

A Short UNIX History

or

How Our Culture Created Linux

Clement T. Cole

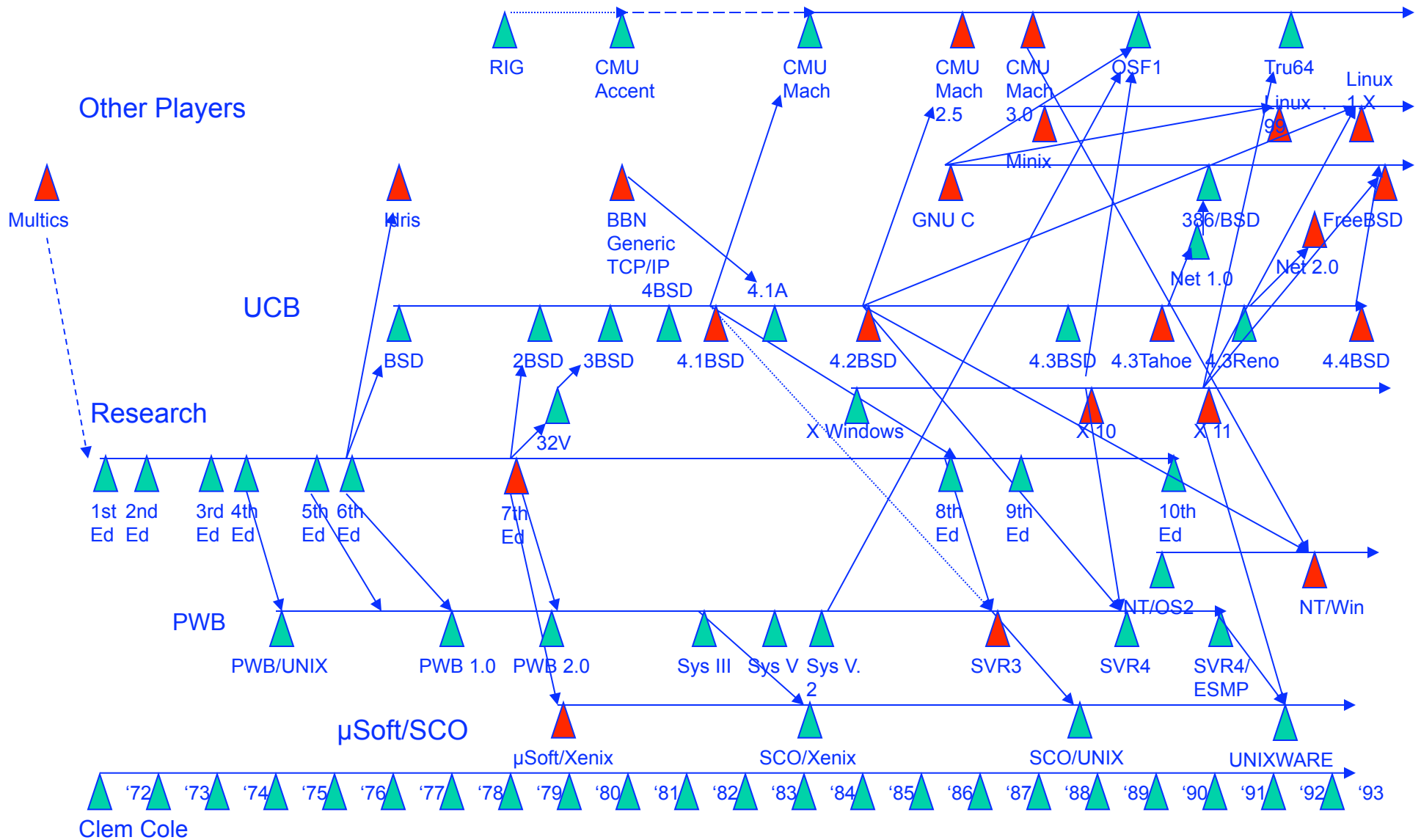
Witch Doctor

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A UNIX Family History



Themes

- ◆ **Something new is really something old.**
- ◆ **The Open Source Culture predates UNIX and Linux.**
- ◆ **Evolution is good.**
- ◆ **Fighting is not always bad, but learn when it's good enough and stop fighting.**

Agenda

- ◆ **Technical History**
- ◆ **Legal History**
- ◆ **What it all means**

A Word on Engineers

“Good programmers write good programs. Great programmers start and build upon other great programmer’s work.”

Unknown origin, often attributed to Fred Brooks.

Multics

- ◆ **MULTiplexed Information and Computing Service**
 - ❖ or “Many Unbelievably Large Tables In Core Simultaneously.”
 - ❖ Actually very cool system, see: *The Multics system; an Examination of its Structure*, Elliott I. Organick 1972
- ◆ **MIT, GE and AT&T Bell Labs built Multics in the late 1960’s on the GE 645 – a.k.a. Multics.**
- ◆ **Late 1969, AT&T pulls out of the project.**
- ◆ **Ken Thompson, Dennis Ritchie and Rudd Canaday continue research on file systems.**

Emasculated Multics

- ◆ **UNIplicated Information and Computing Service**
 - ❖ Peter Neumann's 1970 pun.
- ◆ **Later shorten to UNIX, believed to be coined by Brian Kernighan**
- ◆ **Runs on the PDP-7, written mostly by Ken Thompson.**
 - ❖ Assembled with a homegrown assembler on the GECOS
- ◆ **Two dmr quotes:**
 - ❖ “Ken wanted to do something simple.... The simple fact that our means were much smaller – we could get only small machines with none of the fancy Multics hardware.”
 - ❖ “Multics colored the UNIX approach, but didn't dominate it one way or the other, towards an anti-Multics system or a copy on the cheap.”

Emasculated Multics – cont.

