GNU Linux

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GNU Linux, 2019

History (Unix)

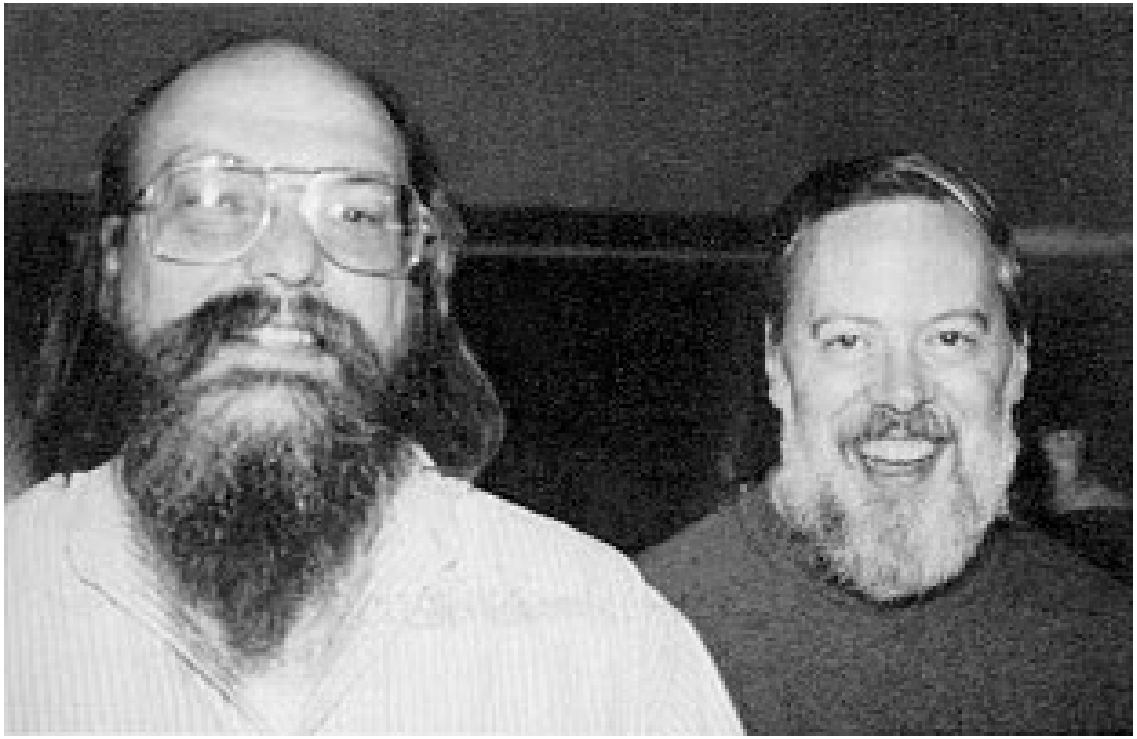
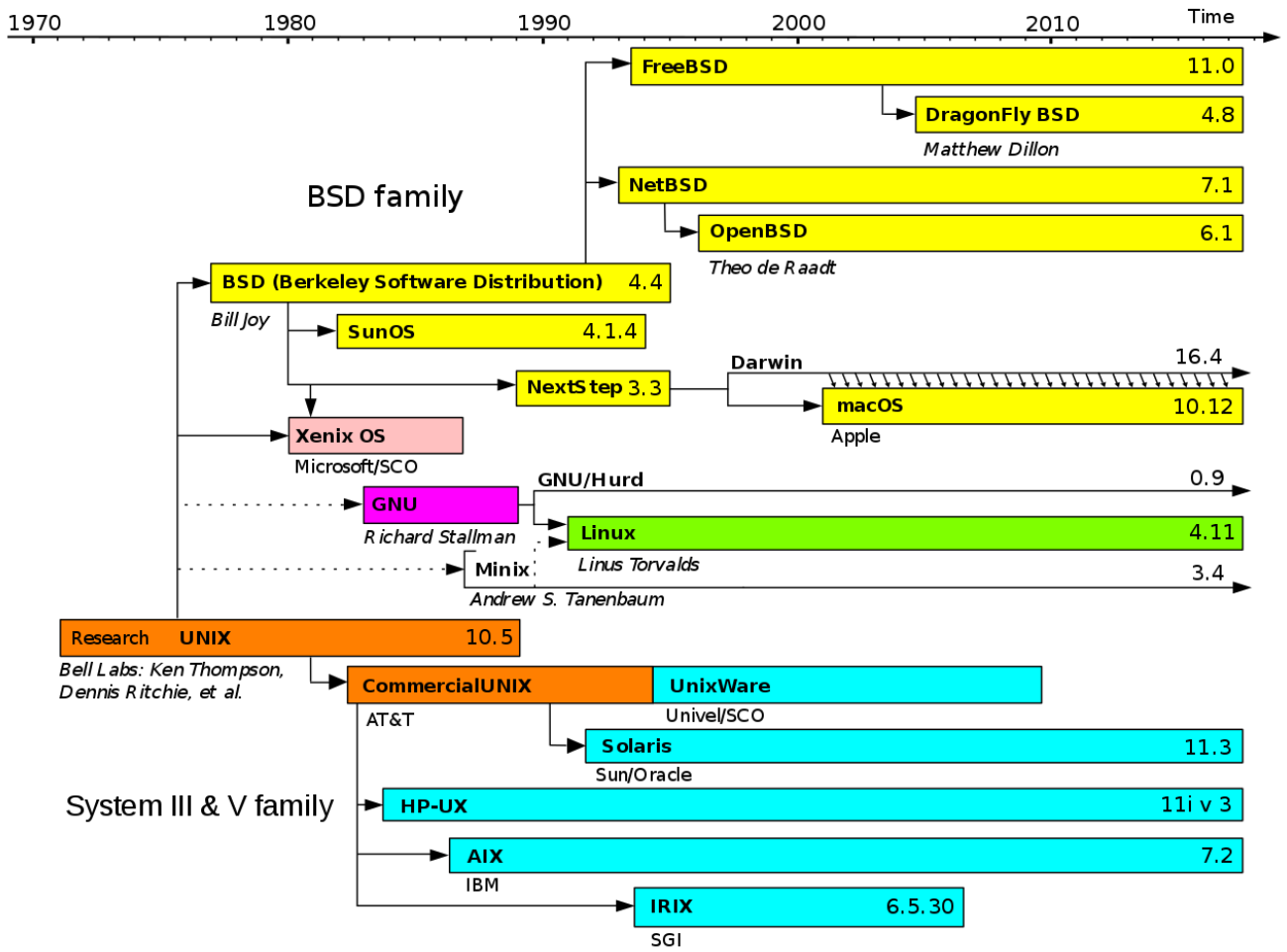


