Operating systems

Introduction to Operating Sistems (part B)

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Main OS

❖ Operating systems can be classified according to different criteria

❖ Application domain

➢ Scientific computing, services, web, etc.

- Supercomputing, mainframe, server, workstation, desktop, laptop

➢ Special applications

- Real-time (e.g., safety critical, aerospace), embedded systems (automotive)
- Handlet device (e.g., bar-code scanners, Personal Digital Assistant, etc.), smart card

Main OS: Diffusion

Type	OS	Market Share
Desktop, laptop, etc.	Windows 7	53.01%
	Windows 8	17.81%
	Windows XP	9.72%
	OS X	8.18%
	Windows 10	5.38%
	Windows Vista	1.93%
	Linux	1.80%
	Altri	2.17%

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http://www.netmarketshare.com/

Type	OS	Market
WEB Client	Windows	49.5%
	Apple	15.62%
	Linux based	19.13%
	Altri	3.83%

Type	OS	Market
All devices	Android	48.61%
	iOS / OS X	11.04%
	Windows	14.0%
	Altri	26.34%

Windows

❖ Microsoft

➢ Founded in 1975 by Bill Gates and Paul Allen

➢ In 1981 introduces MS-DOS

➢ In 1985 introduces Windows

- Operating system with graphical interface based on windows (from which the name)

- Intel processors oriented

➢ Controls 80%-90% of the desktop market (with different versions)

Windows: Versions

Server	**Windows NT 3.1, 3.5, 3.51, 4.0 (dal 1993), Windows 2000, Windows Server 2003, 2003 R2, 2008, 2008 R2, 2012, 2012 R2**
Device - embedded	Windows CE, Windows Embedded, Windows Phone, Windows Mobile, Windows RT, ...
Desktop	Windows 1.01-3.2 (from 1985 to1993) Windows 95, 98, ME (Windows 9x) (from 1993) Windows XP (from 2001) Windows Vista (from 2007): home, premium, business, enterprise, ultimate Windows 7 (from 2009): basic, premium, professional, enterprise, ultimate, thin PC Windows 8, 8.1 (from2012): standard, pro, enterprise Windows 10 (from 2015)

Windows: Versions

16 bit	Windows 1.0 (1985) - Windows 3.1 (1992) Designed to be portable Introduces mouse and GUI (Graphical User Interface) Based on BIOS and DOS for all basic functions
16-32 bit	Windows 9x (1993-2000) Derived from MS-DOS and from the 16 bit versions Introduces a new kernel Not successful, parallel introduction of Windows NT (32 bit)
32- 64 bit	From Windows NT (NT = New Technology?) Discontinues MS-DOS architecture Introduces a new kernel (a hybrid micro-kernel inspired by UNIX) Allows managing multi-users, multi-tasking, multi-processors

MAC OS

❖ Apple

➤ From 1984 to 2001 offers MAC OS

- OS graphic only version
- Structural limits reached at the end of the '90s due to the lack of
  - Preemptive multitasking
  - Protected memory

➤ In 2001 introduces MAC OS X

- Initially for the Macintosh computer
- Initially compatible with MAC OS
- Based on the UNIX BDS architecture and 100% standard POSIX compliant

MAC OS X

❖ Initially MAC OS X was designed according to a micro-kernel structure

➢ Services moved from kernel to user space

➢ Communications among modules by means of message exchange

▪ Performance issues due to frequent communications among users and kernel

❖ Recent versions of MAC OS X use a three layer hybrid structure that includes

➢ The most common UNIX utilities and shells

➢ A native Java machine

➢ The main scripting languages (Python, Perl, etc.)

MAC OS X: Characteristics

❖ **Proprietary architecture, not open source**

➤ Micro-kernel

- Easily adapted to new hardware architectures
- High reliability (kernel has limited tasks)

➤ High security

- Limited diffusion

➤ Expensive architectures and software

- Market share mainly kept due to Apple appeal

UNIX/Linux

❖ UNIX designed in 1970 for PDP11 programming (minicomputer Digital 1970-1990)

❖ Despite its quite high portability, many different version were introduced during the '80s

➢ Many organizations (e.g., the USA government) require its standardization

➢ A **standard** specifies the OS interface

➢ Different actual **implementations** may exist for each **standard** (distributed by different "vendors")

▪ An implementation is often a subset of the standard

UNIX/Linux: Standard

ISO C	1972: UNIX migrates form assembler to C language. Standard C language versions : ANSI C (1989), ISO C or C90 (1990), ISO C o C99 (1999), C11 (2011)
POSIX	POSIX = Portable Operating System Interface Family of standards, proposed to promote UNIX systems portability Defines the services that a UNIX system must satisfy to be "POSIX compliant" Includes the ISO C standard
SUS	SUS = Single UNIX Specification Project developed from the '80s, POSIX superset. Defines what standards an OS has to comply with to qualify for using the "UNIX" trademark

UNIX/Linux: Implementations

❖ AT&T Bell Laboratories, Berkeley Software Distribution (BSD), Free-BSD, Solaris (SUN Microsystems), MAC OS X, etc.

