

同济大学计算机系  
计算机系统实验报告



实验二题目：pmon 引导文件编译和改造

学号： 2154312

姓名： 郑博远

指导教师： 秦国锋

日期： 2024 年 5 月 10 日

## 一、 实验环境

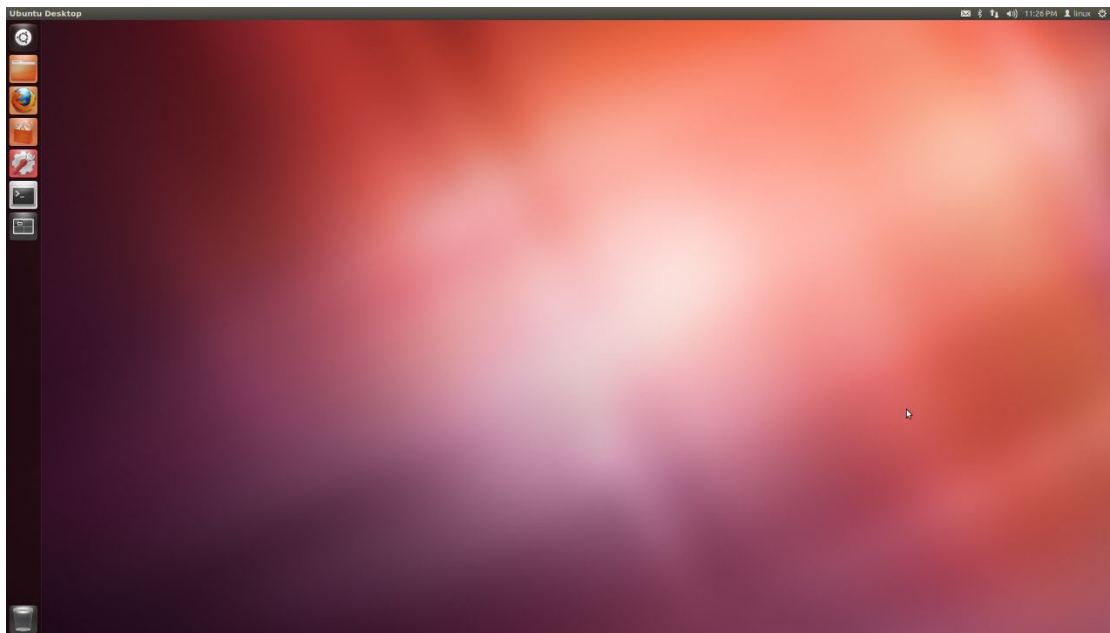
虚拟机	VMware® Workstation 17
Linux 镜像	Ubuntu 12.04.1 LTS

