

CUDA Roll: Users Guide



Version 5.0 Edition



CUDA Roll: Users Guide :

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Preface

The purpose of the NVIDIA® CUDA™ Roll is to install and configure the device driver and full toolchain necessary to run and develop CUDA programs on a Rocks™ cluster. As of this release, this includes: CUDA Toolkit Version 2.0, CUDA SDK Version 2.0, and the NVIDIA Display Driver Version 177.70.18.

Please visit NVIDIA's site¹ to learn more about CUDA.

Notes

1. <http://www.nvidia.com/cuda>

Chapter 1. Requirements and Compatibility

1.1. Rocks Version

The CUDA Roll is for use with Rocks version 5.0 ("V"). At this time only the x86_64 architecture has been tested.

1.2. Hardware

Using CUDA requires CUDA capable devices be installed in the compute nodes. CUDA capable devices include the graphics cards in the NVIDIA G8x series and beyond and all NVIDIA® Tesla™ products. Please visit [CUDA-Enabled GPU Products¹](#) for more details.

1.3. Compatibility

Compatibility has been verified with the following optional Rolls:

- area51
- ganglia
- grid
- java
- sge
- pbs
- intel

Other Rolls may work but have not been tested.



The use of the "Jumbo Roll" which includes the boot, core, and OS roll is **not** recommended because it lacks the rpms for freeglut.



At this time the CUDA Roll is **not** compatible with the viz roll due to the different ways in which they install the device driver in the nvidia-driver rpm. We hope to have a common driver rpm in a future release.