Figure: Ken Thompson and Dennis Ritchie †2011 Turing Award in 1983

Unix Wars


1970
1980
1990
2000
2010
Time
FreeBSD 11.0
DragonFly BSD 4.8
Matthew Dillon
BSD family
NetBSD 7.1
OpenBSD 6.1
Theo de Raadt
BSD (Berkeley Software Distribution) 4.4
Bill Joy
SunOS 4.1.4
Darwin
16.4
NextStep 3.3
macOS 10.12
Apple
Xenix OS
Microsoft/SCO
GNU/Hurd
0.9
GNU
Richard Stallman
Linux 4.11
Linus Torvalds
Minix
3.4
Andrew S. Tanenbaum
Research UNIX 10.5
Bell Labs: Ken Thompson, Dennis Ritchie, et al.
CommercialUNIX
UnixWare
AT&T
Univel/SCO
Solaris 11.3
Sun/Oracle
System III & V family
HP-UX 11i v 3
AIX 7.2
IBM
IRIX 6.5.30
SGI

GNU Linux

- created by Linus Torvalds
- Linux runs on:
  - all android phones, tablets, watches and TV (2 Billion)
  - all supercomputers of the top 500
  - 96.5 % webservers of the top 1 million domains
  - 92 % of all amacon ec2 instances in their cloud
- around 25 million lines of code (C)

Advantages and Disadvantages

- pro:
  - very stable
  - almost never reboots
  - code written for Linux can be ported to all Unixoid operatings systems
  - does not demand many hardware resources
  - one system can be used by multiple users
  - no known virus existing
  - security can be enhanced with selinux (developed by the NSA)
- contra:
  - graphical desktop support is just ok
  - steep learning curve
  - almost no games
  - no support for crazy hardware (special measurement devices . . .)

