Operating System Practice– Lab 1: Developing Embedded Systems

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Preparation

Notices

- No food, no drink
- The evaluation boards are quite expensive
- Do not do anything else to crash the PC
- Do not update the OS nor tools to keep the consistency
- Remember the number of your evaluation board
  - Check the items before you use them
  - Check the items before you return them
- No rubbish

What are We Going to Do?

- Build Cross Development Toolchain
- Build Linux Kernel

  ➔Check Point 1: uImage
- Setup tftp Server
- Setup NFS Server

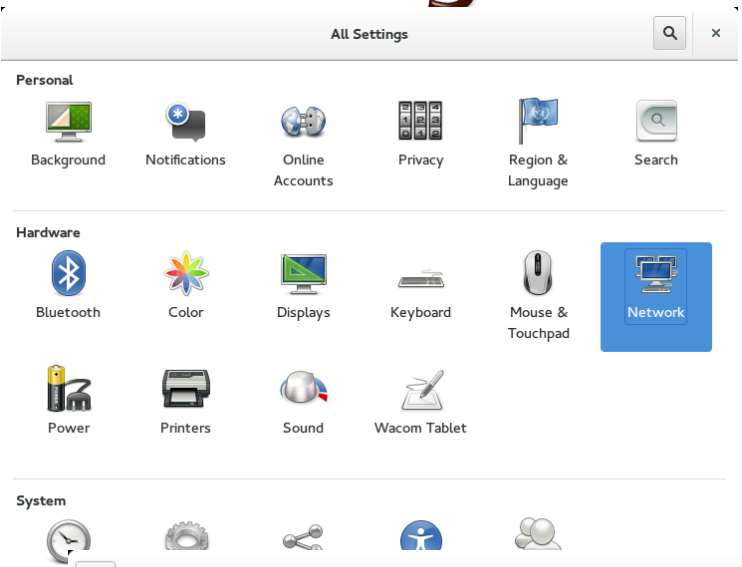
  ➔Check Point 2: Test the Services
- Setup Target Board
- Download Linux Kernel