◆ dmr says from Multics we learned:

- ❖ A tree structured file system.
- ❖ A separate, identifiable program to do the command interpretation (even the name came from Multics – the “shell”).
- ❖ The structure or actually non-structure of files except as arrays of bytes, and basically not interpreted by the OS kernel.
- ❖ Text files are just sequences of characters separated by newlines.
- ❖ The semantics of I/O operations (read and write) as referencing a file handle, a buffer and a count – concealing the underlying disk blocks.
- ❖ The concept of the output of one program becoming the input to another.

Language History

- ◆ **BCPL – Basic Combined Programming Language**
 - ❖ Martin Richard's tool for writing and systems program.
 - ❖ Originally written for Cambridge University, ported to GECOS and Multics by Rudd Canaday.
- ◆ **PL/1 – Sort of a combination of FORTRAN, ALGOL, and COBOL, plus new ideas such as *exceptions*.**
 - ❖ Native language for Multics, huge runtime.
- ◆ **FORTRAN – FORMula TRANslation**
 - ❖ What all serious computers ran (??run??).
- ◆ **B**
 - ❖ Ken Thompson's 1 day failed attempt at writing FORTRAN, became a "cut down" BCPL. Original interpreted under VB the virtual B stack machine.
- ◆ **PDP-7 and PDP-11 Assembler**

More on Engineers

“In hotel room fire:

A mathematician will light another piece of paper on fire, dump it in the toilet and exclaim “there exists a solution .”

A physicist will make precise observations about how the fire is, rate its growing, determine how much water to use, obtain exactly that much, then put the fire out.

An engineer will start and continue to fill the trash can with water and dump them until fire’s out.”

Joke of unknown origin.

Need Created UNIX & C

(Buckets of Water)

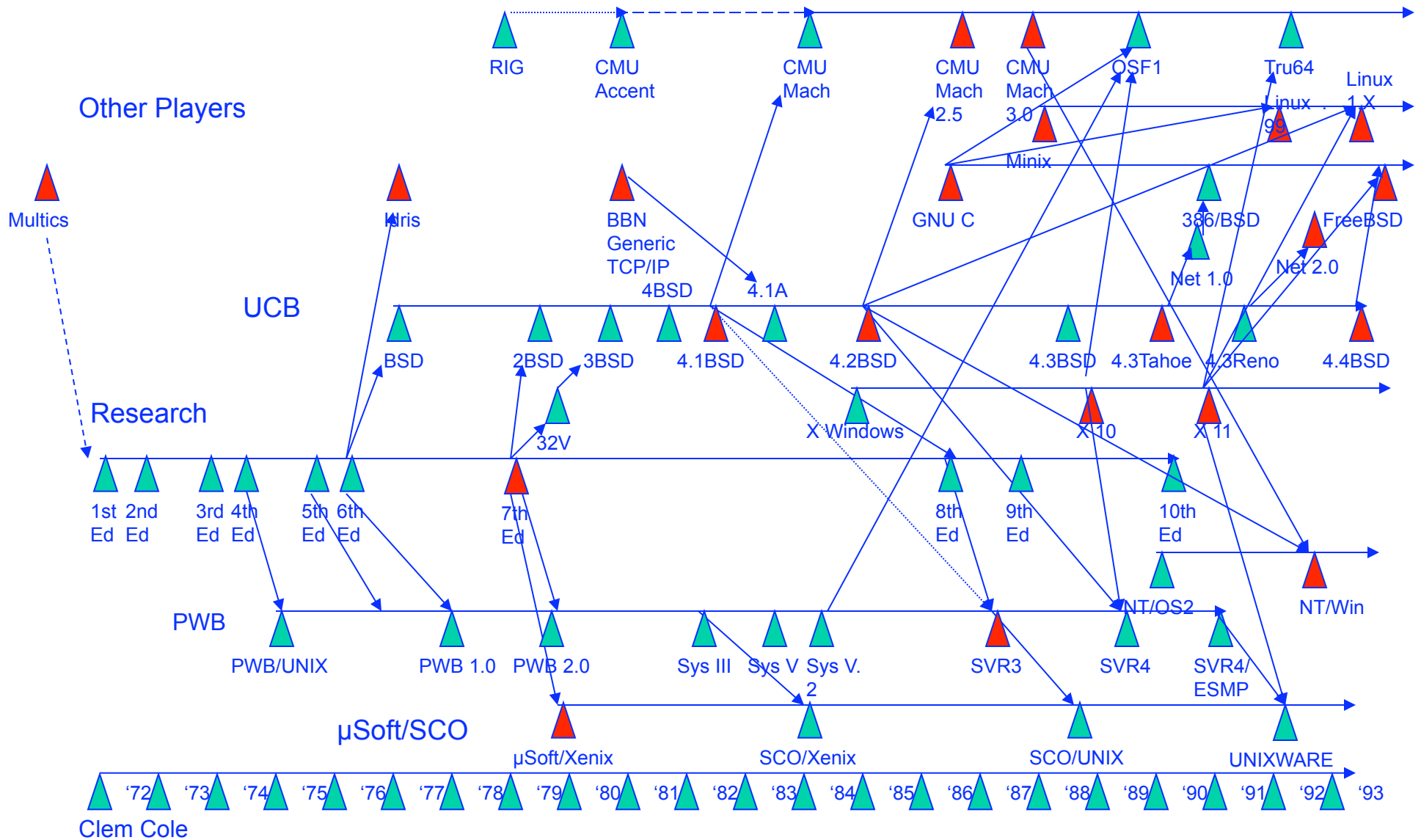
- ◆ **PDP-7 has 4K words of core (main memory).**
 - ❖ PL/1 was out of the question.
 - ❖ FORTRAN was wanted, but B was created as being good enough.
- ◆ **PDP-11 was byte addressed, but BCPL and B were word based languages and lacked structured objects.**
 - ❖ C was created.
- ◆ **I/O redirection and simple programming was understood**
 - ❖ but... taking the output of one program and using it with another was awkward.
 - ❖ PIPES were created by Doug McIlroy

The UNIX Philosophy†

- ◆ Write programs that do one thing well.
- ◆ Write programs that work together.
- ◆ Write programs that handle text streams, because that is the universal interface.