Notes

1. http://www.nvidia.com/object/cuda_learn_products.html

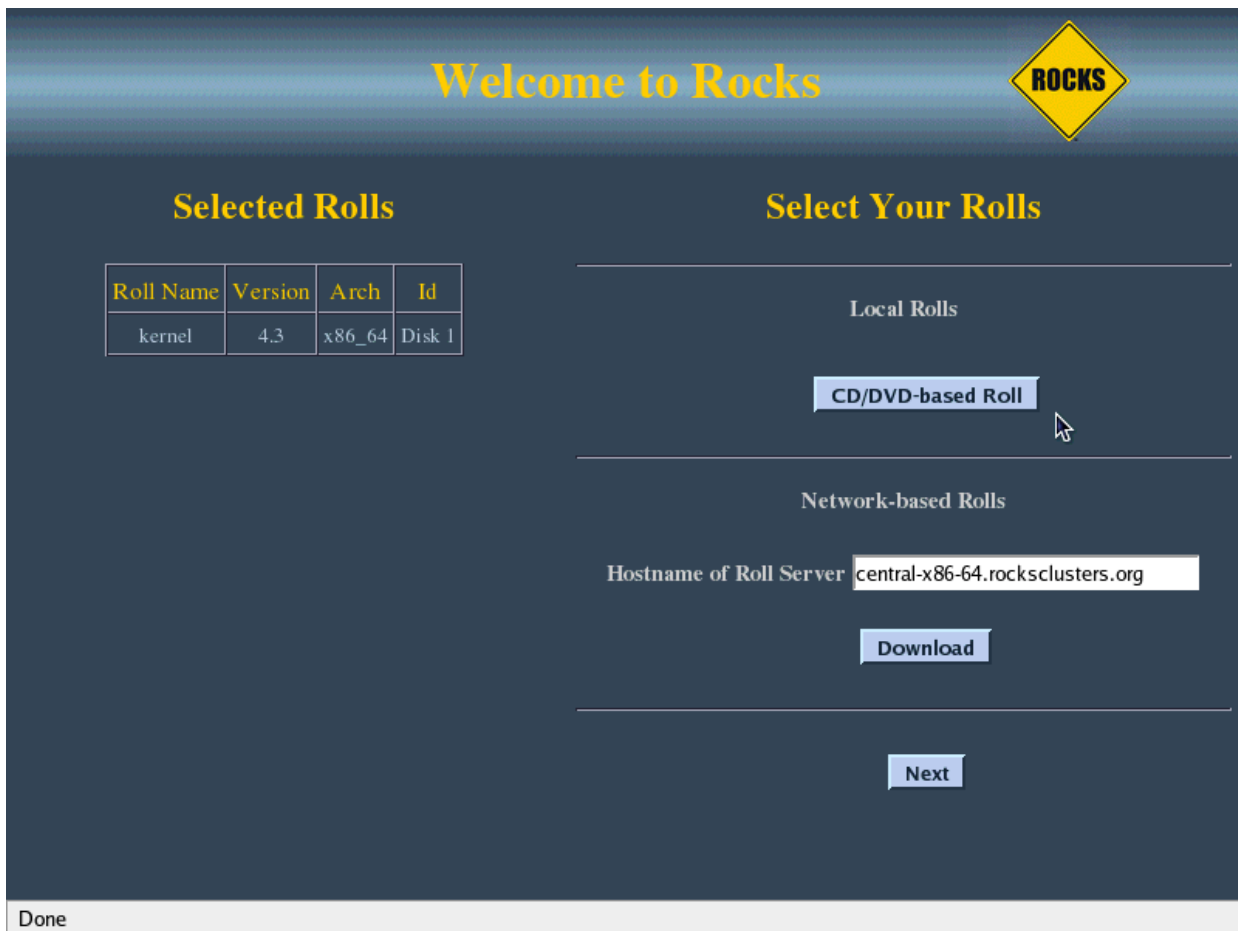
Chapter 2. Installing the CUDA Roll

The CUDA Roll can be installed during the Frontend installation step of your cluster or you can add the CUDA Roll to an existing system.

2.1. Installation on a New System

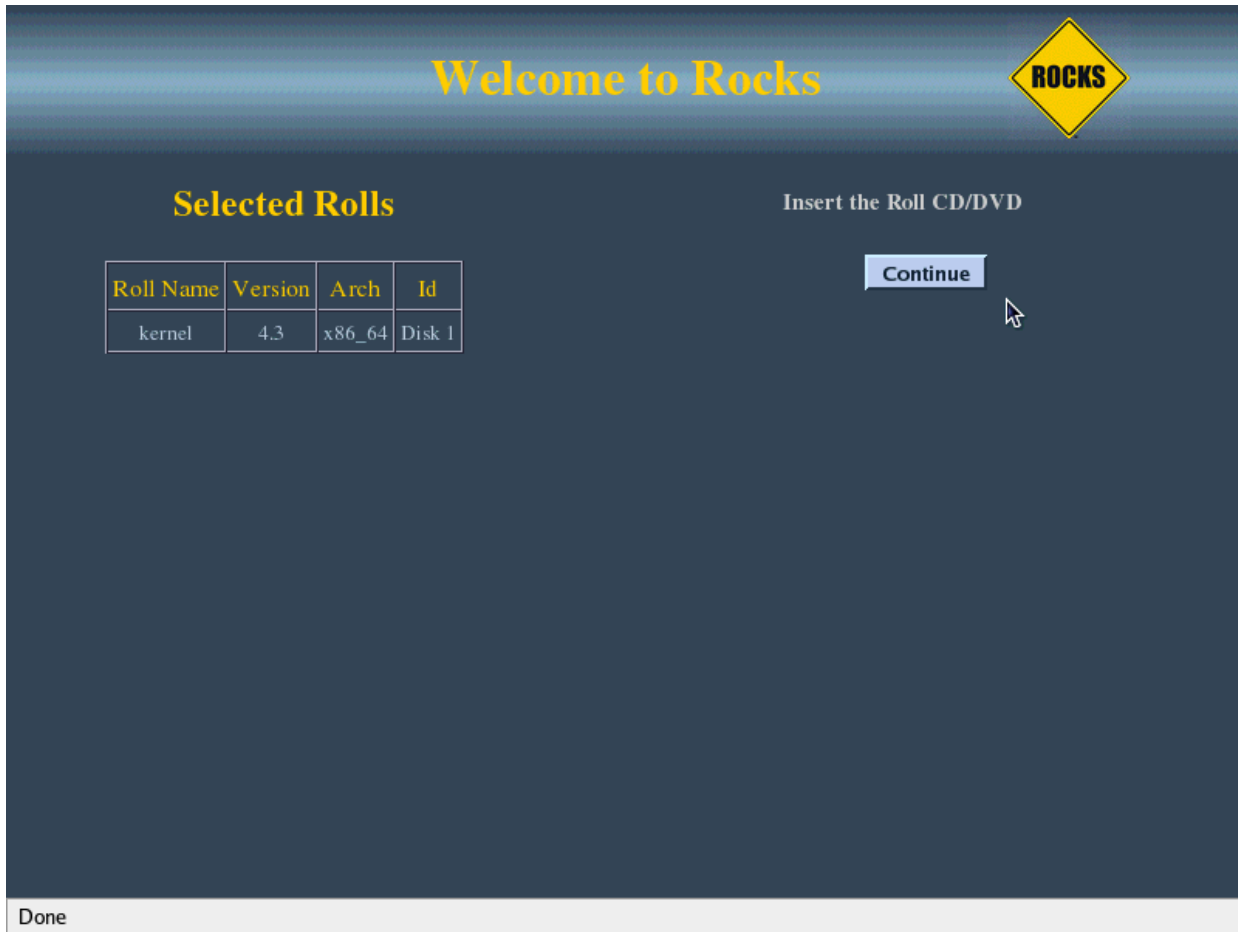
The CUDA Roll is added to a Frontend installation in exactly the same manner as other Rolls. Refer also to Section 2.2 of the Rocks Base Roll: Users Guide for more information. Note that the screenshots in the following figures are from a Rocks 4.3 install as seen in the column "Version". The install process for Rocks 5 is the same.

