



# Overview

- Introduction – Important stuff happening before UNIX
- Part I – The birth of UNIX (1969, early 1970th)
- Part II – UNIX starts getting beautiful
- Part III – Politically incorrect operating system (at least in the Texas): BSD
- Part IV – Everyone does UNIX. And war is cool.



# Part I – The Birth of UNIX



# Multics

- GE, AT&T and MIT were working together on Multics
- The AT&T team had a GE 635 for developing Multics
- Multics was meant for providing services for several hundred users on one machine – not much more powerful than an i386
- Multics seemed to ‘become a first hurd’, most efforts were stopped
- The Multics team was searching for alternatives and tried to acquire hardware (‘Give us some \$100 000 for a machine, we’ll write an operating system for it’)



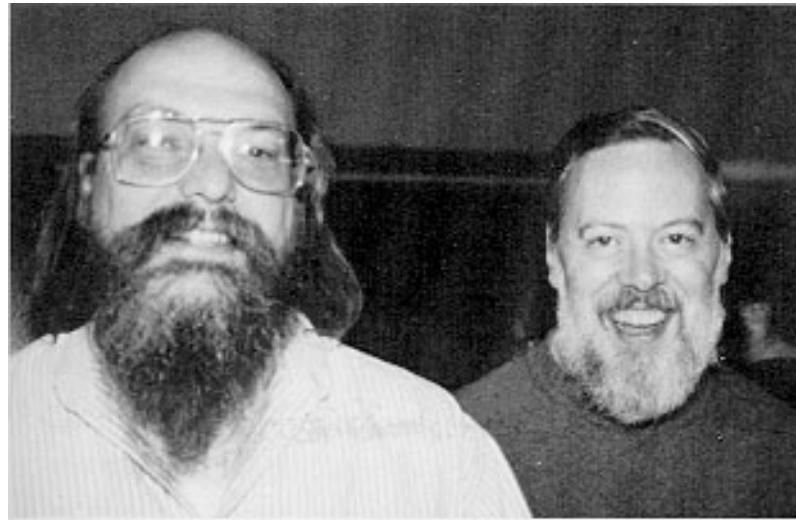
# Spacetravel

- What is this 'space travel game'?
- Thompson wrote this game on their GE 635. One game was worth \$50 – \$75.
- Thompson rewrote this game for an unused PDP-7 when it became clear that they won't keep the GE 635 much longer.
- Thompson learned how to program the PDP-7 by rewriting his game, thus being able to write an operating system for it later.
- They needed a floating point arithmetic package, debugging subsystem, display routines
- Everything was written in PDP-7 assembly – assembled with a cross-assembler producing paper-tapes under GECOS. (Don't you ever complain about building cross-cc toolchains again...)



## Some People behind UNIX

- Ken Thompson can be blamed for writing much of the basic stuff
- Dennis M. Ritchie can be blamed for some userland and finishing C as well as the concept of device files
- Doug McIlroy can be blamed for pipes
- Ken Thompson and Dennis Ritchie in the 1970s



## Look, it's a Filesystem! (1969)

- The MULTICS-group got a disk to play with. Thompson wrote a filesystem for it
- The filesystem was first used on the GE 635, then ported to the PDP-7
- We got the basic system calls – open, read, write, creat (sic!)
- The filesystem gets loaded by paper-tape
- Input on the filesystem is controlled via paper type. Output – what output? (Except rattling noise)
- No way to create device files or even directories after filesystem initialisation
- Every directory contained an i-list as linear array of i-nodes



# Pathnames

- Which pathnames? A filename was a name relative to the current working directory
- link existed: link(dir, file, newname)
- dd directory contains entries for all user directories. To link file x in dir a you'd do

```
ln dd a a  
ln a x x  
rm a
```





## Adding some spice: Interaction

- Using a filesystem without seeing what it does is boring.
- They wrote some tools to load with the filesystem – from paper tape, of course
- They had a shell, used to load the additional tools. `exec()` was born
- copy, print, delete, edit – everything was working.
- Selfhosting, we want selfhosting! – They wrote an assembler and were able to assemble future versions on itself.



