LINUX INTERNALS

A BRIEF TOUR OF THE KERNEL SOURCE TREE

Source: Wikipedia on "Linux Kernel"

...

Development

The kernel changes made in year 2007 have been submitted by no less than 1900 developers – but there may be a lot more because developers working in teams usually count as one. It is generally assumed that the community of Linux kernel developers is composed by 5000 or 6000 members; also, as of 2013, the 3.10 release of the Linux kernel had 15,803,499 lines of code. Without smart project management, it would not be possible to maintain development of such a large codebase.

> Instead of a roadmap, there are technical guidelines. Instead of a central resource allocation, there are persons and companies who all have a stake in the further development of the Linux kernel, quite independently from one another: People like Linus Torvalds and I don't plan the kernel evolution. We don't sit there and think up the roadmap for the next two years, then assign resources to the various new features. That's because we don't have any resources. The resources are all owned by the various corporations who use and contribute to Linux, as well as by the various independent contributors out there. It's those people who own the resources who decide...
>
> —Andrew Morton, 2005
>
> Linux is evolution, not intelligent design
>
> —Linus Torvalds, 2005[105][106]

By this statement it is meant that evolution often does odd (and "sub-optimal") things exactly because it does incremental changes which *do not break* at any point. As a result, any released version of the Linux kernel is fully usable, even if, for example, device drivers do not support all features of the hardware they are written for.

...

For U & Me - Interview
"There are no 'road maps' or rigid rules when it comes to Linux"
With more than two decades of history, the Linux kernel is one of the biggest and fastest developing open source projects, with about 53,600 files and around 20 million lines of code. To understand the story of Linux better and to learn about future open source technologies, Ankita K.S. from OSFY interacted with Kaiwan N. Billimoria, proprietor of kaiwanTECH and author of the book, 'Hands-On System Programming with Linux'.

OpenSource ForYou, Mar 2019

How would a professional Linux product company select a kernel version and what would the product life cycle be like? See this Wikipedia content on RedHat's product life cycle and kernel backporting.

A relevant paragraph from the above article / *"Why does Red Hat Linux use such an old kernel?"*:

"**Kernel backporting**[edit]

To maintain a stable application binary interface (ABI), Red Hat does not update the kernel version, but instead backports new features to the same kernel version with which a particular version of RHEL has been released. New features are backported throughout the Production 1 phase of the RHEL lifecycle.[47] Consequently, RHEL may use a Linux kernel with a dated version number, yet the kernel is up-to-date regarding not only security fixes, but also certain features.[48] One specific example is the S0_REUSEP0RT socket option which was added to Linux kernel 3.9, and was subsequently backported and became available since RHEL 6.5, which uses version 2.6.32 of the Linux kernel.[49][50][51] "
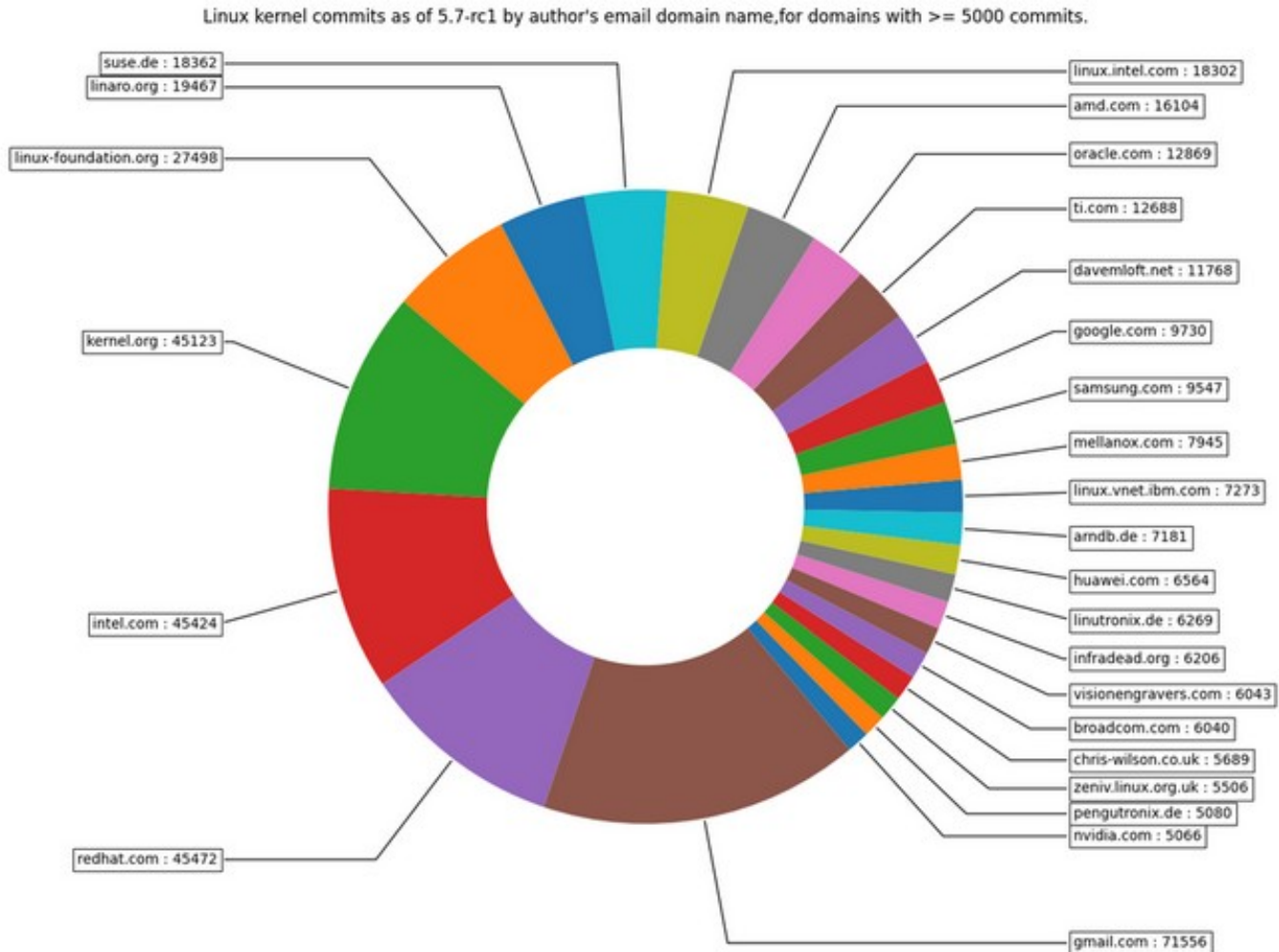
SIDEBAR - "Linux – Who Writes It ?"

