



Exploring New Ideas Reaching New Heights

## Operating Systems Installations

## OS Seminar Agenda (Saturday)



- ▶ Operating Systems ✓
- ▶ File Systems ✓
- ▶ Partitioning Rules ✓
- ▶ MBR & Booting ✓
- ▶ BIOS ✓
- ▶ GParted – Partitioning ✓
- ▶ Windows 7 Installation ✓
- ▶ Disk type & nomenclature ✓
- ▶ Boot loaders ✓
- ▶ Open Solaris Installation ✗
- ▶ Disk size Issue ✓
- ▶ PC BSD Installation ✓
- ▶ Q & A
- ▶ Boot Flag tweaking ✓

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## Before you begin

### Hardware

- ① CPU: Core i3+
- ② RAM: 4GB+
- ③ Disk: \*Disk1 = 250GB+ } SATA disks  
Disk2 = 120GB+
- ④ Graphics Card: On-board

### BIOS

- ① Virtualization: Enabled (VT-x)
- ② Boot mode: UEFI / Legacy
- ③ Secure Boot: OFF
- ④ Boot order
  - ⓐ CD/DVD
  - ⓑ USB/Removable disk
  - ⓒ Disk
- ⑤ Network Boot: disabled.

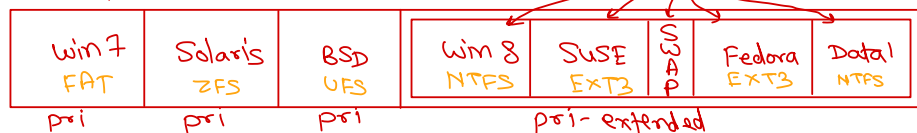
### Partitioning

✓ GParted Live

partition map → GPT

MAC	TM	Data2
HFS+	HFS+	FAT

Partition map → MBR



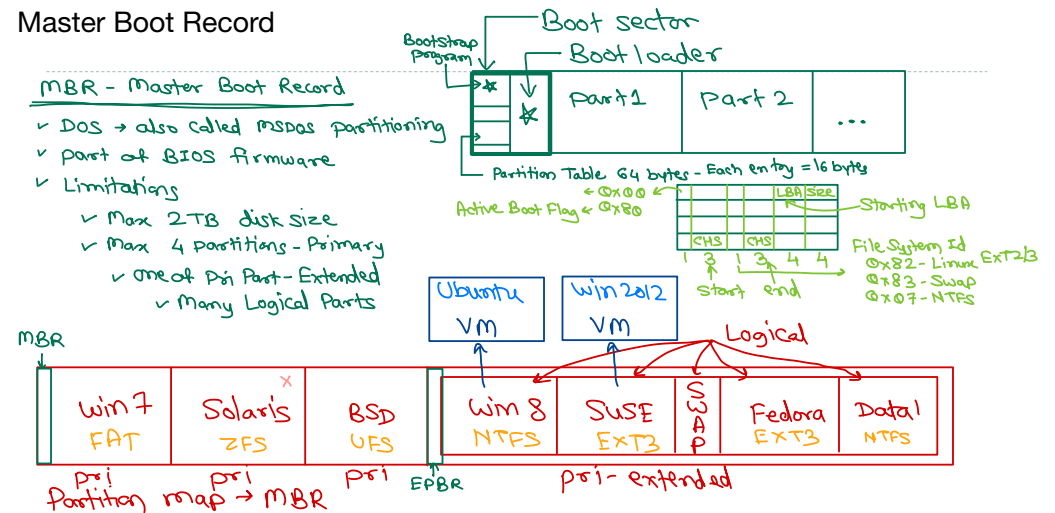
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## Master Boot Record

### MBR - Master Boot Record

- ✓ DOS → also called MSDOS partitioning
- ✓ part of BIOS firmware
- ✓ Limitations
  - ✓ Max 2TB disk size
  - ✓ Max 4 partitions - Primary
  - ✓ one of Pri Part - Extended
  - ✓ Many Logical Parts



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## Installation rules

- ① Windows
  - BL must be installed on first primary partition.
  - Next windows versions can be installed on Pri or Logical.
  - Higher version windows must be installed after lower version.
- ② Solaris
  - BL must be within 1024 cyl boundary (approx. 10 GB).
  - Must be on Primary partition.
- ③ BSD UNIX
  - Must be on Primary partition.
- ④ Linux
  - Any partition.
- ⑤ Mac OS X
  - First Primary Partition, GPT

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## Windows 7 and Solaris Installation