# Commands, Commands – UNIX Edition 1 (1971)

- `tm` was analogous to the `time` command
- `time()` returned the number of sixtieth of seconds since 1/1/1971 – which will make `time_t` overflow within about 2.5 years
- File names were limited to 8 byte, directory names to 10 byte
- UserID – username mappings where listed in `/etc/uids`
- The permission bits were different:
  - 01 write, non owner
  - 02 read, non owner
  - 04 write, owner
  - 10 read, owner
  - 20 executable
  - 40 set user id on execution



## Even more Commands – UNIX Edition 2 (1972)

- `sort` exists – but has no options
- `cc` only has one option: `-c`
- `switch()` in C was supplied as a library function.
- `sleep(2)` sleeps for  $n/60$  seconds. The bugs reads ‘Due to the implementation the sleep interval is only accurate to  $256/60$  (4.26) seconds. Even then, the process is placed on a low priority queue and must be scheduled.’



## Part II – UNIX starts getting beautiful



• **UNIX** •  
THE SUPERMODEL  
NEW YORK

- PRICE -

sway cut (sway cut/shampoo/blow)	¥5,240
color (sway cut/color/shampoo/blow)	¥7,000
perm (sway cut/perm/shampoo/blow)	¥7,000

2F 営業時間 10:00~22:00  
(土・日・祝は全ての受付時間が2時間半まで)



# Porting UNIX to the PDP-11, or: Text processing

- Porting the kernel and the userland – most stuff was written in PDP-7 assembly
- Writing roff in PDP-11 assembly (ouch. That's already pretty painful in C...)
- The first 'real' use of UNIX was for writing patent documents (oh, irony...) at BTL
- Three reasons why UNIX was taken: roff could output line-numbered pages, UNIX supported terminals which could print most of the math symbols needed in the patents and – most important – taking part in an internal alpha test.



# C

- Thompson thought they'd need a Fortran compiler for UNIX/PDP-7. However, while doing the grammar he realized he didn't want Fortran at all
- He created a language called B, loosely based on BCPL
- Ritchie took over B-development, by adding types to B
- Early C did not contain stuff like structs



## We got C, we want to use C

- Thompson started the rewrite in 1972, but got frustrated and abandoned it
- Ritchie added structs and more datatypes to C
- By end of summer 1973 UNIX was rewritten in C



# Input redirection / Process control

- Inspired by Multics:

```
iocall attach user_output file xx
```

```
list
```

```
iocall attach user_output syn user_i/o
```

- The users using this feature heavily did not want to annoy the shell guys with asking for a better syntax
- Pretty much input for a heavily used operation. UNIX syntax: `ls >xx`





# Process control/execution

- Exec on today's UNIX: read command, fork(), child exec()s while parent wait()s, child exit()s, and parent reads another command
- Exec on ancient UNIX: shell closed all open files and opened terminal files for input and output, read command, linked to command, open file, remove link, exec(), exit; exit causes the system to overwrite the process with a new shell



# Pipes!

- Pipes were implemented because Doug McIlroy annoyed the others for month with it
- `cat into grep into ... Or who into cat into grep` is easy to say – but how to implement without messing up options?
- Thompson implemented the pipe syscall in one night (and implemented support for it in the shell and most applications)
- The UNIX-paradigm ‘one tool – one job’ was born.



## Spreading the word. Err, UNIX

- By end of 1974 Thompson taught at UC Berkeley
- Thompson took the UNIX tapes with him for teaching purposes
- AT&T did not care – they were not allowed to sell software due to monopoly restrictions anyway
- A student – Bill Joy – was frustrated with ed and developed em. The first contribution to UNIX from an external person.



## Part III – BSD



## Random facts – 2.8BSD+ (1983)

- ‘The kernel will run on any PDP-II with memory management hardware and at least 192K bytes of memory, including the 11/23, 11/24, 11/34, 11/34A, 11/40, 11/44, 11/45, 11/55, and 11/70.’
- Process control for stopping, starting and putting processes into background
- Automatic reboots, after crashes or on demand (Wow.)
- vfork, an optimised and faster crashing fork (single data, process is not allowed to change the data; vfork may be equivalent to fork)
- A TCP/IP implementation is included (!)
- Pascal (sic!), INGRES (even more sic!), ex, ...



