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# Lab 6

Building Linux Kernel  
including Device Drivers

# Build kernel with new driver

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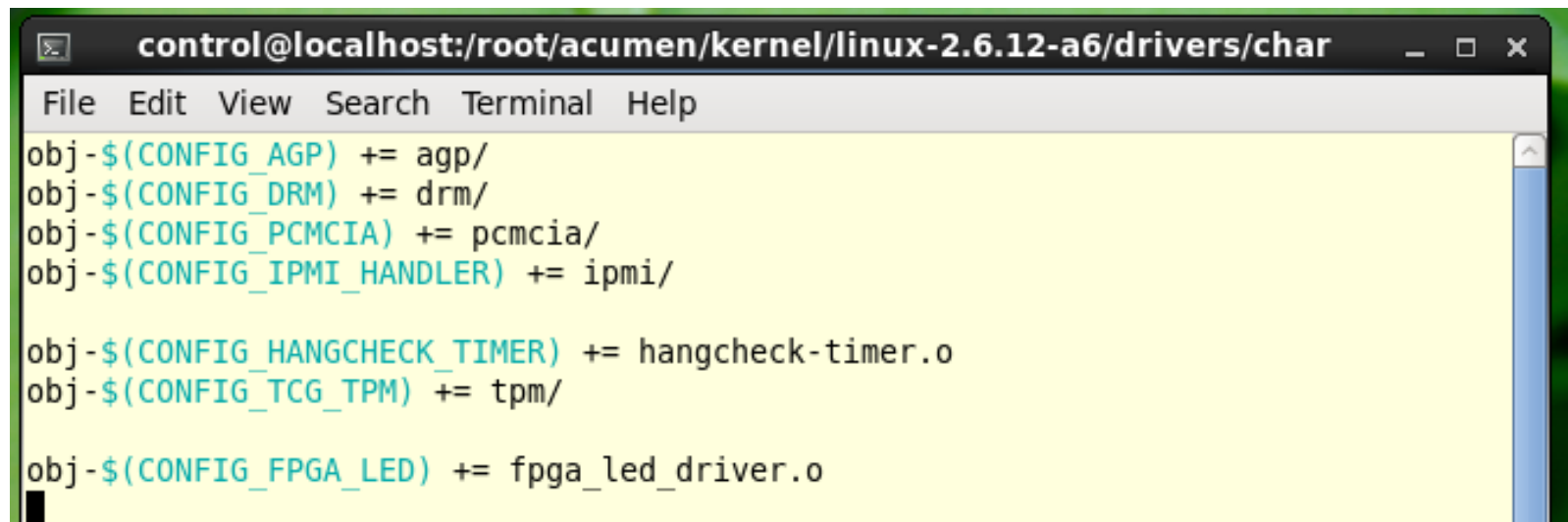
- Adding new driver code to linux kernel source code
- Edit Makefile
- Edit Kconfig file
- Select the driver before kernel build
- Build the linux kernel

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- Add new driver code to linux kernel source code
    - `cd /home/control/work/driver/fpga_led`
    - `cp ./fpga_led_driver.c /root/acumen/kernel/linux-2.6.12-a6/drivers/char`

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## ■ Edit Makefile

- `cd /root/acumen/kernel/linux-2.6.12-a6/drivers/char`
- `vi Makefile`
- `obj-$(CONFIG_FPGA_LED) += fpga_led_driver.o`



The screenshot shows a terminal window titled `control@localhost:/root/acumen/kernel/linux-2.6.12-a6/drivers/char`. The window contains a menu bar with `File Edit View Search Terminal Help`. The main content is a list of object files defined in a Makefile:

```
obj-$(CONFIG_AGP) += agp/  
obj-$(CONFIG_DRM) += drm/  
obj-$(CONFIG_PCMCIA) += pcmcia/  
obj-$(CONFIG_IPMI_HANDLER) += ipmi/  
  
obj-$(CONFIG_HANGCHECK_TIMER) += hangcheck-timer.o  
obj-$(CONFIG_TCG_TPM) += tpm/  
  
obj-$(CONFIG_FPGA_LED) += fpga_led_driver.o
```

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## ■ Edit Kconfig

- `cd /root/acumen/kernel/linux-2.6.12-a6/drivers/char`
- `vi Kconfig`
- `config FPGA_LED`
- `bool "FPGA_LED"`

