• Linux is ten years old today: first announced 25 August 1991.

- Linux is ten years old today: first announced 25 August 1991.
- The IBM PC is 20 years old: first announced 13 August 1981.

- Linux is ten years old today: first announced 25 August 1991.
- The IBM PC is 20 years old: first announced 13 August 1981.
- On 28 August 1977, Bill Joy first released his Berkeley Software Distribution for UNIX.

#### BSD: The other free OS

Greg Lehey grog@FreeBSD.org Adelaide, 25 August 2001





Remember these?

vi



Remember these?

vi

csh



Remember these?

vi

csh

sendmail



Remember these?

vi

csh

sendmail

named (BIND)



Remember these?

vi

csh

sendmail

named (BIND)

The Internet



Remember these?

vi

csh

sendmail

named (BIND)

The Internet

**OpenSSH** 





• UNIX was a research project until 1982.



- UNIX was a research project until 1982.
- Universities had access to the UNIX source code.



- UNIX was a research project until 1982.
- Universities had access to the UNIX source code.
- The Computer Sciences Research Group (CSRG) at the University of California, Berkeley (UCB) wrote much new code.



- UNIX was a research project until 1982.
- Universities had access to the UNIX source code.
- The Computer Sciences Research Group (CSRG) at the University of California, Berkeley (UCB) wrote much new code.
- The code was released on tapes called "Berkeley Software Distribution", or BSD.





• UNIX was ported to the VAX, which required virtual memory support. The first widely distributed UNIX for the VAX was 3BSD.



- UNIX was ported to the VAX, which required virtual memory support. The first widely distributed UNIX for the VAX was 3BSD.
- The American Defense Advanced Research Projects Administration (DARPA) wanted to update their network, ARPANET.



- UNIX was ported to the VAX, which required virtual memory support. The first widely distributed UNIX for the VAX was 3BSD.
- The American Defense Advanced Research Projects Administration (DARPA) wanted to update their network, ARPANET.
- The new protocols were called "Internet Protocols".



- UNIX was ported to the VAX, which required virtual memory support. The first widely distributed UNIX for the VAX was 3BSD.
- The American Defense Advanced Research Projects Administration (DARPA) wanted to update their network, ARPANET.
- The new protocols were called "Internet Protocols".
- DARPA gave the contract to BBN and UCB.



- UNIX was ported to the VAX, which required virtual memory support. The first widely distributed UNIX for the VAX was 3BSD.
- The American Defense Advanced Research Projects Administration (DARPA) wanted to update their network, ARPANET.
- The new protocols were called "Internet Protocols".
- DARPA gave the contract to BBN and UCB.
- The first operating system to support the Internet Protocols was 4.2BSD.





• UNIX is not free software.



- UNIX is not free software.
- All work done at UCB was available without licensing conditions.



- UNIX is not free software.
- All work done at UCB was available without licensing conditions.
- The tapes contained both UNIX and UCB code, so they could only go to UNIX license holders.



- UNIX is not free software.
- All work done at UCB was available without licensing conditions.
- The tapes contained both UNIX and UCB code, so they could only go to UNIX license holders.
- In the late 80's, the CSRG worked to extricate the Berkeley code from the UNIX code.



- UNIX is not free software.
- All work done at UCB was available without licensing conditions.
- The tapes contained both UNIX and UCB code, so they could only go to UNIX license holders.
- In the late 80's, the CSRG worked to extricate the Berkeley code from the UNIX code.
- The results were released as the "Berkeley Networking Tapes", Net/1 and Net/2.



- UNIX is not free software.
- All work done at UCB was available without licensing conditions.
- The tapes contained both UNIX and UCB code, so they could only go to UNIX license holders.
- In the late 80's, the CSRG worked to extricate the Berkeley code from the UNIX code.
- The results were released as the "Berkeley Networking Tapes", Net/1 and Net/2.
- They were not complete operating systems.



• In the early 90s, Bill Jolitz ported 4.3BSD to the Intel 386 architecture.



- In the early 90s, Bill Jolitz ported 4.3BSD to the Intel 386 architecture.
- Some old CSRG members formed a company called Berkeley Software Design, Inc. (BSDI).



- In the early 90s, Bill Jolitz ported 4.3BSD to the Intel 386 architecture.
- Some old CSRG members formed a company called Berkeley Software Design, Inc. (BSDI).
- BSDI marketed a commercial operating system called BSD/386, later BSD/OS.