Who Writes Linux, LF, Feb 2015

This report details who is writing Linux, how fast is it going and what companies and organizations are sponsoring that work. In 2015, Linux development is happening at a pace faster than ever with more first-time contributors than ever before.

Download full report

Linux kernel commits as of 5.7-rc1 by author's email domain name,for domains with >= 5000 commits.

Domain	Commits
suse.de	18362
linaro.org	19467
linux-foundation.org	27498
kernel.org	45123
intel.com	45424
redhat.com	45472
linux.intel.com	18302
amd.com	16104
oracle.com	12869
ti.com	12688
davemloft.net	11768
google.com	9730
samsung.com	9547
mellanox.com	7945
linux.vnet.ibm.com	7273
arndb.de	7181
huawei.com	6564
linutronix.de	6269
infradead.org	6206
visionengravers.com	6043
broadcom.com	6040
chris-wilson.co.uk	5689
zeniv.linux.org.uk	5506
pengutronix.de	5080
nvidia.com	5066
gmail.com	71556

5.7-rc1 : Linux kernel commits as of 5.7-rc1 by author's email domain name,for domains with >= 5000 commits.

[OLDER]
Source:
Linux Foundation Publishes Study on Linux Development Statistics: Who Writes Linux and Who Supports It

A close look at Linux kernel development process reveals the number of Linux kernel developers has tripled over the last three years

SAN FRANCISCO – April 1, 2008 — The Linux Foundation (LF), the nonprofit organization dedicated to accelerating the growth of Linux, today announced it is publishing a new report written by kernel developers Jonathan Corbet and Greg Kroah-Hartman, and LF Director of Marketing Amanda McPherson.

The report titled "Linux Kernel Development: How Fast is it Going, Who is doing it and Who

is Sponsoring it?" is available today at
https://www.linux-foundation.org/publications/linuxkerneldevelopment.php . The paper finds
that over the last three years the number of developers contributing to the kernel has tripled
and that there has been a significant increase in the number of companies supporting kernel
development.

Even though Linux has achieved near-ubiquity as a technology platform powering Internet
applications, corporate servers, embedded and mobile devices and desktops, mainstream users
know very little about how Linux is actually developed. This community paper exposes those
dynamics and describes a large and distributed developer and corporate community that
supports the expansion and innovation of the Linux kernel. The Linux kernel has become a
common resource developed on a massive scale by companies who are fierce competitors in
other areas.

Corbet and Kroah-Hartman, key kernel developers themselves and members of the Linux
Foundation's Technical Advisory Board (TAB), reviewed nearly three years of kernel history
representing Linux releases 2.6.11 through 2.6.24. The report goes into detail on how the
Linux development process works, including who is contributing, how often and why.

Highlights include:

• Who is Writing Linux?
o Every Linux kernel is being developed by nearly 1,000 developers working for more than
100 different corporations. This is the foundation for the largest distributed software
development project in the world.
o Since 2005, the number of active kernel developers has tripled, reflecting the growing
importance of Linux in the embedded systems, server, and desktop markets.
o Between 70 and 95 percent of those developers are being paid for their work, dispelling the
"hobbyist" myth present from the start of open source development.


• Who is Sponsoring Linux?
o More than 70 percent of total contributions to the kernel come from developers working at a
range of companies including IBM, Intel, The Linux Foundation, MIPS Technology,
MontaVista, Movial, NetApp, Novell and Red Hat. These companies, and many others, find
that by improving the kernel they have a competitive edge in their markets.

• How Fast is Linux Developed and Released?
o An average of 3,621 lines of code are added to the kernel tree every day, and a new kernel is
released approximately every 2.7 months.
o The kernel, since 2005, has been growing at a steady state of 10 percent per year.

Brief kernel source tree tour

- *The major subsystems of the Linux Kernel*

VFS		Virtual Memory
	Kernel	
Network		IPC
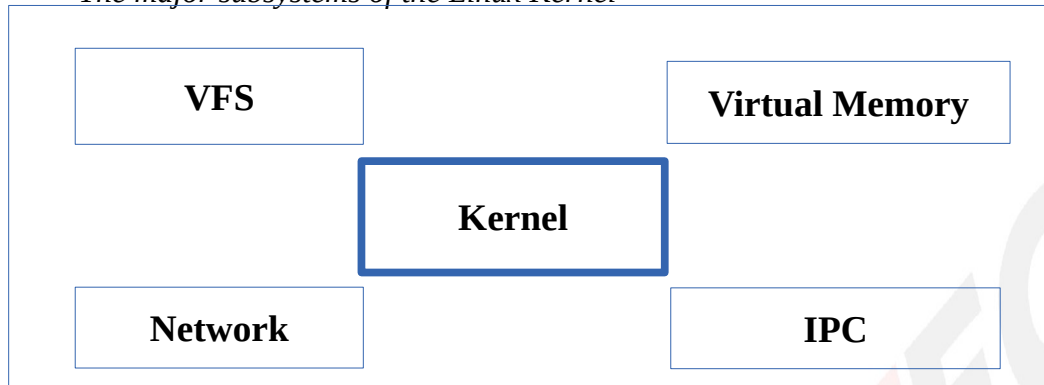
- The **"Kernel "** box is the heart of the Linux operating system. It has the following key responsibilities:
    - allow processes to create new copies of themselves
    - scheduler: determine which process will have access to the CPU and effect the transfer between running processes
    - receive interrupts and route them to the appropriate kernel subsystem
    - manage signalling
    - manage the timer hardware.