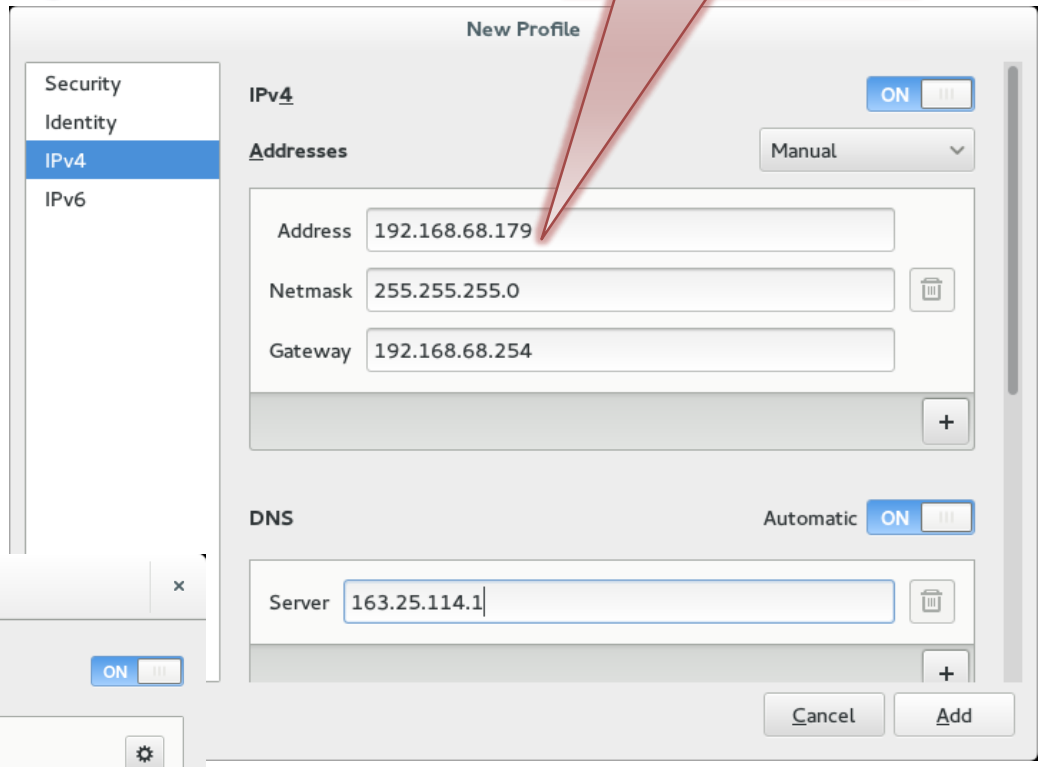
  ➔Check Point 3: Try the Linux Kernel

Fedora Linux

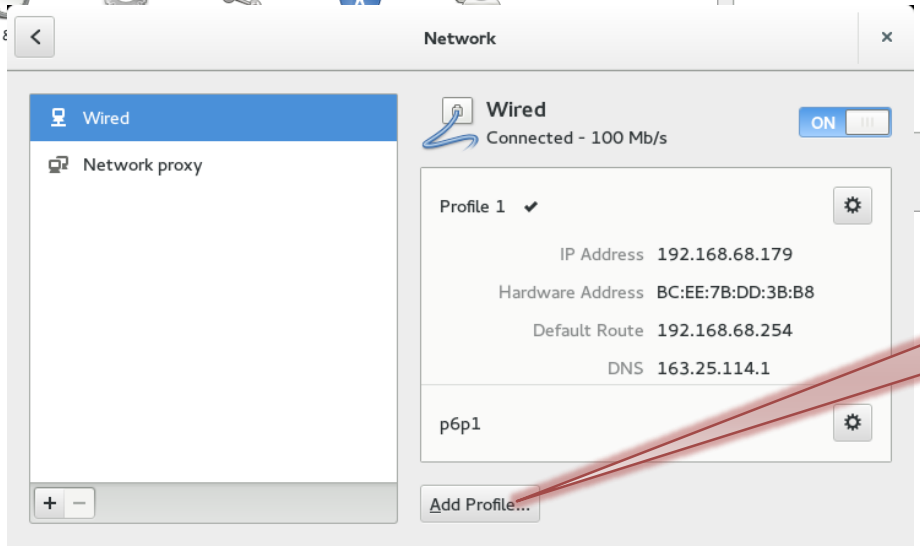
- The Fedora Project was created in late 2003
- We are using the version 38
- Package manager: RPM
- Update method: Yum
  - Password: csie123456
  - Select the language: Taiwan
  - WindowsKey+Space to change the input language
  - Ativeties ➔ Search: terminal ➔ to get the terminal
    - Edit →Profile Preferences → Colors →Uncheck “use colors from system theme”
  - Click the icon at the right-top corner for network setting

Setting Network





Your IP



Add Profile

vi— A Screen-Oriented Text Editor

- vi is widely supported by Unix-like operating system
- Normal mode
  - Move, search, copy, paste, delete,…
  - Press i, I, a, A, o, O,… to change to the insert mode
  - Press : for the command mode
- Command mode
  - Save, quit, load, split,…
  - After enter the command, it will be back to the normal mode
- Insert mode
  - Move and input anything
  - Press ESC to go back to the normal mode

