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How To Compile A Kernel - The Fedora Way

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Each distribution has some specific tools to build a custom kernel from the sources. This article is about compiling a kernel on Fedora systems. It describes how to build a custom kernel using the latest unmodified kernel sources from **www.kernel.org** (**vanilla kernel**) so that you are independent from the kernels supplied by your distribution. It also shows how to patch the kernel sources if you need features that are not in there.

I have tested this on Fedora Core 6.

I want to say first that this is not the only way of setting up such a system. There are many ways of achieving this goal but this is the way I take. I do not issue any guarantee that this will work for you!

1 Preliminary Note

In this article I will describe two ways of building a kernel for Fedora systems. The first one is Fedora-specific, and in the end you will have a kernel rpm package that you can install or share with others. The second way is the same for all Linux distributions, but you don't end up with an rpm package.

I prefer to do all the steps here as the *root* user. However, it's possible to run most commands as a non-privileged user (e.g. user *tom*). Some commands such as *yum* or *rpm* still require root privileges, so you should add *tom* (or whatever your username is) to */etc/sudoers* by running

```
visudo
```

Add this line:

```
tom  ALL=(ALL) ALL
```

Now whenever you run a command that requires root privileges, such as

```
yum install fedora-rpmdevtools unifdef
```

the command will tell you so, and you must run

```
sudo yum install fedora-rpmdevtools unifdef
```

instead. **Remember:** you can forget about *sudo* if you run all commands as *root*. It's up to you which way you prefer.

2 Building A Kernel rpm Package

This chapter shows how to build a kernel and end up with an rpm package that you can install and share with others.

2.1 Create Your rpmbuild Directory

Create your rpmbuild directory as follows:

```
cd ~

cp -a /usr/src/redhat/ rpmbuild

echo '%_topdir %(echo $HOME)/rpmbuild' >> .rpmmacros
```

Then install the required packages for building rpm packages

```
yum install fedora-rpmdevtools unifdef
```

and run

```
fedora-buildrpmtree
```

2.2 Download And Install A Fedora Kernel src.rpm

Next we download the latest kernel src.rpm for our Fedora version. For Fedora Core 6, the src.rpm packages are located in **http://download.fedora.redhat.com/pub/fedora/linux/core/6/source/SRPMS/**, for Fedora Core 5 it's **http://download.fedora.redhat.com/pub/fedora/linux/core/5/source/SRPMS/**, and so on.

The latest Fedora Core 6 kernel src.rpm is `kernel-2.6.18-1.2798.fc6.src.rpm`, so we download and install it now:

```
cd /usr/src

wget http://download.fedora.redhat.com/pub/fedora/linux/core/6/source/SRPMS/kernel-2.6.18-1.2798.fc6.src.rpm

rpm -ivh kernel-2.6.18-1.2798.fc6.src.rpm
```

If you see these warnings:

```
warning: user brewbuilder does not exist - using root
warning: group brewbuilder does not exist - using root
```

you can ignore them.

We have just installed the kernel sources for the `2.6.18` kernel together with lots of Fedora patches and a patch for kernel `2.6.18.1`, so if we continued to build a kernel from this src.rpm we'd end up with kernel `2.6.18.1`.

2.3 Patch The Kernel

Instead of kernel `2.6.18.1` I want to install kernel `2.6.18.2`. The src.rpm we installed came with kernel `2.6.18` plus a patch for kernel `2.6.18.1`. We will now replace that patch with the patch for kernel `2.6.18.2`.

```
cd ~/rpmbuild/SOURCES/

wget http://www.kernel.org/pub/linux/kernel/v2.6/patch-2.6.18.2.bz2
```

You could also use the **http://www.kernel.org/pub/linux/kernel/v2.6/testing/patch-2.6.19-rc5.bz2** ***prepatch*** if you want to end up with kernel `2.6.19-rc5`. Please note that this works only for prepatches, i.e. patches for kernels that aren't available in a final version yet, such as the 2.6.19 kernel. You can apply that patch to the 2.6.18 kernel sources, but not to kernel 2.6.18.1 or 2.6.18.2, etc. This is explained on ***http://kernel.org/patchtypes/pre.html***:

Prepatches are the equivalent to alpha releases for Linux; they live in the testing directories in the archives. They should be applied using the patch(1) utility to the source code of the previous full release with a 3-part version number (for example, the 2.6.12-rc4 prepatch should be applied to the 2.6.11 kernel sources, not, for example, 2.6.11.10.)

Now we must modify the `kernel-2.6.spec` file so that it knows about our new kernel patch:

```
cd ~/rpmbuild/SPECS/
```

```
vi kernel-2.6.spec
```

Search for the line

```
Patch1: patch-2.6.18.1.bz2
```

and replace it with this one:

```
Patch1: patch-2.6.18.2.bz2
```

(or whatever patch you downloaded before).

Then run

```
rpmbuild -bp kernel-2.6.spec
```

(If you want to build the kernel for a specific architecture such as i386, i586, i686, or x86_64, you can do it like this:

```
rpmbuild -bp --target=i686 kernel-2.6.spec
```

I don't specify it in this example and end up with a i386 kernel here. Your system might build a kernel for a different architecture instead if you don't specify it, so keep this in mind when you follow this tutorial.)

Now comes the tricky part. The src.rpm comes with a lot of Fedora-specific patches. Some of them don't work with our 2.6.18.2 patch, so if you see something like this in the `rpmbuild` output:

```
+ echo 'Patch #300 (linux-2.6-ppc-dac960-ipr-clash.patch):'
Patch #300 (linux-2.6-ppc-dac960-ipr-clash.patch):
+ patch -p1 -s
Reversed (or previously applied) patch detected!  Assume -R? [n]
Apply anyway? [n]
1 out of 1 hunk ignored -- saving rejects to file drivers/block/DAC960.c.rej
error: Bad exit status from /var/tmp/rpm-tmp.46287 (%prep)


RPM build errors:
    Bad exit status from /var/tmp/rpm-tmp.46287 (%prep)
```

you must edit `kernel-2.6.spec` again and comment out the patch #300:

```
vi kernel-2.6.spec
```

```
[...]
#Patch300: linux-2.6-ppc-dac960-ipr-clash.patch
[...]
#%patch300 -p1
[...]
```

Then run your rpmbuild command again, e.g.

```
rpmbuild -bp kernel-2.6.spec
```

You must repeat this over and over until there are no more patches that fail to be applied.

