Setup.

- Compiz
- Impress
- 4 desktops
- #1 Multibooting
- #2 Kalc
- #3 Konsole
- #4 Gparted
- Put slide 43 commands into Konsole

Multi-boot.

Multi-Booting
Tips
Traps
& Treasures.

or

How to Multi-Boot
without Tears and Gnashing of Teeth

Where we are going?

- It has been my experience that most club members ar reasonably 'at home' using a live CD to install Linux, but in a dual boot situation are a somewhat unsure about the MBR and partitioning.
- In this presentation I will focus on the MBR and partitioning. Along the way I will provide some multibooting Tips, Traps and Treasures.
- I have assumed that you have a machine with Windows already installed and you wish to multiple boot with Linux.

Copy of Slides on Club Web

- Handout notes are not available, but a copy of the information in the slides will be available on the club's website in the next day or so.

R U  ?

- If you are new,

I may have bitten off a bit more than you chew

- I might go over some parts a bit too fast for you. I may have to cut some questions a bit short!
- Don't be afraid to ask questions, but dont be upset if I say, "Can I answer that later?"
- I am also available at the "Linux Lounge" Friday afternoons to answer your questions.

The systems.

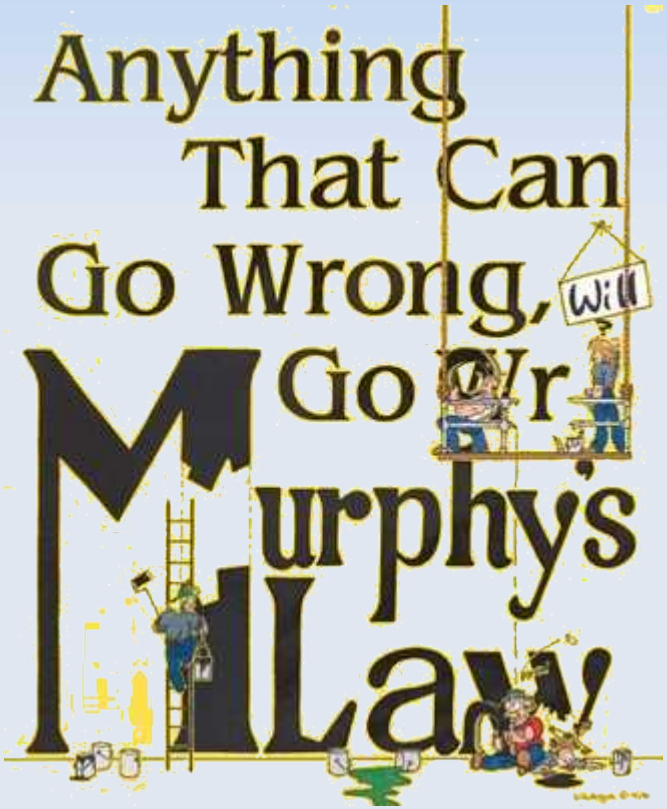
This presentation applies only to

- **x86 BIOS based PCs with**
- **XP, Vista and Linux Debian based desktop systems**
- **using the GRUB loader and**
- **booting from a Hard-drive .**

Don't forget the Irishman!!

- Remember Murphy's law and prepare for the unexpected!

BACKUP,
BACKUP,
BACKUP.



- **Don't say you wern't told!**

Look for the Patterns

Count the Bits.

Oct	Hex	Binary				Dec
		$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$	
0	0	0	0	0	0	0
1	1	0	0	0	1	1
2	2	0	0	1	0	2
3	3	0	0	1	1	3
4	4	0	1	0	0	4
5	5	0	1	0	1	5
6	6	0	1	1	0	6
7	7	0	1	1	1	7
10	8	1	0	0	0	8
11	9	1	0	0	1	9
12	A	1	0	1	0	10
13	B	1	0	1	1	11
14	C	1	1	0	0	12
15	D	1	1	0	1	13
16	E	1	1	1	0	14
17	F	1	1	1	1	15

Count Heaps More Bits

n = number of bits.
2^n is is the number of combinations possible using n bits.

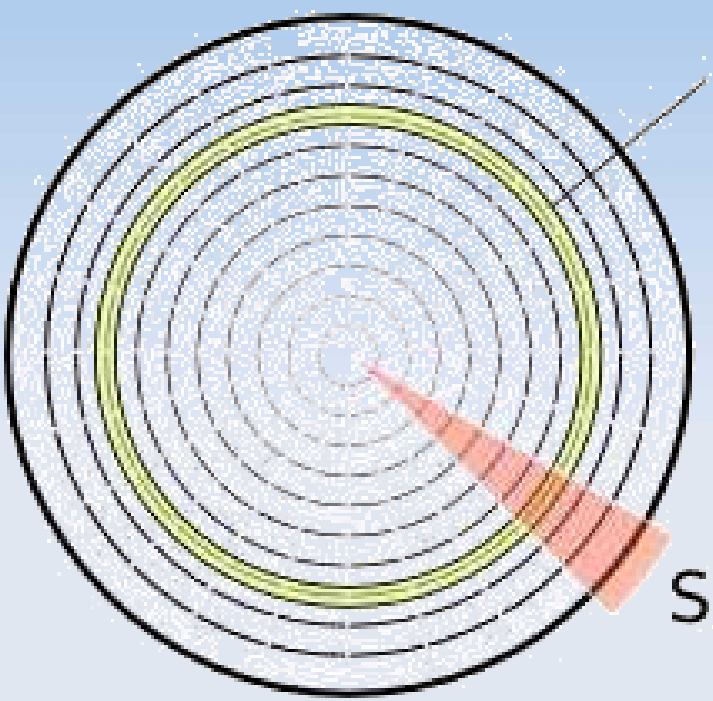
n	2^n	n	2^n	n	2^n	n	2^n	n	2^n
0	1	10	1024	20	1Mi	30	1Gi	40	1Ti
1	2	11	2048	21		31		41	2Ti
2	4	12	4096	22		32			
3	8	13	8Ki	23		33	8 Gi		
4	16	14	16Ki	24		34			
5	32	15	32Ki	25		35			
6	64	16	64Ki	26		36			
7	128	17	128Ki	27		37			
8	256	18	256Ki	28		38			
9	512	19	512Ki	29	512Mi	39			
10	1024 1Ki	20	1Mi 1024^2	30	1Gi 1024^3	40	1Ti 1024^4		

