GNU / Linux and Free Software

An introduction

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Document sources, updates and translations:
http://free-electrons.com/articles/freesw

Corrections, suggestions, contributions and translations are welcome!

Contents

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Unix and its history

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Unix family tree

BSD family

BSD (Berkeley Software Distribution)

Bill Joy

Bill Joy

SunOS (Stanford University Network)

NextStep

FreeBSD

OpenBSD

NetBSD

MacOS X

GNU

Richard Stallman

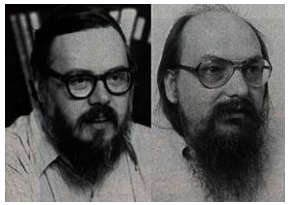
GNU / Linux

Linus Torvalds

You are here

Bell Labs (AT&T)

Ken Thompson
Dennis Ritchie (C language
created to implement a portable OS)



Ritchie, Thompson

SRV5

IRIX (SGI)

HP-UX

Sun Solaris

AIX (IBM)

System V family

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The Unix philosophy

Today's most powerful systems are based on a 35 year old design!

- Small is beautiful
- Make each program do one thing well
- Choose portability over efficiency
- Avoid captive user interfaces

System abstraction

- Kernel: hardware layer
- Shell: text mode layer
- X Window: GUI layer

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Main Unix features

Unix originally created for huge multi-user mainframe computers

- Multi-user and secure:
  Regular users can't mess with other user's files (by default)
  In particular, regular users can't modify system settings, can't remove programs, etc.
- `root`: administrator user with all privileges
- Preemptive multi-tasking
- Supports multiple processors
- Extremely flexible
- Networking support
- Portability
- Scalability

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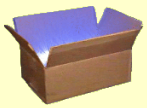
Unix system architecture

Graphical user applications

Web browser, office, multimedia...


Command line applications

ls, mkdir, wget, ssh, gcc, busybox, shells (scripts)...




Shared libraries

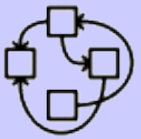
libjpeg, libstdc++, libxml...

C library

GNU C library, uClibc...

Operating system kernel

Linux, Hurd...

Hardware and peripherals



User space

Kernel Space

Hardware

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The GNU Project

GNU = GNU is Not Unix (a recursive acronym!)

- Project to implement a completely free Unix-like operating system
- Started by Richard Stallman in 1984, an MIT researcher, in a time when Unix sources were no longer free.
- Initial components: C compiler (gcc), make (GNU make), Emacs, C library (glibc), coreutils (ls, cp ...)
- However, in 1991, the GNU project was still missing a kernel and was running only on proprietary unice.

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Free Software licenses and legal issues

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Free Software

Free Software grants the below 4 freedoms to the user:

- The freedom to run the program, for any purpose.
- The freedom to study how the program works, and adapt it to one's needs.
- The freedom to redistribute copies to help others.
- The freedom to contribute to one's community: distributing copies of one's modified versions.

See http://www.gnu.org/philosophy/free-sw.html

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BSD-like Free Software licenses

- Of course, guarantee the 4 freedoms to the users
- However, allows to make proprietary software from it
- Example licenses: BSD, Apache

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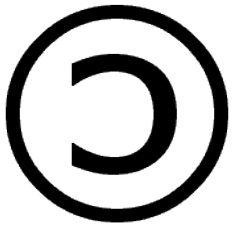
The GNU General Public License (GPL)

The major contribution from the GNU project!

- *Copyleft* licenses use copyright laws to let the author require that modified versions are free software too.
  http://www.gnu.org/copyleft/copyleft.html



- The GNU GPL requires that modifications and derived works are GPL too:
  - Only applies to released software
  - Any program using GPLed code (either by static or even dynamic linking) is considered as an extension of this code

GPL FAQ: http://www.gnu.org/licenses/gpl-faq.html

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GNU Lesser General Public License

http://www.gnu.org/copyleft/lesser.html

- Copyleft license similar to the GNU GPL:
  Modifications must be shared under the same conditions
- However, permits linking with non free modules
- Used by several Free Software libraries. Examples:
  glibc, GTK, Wine, SDL

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GNU GPL v3 (1)

The latest version of the GNU General Public License
http://www.gnu.org/licenses/gpl.html

- Incompatible with GPL v2
  Not allowed to mix GPL v2 code with GPL v3 code.
- Forbids *Tivoization*: must tell the users of consumer products how to modify GPL v3 software running on it. Mustn't prevent from disabling DRM either. Exception for devices exclusively meant for businesses and organizations.
- Gives explicit patent protection of the users from the program's contributors and redistributors. Extends the Novell-Microsoft patent protection to the whole community (as soon as Novell distributes GPL v3 software).