2.4 Specify A Kernel Identification String

Now we should specify a string that allows us to identify our kernel later on. Therefore we do this:

```
cd ~/rpmbuild/BUILD/kernel-2.6.18/linux-2.6.18.i386

vi Makefile
```

In the `EXTRAVERSION` line, you can put the kernel identification. I think it's good to append the kernel version to that string, so something like this is ok:

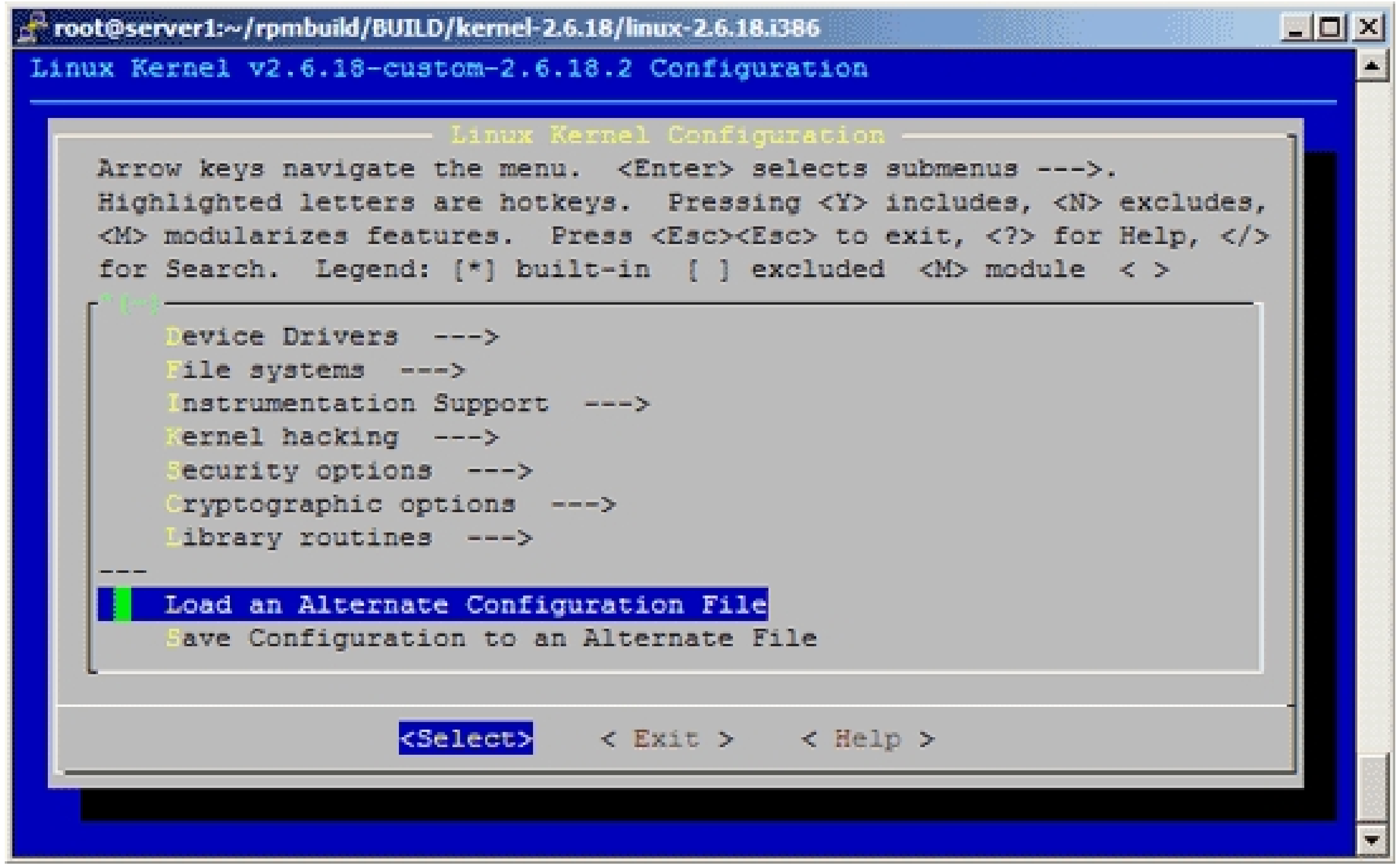
```
EXTRAVERSION = -custom-2.6.18.2
```

2.5 Configure The Kernel

Now we run

```
make menuconfig
```

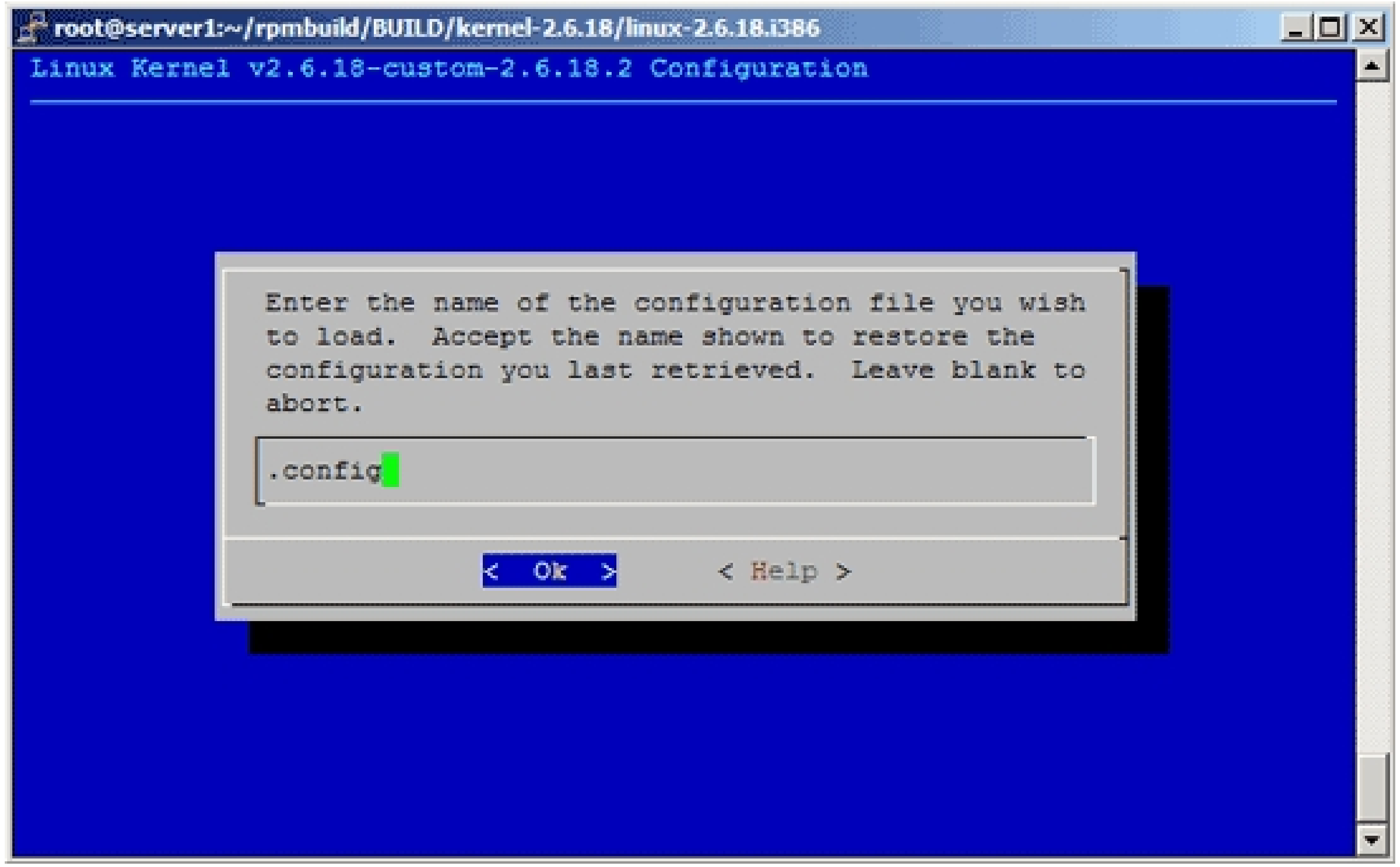
which brings up the kernel configuration menu. Go to `Load an Alternate Configuration File` and choose `.config` as the configuration file:



```
root@server1:~/rpmbuild/BUILD/kernel-2.6.18/linux-2.6.18.i386
 Linux Kernel v2.6.18-custom-2.6.18.2 Configuration

 ──────────────── Linux Kernel Configuration ────────────────
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >
 ┌^(-)─────────────────────────────────────────────────────────────┐
 │      Device Drivers  --->
 │      File systems  --->
 │      Instrumentation Support  --->
 │      Kernel hacking  --->
 │      Security options  --->
 │      Cryptographic options  --->
 │      Library routines  --->
 │  ---
 │      Load an Alternate Configuration File
 │      Save Configuration to an Alternate File
 └─────────────────────────────────────────────────────────────────┘

                <Select>    < Exit >    < Help >
```



