

**Hercules – "mainframe iron in software"**

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# Disclaimer

- Everything in this presentation is Jeff's opinion, and not that of his employer or anybody else, probably.
  - So, what else is new?
- Also, I am not a lawyer, so don't take anything I say as gospel if it has a legal implication. Or, even if it doesn't

# What is Hercules?

- Software implementation (emulator) of mainframe hardware:
  - S/370, ESA/390, z/Architecture
  - a variety of I/O devices
- About 110 kloc of multi-threaded C
- Open sourced, portable, based on gcc
  - By Roger Bowler, Jay Maynard, Jan Jaeger, Greg Smith, Volker Bandke, David "Fish" Trout, and other volunteers

# Why?

- If you don't have access to the Real Thing
- If you have access to the Real Thing, but in-office time just isn't enough
- Development
- Hobbyist "retrocomputing"
- Major geek value: surprise your friends by showing them MVS on your laptop

# Hercules Runs on:

- Windows 98, NT, 2000 using Cygwin
  - Provides Unix APIs Herc uses, esp: threads
  - Go to [sources.redhat.com/cygwin](http://sources.redhat.com/cygwin)
- Linux (including Linux/390)
  - So, you can run Linux under Hercules under Linux under...
- Solaris
- iMac OS/X
- (Rumored) Alpha, OS/2

# Emulated Architectures

- S/370
  - Uniprocessor only
- S/390, ESA
- z/Architecture (64-bit)
- Architecture selected via configuration file or console command

# Emulated Devices

- Local non-SNA 3270
- Printer/console (1052, 3215)
- Card reader/punch (2501, 2540, 3505, 3525)
- Printer (1403, 3211)
- Tape (3420, 3480)
- DASD: (3310, 3370, 9336; 2311, 2314, 3330, 3350, 3375, 3380, 3390)
- CTCA and networking (special cases)

# Compressed CKD disks

- Optional: Compressed CKD disks
  - Stores track images for non-null tracks only
  - Actual track contents stored, not max track size
  - Track compressed via bzip2 or zlib
  - Can specify readahead, full track I/O, cache, lazy writes, etc
- Shadow files for data integrity:
  - Base file and N shadow files containing deltas
  - All changes to current shadow file, others R/O
- Utilities to convert, validate



# Tapes

- Can be any of:
  - AWS tapes (like on P/390)
  - HET (Hercules Emulated Tape); like AWS, but with compression
  - OMA (Optical Media Attach) files with .tdf files to specify contents
  - "Real" SCSI tape drives, on Wintel, at least
- Emulated 3420, 3480

# CTCA

- Can use to connect multiple instances of Hercules via vmnet
- Can use to connect guest S/390 OS IP stack to host's stack via TUN/TAP driver
  - Use for TCP/IP and for Herc-to-Herc comm
  - Point to point connection
  - Linux and Solaris/86 only, today
  - Windows version being tested now

# Config file

- CPUSERIAL 000611
- CPUMODEL 3090
- MAINSIZE 64
- XPNDSIZE 20
- CNSLPORT 3270
- NUMCPU 1
- ARCHMODE ESA/390
- LOADPARAM 0120....
- SYSEPOCH 1900
- TZOFFSET -0500
- OC 3505 icl.txt ascii trunc

-

# Config file, continued

- OSTAILOR OS/390
- PANRATE FAST
- 000C 3505 jcl.txt ascii trunc
- 000D 3525 pch00d.txt ascii
- 000E 1403 prt00e.txt
- 001F 3270
- 0120 3380 mvsv5r.120
- 0121 3380 mvsv5d.121
- 0122 3380 mvswk1.122

# What OSes run on Hercules

- Freely downloadable OSes:
  - OS/360
  - MVS 3.8
  - VM/370 Release 6
  - Linux for S/390 or zSeries
- Licensed IBM OSes are known to work:
  - MVS/XA, OS/390, z/OS
  - VM/ESA, z/VM
  - VSE/ESA

# Performance

- Quite respectable, actually
  - Rough ROT: 1+ MIPS per 100Mhz
  - Very variable based on actual instruction
    - SS instructions slow, for example
  - 20+ MIPS reported for dual Athlon 1.7Ghz
  - 200 Mhz Pentium with 32MB RAM ok low end
- Multiple CPU support very new
  - Real SMP useful for running CPU threads separate from panel, I/O, and timer threads
- Performance being tweaked all the time