†a.k.a. the Toolbox Concept

A UNIX Family History



Sharing Spread the Word

- ◆ V1-V4 about 50-100 sites @ AT&T, WE, BTL
- ◆ V5/V6 about 1000 sites, plus 20-50 outside of Bell System.
- ◆ 1974 SOPS Talk/Paper and CACM paper told folks outside, what it was about.
- ◆ **User Societies shared code already:**
 - ❖ IBM's Share
 - ❖ DEC's DECUS
- ◆ ***UNIX News*, a user newsletter of the mid-1970 begets USENIX.**

Simplicity Cemented the Word

- ◆ **TOPS-10, TENEX/TWENEX, ITS was what the CS community all wanted.**
 - ❖ But PDP-10's cost between \$.5M and \$1.5M
 - ❖ This is what Ken and Dennis tried to purchase but was rejected!
- ◆ **Remember The UNIX Philosophy**
- ◆ **One person could understand and improve it.**
- ◆ **It ran on a mini-computer**
 - ❖ albeit an expensive one – the PDP 11/45 ~\$50K-150K
 - ❖ Most folks could get access to an PDP 11 of some type.
- ◆ **PDP-11 co\$t too much, so “porting” the OS begins**
 - ❖ Even BTL got an Interdata 8/32, not an PDP-11

“Trust the Source Luke.”

- ◆ **Source already available for most OS's**
 - ❖ TOPS-10, TWINEX, OS/386, TSS, MTS
- ◆ **But those systems could not be understood by one person and were not nearly as elegant.**

How you got it

- ◆ Obtain a license from Western Electric's patent office.
- ◆ Ken wrote you a 9-track magnetic tape (~15 Megabytes in a 2400' reel) or
- ◆ Ken gave you copies of a couple of RK05 disk packs (2.5 Megabytes on single platter removable disk pack).

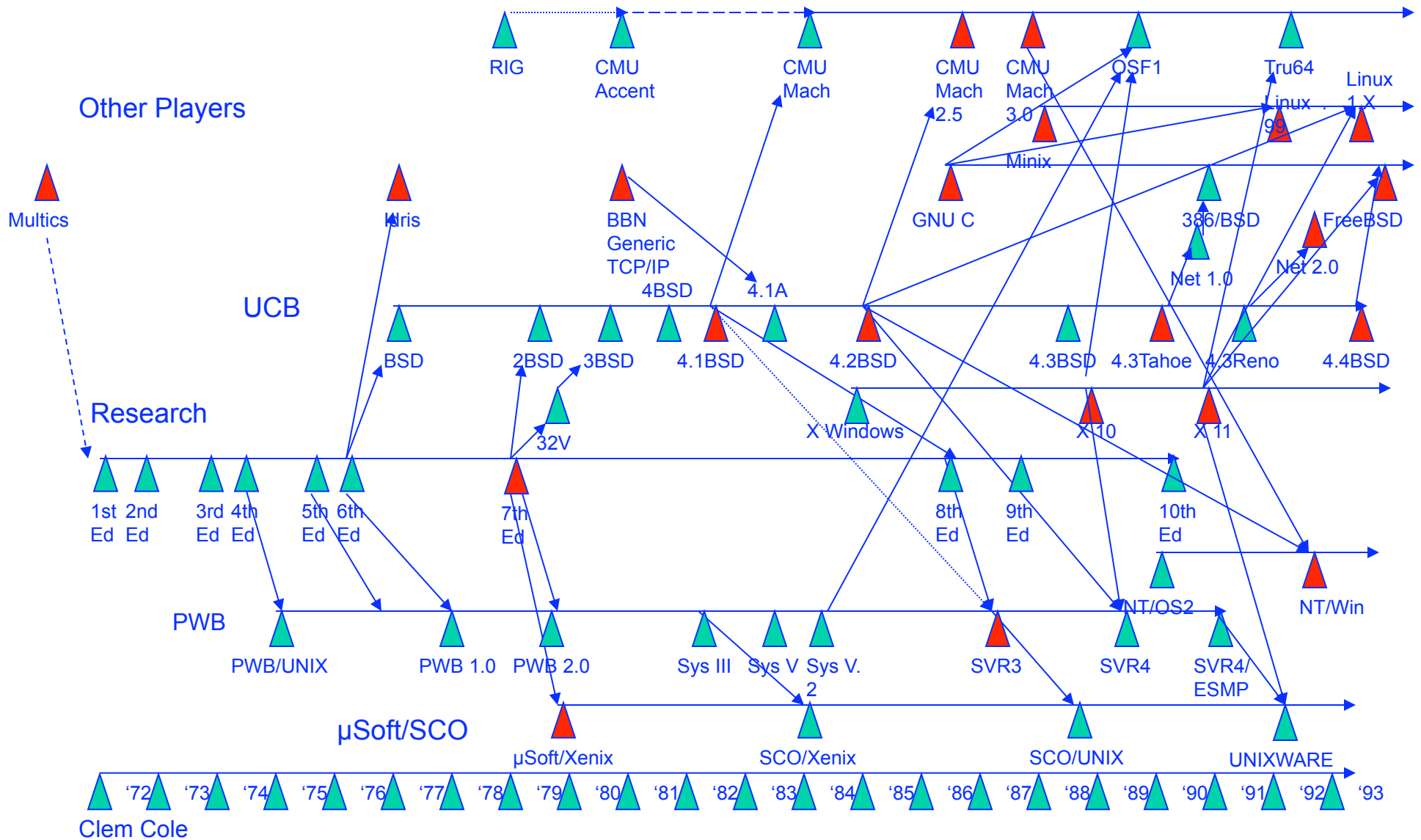
How you Enhanced it

- ◆ **AT&T/We abandons the source on your doorstep.**
- ◆ **Get a copy (by any means) of Lions text.**
- ◆ **Go at it.**
- ◆ **Join USENIX soon thereafter.**