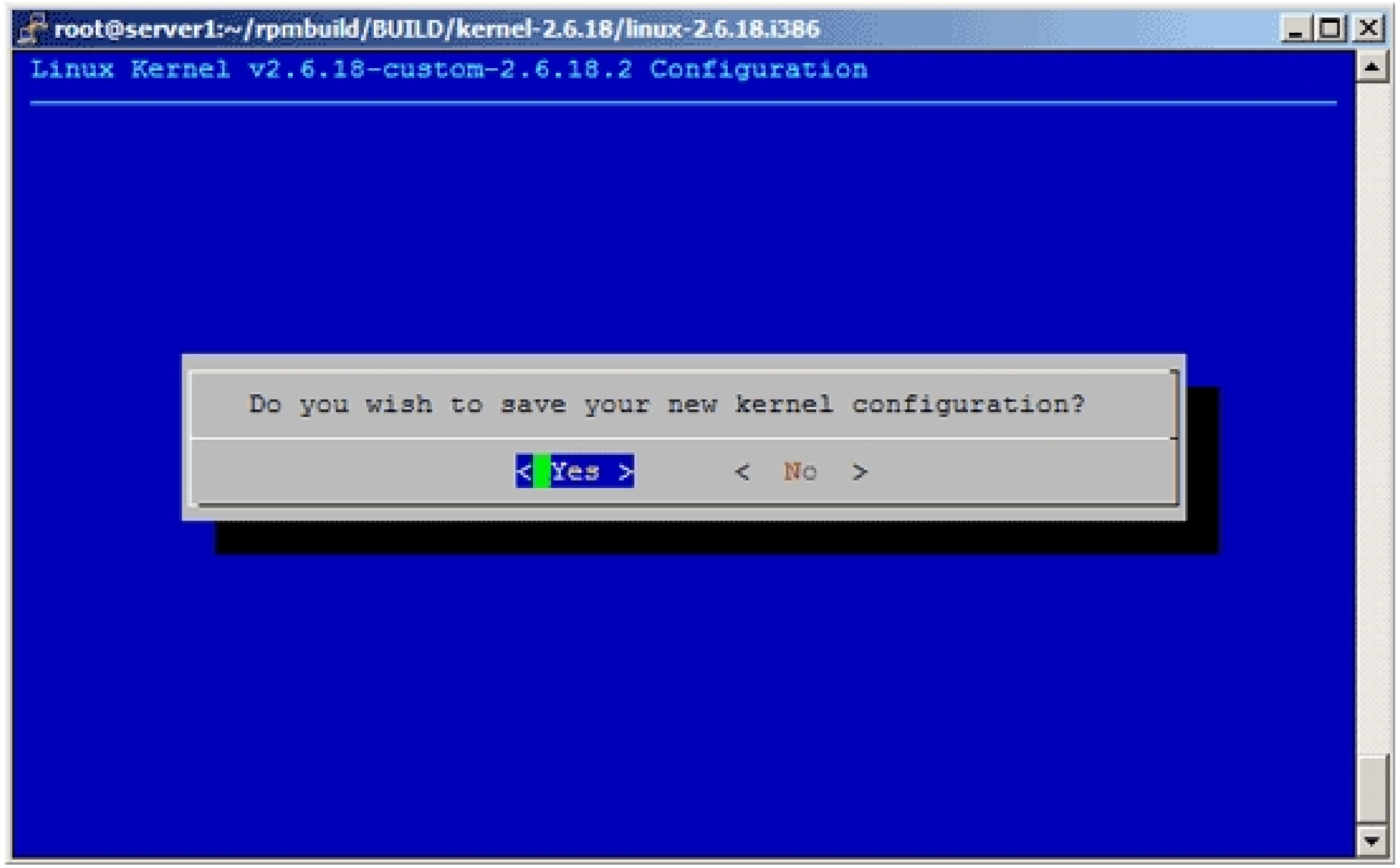
```
root@server1:~/rpmbuild/BUILD/kernel-2.6.18/linux-2.6.18.i386
Linux Kernel v2.6.18-custom-2.6.18.2 Configuration

  Enter the name of the configuration file you wish
  to load.  Accept the name shown to restore the
  configuration you last retrieved.  Leave blank to
  abort.

  .config

              <  Ok  >          < Help >
```

Then browse through the kernel configuration menu and make your choices. When you are finished and select `Exit`, answer the following question (*`Do you wish to save your new kernel configuration?`*) with `Yes`:



```
root@server1:~/rpmbuild/BUILD/kernel-2.6.18/linux-2.6.18.i386

Linux Kernel v2.6.18-custom-2.6.18.2 Configuration

    Do you wish to save your new kernel configuration?

              < Yes >      <  No  >
```

2.6 Build The Kernel

Now we build our kernel rpm package by simply running

```
make rpm
```

Afterwards you will find a new src.rpm package in the *~/rpmbuild/SRPMS/* directory, e.g. *~/rpmbuild/SRPMS/kernel-2.6.18custom2.6.18.2-1.src.rpm*, and the kernel rpm package in *~/rpmbuild/RPMS/i386/* (or *~/rpmbuild/RPMS/i586/, ~/rpmbuild/RPMS/i686/*, etc. depending on your architecture), e.g. *~/rpmbuild/RPMS/i386/kernel-2.6.18custom2.6.18.2-1.i386.rpm*. As you see your kernel identification has been added to the package name.

2.7 Install The New Kernel

Now go the directory where your new kernel rpm package has been created (depending on your architecture, e.g. *~/rpmbuild/RPMS/i386/*), and install the rpm package:

```
cd ~/rpmbuild/RPMS/i386


rpm -ivh kernel-2.6.18custom2.6.18.2-1.i386.rpm
```

(You can now even transfer the rpm package to other Fedora systems and install them there exactly the same way, which means you don't have to compile the kernel there again.)

