103     4.0KB/s   00:00
drbd-utils-8.3.6-1.fc12.x86_64.rpm                                        100%  265KB 264.8KB/s   00:00
drbd-xen-8.3.6-1.fc12.x86_64.rpm                                          100% 6690     6.5KB/s   00:00
[root@pcmk-1 x86_64]# ssh pcmk-2 -- yum localinstall -y --nogpgcheck drbd-utils-8.3.6-*.rpm drbd-
   pacemaker-8.3.6-*.rpm drbd-km-*-8.3.6-*.rpm
Setting up Local Package Process
Examining drbd-utils-8.3.6-1.fc12.x86_64.rpm: drbd-utils-8.3.6-1.fc12.x86_64
Marking drbd-utils-8.3.6-1.fc12.x86_64.rpm to be installed
Examining drbd-pacemaker-8.3.6-1.fc12.x86_64.rpm: drbd-pacemaker-8.3.6-1.fc12.x86_64
Marking drbd-pacemaker-8.3.6-1.fc12.x86_64.rpm to be installed
Examining drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm: drbd-
   km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64
Marking drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64.rpm to be installed
Resolving Dependencies
--> Running transaction check
---> Package drbd-km-2.6.31.6_162.fc12.x86_64.x86_64 0:8.3.6-12.fc12 set to be updated
---> Package drbd-pacemaker.x86_64 0:8.3.6-1.fc12 set to be updated
---> Package drbd-utils.x86_64 0:8.3.6-1.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

================================================================================
 Package         Arch   Version        Repository                          Size
================================================================================
Installing:
 drbd-km-2.6.31.6_162.fc12.x86_64
                x86_64 8.3.6-12.fc12  /drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64
```

```
                                                                          4.2 M
 drbd-pacemaker x86_64 8.3.6-1.fc12   /drbd-pacemaker-8.3.6-1.fc12.x86_64  40 k
 drbd-utils     x86_64 8.3.6-1.fc12   /drbd-utils-8.3.6-1.fc12.x86_64     580 k

Transaction Summary
================================================================================
Install       3 Package(s)
Upgrade       0 Package(s)

Total size: 4.8 M
Downloading Packages:
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : drbd-utils-8.3.6-1.fc12.x86_64                           1/3
  Installing     : drbd-km-2.6.31.6_162.fc12.x86_64-8.3.6-12.fc12.x86_64    2/3
  Installing     : drbd-pacemaker-8.3.6-1.fc12.x86_64                       3/3

Installed:
  drbd-km-2.6.31.6_162.fc12.x86_64.x86_64 0:8.3.6-12.fc12
  drbd-pacemaker.x86_64 0:8.3.6-1.fc12
  drbd-utils.x86_64 0:8.3.6-1.fc12

Complete!
[root@pcmk-1 x86_64]# ssh pcmk-2 -- chkconfig --del drbd
[root@pcmk-1 x86_64]#
```

Configure DRBD

Before we configure DRBD, we need to set aside some disk for it to use.

Create A Partition for DRBD

If you have more than 1Gb free, feel free to use it. For this guide however, 1Gb is plenty of space for a single html file and sufficient for later holding the GFS2 metadata.

lvcreate -n drbd-demo -L 1G VolGroup

lvs

```
[root@pcmk-1 drbd-8.3.6]# lvcreate -n drbd-demo -L 1G VolGroup
  Logical volume "drbd-demo" created
[root@pcmk-1 drbd-8.3.6]# lvs
  LV        VG       Attr   LSize   Origin Snap%  Move Log Copy%  Convert
  drbd-demo VolGroup -wi-a-   1.00G
  lv_root   VolGroup -wi-ao   7.30G
  lv_swap   VolGroup -wi-ao 500.00M
```

Repeat this on the second node, be sure to use the same size partition.

lvs

lvcreate -n drbd-demo -L 1G VolGroup

lvs

```
[root@pcmk-2 ~]# lvs
  LV      VG       Attr   LSize   Origin Snap%  Move Log Copy%  Convert
  lv_root VolGroup -wi-ao   7.30G
  lv_swap VolGroup -wi-ao 500.00M
```

```
[root@pcmk-2 ~]# lvcreate -n drbd-demo -L 1G VolGroup
  Logical volume "drbd-demo" created
[root@pcmk-2 ~]# lvs
  LV        VG       Attr   LSize   Origin Snap%  Move Log Copy%  Convert
  drbd-demo VolGroup -wi-a-   1.00G
  lv_root   VolGroup -wi-ao   7.30G
  lv_swap   VolGroup -wi-ao 500.00M
```

Write the DRBD Config

There is no series of commands for build a DRBD configuration, so simply copy the configuration below to */etc/drbd.conf*

Detailed information on the directives used in this configuration (and other alternatives) is available from http://www.drbd.org/users-guide/ch-configure.html

Be sure to use the names and addresses of *your* nodes if they differ from the ones used in this guide.

```
global {
  usage-count yes;
}
common {
  protocol C;
}
resource wwwdata {
  meta-disk internal;
  device    /dev/drbd1;
  syncer {
    verify-alg sha1;
  }
  net {
    allow-two-primaries;
  }
  on pcmk-1 {
    disk      /dev/mapper/VolGroup-drbd--demo;
    address   192.168.122.101:7789;
  }
  on pcmk-2 {
    disk      /dev/mapper/VolGroup-drbd--demo;
    address   192.168.122.102:7789;
  }
}
```

Initialize and Load DRBD

With the configuration in place, we can now perform the DRBD initialization

drbdadm create-md wwwdata

```
[root@pcmk-1 drbd-8.3.6]# drbdadm create-md wwwdata
md_offset 12578816
al_offset 12546048
bm_offset 12541952

Found some data
 ==> This might destroy existing data! <==

Do you want to proceed?
[need to type 'yes' to confirm] yes

Writing meta data...
initializing activity log
NOT initialized bitmap
New drbd meta data block successfully created.
success
```

Now load the DRBD kernel module and confirm that everything is sane

modprobe drbd

drbdadm up wwwdata

cat /proc/drbd

```
[root@pcmk-1 drbd-8.3.6]# modprobe drbd
[root@pcmk-1 drbd-8.3.6]# drbdadm up wwwdata
[root@pcmk-1 drbd-8.3.6]# cat /proc/drbd
version: 8.3.6 (api:88/proto:86-90)
GIT-hash: f3606c47cc6fcf6b3f086e425cb34af8b7a81bbf build by root@pcmk-1, 2009-12-08 11:22:57