Linux Distributions

- Linux distributions consists of:
  - Linux Kernel (OS)
  - software packages
  - package manager
- famous distributions are:
  - Ubuntu (user friendly)
  - Debian (stable server)
  - CentOS (free) / RHEL (commercial) (cluster)
  - Arch Linux (advanced users)

Boot Process

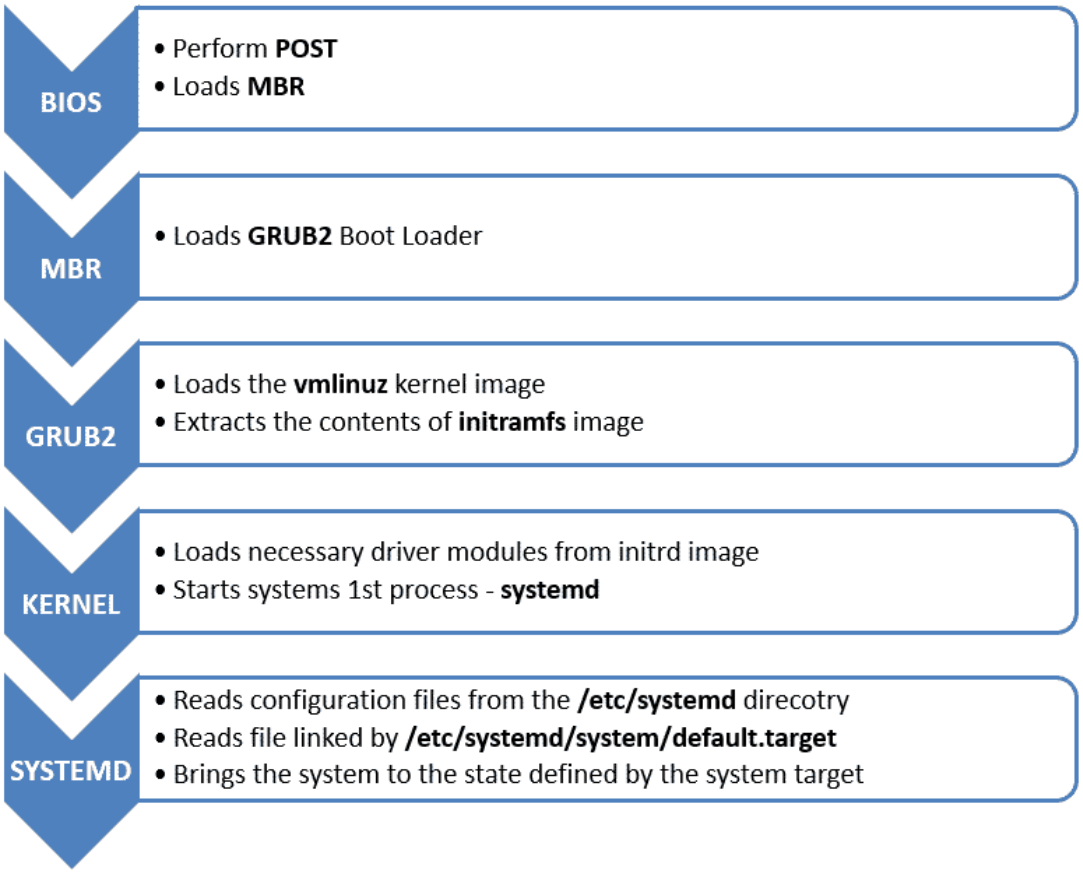


Figure: Caption

TTY

Multi-user OS

- interact with the machine via:
  - keyboard and screen (tty)
  - serial cable
  - ssh from another machine
- share expensive hardware
- share expensive licenses (if they are machine bound)

The Shell

- interacts with the Kernel via the tty
- can be graphical or console based
- available shells:
  - sh
  - bash
  - zsh
  - tcsh
- is a full programming language
- is used to:
  - run programms
  - interact with the filesystem via these programms
  - handels background tasks

Bash

- the shell sh was written by Stephen R. Bourne in 1977
- 1987 it was rewritten and named bourne again shell (bash)
- compatible with the sh
- features:
  - history
  - variables
  - math functions
  - globbing
  - input output redirection
  - pipe operations