Next we create a ramdisk for our new kernel, because otherwise the system will most likely not boot our new kernel:

```
mkinitrd /boot/initrd-2.6.18-custom-2.6.18.2.img 2.6.18-custom-2.6.18.2
```

Then edit */boot/grub/menu.lst*. Have a look at your existing (working) kernel stanzas there and take one of them as a sample for your new stanza and replace the kernel and ramdisk, then add the stanza above all other stanzas.

```
vi /boot/grub/menu.lst
```

For example, my *menu.lst* looks like this before I add the new stanza:

```
# grub.conf generated by anaconda
```

```
#
# Note that you do not have to rerun grub after making changes to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/, eg.
#          root (hd0,0)
#          kernel /vmlinuz-version ro root=/dev/VolGroup00/LogVol00
#          initrd /initrd-version.img
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu

title Fedora Core (2.6.18-1.2798.fc6)
        root (hd0,0)
        kernel /vmlinuz-2.6.18-1.2798.fc6 ro root=/dev/VolGroup00/LogVol00
        initrd /initrd-2.6.18-1.2798.fc6.img
```

and like this afterwards:

```
# grub.conf generated by anaconda
#
# Note that you do not have to rerun grub after making changes to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/, eg.
#          root (hd0,0)
#          kernel /vmlinuz-version ro root=/dev/VolGroup00/LogVol00
#          initrd /initrd-version.img
#boot=/dev/sda
default=0
timeout=5
```

```
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu

title Fedora Core (2.6.18-custom-2.6.18.2)
        root (hd0,0)
        kernel /vmlinuz-2.6.18-custom-2.6.18.2 ro root=/dev/VolGroup00/LogVol00
        initrd /initrd-2.6.18-custom-2.6.18.2.img

title Fedora Core (2.6.18-1.2798.fc6)
        root (hd0,0)
        kernel /vmlinuz-2.6.18-1.2798.fc6 ro root=/dev/VolGroup00/LogVol00
        initrd /initrd-2.6.18-1.2798.fc6.img
```

(You can find out about the right *vmlinuz* and *initrd* files by running

```
ls -l /boot
```

)

Now reboot the system:

```
shutdown -r now
```

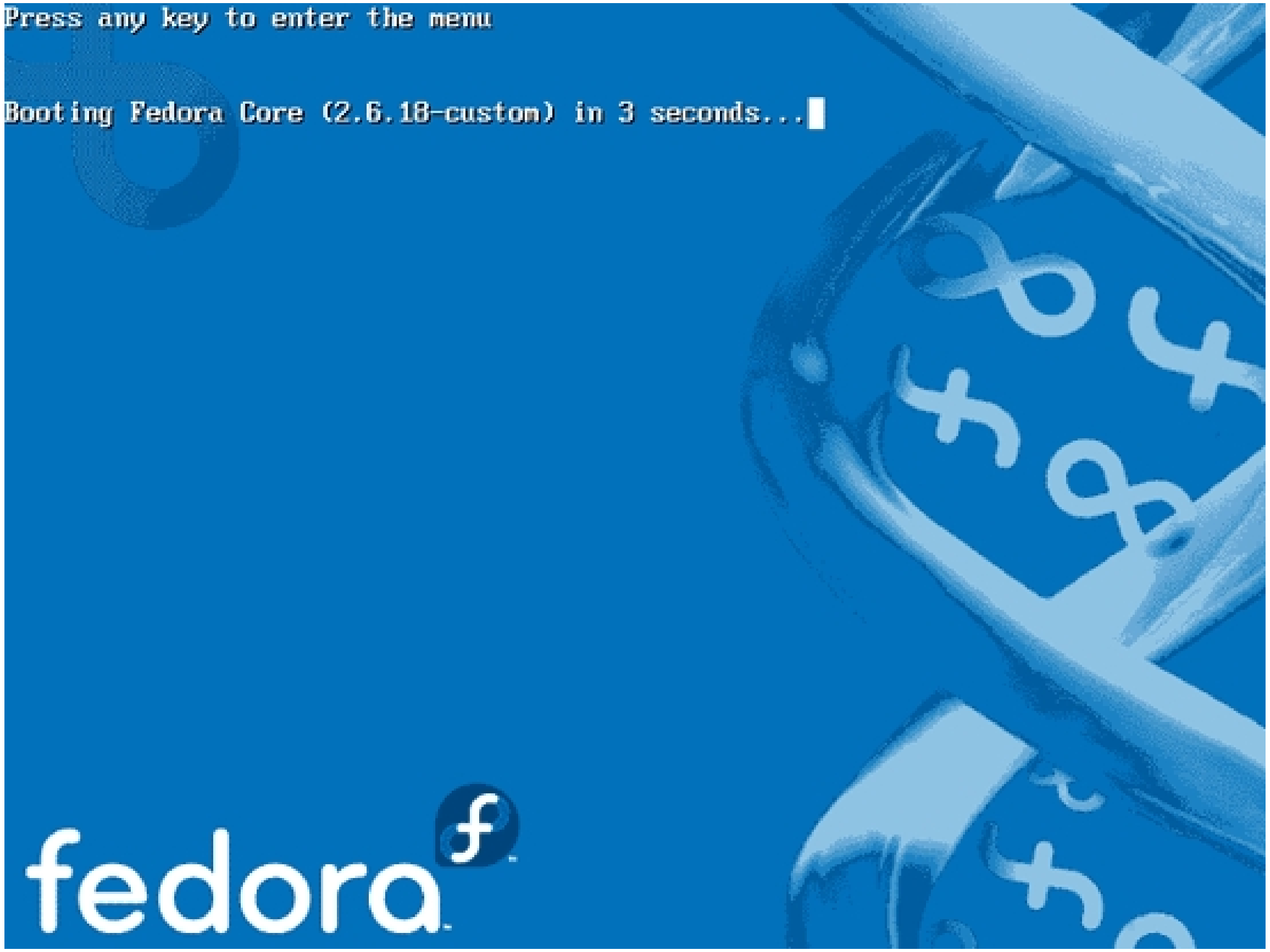
If everything goes well, it should come up with the new kernel. You can check if it's really using your new kernel by running

```
uname -r
```