Simplified Structure of the Linux Kernel : Wikimedia
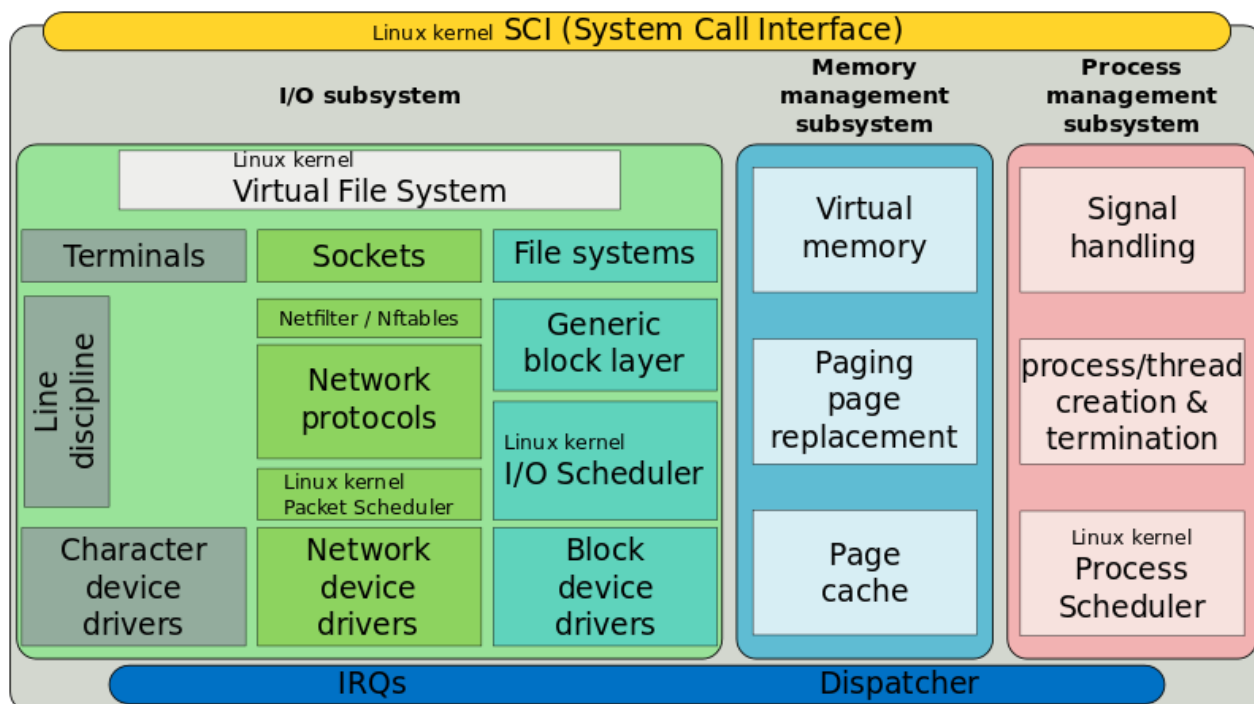
*<< Alternate: another perspective of the Linux kernel architecture.
   Source: IBM DeveloperWorks article >>*
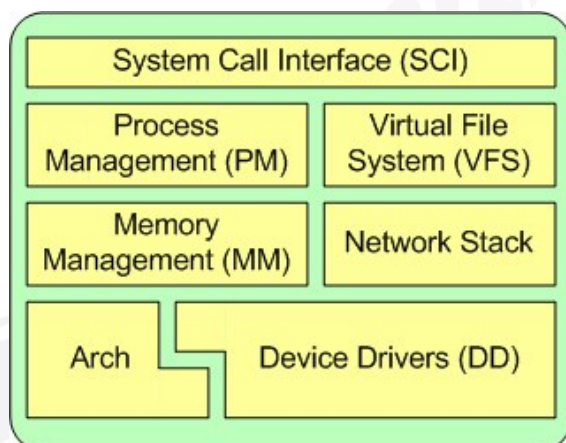
Source Language
Screenshot from https://github.com/torvalds/linux (as of 5.0, 05Mar2019):

☐ torvalds / **linux**		◉ Watch ▾ 6,642	★ Unstar 70,196	⑂ Fork 25,127

‹› Code	⑂ Pull requests **255**	▥ Projects **0**	�旭 Insights

Linux kernel source tree

● **C** 96.3%	● **C++** 1.4%	● **Assembly** 1.3%	● **Objective-C** 0.3%	● **Makefile** 0.3%	● **Shell** 0.2%	● **Other** 0.2%

Branch: **master** ▾ New pull request		Create new file	Upload files	Find file	Clone or download ▾

🜛 **torvalds** Merge tag 'leds-for-5.1-rc1' of git://git.kernel.org/pub/scm/linux/ke… ⋯	Latest commit `cd2a3bf` 7 hours ago

Check this out!   :-)

