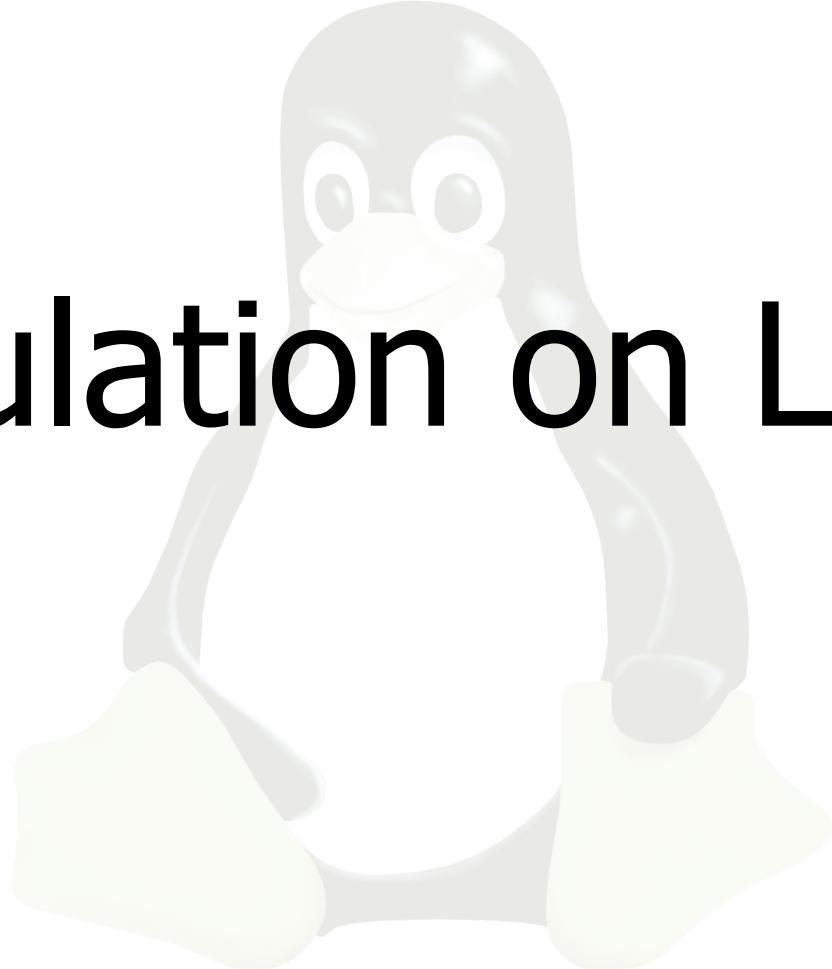


Emulation on Linux



What is It?

- In a nutshell, a program that allows you to run software that wouldn't normally run on your host operating system due to hardware incompatibilities
- Many people associate emulators with playing video games (Nintendo, Sega, arcade) on your computer
- While most people think of emulators purely in this sense, there are many more types for emulating hardware other than game hardware
- I will be discussing systems emulators, not game emulators

Why do it?

- Several motives behind emulation
- To preserve history
- Development on a platform not available to the developer
- To learn other operating systems
- For fun! Emulation gives you a unique perspective on operating systems history and evolution

Other hardware? Like what?

- Motorola 68000 (68k) used in the first line of Macintoshes
- Power PC – used in all Power Macs, G3s, G4s, G5s, iMacs, iBooks
- IBM mainframes – System/370, System/390, zSeries
- DEC PDP-11, VAX, Altair 8800
- Many more – this just scratches the surface

Components of Software Emulators

- Emulators generally don't just emulate the processor, that would be useless in most cases
- Most emulators need to emulate a variety of devices, for example hard drives, CD-ROM drives, Ethernet cards, video cards, and so on.
- Some systems have specific hardware requirements. Hercules emulates punch card readers, card punches, line printers, tape drives, and many other mainframe peripherals

How are the Devices Implemented?

- Direct Access Storage (Hard drives) are generally implemented as large files on the hard drive.
- Some emulators will allow direct access to the physical CD-ROM drive, others emulate it with ISO CD-ROM images
- Ethernet is commonly implemented through the TUN/TAP driver, standard in the 2.6 kernel which provides virtual network interface cards. libpcap is also used by some emulators
- Video cards and other devices are usually pure code

What are the hardware requirements?

