Partitioning the Hard Disk

1 Aim

A hard disk needs to be divided into one or more sections called *partitions*. We will install a number of operating systems onto our hard disks. Each operating system needs at least one partition. We will use the Linux `fdisk` program to create these partitions today. Later, in your subject *Systems and Network Administration*, Albert will show you how to install Windows 2003 into some of these partitions. Our aim for today is to create the partitions necessary for installation of all these operating systems.

2 Background

2.1 Types of partition

On an IBM PC compatible, there are a few types of partition:

type	location
primary	outside of any other partition
extended	outside of any other partition
logical	inside an extended partition

The total number of primary and extended partitions must be four or less. Also, the total number of partitions must be 15 or less. So if p = number of primary, e = number of extended and ℓ = number of logical, then $p + e \leq 4$, and $p + e + \ell \leq 15$.

2.2 Limitations of the original IBM PC BIOS

The computers we use are compatible with the original IBM PC. The BIOS (Basic Input Output System) also remains compatible with the original machine, and has the following limitations:

parameter	number of bits	maximum value
cylinders	10	1023
heads	8	255
sectors	6	63

To boot an operating system on a PC, the BIOS must be able to load the first part of the operating system. The first part of the operating system must be on a location on the hard disk within these limitations. In particular, with older machines, without

an *extended* BIOS, the boot files of the operating system must be entirely below cylinder 1024, or the computer may not be able to boot. However, newer machines, such as those in our lab, have an extended BIOS that gets around these limitations.

2.3   Disk and partition naming scheme in Linux

The motherboards of the computers in the lab have two 40-pin IDE connectors: one is called the *primary* IDE bus, the other the *secondary*. A ribbon cable connects to each of these connectors. There are two female sockets on each cable. One connects to a disk configured as the *master*, the other to the *slave*. Jumpers on the hard disk determine whether the disk is the master or slave.

The naming scheme for IDE disks is:

name	primary/secondary	master/slave
hda	primary	master
hdb	primary	slave
hdc	secondary	master
hdd	secondary	slave

Partitions are named with the first three letters being that of the hard disk. Added to this is a number. A primary partition may be numbered 1 to 4 (i.e., on our hard disks, hda1, hda2, hda3 or hda4). Logical partitions start with the number 5, so on hda, the logical partitions are called hda5, hda6, hda7,...

2.4   Our partitioning scheme

The partitioning scheme we use here will look like figure 1.

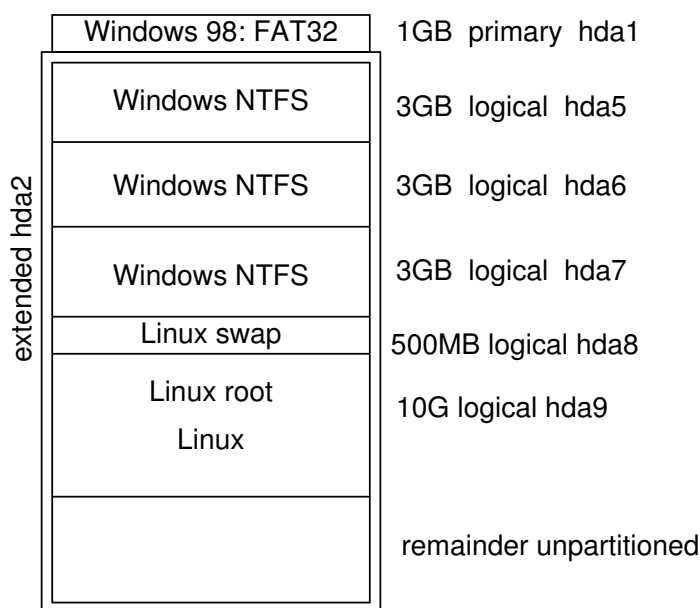| Windows 98: FAT32	1GB primary hda1
Windows NTFS	3GB logical hda5
Windows NTFS	3GB logical hda6
Windows NTFS	3GB logical hda7
Linux swap	500MB logical hda8
Linux root / Linux	10G logical hda9
	remainder unpartitioned

extended hda2

Figure 1: The partioning scheme we will use for our hard disk.