 1: cs:WFConnection ro:Secondary/Unknown ds:Inconsistent/DUnknown C r----
    ns:0 nr:0 dw:0 dr:0 al:0 bm:0 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:12248
[root@pcmk-1 drbd-8.3.6]#
```

Repeat on the second node

drbdadm --force create-md wwwdata

modprobe drbd

drbdadm up wwwdata

cat /proc/drbd

```
[root@pcmk-2 ~]# drbdadm --force create-md wwwdata
Writing meta data...
initializing activity log
NOT initialized bitmap
New drbd meta data block successfully created.
success
[root@pcmk-2 ~]# modprobe drbd
WARNING: Deprecated config file /etc/modprobe.conf, all config files belong into /etc/modprobe.d/.
[root@pcmk-2 ~]# drbdadm up wwwdata
[root@pcmk-2 ~]# cat /proc/drbd
version: 8.3.6 (api:88/proto:86-90)
GIT-hash: f3606c47cc6fcf6b3f086e425cb34af8b7a81bbf build by root@pcmk-1, 2009-12-08 11:22:57

 1: cs:Connected ro:Secondary/Secondary ds:Inconsistent/Inconsistent C r----
    ns:0 nr:0 dw:0 dr:0 al:0 bm:0 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:12248
```

Now we need to tell DRBD which set of data to use. Since both sides contain garbage, we can run the following on pcmk-1:

drbdadm -- --overwrite-data-of-peer primary wwwdata

cat /proc/drbd

```
[root@pcmk-1 ~]# drbdadm -- --overwrite-data-of-peer primary wwwdata
[root@pcmk-1 ~]# cat /proc/drbd
version: 8.3.6 (api:88/proto:86-90)
GIT-hash: f3606c47cc6fcf6b3f086e425cb34af8b7a81bbf build by root@pcmk-1, 2009-12-08 11:22:57

 1: cs:SyncSource ro:Primary/Secondary ds:UpToDate/Inconsistent C r----
    ns:2184 nr:0 dw:0 dr:2472 al:0 bm:0 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:10064
   [=====>.............] sync'ed: 33.4% (10064/12248)K
   finish: 0:00:37 speed: 240 (240) K/sec
[root@pcmk-1 ~]# cat /proc/drbd
version: 8.3.6 (api:88/proto:86-90)
GIT-hash: f3606c47cc6fcf6b3f086e425cb34af8b7a81bbf build by root@pcmk-1, 2009-12-08 11:22:57

 1: cs:Connected ro:Primary/Secondary ds:UpToDate/UpToDate C r----
    ns:12248 nr:0 dw:0 dr:12536 al:0 bm:1 lo:0 pe:0 ua:0 ap:0 ep:1 wo:b oos:0
```

pcmk-1 is now in the Primary state which allows it to be written to. Which means its a good point at which to create a filesystem and populate it with some data to serve up via our WebSite resource.

Populate DRBD with Data

```
mkfs.ext4 /dev/drbd1
```

```
[root@pcmk-1 ~]# mkfs.ext4 /dev/drbd1
mke2fs 1.41.4 (27-Jan-2009)
Filesystem label=
OS type: Linux
Block size=1024 (log=0)
Fragment size=1024 (log=0)
3072 inodes, 12248 blocks
612 blocks (5.00%) reserved for the super user
First data block=1
Maximum filesystem blocks=12582912
2 block groups
8192 blocks per group, 8192 fragments per group
1536 inodes per group
Superblock backups stored on blocks:
   8193

Writing inode tables: done
Creating journal (1024 blocks): done
Writing superblocks and filesystem accounting information: done

This filesystem will be automatically checked every 26 mounts or
180 days, whichever comes first.  Use tune2fs -c or -i to override.
```

Now mount the newly created filesystem so we can create our index file

```
mount /dev/drbd1 /mnt/
cat <<-END >/mnt/index.html
<html>
<body>My Test Site - drbd</body>
</html>
END
umount /dev/drbd1
```

```
[root@pcmk-1 ~]# mount /dev/drbd1 /mnt/
[root@pcmk-1 ~]# cat <<-END >/mnt/index.html
> <html>
> <body>My Test Site - drbd</body>
> </html>
> END
[root@pcmk-1 ~]# umount /dev/drbd1
```

And finally, confirm the data is in sync between the two nodes

```
drbdadm verify wwwdata
echo $?
```

```
[root@pcmk-1 ~]# drbdadm verify wwwdata
[root@pcmk-1 ~]# echo $?
0
```

Configure the Cluster for DRBD

One handy feature of the crm shell is that you can use it in interactive mode to make several changes atomically.

First we launch the shell. The prompt will change to indicate you’re in interactive mode.

```
crm
```

```
[root@pcmk-1 ~]# crm
cib crm(live)#
```

Next we must create a working copy or the current configuration. This is where all our changes will go. The cluster will not see any of them until we say its ok. Notice again how the prompt changes, this time to indicate that we’re no longer looking at the live cluster.

```
cib new drbd
```

```
cib crm(live)# cib new drbd
INFO: drbd shadow CIB created
crm(drbd)#
```

Now we can create our DRBD clone and display the revised configuration.

```
configure primitive wwwdrbd ocf:linbit:drbd params drbd_resource=wwwdata op monitor interval=60s
configure ms WebData wwwdrbd meta master-max=1 master-node-max=1 \
          clone-max=2 clone-node-max=1 notify=true
configure show
```

```
crm(drbd)# configure primitive ocf:linbit:drbd WebData params drbd_resource=wwwdata op monitor interval=60s
crm(drbd)# configure ms WebDataClone WebData meta master-max=1 master-node-max=1 \
    clone-max=2 clone-node-max=1 notify=true
crm(drbd)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
ms WebDataClone WebData \
    meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation website-with-ip inf: WebSite ClusterIP
order apache-after-ip inf: ClusterIP WebSite
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Once we're happy with the changes, we can tell the cluster to start using them and use crm_mon to check everything is functioning.

```
cib commit drbd
quit
crm_mon
```

```
crm(drbd)# cib commit drbd
INFO: commited 'drbd' shadow CIB to the cluster
crm(drbd)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Tue Sep  1 09:37:13 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
3 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-1
WebSite (ocf::heartbeat:apache):        Started pcmk-1
Master/Slave Set: WebDataClone
        Masters: [ pcmk-2 ]
        Slaves: [ pcmk-1 ]
```

Now that DRBD is functioning we can configure a Filesystem resource to use it. In addition to the filesystem's definition, we also need to tell the cluster where it can be located (only on the DRBD Primary) and when it is allowed to start (after the Primary was promoted).