UNSW – John Lions

- ◆ You can understand it and even carry it with you!
- ◆ Entire V6 Source was published in one volume
- ◆ Commentary on how it works, in another.
- ◆ Books were used to teach OS course at UNSW
- ◆ Western Electric takes over publishing, but...
 - ❖ requires a UNIX source license to purchase it.
- ◆ #1 underground photocopied UNIX tool around.
- ◆ Fast-forward to 2000, you can (and should) purchase it:
 - ❖ *Lions' Commentary on Unix: With Source Code* by John Lions, ISBN: 1573980137

A UNIX Family History



Commercial UNIX – Graduation

- ◆ The Rand Corporation
- ◆ NSA
- ◆ CMU – ctc/dvk go on strike

V7 – The Infection Spreads

- ◆ **Runs on most major PDP-11's with MMU**
- ◆ **Boots and installs from the distribution tape**
 - ❖ V6 did this too, but much more limited HW support.
- ◆ **DEC Replaces the 11/40 and 11/45 processors with the PDP 11/34 and 11/44**
- ◆ **V7 Includes UUCP – UNIX to UNIX CoPy**
 - ❖ requires WE212 modems and dialers (UNC has a relay hack!)
- ◆ **Net Noise**
 - ❖ decvax reports a \$.5M phone bill.
 - ❖ Someone (@ Bell Labs ??) claimed that for every call ihnp4 made, it created 5 phone calls downstream
- ◆ **USENIX Funds the Creation of USENET broadcasting which leads to UUNET**

We all keep sharing

- ◆ **USENIX Distribution Tapes**
- ◆ **Harvard Tapes**
- ◆ **Purdue, CMU, MIT Tapes**
- ◆ **Net Noise!**

BSD – UCB's SW Distribution

- ◆ CS Div. is part of the EE department at UC Berkeley.
- ◆ The “give away” culture and processes were already in place.
- ◆ Donald O. Peterson (*a.k.a.* dop) father of the CAD, the IC and “Open Source”
 - ❖ “If I sell the software, I go in the front door like any other salesman, if I give it away as my research, I get to walk in the backdoor and see their secrets.”
 - ❖ EE already gave away it's EE tools: SPICE, SPLICE, MOTIS, *etc.*
 - ❖ BSD (1.0) was tips and tools for the PDP-11/70 at UC Berkeley

VAX and Death of the PDP-10

- ◆ **DEC kills the 18/36 bits systems in favor of the 16/32 bits Virtual Address eXtension to the PDP-11.**
- ◆ **BSD 3.0**
 - ❖ Ozalp Babaglou, Bill Joy and Bob Fabry
 - ❖ BSD 2.0 PDP-11 tools (Pascal, ex/vi, csh, *etc.*)
 - ❖ Support for 11/780 paging hardware.

ARPA and UNIX

- ◆ **ARPA (DoD) picks VAX as the PDP-10 replacement for ARPA contractors and spurns VMS.**
- ◆ **UC Berkeley contracted to support and enhance UNIX on VAX for ARPA.**
 - ❖ CSRG is formed.
 - ❖ BSD 4.1 is first major result.
- ◆ **BBN contracted to supply IP/TCP for BSD UNIX**

Cub's CSRG

- ◆ BerkNET, Ing70, EE Cad Lab
- ◆ sockets
- ◆ my great mistake (talk)
- ◆ More Joy

sendmail

- ◆ **Eric Allan once called this:**
 - ❖ the world's largest NOP.
- ◆ **Solved a problem we had at UC Berkeley**
 - ❖ Ing70 ⇒ IngVax
 - ❖ Ingres is the only system directly on the ArpaNET
 - ❖ mail header format was not stable
 - BerkNET form
 - RFC822
 - UUCP
 - ISO
 - ❖ delivermail is getting hard to hack
- ◆ **smtpd vs. sendmail**

sockets

- ◆ **MIT has ChaosNET**
- ◆ **BBN used the Chaos interface for UNIX**
 - ❖ kernel `lookup()` [part of `open(2)` system call] left chars from `open` available to the driver or other kernel routine.
 - ❖ Dennis would use this trick later for Streams.
- ◆ **Joy felt `open(2)` and `ioctl(2)` were not good semantic fits.**
- ◆ **Accent's Port influenced the new solution.**
- ◆ **At the time IP/TCP was not the clear winner.**
 - ❖ Sockets needed to support XNS and ISO, as well as Delta-T, DECnet *etc.*
 - ❖ Truth is – only IP/TCP worked with BSD 4.2

Observation on BSD 4.2

“BSD 4.2 just like UNIX, only different.”

Henry Spencer, University of Toronto in a net.news posting circa 1982.