- Emulators are unique and one of the most demanding types of applications that exist.
- In pure emulation environments, the software must translate every instruction from the emulated system into a native instruction that can be executed by the processor which is very demanding
- Even emulating hardware that's 10 years old will require a relatively powerful Linux box.
- Virtualization, which is used by products like Microsoft Virtual PC, VMware, and Xen solve this issue by passing as much native x86 code to the processor as possible without translation, however this only works when the guest operating system and host operating system use the same architecture (in this case, x86).
- Emulators are processor hungry. Upgrading the CPU is generally the most effective way to increase emulator performance.
- Even though your games won't use that shiny new dual core processor, some emulators like Hercules exploit multiprocessor systems and will run much faster!

Software Emulators

- There are some closed source proprietary emulators, but fortunately many popular emulators are open source. I will discuss the following open source emulators:
- **Basilisk II** – emulates Motorola 68k
- **PearPC** – emulates Power PC
- **Hercules** – emulates IBM mainframes
- **SIMH** – emulates 20+ systems from the 1970s and earlier

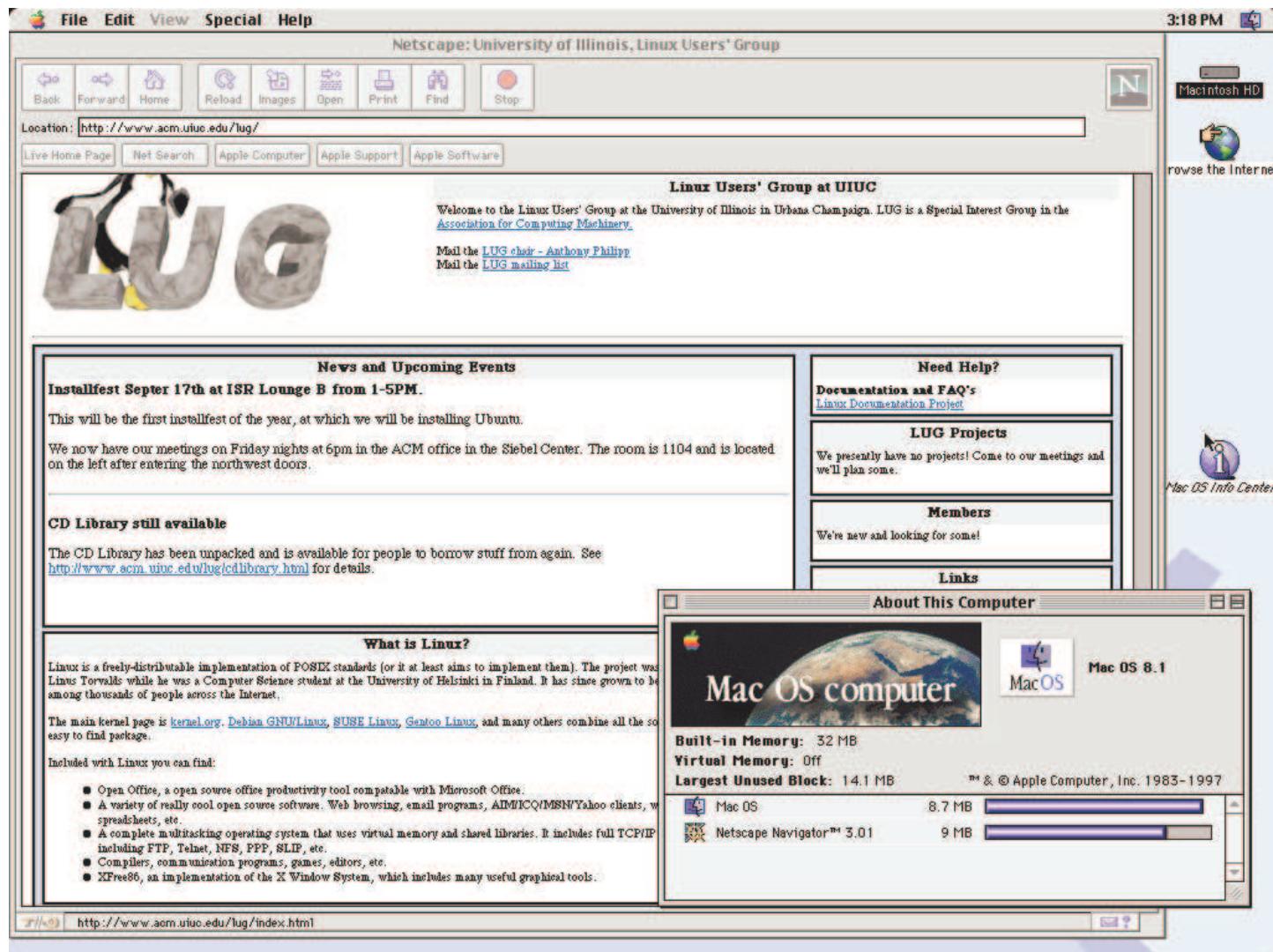
Legal Issues (eek!)