https://www.vidarholen.net/contents/wordcount/#hack*,workaround*,todo,fixme
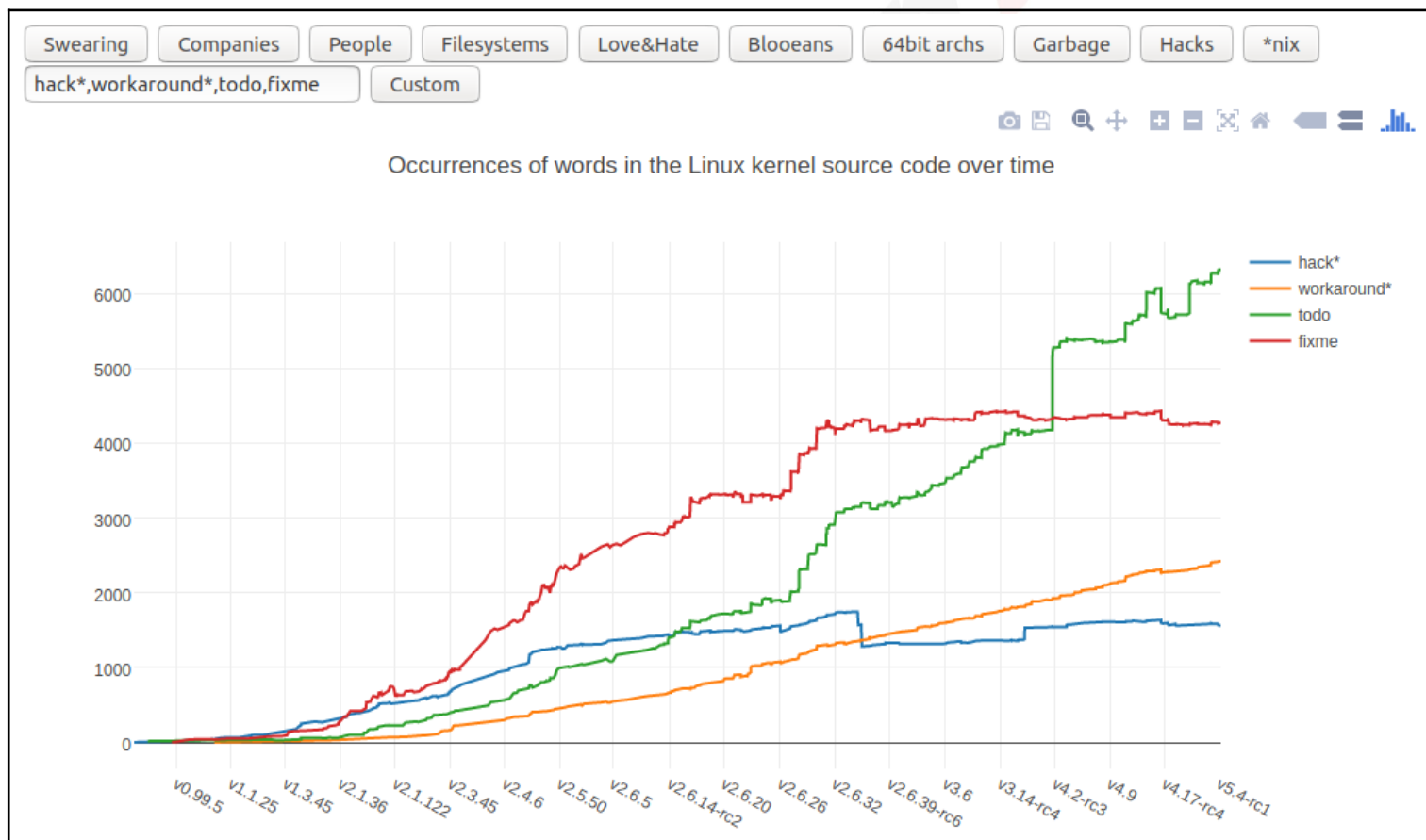
Source

While Linus Torvalds supervises code changes and releases to the latest kernel versions, he has delegated the maintenance of older versions to other programmers.[104]Major releases as old as 2.0 (officially made obsolete with the kernel 2.2.0 release in January 1999) are maintained as needed, although at a very slow pace.

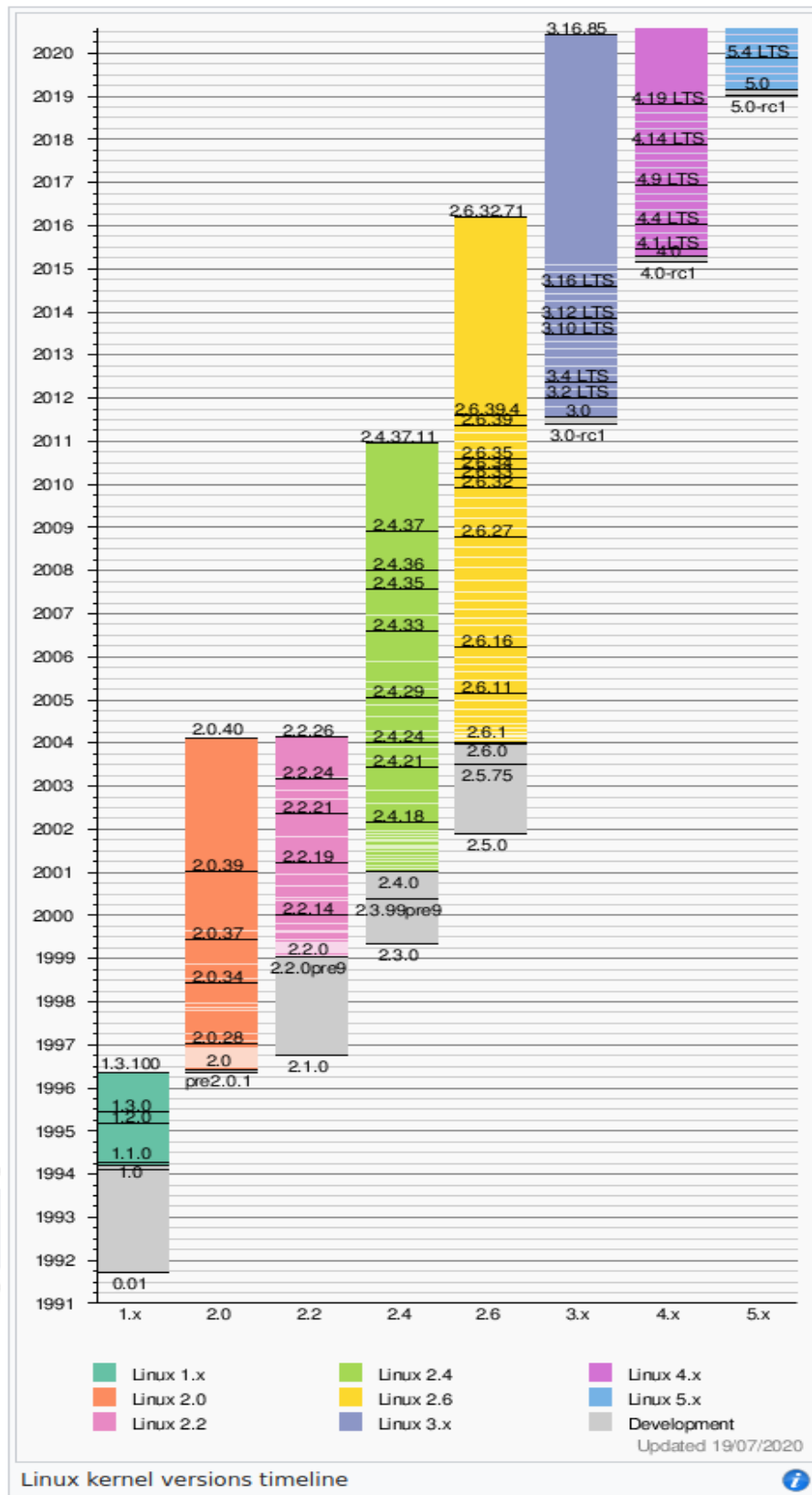| Kernel series	Original release date	Current version	Maintainer	Support Model
0.01	17 September 1991	0.03		**EOL**
0.10	November 1991	0.12		**EOL**
0.95	8 March 1992	0.99.15		**EOL**
1.0	14 March 1994	1.0.9		**EOL**
1.1	6 April 1994	1.1.95		**EOL**
1.2	7 March 1995	1.2.13		**EOL**
1.3	12 June 1995	1.3.100		**EOL**
pre2.0	12 May 1996	pre2.0.14		**EOL**
2.0	9 June 1996	2.0.40[105]	David Weinehall	**EOL** (Officially made obsolete with the kernel 2.2.0 release)[106]
2.2	26 January 1999	2.2.26[107]	Marc-Christian Petersen(former maintainer Alan Cox)	**EOL** (Unofficially obsolete with the 2.2.27-rc2)[108][109]
2.4	4 January 2001	2.4.37.11	Willy Tarreau (former maintainer Marcelo Tosatti)	**EOL** (Maintained from December 2008 to December 2011), last stable release of the 2.4 kernel series.[110]
2.6	18 December 2003	2.6.15		**EOL**
2.6.16	20 March 2006	2.6.16.62	Adrian Bunk (former maintainer Greg Kroah-Hartman)[111]	**EOL** (1st **long-term** stable release from March 2006 to July 2009, replaced by 2.6.27.x)[112]
2.6.27	9 October 2008	2.6.27.62[113]	Willy Tarreau (former maintainer Greg Kroah-Hartman)	**EOL** (2nd **long-term** stable release from October 2008 to March 2012)[114]
2.6.32	3 December 2009[115]	2.6.32.61[116]	Willy Tarreau (former maintainer Greg Kroah-	3rd **long-term** stable release from December 2009 to mid 2014,[118] used in *Debian 6*