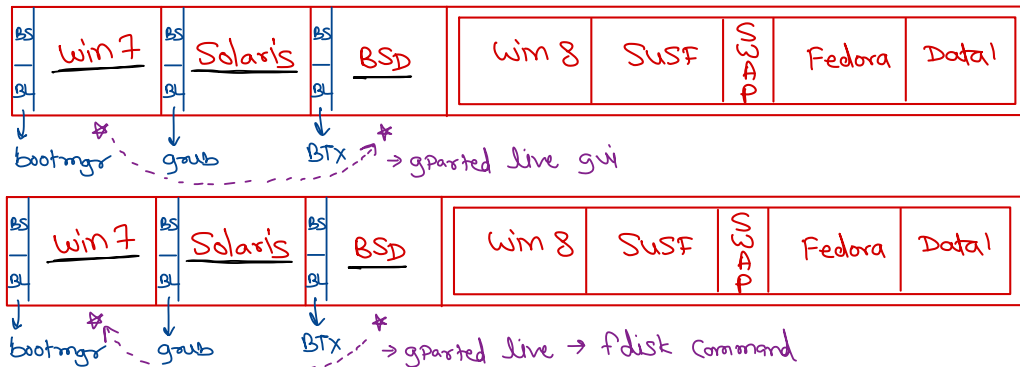


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## PC-BSD Installation and Boot flag tweaking

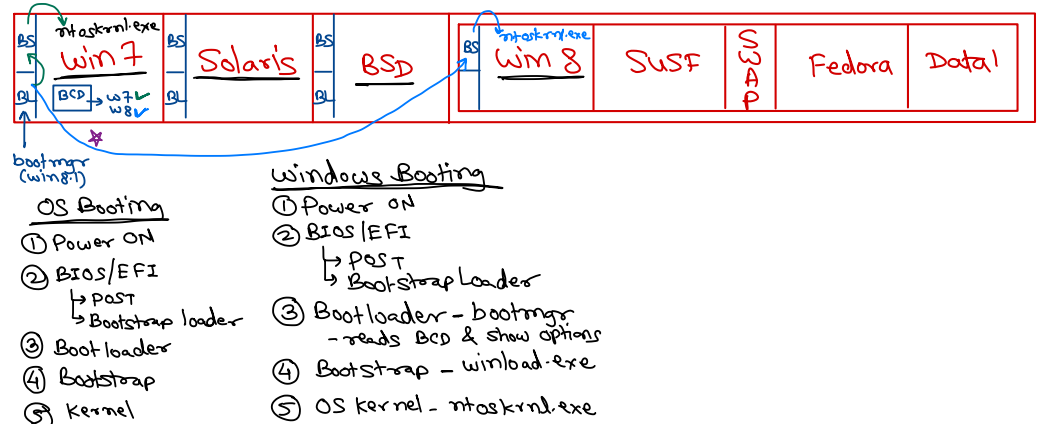
BSD installation → Bootloader = None



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## Windows 8 Installation and Windows Booting



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## Windows Fast Booting

### OS execution

- ① Hw session
  - ↳ hw initialization
  - ↳ CPU, RAM, chipset
- ② System session
  - ↳ System services
  - ↳ network, security, login, ...
- ③ User session
  - ↳ after user login
  - ↳ apps executed by user

### Sleep

- ↳ RAM contents frozen
- ↳ CPU & devices in low power state
- ↳ Needs less power → RAM refresh.
- ↳ On wakeup → RAM unfrozen & devices+CPU in normal power state.

### Hibernate

- ↳ RAM contents suspended & written to disk.
- ↳ CPU & all devices (+RAM) are power off
- ↳ On wakeup → power on & suspended contents loaded back in RAM from disk &

### Shutdown

- ↳ user session is closed (apps terminated)
- ↳ System session is closed (services stopped)
- ↳ power down.

### windows 8

#### - hybrid shutdown

- user session is closed (apps terminated).
- System session hibernated. (saved on disk)
- power down.

### windows 8

#### - fast boot

- Boot after hybrid shutdown.
- Power on (hw session)
- System session is restored
- login screen.

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## Which Operating Systems?