- Users need to pay attention to legal issues associated with software emulation
- The first and foremost issue is being able to legally run the operating system
- In some cases, this means owning the operating system installation media
- Some emulators require users to prove hardware ownership (Basilisk II)
- Some companies have released older operating systems into public domain. IBM allows several of their mainframe operating systems to be used free of charge. Many operating systems for SIMH are free.
- Owning the media does not put you in the clear – IBM explicitly forbids users from running their current mainframe operating systems on Hercules except under individual agreements made with them
- Many open source operating systems (including Linux) exist which will run on the emulated hardware and are almost always completely legal

Assorted Mac 68k Machines



Basilisk II



Mac OS 8.1 running on Basilisk II

Basilisk II



SimCity 2000 running on Mac OS 8.1 – Cool!

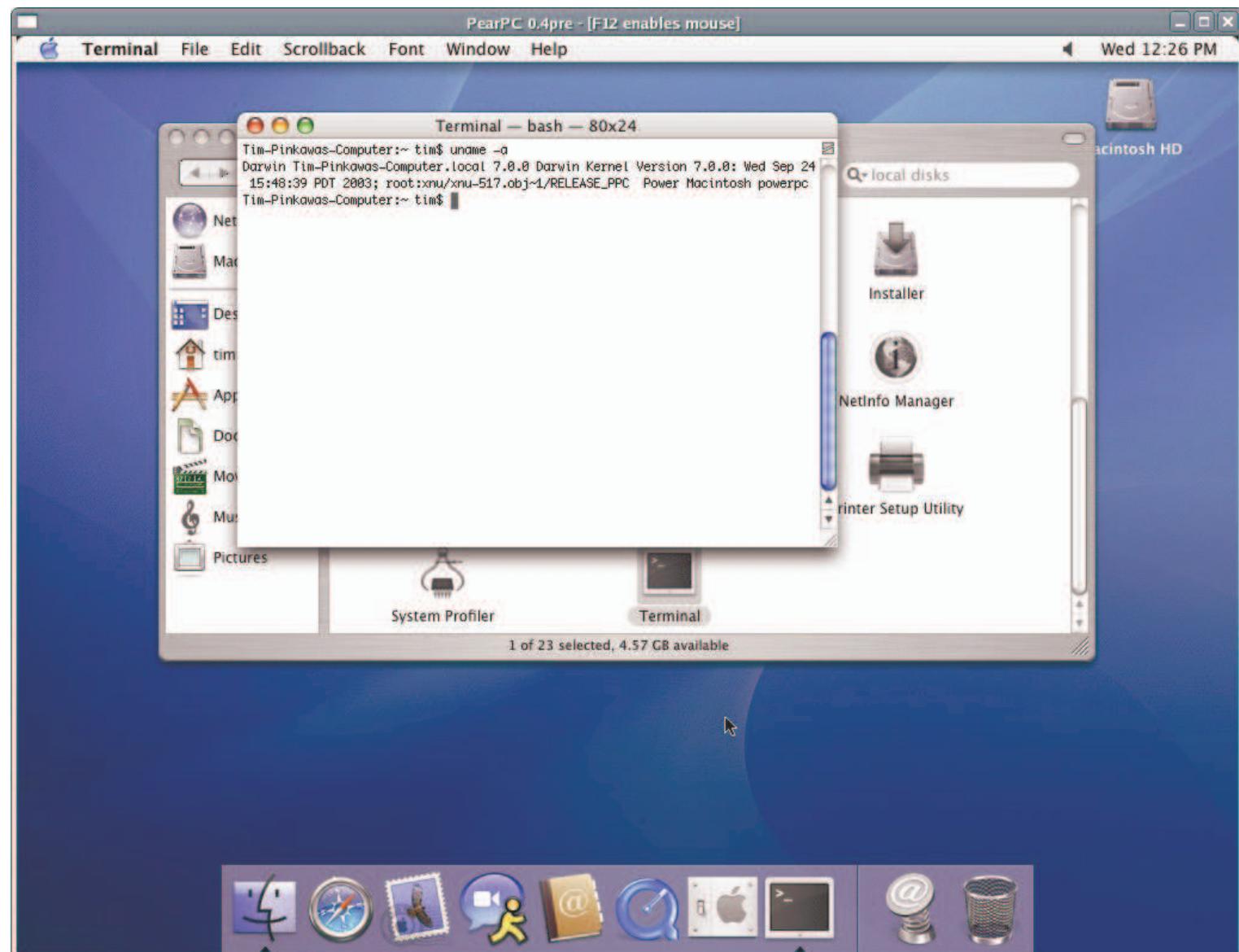
Common Mac PPC Hardware



PearPC



PearPC



Popular IBM Mainframes



3033
Processor
Complex
(System/370)



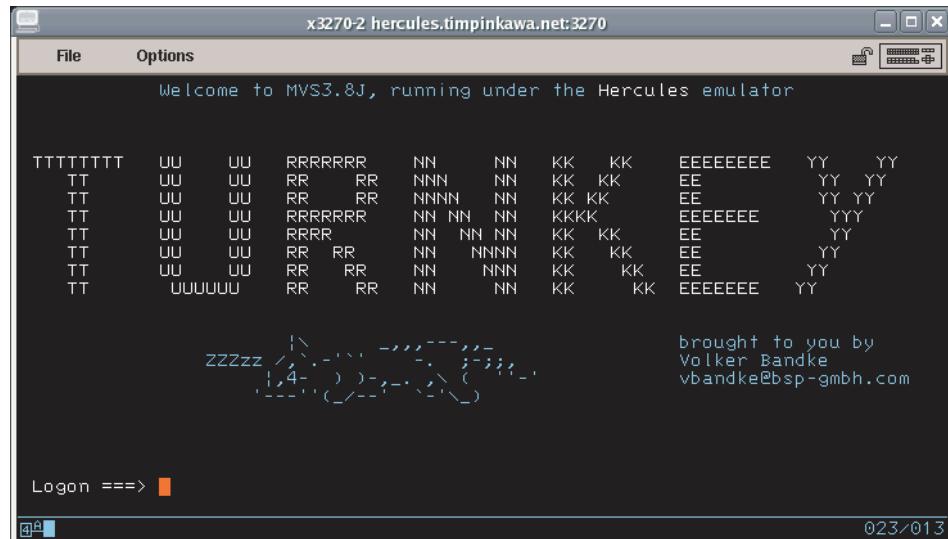
zSeries z990



zSeries z890

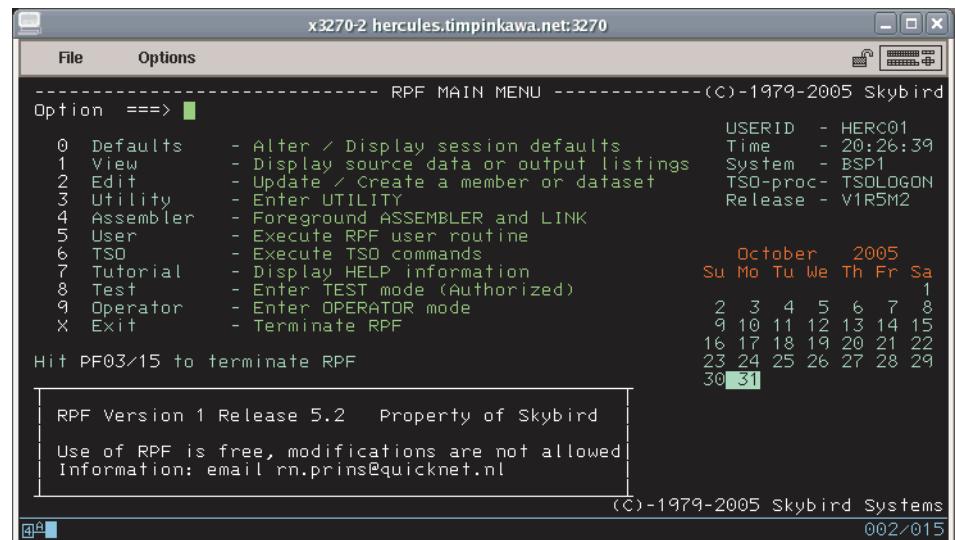


Hercules



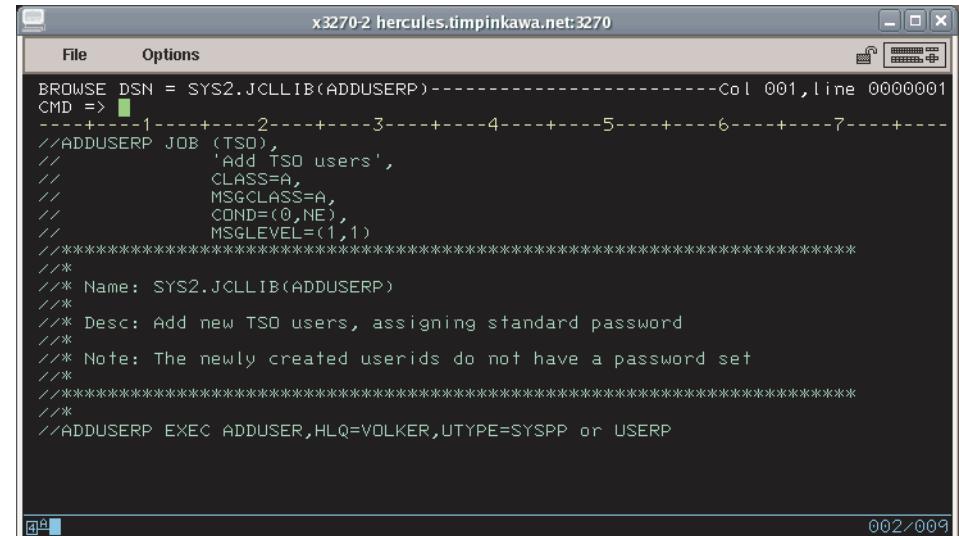
MVS Logon Screen via 3270 terminal

RPF (Rob's Programming Facility)

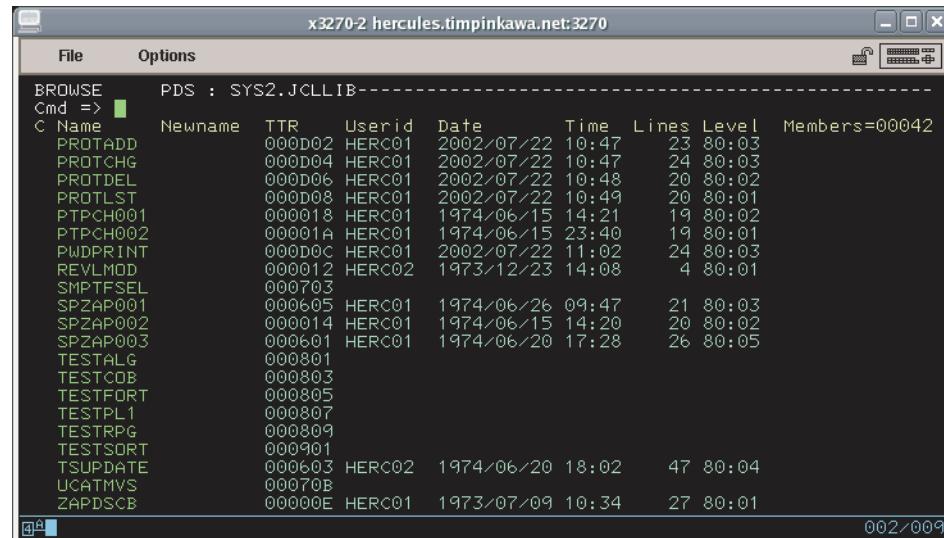


Hercules

Browsing a dataset member
(ADDUSERP)