Kernel series	Original release date	Current version	Maintainer	Support Model
			Hartman)[117]	*Squeeze*[119]
2.6.33	24 February 2010[120]	2.6.33.20[121]	Greg Kroah-Hartman[122]	**EOL** (4th **long-term** stable release from March 2011 to November 2011, Base for Real-Time-Tree, replaced by 3.0.x)[121][122]
2.6.34	16 May 2010[123]	2.6.34.14[124]	Paul Gortmaker[118][125]	5th **long-term** stable release from January 2011 to mid 2013[118][125]
2.6.35	2 August 2010[126]	2.6.35.14[127]	Andi Kleen[128]	**EOL** (6th **long-term** stable release from December 2010 to March 2012)[128]
2.6.39	19 May 2011[129]	2.6.39.4[130]	Greg Kroah-Hartman	**EOL** (Maintained from May 2011 to August 2011), last stable release of the 2.6 kernel series.[130]
3.0	22 July 2011[83]	3.0.101[131]	Greg Kroah-Hartman[118][132]	**EOL** (7th **long-term** stable release from July 2011 to October 2013 (Base for Real-Time-Tree))[118][132]
3.1	24 October 2011[133]	3.1.10[134]	Greg Kroah-Hartman	**EOL** (Maintained from October 2011 to January 2012)[134]
3.2	5 January 2012[135]	3.2.53[136]	Ben Hutchings[118][137]	8th **long-term** stable release from March 2012 to 2016, used in *Ubuntu 12.04 LTS*, *Debian 7 Wheezy* and *Slackware 14.0*.[118][137] It has unofficial extended supported by Canonical until April 2017.[138]
3.3	19 March 2012[139]	3.3.8[140]	Greg Kroah-Hartman	**EOL** (Maintained from March 2012 to June 2012)[140]
3.4	21 May 2012[141][142]	3.4.74[143]	Greg Kroah-Hartman[118][144]	9th **long-term** stable release from May 2012 to October 2014[118][144]
3.5	21 July 2012[145]	3.5.7[146]	Greg Kroah-Hartman	**EOL** (Maintained by Kroah-Hartman until the release of 3.6.1, from July 2012 to October 2012).[146] It has unofficial extended supported by Canonical until April 2014.[138][147]
3.6	1 October 2012[148]	3.6.11[149]	Greg Kroah-Hartman	**EOL** (Maintained from October 2012 to December 2012)[149]
3.7	11 December 2012[150]	3.7.10[151]	Greg Kroah-Hartman	**EOL** (Maintained from December 2012 to March 2013)[151][152]
3.8	19 February 2013[153]	3.8.13[154]	Greg Kroah-Hartman	**EOL** (Maintained from February 2013 to May 2013)[154] It has unofficial extended supported by Canonical until August 2014.[138][155]

Kernel series	Original release date	Current version	Maintainer	Support Model
3.9	29 April 2013[156]	3.9.11[157]	Greg Kroah-Hartman	**EOL** (Maintained from April 2013 to July 2013)[157]
3.10	30 June 2013[158]	3.10.24[159]	Greg Kroah-Hartman[118]	10th **long-term** stable release from August 2013 to September 2015.[118][160]
3.11	2 September 2013[161]	3.11.10[162]	Greg Kroah-Hartman	**EOL** (Maintained from September 2013 to November 2013)[162]

3.12	3 November 2013[171]	3.12.17[172]	Jiří Slabý (formerly Greg Kroah-Hartman)[173]	11th **long-term** stable release from November 2013 to 2016[124]
3.13	19 January 2014[174]	3.13.10[175]	Greg Kroah-Hartman	Supported version.
3.14	30 March 2014[3]	3.14[3]	Linus Torvalds	Latest stable version.
3.15	13 April 2014[4]	3.15-rc1[4]	Linus Torvalds	Latest development version.