We will create all these partitions today.

We will use the Linux installation boot disk as a *rescue disk*. This will boot a basic Linux system independent of the local hard disks, suitable for doing emergency repairs to an installed operating system.

We will use this to run `fdisk` and partition the removable hard disk.

We begin by making two floppy disks: a boot disk and a network driver disk.

3 Procedure

3.1 Making the Two Boot Floppies

1. Either make the two floppy disks yourself or take them from the technician or from the lecturer.

   How to make a the two floppy disks? Boot the lab machine into Linux, change to the network drive on `/home/nfs/redhat-9/images`, and put a *good* floppy disk into the drive. You should format each disk first to verify that it has no bad sectors:

   `$ fdformat /dev/fd0`

   If you get any errors, throw that floppy disk away and get another one. Do the same with the second disk.

   Then use the `dd` command to create the boot disk from the disk image on our network drive:

   ```
   $ cd /home/nfs/redhat-9/images
   $ dd if=bootdisk.img of=/dev/fd0 bs=1440k
   ```

   When the floppy light is off, you have created your boot floppy.

   Then put in the second floppy and make the network driver disk:

   `$ dd if=drvnet.img of=/dev/fd0 bs=1440k`

   You can read more about the `dd` command if you type:

   `$ man dd`

3.2 Removable Hard Disks

Hard disks are very delicate. Treat them as if they were very fragile and very expensive (they are!). **Never** plug or unplug a removable hard disk in while the power is on. ***Wait at least fifteen seconds before putting the hard disk in or removing it from the computer after turning off the power.***

1. Turn off the computer, and wait at least 15 seconds.

2. Install the removable hard disk. Push it in *firmly* with both thumbs until you are sure it is pushed in all the way. This will be the master device on the primary IDE bus.

   Most people do not push the hard disk all the way in the first time!

3.3 Rescue Mode

1. Put the floppy disk into the drive and reboot the machine.

2. At the `boot:` prompt, enter linux rescue:

   `boot: linux rescue`

3. Accept defaults for language and keyboard.

4. When asked "What type of media contains the rescue image?" select "`NFS image`".

5. At the message "No Driver found", select "`Use a driver disk`"

6. For "Driver Disk Source", select `fd0` (the floppy disk), rather than `hdb`. What is

✐   `hdb`? .... [   ]

7. Insert the network driver disk when requested.

8. For "Network Device", choose `eth0`.

    Note that the computers in this lab have two network cards.

9. If you are asked to choose the network driver, select the Intel EtherExpress Pro 100 (e100).
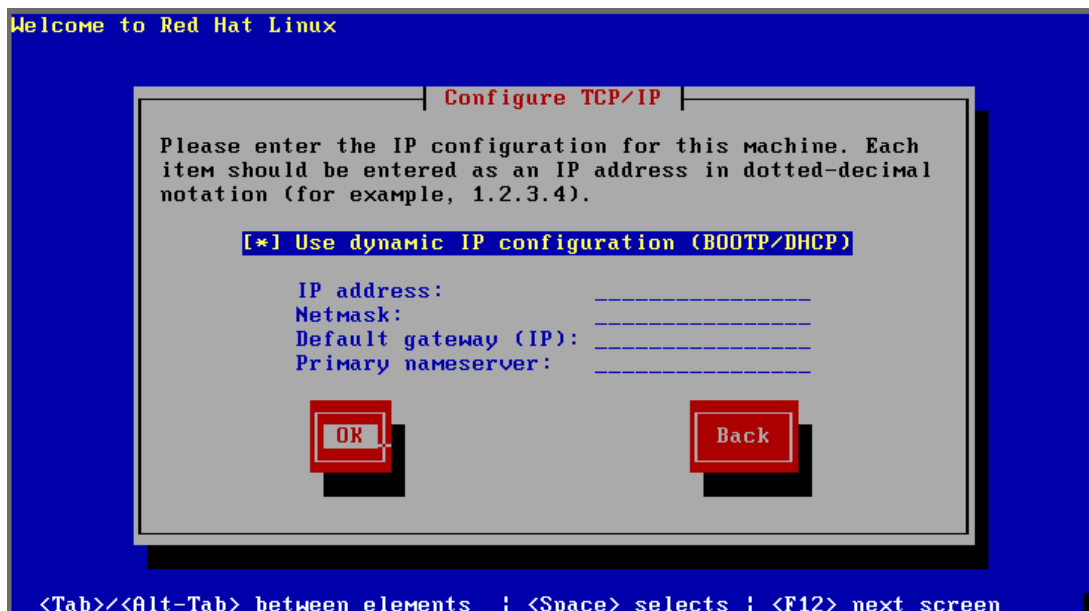