- Windows 7 (W) → Popular for end users
  - ✗ Solaris (S) → Java, ZFS, Most used Unix server OS
  - PC-BSD (P) → Closest to UNIX, 7 things, Network, UFS
  - Red-Hat (L) → Admin, RHEL - most used Linux server
  - SuSE (L) → Good for all.
  - Ubuntu (L) → Community Support, Good for beginners/dev.
  - Windows 2012 (W) → Admin windows.
  - Windows 8.1 (W) → Popular for end users
  - Mac OS X (M) → Hybrid kernel, Artists, Fluid UI, Robust.
- last version - 2003.06
- OpenBSD
  - FreeBSD
  - PC-BSD ✓
  - NetBSD
  - DragonFly BSD

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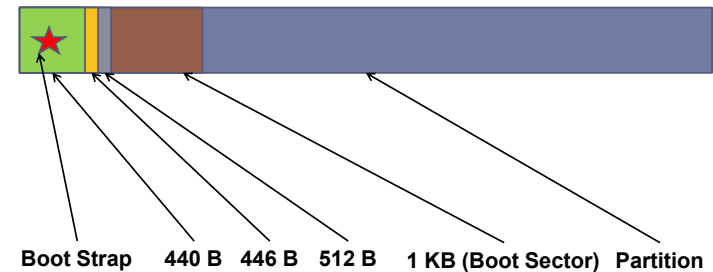
## Important Linux Distros

- RedHat / Fedora
- SuSE
- Mandriva / Mandrake
- Ubuntu
- Gentoo
- Knoppix
- Slackware
- Debian
- Cent OS
- Kali Linux
- RTLinux
- uC Linux

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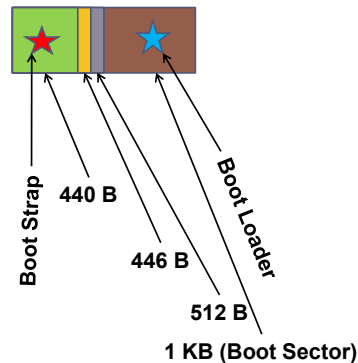
## Boot Partition and Bootstrap Program



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## Boot Sector



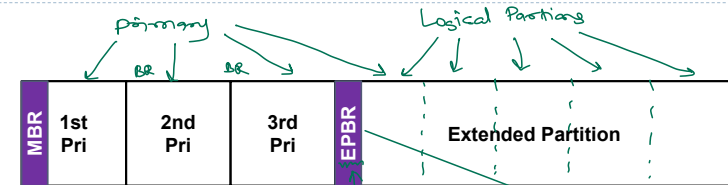
Boot Sector = 1024 B

440B:Boot Strap  
4B:Vendor Disk Sign  
2B:null  
64B:Partition Table  
2B:fdisk Sign (0xAA55)  
512B:Boot Loader

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## MBR and EPBR



BR = Bootstrap Program (if bootable) + partition Boot record  
MBR = Master Boot Record  
= Boot Record + Partition table  
EPBR = Boot Record + Logical Partition's partition table.

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## Boot Loaders → Config file

- Windows:
    - NTLDR : New Technology Loader (boot.ini) ← windows NT to windows 2003 Server
    - BootMgr : Boot Manager (BCD-BootConfig Data) ← windows vista & onwards (bcd) → manipulation utility → bcdedit
  - Linux:
    - GRUB : Grand Unified Bootloader → GrUB 1.x, GrUB 2.x (menu.lst, grub.cfg)
    - LiLo : Linux Loader
  - Solaris:
    - SiLo : SPARC Improved Loader (Open Solaris → GrUB)
  - BSD:
    - BTX : Boot eXtended
  - Mac OS X:
    - BootCamp → Darwin (BSD kernel)
    - Chameleon/Chimera } Hackintosh BL
    - Clover } Hackintosh BL
- Embedded Linux  
- uBoot → uEnv.txt
- ↳ Hacked Mac → to install on any x86 PC.

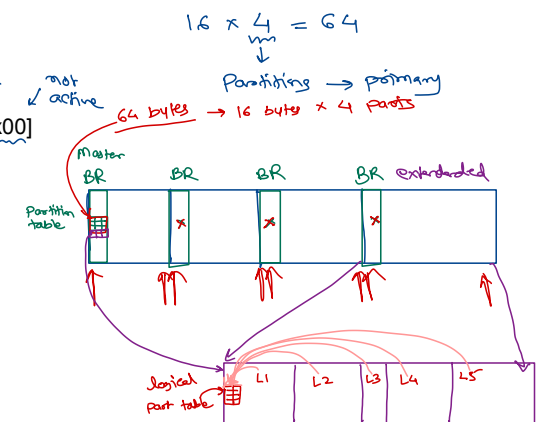
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## Partition Table

### Partition table [64 B]

- Each entry of 16 Bytes.
- One entry in partition table
  - 1: Active Flag [0x80 or 0x00]
  - 3: Starting CHS
  - 1: File System Hex number
  - 3: Ending CHS
  - 4: Starting LBA
  - 4: Number of Logical blocks