Figure 2-1. Adding a roll



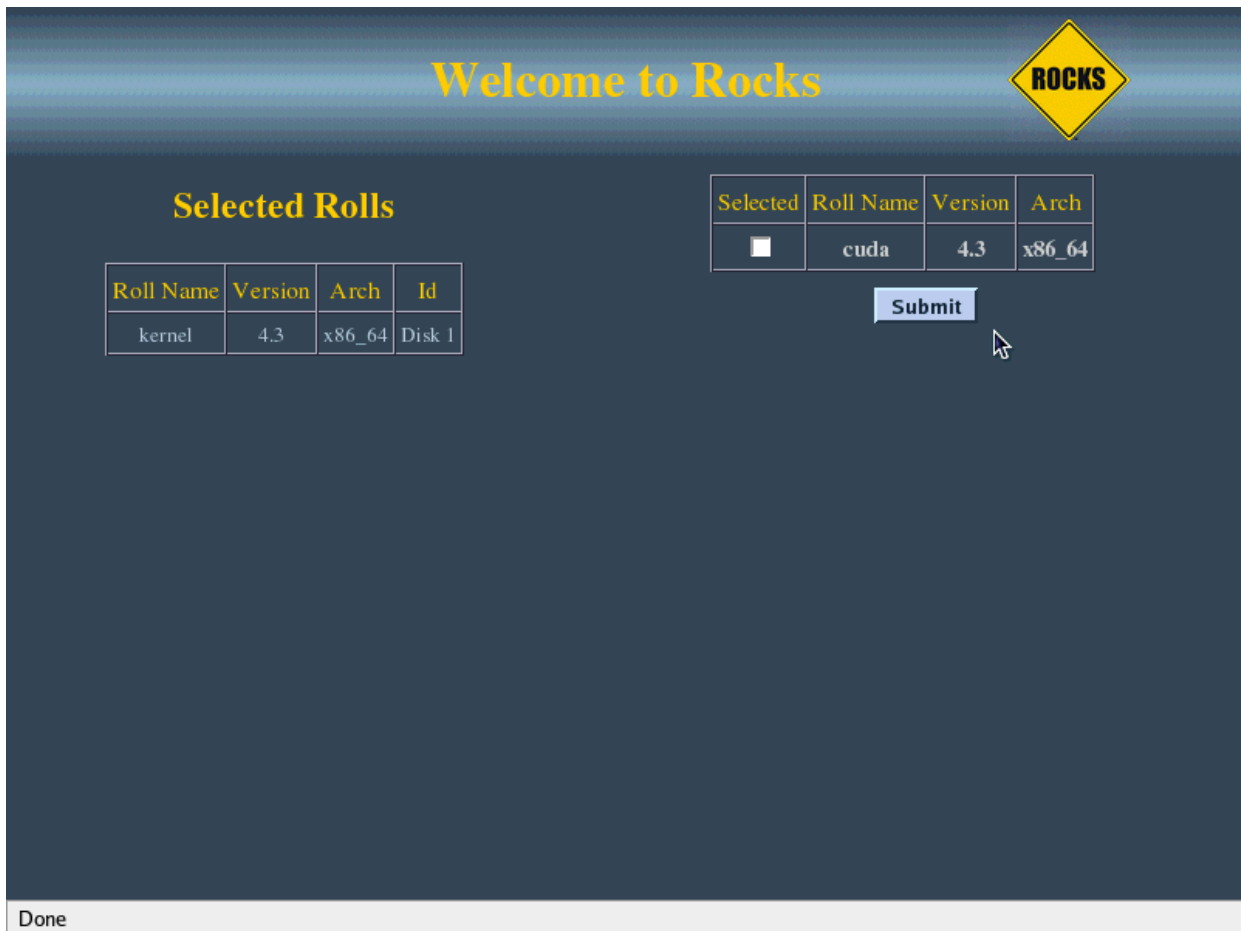
Click on the "CD/DVD-based Roll" button to indicate you have a Roll to add.