Once again we'll use the shell's interactive mode

```
crm
cib new fs
configure primitive WebFS ocf:heartbeat:Filesystem \
          params device="/dev/mapper/VolGroup-drbd--demo" directory="/var/www/html" fstype="ext4"
configure colocation fs_on_drbd inf: WebFS WebDataClone:Master
configure order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
```

```
[root@pcmk-1 ~]# crm
crm(live)# cib new fs
INFO: fs shadow CIB created
crm(fs)# configure primitive WebFS ocf:heartbeat:Filesystem params device="/dev/mapper/VolGroup-drbd--demo"
   directory="/var/www/html" fstype="ext4"
crm(fs)# configure colocation fs_on_drbd inf: WebFS WebDataClone:Master
crm(fs)# configure order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
```

We also need to tell the cluster that Apache needs to run on the same machine as the filesystem and that it must be active before Apache can start.

configure colocation WebSite-with-WebFS inf: WebSite WebFS

configure order WebSite-after-WebFS inf: WebFS WebSite

configure show

```
crm(fs)# configure colocation WebSite-with-WebFS inf: WebSite WebFS
crm(fs)# configure order WebSite-after-WebFS inf: WebFS WebSite
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
   params drbd_resource="wwwdata" \
   op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
   params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype="ext4"
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
   params ip="192.168.9.101" cidr_netmask="32" \
   op monitor interval="30s"
ms WebDataClone WebData \
   meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation WebSite-with-WebFS inf: WebSite WebFS
colocation fs_on_drbd inf: WebFS WebDataClone:Master
colocation website-with-ip inf: WebSite ClusterIP
order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
order WebSite-after-WebFS inf: WebFS WebSite
order apache-after-ip inf: ClusterIP WebSite
property $id="cib-bootstrap-options" \
   dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
   cluster-infrastructure="openais" \
   expected-quorum-votes=”2” \
   stonith-enabled="false" \
   no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
   resource-stickiness=”100”
```

After reviewing the new configuration, we again upload it and watch the cluster put it into effect.

cib commit fs

quit

crm_mon

```
crm(fs)# cib commit fs
INFO: commited 'fs' shadow CIB to the cluster
crm(fs)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Tue Sep  1 10:08:44 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
4 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-1
WebSite (ocf::heartbeat:apache):        Started pcmk-1
Master/Slave Set: WebDataClone
        Masters: [ pcmk-1 ]
        Slaves: [ pcmk-2 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-1
```

Testing Migration

We could shut down the active node again, but another way to safely simulate recovery is to put the node into what is called “standby mode”. Nodes in this state tell the cluster that they are not allowed to run resources. Any resources found active there will be moved elsewhere. This feature can be particularly useful when updating the resources’ packages.

Put the local node into standby mode and observe the cluster move all the resources to the other node. Note also that the node’s status will change to indicate that it can no longer host resources.

```
crm node standby
crm_mon
```

```
[root@pcmk-1 ~]# crm node standby
[root@pcmk-1 ~]# crm_mon
============
Last updated: Tue Sep  1 10:09:57 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
4 Resources configured.
============

Node pcmk-1: standby
Online: [ pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
WebSite (ocf::heartbeat:apache):        Started pcmk-2
Master/Slave Set: WebDataClone
        Masters: [ pcmk-2 ]
        Stopped: [ WebData:1 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-2
```

Once we've done everything we needed to on pcmk-1 (in this case nothing, we just wanted to see the resources move), we can allow the node to be a full cluster member again.

crm node online

crm_mon

```
[root@pcmk-1 ~]# crm node online
[root@pcmk-1 ~]# crm_mon
============
Last updated: Tue Sep  1 10:13:25 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
4 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
WebSite (ocf::heartbeat:apache):        Started pcmk-2
Master/Slave Set: WebDataClone
        Masters: [ pcmk-2 ]
        Slaves: [ pcmk-1 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-2
```

Notice that our resource stickiness settings prevent the services from migrating back to pcmk-1.

Conversion to Active/Active

The primary requirement for an Active/Active cluster is that the data required for your services are available, simultaneously, on both machines. Pacemaker makes no requirement on how this is achieved, you could use a SAN if you had one available, however since DRBD supports multiple Primaries, we can also use that.

The only hitch is that we need to use a cluster-aware filesystem (and the one we used earlier with DRBD, ext4, is not one of those). Both OCFS2 and GFS2 are supported, however here we will use GFS2 which comes with Fedora 12.

Install a Cluster Filesystem - GFS2

The first thing to do is install gfs2-utils on each machine.

NOTE: Unfortunately there are a number of changes needed to gfs-pcmk that aren't yet in Fedora-12 (ETA is January 2010). In order to use GFS2 before then, you'll need to recompile the sources for the cluster package with the following patch: http://git.fedorahosted.org/git/cluster.git?p=cluster.git;a=commit;h=f554d932a817401beaf078e6eed4bb2522a3d0cc