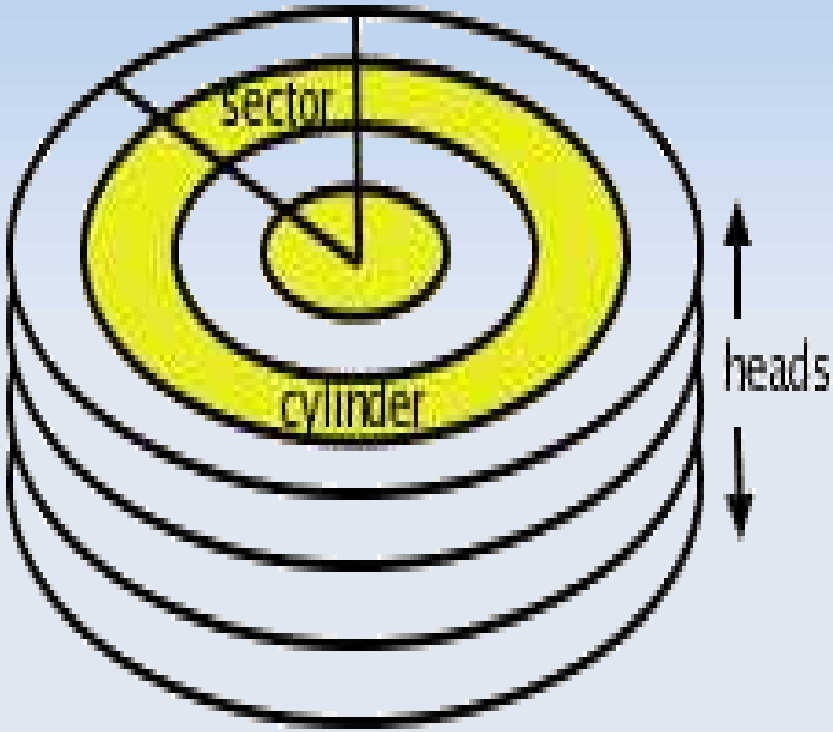
Data Block.

- The term 'Block' refers to a block of binary data on a storage medium.
- The size of a block depends on the medium and the format used. Typical block sizes are 512, 1024, 2048 and 4096 bytes.
- 512 bytes is the block size currently in use for hard-drives on PC's.
- The term 'Block Device' refers to a data storage device that stores data in blocks.

Whizzing Platters of Rust, Batman!

CHS Hard-drive Layout #1



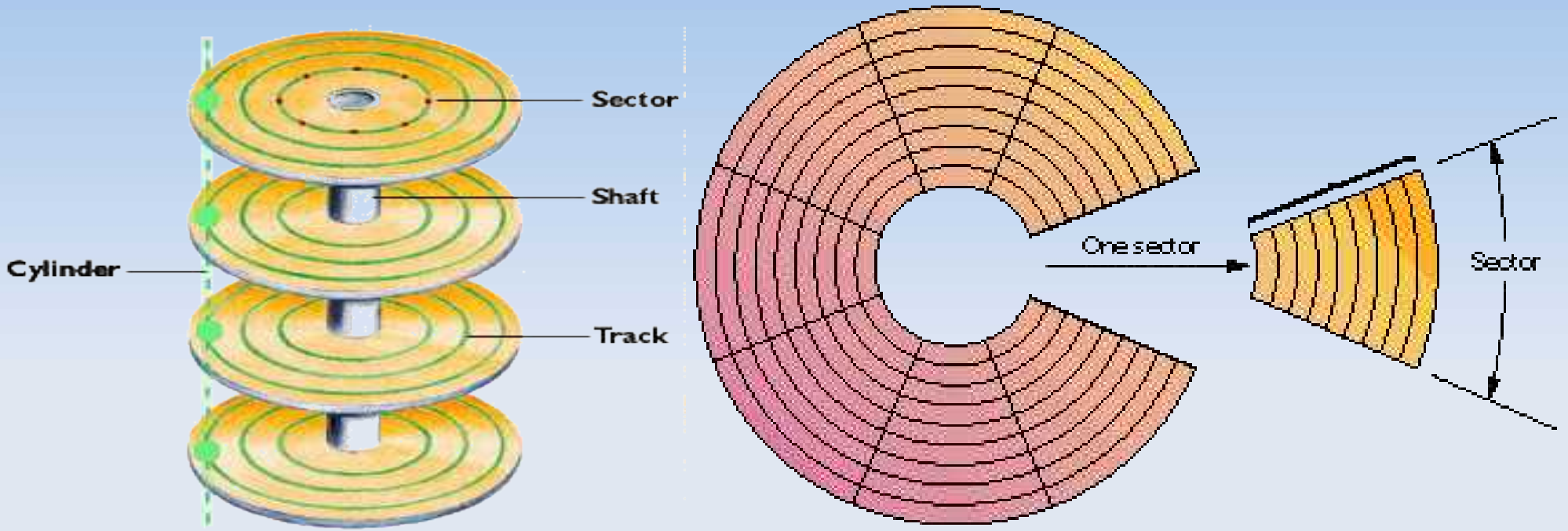


Heads

8 Heads,
4 Platters

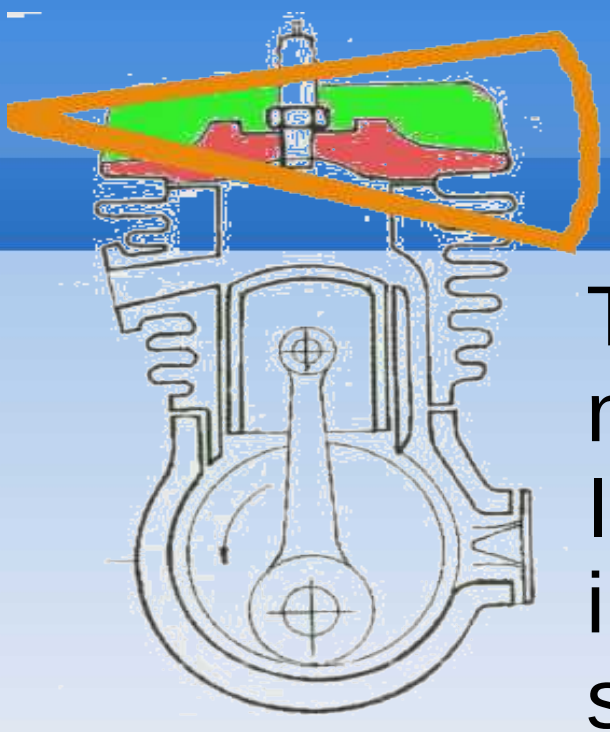
A Block (512 Bytes) is the intersection of a Sector and a Track.