Figure 2-2. Loading the roll



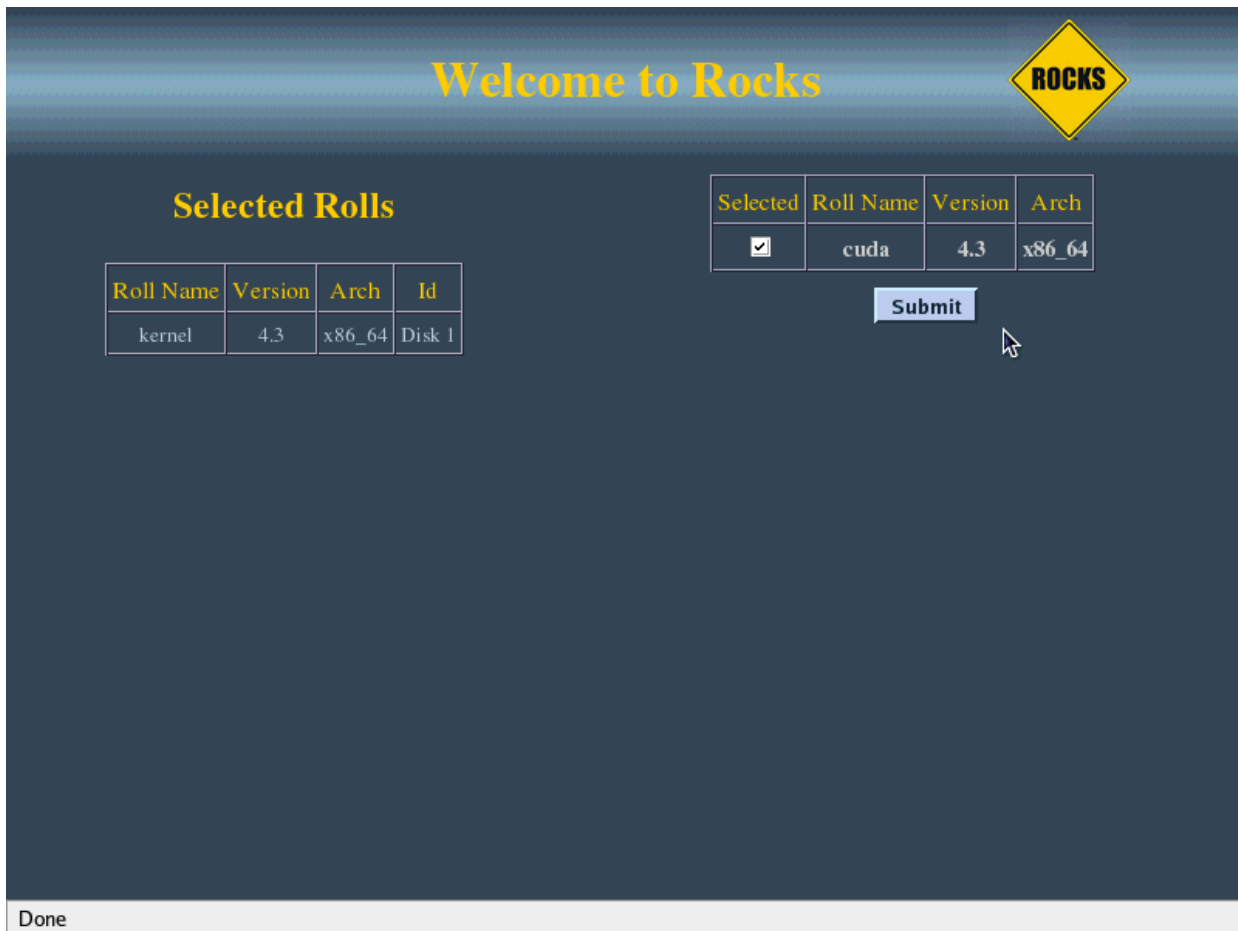
After inserting the CD, click on the "Continue" button.