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GNU GPL v3 (2)

- Compatibility with the Apache license.
- Better internationalization (GPL v2 had a US law bias)
- Smoother termination terms: violations easier to resolve.
- No significant impact yet:
  - Projects like Linux and BusyBox will stay on GPL v2 for the moment.
  - But GNU programs will switch soon: gcc, coreutils, binutils...

See http://gplv3.fsf.org/static/release/rms_gplv3_launch_high_quality.ogg for a short overview video by Richard Stallman.

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Free Software and Open Source

The Free Software movement

- Principle centered approach
- Focuses on individual freedom and on the social usefulness of cooperation. See http://www.gnu.org/philosophy/free-software-for-freedom.html

The Open Source movement

- Pragmatic approach
- Mainly advocates the advantages of sharing the sources and makes choices based on technical superiority.

Though the basic motives are different, both movements work together and get along very well!

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Open Source licenses

From the Open Source Initiative (OSI)
http://opensource.org

- The OSI has its own definition which is fortunately similar to the definition of Free Software:
  http://opensource.org/docs/definition.php
- List of licenses approved by the OSI:
  http://opensource.org/licenses/
  Useful to check that a license is Open Source / Free Software

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Issues with Free Software licenses (1)

- Lack of jurisprudence
  Though the licenses are based on Copyright law, the enforceability of Free Software licenses depends on local law and has seldom been tested in court (just in a few countries).
- Number of Free Software / Open Source licenses to manage
  Fortunately, most tools use a very limited set of licenses.
  License statistics from the Freshmeat software catalog:
  http://freshmeat.net/stats/#license
  GPL: 66.3%, LGPL: 6.4%, BSD: 5.6% (October 2006)

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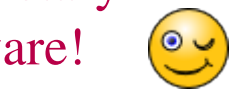
Issues with Free Software licenses (2)

- Copyright ownership
  Do the copyright owners really own the code?
  The code could be owned by their employers or by someone else. No way for users to check.
  They need to have trust in the project maintainer.

Also true with proprietary software!



- Mixing code
  May not be allowed to mix code with different licenses.
  List of licenses compatible and incompatible with the GPL:
  http://gnu.org/licenses/license-list.html#GPLCompatibleLicenses

- Software patents
  In some countries, Free Software with legitimate copyright may not be used if it infringes software patents.

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Software patents: the big legal threat

- Software implementations very well protected internationally by Copyright Law. This is automatic, no paperwork.
- However, in countries like the USA or Japan, it is now legal to patent what the software does, instead of protecting only the implementation.
- Patents can be used to prevent anyone from re-using or even improving an algorithm or an idea!
- Deadly for software competition and innovation: can't write any program without reusing any technique or idea from anyone.

See http://wiki.ffii.org/SwpatAnim050418En for an animated introduction

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Software patents hall of shame

- The progression bar
- Amazon 1-click, Amazon gift ordering
- Electronic shopping cart
- Compressing and decompressing text files
- Compression in mobile communication
- Digital signature with extra info
- Hypermedia linking

See http://swpat.ffii.org/patents/samples/index.en.html for more examples

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How to avoid software patent issues

- Applies too when you develop in software patent free areas.
  You may not be able to export your products.
- Always prefer patent free alternatives
  (PNG instead of GIF, Linux RTAI instead of RTLinux, etc.)
- Except for the above well-known patents, better not to check whether your projects infringes software patents. Given the complexity and number of software patents, it is best when you ignore that you were infringing some of them.
- Don't file patents on your software ideas on your turn. This may expose you more to patent risk. You will lose against software giants.

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Legal support

When lawyers are after you, or to avoid legal trouble...