yum install -y gfs2-utils gfs-pcmk

```
[root@pcmk-1 ~]# yum install -y gfs2-utils gfs-pcmk
Setting up Install Process
Resolving Dependencies
--> Running transaction check
---> Package gfs-pcmk.x86_64 0:3.0.5-2.fc12 set to be updated
--> Processing Dependency: libSaCkpt.so.3(OPENAIS_CKPT_B.01.01)(64bit) for package: gfs-
   pcmk-3.0.5-2.fc12.x86_64
--> Processing Dependency: dlm-pcmk for package: gfs-pcmk-3.0.5-2.fc12.x86_64
--> Processing Dependency: libccs.so.3()(64bit) for package: gfs-pcmk-3.0.5-2.fc12.x86_64
--> Processing Dependency: libdlmcontrol.so.3()(64bit) for package: gfs-pcmk-3.0.5-2.fc12.x86_64
--> Processing Dependency: liblogthread.so.3()(64bit) for package: gfs-pcmk-3.0.5-2.fc12.x86_64
--> Processing Dependency: libSaCkpt.so.3()(64bit) for package: gfs-pcmk-3.0.5-2.fc12.x86_64
---> Package gfs2-utils.x86_64 0:3.0.5-2.fc12 set to be updated
--> Running transaction check
---> Package clusterlib.x86_64 0:3.0.5-2.fc12 set to be updated
---> Package dlm-pcmk.x86_64 0:3.0.5-2.fc12 set to be updated
---> Package openaislib.x86_64 0:1.1.0-1.fc12 set to be updated
--> Finished Dependency Resolution

Dependencies Resolved

========================================================================================================
 Package                  Arch                 Version                        Repository            Size
========================================================================================================
Installing:
 gfs-pcmk                 x86_64               3.0.5-2.fc12                   custom               101 k
 gfs2-utils              x86_64              3.0.5-2.fc12                 custom              208 k
Installing for dependencies:
 clusterlib              x86_64              3.0.5-2.fc12                 custom               65 k
 dlm-pcmk                x86_64              3.0.5-2.fc12                 custom               93 k
 openaislib              x86_64              1.1.0-1.fc12                 fedora               76 k

Transaction Summary
=========================================================================================================
Install       5 Package(s)
Upgrade       0 Package(s)

Total download size: 541 k
Downloading Packages:
(1/5): clusterlib-3.0.5-2.fc12.x86_64.rpm                                       |  65 kB     00:00
(2/5): dlm-pcmk-3.0.5-2.fc12.x86_64.rpm                                         |  93 kB     00:00
(3/5): gfs-pcmk-3.0.5-2.fc12.x86_64.rpm                                         | 101 kB     00:00
(4/5): gfs2-utils-3.0.5-2.fc12.x86_64.rpm                                       | 208 kB     00:00
(5/5): openaislib-1.1.0-1.fc12.x86_64.rpm                                       |  76 kB     00:00
---------------------------------------------------------------------------------------------------------
Total                                                                  992 kB/s | 541 kB     00:00
Running rpm_check_debug
Running Transaction Test
Finished Transaction Test
Transaction Test Succeeded
Running Transaction
  Installing     : clusterlib-3.0.5-2.fc12.x86_64                                                 1/5
  Installing     : openaislib-1.1.0-1.fc12.x86_64                                                 2/5
  Installing     : dlm-pcmk-3.0.5-2.fc12.x86_64                                                   3/5
  Installing     : gfs-pcmk-3.0.5-2.fc12.x86_64                                                   4/5
  Installing     : gfs2-utils-3.0.5-2.fc12.x86_64                                                 5/5

Installed:
  gfs-pcmk.x86_64 0:3.0.5-2.fc12                    gfs2-utils.x86_64 0:3.0.5-2.fc12

Dependency Installed:
  clusterlib.x86_64 0:3.0.5-2.fc12   dlm-pcmk.x86_64 0:3.0.5-2.fc12   openaislib.x86_64 0:1.1.0-1.fc12

Complete!
[root@pcmk-1 x86_64]#
```

Setup Pacemaker-GFS2 Integration

GFS2 needs two services to be running, the first is the user-space interface to the kernel's distributed lock manager (DLM). The DLM is used to co-ordinate which node(s) can access a given file (and when) and integrates with Pacemaker to obtain node membership[16] information and fencing capabilities.

The second service is GFS2's own control daemon which also integrates with Pacemaker to obtain node membership data.

Add the DLM service

The DLM control daemon needs to run on all active cluster nodes, so we will use the shells interactive mode to create a cloned resource.

```
crm
cib new stack-glue
configure primitive dlm ocf:pacemaker:controld op monitor interval=120s
configure clone dlm-clone dlm meta interleave=true
configure show
```

```
[root@pcmk-1 ~]# crm
crm(live)# cib new stack-glue
INFO: stack-glue shadow CIB created
crm(stack-glue)# configure primitive dlm ocf:pacemaker:controld op monitor interval=120s
crm(stack-glue)# configure clone dlm-clone dlm meta interleave=true
crm(stack-glue)# configure show xml
crm(stack-glue)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
   params drbd_resource="wwwdata" \
   op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
   params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype="ext4"
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
   params ip="192.168.9.101" cidr_netmask="32" \
   op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
   op monitor interval="120s"
ms WebDataClone WebData \
   meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone dlm-clone dlm \
   meta interleave="true"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation WebSite-with-WebFS inf: WebSite WebFS
colocation fs_on_drbd inf: WebFS WebDataClone:Master
colocation website-with-ip inf: WebSite ClusterIP
order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
order WebSite-after-WebFS inf: WebFS WebSite
order apache-after-ip inf: ClusterIP WebSite
property $id="cib-bootstrap-options" \
   dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
```

[16] The list of nodes the cluster considers to be available

```
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Review the configuration before uploading it to the cluster, quitting the shell and watching the cluster’s response

```
cib commit stack-glue

quit

crm_mon
```

```
crm(stack-glue)# cib commit stack-glue
INFO: commited 'stack-glue' shadow CIB to the cluster
crm(stack-glue)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Sep  3 20:49:54 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
5 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

WebSite (ocf::heartbeat:apache):        Started pcmk-2
Master/Slave Set: WebDataClone
        Masters: [ pcmk-1 ]
        Slaves: [ pcmk-2 ]
ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
Clone Set: dlm-clone
        Started: [ pcmk-2 pcmk-1 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-2
```

Add the GFS2 service

Once the DLM is active, we can add the GFS2 control daemon.
Use the **crm** shell to create the gfs-control cluster resource:

```
crm

cib new gfs-glue

configure primitive gfs-control ocf:pacemaker:controld          \

          params daemon=gfs_controld.pcmk args="-g 0"     \

          op monitor interval=120s

configure clone gfs-clone gfs-control meta interleave=true
```

```
[root@pcmk-1 ~]# crm
crm(live)# cib new gfs-glue --force
INFO: gfs-glue shadow CIB created
crm(gfs-glue)# configure primitive gfs-control ocf:pacemaker:controld params daemon=gfs_controld.pcmk
    args="-g 0" op monitor interval=120s
crm(gfs-glue)# configure clone gfs-clone gfs-control meta interleave=true
```

Now ensure Pacemaker only starts the gfs-control service on nodes that also have a copy of the dlm service (created above) already running

configure colocation gfs-with-dlm INFINITY: gfs-clone dlm-clone

configure order start-gfs-after-dlm mandatory: dlm-clone gfs-clone

```
crm(gfs-glue)# configure colocation gfs-with-dlm INFINITY: gfs-clone dlm-clone
crm(gfs-glue)# configure order start-gfs-after-dlm mandatory: dlm-clone gfs-clone
```

Review the configuration before uploading it to the cluster, quitting the shell and watching the cluster’s response

configure show

cib commit gfs-glue

quit

crm_mon