UNIX Wars

◆ BSD vs. AT&T

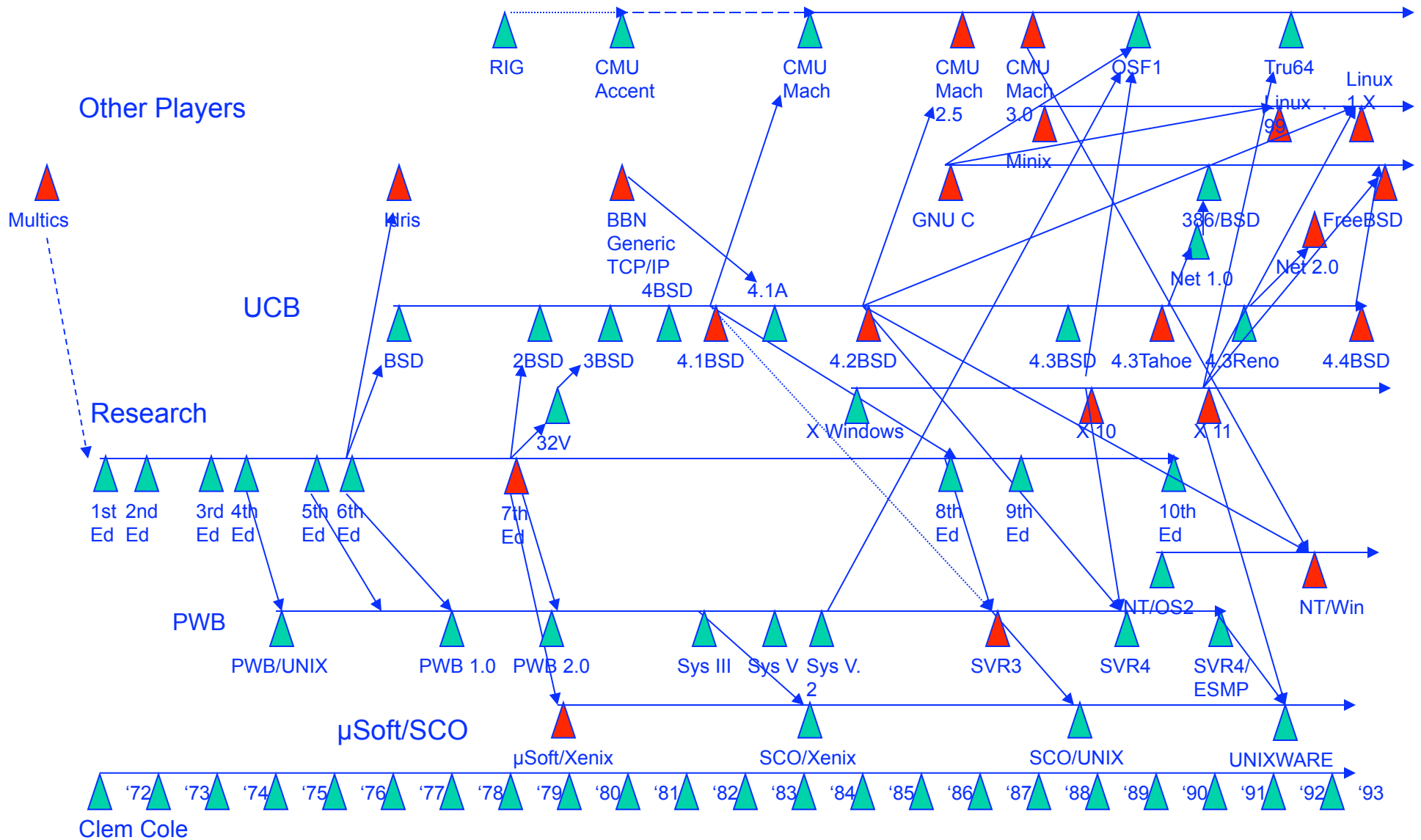
◆ BSD

- ❖ more tools, VM, networking
- ❖ lots of input
 - “peed on to smell like Berkeley”

◆ AT&T

- ❖ more consistant set of tools
- ❖ eventually add VM (actually cleaner)
- ❖ eventually abuse the terminal handler to support networking

A UNIX Family History



We create an Industry

- ◆ /usr/group & the V7 license (HW ports vs. SW ports)
- ◆ Onyx
- ◆ Masscomp, Apollo, and JAWS
- ◆ Stanford University Network Terminal

A Word on Money

“Never confuse cost, price and value.”

Randy Stone to his 1972, Taxes and Investment Course.

UNIX HW Requirements

- ◆ **Linear Address space**
 - ❖ segments are too hard to use.
- ◆ **MMU base limit registers (PDP-11 style) or full VM (VAX or MMU style).**
- ◆ **> 50 megabytes of disk.**
 - ❖ SMD interface pretty much a requirement, ST-506 only 10Megs
- ◆ **ANSI terminal.**
- ◆ **9-track tape must be an option for backup.**

UNIX HW Extras

- ◆ **Ethernet 1.0 or 2.0**
- ◆ **Graphics support (full rasterop best)**
- ◆ **pointing devices (mouse preferred)**

1983 System Cost & Features

- ◆ **VAX 11/750 ~\$300K**
 - ❖ VAX arch, 1MIP, VM HW, ~2-4M of memory, 200-500M of disk.
 - ❖ Add another \$25K for UNIX License if commercial.
 - ❖ Networking and tape are optional add-in.
- ◆ **MC-500/DP ~\$100K**
 - ❖ M68000, 1MIP, VM HW, ~2-4M of memory, 50-500M of disk.
 - ❖ Graphics added, dual process, and Real Time.
 - ❖ Networking and tape are optional add-in.
- ◆ **SUN Terminal ~\$15K**
 - ❖ M68000, 1MIP, base limit MMU, ~2M of memory, 25-50M of disk.
 - ❖ Graphics added
 - ❖ VM supported with second version and M68010 CPU.
 - ❖ Networking on all systems, tape is optional add-in.
- ◆ **PC/XT ~\$2.5K**
 - ❖ i8088 arch, .15 MIP, 640K of memory, 5M of disk.
 - ❖ Simple graphics, but no UNIX.
 - ❖ Networking and tape not available.

UNIX and the CS Community

“UNIX became the Intellectual High Ground of the CS community .”

Dennis M. Ritchie, private communication.