Free support

USA

- The Electronic Frontier Foundation
  http://eff.org/

European Union

- The Foundation for a Free Information Infrastructure
  http://ffii.org

Free Software and Open Source legal consulting, support and insurance

- Software Freedom Law Center
  http://www.softwarefreedom.org/
- Open Source Risk Management
  http://www.osriskmanagement.com/

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Room for proprietary software

With GNU/Linux, you can still use and create proprietary software

- The fact that the Linux kernel is GPL doesn't create any requirement for user applications.
- Most libraries have LGPL or BSD licenses.
  You can create proprietary applications linked with them.
  Need to be careful with exceptions though.

So, the decision is yours!

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Free operating systems

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Linux

- Free Unix-like kernel created in 1991 by Linus Torvalds
- The whole system uses GNU tools:
  C library, gcc, binutils, fileutils, make, emacs...
- So the whole system is called “GNU / Linux”
- Shared very early as free software (GPL license), which attracted more and more contributors and users.
- Since 1991, growing faster than any other operating system (not only Unix).

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How to pronounce “Linux?”

Every language and / or country can have its own way, of course.

In English, it's difficult to guess!
At least, here's how Linus Torvalds pronounces it:
http://free-electrons.com/pub/audio/torvalds-says-linux.ogg

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GNU / Linux distributions

- Take care of releasing a compatible set of kernel, C library, compilers and tools... A lot of work indeed!
- Tools available in *packages* which can be easily installed, removed or upgraded. Tool version dependencies are automatically managed.
- Commercial distributions: include support.
  Sources are free but usually not binaries.
- Community distributions: both sources and binaries are free.
  No support by default.
- Don't confuse the distribution version with the Linux kernel version!

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Commercial distributions

- Red Hat: http://www.redhat.com/
  The most popular. Reliable, safe, user friendly, easy to install, supported by all hardware and software vendors.

- Suse (Novell): http://www.suse.com/
  The main alternative. Easy to install, user friendly, stable. Getting support by hardware and software vendors.

- Mandriva (formerly Mandrake): http://mandrivalinux.com/
  User friendly, easy to install, more innovative, but less stable. More targeted to individual users. Little vendor support.

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Community distributions (1)

- Fedora Core: http://fedora.redhat.com/
  Stable, secure, user friendly, easy to install. Frequent full releases.

- Debian: http://debian.org/
  Very stable and safe, but more difficult to configure and install. Developer but no user friendly yet. Stable releases not frequent enough (every 2 or 3 years). Great for servers, but not for beginners!

- Ubuntu Linux: http://ubuntu-linux.org/
  The growing community distribution. Debian based but stable releases every 6 months. Long term support commitment (5 years!). User friendly. Great for both beginners and experts!

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Community distributions (2)

- Mandriva Community: http://mandrivalinux.com/
  Easy to install, secure, user friendly, frequent full releases, but less stable (not enough testing and taking user feedback into account).

- Gentoo Linux: http://gentoo.org/
  Created to reach the highest levels of customizability. Most packages compiled from source by the user with CPU optimizations. Ported to most architectures supported by the Linux kernel. Frequent releases. Great documentation.
  Not for beginners though great for learning!

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Live distributions (1)

- Linux boots from removable storage (CD-ROM, DVD-ROM or USB stick) and runs everything from the storage medium.
- Great to try GNU / Linux and free software applications without installing anything on the hard drives!
- The system is up and running in 2 or 3 minutes.
  Much faster than installing and configuring GNU / Linux!
- Also useful to rescue data when the OS no longer boots.
- Use compression to store up to 3-4 times the storage capacity !

List of live distros: http://frozentech.com/content/livecd.php

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Live distributions (2)

- Knoppix: http://knoppix.net/
  The most popular. Available in both CD and DVD.
  Great at auto-configuring your hardware!
- Ubuntu: http://ubuntu-linux.org/
  Ships a live CD with each release (every 6 months).
  Actually, the latest releases are live CDs too.

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Microkernel systems

GNU / Hurd: http://www.gnu.org/software/hurd/hurd.html

- GNU tools with the Hurd, the GNU kernel (microkernel)
- Getting mature, but not enough yet for general use.
  Mainly used by Hurd developers so far (2005).

Minix: http://www.minix3.org/

- The system that made Linus believe that writing a kernel was easy!
  Created by Andrew Tanenbaum.
  Versions 1 and 2 (non free) were intended to be used at teaching tools.
- Version 3's goals: serious system on resource-limited and embedded computers and for applications requiring high reliability. Not mature yet!
- Being ported to Xscale and PowerPC.
- License: BSD

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BSD Family

License: BSD!