Figure 2: The screen where you select using DHCP for TCP/IP parameters.

10. When asked for the IP address of the computer, accept the default of `DHCP`. See figure 2. If this does not immediately succeed, click on "`Back`" and choose `eth1`. If that does not work, check the connection of the network cable to the Ethernet socket on the motherboard.

11. For "NFS server name", put `nicku.org`

12. For "Red Hat directory", put `/var/ftp/pub/rh-9-updated`

13. When asked if you want to mount the Linux system that is installed on the local hard disk, select "`Skip`".

    In many other cases, for example, when using the rescue disk to fix some problem on a system that is already installed, it is often helpful to allow the rescue disk to mount that installation.

3.4   Running `fdisk`

1. *Carefully* start the `fdisk` program running on your removable hard disk:

   ```
   # fdisk /dev/hda
   ```

   Make sure you type `/dev/hda`. This is **very important**; do not partition `/dev/hdc`, or Henry the system administrator will need to stay back and re-install the operating system for the other classes; he will be very upset!!! *Be very careful.*

   > If you get an error message:
   >
   > `Unable to open /dev/hda`
   >
   > then there are a few possibilities:
   >
   > - Your hard disk is not pushed all the way in. Turn off the computer, wait 15 seconds, then push it in, and start again; *or*
   > - Your hard disk jumpers are not set as *master*. Verify that this is the case. Do not use the *cable select* or *slave* jumper settings.

2. The lecturer will demonstrate the partitioning procedure. Make sure that you **ask questions** if you are unsure. If you make a mistake and partition the wrong hard disk, you will upset many people.

   The common `fdisk` commands that you will use are:

command	name	action
m	**m**enu	show a list of all the commands
p	**p**rint	display the partition table
n	**n**ew partition	create a new partition
d	**d**elete	delete a partition (useful if you make a mistake!)
a	**a**ctive	make a partition active
q	**q**uit	exit *without saving* the table. Great if you really mess it up!
t	**t**ype	set the **t**ype of partition
w	**w**rite	Write changes to the disk. After that, it's very hard to undo your changes, so think three times before pressing `w`.

3. Use the **p**rint command to display the partition table first.

4. Delete any partitions that are *obviously* the wrong size. ***Be* very careful *NOT to delete the partition that contains your installation of Windows.*** *Think* before you partition. Do *not* blindly follow this procedure if you do not understand what you are doing.

   Here is the sequence of commands I typed to destroy all the previously exising partitions. (Note that since I do not have Windows installed on my hard disk, I deleted all the partitions first):

   ```
   Command (m for help): d
   Partition number (1-9): 9
   ```

```
Command (m for help): d
Partition number (1-8): 8

Command (m for help): d
Partition number (1-7): 7

Command (m for help): d
Partition number (1-6): 6

Command (m for help): d
Partition number (1-5): 5

Command (m for help): d
Partition number (1-5): 2

Command (m for help): d
Selected partition 1
```