CHS Hard-drive Layout #2



Originally there were physically 64 sectors (0 - 63) but sector 0 was reserved for use by the Hard-drive Controller and could not be seen by the BIOS or the OS. Therefore the standard has become

63 sectors per track, numbered 1 - 63



CHS - The way it was

The Cylinder Head Sector (CHS) notation is now an historical remnant. In the early 1990's LBA was introduced. Since then BIOS I/0 services have been able to operate using both forms of addressing.

- CHS uses a 24-bit number,
  C is 10 bits (0 - 1,023),
  H is 8 bits (0 - 255),
  S is 6 bits (1 - 63) no sector 0.

- This means CHS is limited to addressing 8GiB disks when using 512 byte sectors/blocks.

Cylinder Boundary.

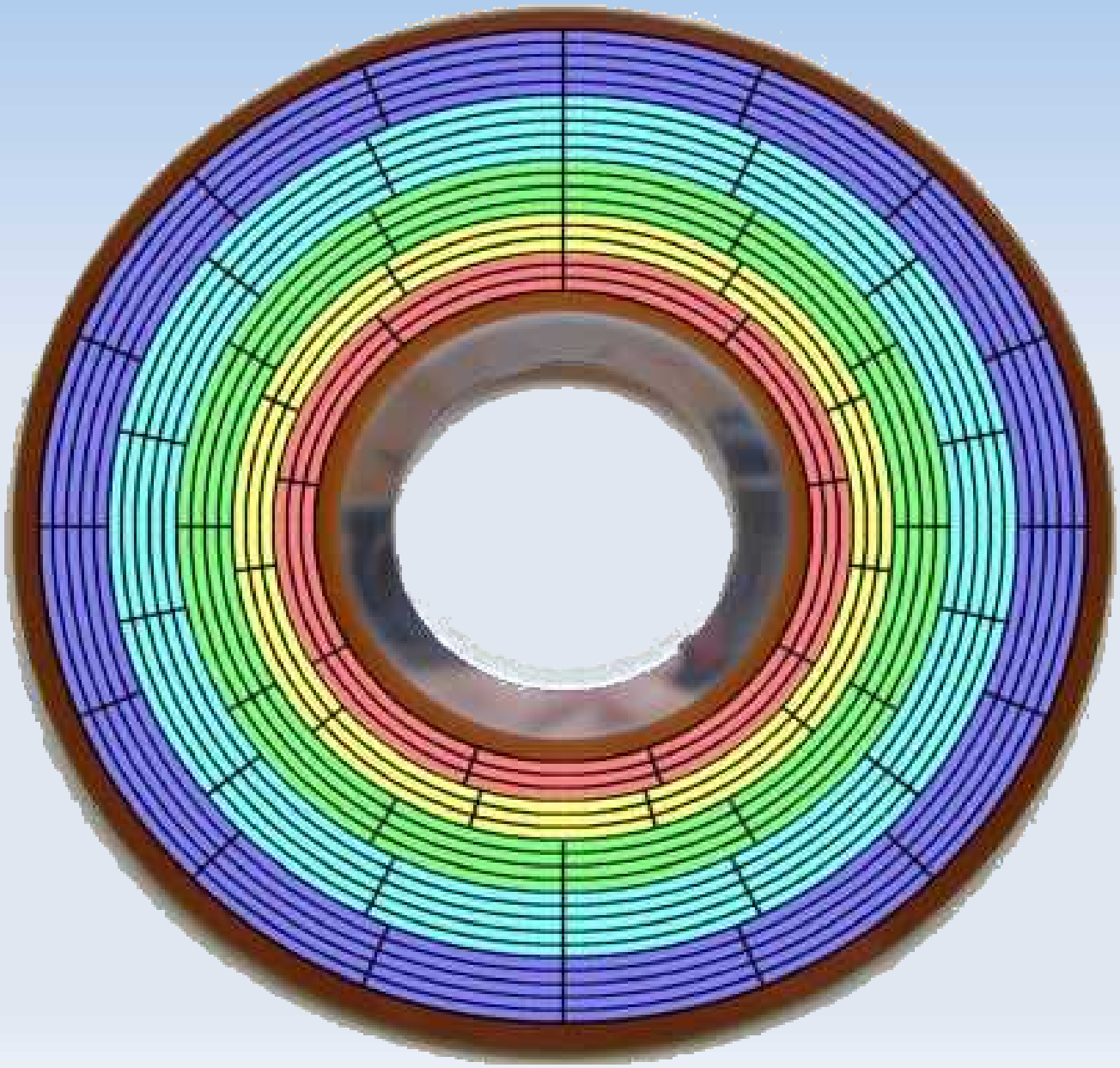
- On all Microsoft systems before Vista, each partition must start and end at a cylinder boundary.

Linux does not have this restriction.

Zoned Bit Recording (ZBR).

Each 512 byte block is approximately the same physical length.

The number of blocks per track varies with the location of the track on the platter.



ZBR Data Transfer Rate.

- The outside tracks on a ZBR disk have a data transfer rate that is about twice that of the inside tracks. This is because the linear velocity is higher on the outside edge of the platter.

To maximize machine performance. Place the partitions requiring fast access on the outside tracks i.e. in the low LBA range.

LBA the way it is today.

- Zoned Bit Recording uses **Logical Block Addressing (LBA)**
- LBA uses a 32 bit number
  0 to 0xFF FF FF FF or
  0 to 4,294,967,295 = 4Gi
- 4Gi multiplied by 512B/block = 2TiB
  (Hint, count the bits 32 + 9 = 41) .
- That is using 32 bit LBA with 512 bytes/sector gives sufficient addressing for disk sizes up to 2TB.

Quick Revision.

A Block is the (512 byte) intersection of a track and a sector.

Each block can be addressed by specifying a cylinder, head and sector (CHS).