- FreeBSD: http://www.freebsd.org/
  Powerful, multiplatform, secure,
  and popular BSD system.

- OpenBSD: http://openbsd.org/
  Built for extreme security and reliability.
  Popular in Internet servers.

- NetBSD: http://netbsd.org/
  BSD distribution designed for portability
  (available on ARM and others)

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Other free Unix systems

System V family

- OpenSolaris: http://opensolaris.org/
  The Open Source core of Sun Solaris.
  Lacking stable and supported distributions (Apr. 2007).

Others

- ECOS: http://ecos.sourceware.org/
  Very lightweight real-time embedded system
  contributed by Red Hat / Cygnus solutions.
  POSIX compliant API.

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Non-Unix systems

- ReactOS - http://reactos.org
  Free operating system targeting compatibility with Windows XP drivers and applications.

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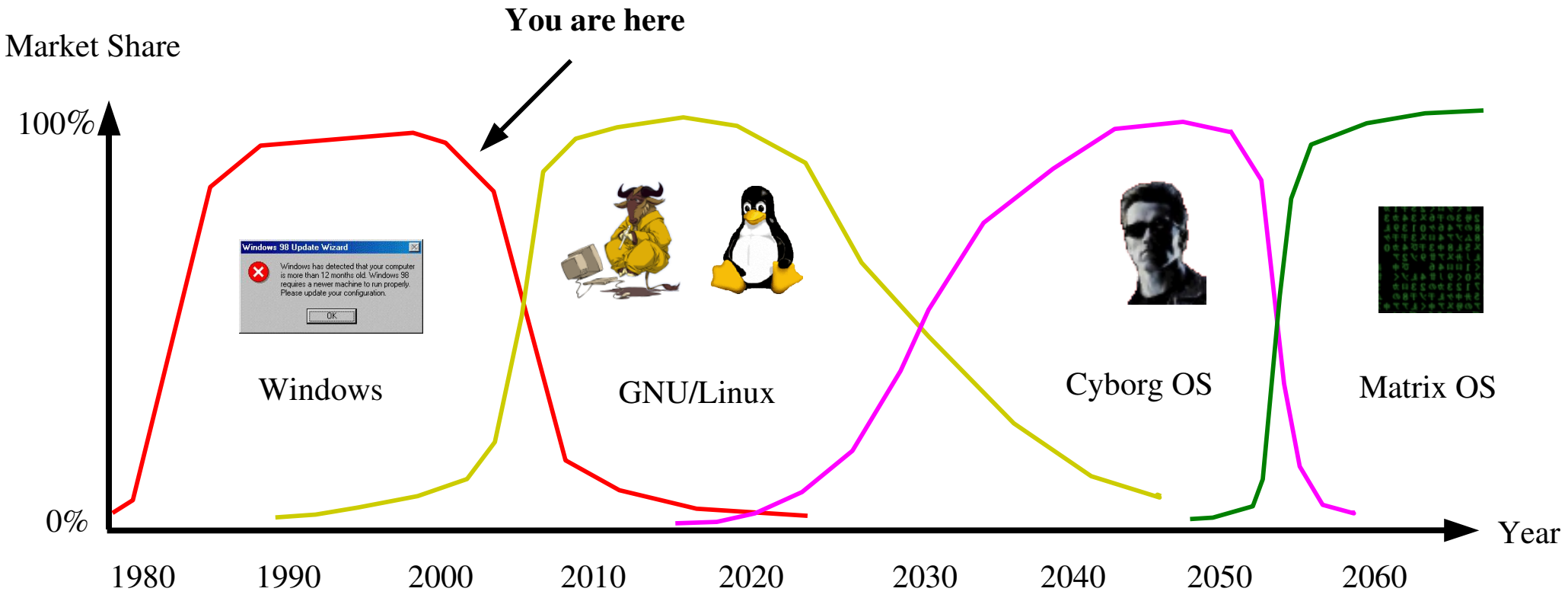
OS roadmap



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Successful project highlights

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Linux kernel

http://kernel.org

A free Unix-like operating system kernel

- License: GPL
- Main developers: community
  Big support and funding by Open Source Development Labs
- The preferred operating system in Internet servers, in compute farms. Roughly the same market share as Windows CE in embedded systems.

