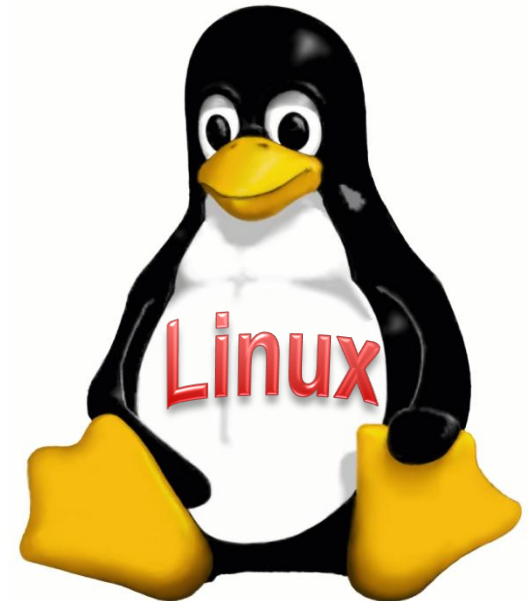
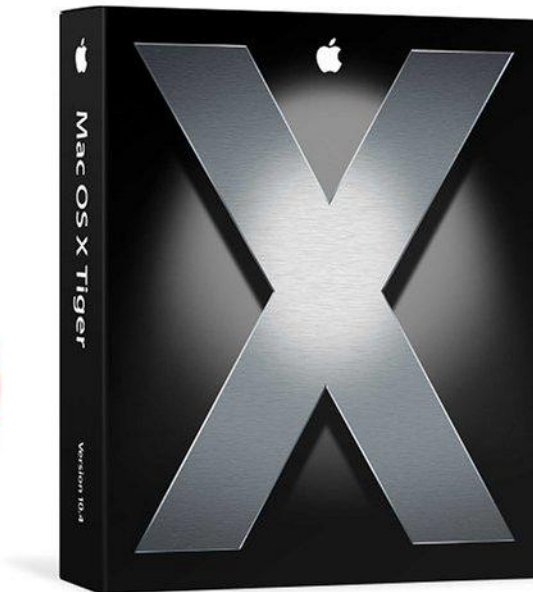


Operating Systems

What are they and why do we care?

interface	NTFS
CLI	Posix
GUI	ext3, ext4 etc.
File systems	HFS-Plus
ACLs	ISO-9660
Journaling	Virtual file system
Unicode	Virtual machine
64 bit vs 32 bit	NFS
Platform	SAMBA
FAT (FAT16, FAT32)	AFP

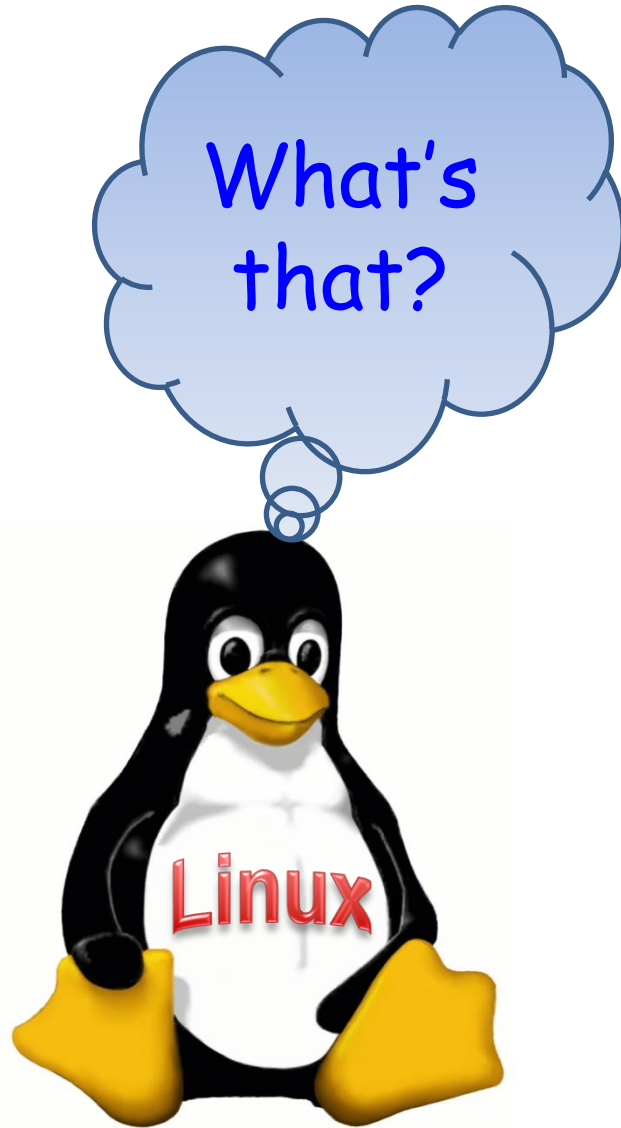
The OS (Operating System) is the "host" software on the computer: Windows XP, Mac OSX, Linux.....



Why do you care?