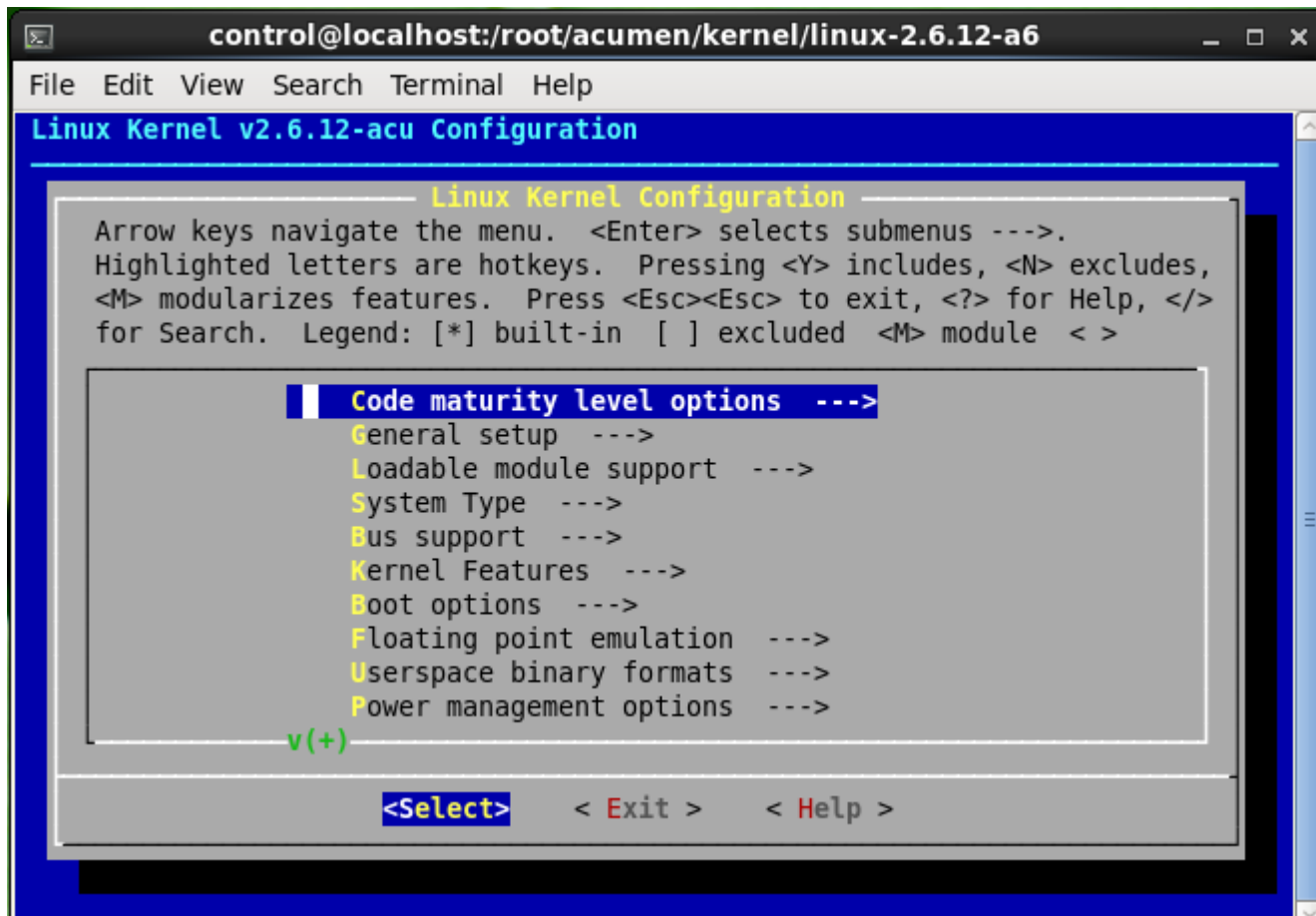
```
config MMTIMER
    tristate "MMTIMER Memory mapped RTC for SGI Altix"
    depends on IA64_GENERIC || IA64_SGI_SN2
    default y
    help
        The mmtimer device allows direct userspace access to the
        Altix system timer.

config FPGA_LED
    bool "FPGA_LED"

source "drivers/char/tpm/Kconfig"

endmenu
```

- Select the driver before kernel build
  - `cd /root/acumen/kernel/linux-2.6.12-a6`
  - `make menuconfig`