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GNU

GNU is Not Unix - http://gnu.org

- Main licenses: GPL and LGPL
- Developers: community
  Support and leadership from the Free Software Foundation
- Together with the Linux kernel, very successful in servers and compute farms. Less used in embedded systems (too big).

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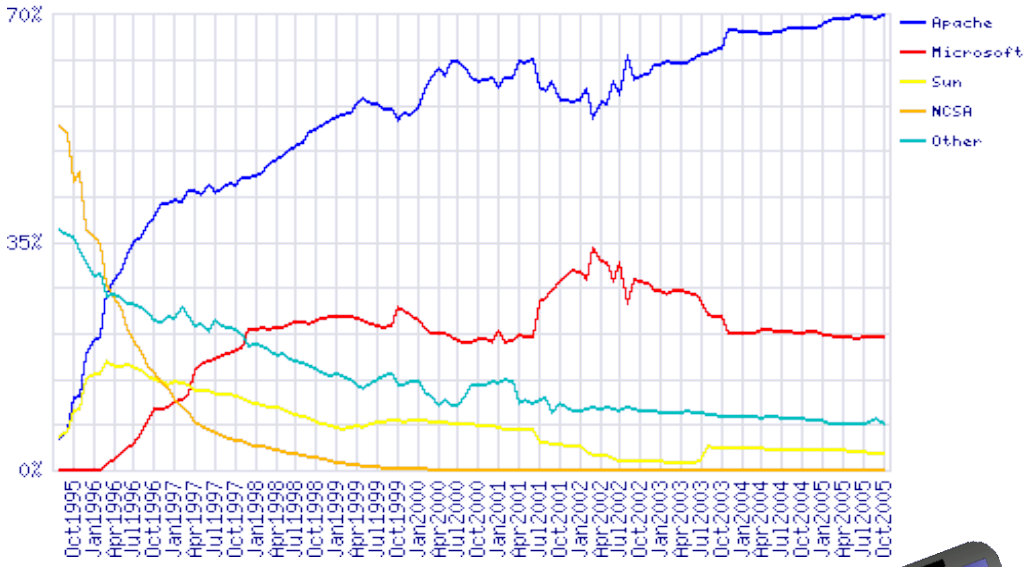
Apache

http://httpd.apache.org
Web server from the Apache Foundation

- License: Apache license (BSD type)
- The most popular web server on Internet since April 1996!
  http://news.netcraft.com/archives/web_server_survey.html
- Supported platforms:
  Unix and Windows NT
- Main developers:
  community



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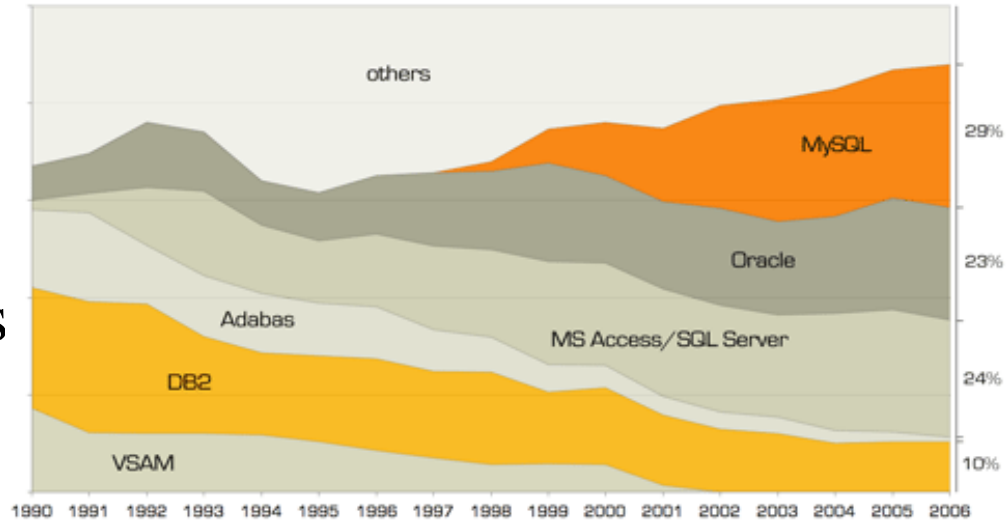
MySQL

The most popular Open Source database server
http://www.mysql.com

- License: GNU GPL
- Main developers: MySQL AB
  Make money on service and on selling commercial licenses
- Fast and easy to configure
- Nice market share!
  http://www.mysql.com/why-mysql/marketshare



Source: JoinVision E-Services GmbH, July 2006

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LAMP

Linux Apache MySQL PHP

- Popular acronym referring to the successful combination of these 4 technologies to implement dynamic websites.
- “P” can also stand for other scripting languages, such as Python or Perl.