Filesystem

- follows the POSIX standard
- everything is mounted under / (called: filesystem root)
- everything is a file in a tree of paths
  - harddisks: /dev/sda /dev/nvmen0
  - partitions: on harddisks /dev/sda1
  - leds: /dev/led0
- storage is mounted to paths in the tree (mount point)
- remote storage can be mounted via sshfs to a local path

User Management

- every user on the system has an account
- every account is member of groups
- every file and directory has permissions for:
  - the user who owns the file
  - the group the file is associated to
  - all others which are not the user or part of that group

Permission System

```
[kemnitzs@frontend /]$ ls -lh
total 333M
lrwxrwxrwx    1 root root    7 Mar 16  2016 bin -> usr/bin
dr-xr-xr-x.   4 root root 4.0K Mar 16  2016 boot
drwxr-xr-x   20 root root 3.4K Feb  6 10:04 dev
drwxr-xr-x. 128 root root  12K Feb 19 14:56 etc
drwxr-xr-x  125 root root  123 Jan 21 14:43 home
lrwxrwxrwx.   1 root root    7 Aug 25  2015 lib -> usr/lib
lrwxrwxrwx.   1 root root    9 Aug 25  2015 lib64 -> usr/lib64
drwx------.   2 root root  16K Aug 25  2015 lost+found
drwxr-xr-x.   2 root root 4.0K Jun 10  2014 media
drwxr-xr-x.   3 root root 4.0K Feb 20 10:56 mnt
drwxr-xr-x.  96 root root 4.0K Feb 13 11:14 opt
dr-xr-xr-x  597 root root    0 Jan 16  2018 proc
dr-xr-x---.  31 root root 4.0K Feb 20 10:56 root
drwxr-xr-x   34 root root 1.2K Feb 19 15:24 run
lrwxrwxrwx.   1 root root    8 Aug 25  2015 sbin -> usr/sbin
drwxr-xr-x.   4 root root 4.0K Aug 25  2015 srv
dr-xr-xr-x   13 root root    0 Jan 16  2018 sys
drwxr-xr-x    2 root root 4.0K Aug 25  2015 sysinst
drwxrwxrwt.  79 root root 764K Feb 20 12:14 tmp
drwxr-xr-x.  13 root root 4.0K Jan 14  2016 usr
drwxr-xr-x.  21 root root 4.0K Jan 16  2018 var
```