## BSDI to 4.4BSD (1994)

- Berkeley Software Design, Inc. – BSD/OS based on the free BSD386
- Customers paid for both sourcecode and – more important – support
- BSDI got sued by AT&T for unlicensed distribution of UNIX source in the early 90th
- They dropped 3 files and edited some more; details of the agreement between AT&T and BSDI are closed, but where partially opened in the SCO case
- BSDI released the changed source as 4.4BSD-lite. FreeBSD/NetBSD were forced to switch to the 4.4BSD-codebase
- BSDI did not release any other versions of BSD



## FreeBSD (1992)

- Started as 'Unofficial 386BSD Patchkit' in 1992 by Jordan Hubbard
- David Greenman suggested to release their own BSD
- Release 1.0 in December 1993
- Upgraded to make use of 4.4BSD-lite, resulting in releasing FreeBSD 2.0 in November 1994
- Introduced the ports collection – now used by all BSDs (and even by some other UNIX clones)
- Meant as 'UNIX for non-techies'



# NetBSD (1993)

- Started in 1993 as a hype-free operating system build by a network community
- Portable?! You call Linux 'portable'?! – NetBSD supports 50+ architectures
- Main focus of NetBSD is portability and academic research
- NetBSD is still pretty much hype-free





# OpenBSD (1995)

- Theo de Raadt forked NetBSD in 1995 – OpenBSD. Reason: He disagreed with the NetBSD coreteam.
- The first release – 2.0 – was made in 1996
- Because Theo is resident in Canada he could include strong cryptography (which was forbidden to export by US law).
- OpenBSD a bit portability with NetBSD. However, many architectures have been removed