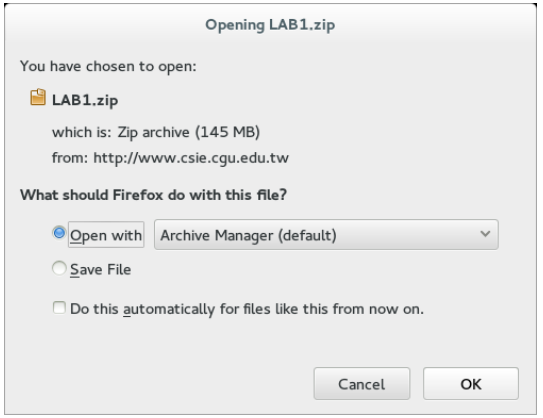
vi Commands

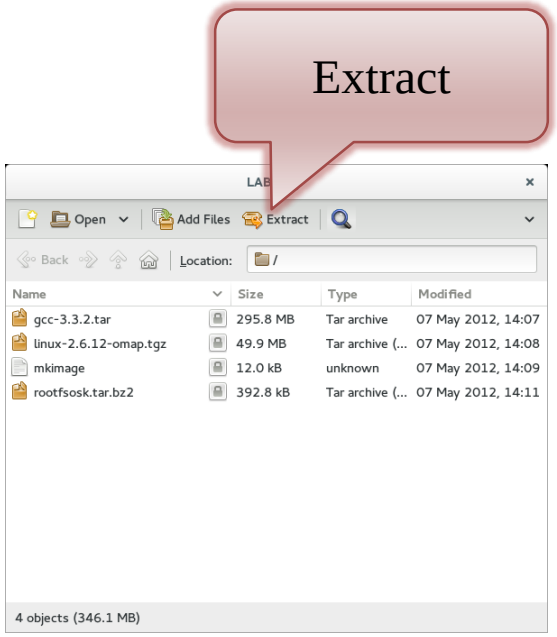
- Press ‘i’ to get the insert mode
- Key-in anything
- Press ‘ESC’ to go back the normal mode
- Press ‘:→w→q→ENTER” to save and quit
- Please search for some tutorial of vi and study by yourself

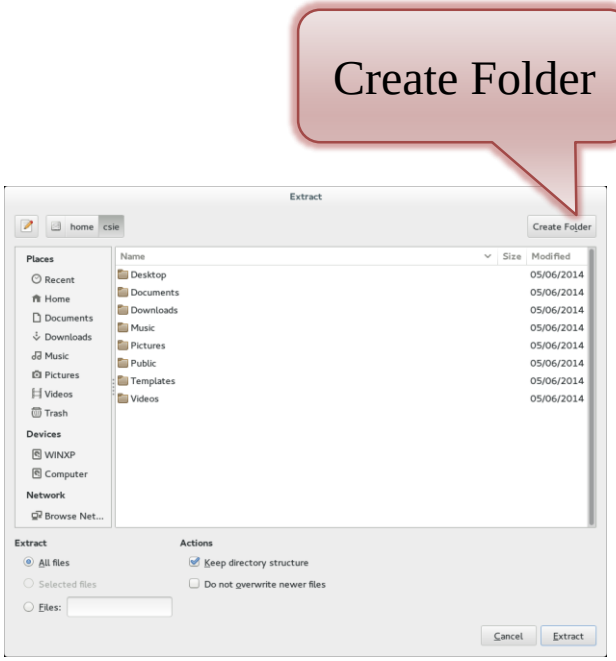
Lab1: Build the Linux Kernel for TI OMAP 5912