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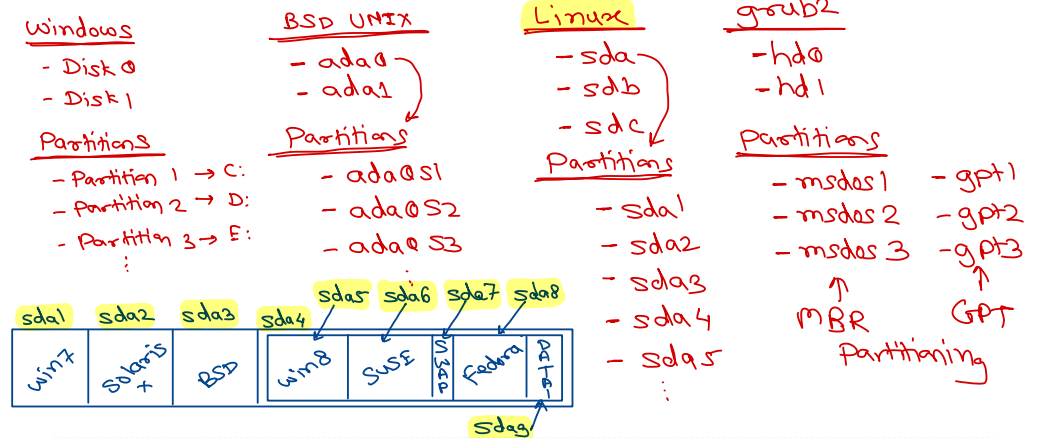
## File System Identifiers

- ▶ 0x0C: FAT32
- ▶ 0x07: NTFS
- ▶ 0x0B: Extended DOS 0x0F
- ▶ 0x83: ext3
- ▶ 0x82: swap
- ▶ 0xAF: HFS
- ▶ 0xBF: Solaris
- ▶ 0xA5: UFS

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## Disk Nomenclature



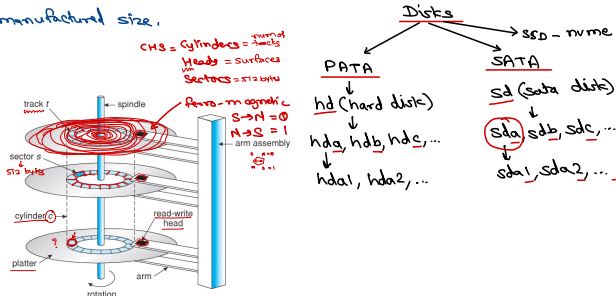
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## Disk size & Nomenclature

Disk size is always detected, then manufactured size.

- ① SI to CHS conversion  
1000 1024
- ② CHS to LBA conversion  
 $LBA = ((C * H * S) + H * S) + 1$
- ③ File system data structures  
\* boot block, \* super block, \* inode list & data blocks.  
format → make file system (mkfs)
- ④ rounding to cylinder boundary.



IF disk size < 1TB:  
Detected size ≈ 0.91 \* manufactured size

IF disk size > 1TB:  
Detected size ≈ 0.93 \* manufactured size

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## OS Seminar Agenda (Sunday)

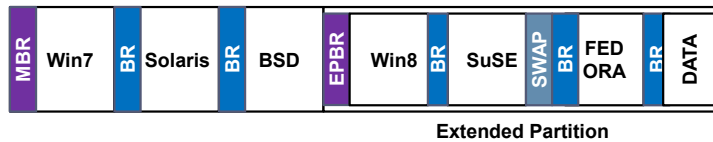


- ▶ Ubuntu Installation
- ▶ Q & A
- ▶ Grub Tweaking ✓
- ▶ Fedora Core Installation ✓
- ▶ UEFI
- ▶ Mounting ✓
- ▶ GPT
- ▶ MAC OS X Installation
- ▶ Q & A
- ▶ Windows 8.1 Installation ✓
- ▶ Win8.1 Booting & bcdedit ✓
- ▶ OpenSUSE Installation ✓
- ▶ Grub Re-installation ✓
- ▶ Virtualization Details ✓
- ▶ Win2012 Server Installation ✓

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## Partition Table



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## Windows 7 Booting

- ▶ General OS Booting:
  - ▶ Firmware → Bootloader → Bootstrap → Kernel
- ▶ Windows 7 Booting:
  - ▶ Firmware → bootmgr → winload.exe → ntoskrnl.exe
  - ▶ "bootmgr" config file is "bcd" i.e. Boot Config Data

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## Windows 8 Fast Booting

- ▶ Normal OS Booting:
  - ▶ Hardware session (Firmware)
  - ▶ Kernel session (OS)
  - ▶ User session (User)
- ▶ Hybrid shutdown:
  - ▶ User session is closed normally (faster than hibernate).
  - ▶ Kernel session (faster than shut down).
  - ▶ Hardware session closed normally.
- ▶ Fast booting:
  - ▶ Hardware session begins (faster with UEFI).
  - ▶ Kernel session resume (faster with multi-core).
  - ▶ User session starts normally.