See http://en.wikipedia.org/wiki/LAMP_%28software_bundle%29

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PHP

PHP Hypertext Processor (recursive acronym)
http://php.net

- License: PHP license (Copyleft)
- Main developers: community, Zend Technologies (business model: service and proprietary PHP development tools)
- Scripting language dedicated to the generation of HTML pages on web servers. Competitor to MS ASP, Sun Java / JSP, Perl...
- Extremely popular in web servers. Lots of ready-made components available.

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The GIMP

The GNU Image Manipulation Program
http://gimp.org

- License: GPL
- Main developers: community
- Extremely powerful image processor
  Similar to Photoshop
- Platforms: Unix / Linux / MacOS X, Windows
- Extensible and scriptable through plugins.

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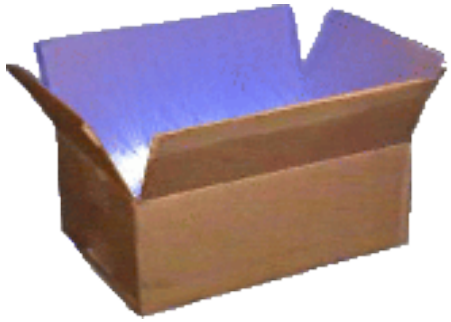
Busybox

http://busybox.net

A very lightweight implementation of many Unix commands, including a DHCP client and a web server!



- License: GPL
- Main developers: CodePoet Consulting
- Shipped in most Linux embedded systems
  Should call the system Busybox / Linux
- It total size doesn't exceed 500 K
  (statically compiled with uClibc)

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OpenOffice.org

Full featured and popular free office suite
http://openoffice.org/

- License: LGPL (since version 2.0)
- Main developer: Sun Microsystems, with support from a big community. Business model: selling desktop solutions without Microsoft software.
- Supported platforms: Unix, Windows, MacOSX
- Eating up MS Office's market share (in particular in administrations).

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Inkscape

A vector graphics editor
http://inkscape.org

- License: GNU GPL
- Developers: community
- Supported platforms: Linux / Unix, Windows and MacOS X
- Competing with Corel Draw and Adobe Illustrator

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Mozilla Firefox

Today's most advanced and friendly web browser
http://mozilla.org/projects/firefox

- License: MPL (copyleft type)
- Main developers: Mozilla Foundation, community
- Supported platforms: Unix / Linux, Windows, MacOS X
- A very serious competitor to Internet Explorer,
  which development was stopped for years!
- Market share (March 2007): 24 % in Europe.
  It even reaches 44% in Slovenia, 41% in Finland and 36% in Germany!
  More statistics on http://www.xitimonitor.com.

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Other successful projects

- KDE
- Gnome
- Perl
- Python
- gcc
- Evolution
- Eclipse
- Blender
- WikiPedia
- Bugzilla
- ... and many other examples!

Alternatives to Windows programs:
http://linux.ie/newusers/alternatives.php

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Free Software and Open Source rules

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What's needed to make a project successful

- A Free Software license!
- An Internet web site! Free downloads.
- A user community
- Active, continued development
- Flexibility, customizability

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What can help to make a project successful (1)

- Attractive / unique features
  (counter examples: projects at the beginning, like Linux)
- Open and easy development
  (counter examples: Mozilla and OpenOffice)
- Interoperability, compliance to standards
- Alternative to another solution (often proprietary)
- Cost difference
- Clear project guidance / leadership.
  Otherwise, you can create bloat.

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What can help to make a project successful (2)

- Money. Not mandatory but really helps (Mozilla, OpenOffice).
- Good communication. Need to advertise their work and attract users and contributors.
- Community communication tools: mailing lists, Wiki, IRC, web forum.
- Bug tracking tools: Bugzilla.
- Open development: public (read) access to the source repository.

