Advanced Linux System Administration

Topic 1. Introduction to UNIX/Linux

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General Properties of UNIX/Linux

- UNIX: born as an Operating System, now a standard.
- **Multiuser & Multitask** capabilities (from the beginning).
- Excellent **environment for networks:**
  - Current networks (TCP/IP) are highly coupled to UNIX.
- **Scalability:** clustering, Symmetric Multiprocess Capability (SMP)
- **Reliability:** large MTBF (Mean time between failures/reboots)
- **Portability** (from a mobile device to the supercomputer with the highest performance):
  - http://www.top500.org/system/177975.
  - **Titan** - Cray XK7 → **Operating System:** Cray **Linux** Environment.

General Properties of UNIX/Linux

Embedded
(80%)

Smartphone/Tablet
(25-40%)

Desktop/Laptop/Netbook
(1.5-30%)

Server
(60%)

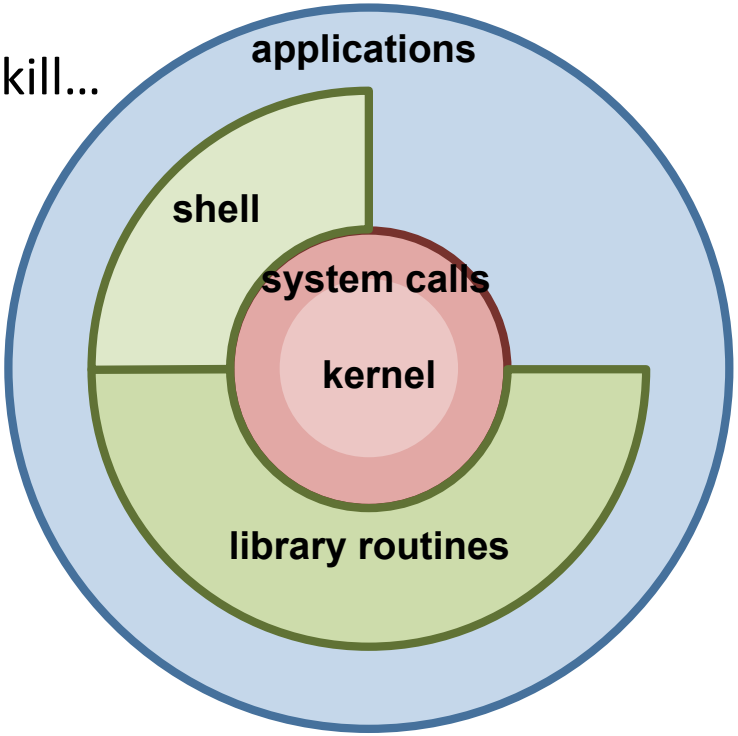
Cluster
(66%)

Supercomputer
(90%)