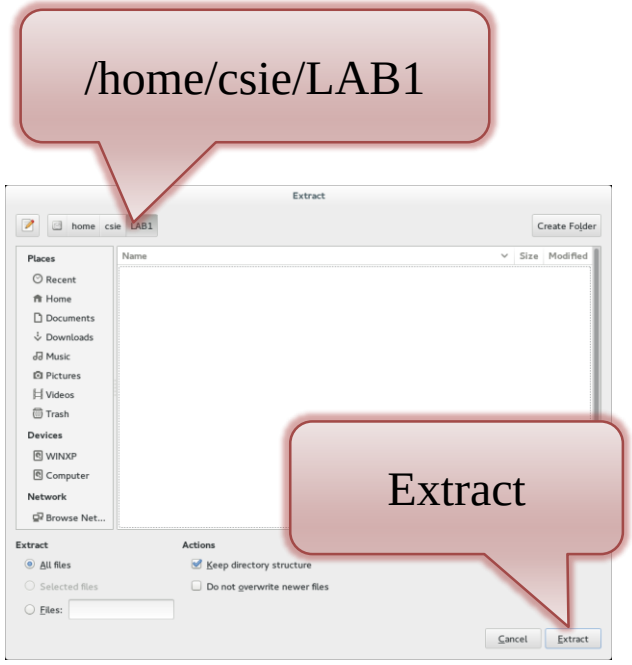
Download Files

- Download the tools from the course website and extract the files









Download Files

- You will need the following files
  - linux-2.6.12-omap.tgz ➔ the kernel source code
  - gcc-3.3.2.tar ➔ some gcc extension for this lab
  - mkimage ➔ some script which is used when compiling kernel
  - rootfsosk.tar.bz2 ➔ the content of the root filesystem
- You need the root privilege for the following actions
  - *sudo passwd root*
  - *su* (the password is root123456) ➔ change to root
  - *cd /home/csie/LAB1*
  - *cp linux-2.6.12-omap.tgz /opt/linux-2.6.12-omap.tgz*
  - *cp gcc-3.3.2.tar /opt/gcc-3.3.2.tar*
  - *chmod +x mkimage*
  - *cd /opt*
  - *tar xvf gcc-3.3.2.tar*
  - *tar zxvf linux-2.6.12-omap.tgz*
  - *cp /home/csie/LAB1/mkimage /opt/usr/local/arm/3.3.2/bin/mkimage*

Prepare the Compiling Environment

- Set Path
  - *export PATH=$PATH:/opt/usr/local/arm/3.3.2/bin* ➔ for every terminal session, before you compile the kernel
  - *export LANG=en*
- Install Tools
  - *yum -y install gcc* ➔ compiler tools
  - *yum -y install glibc.i686* ➔ library for 32bit Linux kernel
  - *yum -y install minicom* ➔ minicom is the utility for the serial port connection

Build the Linux Kernel

- Go to the kernel source directory (be the root)
  - *cd /opt/linux-2.6.12*
- Set the kernel configuration
  - *make omap_osk_5912_defconfig*
- Compile the kernel
  - *make uImage*
- Prepare the root filesystem
  - *cp /home/csie/LAB1/rootfsosk.tar.bz2 /tmp/rootfsosk.tar.bz2*
  - *cd /tmp*
  - *tar jxvf rootfsosk.tar.bz2*

Check Point 1

- Now, you should have the compiled kernel
- The kernel image is at:
  /opt/linux-2.6.12/arch/arm/boot/uImage
- The root filesystem for the evaluation board is at:
  /tmp/roorfs2.6

Set the Network Services (1/2)

- Disable the Firewall (it is not a good idea, only for this lab exercise)
  - *systemctl stop firewalld*
  - *systemctl disable firewalld*
- Set the TFTP Service
  - ~~*yum -y install tftp-server tftp*~~ ➔ ~~tftp is used to download kernel image~~
  - ~~*vi /etc/xinetd.d/tftp*~~
    - ~~Find disable = yes~~
    - ~~Change it to disable = no~~
  - ~~*systemctl start tftp.socket*~~
  - ~~*systemctl enable tftp.socket*~~
  - *dnf install tftp-server tftp -y*
  - *cp /usr/lib/systemd/system/tftp.service /etc/systemd/system/tftp-server.service*
  - *cp /usr/lib/systemd/system/tftp.socket /etc/systemd/system/tftp-server.socket*
  - *vi /etc/systemd/system/tftp-server.service*

```
[Unit]
Description=Tftp Server
Requires=tftp-server.socket
Documentation=man:in.tftpd

[Service]
ExecStart=/usr/sbin/in.tftpd -c -p -s /var/lib/tftpboot
StandardInput=socket

[Install]
WantedBy=multi-user.target
Also=tftp-server.socket
```

  - *systemctl daemon-reload*
  - *systemctl enable --now tftp-server*
  - *chmod 777 /var/lib/tftpboot*

Set the Network Services (2/2)

- Set the NFS Service
  - *yum -y install nfs-utils* ➔ nfs for the root filesystem
  - *vi /etc/exports*
    - Add the line /tmp/rootfs2.6 *(rw,fsid=1,no_root_squash)
  - *exportfs -rv*
  - *systemctl start rpcbind.service*
  - *systemctl start nfs-mountd.service*