JAWS – Just Another WS

- ◆ **The cheap microprocessor made JAWS possible.**
 - ❖ M68000/M68010 became the de facto answer.
- ◆ **But you need an OS and a compiler.**
 - ❖ C and UNIX were good enough, and the CS community concurred.
- ◆ **MIT's RTSL (Steve Ward) provided the 68000/C compiler, and even a simple UNIX port.**

CMU's SPICE

- ◆ **Scientific Programmable Integrated Computing Environment**
- ◆ **Proposal sent to all major systems and electronic vendors (IBM, DEC, HP, Tektronix, etc.)**
- ◆ **3M coined**
 - ❖ 1 MIP, 1 Mega-pixel raster display, 1 Megabyte of memory
 - ❖ Assumes Ethernet connection
- ◆ **CMU wants to pay \$5k in 1985 per system.**
- ◆ **becomes the CMU Andrew project**
 - ❖ CMU partners with IBM to build the SPICE system.
 - ❖ IBM to build the HW, CMU to build the System SW

CMU's SPICE and Andrew

- ◆ 3 River's PERQ (*a.k.a.* PascALTO) is prototype.
- ◆ Accent and the system tools never takes off, but AFS and Andrew (operational SW lives today and extremely influential in the long run).
- ◆ But Accent begets Mach, NT uK, OSF/1 *etc.*

MIT's Project Athena

- ◆ **Reaction to SPICE**
- ◆ **Goal assumed CMU would build the 3M system, MIT asks if such a machine existed, how would it change our environment.**
- ◆ **begets X-Windows, a piece of system SW which is the most used window system. Even influenced uSoft.**
- ◆ **Security work (Kerberos) morphs, but is still the leading solution to the “thousand attackers” problem.**
- ◆ **Management model of clouds of systems lives today.**

Free University's MINIX

- ◆ Andy Tanenbaum needs a teaching tool.
- ◆ 3M machines @ \$5K are still too expensive
- ◆ You need to sign a source license to see UNIX
- ◆ Writes a *mostly V7* clone, does not use MMU.
- ◆ Written as a uKernel.
- ◆ OS Book available with the complete source.

Bill Jolitz and CSRG

- ◆ **Never fully a member.**
- ◆ **Ported BSD 4.1 and 4.2 to the NS16000 while a student and part-time employee of National Semiconductor.**
- ◆ **Tries and fails to sell portable (lug-able) system based on this port.**

Intel 386

- ◆ 40 bit segmented address space, but ...
- ◆ 32 bit linear segment. Can be used like a VAX, 68000, Z8000, NS16000, WE3200 *etc.*
- ◆ Wyse Technologies builds the 32:16 – first PC/AT, ISA based PC clone with a 386 as the processor ~\$2.5K.

386BSD

- ◆ Jolitz Ports BSD 4.3 to PC/386, write DDJ articles
- ◆ Port made available from protected ftp site. You need an AT&T license.
- ◆ Takes off immediately
- ◆ Lots of university & research hackers world wide start to use it.

BSD Net1 and Net2

- ◆ UC Berkeley releases to anyone, the UCB based code
- ◆ McKusick, Karels and Bostic free up the code.
- ◆ Deletes anything not rewritten from AT&T.

BSDi

- ◆ **CSRG project winds down. Stops being research.**
- ◆ **Commercial versions of UNIX now available for DoD.**
- ◆ **Some members form a company to build and sell BSD on the 386 system. Source is available for \$1k. Rewrote any AT&T intellectual property.**

Linus

- ◆ **Linus is given a PC/386 as a student.**
- ◆ **starts to run Minix. Dislikes the lack of VM support and the lack of full V7 support.**
- ◆ **Is not aware of 386BSD efforts.**
- ◆ **He is aware of SunOS from school.**
- ◆ **Attempts to clone 4.2 for personal use and makes it available for ftp.**

Observation on Linux

“Linux is just like UNIX, only names have been changed to protect the guilty.”

Clem Cole, in an evaluation report on Linux to circa 1991.

AT&T sues UCB and BSDi!

AT&T vs. UCB & BSDi

- ◆ **386BSD hackers get scared AT&T will win thinking it was about copyrights.**
- ◆ **Major effort switches from 386BSD to Linux.**
- ◆ **If AT&T had won, Minix, Linux and all UNIX clones would have had to been removed from the market in the US, and probably most of the EU.**
 - ❖ **The case was about trade secrets and AT&T Intellectual Property (not copyrights).**

Agenda

- ◆ **Technical History**
- ◆ **Legal History**
- ◆ **What it all means**

A Word on Lawyers

“The law is the only profession which records its mistakes carefully, exactly as they occurred, and yet does not identify them as mistakes.”

Elliot Dunlop Smith, Quoted by Louis Brown “Legal Autopsy” American Judicial Society Journal November 1954

UNIX/Linux Set Up – The Law

- ◆ **3 Different Legal Actions Created UNIX as we know it and how we come to make Linux successful today:**
 - ❖ 1956 Consent Degree:
 - AT&T/WE not allowed to be in the Computer Business but gets a Telephone System Monopoly in the USA
 - AT&T/WE are allowed to perform experiments in building new technology for use in the phone system.
 - But AT&T/WE are required to license technology for reasonable fees.
 - ❖ Judge Greene’s January 8, 1982 “Modifications of Final Judgement”
 - Splits AT&T and AT&T can now sell computer hardware and software
 - ❖ March 1993, USL (an AT&T Division) case against BSDi and UCB
 - Case is not about Copyright and but Trade Secrets – the key phrase was “Mental Contamination”

What is UNIX to AT&T/WE

- ◆ **It is an experiment:**
 - ❖ Work allowed under 1956 consent decree.
- ◆ **AT&T/WE proprietary technology, covered under trade secret law.**
- ◆ **Term (UNIX) is a registered trademark of Bell Telephone Laboratories.**

AT&T/WE and Licensing

- ◆ **AT&T/WE takes the 1956 decree seriously and basically will license anything.**
- ◆ **But seriously protects its patents and trademarks.**
 - ❖ Even the news letter *UNIX News* had to be renamed.