When you select an operating system, you want to know that it can run on your hardware.

The OS needs to recognize the hardware and have "drivers" for it.

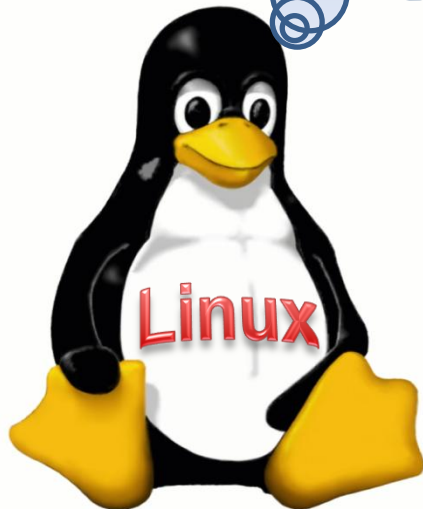


This situation
is a problem



You want your OS to take full advantage of the hardware.

I don't know
what 1000
speed is, I'll
just use 100.



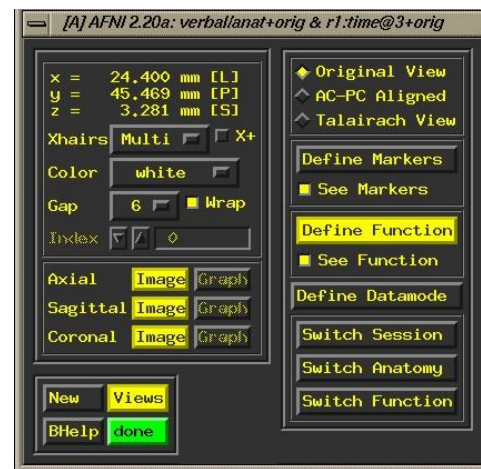
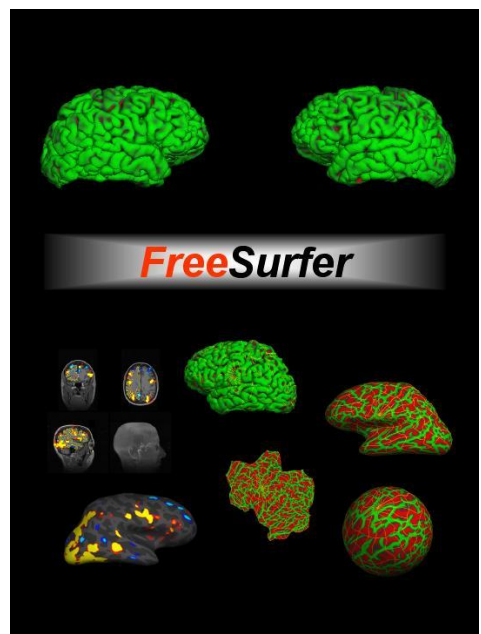
Your OS should also run the applications (programs) you want.