General Properties of UNIX/Linux

SYSTEM STRUCTURE

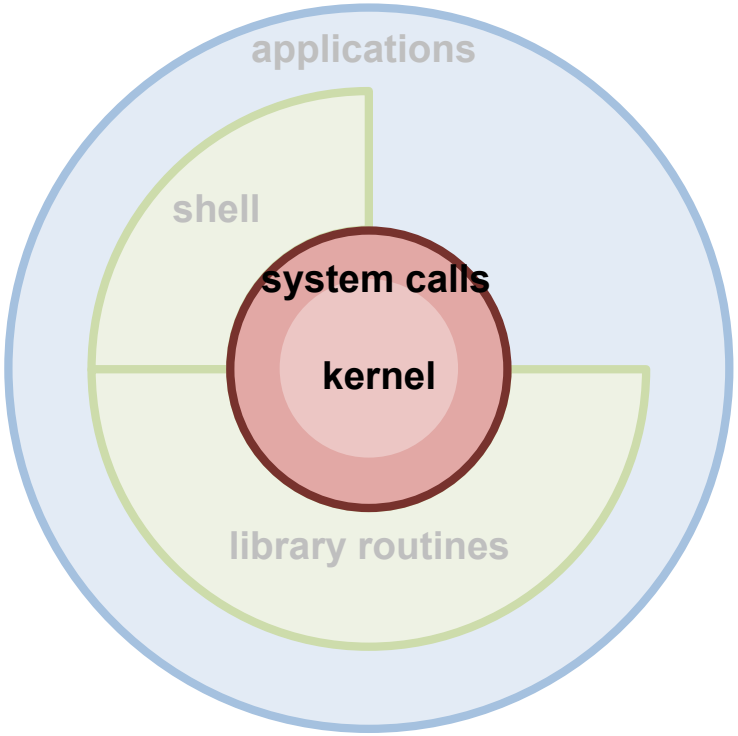
- Monolithic system:
  - The whole OS in a reserved memory space (kernel space). The only component in that space, in supervisor mode.
- User interface: system calls:
  - Open, read, write, close, wait, exec, fork, exit, kill…
- Libraries/command interpreter (shell):
  - Middleware between programs and OS.
  - Glibc: part of C Library with subroutines implemented to perform system calls (printf).
- Hundreds of commands.
- Hundreds of applications.



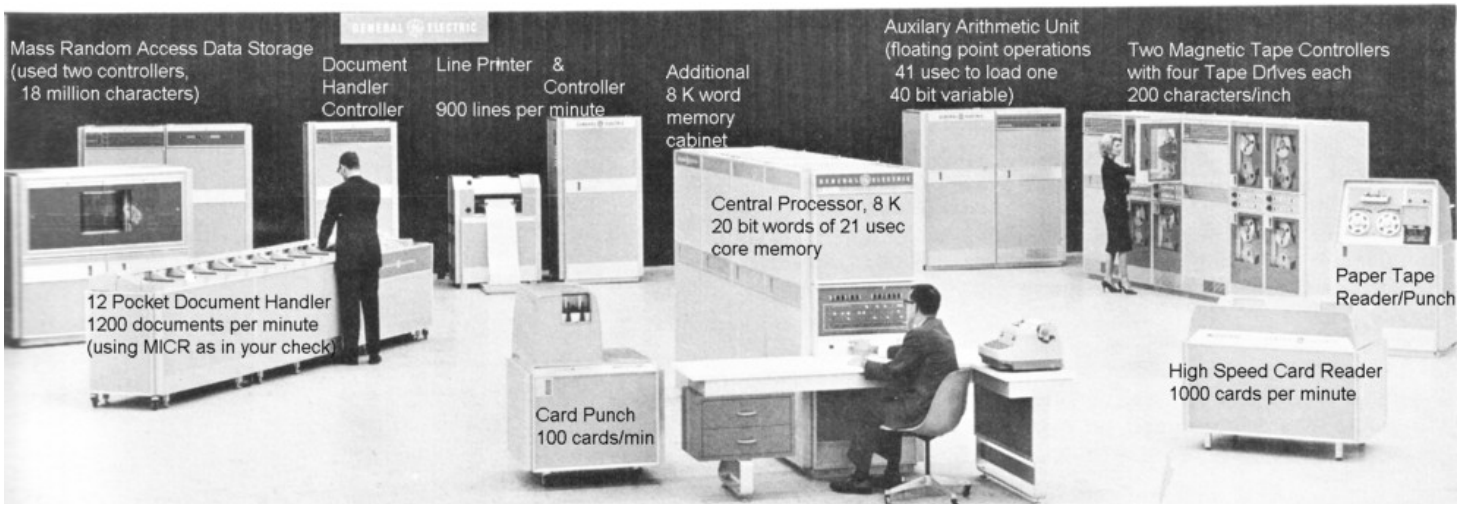
General Properties of UNIX/Linux

SYSTEM STRUCTURE

- The Kernel:
  - Processor management: Scheduling.
  - Memory management, both physical and virtual (swapping).
  - I/O management.
  - Storage, files and folder management.
  - Protection.
  - Time & date management.
  - Accounting.