AT&T/WE Licenses UNIX

“To Preclude any conflict with the Consent Degree, AT&T would license its software ... but would make it clear that it had no intention of pursuing software as a business.”

Otis Wilson of AT&T Technology Licensing Office

The Original UNIX Deal

◆ **University & Researchers Only**

- ❖ Non-Commercial use
- ❖ Western Electric owns the trade secrets
- ❖ Licensees may share with each other

◆ **You Give AT&T:**

- ❖ \$100 and a signed license agreement with Western Electric.

◆ **AT&T Gives You:**

- ❖ A Magnetic Tape, a Manual,
- ❖ “Our best wishes,” and
- ❖ abandons the tape on your doorstep.

Western Electric and Patents

“Please do not forget there are more lawyers in my group than engineers.”

*Al Arms, Director Western Electric Patents and Licensing Group to USENIX
Toronto, June 19, 1979*

The '79 Commercial UNIX Deal

- ◆ No advertising
- ◆ No support
- ◆ No bug fixes
- ◆ Payment in Advance

AI Arm's slide announcing commercial support for UNIX
at USENIX Summer '79 – Commercial Fees set @ \$20K
1st CPU, \$7K 2nd CPU, Non-Commercial @ \$300

Copyrights and Copyleft

◆ **BSD or X Windows Style Copyright**

- ❖ Do anything you like with the code, but don't take our name in vain without our permission, and be sure to give us credit for our work, and include our original copyright.
- ❖ Does not “infect” other code.

◆ **GNU “copyleft” — GPL**

- ❖ The source available, but strings attached – modifications must be given back, and ...
- ❖ GPL is “viral” – once GPL'ed everything must be GPL'ed.
- ❖ However, you can create “commercial” products (Red Hat, SuSE, *etc.*)

◆ **Many in the OSS community dislike the GPL as too restrictive, others the BSD license as too weak.**

The Original BSD UNIX Deal

- ◆ **Send us a copy of your license with Western Electric, a blank magnetic tape, \$1600 and sign our license.**
- ◆ **Have a ball. Do what ever you want with it.**
- ◆ **Keep the UC Berkeley Copyright notice intact.**
- ◆ **Don't sue us.**