I don't know
what these
are



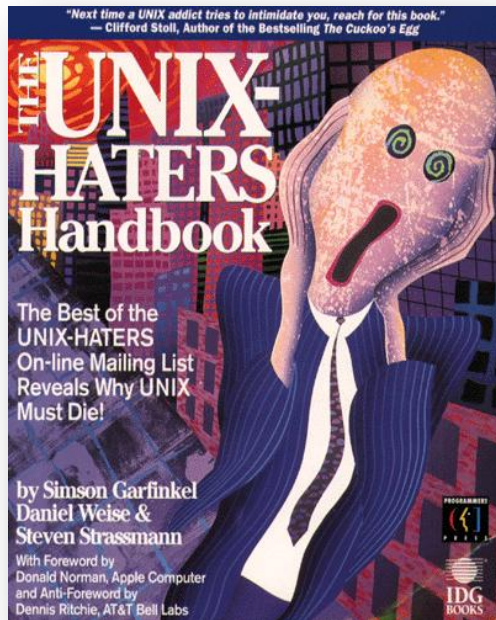


I don't know what these are



AND, finally

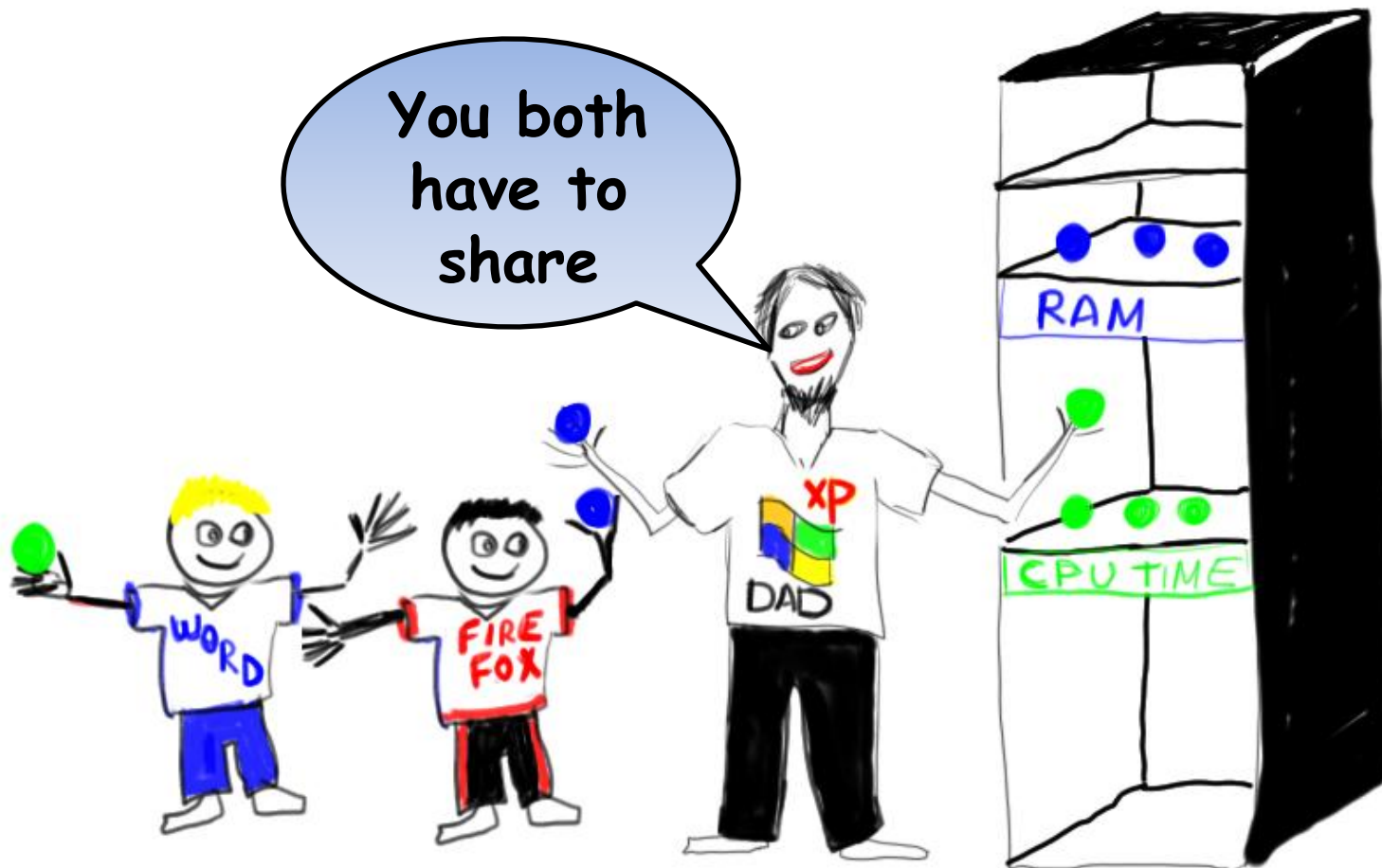
You want an OS you can stand to work with it.



Microsoft®
Stop Making Fun of Us.

What does the OS do?

The OS is responsible for allocating hardware resources (e.g., **cpu**, **ram**, devices) to the applications.



OS meets Hardware: 32 bit & 64 bit (again)

The majority of the 32-bit operating systems and applications are able to run smoothly on the 64-bit hardware.

64 bit hardware is now commonplace.

64 bit operating systems are available, but not as common as the hardware.

So, how do they interact?

64-bit architectures indisputably make working with large data sets in applications such as digital video, scientific computing, and large databases easier.

However, there has been considerable debate as to whether 64 bit systems run 32-bit applications any faster than comparably-priced 32-bit systems.

64 bit vs 32 bit

	32 bit OS	64 bit OS
32 bit hardware	OK	X
64 bit hardware	OK	OK

	32 bit apps	64 bit apps
32 bit OS	OK	X
64 bit OS	OK	OK

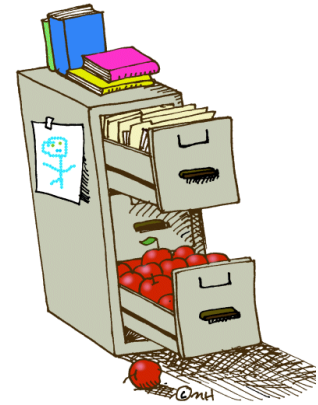
Hardware + OS = Platform

The particular combination of the hardware and operating system is called the **platform**.

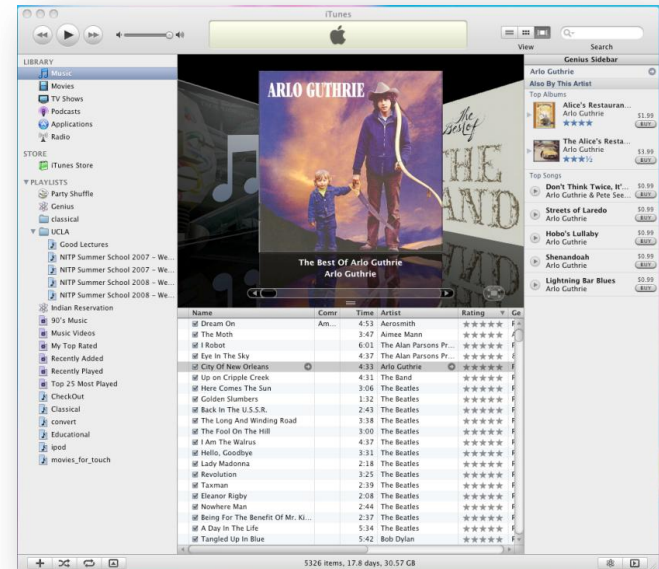
Many programming languages require that you compile source code into binaries for each separate platform where it will run.