Figure 2-3. List of available rolls



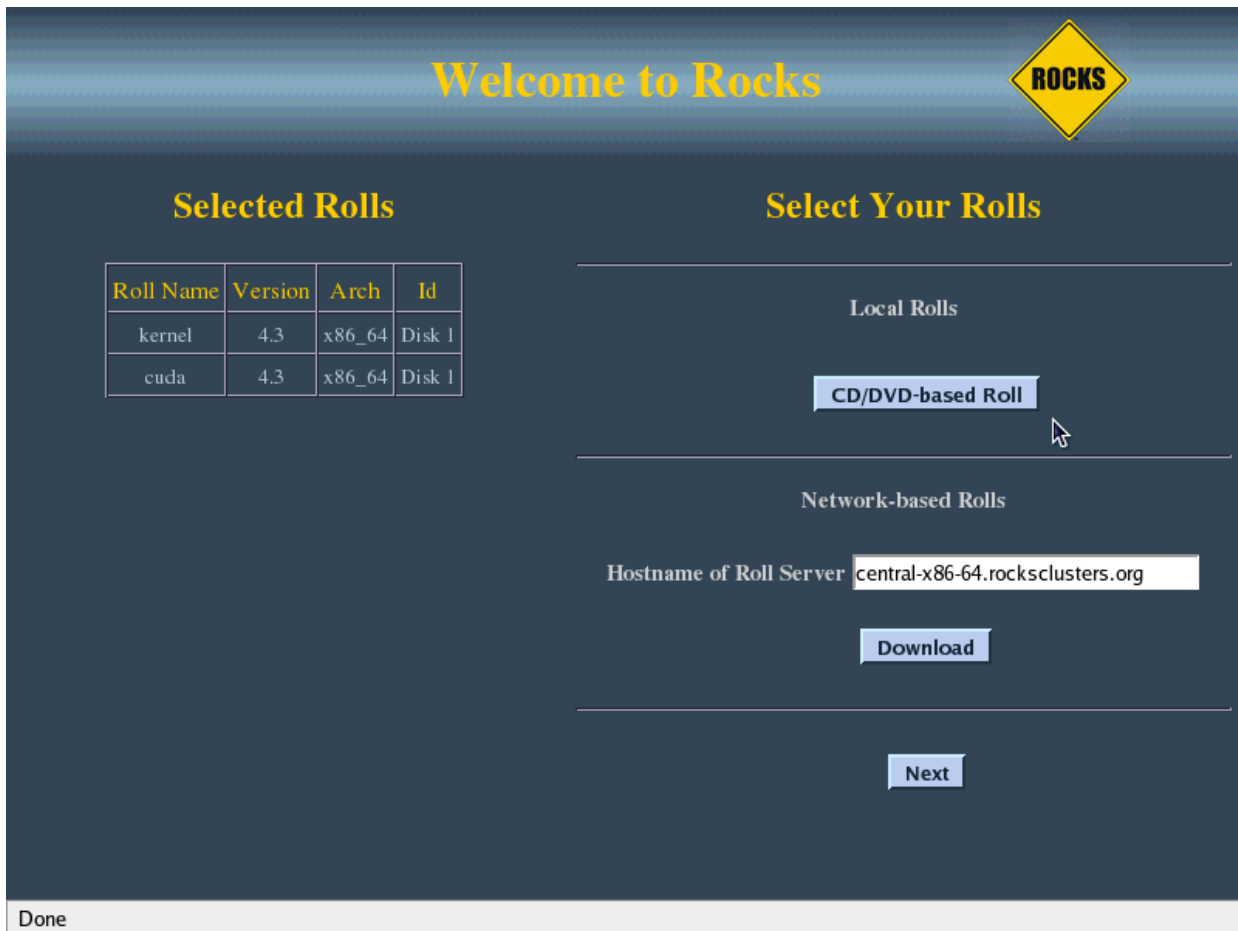
The available rolls will be listed on the right.