Test the Network Services

- You need a friend for the following test
  - One be the server and the other be the client
  - Switch the roles and do it again
- Test TFTP
  - Server side:
    - *vi /var/lib/tftpboot/testfile* ➔ and then key something
  - Client side:
    - *tftp 192.168.68.xxx* (xxx is for the server IP)
    - *get testfile*
    - *quit*
    - *cat testfile*
- Test NFS
  - Server side:
  - Client side:
    - *mkdir /home/csie/nfstest*
    - *mount -t nfs 192.168.68.xxx:/tmp/rootfs2.6 /home/csie/nfstest*
    - *cd /home/csie/nfstest*
    - *ls*
    - *cd /*
    - *umount /home/csie/nfstest*

Check Point 2

- Now, you have enabled the TFTP and NFS services on your PC
- TFTP and NFS are properly working now

Set the Minicom (1 / 3)

- Enter the setting menu
  - *minicom –s*

```
+-----[configuration]------+
| Filenames and paths      |
| File transfer protocols  |
| Serial port setup        |
| Modem and dialing        |
| Screen and keyboard      |
| Save setup as dfl        |
| Save setup as..          |
| Exit                     |
| Exit from Minicom        |
+--------------------------+
```

- Serial port setup ➔ press the letter to change it

```
+-----------------------------------------------------------------------+
| A -    Serial Device      : /dev/ttyS0                                |
|                                                                       |
| C -    Callin Program     :                                           |
| D -   Callout Program     :                                           |
| E -    Bps/Par/Bits       : 115200 8N1                                |
| F - Hardware Flow Control : No                                        |
| G - Software Flow Control : No                                        |
|                                                                       |
|    Change which setting?                                              |
+-----------------------------------------------------------------------+
```


Set the Minicom (2/3)

- Modem and dialing

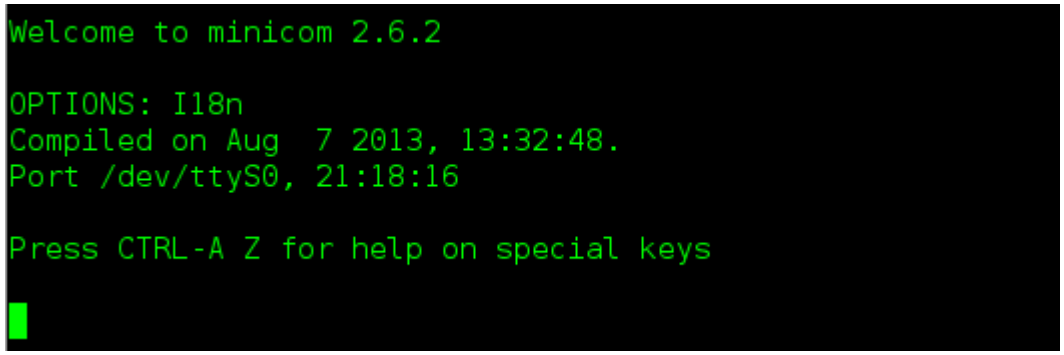
```
+-----[configuration]------+
| Filenames and paths      |
| File transfer protocols  |
| Serial port setup        |
| Modem and dialing        |
| Screen and keyboard      |
| Save setup as dfl        |
| Save setup as..          |
| Exit                     |
| Exit from Minicom        |
+--------------------------+
```

```
+--------------------[Modem and dialing parameter setup]---------------------+
|                                                                             |
| A - Init string .........                                                   |
| B - Reset string ........                                                   |
| C - Dialing prefix #1....                                                   |
| D - Dialing suffix #1....                                                   |
| E - Dialing prefix #2.... ATDP                                              |
| F - Dialing suffix #2.... ^M                                                |
| G - Dialing prefix #3.... ATX1DT                                            |
| H - Dialing suffix #3.... ;X4D^M                                            |
| I - Connect string ...... CONNECT                                           |
| J - No connect strings .. NO CARRIER          BUSY                          |
|                           NO DIALTONE         VOICE                         |
| K - Hang-up string ...... ~~+++~~ATH^M                                      |
| L - Dial cancel string .. ^M                                                |
|                                                                             |
| M - Dial time ........... 45      Q - Auto bps detect ..... No              |
| N - Delay before redial . 2       R - Modem has DCD line .. Yes             |
| O - Number of tries ..... 10      S - Status line shows ... DTE speed       |
| P - DTR drop time (0=no). 1       T - Multi-line untag .... No              |
|                                                                             |
| Change which setting?    Return or Esc to exit. Edit A+B to get defaults.   |
+-----------------------------------------------------------------------------+
```