Organization You See

- The OS organizes your stuff by using files, directories and links (aliases).
- It also provides interfaces for you to interact with:
 - **CLI** (commandline interface: typing)
 - **GUI** (graphical user interface: mousing)



```
Default (97,35)
[seth:/Exps/Data/dti_erp 49] % ls
Dat_Files      e3131      e4171      e4774      probx1
Lobes          e3393      e4175      e4866      probx2
PB_notes.txt   e3472      e4200      e4867      probx3
PNG            e3515      e4205      e4929      probx4
Readme.txt     e3559      e4280      e4934      quad_l_list
TBSS_ERP       e3591      e4287      e4940      quad_r_list
Test           e3647      e4327      e4942      right_list
arc_l.txt      e3717      e4362      e4976      rois_nii
arc_r.txt      e3740      e4364      e4978      rois_pretty
arc_rois       e3824      e4368      e4979      rois_useful
bistensor.dat  e3825      e4379      e4986      rois_wm
bistensor2.dat e3826      e4394      e5008      rois_wm_subj
bvols          e3835      e4411      e5016      slf2_l.txt
bvocs          e3888      e4430      e5052      slf2_r.txt
cingl_l.txt    e3936      e4446      e5052      subjectlist.txt
cingl_r.txt    e3956      e4453      e5052      subjectlist2.txt
cing_l.txt     e3998      e4456      e5052      thresh.txt
cing_r.txt     e4115      e4459      e5052      unc_l.txt
clean_tracts   e4125      e4535      e5052      unc_r.txt
cst_l.txt      e4140      e4617      e5052      lobe_l_list
cst_r.txt      e4150      e4736      e5052      lobe_r_list
[seth:/Exps/Data/dti_erp 50] %
```



But, behind the scenes, there
is a lot more going on.