- In the early 90s, Bill Jolitz ported 4.3BSD to the Intel 386 architecture.
- Some old CSRG members formed a company called Berkeley Software Design, Inc. (BSDI).
- BSDI marketed a commercial operating system called BSD/386, later BSD/OS.
- Bill Jolitz wanted a free version, and created 386BSD.



- In the early 90s, Bill Jolitz ported 4.3BSD to the Intel 386 architecture.
- Some old CSRG members formed a company called Berkeley Software Design, Inc. (BSDI).
- BSDI marketed a commercial operating system called BSD/386, later BSD/OS.
- Bill Jolitz wanted a free version, and created 386BSD.
- Later, other people used this basis to create NetBSD (April 1993), FreeBSD (December 1993) and OpenBSD (October 1995).



# Why such a secret?



• BSD developers are not commercially oriented.



- BSD developers are not commercially oriented.
- No companies to market BSD.



- BSD developers are not commercially oriented.
- No companies to market BSD.
- BSD is "for experts", not so easy to use.



- BSD developers are not commercially oriented.
- No companies to market BSD.
- BSD is "for experts", not so easy to use.
- BSD lawsuit scared people off.





• In 1992, UNIX Systems Laboratories sued BSDI, alleging copyright infringement.



- In 1992, UNIX Systems Laboratories sued BSDI, alleging copyright infringement.
- The case was settled out of court in 1994.



- In 1992, UNIX Systems Laboratories sued BSDI, alleging copyright infringement.
- The case was settled out of court in 1994.
- BSD may no longer be called UNIX.



- In 1992, UNIX Systems Laboratories sued BSDI, alleging copyright infringement.
- The case was settled out of court in 1994.
- BSD may no longer be called UNIX.
- People are still afraid of litigation.



### **BSD** releases

• Continuous development in the CURRENT branch, for developers only.



#### **BSD** releases

- Continuous development in the CURRENT branch, for developers only.
- Regular releases, called RELEASE.



#### **BSD** releases

- Continuous development in the CURRENT branch, for developers only.
- Regular releases, called RELEASE.
- Separate bug fixes to releases in the STABLE branch.



• The BSD projects maintain a single copy of the system sources for all releases.



- The BSD projects maintain a single copy of the system sources for all releases.
- Sources maintained by CVS, allowing easy updating and backout of changes.



- The BSD projects maintain a single copy of the system sources for all releases.
- Sources maintained by CVS, allowing easy updating and backout of changes.
- Sources include the complete operating system, not just the kernel.



51

- The BSD projects maintain a single copy of the system sources for all releases.
- Sources maintained by CVS, allowing easy updating and backout of changes.
- Sources include the complete operating system, not just the kernel.
- CVS allows access to any version of any file in a single tree.



- The BSD projects maintain a single copy of the system sources for all releases.
- Sources maintained by CVS, allowing easy updating and backout of changes.
- Sources include the complete operating system, not just the kernel.
- CVS allows access to any version of any file in a single tree.
- Clear development model: complete project history is available.



### A CVS log: sys/kern/kern\_exec.c

```
RCS file: kern exec.c,v
Working file: kern exec.c
head: 1.110
branch:
locks: strict
access list:
symbolic names:
        RELENG 4 0 0 RELEASE: 1.107
        RELENG 4: 1.107.0.2
        RELENG 4 BP: 1.107
        RELENG 3 4 0 RELEASE: 1.93.2.3
        RELENG 3 3 0 RELEASE: 1.93.2.3
        RELENG 3 2 PAO: 1.93.2.1.0.2
        RELENG 3 2 PAO BP: 1.93.2.1
        RELENG 3 2 0 RELEASE: 1.93.2.1
        POST VFS BIO NFS PATCH: 1.99
        PRE VFS BIO NFS PATCH: 1.99
        POST SMP VMSHARE: 1.99
        PRE SMP VMSHARE: 1.99
        POST NEWBUS: 1.97
        PRE NEWBUS: 1.97
        RELENG 3 1 0 RELEASE: 1.93
        RELENG 3: 1.93.0.2
        RELENG 3 BP: 1.93
        RELENG 2 2 8 RELEASE: 1.47.2.12
```