The screenshot shows a terminal window titled "control@localhost:/root/acumen/kernel/linux-2.6.12-a6". The terminal displays the "Linux Kernel v2.6.12-acu Configuration" menu. The menu is a text-based interface with a blue background and white text. The current selection is "Code maturity level options --->". The menu items are listed as follows:

```
Linux Kernel v2.6.12-acu Configuration

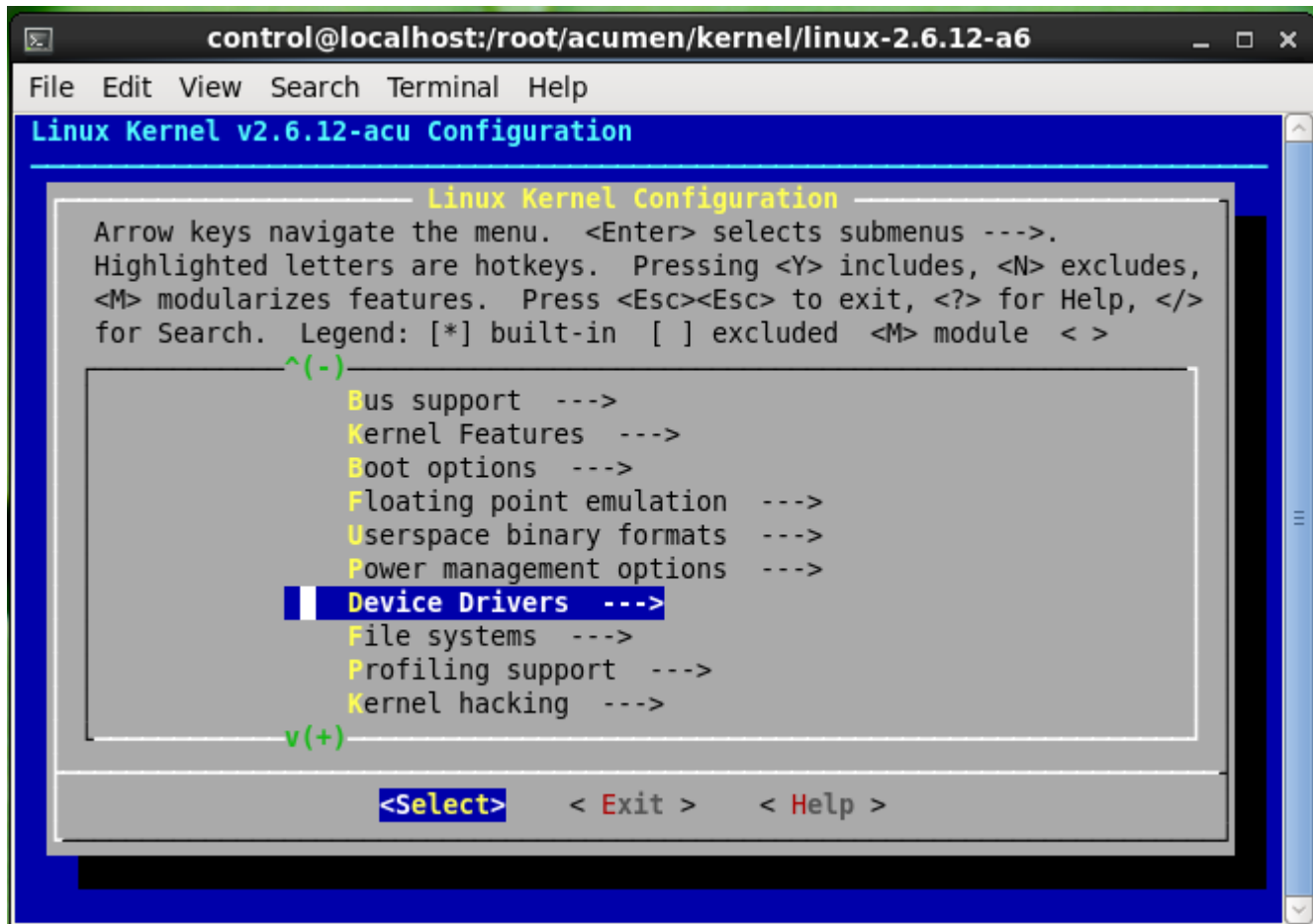
Linux Kernel Configuration

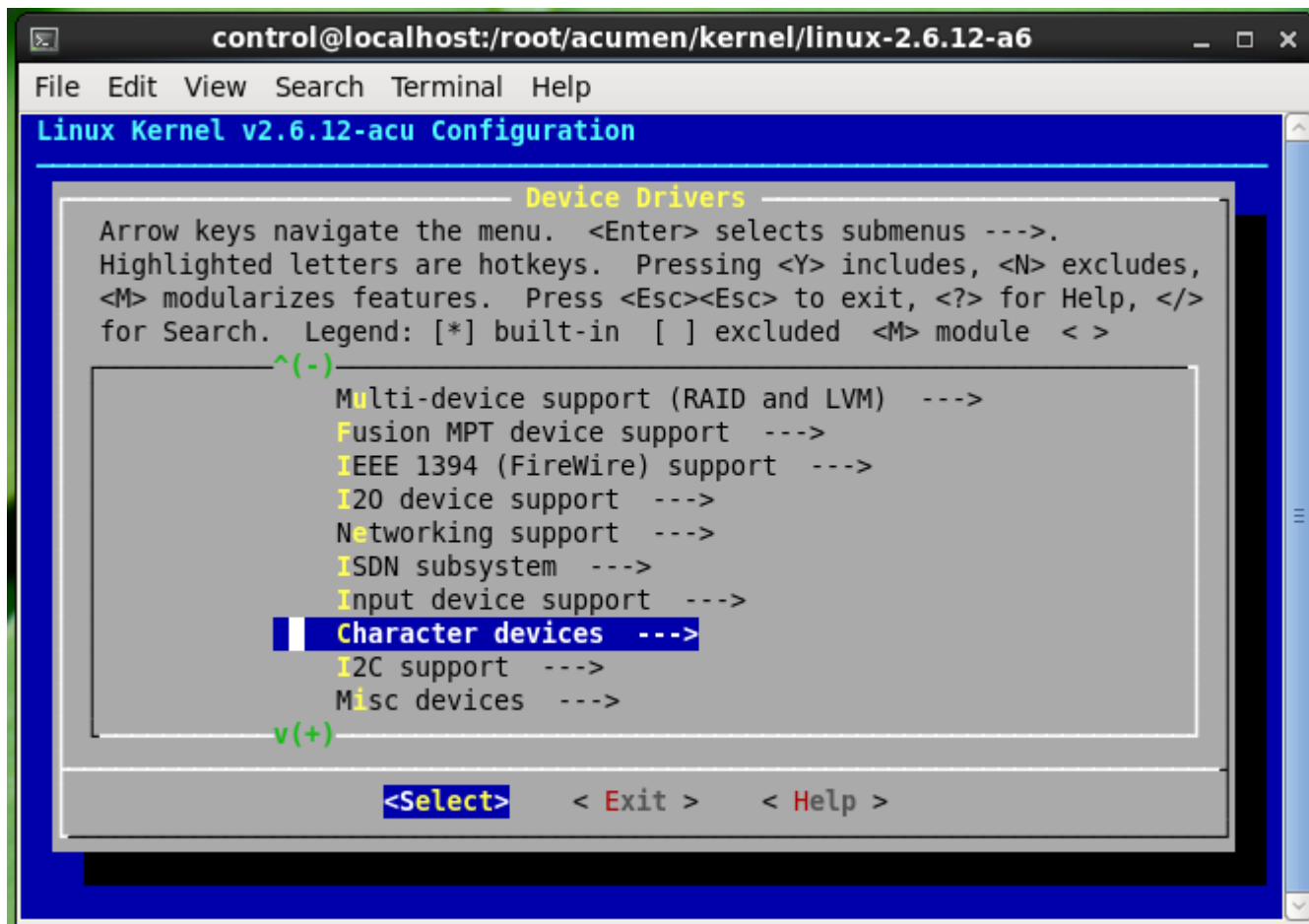
Arrow keys navigate the menu. <Enter> selects submenus --->.
Highlighted letters are hotkeys. Pressing <Y> includes, <N> excludes,
<M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </>
for Search. Legend: [*] built-in [ ] excluded <M> module < >

Code maturity level options --->
General setup --->
Loadable module support --->
System Type --->
Bus support --->
Kernel Features --->
Boot options --->
Floating point emulation --->
Userspace binary formats --->
Power management options --->

v(+)
```