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Unwritten rules

- Community projects. How to choose decision makers?
  Those who contribute most.
- Diversity is always valued.
  New, alternative projects are always welcome.
- Thou shalt not fork.
  Keep the community united.

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Business models

Money can be made with Free Software!

- Service!
  Original developers have a competitive edge
- Dual licensing
  Free GPL edition (wouldn't work with BSD!)
  Commercial license for any other uses
- Custom or first development.

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Business model constraints

- Competition - You have to remain the best supplier.
- No vendor lock-in.
- Need to create real added values, no royalties.
- You can switch the software you create to a proprietary version, but not the versions you already released. Beware of forking and competition!

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How to make your project successful

- Let everyone contribute according to their skills and interests.
- Encourage information sharing: wiki, mailing list (+ archives).
- Release early, release often.
- Accept useful contributions and recognize contributors.
- Have an open development.
- Make sure status and documentation are up to date.
- Publicize your progress to broader audiences.

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Useful reading

- The Cathedral and the Bazaar, Eric S. Raymond
  http://www.catb.org/~esr/writings/cathedral-bazaar
- Open Sources, Voices from the Open Source Revolution
  http://www.oreilly.com/catalog/opensources/book/toc.html

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Annex

Using GNU / Linux at home

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http://free-electrons.com

GNU / Linux at home (1)

GNU / Linux is also a great alternative to Windows for home users

Security

- Virus free
  Most viruses are designed to exploit Windows security flaws and have no impact on GNU / Linux
- Virus proof
  Even if you executed a Linux compatible virus, it wouldn't have permissions to modify the system.
- Mistake proof
  Other family members can't modify the system or somebody else's files either. They can only damage their own files.
- Cracker repellent
  Even always connected to the Internet, your system attracts crackers less.

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GNU / Linux at home (2)

Privacy

- Your system won't silently collect and transmit information about your movie or web site preferences.

User friendliness

- Your programs are made for users by users. They are more likely to satisfy your needs.
- Developers can easily be contacted to suggest new features.

Freedom

- Data you create are yours forever. They are not tied to a proprietary application through a proprietary (sometimes patented!) format.
- You are free to help your neighbors by sharing your programs with them.
- You are free to use your home programs at work too!

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GNU / Linux at home (3)

You can migrate to GNU / Linux for:

- Office work: word processor, spreadsheet, presentations
- Internet: web browsing and e-mail
- Multimedia: video, sound and graphics (including digital cameras)
- Learning about computers and computer programming

If you still have a copy of Windows, you can keep it (double boot) for:

- Gaming. Most consumer games still support Windows or Mac only.
- Using specific proprietary programs or educational cdroms
- Using hardware not supported yet on GNU / Linux

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GNU/Linux alternatives to Windows tools

Internet Explorer	Mozilla Firefox
IIS	Apache
Money	GNU Cash
MS Office	OpenOffice
MS Outlook	Evolution
MS Project	Mr Project (Planner)
Nero	k3b
Photoshop	The GIMP
WinAmp	xmms
W. Media Player	xine mplayer

More alternatives:
http://linux.ie/newusers/alternatives.php

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Using GNU / Linux distributions

GNU / Linux distributions

- Let you install GNU / Linux on free space on your hard disk, and still keep Windows (“double boot”)
- Have a very user-friendly installing interface which can automatically detect most hardware. You don't have any driver to install!
  That's even easier than installing Windows!
- Let you choose the types of applications to install
- Provide user friendly configuration interface
- Recommended distributions for beginners:
  Ubuntu, Fedora Core or Mandriva