# Licensing Software

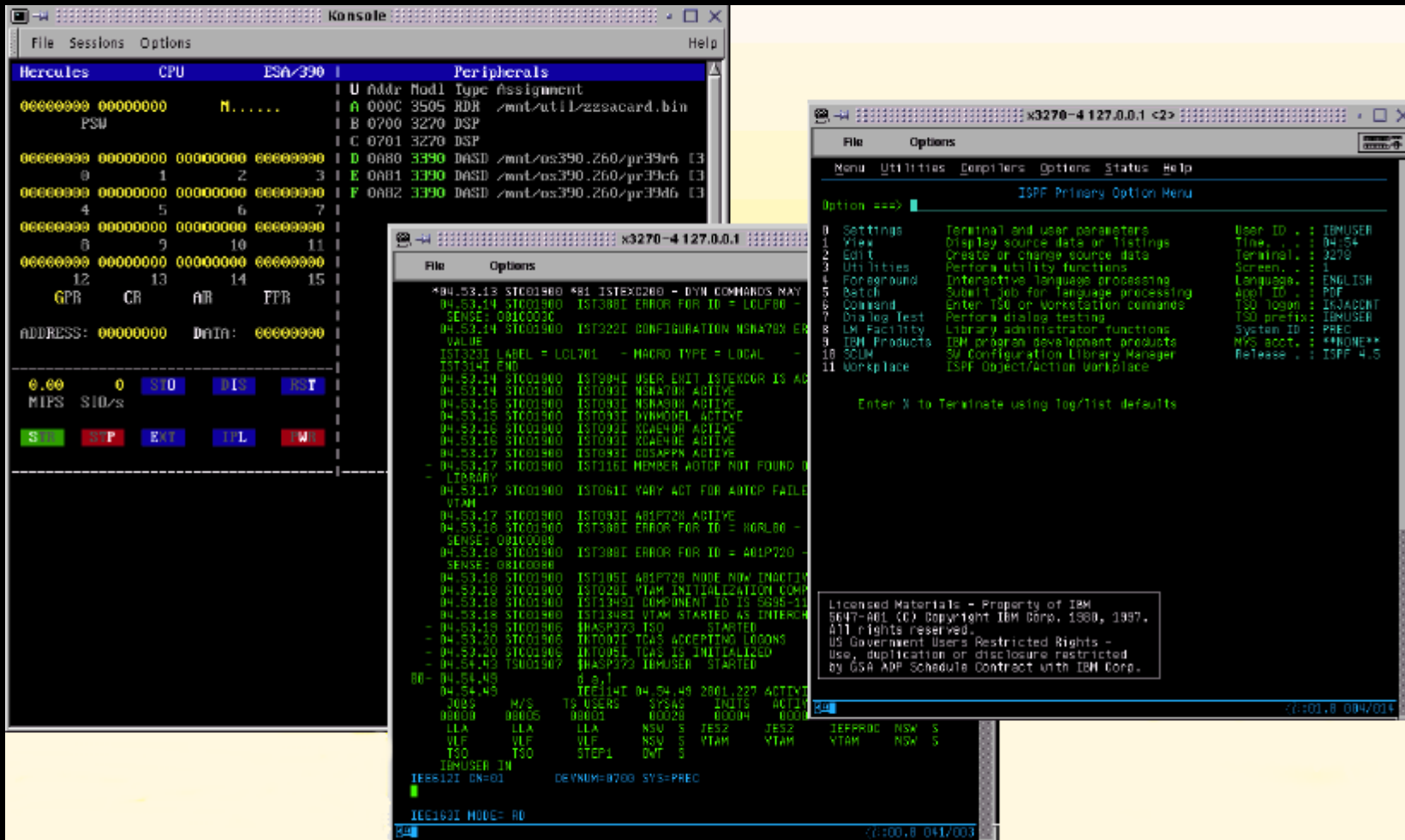
- I don't know, really
- It is claimed that you can license IBM software to run on Hercules via:
  - Run as disaster recovery machine for licensed P/390 or mainframe
  - Get an OTC or LTU license. I don't know how
- Controversial subject. One guy actually got kicked off the Hercules mailing list!
- Mentioned in SG255987 (Linux for S/390 Redbook) so there's some IBM notice of it