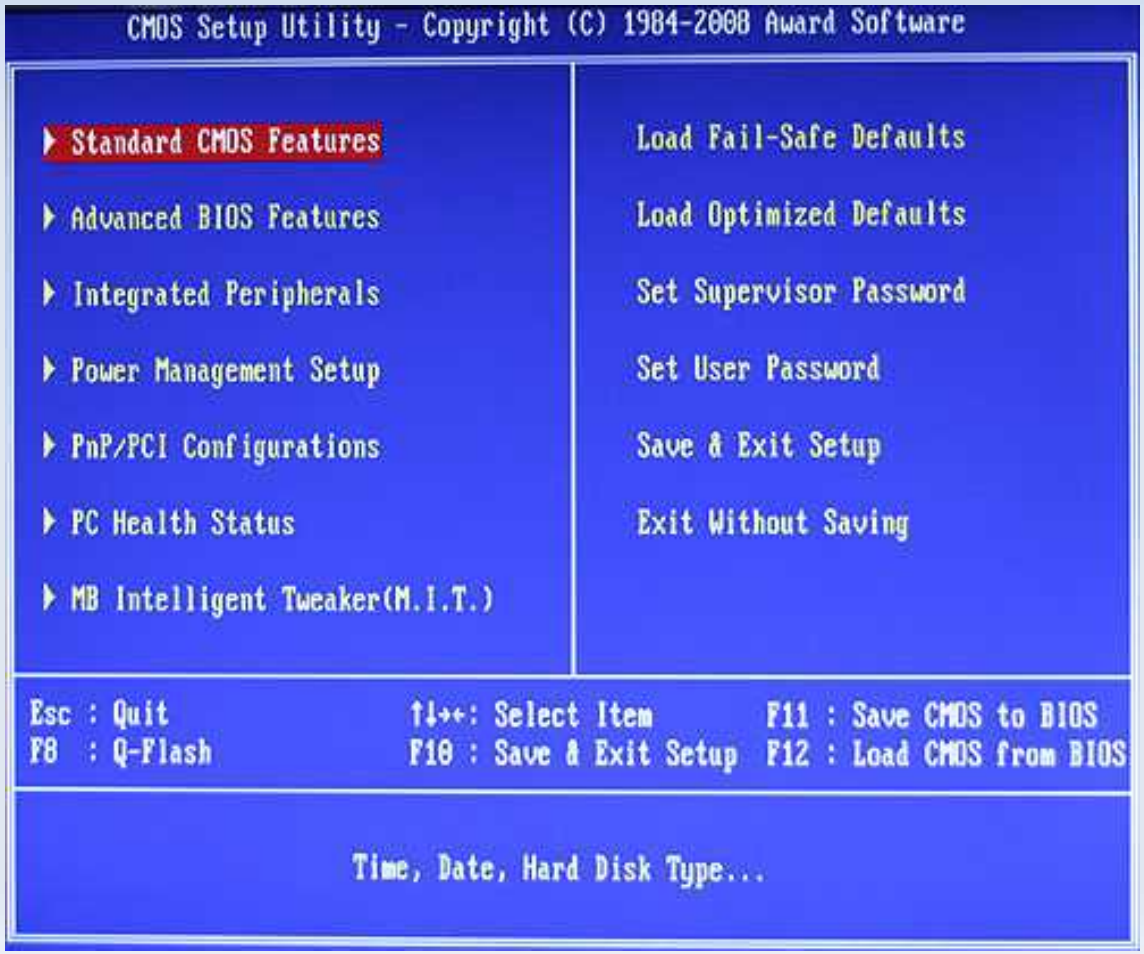
With the advent of Logical Block Addressing (LBA) it has become incorrect but common terminology to use the term sector when refering to a block.

The numbering of sectors on a track start from 1, LBA starts from LBA 0.

The PC BIOS.

The BIOS (Basic Input/Output System) is contained in ROM (Read Only Memory) on the computer's mother board.

The functions performed by the BIOS have changed very little from the 1981 release of the original IBM PC



The Main BIOS Functions.

1. perform the Power On Start Test (POST) which verifies that the hardware is O.K.

2. initialise the loading of the Bootstrap Loader or Initial Program Loader (IPL) that resides on the first sector of the boot device.

3. provide Hard-drive Input/Output services. That can be used by the Boot process and the OS. This function is used very briefly by the Grub boot loader and is not used at all by Linux.

From the Trivia Dept.
What is Bootstraping?

Bootstrap - a tab, loop, strap or lace on a boot to assist in pulling on a boot or securing a boot to the foot.

Bootstraping is.....

Bootstrap - a tab, loop, strap or lace on a boot to assist in pulling on a boot or securing a boot to the foot.

Bootstrapping is a self-sustaining process that proceeds without external help.

The origin of the term is attributed to the story "The Surprising Adventures of Baron Munchausen", where the Baron pulls himself out of a swamp, by his bootstraps.

Bootstraping a Computer.

The computer term bootstraping (later abreviated to booting) began as a metaphor in the mid 1950s.

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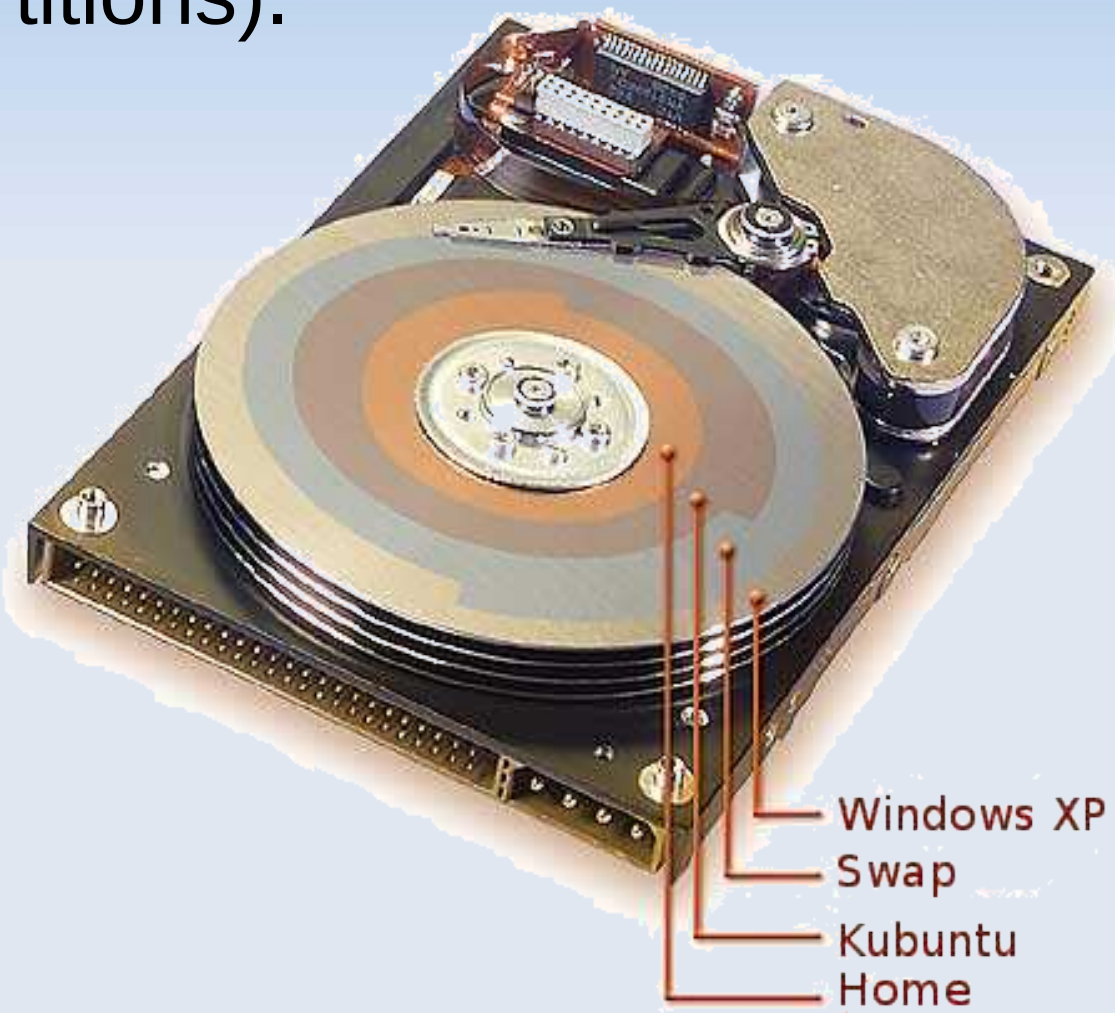
Pressing a bootstrap button initiates a very small bootstrap program contained in some form of ROM, which in turn reads a small program from disk (or tape) which reads a larger program from the disk (or tape) and by this means the process becomes self-sustaining.