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## Boot Config Data

- ▶ Ntldr maintain config data in a file called "boot.ini".
- ▶ Bootmgr maintain config data in a file called "bcd".
- ▶ Each entry has four main parts:
  - ▶ Identifier : GUID → unique 128 bit number (nic id + time) - internally struct.
  - ▶ Device : Drive Name → e.g. partition = C:
  - ▶ Path : File path on drive → e.g. \windows\system32\winload.exe
  - ▶ Description : Title to display on boot screen. - e.g. "windows 7", "windows 8.1"
- ▶ BCD can be modified using "bcdedit" tool.
- ▶ Third party GUI software is "EasyBCD". It internally uses "bcdedit".

friendly names  
 {bootmgr}  
 {current}  
 {default}

Admin  
 cmd> bcdedit /set {current} description "New Title"

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## Making Linux Entry in BCD

- ▶ Execute steps from Linux / Rescue system:
  1. dd if=/dev/sda3 of=linux.bin bs=512 count=1
  2. Copy "linux.bin" to C: (by mounting).
- ▶ Execute steps from Windows 7/8:
  3. `bcdedit /create /d "Linux XYZ" /application bootsector`
  4. `bcdedit /set {ID} device partition=c:`
  5. `bcdedit /set {ID} path \linux.bin`
  6. `bcdedit /displayorder {ID} /addlast`
  7. `bcdedit /timeout 30`

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## Re-install grub

- ▶ Follow the steps from "Rescue Option":
  1. `# grub`
  2. `grub> find /boot/grub/stage1`
  3. `grub> root (hd0,5)`
  4. `grub> setup (hd0)`
  5. `grub> quit`
  6. `# reboot`

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## Re-install grub2

- ▶ Follow the steps from "Rescue Option":

- ▶ Boot from SuSE Rescue option.

- ▶ mount /dev/sda3 /mnt 

- ▶ mount --bind /dev /mnt/dev

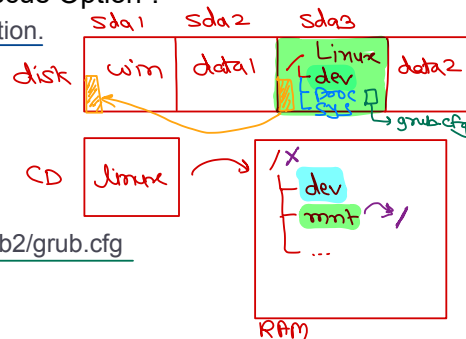
- ▶ chroot /mnt

- ▶ mount /proc

- ▶ mount /sys

- ▶ grub2-mkconfig -o /boot/grub2/grub.cfg

- ▶ grub2-install /dev/sda



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## Re-installing windows bootloader

- ▶ Execute the command from Recovery console:

- ▶ bootsect /nt60 ALL /force /mbr

- ▶ Here

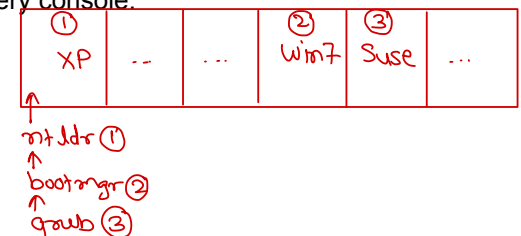
- ▶ nt52 → Windows XP
- ▶ nt60 → Windows Vista & Windows 7
- ▶ nt61 → Windows 7 SP1
- ▶ nt62 → Windows 8
- ▶ nt63 → Windows 8.1

- ▶ From Win98 CD we can remove latest bootloader from MBR using command:

- ▶ fdisk /mbr

- ▶ From Win7/8 DVD we can remove latest bootloader from MBR using command:

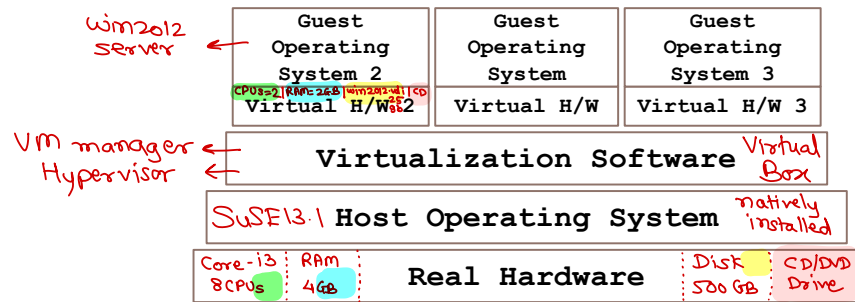
- ▶ bootrec /fixmbr



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## Virtual Machine

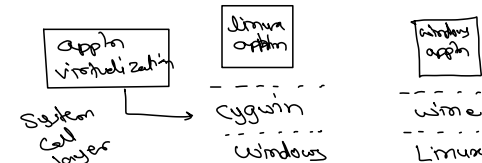


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## Virtualization Softwares

- ▶ VMWare ✓ (w, m, L)
  - ▶ Parallels ✓ (m)
  - ▶ Virtual PC ✓ (w)
  - ▶ Hyper V ✓ (w)
  - ▶ Virtual Box ✓ (w, m, L)
  - ▶ XEN or KVM (L)
- OS Virtualization
- ▶ DOS Emulator → x86 CPU + Dos
  - ▶ Q Emulator → ARM/MIPS/x86 + Linux, ...
  - ▶ BOSCH → hw/cpu virtualization
  - ▶ WINE → windows apps on Linux
  - ▶ CygWin → Linux apps on Windows → syscalls/API virtualization



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## Virtualisation

### applications

- ① appn development
- ② appn deployment
- ③ appn testing
- ④ network simulation

### advantages

- ① resource sharing
- ② maintainence
- ③ compatibility
- ④ economical

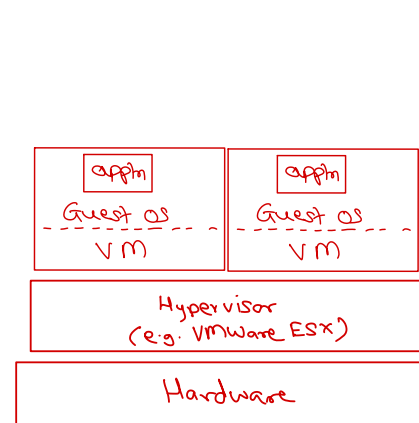
### limitations

- ① hw intensive apps
- ② hw level development
- ③ graphics apps

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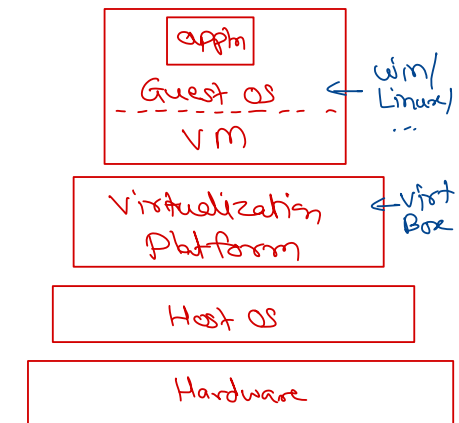
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## Virtualisation Type I



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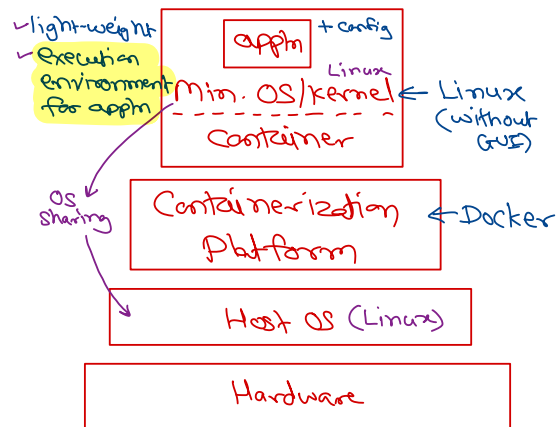
## Virtualisation Type II



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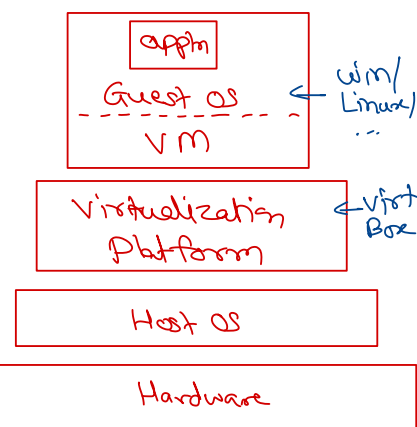
## Containerisation



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## Virtualisation



mounting: → accessing external fs in current fs.

windows:

↳ auto-mounting  
↓  
automatically execute mount command

modern linux:

↳ auto-mounting  
↓  
auto execute mount cmd.