At the bottom of the terminal, there are three options: "<Select>", "< Exit >", and "< Help >".



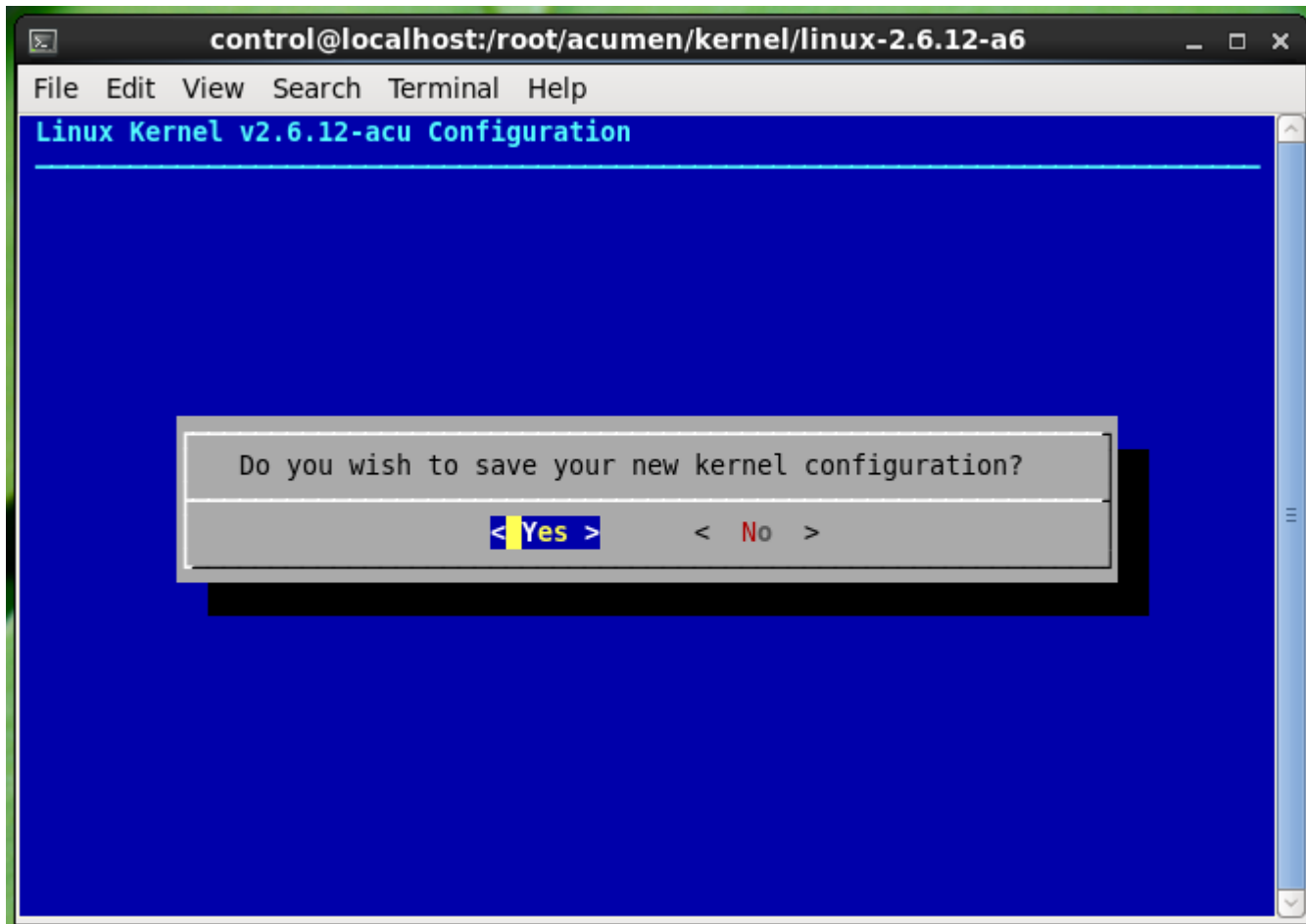




```
control@localhost:/root/acumen/kernel/linux-2.6.12-a6
File Edit View Search Terminal Help
Linux Kernel v2.6.12-acu Configuration


----- Character devices -----
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 < >
^(-)
< > /dev/nvram support
< > Enhanced Real Time Clock Support
< > Double Talk PC internal speech card support
< > Siemens R3964 line discipline
    Ftape, the floppy tape device driver --->
< > Direct Rendering Manager (XFree86 4.1.0 and higher DRI support)
    PCMCIA character devices --->
< > RAW driver (/dev/raw/rawN) (OBSOLETE)
[*] FPGA_LED
    TPM devices --->

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



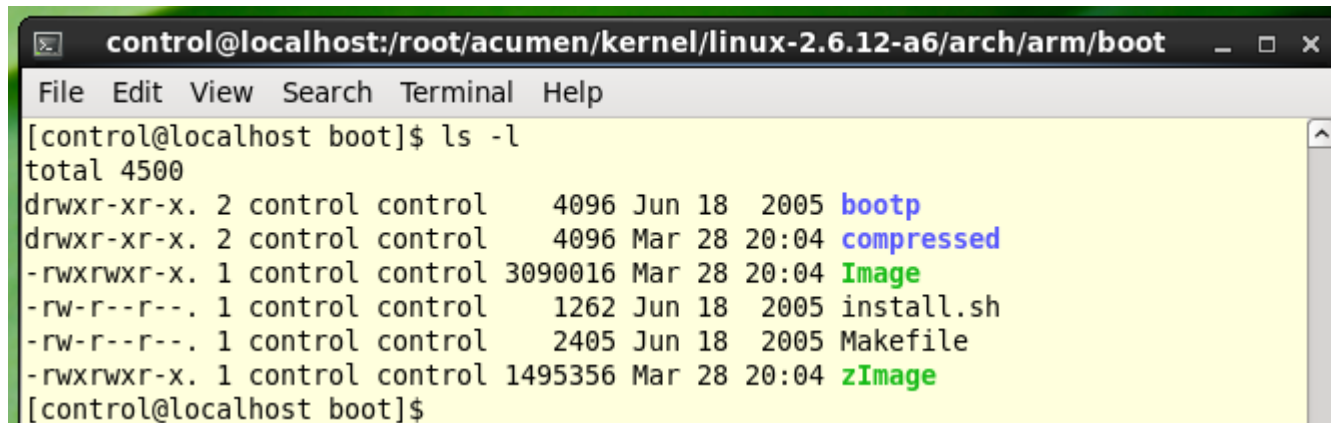
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- make zImage