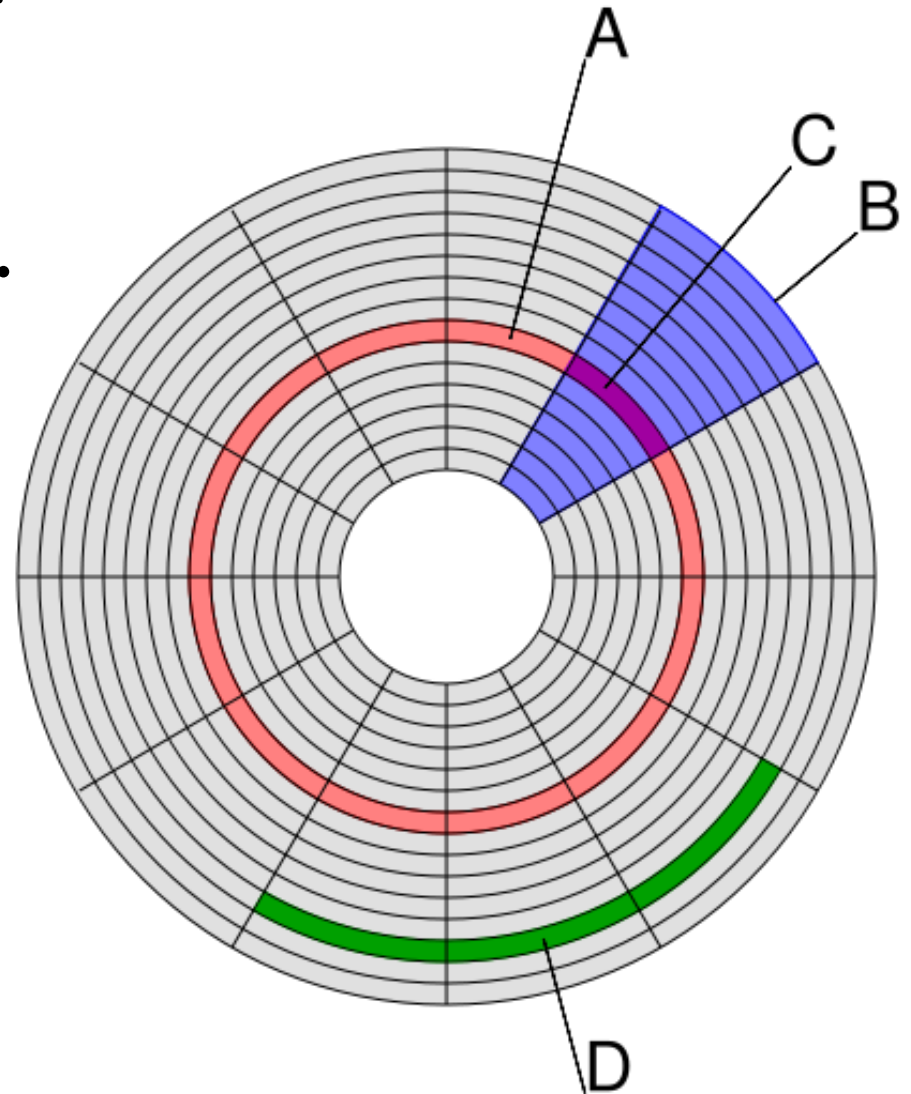
File Systems

Underneath each OS is a file system that organizes files and directories on the storage medium (e.g., the hard drive).

File systems maintain an index to the physical location of files on a data storage device.

Different indexing schemes have advantages and disadvantages.

e.g., The indexing scheme can limit the maximum number of **clusters** the file system can address.



Flat vs Hierarchical Systems

A flat filesystem stores all files at the top level (DOS 1.0 and early mac OS).

Even if you had the illusion of directories, you could not have files with the same names in different directories.

Hierarchical systems (allowing true directories and subdirectories) quickly became the norm.

Permissions

Early OS's did not have any way to control what users could do to files.

Traditional unix permissions have fairly simple "read, write and execute" attributes on files and directories.

ACLs (Access Control Lists) provide an extra ~~nightmare~~ detailed layer of control.

Journaling File systems

A journaling file system logs changes to a journal (usually a log in a dedicated area) before committing them to the main file system.

Such file systems are less likely to become corrupted (fragmented) in the event of power failure or system crash.

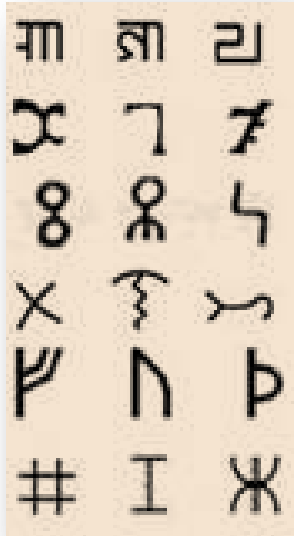
However, journaling requires more read/write operations and is hard on flash (e.g., SSD) drives (which have limit read/write life cycles)

ASCII vs Unicode

古書市ご米場のお客様は
1階正面玄関へお越し下
さいませ。

Early OS's used ASCII with 128 characters

However, as computing has become worldwide, it has become important to natively support a LOT more characters.



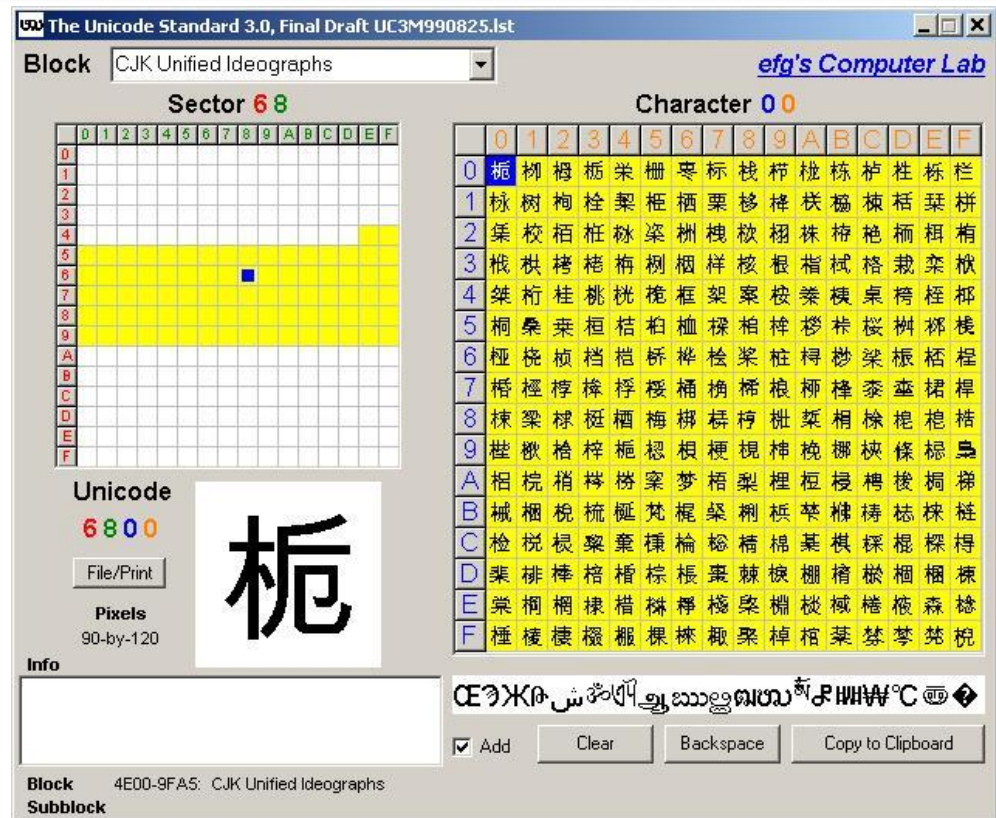
நீராரும் கடலுடுத்த நிலமடந்தைக் கெழிலொழுகும்
சீராரும் வதனமெனத் திகழ்பரதக் கண்டமிதில்
தெக்கணமும் அதிற்சிறந்த திராவிடநல் திருநாடும்
தக்கசிறு பிறைநுதலும் தரித்தநறுந் திலகமுமே
அத்திலக வாசனைபோல் அனைத்துலகும் இன்பமுற
எத்திசையும் புகழ்மணக்க இருந்தபெருந் தமிழணங்கே!
தமிழணங்கே!