Figure 2-4. Selecting the CUDA Roll



Click on the box for CUDA and then click "Submit".

Figure 2-5. CUDA Roll selected for installation



The CUDA Roll will be added to the selected rolls on the left. You can now continue to add and select other rolls or start the installation as necessary.

Note that the device driver will not be installed on the Frontend by default. If you have an CUDA capable device in the Frontend and want to manually install the driver for it you can do so after the machine is up and running. Refer to the commands for manually installing the driver on the Frontend in the last section of this chapter.

2.2. Adding the Roll to an Existing Installation

The CUDA Roll can also be added to an existing system. Mount the CD at /mnt/cdrom or use the iso file directly:

```
# mount -o loop cuda-5.0-0.x86_64.disk1.iso /mnt/cdrom
```

Add the roll to the cluster:

```
# rocks add roll
cuda-5.0-0.x86_64.disk1.iso on /mnt/cdrom type iso9660 (rw,loop=/dev/loop0)
Copying cuda to Rolls.....185328 blocks
```

Make sure the roll is enabled by listing the rolls:

```
# rocks list roll
NAME                                VERSION ARCH  ENABLED
kernel:                             5.0      x86_64 yes
base:                                5.0      x86_64 yes
ganglia:                             5.0      x86_64 yes
hpc:                                  5.0      x86_64 yes
web-server:                          5.0      x86_64 yes
Red_Hat_Enterprise_Linux_Server_5:  5.0      x86_64 yes
cuda:                                 5.0      x86_64 yes
```

If the CUDA roll is not shown as enabled, enable the roll with the command:

```
# rocks enable roll cuda
```