### A CVS log(2)

```
total revisions: 138; selected revisions: 138
description:
revision 1.110
date: 2000/04/26 20:58:39; author: dillon; state: Exp; lines: +38 -29
    Fix #! script exec under linux emulation. If a script is exec'd from a
    program running under linux emulation, the script binary is checked for
    in /compat/linux first. Without this patch the wrong script binary
    (i.e. the FreeBSD binary) will be run instead of the linux binary.
    For example, #!/bin/sh, thus breaking out of linux compatibility mode.
    This solves a number of problems people have had installing linux
    software on FreeBSD boxes.
revision 1.109
date: 2000/04/18 15:15:18; author: phk; state: Exp; lines: +1 -2
Remove unneeded <sys/buf.h> includes.
Due to some interesting cpp tricks in lockmgr, the LINT kernel shrinks
by 924 bytes.
revision 1.108
date: 2000/04/16 18:53:09; author: ilemon; state: Exp; lines: +6 -1
Introduce kgueue() and kevent(), a kernel event notification facility.
```

### Another CVS log

```
revision 1.152
date: 1997/10/06 09:58:11; author: jkh; state: Exp; lines: +41 -13
Hooboy!
```

Did I ever spam this file good with that last commit. Despite 3 reviewers, we still managed to revoke the eBones fixes, TCL 8.0 support, libvgl and a host of other new things from this file in the process of parallelizing the Makefile. DOH! I think we need more **pointy hats** - this particular incident is worthy of a small children's birthday party's worth of pointy hats. ;-)

I certainly intend to take more care with the processing of aged diffs in the future, even if it does mean reading through 20K's worth of them. I might also be a bit more careful about asking for more up-to-date changes before looking at them.;)



• Written late, after separation from UNIX.



- Written late, after separation from UNIX.
- The fewest restrictions of any free software license.



- Written late, after separation from UNIX.
- The fewest restrictions of any free software license.
- A bone of contention in the "UNIX wars".



- Written late, after separation from UNIX.
- The fewest restrictions of any free software license.
- A bone of contention in the "UNIX wars".
- A good choice for embedded systems.



• The *core team* or *core group* controls the project with a loose rein.



- The *core team* or *core group* controls the project with a loose rein.
- *Committers* are developers with direct write access to the source tree.



- The *core team* or *core group* controls the project with a loose rein.
- *Committers* are developers with direct write access to the source tree.
- *Contributors* are developers without direct write access to the source tree.



- The *core team* or *core group* controls the project with a loose rein.
- *Committers* are developers with direct write access to the source tree.
- *Contributors* are developers without direct write access to the source tree.
- Many committers work on more than one BSD project.



• Communication primarily by mail.



- Communication primarily by mail.
- Many special-purpose mailing lists.



- Communication primarily by mail.
- Many special-purpose mailing lists.
- Some developers communicate in real time with *irc*.



- Communication primarily by mail.
- Many special-purpose mailing lists.
- Some developers communicate in real time with *irc*.
- Source update with CVSup or sup.



# The NetBSD project

• Founded in April 1993.

#### Goals:

- Architecturally clean.
- Highly portable.
- Highly interoperable.
- State-of-the-art security.
- Core group of 5 members.
- Over 150 committers with direct access to source tree.
- How many users?



### The FreeBSD project

- Founded in December 1993.
- Core team of 9 members, elected by the committers.
- Over 200 committers with direct access to source tree.
- Over 2 million users.
- 4 releases per year.
- 4,000 applications in the "Ports Collection".
- Release 4.4 in September 2001.



### The OpenBSD project

- Derived from NetBSD in 1995.
- "Benevolent Dictatorship" under leader Theo de Raadt.
- Approximately 115 committers with direct access to the source tree.
- How many users?



### **OpenBSD**

- Portability.
- Standardization.
- Correctness.
- Proactive security.
- Integrated cryptography.
- Largely developed by non-Americans.
- Has proven to be a testbed for "cryptography inside an operating system".





• Yahoo! (FreeBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)
- International Space Station (NetBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)
- International Space Station (NetBSD)
- (Censored) (OpenBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)
- International Space Station (NetBSD)
- (Censored) (OpenBSD)
- Telstra Internet (FreeBSD)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)
- International Space Station (NetBSD)
- (Censored) (OpenBSD)
- Singapore Housing Development Board (OpenBSD)
- Apple computer (MacOS X)



- Yahoo! (FreeBSD)
- Hotmail (FreeBSD)
- IBM (Whistle InterJet, FreeBSD)
- International Space Station (NetBSD)
- (Censored) (OpenBSD)
- Singapore Housing Development Board (OpenBSD)
- Apple computer (MacOS X)
- Who knows? (other embedded systems)



• Apple MacOS X based on BSD.