```
crm(gfs-glue)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
    params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype="ext4"
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
ms WebDataClone WebData \
    meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
location prefer-pcmk-1 WebSite 50: pcmk-1
colocation WebSite-with-WebFS inf: WebSite WebFS
colocation fs_on_drbd inf: WebFS WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSite ClusterIP
order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
order WebSite-after-WebFS inf: WebFS WebSite
order apache-after-ip inf: ClusterIP WebSite
order start-gfs-after-dlm inf: dlm-clone gfs-clone
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
crm(gfs-glue)# cib commit gfs-glue
INFO: commited 'gfs-glue' shadow CIB to the cluster
crm(gfs-glue)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Sep  3 20:49:54 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
6 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

WebSite (ocf::heartbeat:apache):        Started pcmk-2
Master/Slave Set: WebDataClone
        Masters: [ pcmk-1 ]
        Slaves: [ pcmk-2 ]
ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
Clone Set: dlm-clone
        Started: [ pcmk-2 pcmk-1 ]
Clone Set: gfs-clone
        Started: [ pcmk-2 pcmk-1 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-1
```

Create a GFS2 Filesystem

Preparation

Before we do anything to the existing partition, we need to make sure it is unmounted. We do this by tell the cluster to stop the WebFS resource. This will ensure that other resources (in our case, Apache) using WebFS are not only stopped, but stopped in the correct order.

crm_resource --resource WebFS --set-parameter target-role --meta --parameter-value Stopped

crm_mon

```
[root@pcmk-1 ~]# crm_resource --resource WebFS --set-parameter target-role --meta --parameter-value Stopped
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Sep  3 15:18:06 2009
Stack: openais
Current DC: pcmk-1 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
6 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

Master/Slave Set: WebDataClone
   Masters: [ pcmk-1 ]
   Slaves: [ pcmk-2 ]
ClusterIP (ocf::heartbeat:IPaddr):   Started pcmk-1
Clone Set: dlm-clone
        Started: [ pcmk-2 pcmk-1 ]
Clone Set: gfs-clone
        Started: [ pcmk-2 pcmk-1 ]
```

Note that Apache and WebFS have both been stopped.

Create and Populate an GFS2 Partition

Now that the cluster stack and integration pieces are running smoothly, we can create an GFS2 partition.

Important: This will erase all previous content stored on the DRBD device. Ensure you have a copy of any important data.

We need to specify a number of additional parameters when creating a GFS2 partition.

First we must use the -p option to specify that we want to use the the Kernel's DLM. Next we use -j to indicate that it should reserve enough space for two journals (one per node accessing the filesystem).

Lastly, we use -t to specify the lock table name. The format for this field is clustername:fsname. For the fsname, we just need to pick something unique and descriptive and since we haven't specified a clustername yet, we will use the default (pcmk).

To specify an alternate name for the cluster, locate the service section containing "name: pacemaker" in corosync.conf and insert the following line anywhere inside the block:

clustername: myname

Do this on each node in the cluster and be sure to restart them before continuing.

```
mkfs.gfs2 -p lock_dlm -j 2 -t pcmk:web /dev/drbd1
```

```
[root@pcmk-1 ~]# mkfs.gfs2 -t pcmk:web -p lock_dlm -j 2 /dev/vdb
This will destroy any data on /dev/vdb.
It appears to contain: data

Are you sure you want to proceed? [y/n] y

Device:                    /dev/vdb
Blocksize:                 4096
Device Size                1.00 GB (131072 blocks)
Filesystem Size:           1.00 GB (131070 blocks)
Journals:                  2
Resource Groups:           2
Locking Protocol:          "lock_dlm"
Lock Table:                "pcmk:web"
UUID:                      6B776F46-177B-BAF8-2C2B-292C0E078613

[root@pcmk-1 ~]#
```

Then (re)populate the new filesystem with data (web pages). For now we'll create another variation on our home page.

```
mount /dev/drbd1 /mnt/
cat <<-END >/mnt/index.html
<html>
<body>My Test Site - GFS2</body>
</html>
END
umount /dev/drbd1
drbdadm verify wwwdata
```

```
[root@pcmk-1 ~]# cat <<-END >/mnt/index.html
> <html>
> <body>My Test Site - drbd</body>
> </html>
> END
[root@pcmk-1 ~]#
```

Reconfigure the Cluster for GFS2

crm

cib new GFS2

configure delete WebFS

configure primitive WebFS ocf:heartbeat:Filesystem \

params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”

```
[root@pcmk-1 ~]# crm
crm(live)# cib new GFS2
INFO: GFS2 shadow CIB created
crm(GFS2)# configure delete WebFS
crm(GFS2)# configure primitive WebFS ocf:heartbeat:Filesystem params device="/dev/drbd/by-res/wwwdata"
   directory="/var/www/html" fstype=”gfs2”
```

Now that we’ve recreated the resource, we also need to recreate all the constraints that used it. This is because the shell will automatically remove any constraints that referenced WebFS.

configure colocation WebSite-with-WebFS inf: WebSite WebFS

configure colocation fs_on_drbd inf: WebFS WebDataClone:Master

configure order WebFS-after-WebData inf: WebDataClone:promote WebFS:start

configure order WebSite-after-WebFS inf: WebFS WebSite

configure colocation WebFS-with-gfs-control INFINITY: WebFS gfs-clone

configure order start-WebFS-after-gfs-control mandatory: gfs-clone WebFS

configure show