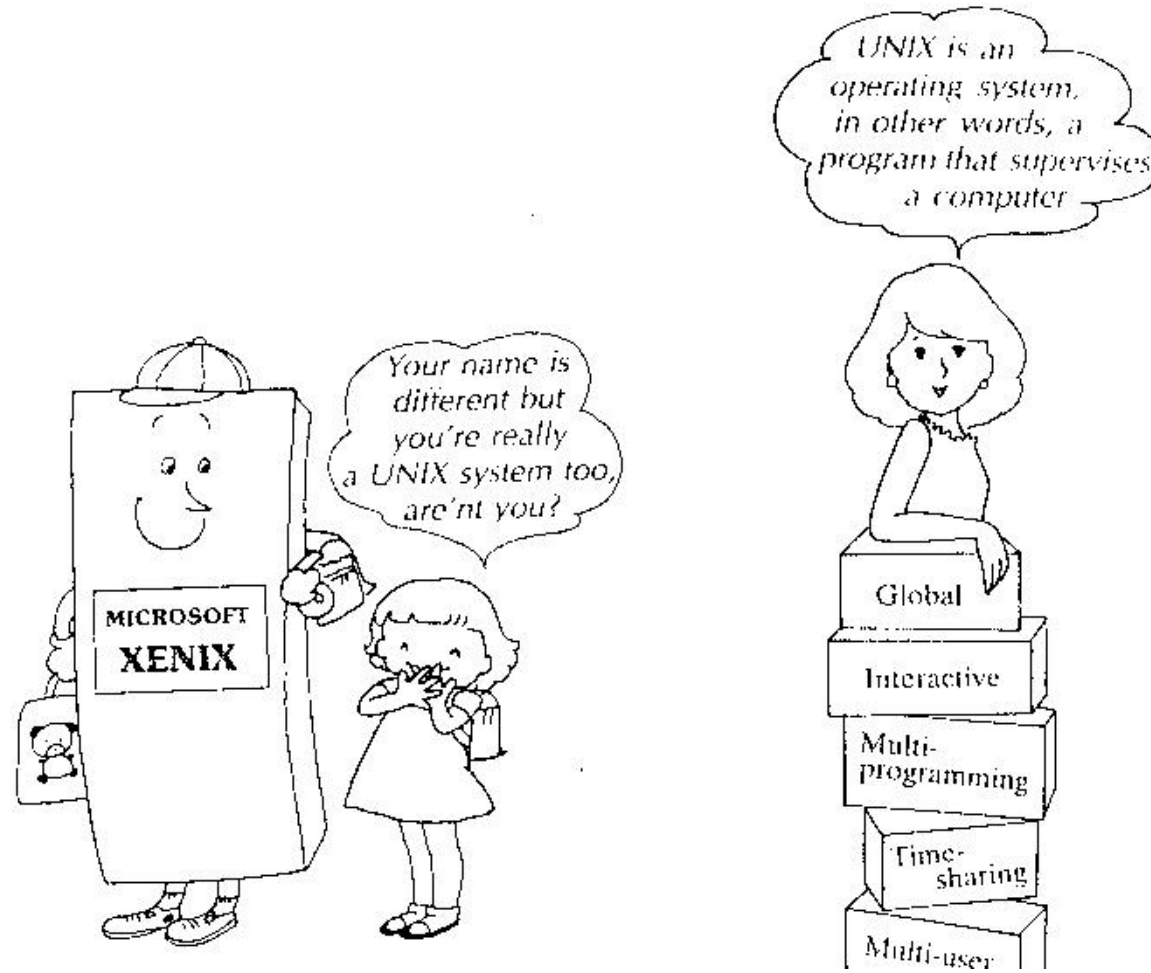


## Darwin – 5BSD? (2000?)

- Darwin is a micro-kernel which does not share much with the other BSDs
- The userland is pretty much ‘ordinary BSD’
- Apple aims to be compatible to FreeBSD, their ‘BSD reference platform’



# Part IV – Everyone does UNIX. And war is cool.



# Commercial UNIX

Just some of the many commercial UNIX systems (the bigger ones)

- IBMs AIX on Power / PowerPC
- Compaqs Tru64 on Alpha
- HPs HP-UX on PARISC
- Suns Solaris on SPARC
- SGIs IRIX, ...
- Siemens Sinix/Reliant



# Sun is raising (1982)



- Sun decided to use UNIX for workstations (!) in 1982
- Sun tried to make SunOS a single-user operating system with a windowing system on top
- SunOS 2.0 got an NFS-implementation in 1984 (Sun, thanks for all the RPC-crap)
- SunOS 4.0 (aka Solaris 1) added support for the SPARC cpu, 4.1 added OpenWindows (X11)
- In 1992 Solaris 2 had SMP and threads (POSIX threads are modelled after this)
- Current Solaris supports 160 CPUs, SPARC64, i386 and ia64



# AIX Ain't unIX

- Originally 'Advanced IBM UNIX', renamed to 'Advanced Interactive eXecutive' (Fuck the legal department)
- User-management like on files (chuser, mkuser, rmuser)
- Logical volume managment, like it's now available on free operating systems
- First release in 1986, based on System V R3
- OS for the RS/6000, got some features from 4.2/4.3-BSD



## Linux comes up (1991+)

- Linus Torvalds hacked a task switcher writing As and Bs to the terminal to get used to programming his new i386-machine
- The task switcher gets extended pretty soon to a stand-alone terminal application he uses to dial-in to the universities UNIX systems
- Minix does not allow redistribution changes; Torvalds decides to extend its terminal application to become a UNIX clone for i386
- GNU userland works pretty soon, Linux can be compiled on itself
- By 1993 Linux can handle TCP/IP, XFree, ...



# UNIX 95 / wanna buy UNIX?

- AT&T sold the UNIX-rights to Novell, Novell sold it to SCO, SCO got bought by Caldera, Caldera renamed itself into SCO and provides much fun by suing everyone. Novell claims they did not sell the right to sue anybody because of UNIX.
- The OpenGroup got founded and released the POSIX and later SuS papers (SuS3: IEEE 1003 and ISO/IEC 9945)
- IBMs mainframe operating system OS/390 got certified as the first UNIX/95-system which did not originate from the AT&T-source
- Windows NT implements parts of the POSIX specification. Some got dropped with Windows 2000, but there are 3rd party tools





# Trivia

- Values of  $\beta$  will give raise to dom! error message in mv; they got this message from a cancelled print job
- a.out! The early PDP-11 did not contain memory protection. One was expected to jell 'A.OUT' before trying new software...



# A minimal part of the UNIX tree