This should display something like

```
2.6.18-custom-2.6.18.2
```

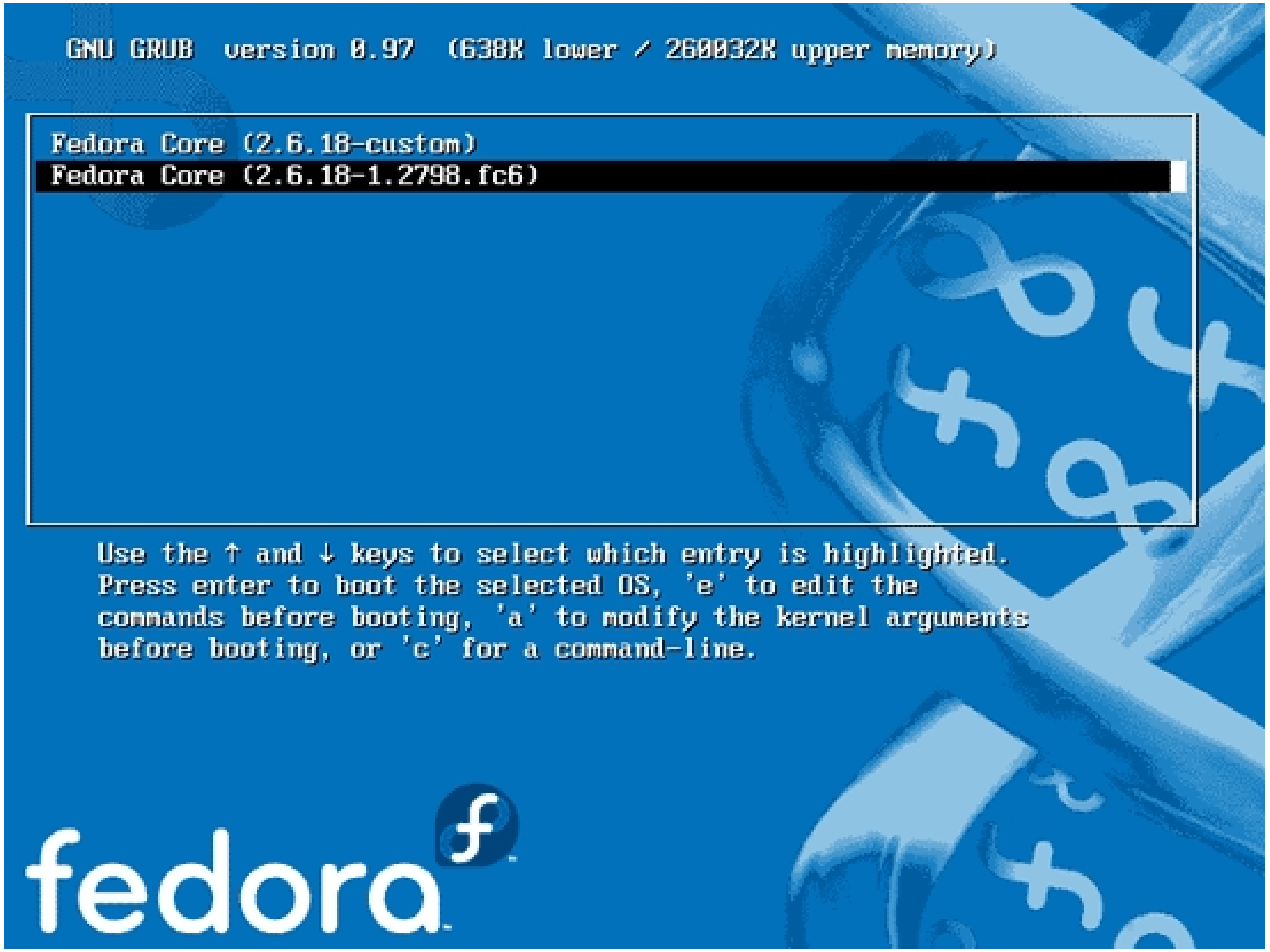
If the system doesn't start, restart it, and when you see this:



```
Press any key to enter the menu

Booting Fedora Core (2.6.18-custom) in 3 seconds...
```

press any key to enter the GRUB menu:



```
GNU GRUB  version 0.97  (638K lower / 260032K upper memory)

Fedora Core (2.6.18-custom)
Fedora Core (2.6.18-1.2798.fc6)

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the
commands before booting, 'a' to modify the kernel arguments
before booting, or 'c' for a command-line.
```

Select your old kernel and start the system. You can now try again to compile a working kernel. Don't forget to remove the stanza of the not-working kernel from `/boot/grub/menu.lst`.

3 Building A Kernel The Traditional Way

This chapter describes a different approach that can be used on any Linux system. As there's nothing Fedora-specific in this, of course you will not end up with a kernel rpm package.

3.1 Download The Kernel Sources

We download our desired kernel to `/usr/src`. Go to www.kernel.org and select the kernel you want to install, e.g. `linux-2.6.18.2.tar.bz2` (you can find all 2.6 kernels here: http://www.kernel.org/pub/linux/kernel/v2.6/). Then you can download it to `/usr/src` like this:

```
cd /usr/src

wget http://www.kernel.org/pub/linux/kernel/v2.6/linux-2.6.18.2.tar.bz2
```

Then we unpack the kernel sources and create a symlink linux to the kernel sources directory:

```
tar xjf linux-2.6.18.2.tar.bz2

ln -s linux-2.6.18.2 linux

cd /usr/src/linux
```

3.2 Apply Patches To The Kernel Sources (Optional)

Sometimes you need drivers for hardware that isn't supported by the new kernel by default, or you need support for virtualization techniques or some other bleeding-edge technology that hasn't made it to the kernel yet. In all these cases you have to patch the kernel sources (provided there is a patch available...).

Now let's assume you have downloaded the needed patch (I call it `patch.bz2` in this example) to `/usr/src`. This is how you apply it to your kernel sources (you must still be in the `/usr/src/linux` directory):

```
bzip2 -dc /usr/src/patch.bz2 | patch -p1 --dry-run
```

```
bzip2 -dc /usr/src/patch.bz2 | patch -p1
```

The first command is just a test, it does nothing to your sources. If it doesn't show errors, you can run the second command which actually applies the patch. Don't do it if the first command shows errors!

You can also apply kernel prepatches to your kernel sources. For example, if you need a feature that is available only in kernel `2.6.19-rc5`, but the full sources haven't been released yet for this kernel. Instead, a `patch-2.6.19-rc5.bz2` is available. You can apply that patch to the `2.6.18` kernel sources, but not to kernel `2.6.18.1` or `2.6.18.2`, etc. This is explained on http://kernel.org/patchtypes/pre.html:

Prepatches are the equivalent to alpha releases for Linux; they live in the testing directories in the archives. They should be applied using the patch(1) utility to the source code of the previous full release with a 3-part version number (for example, the 2.6.12-rc4 prepatch should be applied to the 2.6.11 kernel sources, not, for example, 2.6.11.10.)

So if you want to compile a `2.6.19-rc5` kernel, you must download the `2.6.18` kernel sources (http://www.kernel.org/pub/linux/kernel/v2.6/linux-2.6.18.tar.bz2) in step 3.1 instead of kernel `2.6.18.2`!

This is how you apply the `2.6.19-rc5` patch to kernel `2.6.18`:

```
cd /usr/src

wget http://www.kernel.org/pub/linux/kernel/v2.6/testing/patch-2.6.19-rc5.bz2

cd /usr/src/linux

bzip2 -dc /usr/src/patch-2.6.19-rc5.bz2 | patch -p1 --dry-run

bzip2 -dc /usr/src/patch-2.6.19-rc5.bz2 | patch -p1
```

3.3 Configure The Kernel

It's a good idea to use the configuration of your current working kernel as a basis for your new kernel. Therefore we copy the existing configuration to `/usr/src/linux`:

