Using udev

DEVICE JUNGLE

Learn how to create your own udev rules and deploy command-line tools to monitor and control udev events to clear your way through the Linux device jungle. **BY HEIKE JURZIK**

In the past few years, Linux has progressed in the field of hardware detection and management. The days of static device files huddled below the */dev* directory are long gone, and **Devfs** is also obsolete. Since kernel 2.6, udev [1] has been responsible for handling both the device filesystem and **Hotplug**, which includes setting up the required device files, setting permissions, and optionally launching certain programs.

User Space

In contrast to its predecessors, udev runs in **user space** – that is, as a “normal” program. This has a number of advantages, including freeing the kernel from the responsibility of management and naming attached devices, which facilitates configuration.

Udev has more benefits for users; for example, you can choose your own device names, and hardware assignments are always unique.

To keep everything running smoothly, udev needs rules that it references to discover a device’s name and how to handle the device.

Device Garage

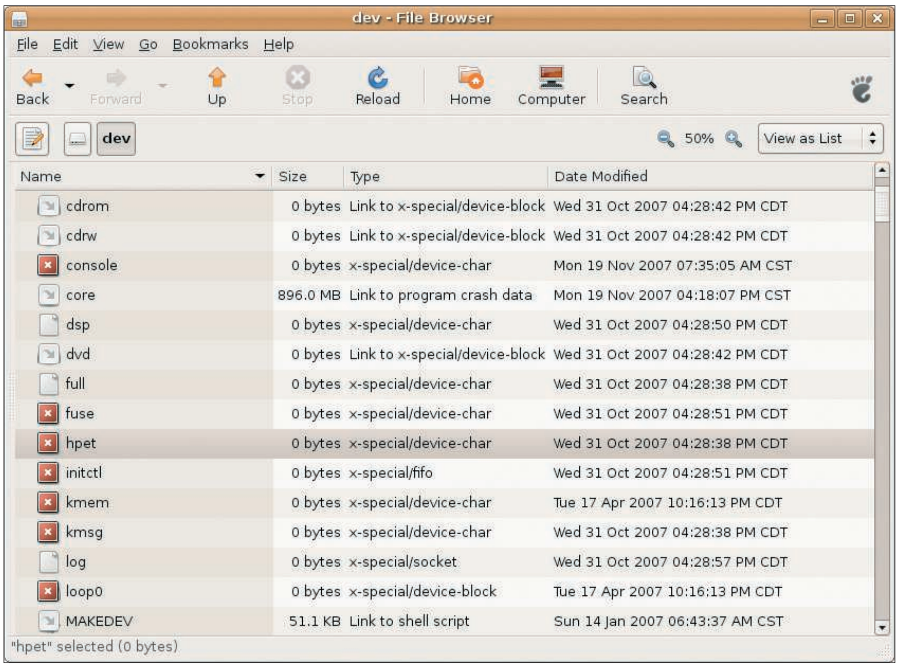
The udev “repository” is the */dev* directory, which is where the device files that allow applications to access hardware reside. If you look inside the folder, you will see not only the file names for your hard disks and partitions (for example, *sda*, as in *sda1*, *sda2*), but also files for CD/DVD drives (a symlink to *cdrom* typically points to the “genuine” device, e.g., *hdc*), serial ports (e.g., *ttyS0*, *ttyS1*), and so on (see Figure 1).

The operating system stores the content of the */dev* folder in a temporary filesystem, as you can see by listing the currently mounted RIS:

```
$ mount
...
udev on /dev type tmpfs (rw,mode=0755)
...
```

Listing 1: Rules

```
$ ls -la /etc/udev/rules.d/
...
lrwxrwxrwx 1 root root   20 2007-05-09 23:40 020_permissions.rules -> ../permissions.rules
lrwxrwxrwx 1 root root   19 2007-05-10 00:39 025_libgphoto2.rules -> ../libgphoto2.rules
lrwxrwxrwx 1 root root   16 2007-05-10 00:39 025_libsane.rules -> ../libsane.rules
...
lrwxrwxrwx 1 root root   12 2007-05-10 00:36 z99_hal.rules -> ../hal.rules
```