உன் சீரிளமைத் திறம்வியந்து
செயல்மறந்து வாழ்த்துதுமே!
வாழ்த்துதுமே!
வாழ்த்துதுமே!

மனோன்மனியம் பெ. சுந்தரம் பிள்ளை

0	1	2	3	4
⠠	•	••	•••	••••
5	6	7	8	9
⠡	•	••	•••	••••
10	11	12	13	14
⠢	•	••	•••	••••
15	16	17	18	19
⠤	•	••	•••	••••

Most modern OSs support unicode.



File System Summary

Modern OSs are hierarchical and use journalling to reduce data corruption.

They provide permissions, to help protect your data and support privacy on multi-user systems.

They support multiple languages and fonts natively.

64 bit systems can handle bigger hard drives, more memory and bigger chunks of data.

But File systems aren't just for OS's:

File systems for OS's

CD/DVD file systems

Virtual File systems

Network File systems

FAT File Systems

FAT (File Allocation Table)

- FAT 16 (uses 16 bits per entry)
- FAT 32 (uses 32 bits per entry)

Invented by Bill Gates and Mark McDonald
1976-77.

Very simple, widely supported (Windows, Linux, MAC can read FAT and it is used for memory cards, USB keys etc.)



FAT 16

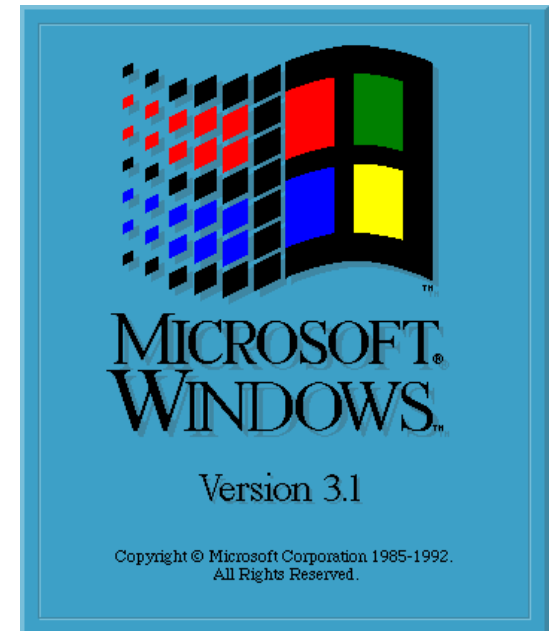
FAT 16: Could not address more than 2GB of storage.

Filenames limited to 8.3:

- iam8char.txt is okay
- iam8characters.txt is too long

Subject to fragmentation

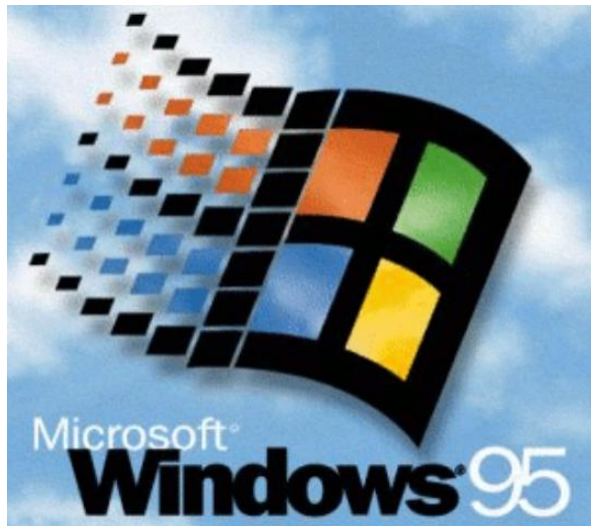
No file permissions



FAT 32

Could address 4 TB of storage (but Windows OS limited HD to 127 GB to support scandisk utility)

255 characters allowed in filenames



NTFS

Added file permissions

Journaling system

Unicode support

64 bit versions became available

16 EB (max HD or file)

Was proprietary so other OS's
(linux, mac) had trouble reading it.

Not POSIX compliant



What's Posix?

The Posix standard defines a set of criteria for all unix-type systems to adhere to.