Then rebuild the distribution:

```
# cd /home/install/
# rocks-dist dist
Cleaning distribution
Resolving versions (base files)
  including "kernel" (5.0,x86_64) roll...
  including "Red_Hat_Enterprise_Linux_Server_5" (5.0,x86_64) roll...
  including "hpc" (5.0,x86_64) roll...
  including "base" (5.0,x86_64) roll...
  including "cuda" (5.0,x86_64) roll...
  including "web-server" (5.0,x86_64) roll...
  including "ganglia" (5.0,x86_64) roll...
Including critical RPMS
Resolving versions (RPMs)
  including "kernel" (5.0,x86_64) roll...
  including "Red_Hat_Enterprise_Linux_Server_5" (5.0,x86_64) roll...
  including "hpc" (5.0,x86_64) roll...
  including "base" (5.0,x86_64) roll...
  including "cuda" (5.0,x86_64) roll...
  including "web-server" (5.0,x86_64) roll...
  including "ganglia" (5.0,x86_64) roll...
Resolving versions (SRPMS)
  including "kernel" (5.0,x86_64) roll...
  including "Red_Hat_Enterprise_Linux_Server_5" (5.0,x86_64) roll...
  including "hpc" (5.0,x86_64) roll...
  including "base" (5.0,x86_64) roll...
  including "cuda" (5.0,x86_64) roll...
  including "web-server" (5.0,x86_64) roll...
  including "ganglia" (5.0,x86_64) roll...
Creating files (symbolic links - fast)
Applying stage2.img
Applying updates.img
Installing XML Kickstart profiles
```

```

installing "cuda" profiles...
installing "hpc" profiles...
installing "web-server" profiles...
installing "base" profiles...
installing "kernel" profiles...
installing "ganglia" profiles...
installing "site" profiles...
Creating repository
making "torrent" files for RPMS
Cleaning distribution
Resolving versions (base files)
    including "kernel" (5.0,x86_64) roll...
    including "base" (5.0,x86_64) roll...
Including critical RPMS
Resolving versions (RPMS)
    including "kernel" (5.0,x86_64) roll...
    including "base" (5.0,x86_64) roll...
Resolving versions (SRPMS)
    including "kernel" (5.0,x86_64) roll...
    including "base" (5.0,x86_64) roll...
Creating files (symbolic links - fast)
Applying stage2.img
Applying updates.img
Installing XML Kickstart profiles
    installing "kernel" profiles...
    installing "base" profiles...
Creating repository
Linking boot stages from lan
Building Roll Links

```

Now you can try reinstalling a compute node:

```
# shoot-node compute-0-0
```

After verifying the proper operation of the compute node (see Section 3.2: Testing the Installation for more details), reinstall the rest of the nodes in the cluster.

When adding the CUDA Roll on a running system the CUDA Toolkit, CUDA SDK, and the roll users guide will not be automatically installed on the Frontend. Install them with the commands:

```
# cd /home/install/rolls/cuda/5.0/x86_64/RedHat/RPMS
# rpm -i cuda-toolkit*
# rpm -i cuda-sdk*
# rpm -i roll-cuda-usersguide*
```

The device driver is not installed on the Frontend by default. If you have an CUDA capable device in the Frontend and want to install the driver for it refer to the commands for manually installing the driver on the Frontend in the last section of this chapter.

2.3. Optional installation of the driver on the Frontend

By default the device driver will not be installed on the Frontend. If you have an CUDA capable device in the Frontend and wish to install the device driver, you can manually install the rpm and load the driver:

```
# cd /home/install/rolls/cuda/5.0/x86_64/RedHat/RPMS  
# rpm -i nvidia-driver*  
# /etc/rc.d/init.d/nvidia start
```

On subsequent reboots the device driver will be automatically loaded.

Chapter 3. Using the CUDA Roll

The CUDA Roll provides the device driver, toolkit, and SDK for developing and running CUDA enabled programs.

3.1. Summary of Installed Components

The NVIDIA Display Driver is loaded automatically at boot time by the `/etc/rc.d/init.d/nvidia` script. It attempts to load the driver, and if it fails (which happens most often because the driver hasn't been installed for the currently running kernel) will reinstall the driver. The installation of the driver will always happen upon first boot after installation and will add approximately one minute to the boot time.

The CUDA Toolkit is installed in `/usr/local/cuda` and the files `/etc/profile.d/cuda.*` automatically add the proper location to the `PATH` and `LD_LIBRARY_PATH` environment variables.

A copy of the CUDA SDK is placed in `/usr/local/NVIDIA_CUDA_SDK` with precompiled debug and release versions of the SDK examples in `/usr/local/NVIDIA_CUDA_SDK/linux/bin/debug` and `/usr/local/NVIDIA_CUDA_SDK/linux/bin/release` respectively.