Name	Size	Type	Date Modified
cdrom	0 bytes	Link to x-special/device-block	Wed 31 Oct 2007 04:28:42 PM CDT
cdrw	0 bytes	Link to x-special/device-block	Wed 31 Oct 2007 04:28:42 PM CDT
console	0 bytes	x-special/device-char	Mon 19 Nov 2007 07:35:05 AM CST
core	896.0 MB	Link to program crash data	Mon 19 Nov 2007 04:18:07 PM CST
dsp	0 bytes	x-special/device-char	Wed 31 Oct 2007 04:28:50 PM CDT
dvd	0 bytes	Link to x-special/device-block	Wed 31 Oct 2007 04:28:42 PM CDT
full	0 bytes	x-special/device-char	Wed 31 Oct 2007 04:28:38 PM CDT
fuse	0 bytes	x-special/device-char	Wed 31 Oct 2007 04:28:51 PM CDT
hpet	0 bytes	x-special/device-char	Wed 31 Oct 2007 04:28:38 PM CDT
initctl	0 bytes	x-special/fifo	Wed 31 Oct 2007 04:28:51 PM CDT
kmem	0 bytes	x-special/device-char	Tue 17 Apr 2007 10:16:13 PM CDT
kmsg	0 bytes	x-special/device-char	Wed 31 Oct 2007 04:28:38 PM CDT
log	0 bytes	x-special/socket	Wed 31 Oct 2007 04:28:57 PM CDT
loop0	0 bytes	x-special/device-block	Tue 17 Apr 2007 10:16:13 PM CDT
MAKEDEV	51.1 KB	Link to shell script	Sun 14 Jan 2007 06:43:37 AM CST

"hpet" selected (0 bytes)

Figure 1: The Linux device garage is located in the /dev folder.

Linux always sets up the files in */dev* at boot time, but it also sets up a file when a new device is attached. It only makes sense that a device name will disappear when you remove the matching hardware. What keeps the directory clean and dynamic, while avoiding user confusion over changing device names, are the udev rules.

Udev Rules!

Various rule files, located in */etc/udev/* and */etc/udev/rules.d/*, control udev's behavior. Some distributions, such as Debian, use symbolic links in the latter directory to point to the rules in */etc/udev/*.

As you can see from Listing 1, rules are enumerated or start with a letter because udev works through the directory in alphabetic order when an event occurs. This method ensures that critical rules are processed first. The last port of call is normally the **HAL** daemon. (Udev notifies the daemon of the new device.)

If you take a closer look at a rule file, you will discover one or multiple instructions in a single line (without line breaks). The instructions contain various comma-separated conditions and control commands.

Shell-style wildcards, such as ***, *?*, *[...]*, and so on, are supported. Additionally, various operators are typically used (see Table 1). Table 2 shows you an overview of frequently used constants and variables. The man page (*man udev*) also has a full list of operators, constants, and variables.

Creating your own udev rules, thus extending hardware detection functionality, is fairly easy. If you use external USB memory devices, they are assigned different names depending on the order you plug them in. In this case, I'll assume you have a hard disk on which you regularly back up your data.

Saving Steps

Of course, you could plug in the disk, wait until it is correctly mounted, then discover the mount points and launch a backup script to complete the job. Thanks to udev, you can save a couple of these steps. To do so, you need to create a rule that automatically assigns the same device name to the hard disk. If you like, you can add a mount command to the rule or run a shell script to launch the backup.

First, you need some information about the device; you can use the *lsusb* (Listing 2) program for this. Make a note of the details that follow *idVendor*, *idProduct*, or *iSerial*, which you need to uniquely identify the device.

Creating Your Own Rule

Now, you need to write a new rule file. The file will reside in */etc/udev/rules.d*. Working as root, launch your favorite editor to create the file.

Use a unique number to insert the rule into the existing sequence, and add a *.rules* prefix. On my Debian Etch test system, I assigned the name *z98_usb-platte.rules* for the file and then added the following content:

```
SUBSYSTEM=="block", SYSFS{idProd
uct}=="2338", SYSFS{idVendor}=="
152d", NAME="backup"
```

Apart from saying that the device is a block device, the rule states the *idProduct* and *idVendor* information discovered by running *lsusb* and then specifies the name of the device file.

GLOSSARY

Devfs: The predecessor to udev. Up to kernel 2.4, the device filesystem was responsible for managing files in the */dev* directory. Devfs tasks included creating and deleting device files for removable media. On top of this, Devfs was responsible for rights management and thus controlled user access to devices.

Hotplug: The Hotplug system controls hardware initialization, which means any hardware discovered in the course of the boot process as well as devices that are added and removed at run time.

User space: Memory area reserved for user applications (i.e., for programs and data that are not directly related to the kernel.)

HAL: Hardware Abstraction Layer. The HAL daemon provides the details (e.g., driver information, drive types, and so on) of available devices to programs.