Origins (60's)



- (1964) **MULTICS** (Multiplexed Information and Computing System):
  - MIT + Bell Labs (AT&T) + General Electrics.
  - Experimental OS for the Mainframe GE-645 (18-bit): Time sharing + remote terminals (phone) to edit documents, run calculations…
  - Delays, High cost, Low performance → Cancelation (1969).
- (1969) **UNICS** (Uniplexed Information and Computing System):
  - Developed by Dennis Ritchie and Ken Thompson for a DEC PDP-7.
  - "Space Travel" game involved.
  - Incorporates: process concept, File system, command interpreter (shell).

Origins (early 70's)

- (1970) Migration to a new machine (DEC PDP-11/20):
  - Thompson & Ritchie "cheat" their bosses: they need the new machine to develop new text processing tools.
  - Small print: a new OS will be developed to support those tools.
  - …assembly develops. Implications?
- (1972) UNIX code is re-written in C (**C-UNIX**):
  - Portable and architecture-independent (multiplattform).
  - C was created by Ritchie, as an evolution of B (BCPL: Basic Combined Programming Language).

PDP-7

PDP-11/20

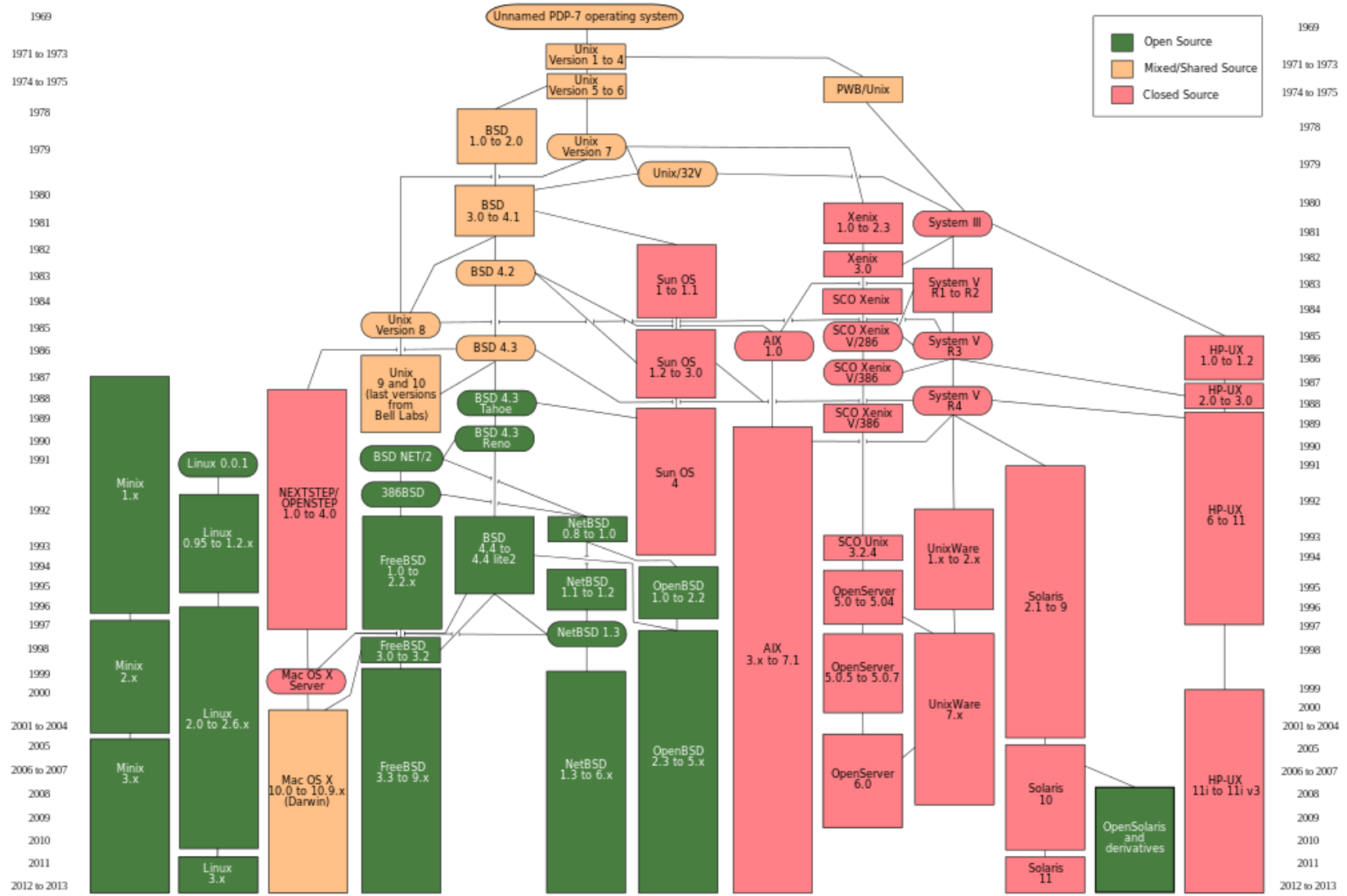
Expansion (mid-late 70's)