```
crm(GFS2)# configure colocation WebSite-with-WebFS inf: WebSite WebFS
crm(GFS2)# configure colocation fs_on_drbd inf: WebFS WebDataClone:Master
crm(GFS2)# configure order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
crm(GFS2)# configure order WebSite-after-WebFS inf: WebFS WebSite
crm(GFS2)# configure colocation WebFS-with-gfs-control INFINITY: WebFS gfs-clone
crm(GFS2)# configure order start-WebFS-after-gfs-control mandatory: gfs-clone WebFS
crm(GFS2)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
   params drbd_resource="wwwdata" \
   op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
   params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip="192.168.9.101" cidr_netmask="32" \
    op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
ms WebDataClone WebData \
    meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation WebFS-with-gfs-control inf: WebFS gfs-clone
colocation WebSite-with-WebFS inf: WebSite WebFS
colocation fs_on_drbd inf: WebFS WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSite ClusterIP
order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
order WebSite-after-WebFS inf: WebFS WebSite
order apache-after-ip inf: ClusterIP WebSite
order start-WebFS-after-gfs-control inf: gfs-clone WebFS
order start-gfs-after-dlm inf: dlm-clone gfs-clone
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Review the configuration before uploading it to the cluster, quitting the shell and watching the cluster’s response

```
cib commit GFS2
quit
crm_mon
```

```
crm(GFS2)# cib commit GFS2
INFO: commited 'GFS2' shadow CIB to the cluster
crm(GFS2)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Sep  3 20:49:54 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
6 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

WebSite (ocf::heartbeat:apache):        Started pcmk-2
Master/Slave Set: WebDataClone
        Masters: [ pcmk-1 ]
        Slaves: [ pcmk-2 ]
```

```
ClusterIP (ocf::heartbeat:IPaddr):        Started pcmk-2
Clone Set: dlm-clone
        Started: [ pcmk-2 pcmk-1 ]
Clone Set: gfs-clone
        Started: [ pcmk-2 pcmk-1 ]
WebFS   (ocf::heartbeat:Filesystem):    Started pcmk-1
```

Reconfigure Pacemaker for Active/Active

Almost everything is in place. Recent versions of DRBD are capable of operating in Primary/Primary mode and the filesystem we're using is cluster aware. All we need to do now is reconfigure the cluster to take advantage of this.

This will involve a number of changes, so we'll again use interactive mode.

```
crm
cib new active
```

There's no point making the services active on both locations if we can't reach them, so lets first clone the IP address. Cloned IPaddr2 resources use an *iptables* rule to ensure that each request only processed by one of the two clone instances. The additional *meta* options tell the cluster how many instances of the clone we want (one "request bucket" for each node) and that if all other nodes fail, then the remaining node should hold *all of them*. Otherwise the requests would be simply discarded.

```
configure clone WebIP ClusterIP  \
          meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
```

Now we must tell the ClusterIP how to decide which requests are processed by which hosts. To do this we must specify the clusterip_hash parameter.

Open the ClusterIP resource

```
configure edit  ClusterIP
```

And add the following to the params line

```
clusterip_hash="sourceip"
```

So that the complete definition looks like:

```
primitive ClusterIP ocf:heartbeat:IPaddr2 \
        params ip="192.168.9.101" cidr_netmask="32" clusterip_hash="sourceip" \
        op monitor interval="30s"
```

configure show

```
[root@pcmk-1 ~]# crm
crm(live)# cib new active
INFO: active shadow CIB created
crm(active)# configure clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
crm(active)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
    params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip=”192.168.9.101” cidr_netmask=”32” clusterip_hash=”sourceip” \
    op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
ms WebDataClone WebData \
    meta master-max="1" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation WebFS-with-gfs-control inf: WebFS gfs-clone
colocation WebSite-with-WebFS inf: WebSite WebFS
colocation fs_on_drbd inf: WebFS WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSite WebIP
order WebFS-after-WebData inf: WebDataClone:promote WebFS:start
order WebSite-after-WebFS inf: WebFS WebSite
order apache-after-ip inf: WebIP WebSite
order start-WebFS-after-gfs-control inf: gfs-clone WebFS
order start-gfs-after-dlm inf: dlm-clone gfs-clone
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Notice how any constraints that referenced *ClusterIP* have been updated to use *WebIP* instead. This is an additional benefit of using the crm shell.

Next we need to convert the filesystem and Apache resources into clones. Again, the shell will automatically update any relevant constraints.

```
configure clone WebFSClone WebFS
configure clone WebSiteClone WebSite
```

The last step is to tell the cluster that it is now allowed to promote both instances to be Primary (aka. Master).

```
configure edit WebDataClone
```

Change *master-max* to *2*

```
configure show
```

```
crm(active)# configure clone WebFSClone WebFS
crm(active)# configure clone WebSiteClone WebSite
crm(active)# configure edit WebDataClone
crm(active)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
    params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip=”192.168.9.101” cidr_netmask=”32” clusterip_hash=”sourceip” \
    op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
ms WebDataClone WebData \
    meta master-max="2" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone WebFSClone WebFS
clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
clone WebSiteClone WebSite
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation WebFS-with-gfs-control inf: WebFSClone gfs-clone
colocation WebSite-with-WebFS inf: WebSiteClone WebFSClone
colocation fs_on_drbd inf: WebFSClone WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSiteClone WebIP
order WebFS-after-WebData inf: WebDataClone:promote WebFSClone:start
order WebSite-after-WebFS inf: WebFSClone WebSiteClone
order apache-after-ip inf: WebIP WebSiteClone
order start-WebFS-after-gfs-control inf: gfs-clone WebFSClone
order start-gfs-after-dlm inf: dlm-clone gfs-clone
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="false" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Review the configuration before uploading it to the cluster, quitting the shell and watching the cluster’s response

```
cib commit active
quit
crm_mon
```

```
crm(active)# cib commit active
INFO: commited 'active' shadow CIB to the cluster
crm(active)# quit
bye
[root@pcmk-1 ~]# crm_mon
============
Last updated: Thu Sep  3 21:37:27 2009
Stack: openais
Current DC: pcmk-2 - partition with quorum
Version: 1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7
2 Nodes configured, 2 expected votes
6 Resources configured.
============

Online: [ pcmk-1 pcmk-2 ]

Master/Slave Set: WebDataClone
        Masters: [ pcmk-1 pcmk-2 ]
Clone Set: dlm-clone
        Started: [ pcmk-2 pcmk-1 ]
Clone Set: gfs-clone
        Started: [ pcmk-2 pcmk-1 ]
Clone Set: WebIP
        Started: [ pcmk-1 pcmk-2 ]
Clone Set: WebFSClone
        Started: [ pcmk-1 pcmk-2 ]
Clone Set: WebSiteClone
        Started: [ pcmk-1 pcmk-2 ]
```

Recovery

Configure STONITH

Why You Need STONITH

STONITH is an acronym for Shoot-The-Other-Node-In-The-Head and it protects your data from being corrupted by rouge nodes or concurrent access.

Just because a node is unresponsive, this doesn't mean it isn't accessing your data. The only way to be 100% sure that your data is safe, is to use STONITH so we can be certain that the node is truly offline, before allowing the data to be accessed from another node.

STONITH also has a role to play in the event that a clustered service cannot be stopped. In this case, the cluster uses STONITH to force the whole node offline, thereby making it safe to start the service elsewhere.