Table 1: Operators

Operator	Type	Meaning
==	Comparison	True if the two expressions are identical
!=	Comparison	True if the two expressions are not identical
=	Assignment	Assigns the value on the right to the expression on the left
:=	Assignment	Like =, protects the left-hand side against later changes
+=	Assignment	Adds the value on the right to that on the left

Listing 2: lsusb

```
$ lsusb -v
...
Bus 003 Device 010: ID 152d:2338
Device Descriptor:
...
  idVendor            0x152d
  idProduct           0x2338
  bcdDevice             1.00
  iManufacturer            1
  iProduct                 2
  iSerial                  5
  bNumConfigurations       1
...
```

Running the command

```
udevcontrol reload_rules
```

as root reparses the rules. Alternatively, you can unplug your USB device and then plug it back in. The *udevmonitor* tool shows you what is going on behind the scenes. In combination with the *--env* option, the tool becomes more verbose and shows various details related to the rule on the test machine:

```
# udevmonitor --env
...
ACTION=add
DEVPATH=/block/sda/sda1
SUBSYSTEM=block
...
DEVNAME=/dev/backup
...
```

A quick check of the */dev* directory reveals that udev really has created a */dev/backup* device file, just like the doctor ordered. If you unplug the USB disk, the entry disappears again.

Mount or Script?

As Table 2 shows, you can use *RUN* to define the program to execute in your rule file.

If you want to mount */dev/backup* in */media/backup* in one fell swoop, you can extend the rule like this:

```
SUBSYSTEM=="block", SYSFS{idProd
uct}=="2338", SYSFS{idVendor}=="
152d", NAME="backup", RUN+="/bin
/mount /dev/backup ⮐
/media/backup"
```

Make sure you enter the pull path to the program (*/bin/mount* in this case), but you need to create the mount point */media/backup* with the *mkdir* command (working as root) first:

```
$ mkdir /media/backup
```

Then, you can launch the backup program manually. As an alternative, you could create an entry for the device in your */etc/fstab* file as follows:

```
/dev/backup /media/backup ext3 u
sers,atime,noauto,rw,nodev,exec,
nosuid 0 0
```

This would let you add the mount command to the backup script to make sure that the external disk is mounted before backing up your data. In the udev rule, you would then replace "*/bin/mount* ... with the path to the backup script:

```
..., RUN+="/home/chicken/bin/ ⮐
backup.sh"
```

Table 2: Udev: Constants and Variables

Name	Meaning
ACTION	Event, either *add* or *remove*
SUBSYSTEM	Device type – for example, *usb_device*, *block*, and so on
BUS	Device bus system – for example, *ieee1394* or *usb*
ID	Device ID (in relation to the bus)
NAME	Name of network device (*eth0*, *eth1*, etc.) or the device file in */dev*
KERNEL	Device name according to the kernel
SYSFS{Datei}	Uses information from various files in */sys* (containing hardware details); maximum of five *SYSFS* constants per rule
OWNER	Owner (user name or UID)
GROUP	Group (name or GID)
MODE	Permissions (octal number)
RUN	Executes the specified program
SYMLINK	Creates a symbolic link that points to the device name proper
GOTO	Jumps to a specified label
LABEL	Name of label

Fighting NIC Chaos

If your computer has a single Ethernet card, the card will typically go by the name *eth0*. If you add a second card, such as a WLAN device to the machine, the card could be *ath0* or *eth1* depending on the driver. If you prefer your network cards to use the same names, you could create a rule to enforce this behavior. Instead of *idProduct* or *idVendor*, type the MAC address for your NIC, as shown after *SYSFS{address}* here. To discover the MAC, you can run *ifconfig*:

```
$ <B>/sbin/ifconfig<B>
eth0  Protocol:Ethernet  Hardwa
re Address 00:10:A7:21:36:7C
...
ath0  Protocol:Ethernet  Hardwa
re Address 00:00:C0:77:D8:F5
...
```

Listing 3 shows you how to create a matching rule. ■

Listing 3: Matching Rule

```
KERNEL=="eth*", SYSFS{address}=="00:10:A7:21:36:7C", NAME="eth0"
KERNEL=="eth*", SYSFS{address}=="00:00:C0:77:D8:F5", NAME="wlan0"
```

INFO

[1] Udev homepage: *http://www.kernel.org/pub/linux/utils/kernel/hotplug/udev.html*

THE AUTHOR

Heike Jurzik studied German, Computer Science and English at the University of Cologne, Germany. She discovered Linux in 1996 and has been fascinated with the scope of the Linux command line ever since. In her leisure time you might find Heike hanging out at Irish folk sessions or visiting Ireland.