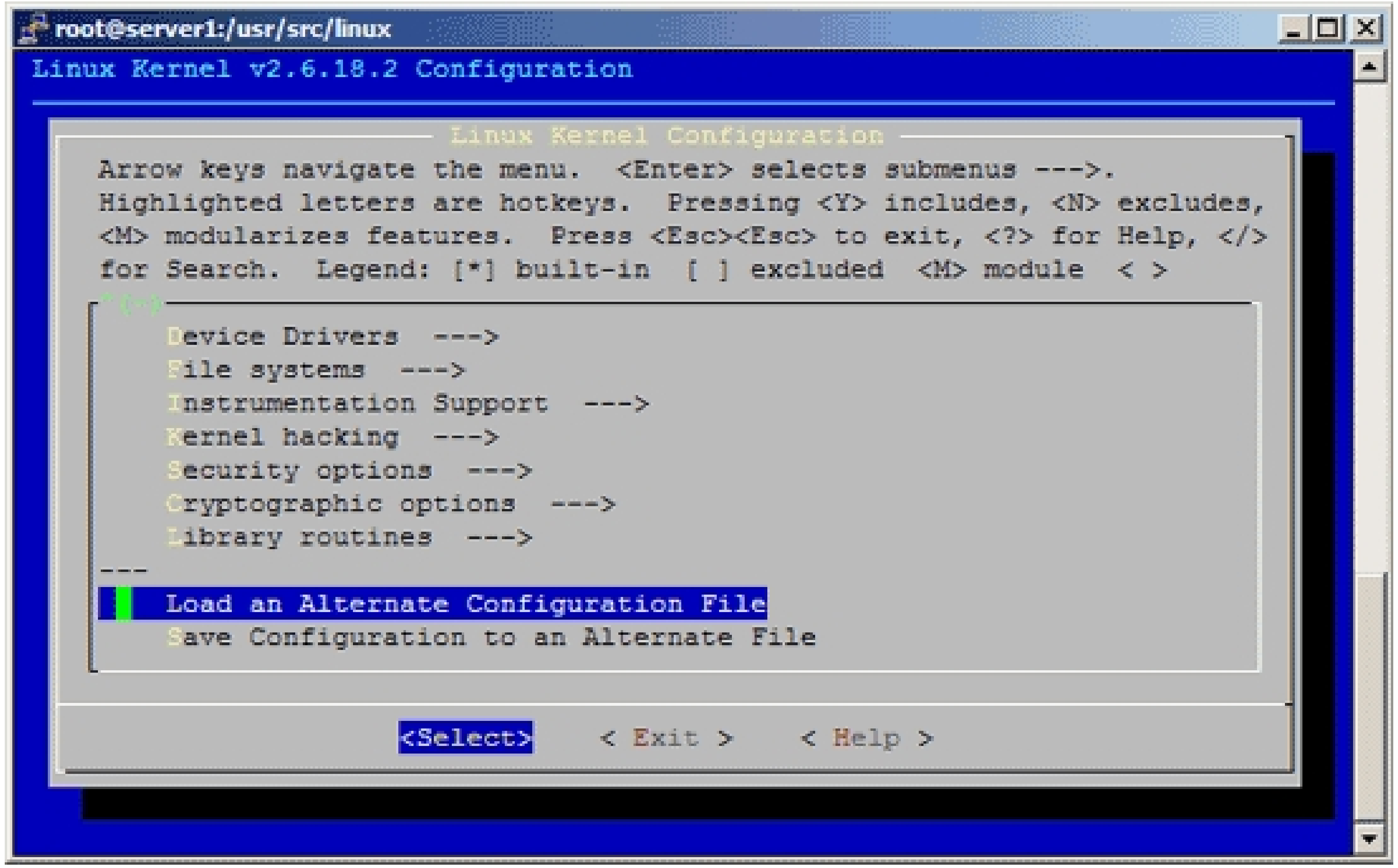
```
make mrproper


cp /boot/config-`uname -r` ./.config
```

Then we run

```
make menuconfig
```

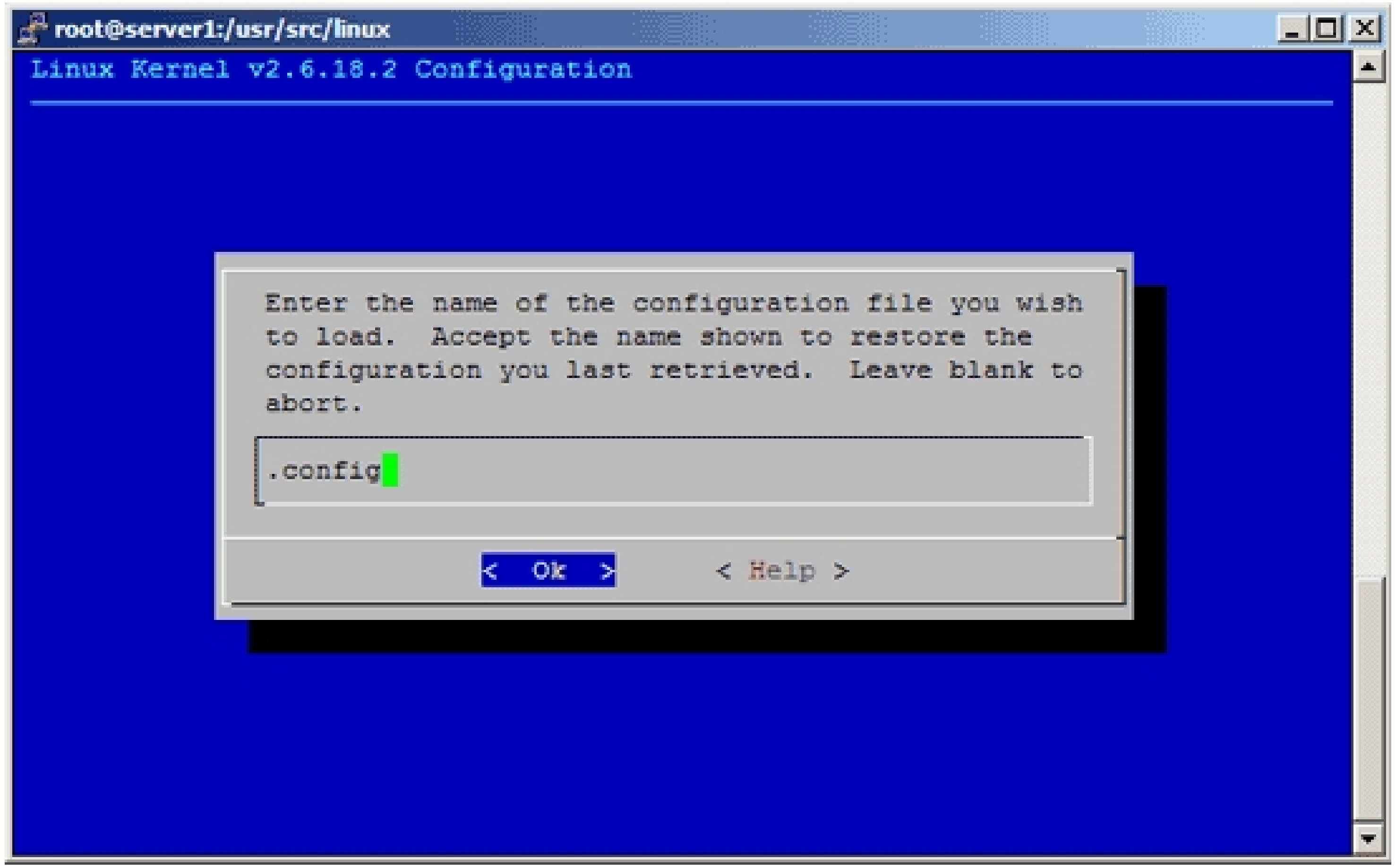
which brings up the kernel configuration menu. Go to `Load an Alternate Configuration File` and choose `.config` (which contains the configuration of your current working kernel) as the configuration file:



```
root@server1:/usr/src/linux
Linux Kernel v2.6.18.2 Configuration

                    Linux Kernel Configuration
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >
  ^(-)
      Device Drivers  --->
      File systems  --->
      Instrumentation Support  --->
      Kernel hacking  --->
      Security options  --->
      Cryptographic options  --->
      Library routines  --->
  ---
      Load an Alternate Configuration File
      Save Configuration to an Alternate File

              <Select>    < Exit >    < Help >
```