## 二、实验目的

在 Linux 系统上实现 tftp 的配置，并配置 pmon 引导程序编译环境，交叉编译生成 gzrom-dtb.bin，为后续编译操作系统铺垫。

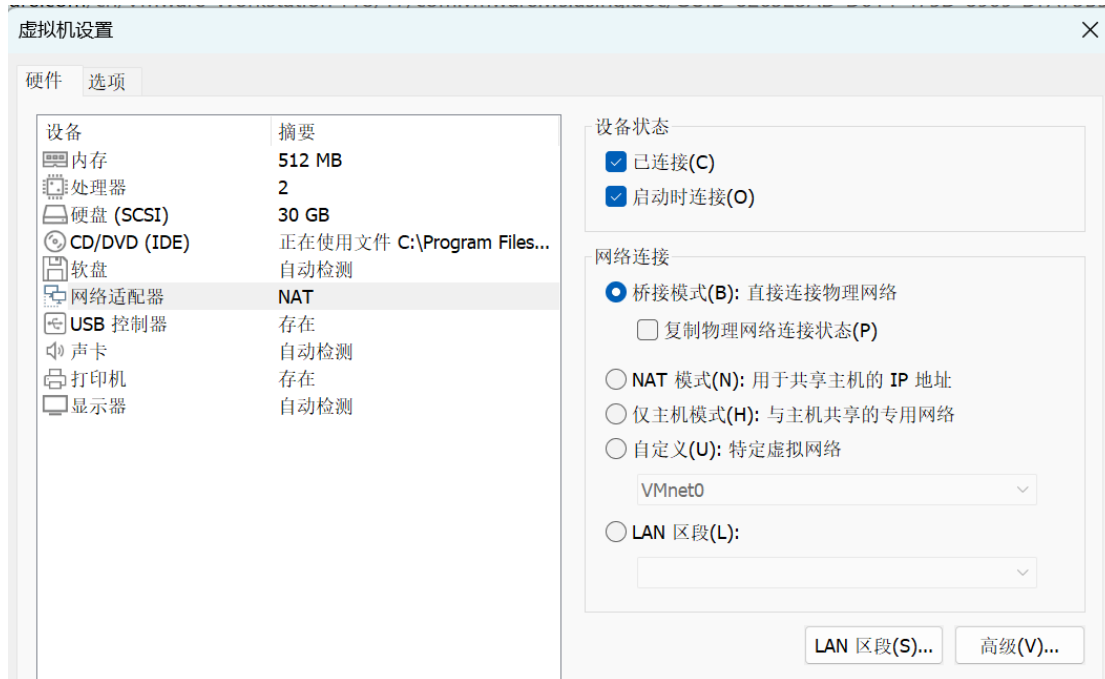
## 三、实验过程及内容

### 1. 安装 VMware，打开对应镜像：

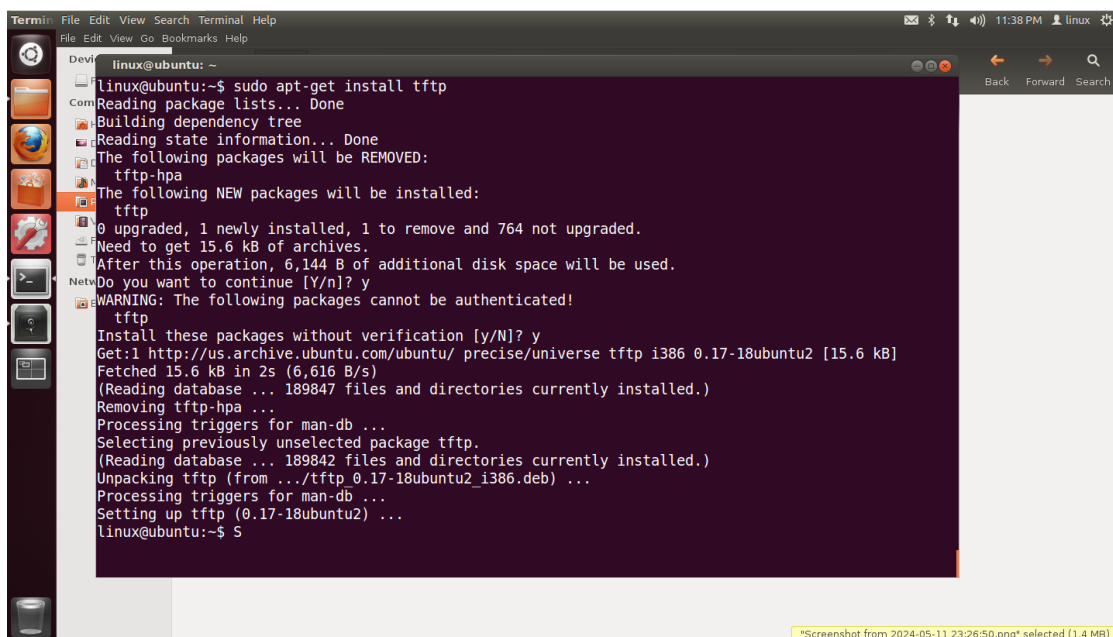


### 2. 配置 tftp

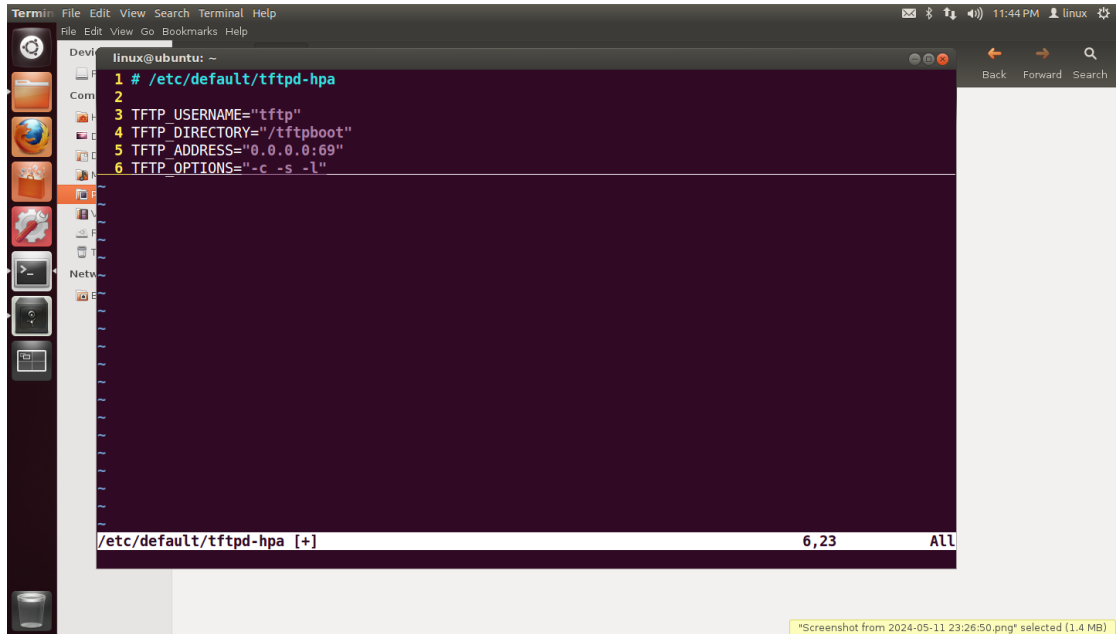
#### 1) 虚拟机设置桥接模式。



2) apt-get 安装 tftp。



3) 修改配置文件。

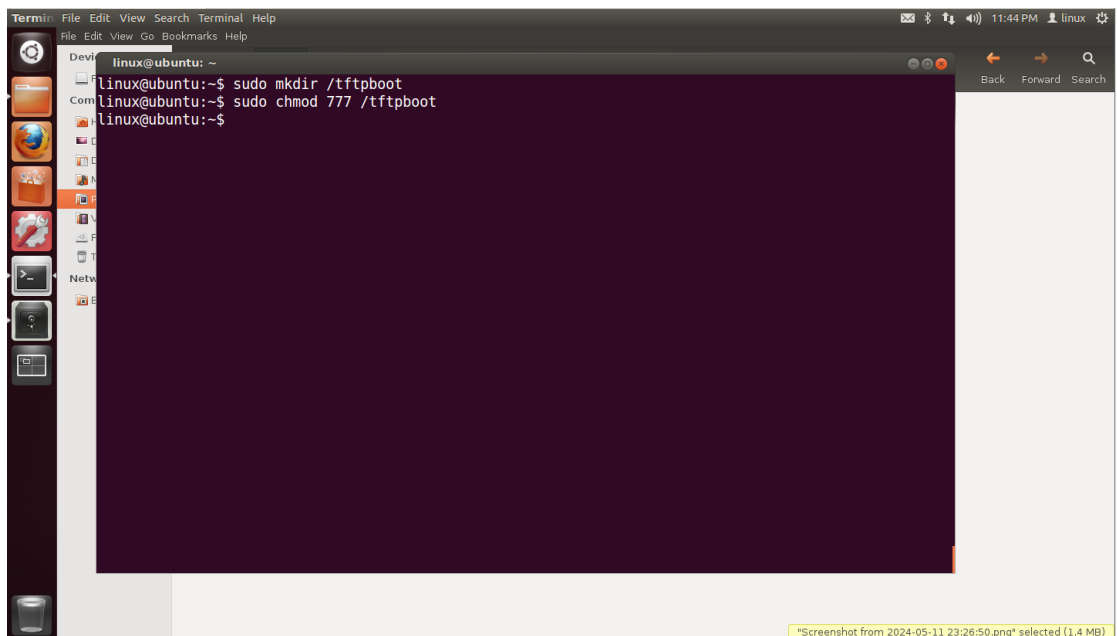


A terminal window on a Linux system (Ubuntu) showing the editing of the file `/etc/default/tftpd-hpa`. The terminal has a dark purple background. The command `1 # /etc/default/tftpd-hpa` has been entered. The file content is as follows:

```
2  
3 TFTP_USERNAME="tftp"  
4 TFTP_DIRECTORY="/tftpboot"  
5 TFTP_ADDRESS="0.0.0.0:69"  
6 TFTP_OPTIONS="-c -s -l"
```

The terminal status bar at the bottom shows `/etc/default/tftpd-hpa [+]`, `6,23`, and `All`. The system clock in the top right corner shows 11:44 PM.