`sudo mount -t fstype partition mount point`

`sudo mount -t ext3 /dev/sda8 /mnt`

...

`sudo umount /mnt`

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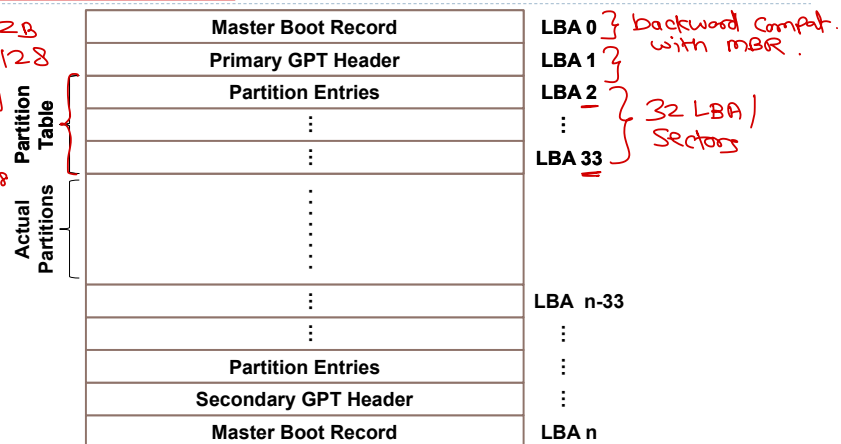
## GUID Partition Table

Max Disk = 8 ZB  
Max parts = 128

One Part Entry = 128 bytes

Size of Part Table = 128 x 128 = 16 KB = 32 sectors

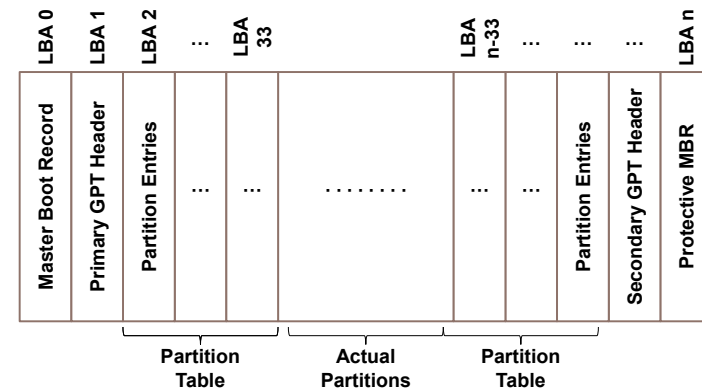
Sector = LBA



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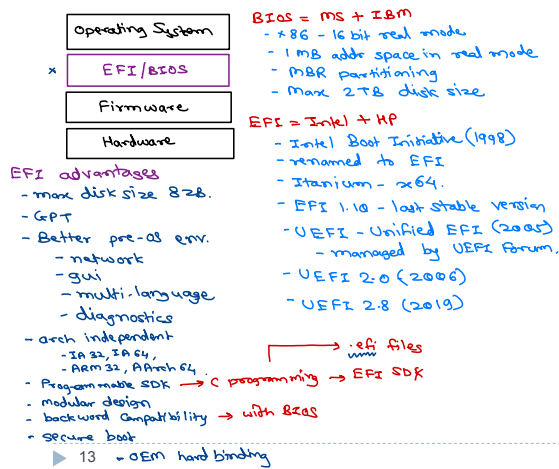
## GUID Partition Table



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## EFI (Extensible Firmware Interface).



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### EFI System Partition (ESP)

- Stores EFI apps & Bootloaders
- FAT File system
- In Linux mounted under /boot/efi

Ubuntu → EFI bootmgr  
 Windows → Easy UEFI ✓

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### vmlinuz (Linux Kernel)

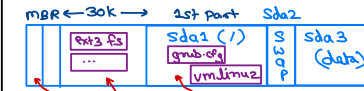
- task mgmt
- scheduler
- system calls
- basic memory mgmt
- io subsystem

Static Components of Linux Kernel

grub loads vmlinuz in memory & it gets extracted (self).  
 Kernel needs a temp file system that contains basic drivers and other files, until root fs is avail from the disk. This in-memory temp fs is given in **initrd** or **initramfs**.