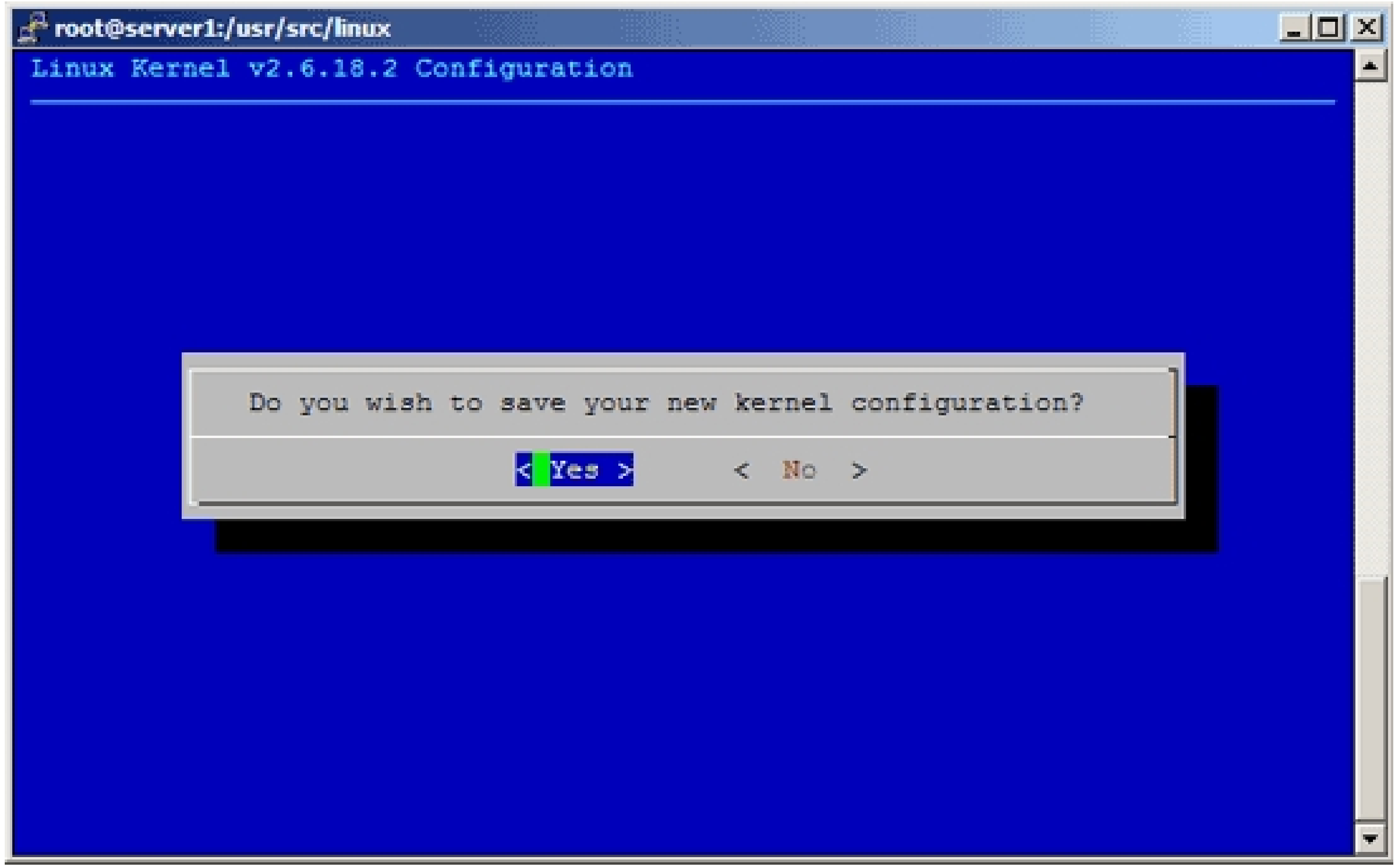
```
Linux Kernel v2.6.18.2 Configuration

Enter the name of the configuration file you wish
to load.  Accept the name shown to restore the
configuration you last retrieved.  Leave blank to
abort.

.config

<  Ok  >      < Help >
```

Then browse through the kernel configuration menu and make your choices. When you are finished and select `Exit`, answer the following question (*`Do you wish to save your new kernel configuration?`*) with *`Yes`*:


```
root@server1:/usr/src/linux
Linux Kernel v2.6.18.2 Configuration

Do you wish to save your new kernel configuration?

< Yes >        <  No  >
```

3.4 Build And Install The Kernel

To build and install the kernel, execute these three commands:

```
make all

make modules_install
make install
```

Now be patient, the kernel compilation can take some hours, depending on your kernel configuration and your processor speed. The last command will also automatically create a ramdisk for you as well as configure `/boot/grub/menu.lst`.

Now edit `/boot/grub/menu.lst`. You should find a stanza for your new kernel at the top of the list, but to make sure that the new kernel gets booted instead of your old one, you must set the value of `default` to `0`.

```
vi /boot/grub/menu.lst
```

My `menu.lst` looks like this:

```
# grub.conf generated by anaconda
#
# Note that you do not have to rerun grub after making changes to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/, eg.
#          root (hd0,0)
#          kernel /vmlinuz-version ro root=/dev/VolGroup00/LogVol00
#          initrd /initrd-version.img
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/grub/splash.xpm.gz
hiddenmenu

title Fedora Core (2.6.18.2)
        root (hd0,0)
        kernel /vmlinuz-2.6.18.2 ro root=/dev/VolGroup00/LogVol00
        initrd /initrd-2.6.18.2.img

title Fedora Core (2.6.18-1.2798.fc6)
        root (hd0,0)
        kernel /vmlinuz-2.6.18-1.2798.fc6 ro root=/dev/VolGroup00/LogVol00
        initrd /initrd-2.6.18-1.2798.fc6.img
```