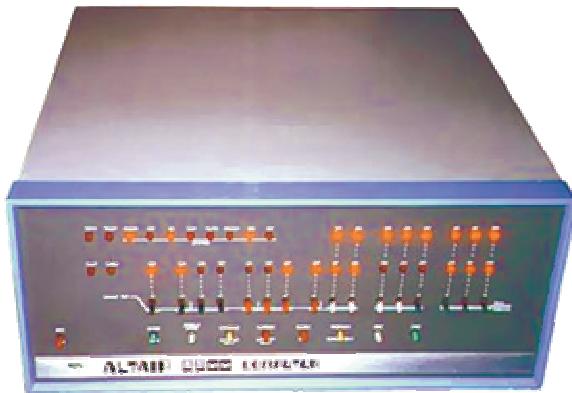
```
x3270-2 hercules.timpinkawa.net:3270
File Options
BROWSE DSN = SYS2.JCLLIB(ADDUSERP)-----Col 001, line 0000001
CMD => [ ] -----
-----1-----2-----3-----4-----5-----6-----7-----+
//ADDUSERP JOB (TSO),
//          'Add TSO users',
//          CLASS=A,
//          MSGCLASS=A,
//          COND=(0,NE),
//          MSGLEVEL=(1,1)
//*****
//** Name: SYS2.JCLLIB(ADDUSERP)
//**
//** Desc: Add new TSO users, assigning standard password
//**
//** Note: The newly created userids do not have a password set
//**
//*****
//ADDUSERP EXEC ADDUSER,HLQ=VOLKER,UTYPE=SYSPP or USERP
002/009
```



```
x3270-2 hercules.timpinkawa.net:3270
File Options
BROWSE PDS : SYS2.JCLLIB-----
Cmd => [ ] -----
C Name    Newname   TTR     Userid  Date      Time    Lines  Level  Members=00042
PROTADD   000D02  HERC01  2002/07/22 10:47   23 80:03
PROTCHG   000D04  HERC01  2002/07/22 10:47   24 80:03
PROTDEL   000D06  HERC01  2002/07/22 10:48   20 80:02
PROTLST   000D08  HERC01  2002/07/22 10:49   20 80:01
PTPCH001  000018  HERC01  1974/06/15 14:21   19 80:02
PTPCH002  00001A  HERC01  1974/06/15 23:40   19 80:01
PWDPRINT 000D0C  HERC01  2002/07/22 11:02   24 80:03
REVLMOD   000012  HERC02  1973/12/23 14:08   4 80:01
SMTPSEL   000703
SPZAP001   000605  HERC01  1974/06/26 09:47   21 80:03
SPZAP002   000014  HERC01  1974/06/15 14:20   20 80:02
SPZAP003   000601  HERC01  1974/06/20 17:28   26 80:05
TESTALG   000801
TESTCOB   000803
TESTFORT  000805
TESTPL1   000807
TESTRPG   000809
TESTSORT  000901
TSUPDATE  000603  HERC02  1974/06/20 18:02   47 80:04
UCATMVS   00070B
ZAPDSCB   00000E  HERC01  1973/07/09 10:34   27 80:01
002/009
```

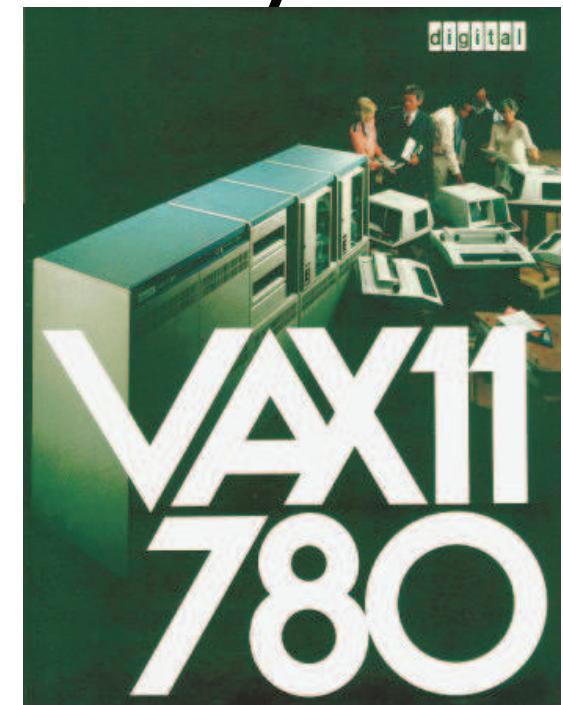
Browsing a dataset (SYS2.JCLLIB)