- Apple MacOS X based on BSD.
- Apple's low-level operating system (Darwin) is free software.



- Apple MacOS X based on BSD.
- Apple's low-level operating system (Darwin) is free software.
- Apple developers have commit access to FreeBSD source tree.



- Apple MacOS X based on BSD.
- Apple's low-level operating system (Darwin) is free software.
- Apple developers have commit access to FreeBSD source tree.
- Changes in Darwin returned to FreeBSD.



- Apple MacOS X based on BSD.
- Apple's low-level operating system (Darwin) is free software.
- Apple developers have commit access to FreeBSD source tree.
- Changes in Darwin returned to FreeBSD.
- FreeBSD changes (SMP) planned for inclusion in MacOS X.



• No viruses.



- No viruses.
- Include *OpenSSL* and *OpenSSH*.



- No viruses.
- Include *OpenSSL* and *OpenSSH*.
- IPSec (OpenBSD was the first operating system to include it).



- No viruses.
- Include *OpenSSL* and *OpenSSH*.
- IPSec (OpenBSD was the first operating system to include it).
- Each team has a security officer.



- No viruses.
- Include *OpenSSL* and *OpenSSH*.
- IPSec (OpenBSD was the first operating system to include it).
- Each team has a security officer.
- Regular security advisories.



• UNIX was designed as a multi-user system.



- UNIX was designed as a multi-user system.
- Different mail paradigms.



- UNIX was designed as a multi-user system.
- Different mail paradigms.
- More transparent command structure.



- UNIX was designed as a multi-user system.
- Different mail paradigms.
- More transparent command structure.
- Careful attention to detail.



• BSD considered user-unfriendly.



- BSD considered user-unfriendly.
- But it uses *exactly* the same desktop software as Linux.



- BSD considered user-unfriendly.
- But it uses *exactly* the same desktop software as Linux.
- Linux applications software runs on BSD unchanged.



- BSD considered user-unfriendly.
- But it uses *exactly* the same desktop software as Linux.
- Linux applications software runs on BSD unchanged.
- Apple's MacOS X is based on BSD.





• Difficult to put the projects into a box.



- Difficult to put the projects into a box.
- All three projects produce high performance, portable, secure systems, but the slogans say...



- Difficult to put the projects into a box.
- All three projects produce high performance, portable, secure systems, but the slogans say...
- FreeBSD for performance: "The power to serve".



- Difficult to put the projects into a box.
- All three projects produce high performance, portable, secure systems, but the slogans say...
- FreeBSD for performance: "The power to serve".
- NetBSD for portability: "Of course it runs NetBSD".



- Difficult to put the projects into a box.
- All three projects produce high performance, portable, secure systems, but the slogans say...
- FreeBSD for performance: "The power to serve".
- NetBSD for portability: "Of course it runs NetBSD".
- OpenBSD for security: "Four years without a remote hole in the default install".

#### Current releases

- FreeBSD 4.3 was released in April 2001.
- FreeBSD 4.4 will be released in September 2000.
- NetBSD 1.5 was released in December 2000.
- NetBSD 1.5.1 was released in July 2001.
- OpenBSD 2.8 was released in December 2000.
- OpenBSD 2.9 was released in June 2001.



• Wind River Systems support FreeBSD.



- Wind River Systems support FreeBSD.
- Wasabi Systems support NetBSD.



- Wind River Systems support FreeBSD.
- Wasabi Systems support NetBSD.
- Many individuals



- Wind River Systems support FreeBSD.
- Wasabi Systems support NetBSD.
- Many individuals
- In Adelaide, Tellurian supports BSD.



#### Acknowledgements

The free software ethic says "don't reinvent the wheel".



#### Acknowledgements

The free software ethic says "don't reinvent the wheel".

#### Thanks for contributions from:

- Jordan Hubbard < jkh@FreeBSD.org>
- Luke Mewburn < lukem@NetBSD.org>
- Theo de Raadt <deraadt@cvs.OpenBSD.org>



#### For more information

- These slides are available at http://www.lemis.com/installfest.pdf
- http://www.FreeBSD.org/
- http://www.NetBSD.org/
- http://www.OpenBSD.org/
- http://www.apple.com/
- http://www.bsdi.com/
- http://www.wasabi.com/