What STONITH Device Should You Use

It is crucial that the STONITH device can allow the cluster to differentiate between a node failure and a network one.

The biggest mistake people make in choosing a STONITH device is to use remote power switch (such as many onboard IMPI controllers) that shares power with the node it controls. In such cases, the cluster cannot be sure if the node is really offline, or active and suffering from a network fault.

Likewise, any device that relies on the machine being active (such as SSH-based "devices" used during testing) are inappropriate.

Configuring STONITH

1. Find the correct driver: stonith -L

2. Since every device is different, the parameters needed to configure it will vary. To find out the parameters required by the device: stonith -t {type} -n

   Hopefully the developers chose names that make sense, if not you can query for some additional information by finding an active cluster node and running:

   ```
   lrmadmin -M stonith {type} pacemaker
   ```

   The output should be XML formatted text containing additional parameter descriptions

3. Create a file called stonith.xml containing a primitive resource with a *class* of stonith, a *type* of {type} and a parameter for each of the values returned in step 2

4. Create a clone from the primitive resource if the device can shoot more than one node **and supports multiple simultaneous connections**.

5. Upload it into the CIB using cibadmin: cibadmin -C -o resources --xml-file stonith.xml

Example

Assuming we have an IBM BladeCenter containing our two nodes and the management interface is active on 192.168.9.31, then we would chose the external/ibmrsa driver in step 2 and obtain the following list of parameters

```
stonith -t external/ibmrsa -n
```

```
[root@pcmk-1 ~]# stonith -t external/ibmrsa -n
hostname  ipaddr  userid  passwd  type
```

Assuming we know the username and password for the management interface, we would create a STONITH resource with the shell

```
crm
cib new active
configure primitive rsa-fencing stonith::external/ibmrsa \
        params hostname=”pcmk-1 pcmk-2" ipaddr=192.168.9.31 userid=mgmt passwd=abc123 type=ibm \
        op monitor interval="60s"
configure clone Fencing rsa-fencing
```

```
[root@pcmk-1 ~]# crm
crm(live)# cib new stonith
INFO: stonith shadow CIB created
crm(stonith)# configure primitive rsa-fencing stonith::external/ibmrsa \
   params hostname=”pcmk-1 pcmk-2" ipaddr=192.168.9.31 userid=mgmt passwd=abc123 type=ibm \
   op monitor interval="60s"
crm(stonith)# configure clone Fencing rsa-fencing
```

And finally, since we disabled it earlier, we need to re-enable STONITH

```
configure property stonith-enabled="true"
configure show
```

```
crm(stonith)# configure property stonith-enabled="true"
crm(stonith)# configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
   params drbd_resource="wwwdata" \
   op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
   params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
   params ip=”192.168.9.101” cidr_netmask=”32” clusterip_hash=”sourceip” \
   op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
   op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
   op monitor interval="120s"
primitive rsa-fencing stonith::external/ibmrsa \
    params hostname=”pcmk-1 pcmk-2" ipaddr=192.168.9.31 userid=mgmt passwd=abc123 type=ibm \
    op monitor interval="60s"
ms WebDataClone WebData \
    meta master-max="2" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone Fencing rsa-fencing
clone WebFSClone WebFS
clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
clone WebSiteClone WebSite
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation WebFS-with-gfs-control inf: WebFSClone gfs-clone
colocation WebSite-with-WebFS inf: WebSiteClone WebFSClone
colocation fs_on_drbd inf: WebFSClone WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSiteClone WebIP
order WebFS-after-WebData inf: WebDataClone:promote WebFSClone:start
order WebSite-after-WebFS inf: WebFSClone WebSiteClone
order apache-after-ip inf: WebIP WebSiteClone
order start-WebFS-after-gfs-control inf: gfs-clone WebFSClone
order start-gfs-after-dlm inf: dlm-clone gfs-clone
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled="true" \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Configuration Recap

Final Cluster Configuration

crm configure show

```
[root@pcmk-1 ~]# crm configure show
node pcmk-1
node pcmk-2
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
primitive WebFS ocf:heartbeat:Filesystem \
    params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
primitive WebSite ocf:heartbeat:apache \
    params configfile="/etc/httpd/conf/httpd.conf" \
    op monitor interval="1min"
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip=”192.168.9.101” cidr_netmask=”32” clusterip_hash=”sourceip” \
    op monitor interval="30s"
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
primitive gfs-control ocf:pacemaker:controld \
    params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
primitive rsa-fencing stonith::external/ibmrsa \
    params hostname=”pcmk-1 pcmk-2" ipaddr=192.168.9.31 userid=mgmt passwd=abc123 type=ibm \
    op monitor interval="60s"
ms WebDataClone WebData \
    meta master-max="2" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
clone Fencing rsa-fencing
clone WebFSClone WebFS
clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
clone WebSiteClone WebSite
clone dlm-clone dlm \
    meta interleave="true"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation WebFS-with-gfs-control inf: WebFSClone gfs-clone
colocation WebSite-with-WebFS inf: WebSiteClone WebFSClone
colocation fs_on_drbd inf: WebFSClone WebDataClone:Master
colocation gfs-with-dlm inf: gfs-clone dlm-clone
colocation website-with-ip inf: WebSiteClone WebIP
order WebFS-after-WebData inf: WebDataClone:promote WebFSClone:start
order WebSite-after-WebFS inf: WebFSClone WebSiteClone
order apache-after-ip inf: WebIP WebSiteClone
order start-WebFS-after-gfs-control inf: gfs-clone WebFSClone
order start-gfs-after-dlm inf: dlm-clone gfs-clone
```

```
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled=”true” \
    no-quorum-policy="ignore"
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Node List

The list of cluster nodes is automatically populated by the cluster.

```
node pcmk-1
node pcmk-2
```

Cluster Options

This is where the cluster automatically stores some information about the cluster

- dc-version - the version (including upstream source-code hash) of Pacemaker used on the DC
- cluster-infrastructure - the cluster infrastructure being used (heartbeat or openais)
- *expected-quorum-votes* - the maximum number of nodes expected to be part of the cluster

and where the admin can set options that control the way the cluster operates

- *stonith-enabled=true* - Make use of STONITH
- *no-quorum-policy=ignore* - Ignore loss of quorum and continue to host resources.

```
property $id="cib-bootstrap-options" \
    dc-version="1.0.5-462f1569a43740667daf7b0f6b521742e9eb8fa7" \
    cluster-infrastructure="openais" \
    expected-quorum-votes=”2” \
    stonith-enabled=”true” \
    no-quorum-policy="ignore"
```

Resources

Default Options

Here we configure cluster options that apply to every resource.