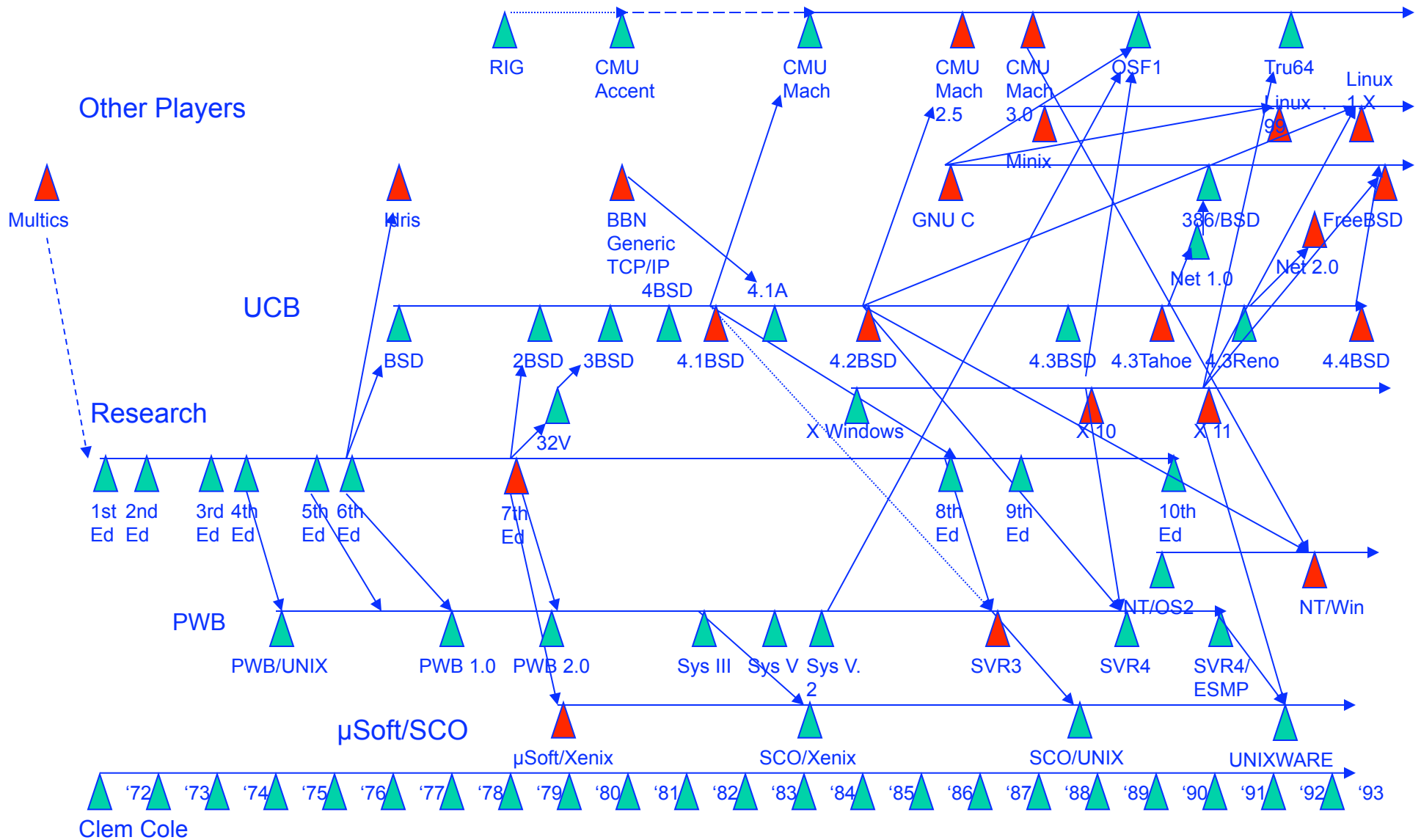
The Linux Deal

- ◆ **Get the binaries (and source) from someone. You don't need to sign anything.**
- ◆ **If you use it, must give the sources away plus any changes you made to our code too.**
- ◆ **You can charge for packaging and extra's, just not for "our work." Most people will pay between \$25-\$100 for the code (binary and source).**
- ◆ **You can't sue us. We didn't tell you to use it or sell it to you.**

The BSD4.4 UNIX Deal

- ◆ **Get the binaries (and source) from someone. Have a ball. Most people will pay between \$25-\$100 for the code (binary and source).**
- ◆ **Do what ever you want with it.**
- ◆ **Keep the UC Berkeley Copyright notice intact.**
- ◆ **Don't try to sue us. The courts already agreed we did not steal this; plus we didn't tell you to use it or sell it to you anyway.**

A UNIX Family History



UNIX/Linux Gestation – Learning

◆ V7 as a Teaching Tool

- ❖ Some universities believe students need to sign an agreement to adhere to the Western Electric License.
- ❖ Not everyone has a PDP-11 or later a VAX
- ❖ PC/XT are reasonably cheap.

◆ Minix

- ❖ V7 clone sans ptrace(2), created by Andy Tanenbaum – see *Operating Systems – Design and Implementation*.
- ❖ Only Requires PC/XT, no MMU required – even runs off floppies!

◆ 386/BSD

- ❖ PC/AT clones using 386 appear (Wyse 32:16 is the first)
- ❖ Bill Jolts ports 4.3BSD to a 386 clone, requires a BSD license

◆ Linux

- ❖ Linus purchases 386 clone, Minix does not use MMU

UNIX/Linux Gestation – Sharing

- ◆ **AT&T abandoned you and DEC did not love you.**
- ◆ **Share/DECUS/USENIX**
 - ❖ User Groups for IBM, DEC or UNIX already exists.
 - ❖ A tradition of sharing programs (w source) and fixes develop.
- ◆ **DARPA, BBN and BSD**
 - ❖ DARPA funds UC Berkeley to support Berkeley UNIX on the VAX
 - ❖ DARPA funds BBN to network Berkeley UNIX with a IP/TCP stack
 - ❖ All Western Electric Licenses are allowed to share code.
- ◆ **GNU C**
 - ❖ A production quality compiler for many different architectures, available to any one.
- ◆ **The Internet!**
 - ❖ A global distribution mechanism, cost not seen by users.

UNIX/Linux Gestation – Fees

◆ '79 Commercial License

- ❖ 20K 1st commercial CPU
- ❖ 7K 2nd, 3rd ... CPU

◆ '80 Redistribution License

- ❖ Base fees rise by 10K, redistribution 50K
- ❖ plus per CPU shipped fee, different fee depending
 - 1 user vs. 2 user vs. multi-user [what's a user anyway]

◆ USL Licenses

- ❖ Redistribution goes up 100K.
- ❖ Source fees to 100K
- ❖ plus per CPU shipped fee, different fee depending
 - 1/2 user vs. 8 user vs. 16 user vs. 32 user vs. 64 user vs. unlimited users
- ❖ \$86Million SMI buys out its UNIX license.

Agenda

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- ◆ **Legal History**
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Presidential Wisdom

“Things are more like they are today, than they have ever been before.”

President Dwight David Eisenhower, 1954

Is Linux Really New?

- ◆ **Same need based culture.**
- ◆ **Same sharing culture.**
- ◆ **Other systems cost too much, so you build your own.**
 - ❖ Mostly a rewrite of previous work.
 - ❖ Not quite enough borrowing of other's work.
- ◆ **Natural selection modified by different legal culture.**
 - ❖ Add some new things (kernel modules).

UNIX Wars – it's 1979 again

- ◆ **Late 1970s, early 1980s BSD was the popular, feature rich UNIX.**
 - ❖ VM, Networking, lots of cool applications *etc.*
 - ❖ Universities ran on it.
 - ❖ Hackers loved it.
- ◆ **AT&T's UNIX was unadorned.**
 - ❖ TeleCo's ran it, but the hackers dislike it compared to BSD.
 - ❖ Lots of \$'s behind it from commercial side.
 - ❖ AT&T want to sell it – “Consider it Standard”
- ◆ **We now call this “The UNIX Wars.”**

UNIX Wars – it's 1979 again

- ◆ **Late 1990s, early 2000s *BSD was the popular, feature rich UNIX.**
 - ❖ VM, Networking, lots of cool applications *etc.*
 - ❖ It meets the full UNIX standards.
 - ❖ Universities ran on it and teach with it.
 - ❖ Hackers loved it.
- ◆ **Linux was unadorned.**
 - ❖ Some hackers love it, but other hackers dislike it compared to BSD.
 - ❖ Deviates from the UNIX standard.
 - ❖ But Universities/Researchers are now running it.
 - ❖ And lots commercial \$'s behind it.
- ◆ **I call this “The Linux Wars.”**

Fast Forward to 2000

- ◆ **Standards are an agreement that it's time to stop fighting.**
- ◆ **We have a UNIX standard already, let's not create a new one.**
- ◆ ***BSD brings as much to the table as Linux.**
- ◆ **If Open Source is to succeed, the BSD/Linux rift must stop.**



Questions?