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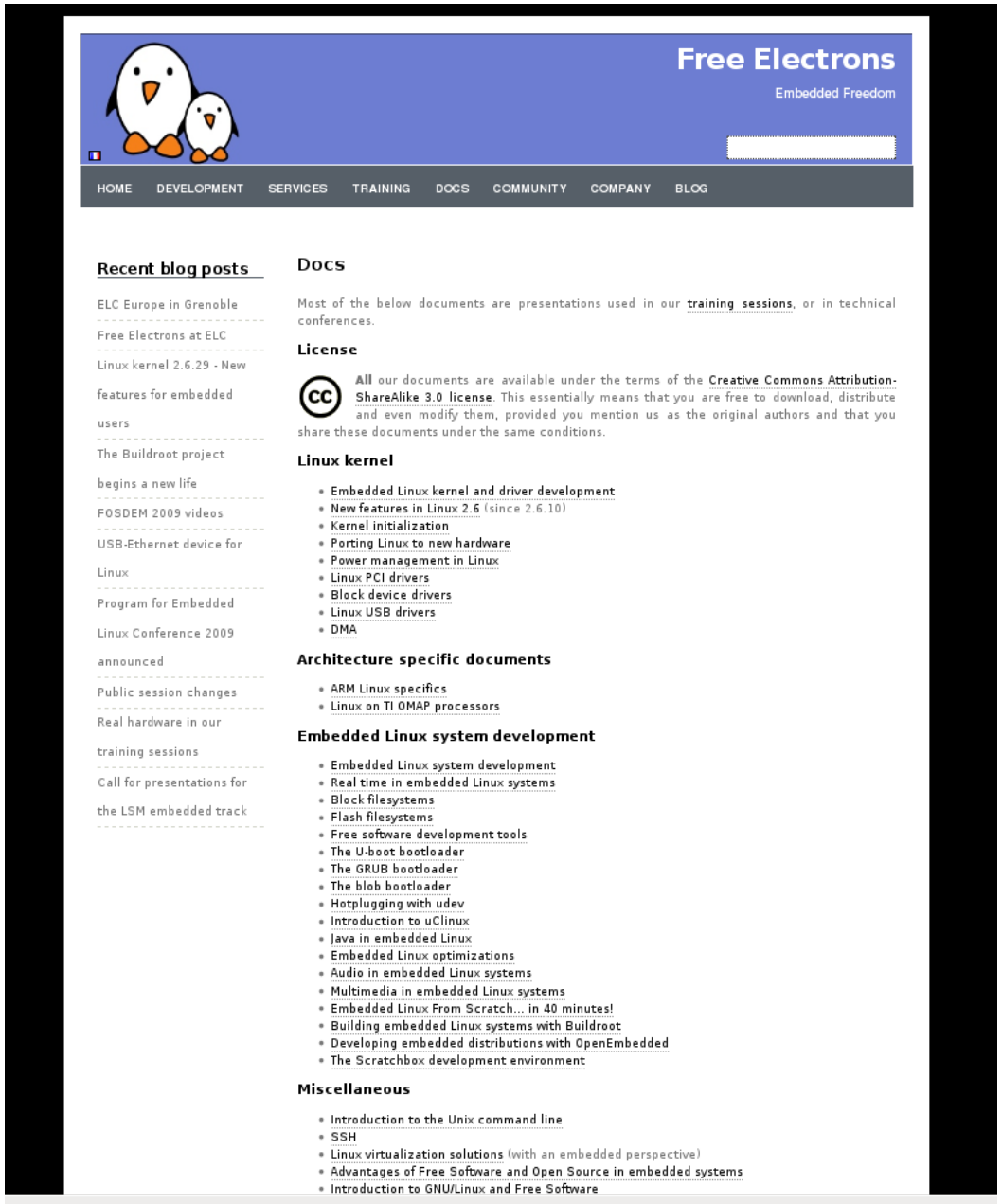
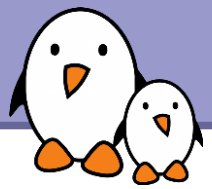
Related documents



All our technical presentations on http://free-electrons.com/docs

- Linux kernel
- Device drivers
- Architecture specifics
- Embedded Linux system development



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- By asking your organization to order development, consulting and training services performed by the authors of these documents (see http://free-electrons.com/).
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Linux kernel

Linux device drivers
Board support code
Mainstreaming kernel code
Kernel debugging

Embedded Linux Training

All materials released with a free license!

Unix and GNU/Linux basics
Linux kernel and drivers development
Real-time Linux, uClinux
Development and profiling tools
Lightweight tools for embedded systems
Root filesystem creation
Audio and multimedia
System optimization

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Our services

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System integration
Embedded Linux demos and prototypes
System optimization
Application and interface development

Consulting and technical support

Help in decision making
System architecture
System design and performance review
Development tool and application support
Investigating issues and fixing tool bugs