```
control@localhost:/root/acumen/kernel/linux-2.6.12-a6
File Edit View Search Terminal Help
LD      drivers/char/built-in.o
LD      drivers/built-in.o
GEN     .version
CHK     include/linux/compile.h
UPD     include/linux/compile.h
CC      init/version.o
LD      init/built-in.o
LD      .tmp_vmlinux1
KSYM    .tmp_kallsyms1.S
AS      .tmp_kallsyms1.o
LD      .tmp_vmlinux2
KSYM    .tmp_kallsyms2.S
AS      .tmp_kallsyms2.o
LD      vmlinux
SYSMAP  System.map
SYSMAP  .tmp_System.map
OBJCOPY arch/arm/boot/Image
Kernel: arch/arm/boot/Image is ready
GZIP    arch/arm/boot/compressed/piggy.gz
AS      arch/arm/boot/compressed/piggy.o
LD      arch/arm/boot/compressed/vmlinux
OBJCOPY arch/arm/boot/zImage
Kernel: arch/arm/boot/zImage is ready
[control@localhost linux-2.6.12-a6]$
```

- 
- New kernel image location
  - /root/acumen/kernel/linux-2.6.12-a6/arch/arm/boot
  - `cp /root/acumen/kernel/linux-2.6.12-a6/arch/arm/boot/zImage /tftpboot`



```
control@localhost:/root/acumen/kernel/linux-2.6.12-a6/arch/arm/boot
File Edit View Search Terminal Help
[control@localhost boot]$ ls -l
total 4500
drwxr-xr-x. 2 control control 4096 Jun 18 2005 bootp
drwxr-xr-x. 2 control control 4096 Mar 28 20:04 compressed
-rwxrwxr-x. 1 control control 3090016 Mar 28 20:04 Image
-rw-r--r--. 1 control control 1262 Jun 18 2005 install.sh
-rw-r--r--. 1 control control 2405 Jun 18 2005 Makefile
-rwxrwxr-x. 1 control control 1495356 Mar 28 20:04 zImage
[control@localhost boot]$
```

# Building a root file system

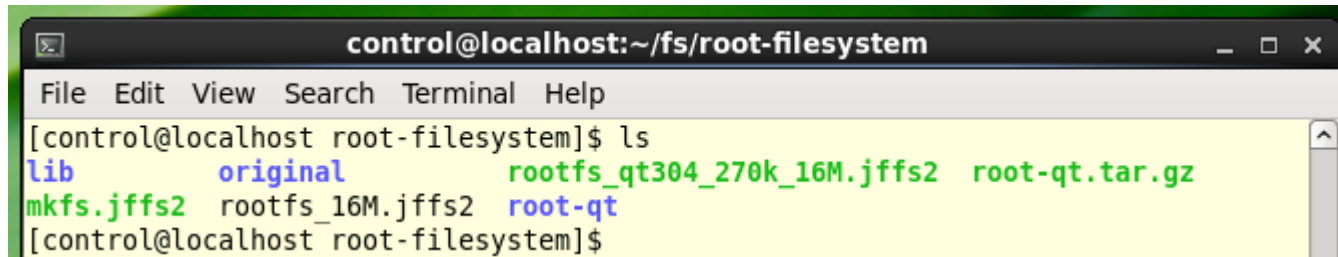
- Copy /dev/fpga\_led to host