Microsoft does not fully support Posix

Apple's original OS did not support Posix

All unix systems support the standard: sun, sgi, linux,
mac osx

Linux Filesystems

POSIX compliant

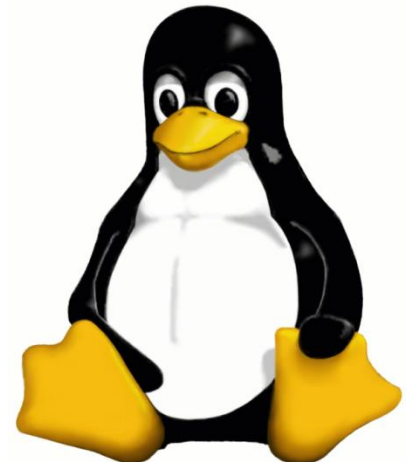
Permissions

ext3 (2001) was the first of the ext filesystems to provide journaling.

- safer than ext2, but slower
- 16TB HDs, 2 TB files

ext4 (Dec 2008)

- 1 EB HDs and 16 TB files



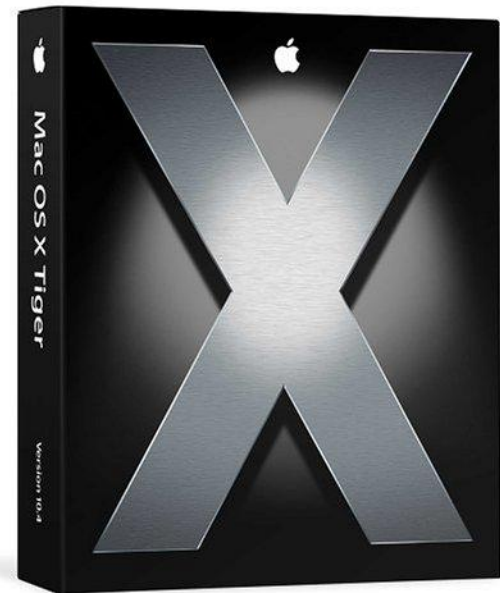
HFS-Plus: Mac OS X Filesystems

64 bit OS

16 EB max HD, 8 EB max file size

Journaling, Permissions

POSIX compliant



ISO 9660: CD File System

It aims at supporting multiple OS's, so that data may be exchanged.

The Rock Ridge extension to ISO 9660 adds support for POSIX file permissions and ownership, symbolic links, and longer file names;

The Joliet extension to ISO 9660, adds support for longer file names and the Unicode character set.

UDF: Universal Disk Format

UDF replaces ISO 9660 as the standard format for optical media.

It is widely used, especially on DVDs, but also for CDs.

Virtual File Systems: Motivation

- You have a laptop w/o a built in cd drive, but you want to use a cd-based program on it without dragging your external cd drive along.

Virtual CDs

If you copy a software CD onto your hard drive...you can browse the files, but you can't use the files to actually install or run the program, because the ISO 9660 filesystem is gone.

If you create a file (often a *.iso file) containing the CD filesystem and files, then you can use it to install or run software. This is a virtual CD.