5. Here are the `fdisk` commands I used to create the partition table:

```
Command (m for help): p

Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

   Device Boot    Start        End     Blocks   Id  System

Command (m for help): n
Command action
   e   extended
   p   primary partition (1-4)
p
Partition number (1-4): 1
First cylinder (1-5318, default 1):
Using default value 1
Last cylinder or +size or +sizeM or +sizeK (1-5318, default 5318): +1g

Command (m for help): p

Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

   Device Boot    Start        End     Blocks   Id  System
/dev/hda1              1        130     982768+  83  Linux

Command (m for help): t
Selected partition 1
Hex code (type L to list codes): l

  0  Empty          1c  Hidden Win95 FA 70  DiskSecure Mult bb  Boot Wizard hid
```

```
   1   FAT12            1e  Hidden Win95 FA 75  PC/IX            be  Solaris boot
   2   XENIX root       24  NEC DOS         80  Old Minix        c1  DRDOS/sec (FAT-
   3   XENIX usr        39  Plan 9          81  Minix / old Lin  c4  DRDOS/sec (FAT-
   4   FAT16 <32M       3c  PartitionMagic  82  Linux swap       c6  DRDOS/sec (FAT-
   5   Extended         40  Venix 80286     83  Linux            c7  Syrinx
   6   FAT16            41  PPC PReP Boot    84  OS/2 hidden C:   da  Non-FS data
   7   HPFS/NTFS        42  SFS             85  Linux extended   db  CP/M / CTOS / .
   8   AIX              4d  QNX4.x          86  NTFS volume set  de  Dell Utility
   9   AIX bootable     4e  QNX4.x 2nd part 87  NTFS volume set  df  BootIt
   a   OS/2 Boot Manag  4f  QNX4.x 3rd part 8e  Linux LVM        e1  DOS access
   b   Win95 FAT32      50  OnTrack DM      93  Amoeba           e3  DOS R/O
   c   Win95 FAT32 (LB  51  OnTrack DM6 Aux 94  Amoeba BBT       e4  SpeedStor
   e   Win95 FAT16 (LB  52  CP/M            9f  BSD/OS           eb  BeOS fs
   f   Win95 Ext'd (LB  53  OnTrack DM6 Aux a0  IBM Thinkpad hi  ee  EFI GPT
  10   OPUS             54  OnTrackDM6      a5  FreeBSD          ef  EFI (FAT-12/16/
  11   Hidden FAT12     55  EZ-Drive        a6  OpenBSD          f0  Linux/PA-RISC b
  12   Compaq diagnost  56  Golden Bow      a7  NeXTSTEP         f1  SpeedStor
  14   Hidden FAT16 <3  5c  Priam Edisk     a8  Darwin UFS       f4  SpeedStor
  16   Hidden FAT16     61  SpeedStor       a9  NetBSD           f2  DOS secondary
  17   Hidden HPFS/NTF  63  GNU HURD or Sys ab  Darwin boot      fd  Linux raid auto
  18   AST SmartSleep   64  Novell Netware  b7  BSDI fs          fe  LANstep
  1b   Hidden Win95 FA  65  Novell Netware  b8  BSDI swap        ff  BBT
Hex code (type L to list codes): c
Changed system type of partition 1 to c (Win95 FAT32 (LBA))


Command (m for help): p


Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes


   Device Boot     Start       End     Blocks   Id  System
/dev/hda1              1       130     982768+   c   Win95 FAT32 (LBA)


Command (m for help): n
Command action
   e   extended
   p   primary partition (1-4)
e
Partition number (1-4): 2
First cylinder (131-5318, default 131):
Using default value 131
Last cylinder or +size or +sizeM or +sizeK (131-5318, default 5318):
Using default value 5318


Command (m for help): p


Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes


   Device Boot     Start       End     Blocks   Id  System
/dev/hda1              1       130     982768+   c   Win95 FAT32 (LBA)
```

```
/dev/hda2              131     5318  39221280     5   Extended


Command (m for help): t
Partition number (1-5): 2
Hex code (type L to list codes): f
Changed system type of partition 2 to f (Win95 Ext'd (LBA))


Command (m for help): p


Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

    Device Boot     Start        End      Blocks   Id  System
/dev/hda1               1        130      982768+   c  Win95 FAT32 (LBA)
/dev/hda2             131       5318   39221280     f  Win95 Ext'd (LBA)


Command (m for help): n
Command action
   l   logical (5 or over)
   p   primary partition (1-4)
l
First cylinder (131-5318, default 131):
Using default value 131
Last cylinder or +size or +sizeM or +sizeK (131-5318, default 5318): +3g


Command (m for help): p


Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

    Device Boot     Start        End      Blocks   Id  System
/dev/hda1               1        130      982768+   c  Win95 FAT32 (LBA)
/dev/hda2             131       5318   39221280     f  Win95 Ext'd (LBA)
/dev/hda5             131        519    2940808+   83  Linux


Command (m for help): t
Partition number (1-6): 5
Hex code (type L to list codes): 7
Changed system type of partition 5 to 7 (HPFS/NTFS)


Command (m for help): p


Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

    Device Boot     Start        End      Blocks   Id  System
/dev/hda1               1        130      982768+   c  Win95 FAT32 (LBA)
/dev/hda2             131       5318   39221280     f  Win95 Ext'd (LBA)
/dev/hda5             131        519    2940808+    7  HPFS/NTFS
```

```
Command (m for help):
```