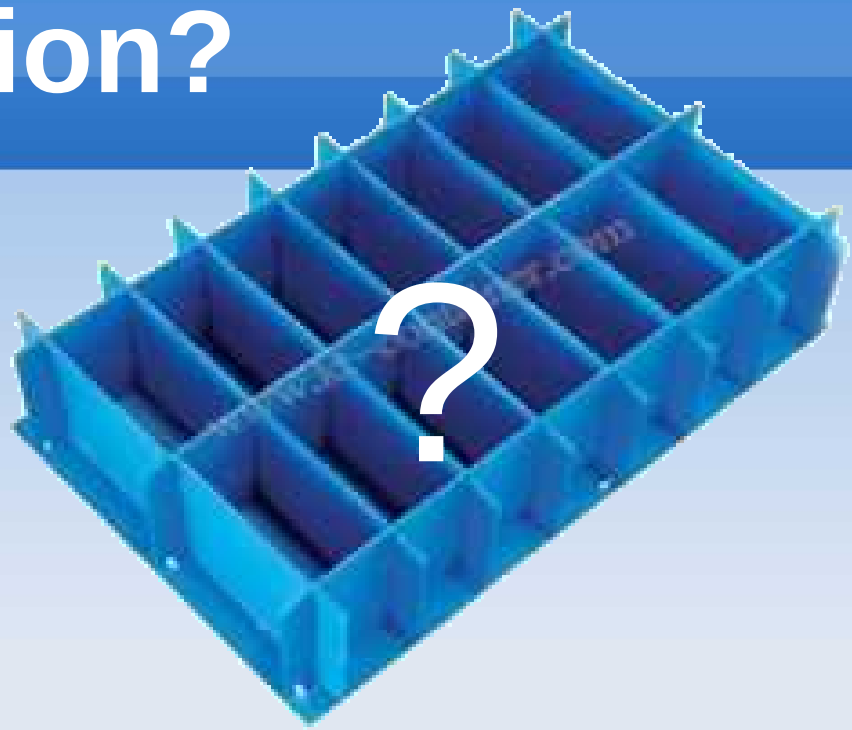
What is Disk Partitioning?

Disk partitioning is dividing the storage space into separate areas (partitions).

Partitioning provides separate areas for operating systems, virtual memory (swap space) and data.



Why Partition?



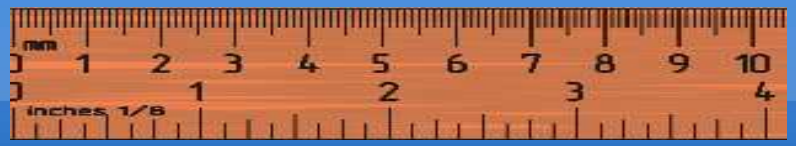
Provide Swap Space

Facilitate multi booting.

Protecting or isolating Data, to make backup and recovery easier.

"Short Stroking" improves performance by minimising performance-eating head repositioning delays .

PC Partitioning Rules.



1. A max. of four primary partitions, numbered 1 to 4.

2. Any one, but only one, primary partition may be designated as an extended primary partition; It will be designated partition 4.

3. The extended partition can only hold Logical partitions. Logical partitions start numbering from 5.

4. Logical partitions are contiguous, each logical partition has a pointer to the following logical partition.

5. There can be only one active boot partition.

The Master Boot Record (MBR) or the Boot-Table.

The MBR is 512 bytes long and is located at Logical Block Address (LBA) 0 on the boot device. LBA 1 - 62 (sectors 2 - 63) are not used by Microsoft.

Two useful reference documents.
List of partition identifiers http://www.win.tue.nl/~aeb/partitions/partition_types.html#toc1
Intro to Partition Types http://www.win.tue.nl/~aeb/partitions/partition_types-1.html

We Interrupt, for a word from our sponsor .

Matthew 20:16 "So shall the last be first, and the first last" herewith we Endian this Little lesson.

We Interrupt, for a word from our sponsor .

Matthew 20:16 "So shall the last be first, and the first last" herewith we Endian this Little lesson.

Little Endian means the little end bytes go first.
(Matthew worked for Intel that's why Intel have used the little endian convention ever since Adam was in rompers).

UUID (Universally Unique Identifier) is an identifier standard intended to provide unique identifier for devices or information.