```
COM1:115200baud - Tera Term VT
File Edit Setup Control Window Help

[root@Linux /root]#mount -t nfs 192.168.0.68:/nfsroot /mnt/nfs -o nolock -o rsize=1024
nfs warning: mount version older than kernel
[root@Linux /root]#cd /mnt/nfs
[root@Linux nfs]#cp /dev/fpga_led .
[root@Linux nfs]#ls
ButtonTest          fnd-app            fpga_led_driver.ko
CounterTest        fpga_clcd_driver.ko  int0-app
a.out              fpga_fnd_driver.ko  led-app
archive            fpga_int0_driver.ko test.c
clcd-app           fpga_led           test.c~
[root@Linux nfs]#
```

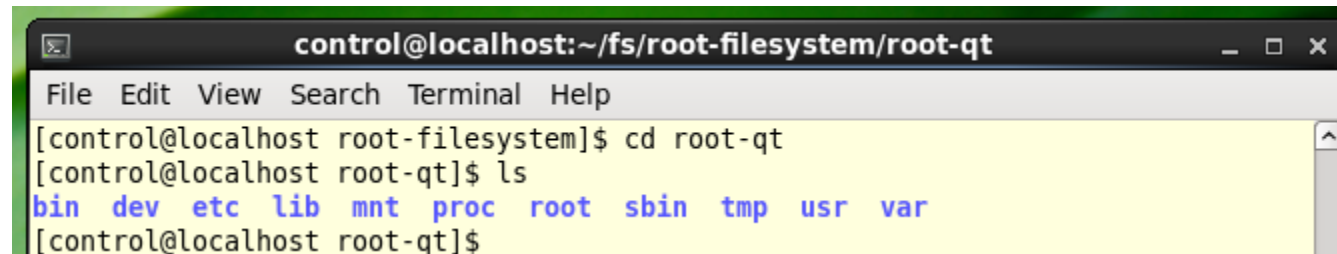
# Building a root file system

- `cd /home/control/fs/root-filesystem`



```
control@localhost:~/fs/root-filesystem
File Edit View Search Terminal Help
[control@localhost root-filesystem]$ ls
lib          original      rootfs_qt304_270k_16M.jffs2  root-qt.tar.gz
mkfs.jffs2   rootfs_16M.jffs2  root-qt
[control@localhost root-filesystem]$
```

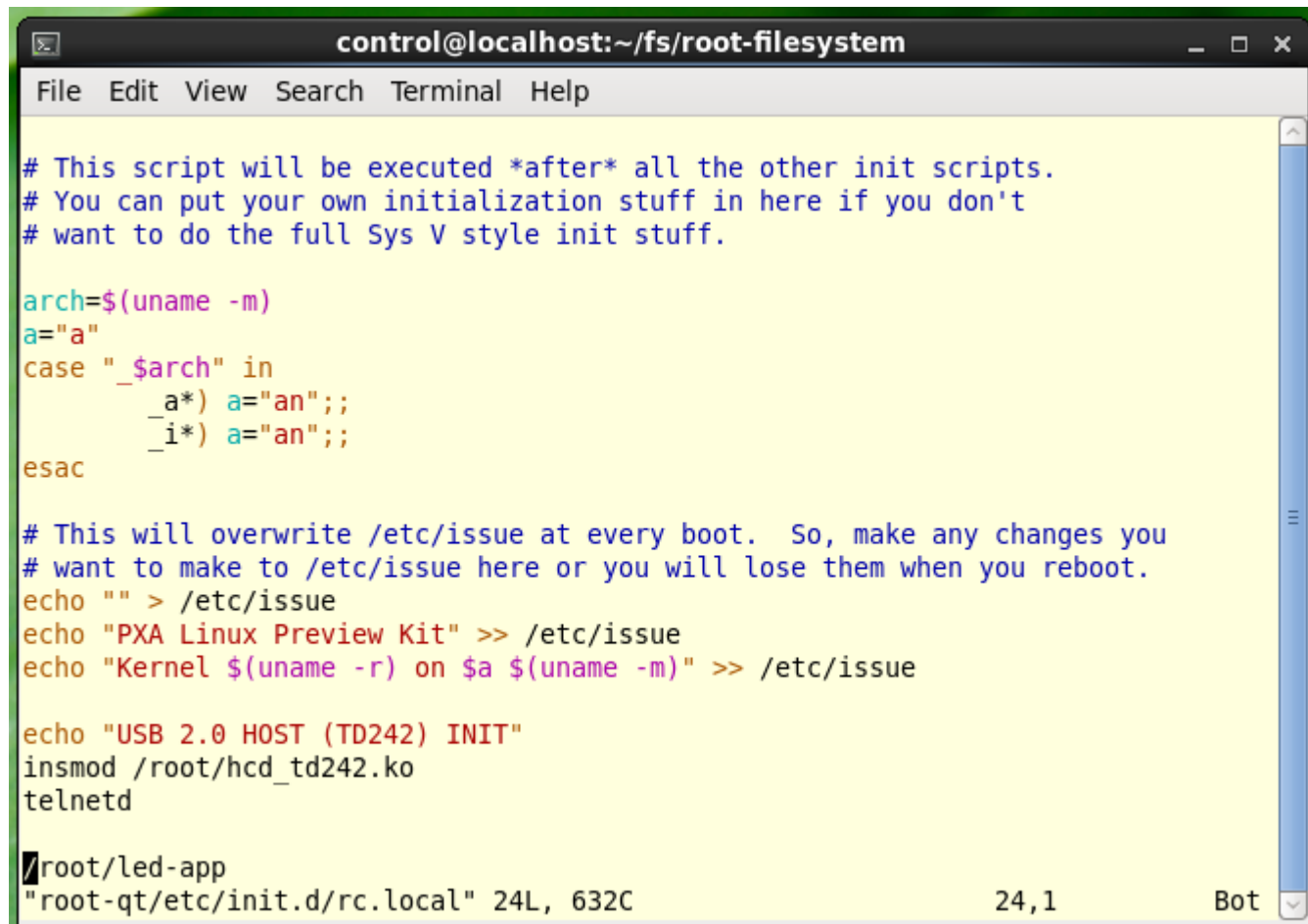
- `mv /nfsroot/fpga_led root-qt/dev`
- `cp /home/control/work/driver/fpga_led/led-app root-qt/root`