4) 创建服务端文件夹并设置为最高权限。

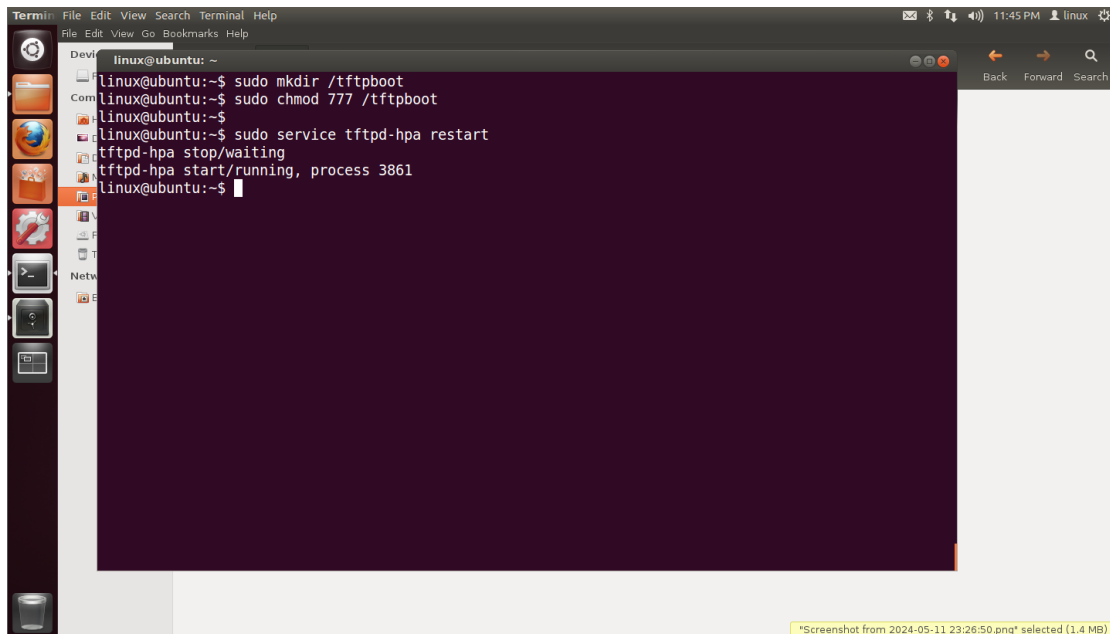


A terminal window on a Linux system (Ubuntu) showing the creation of the `/tftpboot` directory. The terminal has a dark purple background. The commands entered are:

```
linux@ubuntu:~$ sudo mkdir /tftpboot  
linux@ubuntu:~$ sudo chmod 777 /tftpboot  
linux@ubuntu:~$
```

The terminal status bar at the bottom shows `linux@ubuntu:~$`. The system clock in the top right corner shows 11:44 PM.