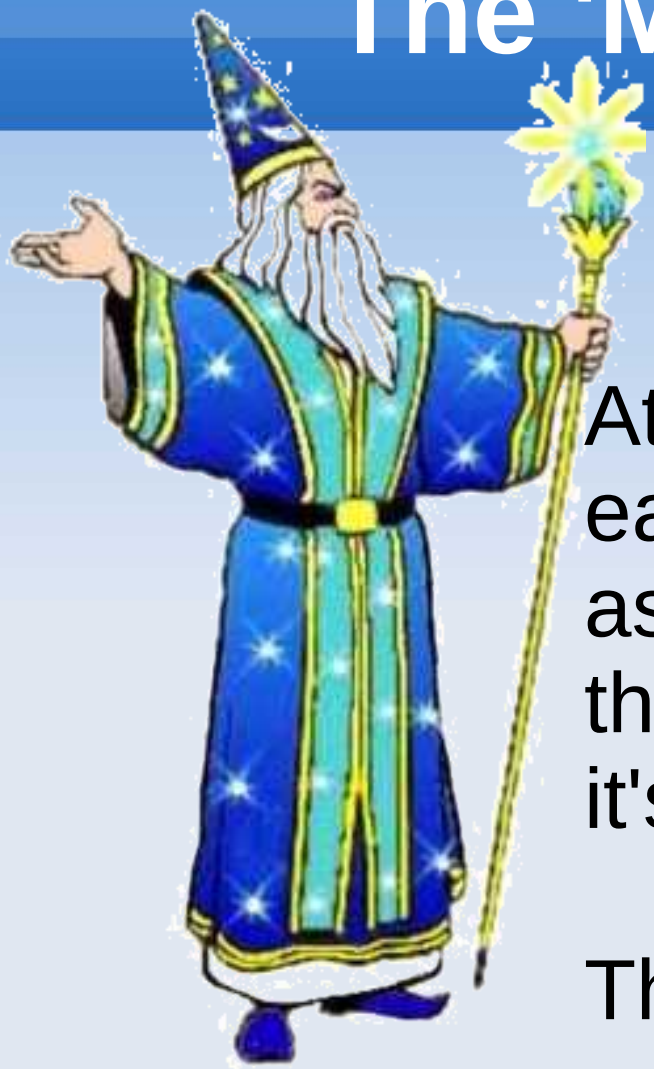
Address			The MBR		Size in
Hex	Oct	Dec	Description		bytes
0000	0000	0	Code area for the Initial Program Loader (IPL)		440
01B8	0670	440	~~Optional~~ Disk signature		4
01BC	0674	444	Usually Nulls; 0x0000		2
1BE	676	446	4 table entries, one for each Primary Partition. Any one, but only one Primary Partition can be used as an Extended Partition.		16
1CE	716	462			16
1DE	736	478			16
1EE	756	494			16
01FE	0776	510	55h	MBR signature; 0xAA55	2
01FF	0777	511	AAh		
MBR, total size: 446 + 64 + 2 =					**512**

Note on Disk Signature. (Previous Slide)

- If Vista cant find the the disk signature at location Dec. 440 or the signature has changed then bootmgr, will halt the boot process and display the message
  "winload.exe..... is missing or corrupt".

For more info go to http://www.multibooters.co.uk/mbr.html

The 'Magic Number' AA55



At Boot time the BIOS searches in turn each of the block devices that are listed as boot-devices, looking a device with the 'magic number' AA55 at the end of it's first block.

The first device it encounters that satisfies this criteria will be used as the Boot Device.

Offset	Field length (bytes)	Layout of one 16-byte partition record.
		Description
0x00	1	status (0x80 = bootable (*active*), 0x00 = non-bootable, other = invalid)
0x01	3	CHS address of first block in partition. The format is described in the next 3 bytes.
0x01	1	head
0x02	1	sector is in bits 5–0 ; bits 9–8 of cylinder are in bits 7–6
0x03	1	bits 7–0 of cylinder
0x04	1	partition type
0x05	3	CHS address of last block in partition. The format is described in the next 3 bytes.
0x05	1	head
0x06	1	sector is in bits 5–0; bits 9–8 of cylinder are in bits 7–6
0x07	1	bits 7–0 of cylinder
0x08	4	LBA of first sector in the partition
0x0C	4	number of blocks in partition, in little-endian format

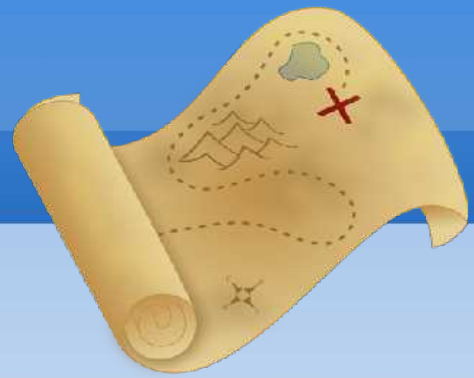
Extract from the previous slide.

Offset	Field length (bytes)	Description
0x00	1	status (0x80 = bootable (*active*), 0x00 = non-bootable, other = invalid)
0x04	1	partition type
0x08	4	LBA of first sector in the partition
0x0C	4	number of blocks in partition, in little-endian format

Some Partition Type Identifiers.

05¶	Extended·Partition,·(also·see·0F·below).¶
06¶	16-bit·FAT,·partition;·greater·than·or·equal·to·32·MB¶
07¶	Windows·NT·NTFS¶
07¶	exFAT··Extended·FAT,·a.k.a.·FAT64.¶
0C¶	32-bit·FAT,·using·INT·13·Extensions.¶
0E¶	16-bit·FAT·>=·32·MB,·using·INT·13·Extensions.¶
0F¶	Extended·Partition,·¶
27¶	Windows·Recovery·Environment·(RE)·hidden partition.·Reboot·and·press·F8·in·order·to·boot·into the·RE.¶
42¶	Secure·File·System,Windows·2000/XP·(NT·5)¶
84¶	Hibernation·partition·for·Windows¶
82¶	Linux·Swap·partition,·Prime·or·Solaris·(Unix)¶
83·¶	Linux·native·file·systems·¶
93¶	Hidden·Linux·native·partition¶

The Treasure Map
The MBR.



To inspect an MBR on the first hard-drive.
This is an extract from - sudo hexedit -s /dev/sda

```
00000160   7D E8 3A 00 EB 06 BE 8B   7D E8 32 00 BE 90 7D E8   }.:.....}.2...}.
00000170   2C 00 CD 18 EB FE 47 52   55 42 20 00 47 65 6F 6D   ,.....GRUB .Geom
00000180   00 48 61 72 64 20 44 69   73 6B 00 52 65 61 64 00   .Hard Disk.Read.
00000190   20 45 72 72 6F 72 00 BB   01 00 B4 0E CD 10 AC 3C    Error.........<
000001A0   00 75 F4 C3 00 00 00 00   00 00 00 00 00 00 00 00   .u..............
000001B0   00 00 00 00 00 00 00 00   7A C4 05 00 00 00 80 01   ........z.......
000001C0   01 00 83 FE 3F 10 3F 00   00 00 92 2A 04 00 00 00   ....?.?....*....
000001D0   00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 FE   ................
000001E0   FF FF 83 FE FF FF 47 41   75 02 19 1C C8 02 00 FE   ......GAu.......
000001F0   FF FF 05 FE FF FF 60 5D   3D 05 61 80 0C 12 55 AA   ......`]=.a...U.
```

83=Linux 00=Not Used 05=Extended

0x05 3D 5D 60 = 87,907,680
Pointer to LBA of the EBR for Partition 4.