```
control@localhost:~/fs/root-filesystem/root-qt
File Edit View Search Terminal Help
[control@localhost root-filesystem]$ cd root-qt
[control@localhost root-qt]$ ls
bin dev etc lib mnt proc root sbin tmp usr var
[control@localhost root-qt]$
```

# Building a root file system

- vi root-qt/etc/init.d/rc.local
- add **/root/led-app** at the end of rc.local



```
control@localhost:~/fs/root-filesystem
File Edit View Search Terminal Help

# This script will be executed *after* all the other init scripts.
# You can put your own initialization stuff in here if you don't
# want to do the full Sys V style init stuff.

arch=$(uname -m)
a="a"
case "$arch" in
  _a*) a="an";;
  _i*) a="an";;
esac

# This will overwrite /etc/issue at every boot.  So, make any changes you
# want to make to /etc/issue here or you will lose them when you reboot.
echo "" > /etc/issue
echo "PXA Linux Preview Kit" >> /etc/issue
echo "Kernel $(uname -r) on $a $(uname -m)" >> /etc/issue

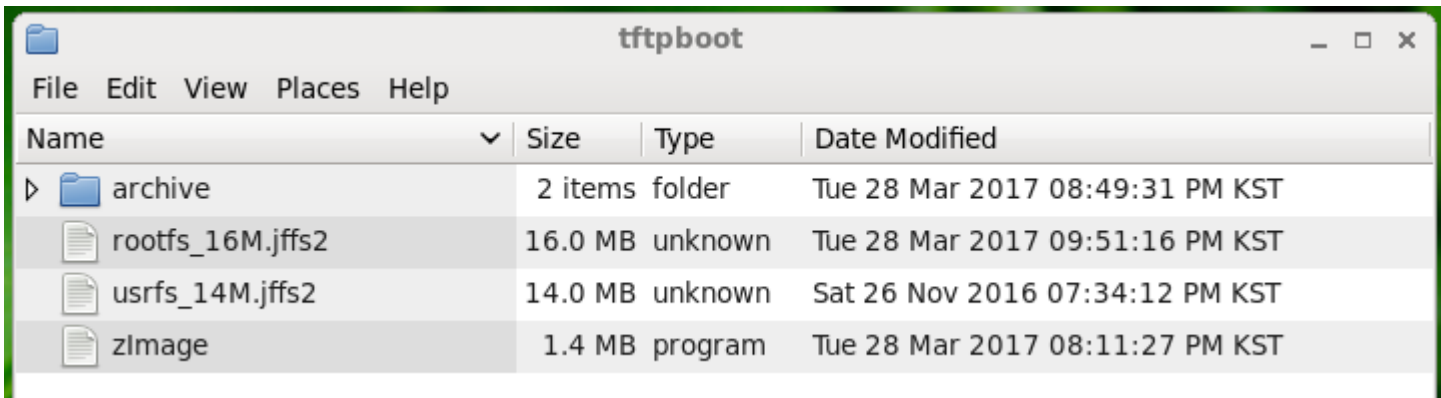
echo "USB 2.0 HOST (TD242) INIT"
insmod /root/hcd_td242.ko
telnetd