Legend:
Old version   Older version, still supported   **Latest version**   Latest preview version

3.17   5 October 2014[193]
3.17.2[194]**Greg Kroah-Hartman**
Latest stable version3.18   19 October 2014[195]
3.18-rc3[196]**Linus TorvaldsThird Release Candidate version**

The above table in this material is bound to get outdated; please refer to the Wikipedia page for the latest version.

<<
***Wikipedia** : Screenshot (taken on 05 Dec 2019) of the last few lines of the above table(s):*
https://en.wikipedia.org/wiki/Linux_kernel_version_history

Linux kernel versions timeline

Releases 5.x.y [edit]

Version	Original release date	Current version	Maintainer	Support model	[hide]
5.0	3 March 2019[212]	5.0.21[213]	Greg Kroah-Hartman	EOL (maintained from March 2019 to June 2019)[213]	
5.1	5 May 2019[214]	5.1.21[215]	Greg Kroah-Hartman	EOL (maintained from May 2019 to July 2019)[215]	
5.2	7 July 2019[216]	5.2.20[217]	Greg Kroah-Hartman	EOL (maintained from July 2019 to October 2019)[217]	
5.3	15 September 2019[218]	5.3.18[219]	Greg Kroah-Hartman	EOL (maintained from September 2019 to December 2019)[219]	
5.4	24 November 2019[220]	5.4.63[221]	Greg Kroah-Hartman & Sasha Levin[70]	20th LTS release, maintained from November 2019 to December 2025[70]	
5.5	26 January 2020[222]	5.5.19[223]	Greg Kroah-Hartman	EOL (maintained from January 2020 to April 2020)[223]	
5.6	29 March 2020[224]	5.6.19[225]	Greg Kroah-Hartman	EOL (maintained from March 2020 to June 2020)[225]	
5.7	31 May 2020[226]	5.7.19[227]	Greg Kroah-Hartman	EOL (maintained from May 2020 to August 2020)[227]	
5.8	2 August 2020[228]	5.8.8[229] (9 September 2020; 0 days ago) [±]	Greg Kroah-Hartman	Stable release	
5.9	not yet released	5.9-rc4[230] (6 September 2020; 3 days ago) [±]	Linus Torvalds	Preview release	
Legend:	Old version	Older version, still maintained	**Latest version**	Latest preview version	

(As of Sept 2020)
>>

How would a professional Linux product company select a kernel version and what would the product life cycle be like? See this Wikipedia content on RedHat's product life cycle and kernel backporting.

==Get the Linux kernel 'finger banner'==

curl -L https://www.kernel.org/finger_banner

As of 01 Jan 2020

```
$ curl -L https://www.kernel.org/finger_banner
The latest stable version of the Linux kernel is:          5.4.7
The latest mainline version of the Linux kernel is:        5.5-rc4
The latest stable 5.4 version of the Linux kernel is:      5.4.7
The latest stable 5.3 version of the Linux kernel is:      5.3.18 (EOL)
The latest longterm 4.19 version of the Linux kernel is:   4.19.92
The latest longterm 4.14 version of the Linux kernel is:   4.14.161
The latest longterm 4.9 version of the Linux kernel is:    4.9.207
The latest longterm 4.4 version of the Linux kernel is:    4.4.207
The latest longterm 3.16 version of the Linux kernel is:   3.16.80
The latest linux-next version of the Linux kernel is:      next-20191220
$
```

SLOCs

Source

Kernel Codebase Size

Linux kernel source size (tar.bz2)