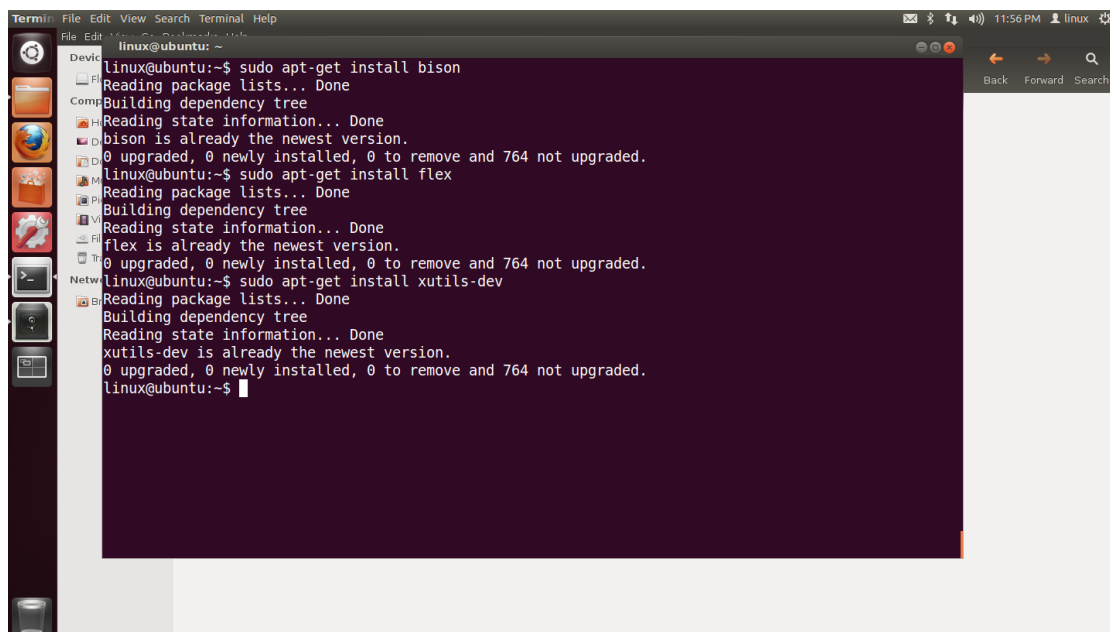
5) 重启 tftp 服务，配置生效：

A terminal window on a Linux system. The user runs several commands to set up the tftpd-hpa service. The terminal output shows the directory creation, permissions setting, and the service being restarted successfully.

```
linux@ubuntu: ~  
linux@ubuntu:~$ sudo mkdir /tftpboot  
linux@ubuntu:~$ sudo chmod 777 /tftpboot  
linux@ubuntu:~$  
linux@ubuntu:~$ sudo service tftpd-hpa restart  
tftpd-hpa stop/waiting  
tftpd-hpa start/running, process 3861  
linux@ubuntu:~$
```

### 3. pmon 编译。

#### 1) 安装编译所需工具

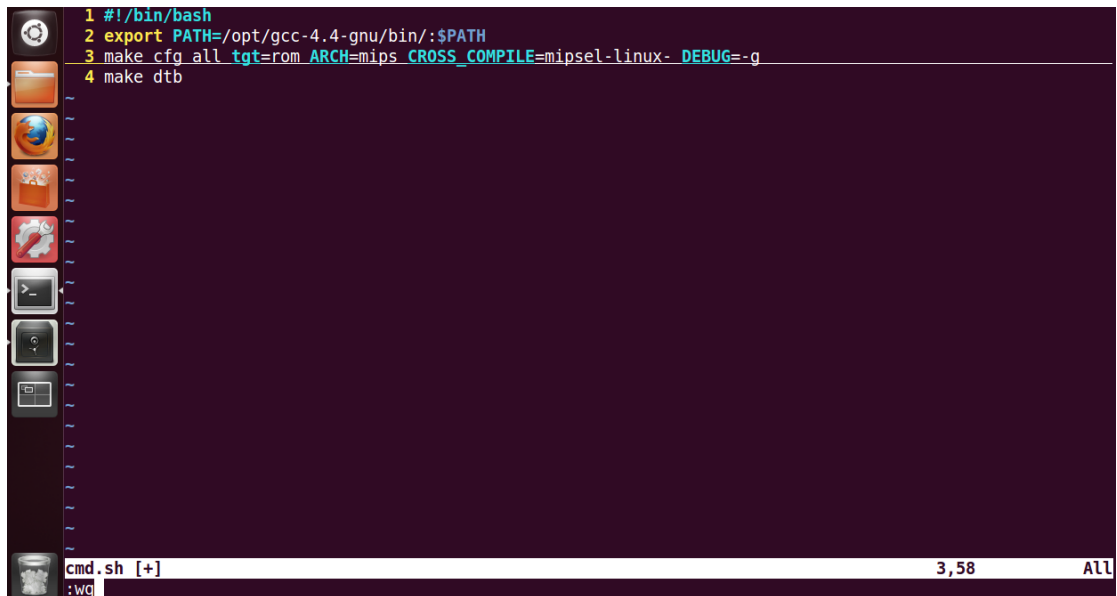
A terminal window showing the installation of three packages: bison, flex, and xutils-dev. Each installation command is followed by output indicating that the package is already the newest version.

```
linux@ubuntu: ~  
linux@ubuntu:~$ sudo apt-get install bison  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
bison is already the newest version.  
0 upgraded, 0 newly installed, 0 to remove and 764 not upgraded.  
linux@ubuntu:~$ sudo apt-get install flex  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
flex is already the newest version.  
0 upgraded, 0 newly installed, 0 to remove and 764 not upgraded.  
linux@ubuntu:~$ sudo apt-get install xutils-dev  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
xutils-dev is already the newest version.  
0 upgraded, 0 newly installed, 0 to remove and 764 not upgraded.  
linux@ubuntu:~$
```