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## Linux booting



GrUB → Stage 1, Stage 1.5, Stage 2

init startup levels = runlevels : Systemd targets

- > init 0 → shutdown
- > init 1 → single user mode (rescue system) - root login
- > init 2 → multi user - user login ... like safe mode windows.
- > init 3 → with network - CLI based
- 4 → reserved (unused)
- > init 5 → with gui ← graphical-target
- > init 6 → reboot
- > man 7 boot
- > man 7 bootup

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## Important Files of Different OS

### DOS files

- io.sys → device drivers
- msdos.sys → kernel
- command.com → shell

### Windows 3.x files

- io.sys
- msdos.sys
- command.com
- 386spart.par → Page File (swap area)
- emmm386.exe → memory management
- wina20.386 → A20 gate

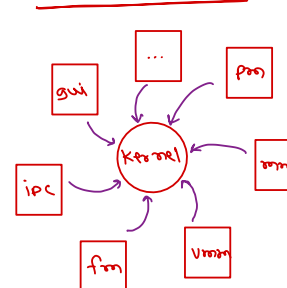
### Windows NT files

- hal.dll → hardware abstraction layer
- pagefile.sys → swap file
- ntldr → boot loader
- boot.ini → boot loader config file
- ntdetect.com → basic hw detection for start
- ntoskrnl.exe → kernel
- bootsect.dos → bootstrap
- ntbootdd.sys → scsi disk driver used while booting.

### Linux files

- vmlinuz - kernel
- initrd - init ram disk

### Modular Kernel



### modules

- .dll/.sys : windows
- .so/.ko : Linux

### Windows update

- improved modules are downloaded on the system.
- replace the old modules
- next reboot loads as with new modules.

### Linux Kernel

- \* ① monolithic → vmlinuz
  - task mgmt
  - scheduler
  - system calls
  - basic memory mgmt
  - io subsystem
- ② modular → /lib/modules/x.ko
  - file systems
  - device drivers
- ③ micro-kernel
  - x server → gui

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1965: AT&T, GE, MIT  
Target: Multi-tasking, Multiuser OS } MULTICS (R&D)

1968: AT&T stopped project  
Team: Thompson, Ritchie,...

1969: new project - Office editorial System  
Requirement: Multiple files by Multiple users - manage.

1970: UNICS → UNIX  
Developed on: PDP-7  
Language: PL/1, assembly

1971: C language by Ritchie

1973: UNIX on PDP-11 → C & assembly

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## UNIX flavours

UNIX - AT&T

BSD UNIX - UCS

AIX - IBM

Solaris - Sun Microsystems

HP-UX - HP

dg-UX - Data General

IRIX - SGI

Xenix - Microsoft

SCO UNIX - Santa Cruz Ops

Mac OS X - Apple

...

XINU - Comer

MINIX - Tenenbaum

Linux - Linus Torvalds 1991

→ follow same philosophy but implemented from scratch - different code/implementation

UNIX needs a standard

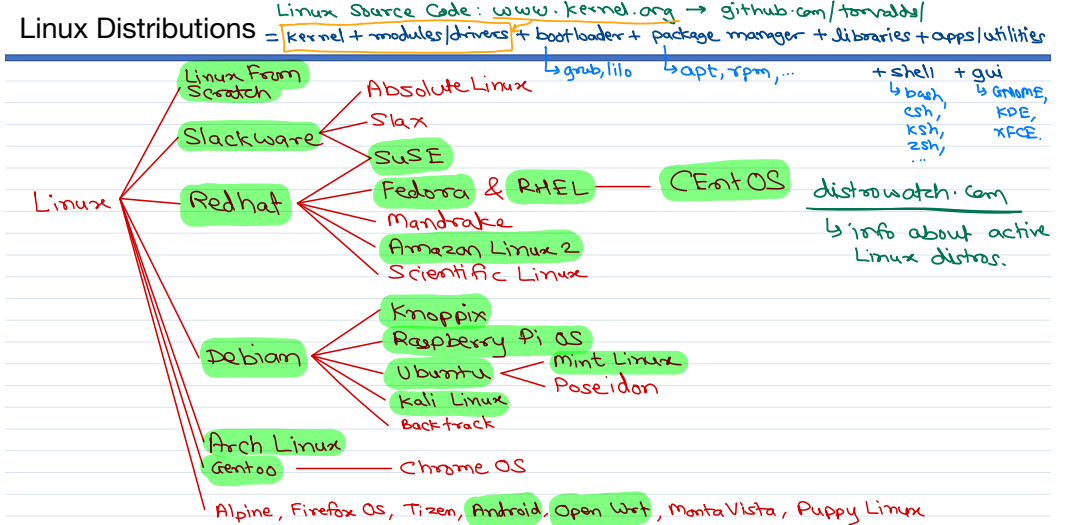
✓ X/Open - MIT

✓ POSIX - IEEE

1983 - OSF  
GNU project  
Richard Stallman

→ Linux → GNU Linux  
← contributed by many developers

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Thank You!