- *resource-stickiness* - Specify the aversion to moving resources to other machines

```
rsc_defaults $id="rsc-options" \
    resource-stickiness=”100”
```

Fencing

```
primitive rsa-fencing stonith::external/ibmrsa \
    params hostname=”pcmk-1 pcmk-2" ipaddr=192.168.9.31 userid=mgmt passwd=abc123 type=ibm \
    op monitor interval="60s"
clone Fencing rsa-fencing
```

Service Address

Users of the services provided by the cluster require an unchanging address with which to access it. Additionally, we cloned the address so it will be active on both nodes. An *iptables* rule (created as part of the resource agent) is used to ensure that each request only processed by one of the two clone instances. The additional *meta* options tell the cluster that we want two instances of the clone (one “request bucket” for each node) and that if one node fails, then the remaining node should hold *both*.

```
primitive ClusterIP ocf:heartbeat:IPaddr2 \
    params ip=”192.168.9.101” cidr_netmask=”32” clusterip_hash=”sourceip” \
    op monitor interval="30s"
clone WebIP ClusterIP  \
    meta globally-unique=”true” clone-max=”2” clone-node-max=”2”
```

Distributed lock manager

Cluster filesystems like GFS2 require a lock manager. This service starts the daemon that provides user-space applications (such as the GFS2 daemon) with access to the in-kernel lock manager. Since we need it to be available on all nodes in the cluster, we have it cloned.

```
primitive dlm ocf:pacemaker:controld \
    op monitor interval="120s"
clone dlm-clone dlm \
    meta interleave="true"
```

Oracle control daemon

GFS2 also needs a user-space/kernel bridge that runs on every node. So here we have another clone, however this time we must also specify that it can only run on machines that are also running the DLM (colocation constraint) and that it can only be started after the DLM is running (order constraint). Additionally, the gfs-control clone should only care about the DLM instances it is paired with, so we need to set the interleave option.

```
primitive gfs-control ocf:pacemaker:controld \
   params daemon=”gfs_controld.pcmk” args=”-g 0” \
    op monitor interval="120s"
clone gfs-clone gfs-control \
    meta interleave="true"
colocation gfs-with-dlm inf: gfs-clone dlm-clone
order start-gfs-after-dlm inf: dlm-clone gfs-clone
```

DRBD - Shared Storage

Here we define the DRBD service and specify which DRBD resource (from drbd.conf) it should manage. We make it a master/slave resource and, in order to have an active/active setup, allow both instances to be promoted by specifying master-max=2. We also set the notify option so that the cluster will tell DRBD agent when it’s peer changes state.

```
primitive WebData ocf:linbit:drbd \
    params drbd_resource="wwwdata" \
    op monitor interval="60s"
ms WebDataClone WebData \
    meta master-max="2" master-node-max="1" clone-max="2" clone-node-max="1" notify="true"
```

Cluster Filesystem

The cluster filesystem ensures that files are read and written correctly. We need to specify the block device (provided by DRBD), where we want it mounted and that we are using GFS2. Again it is a clone because it is intended to be active on both nodes. The additional constraints ensure that it can only be started on nodes with active gfs-control and drbd instances.

```
primitive WebFS ocf:heartbeat:Filesystem \
   params device="/dev/drbd/by-res/wwwdata" directory="/var/www/html" fstype=”gfs2”
clone WebFSClone WebFS
colocation WebFS-with-gfs-control inf: WebFSClone gfs-clone
colocation fs_on_drbd inf: WebFSClone WebDataClone:Master
order WebFS-after-WebData inf: WebDataClone:promote WebFSClone:start
order start-WebFS-after-gfs-control inf: gfs-clone WebFSClone
```

Apache

Lastly we have the actual service, Apache. We need only tell the cluster where to find it’s main configuration file and restrict it to running on nodes that have the required filesystem mounted and the IP address active.

```
primitive WebSite ocf:heartbeat:apache \
   params configfile="/etc/httpd/conf/httpd.conf" \
   op monitor interval="1min"
clone WebSiteClone WebSite
colocation WebSite-with-WebFS inf: WebSiteClone WebFSClone
colocation website-with-ip inf: WebSiteClone WebIP
order apache-after-ip inf: WebIP WebSiteClone
order WebSite-after-WebFS inf: WebFSClone WebSiteClone
```

Add a Third Node

Appendix: Sample openais.conf

```
# Please read the openais.conf.5 manual page
compatibility: whitetank

aisexec {
    # Run as root - this is necessary to be able to manage resources with Pacemaker
    user:  root
    group: root
}

service {
    # Load the Pacemaker Cluster Resource Manager
    ver:       0
    name:      pacemaker
    use_mgmtd: yes
    use_logd:  yes
}

totem {
    version: 2

    # How long before declaring a token lost (ms)
    token:          5000

    # How many token retransmits before forming a new configuration
    token_retransmits_before_loss_const: 10

    # How long to wait for join messages in the membership protocol (ms)
    join:           1000

    # How long to wait for consensus to be achieved before starting a new round of membership configuration (ms)
    consensus:      2500

    # Turn off the virtual synchrony filter
    vsftype:        none

    # Number of messages that may be sent by one processor on receipt of the token
    max_messages:   20

    # Stagger sending the node join messages by 1..send_join ms
    send_join: 45

    # Limit generated nodeids to 31-bits (positive signed integers)
    clear_node_high_bit: yes
    # Disable encryption
    secauth:     off

    # How many threads to use for encryption/decryption
    threads:     0

    # Optionally assign a fixed node id (integer)
    # nodeid:         1234

    interface {
          ringnumber: 0

          # The following values need to be set based on your environment
bindnetaddr: 192.168.9.0
mcastaddr: 226.94.1.1
mcastport: 4000
    }
}

logging {
    debug: off
    fileline: off
    to_syslog: yes
    to_stderr: off
    syslog_facility: daemon
    timestamp: on
}

amf {
    mode: disabled
}
```

Appendix: Further Reading

Project Website

http://www.clusterlabs.org

Cluster Commands

A comprehensive guide to cluster commands has been written by Novell and can be found at:

http://www.novell.com/documentation/sles11/book_sleha/index.html?page=/documentation/sles11/book_sleha/data/book_sleha.html

OpenAIS

http://www.openais.org