Various systems emulated by SIMH



Altair 8800

Dennis Ritchie and Ken Thompson, authors of UNIX, working on the second UNIX platform, a DEC PDP-11



VAX advertisement

SIMH

```
PDP-11 simulator V3.4-0
sim> set cpu U18
Disabling XQ
sim> attach rk0 unix_v5_rk.dsk
sim> boot rk0
@unix
```

```
login: root
#
```

Booting UNIX Version 5 (the oldest available) on PDP-11

The entire disk image is only 2.4 MB!

SIMH

```
# chdir /usr/games
# ttt
Tic-Tac-Toe
Accumulated knowledge?
0 'bits' of knowledge
new game
123
456
789

?
```

Tic-Tac-Toe (ttt) on UNIX v5 running on PDP-11.

The 'cd' command does not exist yet (neither does 'alias').

SIMH

```
Altair 8800 (Z80) simulator V3.4-0
```

```
64K CP/M Version 2.2 (SIMH ALTAIR 8800, BIOS V1.23,  
2 HD, 20-Oct-02)
```

```
A>speed
```

```
SPEED V-1.02 (03-Jul-2004)
```

```
Executing 100 * 10'000'000 t-states - Please wait  
...
```

```
Time needed in milliseconds = 3937  
Average time in milliseconds = 39  
CPU clock frequency in MHz = 256
```

Emulated CPU is over 100 times faster than the first generation Z80s

How can I get started with Basilisk II?

- Basilisk II – 68k emulator
- There is a free working copy of System 7.5.5 on the Basilisk website to get you started
- On the down side, you need ROMs from the original hardware
- Performance is relatively good. The system is generally responsive and it can run most applications at a usable speed.
- **<http://basilisk.cebix.net>**

How can I get started with PearPC?

- PearPC – PowerPC emulator
- Can supposedly run Darwin and some Mac Linux distros
- Of more interest to most users, it can also run Mac OS X.
- No ROM requirements like Basilisk II.
- Needs a very high end machine for usable performance (3 GHz+ recommended)
- x86 JITer is practically required for acceptable performance
- Mac OS X can be bought with a student discount if you want to try it out (\$69), but OS X 10.3 “Panther” discs are recommended at the moment
- **<http://pearpc.sourceforge.net>**

How can I get started with Hercules?

- Hercules - IBM mainframe emulator
- Will run OS/360, DOS/360 (no relation to MS), MVS, VM/370, TSS/370, MUSIC/SP
- All of these can be legally obtained for free. Feel free to ask me for copies of any of them. (I have most on CD)
- Can run (but not legally) MVS/XA, MVS/ESA, OS/390, z/OS, VM/ESA, z/VM, z/VSE, z/TPF, and others.
- Will also run Linux (RHEL, CentOS, Debian, SUSE)
- System/370 operating systems run *much* faster on emulated hardware than on the original hardware.
- Linux on System/390 & zSeries is generally on par with a Pentium I class processor on a 1.8 GHz Athlon 64 host.
- Very mature project – has been under constant development for almost 6 years
- **<http://www.conmicro.cx/hercules>**

How can I get started with SIMH?

- SIMH – emulates over 20 systems from the 1970s and earlier
- Popular systems emulated include the PDP-11 and VAX
- Dozens of free operating systems available on the SIMH site including the oldest surviving version of UNIX (v5 for PDP-11).
- NetBSD, OpenBSD, and 4.3BSD will also run on VAX
- OpenVMS for VAX can be obtained through the OpenVMS Hobbyist License program
- CP/M 2.2 for Z80 (Altair 8800)
- Performance is generally good due to the age of the emulated hardware
- **<http://simh.trailing-edge.com>**

Get Involved!

- No software is perfect. All of these emulators are open source so if you fix a bug or add a missing feature, submit it to the project.
- You don't need to have an intimate knowledge of how the emulator works or how the real system works before you start hacking the code.

Questions?

- You can also send questions to the LUG mailing list