Permission System ctd

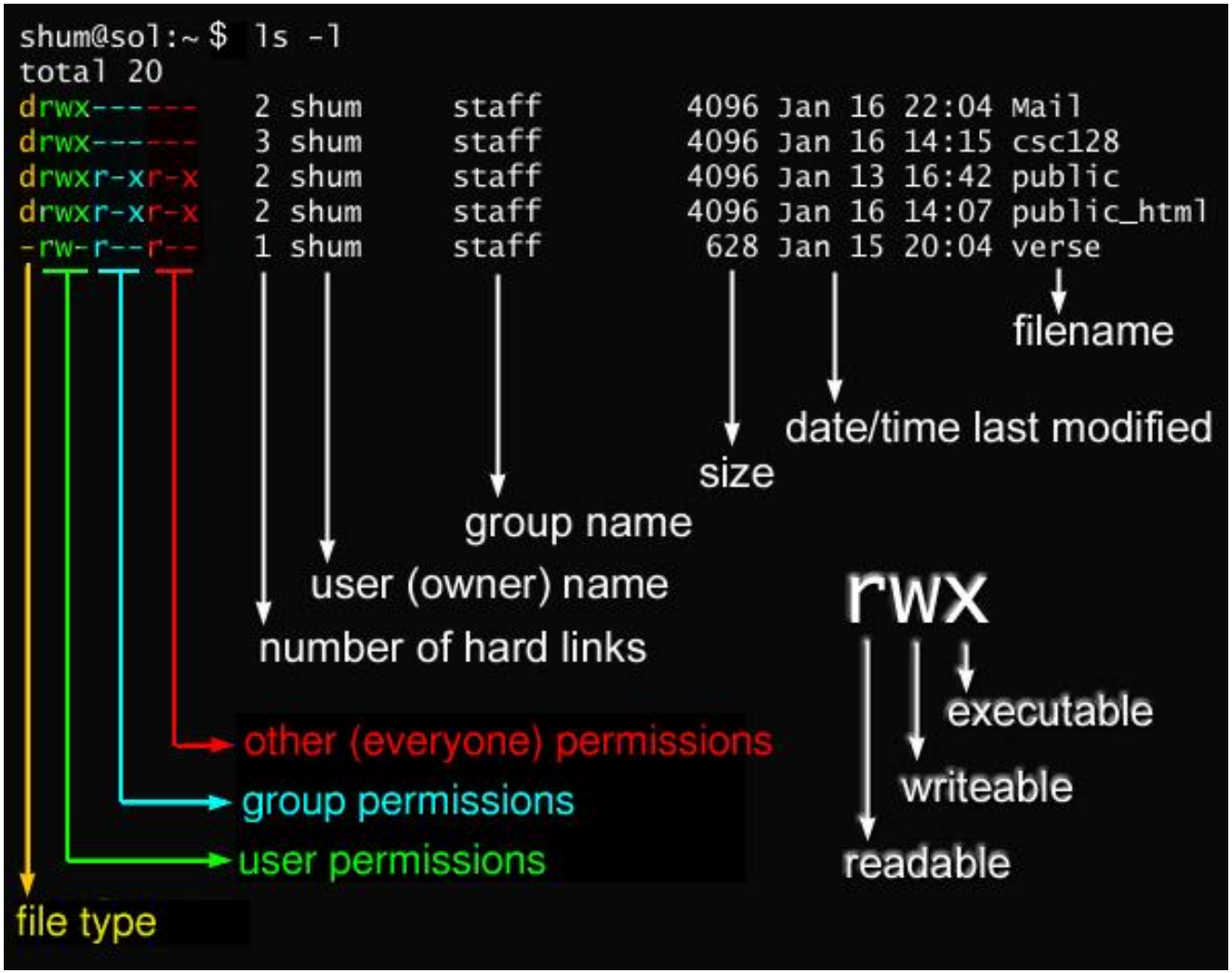
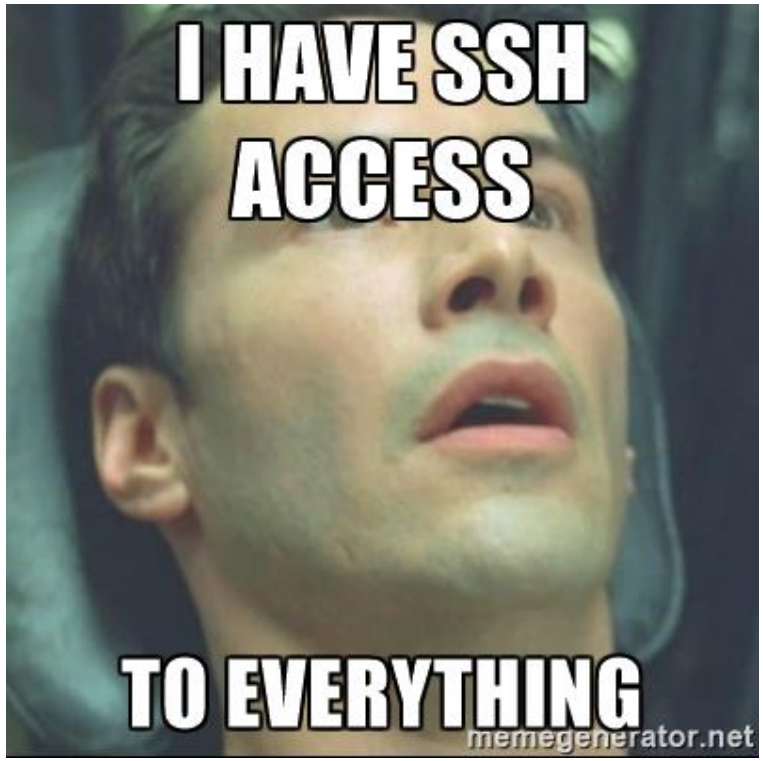


Figure: Permissions

Secure Shell Protocol

- get a shell on a remote system
- copy data
- tunnel network traffic
- forward browser traffic via socks proxy
- mount a remote filesystem to your local machine



Secure Shell Protocol

- client side:
  - from windows:
    - putty
    - OpenSSH beta client
  - on all distributions installed
- server side:
  - windows: left open for the interested reader
  - linux: you can make yourself an ssh server in 30s