#### 2) 进入 pmon 源码顶层目录下：



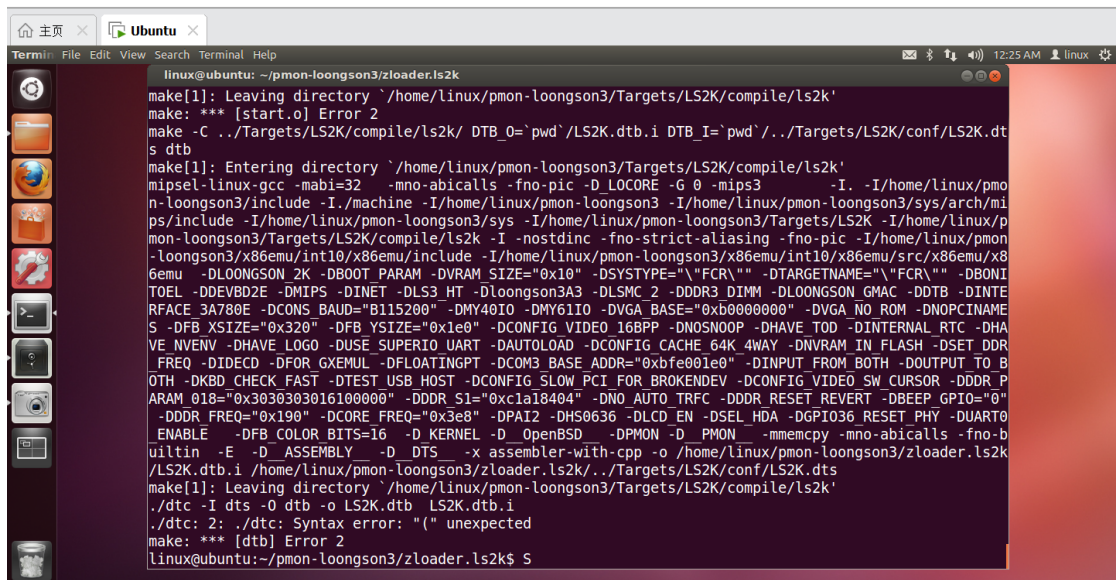
4) 进入 pmon 源码顶层目录下，编写 cmd.sh:



```
1 #!/bin/bash
2 export PATH=/opt/gcc-4.4-gnu/bin/:$PATH
3 make cfg all tgt=rom ARCH=mips CROSS_COMPILE=mipsel-linux- DEBUG=-g
4 make dtb
```