$$y=0.175822*1.0243^{(x/1.1939)}+1$$
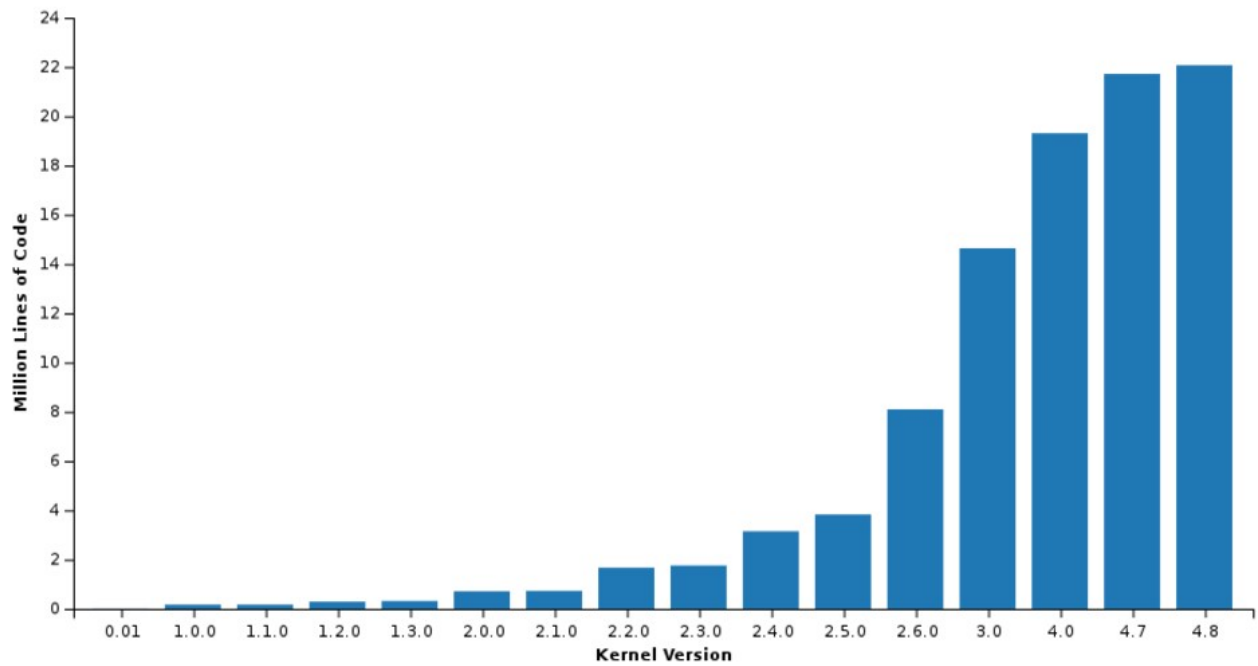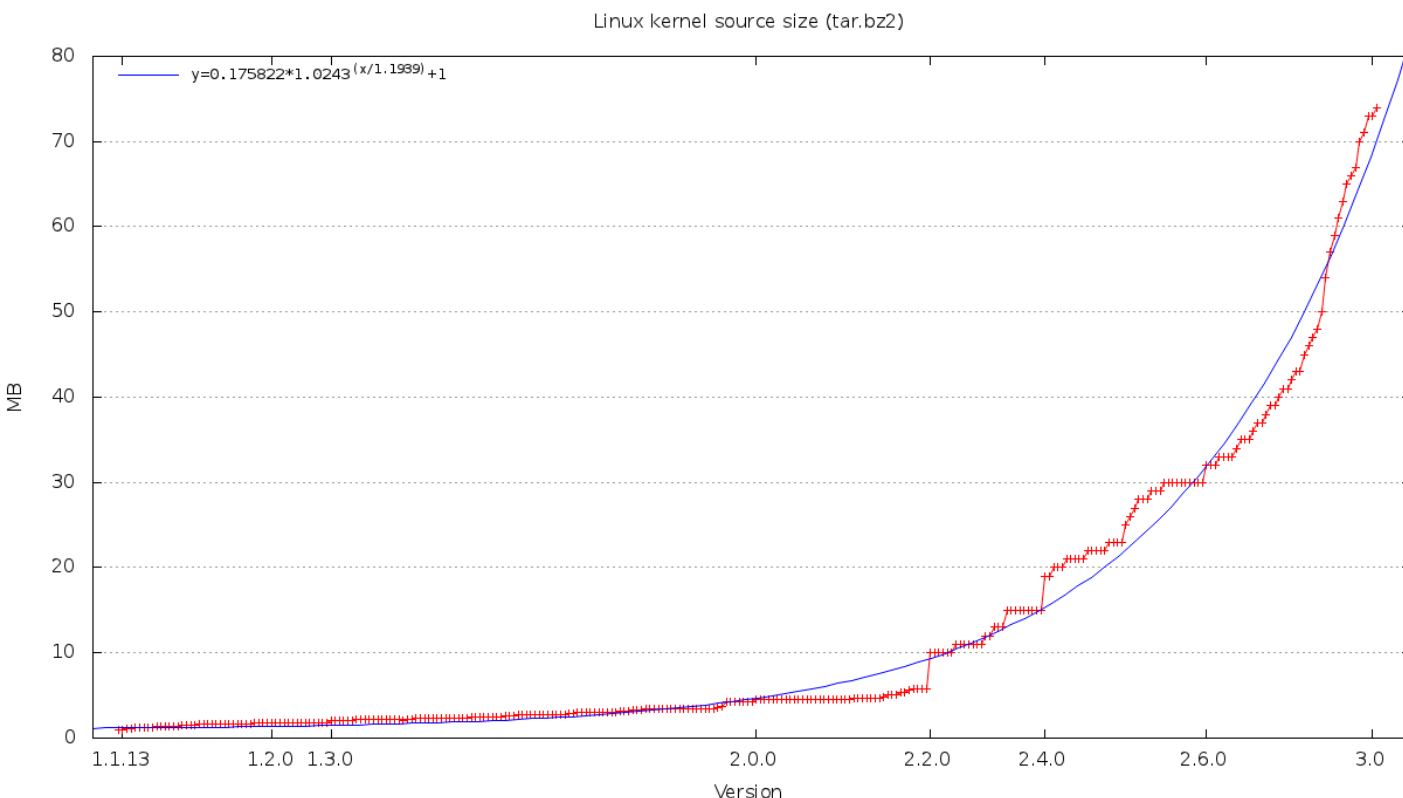
Above pic sourced from here.

Source: LinuxFoundation report "Who Writes Linux", Feb 2015.
...
Kernel Source Size

Kernel Release	Files	Lines
3.11	44,017	17,407,037
3.12	44,601	17,730,630
3.13	44,985	17,934,674
3.14	45,950	18,275,747
3.15	46,795	18,636,331
3.16	47,440	18,882,881
3.17	47,505	18,868,140
3.18	47,986	18,997,848

FYI:
Compressed and archived linux-0.01.tar.bz2 is 62 KB.
Uncompressed linux-0.01 tree is 275 KB.

Compressed and archived linux-2.6.10.tar.bz2 is 35 MB.

Uncompressed linux-2.6.10 tree is 227 MB.
Uncompressed linux-2.6.16 tree is 340 MB.
Compressed and archived linux-2.6.20.tar.bz2 is 41.4 MB.
[April 2008] Uncompressed linux-2.6.25 tree is 317 MB.
Uncompressed linux-2.6.27 tree is 327 MB.
[Dec 2008]   Uncompressed linux-2.6.28 tree is ~ 340 MB.
[9 June 2009] Uncompressed linux-2.6.30 tree is 390 MB.
[06 Jan 2011] Compressed linux-2.6.30 tree is 64.5 MB.
[06 Jan 2011] Uncompressed linux-2.6.30 tree is 448 MB.
Uncompressed linux-2.6.35.11 tree is 458 MB.
[Aug 2011] Compressed 2.6.39.4.tar.bz2 tree is 72.6 MB   *<-- last 2.6.x.y kernel src tree*