6. The finished partition table should look something like this:

```
Command (m for help): p

Disk /dev/hda: 41.1 GB, 41174138880 bytes
240 heads, 63 sectors/track, 5318 cylinders
Units = cylinders of 15120 * 512 = 7741440 bytes

   Device Boot      Start         End      Blocks   Id  System
/dev/hda1   *           1         130      982768+   c  Win95 FAT32 (LBA)
/dev/hda2             131        5318    39221280    f  Win95 Ext'd (LBA)
/dev/hda5             131         519     2940808+   7  HPFS/NTFS
/dev/hda6             520         908     2940808+   7  HPFS/NTFS
/dev/hda7             909        1297     2940808+   7  HPFS/NTFS
/dev/hda8            1298        1363      498928+  82  Linux swap
/dev/hda9            1364        2656     9775048+  83  Linux
```

Note that the type of the swap partition is "83 Linux swap".

7. When the partitioning procedure is finished and you have pressed $\boxed{\text{w}}$ to **w**rite your new partition table, then:

   (a) type the `sync` (short for *synchronise*) command a few times to ensure that the memory buffers are written to the hard disk before you shut down the computer.

   (b) type `exit`, and turn off the power on the computer when requested.

   (c) Wait 15 seconds before removing the hard disk and returning it to the cabinet at the end of the class.

   (d) Answer the questions in section 4 on the following page.

4   Review Questions

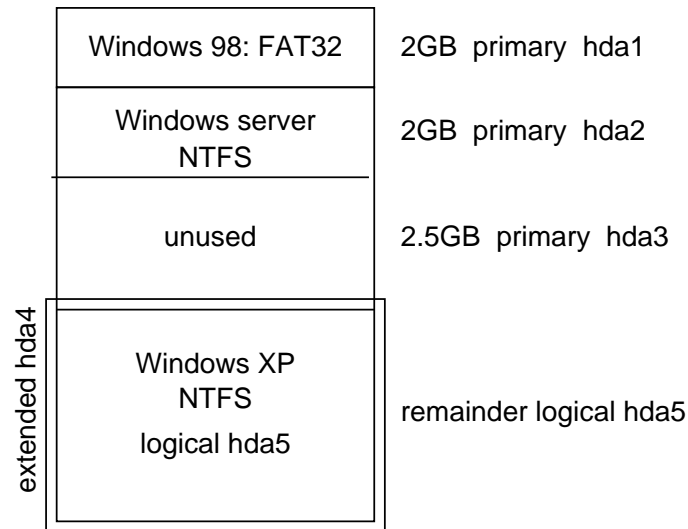A system administrator is given a disk partitioned as shown in figure 3.

Windows 98: FAT32	2GB primary hda1
Windows server NTFS	2GB primary hda2
unused	2.5GB primary hda3
Windows XP NTFS logical hda5	remainder logical hda5

extended hda4

Figure 3: A partioning scheme. We want to add two more partitions.

1. Can you add two partitions, if the NTFS and FAT32 partitions all contain data?

2. What would you do if you were the system administrator?

3. If you were creating the partitions originally, how would you have done it?