# Operation

- Download and install
  - Self-extracting EXE for Windows, but you have to install Cygwin for it to run
  - RPM for Linux
  - Autoconf/Automake to rebuild
- Build a config file
- Start it in a command-line window
  - Brings up command/display panel
- Connect a telnet/tn3270 client to localhost at designated port in config file



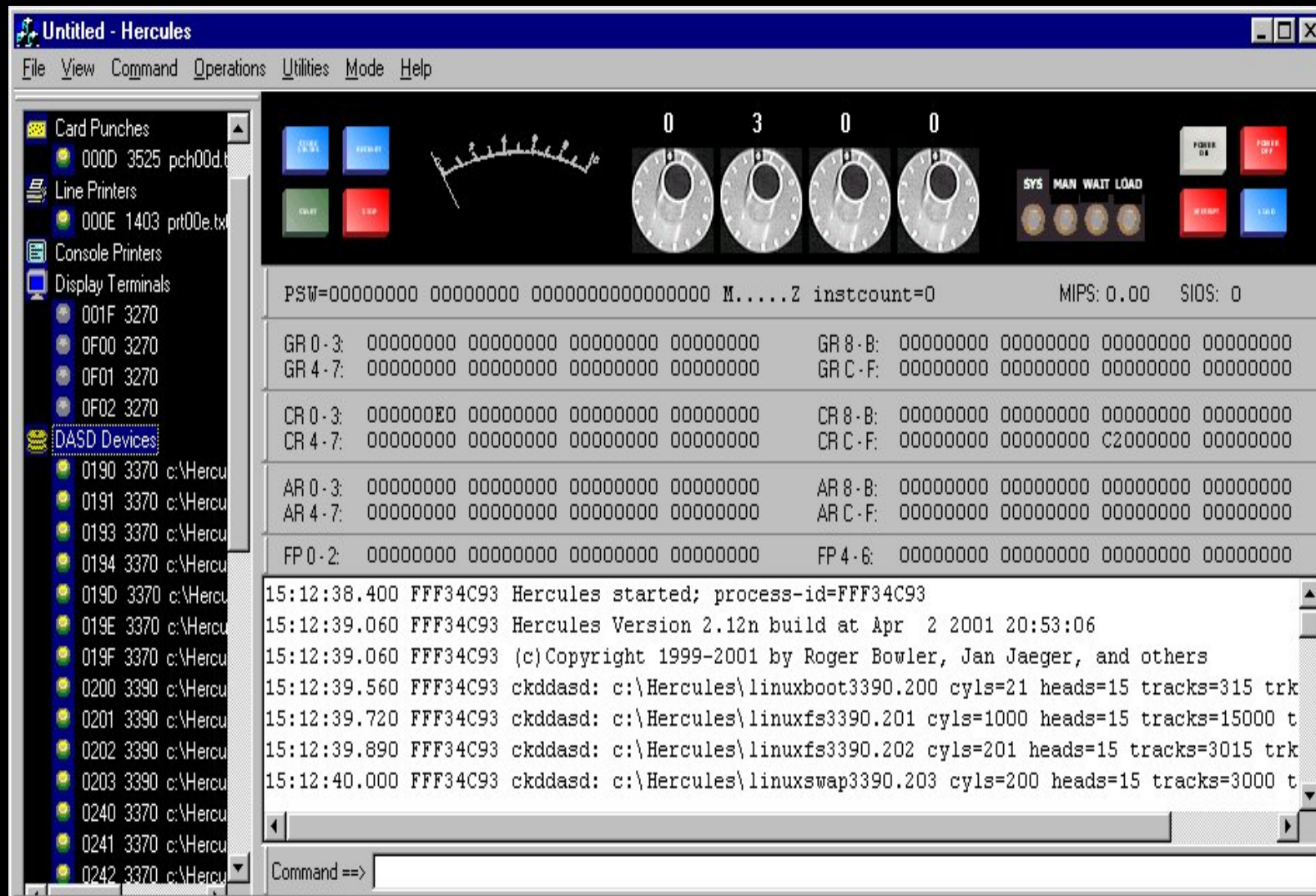
# Looks like:



The image shows a Hercules emulator interface with three main windows:

- Konsole (top left):** Displays system configuration for an IBM S/390 environment. It lists hardware components like CPU, PSW, DASD, and GPR/CR/AR/FPR. The configuration includes details for a 3390 DASD and a 3270 terminal.
- Konsole (bottom left):** Shows system boot logs for S/390. It details the initialization of various components such as VTAM, APLP728, and TSO, along with user logon information for 'IBMUSER'.
- ISPF Primary Option Menu (right):** A menu for the Interactive System/390 (ISPF) environment. It lists options like Settings, View, Edit, Utilities, Background, Batch, Command, Dialog Test, LM Facility, IBM Products, and Workplace. It also displays user information for 'IBMUSER' and a license notice for ISPF 4.5.