0x12 0C 80 61 = 302,809,185
Size of partition in blocks

The Extended Boot Records (EBR)

The Extended Boot Record is a rather messy work-around the fact that the design of the BIOS/MBR system is way past its 'use-by date' and is not really suited for modern systems.

Google - Extensible Firmware Interface (EFI) and
- GUID Partition Table (GPT)

The previous slide showed the partition record for Partition 4 pointing to an Extended Boot Record.

The Logical Partitions (Partition 5 and above) reside inside Partition 4.

The Chain-linked EBR

The Extended Partition 4 contains contiguous (chain linked) Logical Partitions.

The EBR for partition 4 will point to an EBR for Partition 5 which will in turn have a pointer to the EBR for Partition 6 etc. etc.

The EBR's have a format that is similar to the MBR.

'Bout time, Whad'ya Reckon?

Time's Up!

What a little Treasure !
GParted.

/dev/sda - GParted

GParted Edit View Device Partition Help

New Delete Resize/Move Copy Paste Undo Apply /dev/sda (186.31 GiB)

/dev/sda3
22.25 GiB

/dev/sda5
144.38 GiB

Partition	File System	Mount Point	Size	Used	Unused	Flags
/dev/sda1	ext2		133.32 MiB	30.23 MiB	103.09 MiB	boot
unallocated	unallocated		19.53 GiB	---	---	
/dev/sda3	ext3	/	22.25 GiB	8.92 GiB	13.33 GiB	
/dev/sda4	extended		144.39 GiB	---	---	
/dev/sda6	linux-swap		7.78 MiB	---	---	
/dev/sda5	ext3	/home	144.38 GiB	76.35 GiB	68.03 GiB	

0 operations pending

Treasures for the Command Line Freaks.

RU a command line hardliner? Try these.

sfdisk - a partition table manipulator
Trap! sfdisk description is in 1,024 Blocks
sudo sfdisk -l /dev/sda (Ctrl+C - unconditional quit)

parted - another partition table manipulator
sudo parted -l

block device id - filesystem type and uuid
sudo blkid /dev/sda1

convert hex to dec: echo $((0xff))

Grub

GRUB the GRand Unified Boot Loader is a Multi-boot loader.

The IPL part of the MBR is the first software program that runs after the BIOS POST.

The IPL part of Grub in the MBR calls the part of grub normally resident in track 0 which loads the kernel into memory which in turn loads the rest of the operating system.

Grub

Once the Kernel is operating the Boot Loader (GRUB) ceases to function until the next system boot.

The Windows Boot Process

XP boot - the IPL loads NT Loader (NTLDR), which uses system configuration data contained in boot.ini.

Vista boot - the IPL loads the Windows Boot Manager (BOOTMGR) which uses system information in the Boot Configuration Data (BCD) database.

Grub1 Grub2

GRUB1		GRUB2	
Drive names must be enclosed in parenthesis ( )			
There is no distinguishing between serial & parallel. | All Hard drives start with hd. Floppy disks start with fd.			
Drive numbers start from zero.			
Partition numbers start at 0 Example		**Partition numbers start at 1** Example	
Linux	**Grub1**	**Linux**	**Grub2**
sda1	**(hd0,0)**	**sda1**	**(hd0,1)**
The partition number for an extended partition is always 4.			
Good GRUB Guides http://ubuntuforums.org/showthread.php?t=1195275 https://wiki.ubuntu.com/Grub2 http://kubuntuforums.net/forums/index.php?topic=3106368.0			

Chain Loading.

Chain-loading refers to the process whereby one boot-loader calls-up (executes) another boot loader loader.

An example of this is when GRUB calls-up the Windows loader NTLDR (XP) or BOOTMGR (Vista) which in turn loads Windows.

Tips.

- Windows likes be first on the primary partition.
- On old hardware the BIOS may only be able to access the first 1024 cylinders, so it may be necessary to install a small Linux Boot partition immediately before or after the Windows partition and within the first 1024 cylinders.
- Ideally GRUB should be on a primary partition, this is not a technical requirement but it does make disaster recovery a little easier.

Windows Wacky Terminology.

The system files are those in the, System32 Folder.
The system files must be in a primary partition.

The boot (or startup) partition is the disk partition that includes the Windows operating system (OS) files in the directory WINDOWS or WINNT, but not necessarily the *system files* required for booting.

Reference.
http://technet.microsoft.com/en-us/library/bb457124.aspx

Windows Bitlocker the Partition Encryption Program

On most XP and some Vista installations, the system and boot partitions are the same partition (drive C:).

However if Bitlocker, (the windows partition encryption tool) is installed it requires a separate, unencrypted system partition of at least 1.5 gigabytes. This will usually be on the first partition.

MS System Partition Info.
http://support.microsoft.com/kb/309531/en-us
Use the Bootrec.exe tool in Vista recovery.
http://support.microsoft.com/kb/927392/en-us

Primary Partition Hogs.

A lot of OEM Vista installs such as some Toshibas, hog three primary partitions!

- Partition 1 contains Vista *system* files and the Bitlocker files (~1.5 – 2 Gb),
- Partition 2 is the Windows C: drive and
- Partition 3 is used for system recovery files.

One or two of the above mentioned partitions may have 'hidden' partition type identifiers and will not show up on Windows Explorer.

The Track0 Trap

Track0 in the following context refers to LBA 1-62

Some Windows software producers use Track0 to store licensing information because it cannot be easily seen, modified or replicated by Windows users.

GRUB uses part of Track0

These two factors in combination can cause you grief if you have not 'dd & saved' Track0 before dual booting with Linux!

Getting in & Doing it!

- Will Linux work on the h/w?
  First try it out with a live CD.
- Problem areas are typically Wireless, Inbuilt Webcams, Inbuilt Microphones and Cannon printers.

- Familiarise yourself with the system including,
  The number of drives,
  Size of the drives,
  Number of partitions, (don't forget some may be hidden!!)
  The use of each partition.

Doing it!

- Is using two separate drives an option? If so, do so!
- Develop a new partition plan.
- Put Linux on at least 2 partitions, Root and Home.
- If you are going to be using Linux to rip/burn CD/DVD's make sure you have allowed enough headroom in the Root partition for the 'tmp' directory to expand to accommodate the temporary storage required. Up to 10 GiB for a dual layer DVD.