root/led-app
"root-qt/etc/init.d/rc.local" 24L, 632C 24,1 Bot
```

# Building a root file system

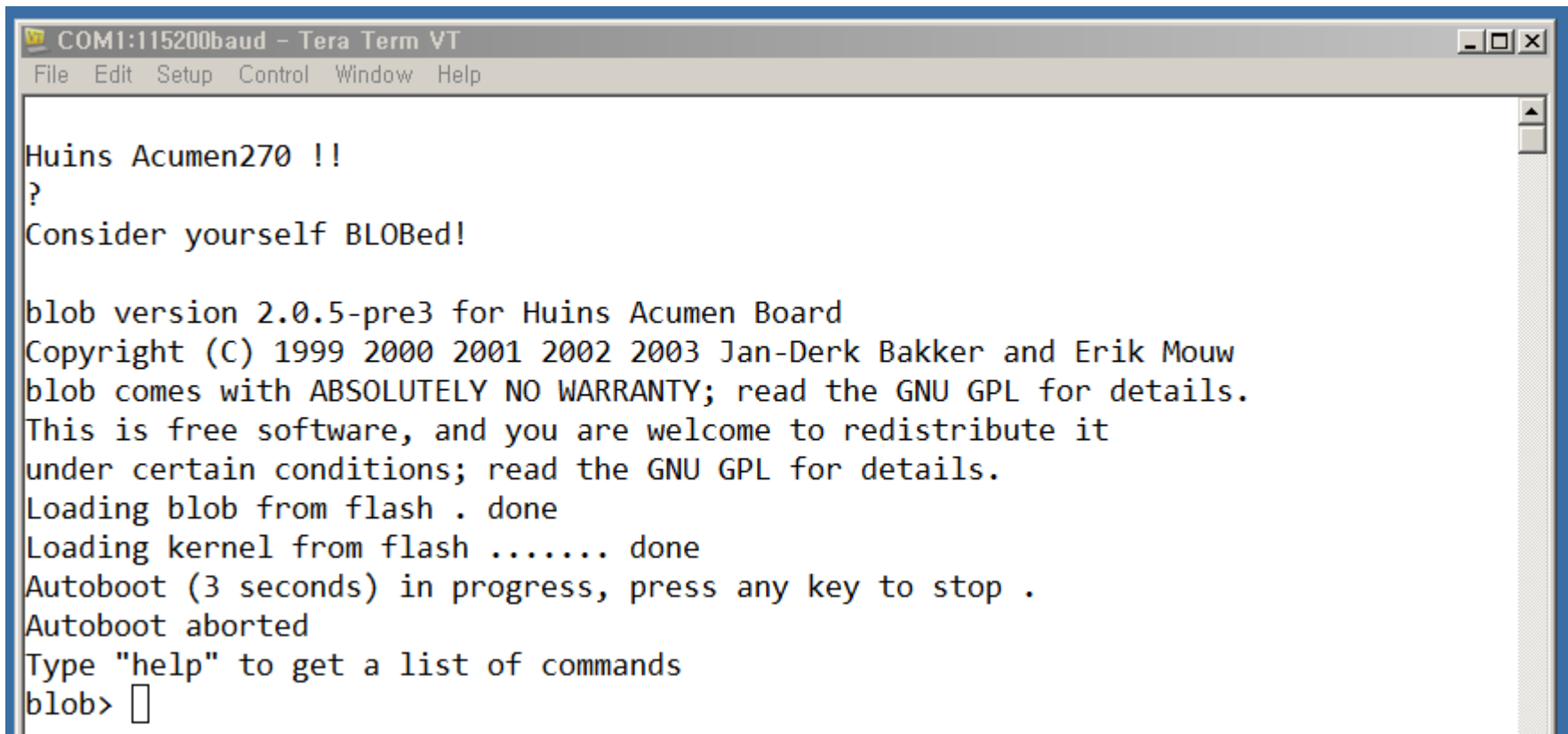
---

- `./mkfs.jffs2 -r root-qt -o rootfs_16M.jffs2 --eraseblock=0x40000 --pad=0x1000000`
- `cp rootfs_16M.jffs2 /tftpboot`





- Press any key within 3 seconds

A screenshot of a terminal window titled "COM1:115200baud - Tera Term VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The terminal output shows the following text:

```
Huins Acumen270 !!  
?  
Consider yourself BLOBed!  
  
blob version 2.0.5-pre3 for Huins Acumen Board  
Copyright (C) 1999 2000 2001 2002 2003 Jan-Derk Bakker and Erik Mouw  
blob comes with ABSOLUTELY NO WARRANTY; read the GNU GPL for details.  
This is free software, and you are welcome to redistribute it  
under certain conditions; read the GNU GPL for details.  
Loading blob from flash . done  
Loading kernel from flash ..... done  
Autoboot (3 seconds) in progress, press any key to stop .  
Autoboot aborted  
Type "help" to get a list of commands  
blob> █
```

# blob: flash write

---

- tftp zImage
- fwrite 0xa1000000 0x40000 0x200000
  
- tftp rootfs\_16M.jffs2
- fwrite 0xa1000000 0x200000 0x1000000
  
- tftp usrfs\_14M.jffs2
- fwrite 0xa1000000 0x1200000 0xe00000

```
COM1:115200baud - Tera Term VT
File Edit Setup Control Window Help
blob> tftp zImage
TFTPing zImage*.....
..... OK.
received 2922 blocks (1495356 bytes)
tftp_cmd: file 'zImage' loaded via tftp to address 0xa1000000.
blob> fwrite 0xa1000000 0x40000 0x200000
Erasing 8 blocks at 0x00040000:.....done
Flashing 0x00200000 bytes at 0x00040000:.....done
blob>
```





# Exercise

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- Embedded linux가 booting 되었을 때, fpga\_led device를 사용하는 led-app가 자동으로 실행되는 것을 확인.