- (1974) Their authors publish a paper *(Communications of the ACM):*
  - Copies requested. As AT&T can only sell telephone and telecommunication products by law, it is freely distributed.
  - "No advertising, no support, no bug fixes, payment in advance".
- Origin of the OpenSource movement: **Usenix:**
  - No support, users organize themselves to provide mutual support.
  - Exchange magnetic tapes with new software or corrections.
- UNIX "Flavors":
  - AT&T Unix versions (free): version 1-7 + 8-10.
  - AT&T Unix System III-V (commercial): Introduced in 1981, System V eliminates version dispersion.
  - BSD, Berkeley Software Distribution (free): Promoted by Thompson during a sabbatical at California University. Incorporates many improvements (Virtual Memory, c-shell, sendmail, etc.).

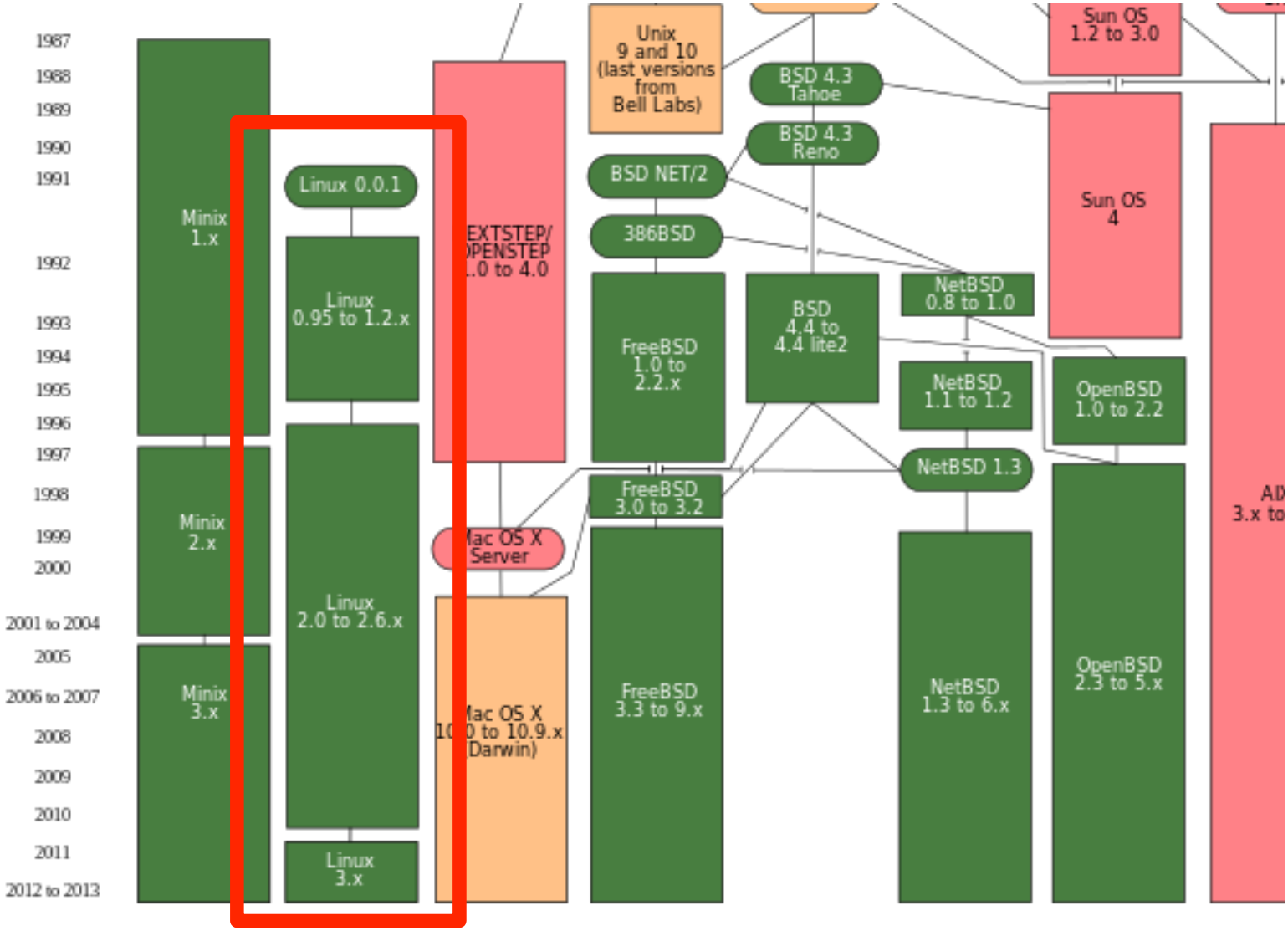
UNIX Nowadays

- Does not exist as an OS, the term UNIX is only employed to designate a family of Operating Systems.
- UNIX Operating System:
  - To be considered a UNIX system, an OS must fulfill the “Single UNIX specification” (extension of the POSIX standard and official definition of a UNIX system).