cmd.sh [+]  
:wq

5) 运行 cmd.sh，发现 dtb 报错:



```
linux@ubuntu: ~/pmon-loongson3/zloader.ls2k
make[1]: Leaving directory `/home/linux/pmon-loongson3/Targets/LS2K/compile/ls2k'
make: *** [start.o] Error 2
make -C ../Targets/LS2K/compile/ls2k/ DTB_0='pwd'/LS2K.dtb.i DTB_I='pwd'../Targets/LS2K/conf/LS2K.dts
s dtb
make[1]: Entering directory `/home/linux/pmon-loongson3/Targets/LS2K/compile/ls2k'
mipsel-linux-gcc -mabi=32 -mno-abisalls -fno-pic -D LOCORE -G 0 -mips3 -I. -I/home/linux/pmo
n-loongson3/include -I./machine -I/home/linux/pmon-loongson3 -I/home/linux/pmon-loongson3/sys/arch/mi
ps/include -I/home/linux/pmon-loongson3/sys -I/home/linux/pmon-loongson3/Targets/LS2K -I/home/linux/p
mon-loongson3/Targets/LS2K/compile/ls2k -I -nostdinc -fno-strict-aliasing -fno-pic -I/home/linux/pmon
-loongson3/x86emu/int10/x86emu/include -I/home/linux/pmon-loongson3/x86emu/int10/x86emu/src/x86emu/x8
6emu -DLOONGSON_2K -DBOOT_PARAM -DVRAM_SIZE="0x10" -DSYSTYPE="\FCR\" -DTARGETNAME="\FCR\" -DBONI
TOEL -DDEVBD2E -DMIPS -DINET -DLS3_HT -Dloongson3A3 -DLSMC_2 -DDDR3_DIMM -DLOONGSON_GMAC -DDTB -DINTE
RFACE_3A780E -DCONS_BAUD="B115200" -DMY40I0 -DMY61I0 -DVGA_BASE="0xb0000000" -DVGA_NO_ROM -DNOPCINAME
S -DFB_XSIZE="0x320" -DFB_YSIZE="0x1e0" -DCONFIG_VIDEO_16BPP -DNOSNOOP -DHAVE TOD -DINTERNAL_RTC -DHA
VE_NVEN -DHAVE_LOGO -DUSE_SUPERIO_UART -DAUTOLOAD -DCONFIG_CACHE_64K_4WAY -DNVRAM_IN_FLASH -DSET_DDR
FREQ -DIDECD -DFOR_GXEMUL -DFLOATINGPT -DCOM3_BASE_ADDR="0xbfe001e0" -DINPUT_FROM_BOTH -DOUTPUT_TO_B
OTH -DKBD_CHECK_FAST -DTEST_USB_HOST -DCONFIG_SLOW_PCI_FOR_BROKENDEV -DCONFIG_VIDEO_SW_CURSOR -DDDR_P
ARAM_018="0x3030303016100000" -DDDR_S1="0xc1a18404" -DNO_AUTO_TRFC -DDDR_RESET_REVERT -DBEEP_GPIO="0"
-DDDR_FREQ="0x190" -DCORE_FREQ="0x3e8" -DPAI2 -DHS0636 -DLCD_EN -DSEL_HDA -DGPI036_RESET_PHY -DUART0
ENABLE -DFB_COLOR_BITS=16 -D_KERNEL -D_OpenBSD -DPMON -D_PMON -mmemcpy -mno-abisalls -fno-b
uiltin -E -D_ASSEMBLY -D_DTS -x assembler-with-cpp -o /home/linux/pmon-loongson3/zloader.ls2k
/LS2K.dtb.i /home/linux/pmon-loongson3/zloader.ls2k/./Targets/LS2K/conf/LS2K.dts
make[1]: Leaving directory `/home/linux/pmon-loongson3/zloader.ls2k'
./dtc -I dts -O dtb -o LS2K.dtb LS2K.dtb.i
./dtc: 2: ./dtc: Syntax error: "(" unexpected
make: *** [dtb] Error 2
linux@ubuntu:~/pmon-loongson3/zloader.ls2k$
```