❖ Linux

- ➢ Developed from Minix (Tanenbaum)
- ➢ Created in 1991 by **Linus** Torvalds (Helsinki)
- ➢ Designed for educational purposes, rapidly becomes **open software** (main difference with respect to other UNIX systems)
  - ▪ Usage and development allowed according to "**GNU** Public License"
- ➢ Many distributions exist, but the common element is the kernel ("Linux" identifies the "kernel")

Linux: Distributions

Distribution	Characteristics
CentOS	Derived from RedHat Entrerprise; enterprise market oriented
Debian	Includes open software only
Fedora	Implemented by GNU/Linux, sponsored by Red Hat
Mandriva	Originally **Mandrake**, for less expert users
Red Hat	Developed till 2004. Replaced by Red Hat Enterprise
SuSE	Developed by Novel
Slackware	From 1993. For experts
Ubuntu	Currently the most widespread; Based on Debian; complete and easy; proposes several official flavors: EduUbuntu (educational), Kubuntu (KDE), Lubuntu (LXDE), Ubuntu Mobile, etc.

Linux: Characteristics

❖ **Diffusion**

- Desktop 1.6% (2014)
- Server 60% (2008)
- 95% of Hollywood special effects and animations (e.g., Titanic 1997) are developed on Linux systems

❖ **Debian 4.0 complexity (2007)**

- 283 millions of code lines
- Without relying on open source the development would require 73000 man-years and 8.16 billion dollars

❖ **Many consider Linux the most advanced OS**

➢ Reference for kernel development

Comparison

❖ The comparison among Operating Systems

➢ Is difficult

▪ Different versions exist with different characteristics versions (desktop, server, mobile)

▪ Prices and support depend on the versions

➢ For each statement that you can find on a publication or on internet, another one can be found that contradicts the first

Comparisons

❖ Most of the debate often reduces to trivial statements

- ➢ Windows: not stable
- ➢ MAC OS X – IOS: elegant
- ➢ Linux: Difficult to use, and less software available

❖ These considerations may apply only to obsolete OS versions

❖ Many considerations depend on the personal taste or on the current vogue

❖ In practice, different OS may co-exist and can be used for different tasks

Diffusion

Windows	About 80.0% of the desktops Pre-installed in most desktops and laptops
MAC OS X	In 2011 • About 14.0% in USA • About 6.5% in the world Pre-installed on all Apple computers Can be used only on MAC computers
Linux	In 2014 • 2.0% of the desktops • 60.0% of the servers Rarely pre-installed

Costs and licenses

Windows	OS cost about 100$ Additional software is often proprietary (End User License Agreement EULA)
MAC OS X	OS generally more expensive than Windows Proprietary software
Linux	Free OS, can be downloaded Free software (GPL)

❖ Microsoft considers Linux and open source an increasing market threat

Installation

Windows	Simplified since Windows XP Requires up to 60 minutes Additional software is often not free Many drivers must be installed additionally, but automatic installing
MAC OS X	Pre-installed Rarely re-installing Automatic updates Allows using only specific software
Linux	Installation modality depending on the edition Requires 5 to 60 minutes Many alternatives are pre-installed Most software is free Free drivers are pre-installed, proprietary drivers must be downloaded from repositories

Stability

Windows	Increases with NT kernel Requires frequent restarts The task manager allows killing undesired processes
MAC OS X	Very stable Takes advantage of its limitation (it runs only on Apple computers)
Linux	Linux has a very stable modular structure. Must be restarted only after kernel update (some Linux systems have not been restarted for years) Easy process management by means of command lines

Security

Windows	About 11,000 malwares discovered in 2005 Mandatory use of antivirus, antispam, etc. Once infected, it is difficult to solve the problem
MAC OS X	Practically virus-free This is mainly due to its relative small diffusion
Linux	Being "open" it is virtually less secure than MAC OS X 800 malwares discovered In practice, extremely difficult that it is infected

❖ Monolithic kernels are more subject to problems (once a components infected, the problem propagates)

❖ Less problems if the root super-user is well protected

Interface

Windows	A desktop partially customizable Provide MS-DOS command prompts PowerShell and Cygwin (GPL) allow obtaining a UNIX-like shell
MAC OS X	If you like Windows, MAC generally is more pleasant
Linux	Many alternatives (GNOME, KDE, FluxBox, Enlightment, etc.) Shell are completely integrated with the console

Performance

Windows	**Windows Vista e Windows 7 require many resources** **Slow both at bootstrap and executing various applications**
MAC OS X	**In 2006 twice slower than Windows e Linux** **Great improvement recently** **In 2012 MAC OS X and Windows show similar performance on many applications** **Excellent for graphical applications, does not always exploit efficiently the CPU hyper-threading**
Linux	**In theory more efficient** **Excellent hardware exploitation, comparable with the expensive UNIX workstations** **On CPU-intensive applications it is 2-3 times faster than MAC OS X**

Synoptic comparison

Characteristics	Windows	MAC OS X	Linux
Price	≥ 100$	≥ 100$	Free
Ease	Easy	Easy	Average
Reliability	Average	Good	Excellent
Software #	High	High	Good
Software cost	≥ 200$	≥ 200$	Free
Hardware support	Very large	Good	Average
Security	Average	Good	Excellent
Open Source	No	No	Yes
Support	Proprietary	Proprietary	Online