Now reboot the system:

```
shutdown -r now
```

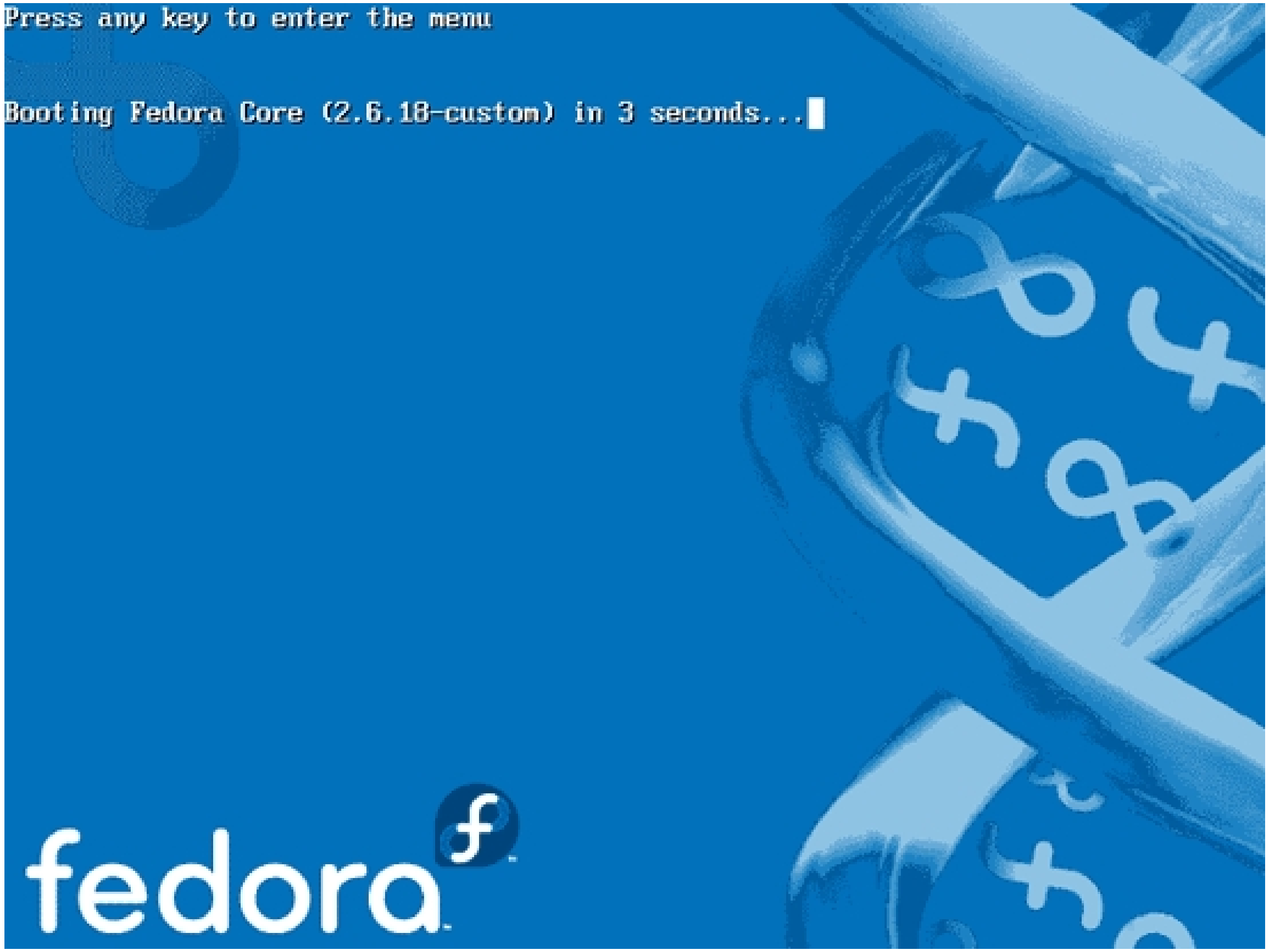
If everything goes well, it should come up with the new kernel. You can check if it's really using your new kernel by running

```
uname -r
```

This should display something like

```
2.6.18.2
```

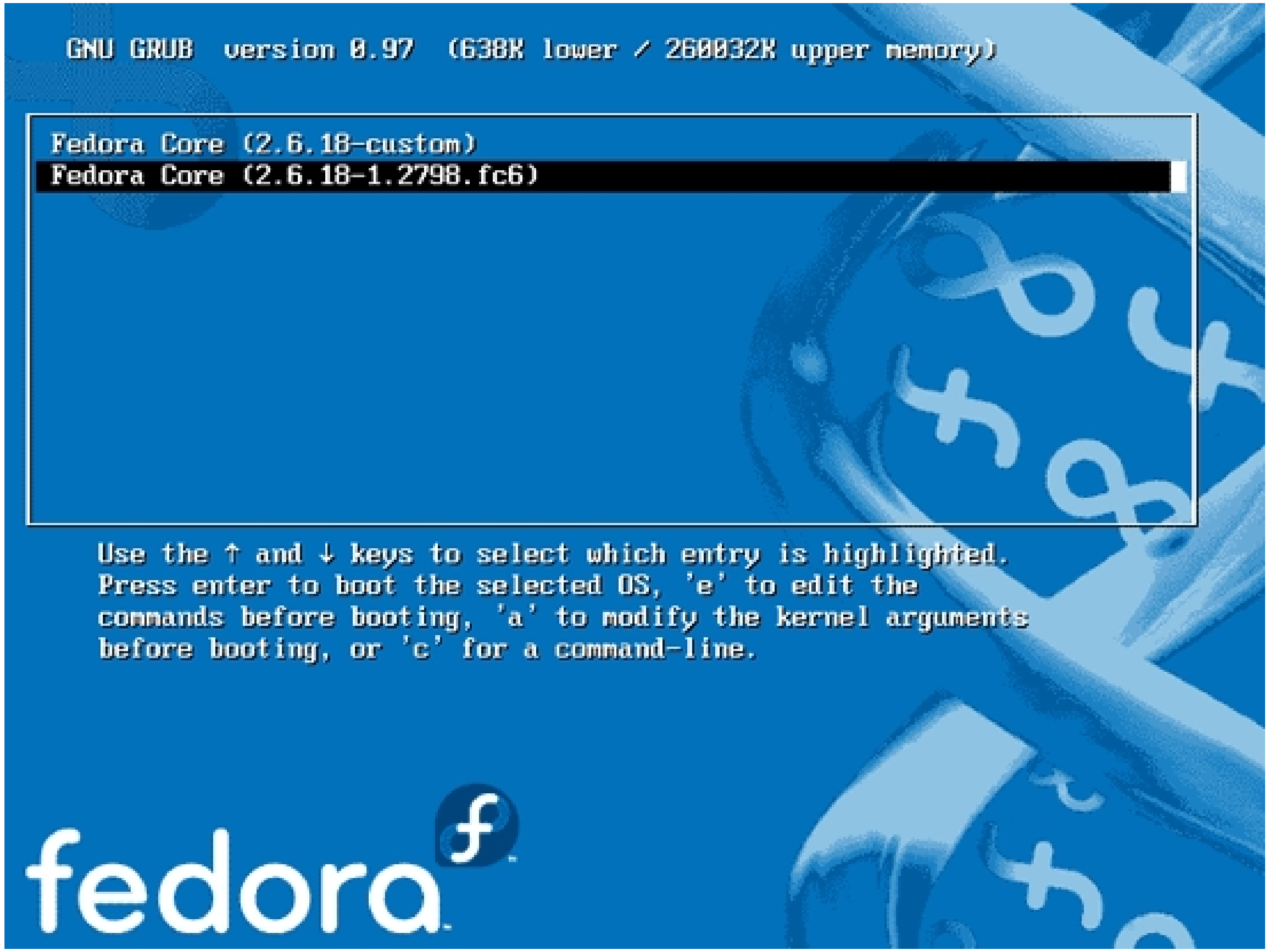
If the system doesn't start, restart it, and when you see this:



```
Press any key to enter the menu

Booting Fedora Core (2.6.18-custom) in 3 seconds...
```

press any key to enter the GRUB menu:



```
    GNU GRUB  version 0.97  (638K lower / 260032K upper memory)

 Fedora Core (2.6.18-custom)
 Fedora Core (2.6.18-1.2798.fc6)

      Use the ↑ and ↓ keys to select which entry is highlighted.
      Press enter to boot the selected OS, 'e' to edit the
      commands before booting, 'a' to modify the kernel arguments
      before booting, or 'c' for a command-line.
```

Select your old kernel and start the system. You can now try again to compile a working kernel. Don't forget to remove the stanza of the not-working kernel from `/boot/grub/menu.lst`.

4 Links

- Fedora: ***http://fedora.redhat.com***
- Fedora Wiki: ***http://fedoraproject.org/wiki***
- The Linux Kernel Archives: ***http://www.kernel.org***