Set the Minicom (3/3)

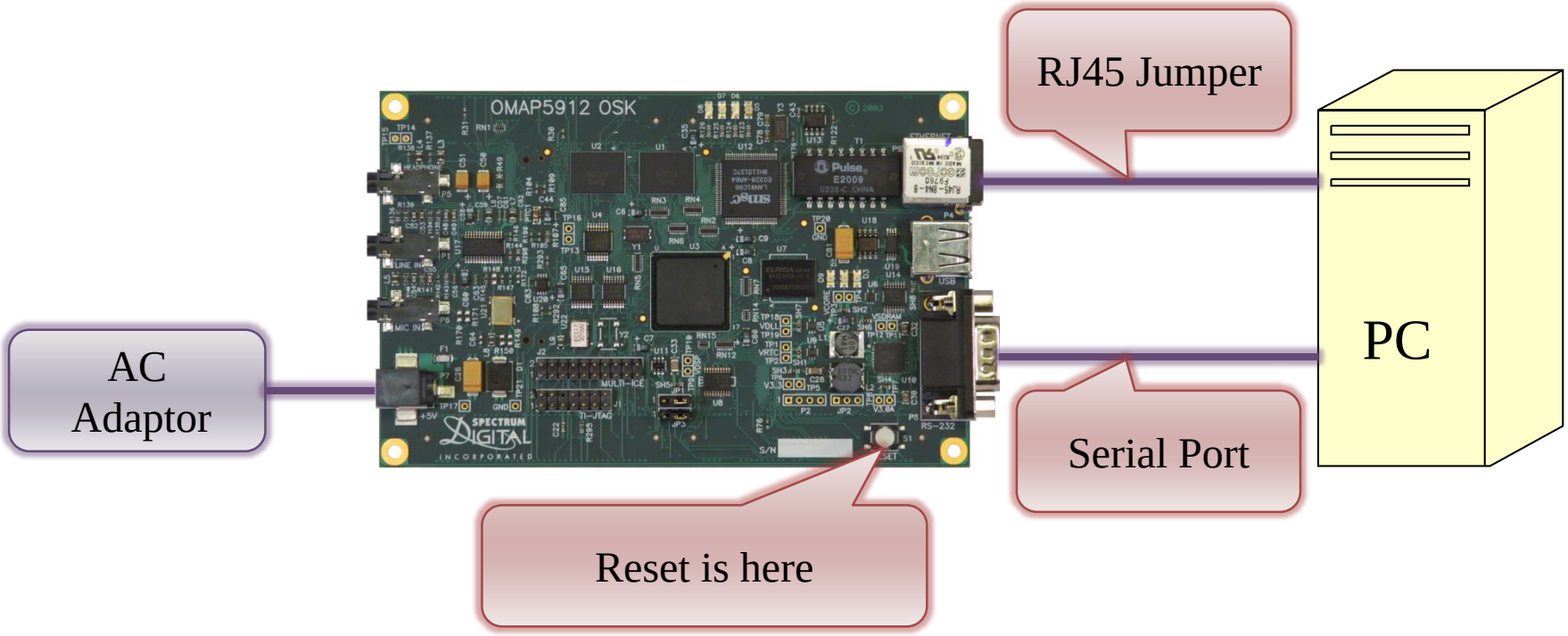
- Save and leave the setting interface

- Start and quit minicom
  - Start *minicom*
  - Quit *CTRL+A ➔ Q*



Prepare for the Booting

- Copy the boot image for TFTP booting
  - *cp /opt/linux-2.6.12/arch/arm/boot/uImage /var/lib/tftpboot/uImage*
- Set the evaluation board as follows