3.2. Testing the Installation

The pre-compiled SDK samples can be used to verify proper setup of your cluster. For example, the `deviceQuery` example can be run on a compute node to list the CUDA capable devices:

```
[tux@compute-0-0]$ cd /usr/local/NVIDIA_CUDA_SDK/bin/linux/release
[tux@compute-0-0]$ ./deviceQuery -noprompt
There are 2 devices supporting CUDA
```

Device 0: "Tesla T10 Processor"

Major revision number:	1
Minor revision number:	3
Total amount of global memory:	4294705152 bytes
Number of multiprocessors:	30
Number of cores:	240
Total amount of constant memory:	65536 bytes
Total amount of shared memory per block:	16384 bytes
Total number of registers available per block:	16384
Warp size:	32
Maximum number of threads per block:	512
Maximum sizes of each dimension of a block:	512 x 512 x 64
Maximum sizes of each dimension of a grid:	65535 x 65535 x 1
Maximum memory pitch:	262144 bytes
Texture alignment:	256 bytes
Clock rate:	1.44 GHz
Concurrent copy and execution:	Yes

Device 1: "Tesla T10 Processor"

Major revision number:	1
Minor revision number:	3

```

Total amount of global memory:          4294705152 bytes
Number of multiprocessors:              30
Number of cores:                        240
Total amount of constant memory:        65536 bytes
Total amount of shared memory per block: 16384 bytes
Total number of registers available per block: 16384
Warp size:                              32
Maximum number of threads per block:    512
Maximum sizes of each dimension of a block: 512 x 512 x 64
Maximum sizes of each dimension of a grid: 65535 x 65535 x 1
Maximum memory pitch:                   262144 bytes
Texture alignment:                      256 bytes
Clock rate:                             1.44 GHz
Concurrent copy and execution:          Yes

```

Test PASSED

3.3. Troubleshooting

If the installation does not work, please make sure that the devices are among the list of PCI devices on the system:

```

[tux@compute-0-0 ~]$ /sbin/lspci | grep -i nvidia
01:00.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a2)
02:00.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a2)
02:01.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a2)
02:02.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a2)
02:03.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a2)
05:00.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a3)
06:00.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a3)
06:01.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a3)
06:02.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a3)
06:03.0 PCI bridge: nVidia Corporation: Unknown device 05be (rev a3)
07:00.0 3D controller: nVidia Corporation: Unknown device 05e7 (rev a1)
09:00.0 3D controller: nVidia Corporation: Unknown device 05e7 (rev a1)

```

In the output from `lspci` the entries will often show up as "Unknown device" because the hardware is too new to be in the `/usr/share/hwdata/pci.ids` file. For the example above the PCI bridge entries correspond to the host adapter card for a Tesla 1U computing system. The 3D controller entries are GPUs from a Tesla S1070.

Make sure that the proper driver version is loaded and that the device node files are present:

```

[tux@compute-0-0 ~]$ /sbin/lsmmod | grep nvidia
nvidia          7793880  32
i2c_core        56129   3 nvidia,i2c_ec,i2c_i801
[tux@compute-0-0 ~]$ cat /proc/driver/nvidia/version
NVRM version: NVIDIA UNIX x86_64 Kernel Module  177.70.18  Fri Oct 10 16:46:46 PDT 2008
GCC version:  gcc version 4.1.2 20071124 (Red Hat 4.1.2-42)
[tux@compute-0-0 ~]$ ls /dev/nv*
/dev/nvidia0 /dev/nvidia1 /dev/nvidiactl

```

There should be an entry for `nvidiactl` and one entry for each NVIDIA graphics card, starting with `nvidia0`.

Please include the `nvidia-bug-report.log` file created by running `nvidia-bug-report.sh` when reporting any problems with your installation.

Appendix A. Rocks Copyright

Rocks(r)
www.rocksclusters.org
version 5.0 (V)

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