# Looks like (with Fish WinGUI)



**PSW=00000000 00000000 0000000000000000 M.....Z instcount=0 MIPS:0.00 SIOS: 0**

GR 0-3: 00000000 00000000 00000000 00000000	GR 8-B: 00000000 00000000 00000000 00000000
GR 4-7: 00000000 00000000 00000000 00000000	GR C-F: 00000000 00000000 00000000 00000000
CR 0-3: 000000E0 00000000 00000000 00000000	CR 8-B: 00000000 00000000 00000000 00000000
CR 4-7: 00000000 00000000 00000000 00000000	CR C-F: 00000000 00000000 C2000000 00000000
AR 0-3: 00000000 00000000 00000000 00000000	AR 8-B: 00000000 00000000 00000000 00000000
AR 4-7: 00000000 00000000 00000000 00000000	AR C-F: 00000000 00000000 00000000 00000000
FP 0-2: 00000000 00000000 00000000 00000000	FP 4-6: 00000000 00000000 00000000 00000000

```

15:12:38.400 FFF34C93 Hercules started; process-id=FFF34C93
15:12:39.060 FFF34C93 Hercules Version 2.12n build at Apr  2 2001 20:53:06
15:12:39.060 FFF34C93 (c)Copyright 1999-2001 by Roger Bowler, Jan Jaeger, and others
15:12:39.560 FFF34C93 ckddasd: c:\Hercules\linuxboot3390.200 cyls=21 heads=15 tracks=315 trk
15:12:39.720 FFF34C93 ckddasd: c:\Hercules\linuxfs3390.201 cyls=1000 heads=15 tracks=15000 t
15:12:39.890 FFF34C93 ckddasd: c:\Hercules\linuxfs3390.202 cyls=201 heads=15 tracks=3015 trk
15:12:40.000 FFF34C93 ckddasd: c:\Hercules\linuxswap3390.203 cyls=200 heads=15 tracks=3000 t
  
```

Command ==>

# Looks like... on iMac G4

The screenshot displays a classic Mac OS X desktop environment on an iMac G4. The desktop background is a dark blue gradient with a grid of icons. The dock at the bottom contains several application icons, including Radio Tuner, AM Gold, Bread, Fleetwood Mac, George Winston, Midi Files, Neil Young, and Nena.

Three windows are open:

- Terminal (x3270-4 localhost 3270):** Shows a Solaris OS boot log. The log includes the following key messages:
 

```

      *22.04.19 STC00004 *02 ISEX0200 - DYN COMMANDS MAY BE ENTERED
      22.05.47 8PXF024I (FTPD) Nov 19 02:05:47 ftpd 6 : EZYFT41I
      Server-FTP: process
      10 5, server 100 name FTDP1
      22.05.48 STC00013 EBB1001 22 : ACTIVE
      22.05.53 STC00022 $HASP373 BPXAS  STARTED
      22.05.53 STC00022 IEF404I BPXAS  - ENDED - TIME=22.05.53
      22.05.56 STC00018 IEF404I FTPD  - ENDED - TIME=22.05.56
      22.05.56 STC00014 E220400I TELNET/VTAM (SECOND PASS) BEGINNING FOR FILE:
      00:PROFILE
      22.05.58 STC00014 E226003I TELNET LISTENING ON PORT 23
      22.05.58 STC00014 E226018I TELNET PROFILE UPDATE COMPLETE
      22.05.58 STC00014 E220403I TELNET/VTAM (SECOND PASS) COMPLETE FOR FILE:
      00:PROFILE
      22.06.05 STC00023 $HASP373 BPXAS  STARTED
      22.06.06 STC00023 IEF404I BPXAS  - ENDED - TIME=22.06.06
      22.06.17 STC00024 $HASP373 BPXAS  STARTED
      22.06.18 STC00024 IEF404I BPXAS  - ENDED - TIME=22.06.18
      22.06.23 TSU00025 $HASP373 P390  STARTED
      22.06.25 STC00026 $HASP373 BPXAS  STARTED
      22.06.25 STC00026 IEF404I BPXAS  - ENDED - TIME=22.06.25
      22.06.40 STC00027 $HASP373 BPXAS  STARTED
      22.06.41 STC00027 IEF404I BPXAS  - ENDED - TIME=22.06.41
      22.06.52 STC00028 $HASP373 BPXAS  STARTED
      22.06.52 STC00028 IEF404I BPXAS  - ENDED - TIME=22.06.52
      22.07.03 STC00029 $HASP373 BPXAS  STARTED
      22.07.03 STC00029 IEF404I BPXAS  - ENDED - TIME=22.07.03
      22.07.14 STC00030 $HASP373 BPXAS  STARTED
      22.07.14 STC00030 IEF404I BPXAS  - ENDED - TIME=22.07.14
      22.07.25 STC00031 $HASP373 BPXAS  STARTED
      22.07.26 STC00031 BPXIO26I THE ETCINIT JOB COULD NOT BE STARTED.
      BPXIFRK  RETURN CODE 0000070 REASON CODE 0BFC0431
      22.07.26 STC00031 BPXIO27I THE ETCINIT JOB ENDED IN ERROR, EXIT STATUS
      0000009
      22.07.26 BPXIO04I OMVS INITIALIZATION COMPLETE
      22.07.27 STC00031 IEF404I BPXAS  - ENDED - TIME=22.07.27
      22.10.33 STC00032 $HASP373 PORTMAP STARTED
      22.10.35 STC00032 *EZAP252I portmap started
      00-22.12.46 TSU00033 $HASP373 IBMUSER STARTED
      IEE612I CN=01 DEYNUM=0700 SYS=P390
      IEE163I MODE= RD
      
```
- Hercules (/bin/tcsh (tty2)):** A Hercules emulator window showing a list of devices and their assignments. The table below summarizes the visible data:
 