  - Registered UNIX systems: **Mac OS X** 10.5 and 10.6 (Apple Inc.), **HP-UX** 11i V3 release B.11..31 and later (HP), **AIX** 5L V5.3 (IBM), **Solaris** 10 (Sun and Fujitsu), **IRIX** 6.5.28 (SGI).
- UNIX-like Operating System:
  - Multiuser systems based on POSIX (do not fulfill the specification extension “Single UNIX specification”).
  - Non UNIX Systems: GNU Linux, FreeBSD, OpenBSD.

UNIX Nowadays



Linux (GNU)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2001 to 2004
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2006 to 2007
2008
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2010
2011
2012 to 2013
Minix 1.x
Minix 2.x
Minix 3.x
Linux 0.0.1
Linux 0.95 to 1.2.x
Linux 2.0 to 2.6.x
Linux 3.x
EXTSTEP/ OPENSTEP .0 to 4.0
Mac OS X Server
Mac OS X 10.0 to 10.9.x (Darwin)
Unix 9 and 10 (last versions from Bell Labs)
BSD NET/2
386BSD
FreeBSD 1.0 to 2.2.x
FreeBSD 3.0 to 3.2
FreeBSD 3.3 to 9.x
BSD 4.3 Tahoe
BSD 4.3 Reno
BSD 4.4 to 4.4 lite2
Sun OS 1.2 to 3.0
Sun OS 4
NetBSD 0.8 to 1.0
NetBSD 1.1 to 1.2
NetBSD 1.3
NetBSD 1.3 to 6.x
OpenBSD 1.0 to 2.2
OpenBSD 2.3 to 5.x

Linux (GNU)