Boot the Evaluation Board

- Start mimicom
  - *minicom*
- Press the reset button on the board
  - After the reset, immediately press any key on minicom terminal
  - You will get the following prompt

```
OMAP5912 OSK #
```


Download the New Kernel

- Set the boot configuration
  - *set ipaddr 192.168.68.yy* (evaluation board IP)
  - *set serverip 192.168.68.zz* (PC IP)
  - *set netmask 255.255.255.0*
  - *set gatewayip 192.168.68.254*
  - *set ethaddr 00-0e-99-xx-xx-xx*
  - *set bootargs console=ttyS0,115200n8 rw ip=192.168.68.yy root=/dev/nfs nfsroot=192.168.68.zz:/tmp/rootfs2.6,v3*
  - *printenv* ➔ double check the setting

```
OMAP5912 OSK # printenv
bootdelay=3
baudrate=115200
bootfile="uImage"
bootcmd=bootm 0x100000
ipaddr=192.168.68.123
serverip=192.168.68.186
netmask=255.255.255.0
gatewayip=192.168.68.254
ethaddr=00-0e-99-02-0d-0b
stdin=serial
stdout=serial
stderr=serial
bootargs=console=ttyS0,115200n8 rw ip=192.168.68.123 root=/dev/nfs nfsroot=192.168.68.186:/tmp/rootfs2.6,v3

Environment size: 337/131068 bytes
OMAP5912 OSK #
```

  - *saveenv* ➔ if everything is correct ➔ be careful, do not crash the entire system

Boot the New Kernel and Mount the NFS Root Filesystem

- Download the kernel: *tftpboot 0x10000000 uImage*

```
OMAP5912 OSK # tftpboot 0x10000000 uImage
TFTP from server 192.168.68.186; our IP address is 192.168.68.123
Filename 'uImage'.
Load address: 0x10000000
Loading: #################################################################
         #################################################################
         #################################################################
         ######################
done
Bytes transferred = 1110712 (10f2b8 hex)
OMAP5912 OSK #
```

- Boot the OS: *bootm 0x10000000*

```
Looking up port of RPC 100003/3 on 192.168.68.186
Looking up port of RPC 100005/3 on 192.168.68.186
VFS: Mounted root (nfs filesystem).
Freeing init memory: 112K
init started:  BusyBox v1.00-pre8 (2004.03.05-22:18+0000) multi-call binary

*******************************************
Starting System Init for OMAP5912OSK
*******************************************

Please press Enter to activate this console.
```


Done!

Or Bugs!?

Common Mistakes

- *su* and *export* should be used whenever a new terminal is created
  - If you extract the root file system by the user csie, there will be an error when you boot the board to mount the NFS root file system
    - Reboot the computer and do everything again
  - If you do not export the path of the tools, you will get some error when you compile the kernel module
- Please read the error message if you type something wrong
- UART: it should be connected to the bottom port
- Ethernet: do check the IP is correct
- Some evaluation boards were tested to be good: 1(no usb cable), 7, 9, 10, 11, 15, 19, 20

Grading this Exercise

- Attend and understand this exercise: 10%
- Check point 1: 10%
- Check point 2: 10%
- Final results: 20%
- Report before the exercise: 25%
- Report after the exercise: 25%

Report Requirements

- Report before the exercise:
  - Only two pages, 12-pt font size
  - Deadline is 20:00, 2023/05/17
  - File name: OSP-Lab1-Study-StudentID
  - File type: PDF or Word
  - Upload to the e-learning system
- Report after the exercise:
  - Only two pages, 12-pt font size
  - Deadline is 20:00, 2023/05/26
  - File name: OSP-Lab1-Report-GroupID
  - File type: PDF or Word
  - Upload to the e-learning system
  - Remember to list all student IDs of your group