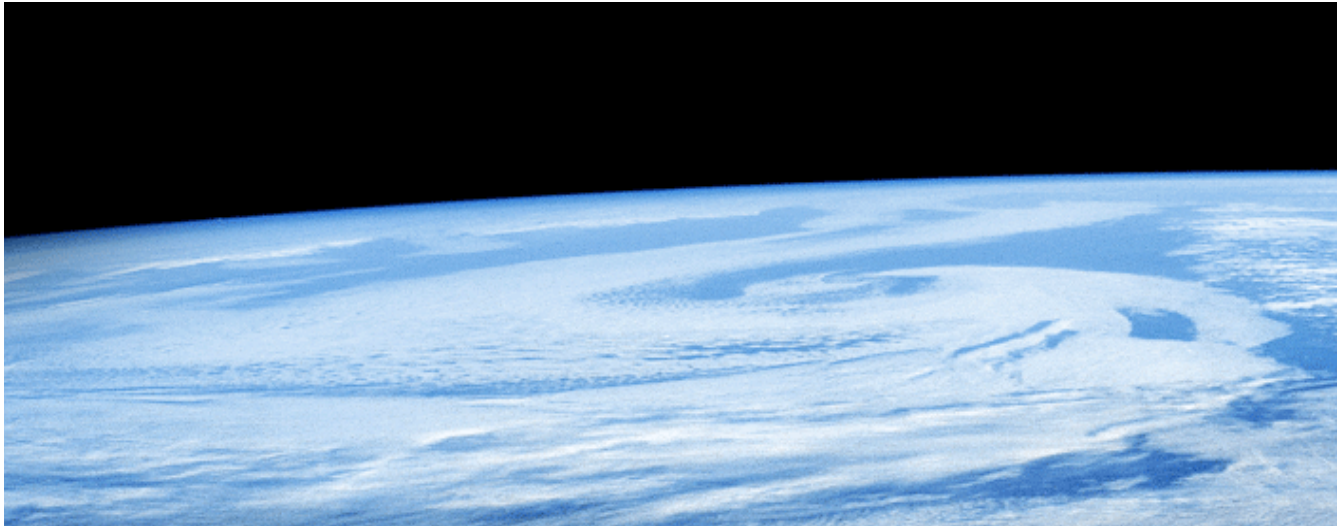
Device	CPU	ESA/390	Peripherals
SVS1.CBRI	070E0000	00000000	..V.....
SVS1.CDR	PSW		
SVS1.CIC	00000000	00000000	00000000
SVS1.CIO	0	1	2
SVS1.CLI	00000000	00000000	00000000
SVS1.CML	4	5	6
SVS1.CMI	00000000	00000000	00000000
SVS1.CM0	8	9	10
SVS1.CM1	00000000	00000000	00000000
SVS1.CM2	12	13	14
SVS1.CM3	GPR	CR	AR
SVS1.CM4	347		
SVS1.CM5	0		
SVS1.CM6	0		
SVS1.CM7	0		
SVS1.CM8	0		
SVS1.CM9	0		
SVS1.CM10	0		
SVS1.CM11	0		
SVS1.CM12	0		
SVS1.CM13	0		
SVS1.CM14	0		
SVS1.CM15	0		
SVS1.CM16	0		
SVS1.CM17	0		
SVS1.CM18	0		
SVS1.CM19	0		
SVS1.CM20	0		
SVS1.CM21	0		
SVS1.CM22	0		
SVS1.CM23	0		
SVS1.CM24	0		
SVS1.CM25	0		
SVS1.CM26	0		
SVS1.CM27	0		
SVS1.CM28	0		
SVS1.CM29	0		
SVS1.CM30	0		
SVS1.CM31	0		
SVS1.CM32	0		
SVS1.CM33	0		
SVS1.CM34	0		
SVS1.CM35	0		
SVS1.CM36	0		
SVS1.CM37	0		
SVS1.CM38	0		
SVS1.CM39	0		
SVS1.CM40	0		
SVS1.CM41	0		
SVS1.CM42	0		
SVS1.CM43	0		
SVS1.CM44	0		
SVS1.CM45	0		
SVS1.CM46	0		
SVS1.CM47	0		
SVS1.CM48	0		
SVS1.CM49	0		
SVS1.CM50	0		
SVS1.CM51	0		
SVS1.CM52	0		
SVS1.CM53	0		
SVS1.CM54	0		
SVS1.CM55	0		
SVS1.CM56	0		
SVS1.CM57	0		
SVS1.CM58	0		
SVS1.CM59	0		
SVS1.CM60	0		
SVS1.CM61	0		
SVS1.CM62	0		
SVS1.CM63	0		
SVS1.CM64	0		
SVS1.CM65	0		
SVS1.CM66	0		
SVS1.CM67	0		
SVS1.CM68	0		
SVS1.CM69	0		
SVS1.CM70	0		
SVS1.CM71	0		
SVS1.CM72	0		
SVS1.CM73	0		
SVS1.CM74	0		
SVS1.CM75	0		
SVS1.CM76	0		
SVS1.CM77	0		
SVS1.CM78	0		
SVS1.CM79	0		
SVS1.CM80	0		
SVS1.CM81	0		
SVS1.CM82	0		
SVS1.CM83	0		
SVS1.CM84	0		
SVS1.CM85	0		
SVS1.CM86	0		
SVS1.CM87	0		
SVS1.CM88	0		
SVS1.CM89	0		
SVS1.CM90	0		
SVS1.CM91	0		
SVS1.CM92	0		
SVS1.CM93	0		
SVS1.CM94	0		
SVS1.CM95	0		
SVS1.CM96	0		
SVS1.CM97	0		
SVS1.CM98	0		
SVS1.CM99	0		
SVS1.CM100	0		
- CPU Monitor:** A window showing a real-time CPU usage graph with multiple colored bars representing different processes or system components.

# Conclusions/Notes

- You can run a 360/370/390 on your PC
  - Faster than any real 360/370 ever was; breaks some timing loops on older OSes!
- Not sure if you can use it for "real work"
  - Legal issues
  - Not the authors' intention anyway
- Impressive – "feels like the real thing"
- Shocking proof of Moore's Law

# Resources

- [www.conmicro.cx/hercules](http://www.conmicro.cx/hercules)
- [www.i-foo.com/hercules](http://www.i-foo.com/hercules)
- [www.jaymosely.com](http://www.jaymosely.com)
- [www.bsp-gmbh.com/hercules/](http://www.bsp-gmbh.com/hercules/)
- [penguinvm.princeton.edu/hercules/](http://penguinvm.princeton.edu/hercules/)
- <ftp://source.rfc822.org/pub/mirror/hercules/mvs38j/>
- [groups.yahoo.com](http://groups.yahoo.com): see hercules-390 list, and also H390-VM



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