- Project GNU (1983): develop a whole free sw OS:
  - Originally aims to implement their own kernel (HURD).
  - recursive acronym: GNU is not UNIX.
- Linux: Graduation project by Linus Torvalds (1991):
  - PhD Requirements: proposed an improved version of MINIX (academic OS proposed by Tanenbaum).
  - Web-hosted project that kept on expanding until 1992, reaching the first Linux version (1.0).
- Linux is OpenSource. Most of its code is developed by the GNU movement (gcc compiler, bash, gnome…):
  - Other OpenSource licenses: MIT, Apache, FreeBSD, etc.
- Stallman vs. Torvalds (GNU-Linux vs. Linux).

Linux (GNU)

- Large diversity of distributions (projects):
  - Some of them commercially supported: Fedora core (Red Hat), Open Suse (Suse-Novell), Ubuntu (Debian), Gentoo (Linux BSD), Android (Linux).
  - http://futurist.se/gldt/.
- The only official part in LINUX is the kernel:
  - Many important companies have already invested large amounts of money in its development: IBM, SGI, Intel, AMD, etc.
  - GPL License (GNU Public License):
    - Source code can be copied and distributed, citing the origin of the code.
    - Modifications must be distributed under GPL license.
    - Making use of code fragments under others kinds of licenses requires the acknowledgement of the authors.
    - The cost of a distribution only involves the cost of providing support.
  - Can be updated via web: www.linux.org.

Linux (GNU)

- **Main technical features**
  - **Multitask:** multiple processes running at the same time:
    - Time multiplexing + context switch. The kernel has full control.
  - **Multiuser:**
    - Apps of each user run without interfering with the rest of users.
  - **Multiprocessor**: Kernel support for SMP.
  - **Multiplatform**: Architecture independent.
  - **Standard Interface**: SYSV, BSD & POSIX 1003.c.
  - **Protected Memory model** (processor protection modes):
    - Prevents access to memory portions in use by other processes or the kernel.
  - **Multiple file systems supported:**
    - Native system is ext (Extended File System) (ext4 currently), but supports many more: VFS, JFS, FAT, ISO9600 (iso mounting), HPFS, NTFS.
  - **Wide network support** (TCP/IP, IPX, Eth, Inf, etc.).
  - **Multiple binary formats** (iBCS, UNIX, etc.).

Linux (GNU)

PROS & CONS

- Cost (Licensing): 
  - Usually free and available Source Code (GPL).
  - Fast solution to security problems, incompatibility issues, etc. Early adoption of novel technologies.
- Cost (Administration): 
  - Much Larger learning curve.
  - Deep system understanding required.
  - Some solutions available for the desktop environment (ubuntu).
- Security: 
  - Far less susceptible to viruses and malware. Anti-virus software usually not required.
  - Security might be sometimes a matter of market quote.

Linux (GNU)

PROS & CONS

- Hardware: 
  - Works well on older machines, requires less powerful hardware.
- Proprietary Software (Availability): 
  - Some admin/network tools not available (sharepoint).
  - MS Office far better than LibreOffice/OpenOffice.
  - Internet Explorer legacy web apps.
- Support: 
  - Growing number of companies provide professional support (IBM, HP, RedHat…).
  - Big companies moving their business model towards Linux.
  - Moreover… active user community willing to help: Newsgroups, Forums, Online communities (stackoverflow, hispalinux, etc.).

Linux (GNU)

PROS & CONS

- Compatibility: 
  - Fulfills standards IEEE POSIX1, SYSVR3, SYSVR4.
  - Written mainly in C (portability).
  - Can run in: intel X86, Itanium (64b), MIPS, Motorola-PPC, Alpha, ARM, etc.
  - Drivers??
- The “Driver Issue”: 
  - Apple: Easy time. Only support a curated, small hw set.
  - Windows: a large amount of drivers. Manufacturers need to provide a driver (quality??).
  - Linux: Also attempts to support a lot of hw, but some manufacturers are indifferent (market quote).
    - Developed without manufacturer support in some cases (quality??).