Partition Plan Considerations the 1024 Cylinder Limit .

- On old hardware the BIOS may be limited to 1024 cylinders.
- Linux does not use the BIOS for disk access and can operate from partitions outside the 1024 cylinder limit, if the Boot Partition containing GRUB is within the 1024 limit.
- The Windows partition must be within the 1024 cylinder range.

Doing it!

Clean your Windows and backup.

Create a restore point.

Run the virus checker.

Defrag the Drive.

Backup the data files or better still, clone the drive.

Create another restore Point.

Belt 'n Braces.

Use Gparted to check the partition usage,or
sudo dd bs=512 count=1 skip=0 if=/dev/sda | od -Ax -tx1z
and inspect the MBR.

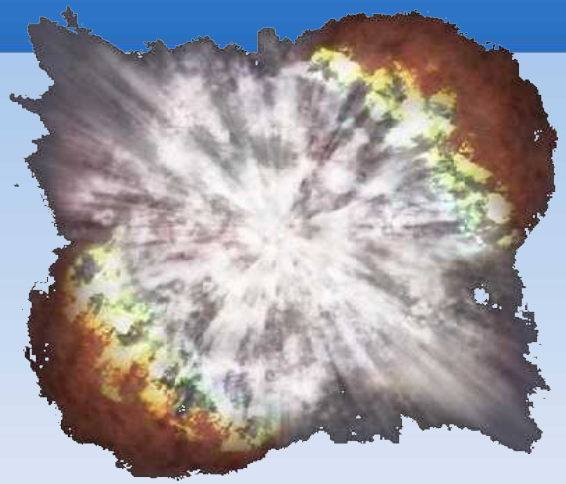
Back up the MBR to usb flash. This backup includes winwows IPL (boot program)
sudo dd bs=512 count=1 skip=0 if=/dev/sda of=/media/xx/bak_win_mbr

Or if there is a chance that other Windows s/w may be using track 0 back up the lot.
sudo dd bs=512 count=63 skip=0 if=/dev/sda of=/where-ever/bak_win_track0

Partition, dd MBR, Install.

- Use GParted to shrink existing partitions and create the new partitions.
- Check the Windows system is OK
- You now have a new MBR - dd the MBR to usb flash again - use a different file name.
  sudo dd bs=512 count=1 skip=0 if=/dev/sda of=/media/xx/bak_grub_mbr
- Install your chosen distro - choose manual partitioning to install the system the way you want it.
- Congratulations - Job well done!

dd Restorations.



Take great care with dd.
dd can be a data destroyer by accidentally overwriting valuable data with incorrect info.

The following command will restore the Windows Boot Prog + Disk signature to the MBR but preserves the new partition table.

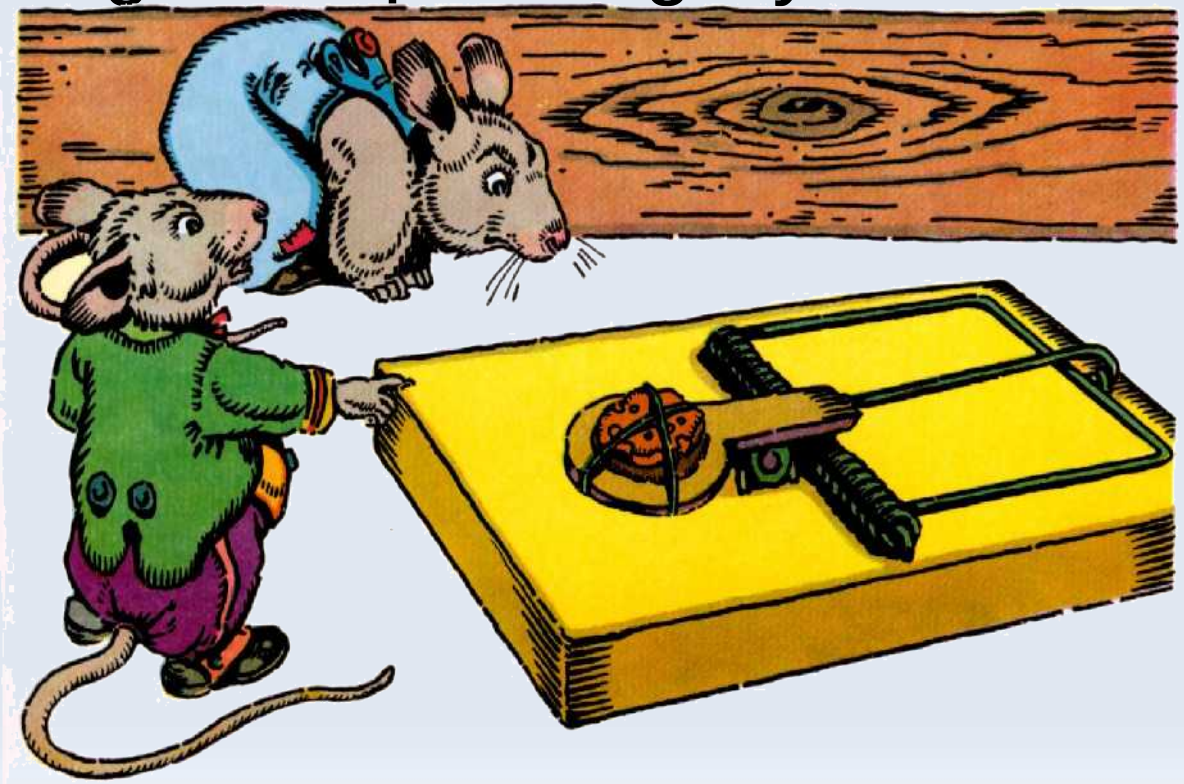
```
sudo dd bs=446 count=1 skip=0 if=/media/xx/bak_win_mbr of=/dev/sda
```

This command will restore the the new grub based MBR including the partition table.

```
sudo dd bs=512 count=1 skip=0 if=/media/xx/bak_grub_mbr of=/dev/sda
```

Don't Say You Weren't Warned

If things don't go the way you expect, don't use **Windows System Recovery** in an attempt to fix it. *System Restore will probably destroy all the data on drive C:* in the process of recovering the Operating System files.



Your Toolkit.

- The Live CD/DVD for your favourite distro.
- dd - learn how to use the dd command, but take care dd can be a data destroyer!!
- Clonezilla to clone drives and partitions
- GParted partition editing tool.
- Super GRUB - a good tool for installing GRUB in many configurations.


That's all Folks!

The End.