



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.

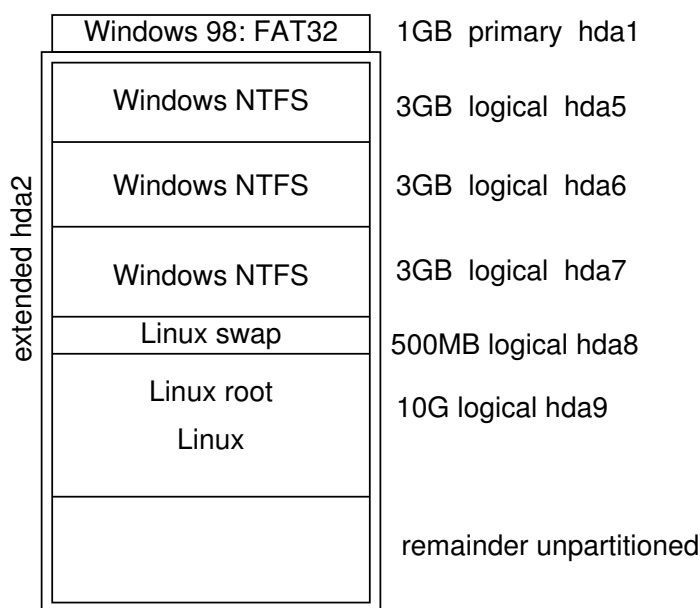


Figure 1: The partitioning scheme we will use for our hard disk.

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).

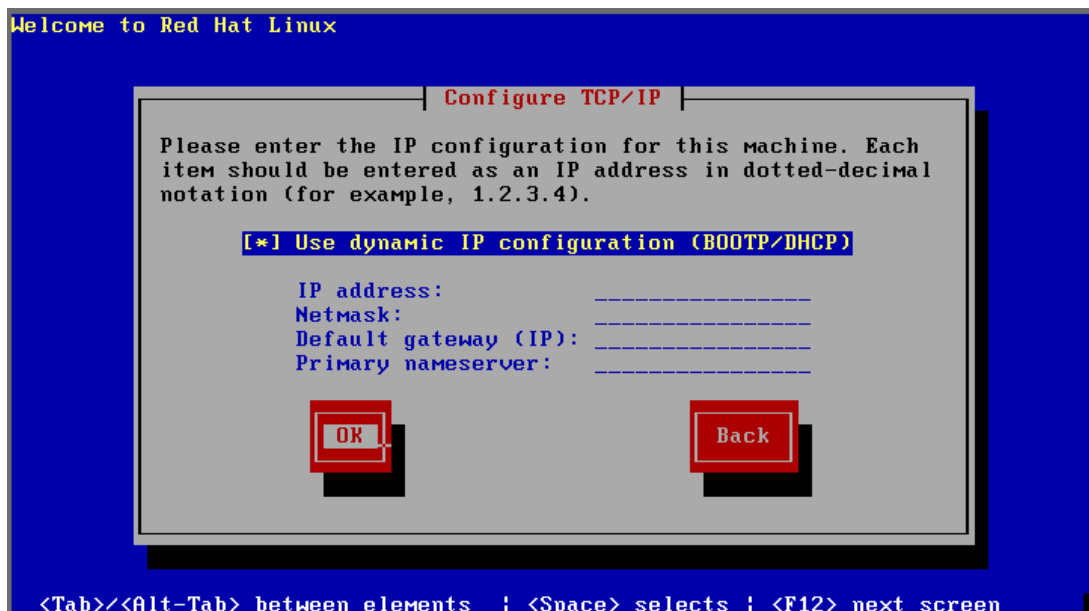


Figure 2: The screen where you select using DHCP for TCP/IP parameters.

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	menu	show a list of all the commands
p	print	display the partition table
n	new partition	create a new partition
d	delete	delete a partition (useful if you make a mistake!)
a	active	make a partition active
q	quit	exit <i>without saving</i> the table. Great if you really mess it up!
t	type	set the type of partition
w	write	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 `print` 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 existing 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): 1
```

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):

- 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”.

- When the partitioning procedure is finished and you have pressed **(w)** to write your new partition table, then:
 - 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.
 - type `exit`, and turn off the power on the computer when requested.
 - Wait 15 seconds before removing the hard disk and returning it to the cabinet at the end of the class.
 - 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.

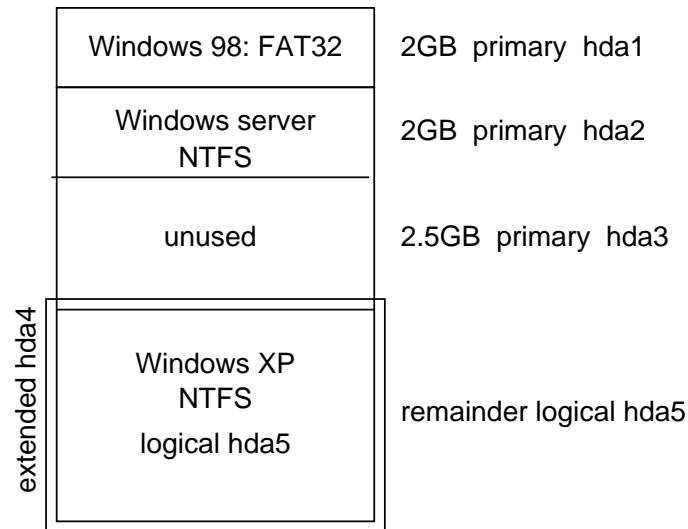


Figure 3: A partitioning scheme. We want to add two more partitions.

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?