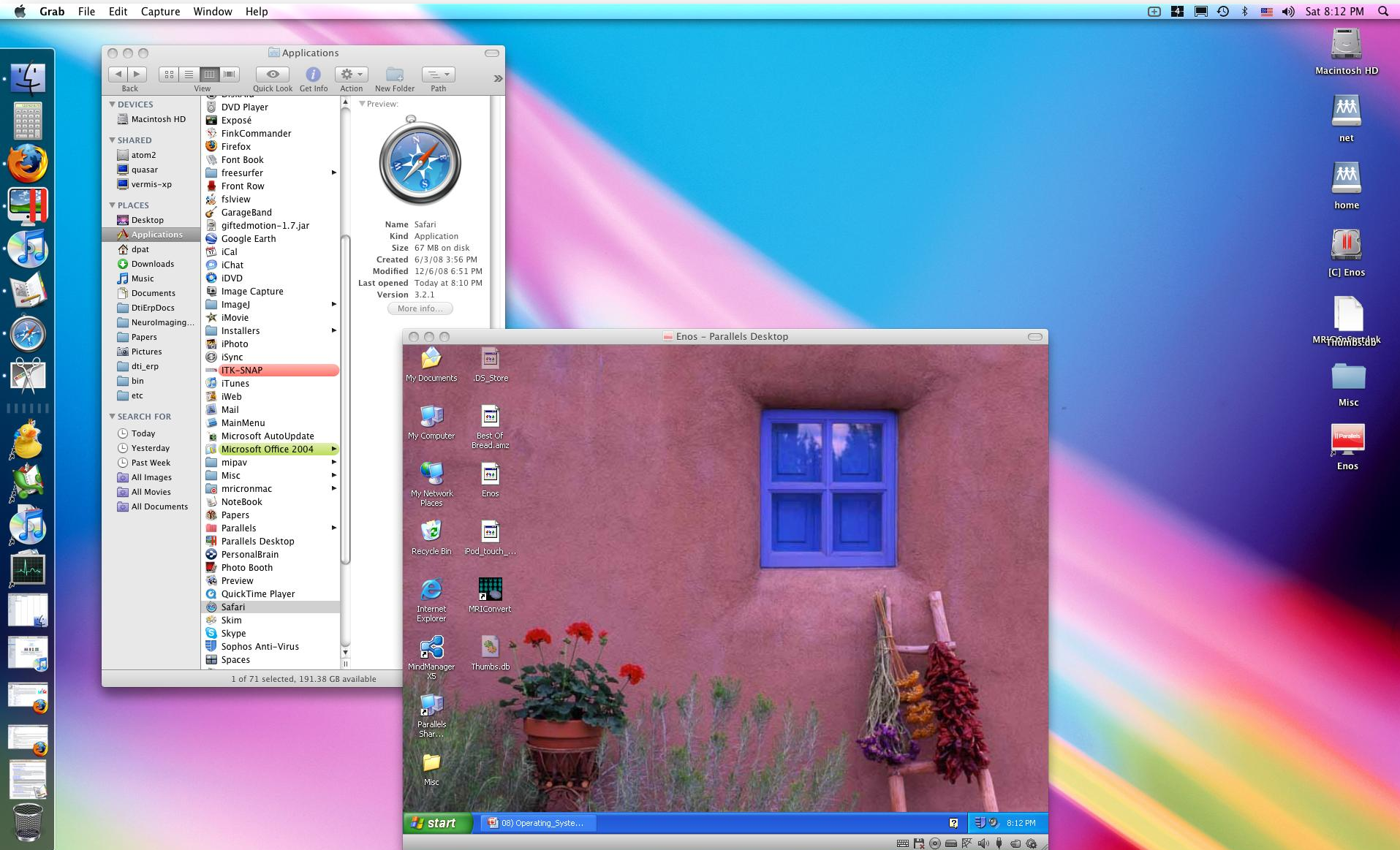
Virtual Machines: Motivation

You have a windows machine, but you want to run a unix program

You have a mac, but sometimes you want to run windows programs

You don't want to buy another machine

XP running on OS X



XP & Linux running on Mac OSX



Virtual Machines

You've seen why
you'd want a
virtual machine

You've seen actual
pictures of virtual
machines running

What is going on
here?



Virtual Machines

A virtual machine is a computer inside of a computer.

It uses your hardware and your operating system to emulate a standardized machine

You can then install another OS on this standardized virtual machine.

Virtual Machines

Parallels desktop for Mac OSX (Intel) allows you to create as many virtual intel machines as you want.

You can install Windows, Linux etc. on these virtual machines.

You can shut the machines down, boot them up, install software on them, and run that software when you are running the virtual machine.

VMWare competes with Parallels

Virtual Machines

Each virtual machine is contained in a large file (e.g. a *.hdd file) which holds the operating system and filesystem.

Early VMs were not aware of their host OS (It was difficult to move the mouse or data between the systems)

Newer VMs allow drag and drop, copy and paste, and seamless mouse movement with their host.

Network File Systems

Any file system that allows the sharing of resources on another computer

File permissions may be different when accessed on a network share, than they are if you are directly logged on to the machine.

This is because the network file system imposes its own layer of permissions.

Network File Systems

NFS

The Network File System developed by Sun for unix machines in the 1980s

Samba

An open source version of the MS Windows SMB (server Message Block) protocol

AFP

Apple Filing Protocol, a file sharing protocol for Apple OS's

Why do you care about Network File Systems?

Any time you store data on one machine, and access it from another machine, you involve the network.

As soon as you involve the network in data access, you must use a network file system.

Choosing an OS

Microsoft Windows

Good: Very common, lots of applications, most people familiar with it, easy to use interface, a pretty good choice for matlab and spm, has excellent hardware support.

Bad: A generally unstable OS with lots of security problems, not good for afni or fsl, weak commandline interface.

Windows XP is relatively reliable (Vista has had lots of problems).

Linux

Good: Cheap or free, supports afni and fsl, powerful commandline interface, should also work with matlab/spm, tends to be stable and has no virus issues.

Bad: Lots of versions, not always good support for new hardware, requires some expertise to set up and use efficiently (but easier than it used to be)

Mac OSX

Good: Pretty reliable (good marriage of hardware and software reduces problems), Excellent platform for FSL, easy to use interface AND powerful commandline tools, *should* work with spm/matlab, good security (few viruses), can run virtual windows machine. Native 64 bit

Bad: Relatively expensive, not quite standard unix (though technically Posix compliant)

interface

CLI

GUI

File systems

ACLs

Journaling

Unicode

64 bit vs 32 bit

Platform

FAT (FAT16, FAT32)

NTFS

Posix

ext3, ext4 etc.

HFS-Plus

ISO-9660

Virtual file system

Virtual machine

NFS

SAMBA

AFP

Summary

We've compared operating systems and looked at their evolution.

As part of this, we've looked at the underlying file systems, including virtual file systems and network file systems.