6) 替换文件夹下的的 dtc，重新运行成功:



```
File Edit View Search Terminal Help 12:45 AM linux
loader.ls2k/LS2K.dtb.i /home/linux/pmon-loongson3/zloader.ls2k/./Targets/LS2K/conf/LS2K.dts
make[1]: Leaving directory `/home/linux/pmon-loongson3/Targets/LS2K/compile/ls2k'
./dtc -I dts -O dtb -o LS2K.dtb LS2K.dtb.i
Warning (reg_format): "reg" property in /soc/i2c@3/eeeprom@50 has invalid length (4 bytes) (#address-cells == 2, #size-cells == 1)
Warning (reg_format): "reg" property in /soc/i2c@3/codec@1a has invalid length (4 bytes) (#address-cells == 2, #size-cells == 1)
Warning (reg_format): "reg" property in /soc/spi@1fff0220/spidev@1/partition@0 has invalid length (8 bytes) (#address-cells == 2, #size-cells == 1)
Warning (reg_format): "reg" property in /soc/spi@1fff0220/spidev@1/partition@0x01400000 has invalid length (8 bytes) (#address-cells == 2, #size-cells == 1)
Warning (avoid_default_addr_size): Relying on default #address-cells value for /soc/i2c@3/eeeprom@50
Warning (avoid_default_addr_size): Relying on default #size-cells value for /soc/i2c@3/eeeprom@50
Warning (avoid_default_addr_size): Relying on default #address-cells value for /soc/i2c@3/codec@1a
Warning (avoid_default_addr_size): Relying on default #size-cells value for /soc/i2c@3/codec@1a
Warning (avoid_default_addr_size): Relying on default #address-cells value for /soc/spi@1fff0220/spidev@1/partition@0
Warning (avoid_default_addr_size): Relying on default #size-cells value for /soc/spi@1fff0220/spidev@1/partition@0
Warning (avoid_default_addr_size): Relying on default #address-cells value for /soc/spi@1fff0220/spidev@1/partition@0x01400000
Warning (avoid_default_addr_size): Relying on default #size-cells value for /soc/spi@1fff0220/spidev@1/partition@0x01400000
[ -f gzrom.bin ] && cp gzrom.bin gzrom-dtb.bin && python ../tools/pmonenv.py -f gzrom-dtb.bin -d LS2K.dtb -w al=(usb0,0)/boot/vmlinuz al1=(wd0,0)/boot/vmlinuz append="'console=ttyS0,115200 console=tty initcall_debug=1 loglevel=20'" FR=1
{'FR': '1', 'al': '(usb0,0)/boot/vmlinuz', 'append': "'console=ttyS0,115200 console=tty initcall_debug=1 loglevel=20'", 'al1': '(wd0,0)/boot/vmlinuz'}
linux@ubuntu:~/pmon-loongson3/zloader.ls2k$
```

```
File Edit View Search Terminal Help 12:46 AM linux
linux@ubuntu:~/pmon-loongson3/zloader.ls2k$ ls
bin2c      Makefile.2c1m      Makefile.2g5536      Makefile.3amcp68      pmon.bin.gz
c2bin      Makefile.2ecard     Makefile.2g5ddr2_1a  Makefile.3aserver     program.S
cmd.sh      Makefile.2ecpci     Makefile.2g5ddr3_1a  Makefile.3asis        readme.txt
copypmon.S  Makefile.2eCPCI     Makefile.2g690e      Makefile.3b780e       start.o
dtc          Makefile.2edev      Makefile.2gq2h       Makefile.3bserver     startram.S
genram      Makefile.2elm       Makefile.2gq780e     Makefile.3c2h         test
genrom      Makefile.2emcpu     Makefile.3a2h        Makefile.3c780e       xmodem.c
genrom_ejtag Makefile.2emini     Makefile.3a3000_7a   Makefile.3cserver     zlib_deflate
getname     Makefile.2enc       Makefile.3a780e      Makefile.3cpci        zlib_gzip.c
gzrom       Makefile.2fla       Makefile.3a82h       Makefile.fcr          zlib_inflate
gzrom.bin   Makefile.2f7inch    Makefile.3a82w       Makefile.inc          zlib_loader.c
gzrom-dtb.bin Makefile.2fdev      Makefile.3a84w       Makefile.IT8172       zlib_pmon.bin.c
inflate.c   Makefile.2fdev.cs5536 Makefile.3a8780e     Makefile.linuxpc      zlib_pmon.bin.gz
initmips.c  Makefile.2fdev.firewall Makefile.3a92h       Makefile.ls232.sm502  zloader.c
ld.script   Makefile.2fdev.sm502 Makefile.3a92w       Makefile.ls2k         zloader.o
ld.script.S Makefile.2fdev.via.jingxing Makefile.3a94w       malloc.c
LS2K.dtb    Makefile.2fdev.via.sisfb Makefile.3a9780e     memop.c
LS2K.dtb.i  Makefile.2feva      Makefile.3adawning   mymake
Makefile     Makefile.2gla       Makefile.3afirewall  pmon.bin.c
linux@ubuntu:~/pmon-loongson3/zloader.ls2k$
```

## 四、实验小结

在本次实验中，我对 pmon 进行了了解。pmon 具备 BIOS 和 bootloader 的部分功能，广泛应用于嵌入式系统中。在基于龙芯的系统中，pmon 不仅作为类 BIOS 和 bootloader 使用，还经过优化为内核



运行提供了良好的环境。我掌握了 pmon 的启动过程，它主要分为四个阶段：从 nor flash 中加载 pmon 二进制文件、解压 pmon 二进制文件、进行 C 语言部分的初始化以及在命令行下接收并执行用户命令。

此外，我还成功配置了 pmon 引导程序的编译环境，并实现了交叉编译，生成了 gzrom-dtb.bin 文件，这为后续操作系统的编译工作奠定了坚实的基础。在实验过程中，我也对 TFTP 协议有了初步的认识，TFTP 是一个用于文件传输的协议，它与 pmon 一同在嵌入式系统中发挥着重要作用。通过学习和实践，我不仅掌握了 TFTP 协议的基本原理和使用方法，还学会了如何在 Linux 系统上安装和配置 TFTP 服务器，以及如何配置编译环境。这些知识和技能的学习，为我后续在龙芯派编译和 PISC-V 指令集系统设计实现方面的工作，打下了坚实的基础。通过这些实验，我不仅提升了自己的技术能力，也对嵌入式系统有了更深入的理解。