[Jul 2011] Compressed linux-3.0.tar.bz2 tree is 73.2 MB.
Uncompressed linux-3.0 tree is 494 MB.
[Oct 2011] Compressed linux-3.1.tar.xz tree is 60.8 MB.
Uncompressed linux-3.1 tree is 498 MB.
[Mar 2012] Compressed linux-3.2.11.tar.xz tree is 62.1 MB.
Uncompressed linux-3.2.11 is 505 MB.
[May 2012] Compressed linux-3.3.7.tar.xz tree is 63 MB.
                 Compressed linux-3.3.7.tar.bz2 tree is 75 MB.
[Aug 2012] Compressed linux-3.4.8.tar.xz tree is 63.7 MB.
                 Uncompressed linux-3.4.8.tar.xz tree is 517 MB.
[Dec 2012] Compressed linux-3.6.11.tar.xz tree is 65.8 MB.
[May 2013] Compressed linux-3.8.13.tar.xz tree is 67.7 MB.
[Jul 2013]   Compressed linux-3.10.1.tar.xz tree is 69.8 MB.
[Jul 2014]   Compressed linux-3.10.48.tar.xz tree is 70 MB. *<-- 10th LTS; Aug '13 to Sep '15*
                 Uncompressed linux-3.10.48.tar.xz tree is 573 MB.
[Oct 2014]   Compressed linux-3.14.23.tar.xz tree is 75 MB.
                 Uncompressed linux-3.10.48.tar.xz tree is 614 MB.
 ...
[Jan 2016]   Compressed linux-4.4.21.tar.xz tree is 87 MB.
                 Uncompressed linux-4.4.21 tree is 710 MB.
...
[Mar 2016] Uncompressed linux-4.5.0 is 1640 MB (1.6 GB)
…
[Mar 2016] Uncompressed linux-4.5.0 is 1640 MB (1.6 GB)
...
[Feb 2018]   Compressed linux-4.15.4.tar.xz tree is 97 MB

[28 Mar 2018]   Compressed linux-4.15.14.tar.xz tree is 98 MB
                 Uncompressed linux-4.15.14 tree is   903 MB.

[03 June 2018]   Compressed linux-4.17.tar.xz tree is 98 MB
                 Uncompressed linux-4.17 tree is   903 MB.

[23 Nov 2018]   Compressed linux-4.19.4.tar.xz tree is 99 MB
                 Uncompressed linux-4.19.4 tree is   908 MB.

[03 Mar 2019]   Compressed linux-5.0.tar.xz tree is 101 MB

Uncompressed linux-5.0 tree is   934 MB.

[24 Nov 2019]   Compressed linux-5.4.tar.xz tree is 105 MB   <-- *20th LTS rel; Nov '19 to Dec 2021 (for now)*

Uncompressed linux-5.4 tree is   1011 MB.

<<
The kernel source tree shown below of the stable vanilla kernel version 5.4.0 - the 20th long term stable (LTS) release.
>>

```
$ ls -F
arch/      crypto/       Documentation/   ipc/       LICENSES/    README       sphinx_1.7.9/
block/     cscope.files  drivers/         Kbuild     MAINTAINERS  samples/     tags
certs/     cscope.out    fs/              Kconfig    Makefile     scripts/     tools/
COPYING    cscope.out.in include/         kernel/    mm/          security/    usr/
CREDITS    cscope.out.po init/            lib/       net/         sound/       virt/
$
$ head -n6 Makefile
# SPDX-License-Identifier: GPL-2.0
VERSION = 5
PATCHLEVEL = 4
SUBLEVEL = 0
EXTRAVERSION =
NAME = Kleptomaniac Octopus
$
$ ls -F arch/
alpha/   arm64/   h8300/    Kconfig        mips/    openrisc/  riscv/   sparc/       x86/
arc/     c6x/     hexagon/  m68k/          nds32/   parisc/    s390/    um/          xtensa/
arm/     csky/    ia64/     microblaze/    nios2/   powerpc/   sh/      unicore32/
$
```

<< *Note-*
Starting from 2.6.24, the i386 and the x86_64 (the 64-bit variant of the 32-bit x86 architecture), have been unified into a common *arch/x86* directory.
Similarly, the *include/* branch now has a *include/asm-x86* directory.
>>

Miscellaneous / Optional
[Quora] How large is the largest function in Linux kernel?

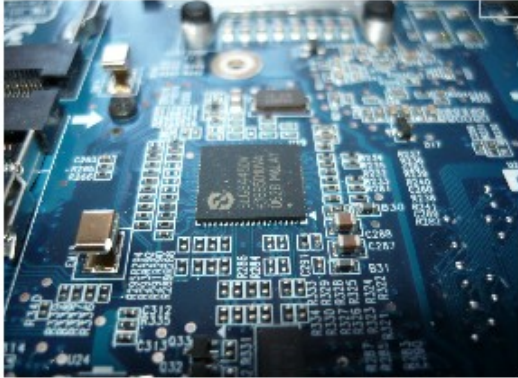Short Answer: as of 4.7 Linux:

```
"total functions: 22600
file with most functions: linux-4.7-rc1/drivers/infiniband/hw/hfi1/chip.c
( 577 )

file with largest function:
linux-4.7-rc1/drivers/staging/lustre/lustre/ptlrpc/wiretest.c        function at
line num: 48                function size: 4179 lines".
```

Linux Operating System
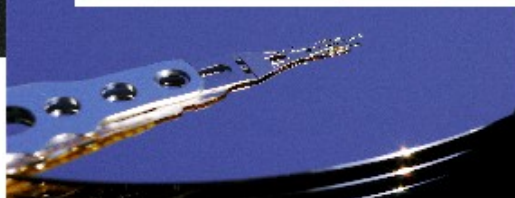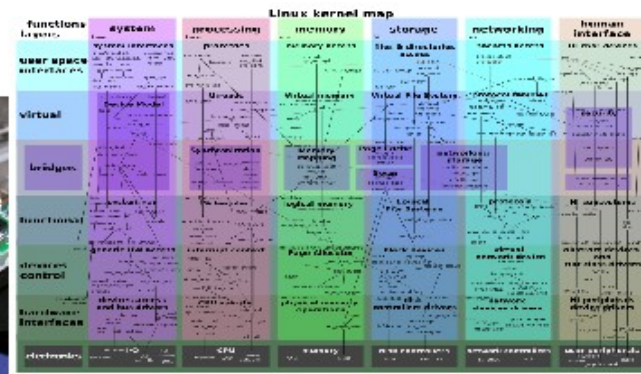**Specialized**

kaiwanTECH

The highest quality Training on:

Linux Fundamentals, CLI and Scripting
Linux Systems Programming
Linux Kernel Internals
Linux Device Drivers
Embedded Linux
Linux Debugging Techniques
New! Linux OS for Technical Managers

Please do visit our website for details:
http://kaiwantech.in

http://kaiwantech.in