

Hercules FAQ as a Word Document

Written by Jay Maynard, 1999-2003. Edited by Dave Morton, 2000 and 2003.

(This document needs more work, in my opinion, but it is a substantial improvement over the original, and was done gratis, as a member of this special-interest group. It has been updated several times by the original author, since August 2000.

*The Hercules system, with its related PC software and hardware, a multitude of mainframe operating systems, and national and international copyright and licensing issues, is **VERY** complex. There are so many options and issues that it's difficult to simplify. But this is not the place for over-simplification or lack of detail - just **clarity** wherever possible.)*

Flesch Reading Ease: 50.8

Flesch-Kincaid Grade Level: 10.2

Hercules Version 3: Frequently Asked Questions

1.01 What is Hercules?

Hercules is an IBM mainframe emulator program that runs on a PC.

It is a software implementation of several types of IBM computers – System/370, ESA/390 and z/Architecture hardware – that runs under Linux or Windows NT/2000/XP on several hardware platforms, including the Intel Pentium PC.

1.02 So what exactly does that mean?

It means that your PC can emulate an IBM mainframe processor.

The mainframe can range from a 360 to a z900, running one of the following architectures:

- System/370
- ESA/390
- z/Architecture

(System/360 programs and operating systems can run on a System/370 computer: They will not invoke 370 features.)

Hercules executes both instructions and channel programs, and emulates mainframe I/O devices by using PC devices. For example, 3390 DASD devices are emulated by large files on your hard disk, and local 3270 screens are emulated by tn3270 sessions.

(Note: Not all 370 and 390 features have been implemented in Hercules. See the list of particulars later in this document. Also, certain non-standard models, 360/20s, and the 360/67 virtual memory mode are not emulated.)

Hercules implements only the raw instruction set: It does not provide any operating system facilities. This means that you need to provide an operating system or standalone program that Hercules can load from an emulated disk or tape device. You will have to write the operating system or standalone program yourself, or use IBM programs and operating systems that have been placed in the public domain, or obtain a license from IBM to run one of their operating systems on your PC.

1.03 Is it functional enough to run production work?

No. At the moment, it's a system programmer's toy, although it's rapidly becoming good enough to run a wide range of software without problems.

1.04 What are the licensing restrictions for Hercules?

Hercules is a copyright work, which has been made generally available, subject to the terms of the [Q Public License](#). In essence, this allows free use and distribution of the program for personal and commercial use. You may not distribute modified copies of the program, but you may distribute your own patches along with the program, if you also grant the maintainer permission to include those patches in future versions of the program. You may not copy any portion of the source code for use in any other program.

Hercules is *not*, repeat, *not* GPL software! The GNU General Public License is a Unix/Linux software licensing agreement, which we, the authors, will not participate in. We believe that the QPL, which has been certified as compliant with the [Open Source Definition](#), provides the benefits and protections of open source for both users and developers, without the political baggage that has come to be associated with the GPL.

2.01 Can it run OS/390, VM/ESA, and VSE/ESA?

Yes. Hercules is a software implementation of ESA/390, and so it is capable of running OS/390, VM/ESA and VSE/ESA, as well as older versions of these OS's.

2.02 What operating systems can I run legally?

Most 3rd party operating systems like Linux/390, z/Linux and TELPAR are covered under their own *free* license and can therefore run under Hercules without any legal problems.

OS/360 (PCP, MFT and MVT) is in the public domain, as far as we know, and can be run legally. The status of OS's for which IBM did not charge a license fee is somewhat murky; these include *MVS* 3.8, *VM/370* release 6, and *DOS/VS* release 34.

The legal status outside the USA, where something like public domain software, or software without copyright, doesn't exist, is "copyrighted software provided at no charge". It is a known

fact that vendors like *Amdahl*, *Hitachi*, *Nixdorf* and others modified those operating systems, and distributed them as their own OS for their own hardware, without asking IBM for permission. But the law had been changed since then, so it's not clear if the same legal status applies in **your** country right now.

Rick Fochtman managed to obtain a letter from IBM that he is allowed to distribute OS/360. Try to ask your sales droid for a similar letter for VM/370, MVS 3.8j or DOS/VS next time he wants to sell you a major upgrade.

OS/390 and other ESA versions of OS's are definitely licensed to a particular machine. Therefore, in practice you **cannot** legally run any ESA operating system on your PC unless you can obtain a license from IBM allowing you to do so.

We believe, however, there are 3 legal ways you could run OS/390, VM/ESA, or VSE/ESA under Hercules:

1. Running under Linux on the Pentium processor of a P/390, which is licensed to run the OS.
2. Running under Linux/390 on a mainframe, which is licensed to run the OS.
3. Running under the terms of a disaster recovery provision of the OS license (but I really don't recommend depending on Hercules to be your disaster recovery solution!).

2.03 What other programs will run under Hercules?

Any program that uses the 370/390/z-architecture instruction set, as implemented in Hercules. Some special utilities in the form of standalone programs are known to run well. I can particularly recommend Jan Jaeger's excellent standalone editor, ZZSA, which is included in the Hercules distribution, or which can be downloaded from <http://home.worldonline.nl/~jjaeger>. I use it regularly to look at DASD while debugging an OS installation, which is just what it's designed to do. Note: ZZSA runs in ESA/390 mode. See Jan Jaeger's website for more information and special logon procedures.

2.04 Where can I obtain OS/360?

1. Rick Fochtman's OS/360 archive CD is now obtainable by download from these locations:

- <http://www.cyberdynesys.com/os360.tgz>
- <ftp://ftp.ox.ac.uk/pub/linux/hercos360/os360.tar.gz>
- <ftp://source.rfc822.org/pub/mirror/hercules/hercos360/os360.tar.gz>
- <http://open360.copyleft.de/pub/os360-cdrom-1999-325.tar.gz>

2. If you are interested in obtaining a copy of the CD itself, contact Rick Fochtman at rfochtman@ync.net.

3. Alternatively, you can download the [OS/360 Y2K Starter](#) package that contains a full-featured MVT system on a 3330 image, with some minimal documentation. The configuration is that of a 370/158 with 4 megabytes of main storage, running OS/MVT Release 21.0. The same site also offers a MVTDBL volume and a *Builder* package for those who like to participate in OS/360 nucleus hacking.

2.05 Where can I obtain MVS 3.8 ?

The Original MVS 3.8 distribution as it was first used came from:

- <ftp://ftp.cbttape.org/pub/cbttape/mvs38/>

They advise using the mirrors at:

- <ftp://ftp.ox.ac.uk/pub/linux/mvs38j/>
- <http://source.rfc822.org/pub/mirror/hercules/mvs38j/>
- <ftp://source.rfc822.org/pub/mirror/hercules/mvs38j/>

Several people have generated a functional MVS system from these archives:

- [Jay Moseley from Terrashare](#)
- [Volker Bandke from BSP GmbH](#)
- [Wolfgang Schäfer from Schäfernet](#)

2.05 Where can I obtain VM/370?

From Bob Abeles who started a VM/370 web site at:

- <http://www.archaelogic.com/vm370/>

Right now, it's in an embryonic state. If anyone has material that they would like to contribute, please send it to me. I'm looking for FAQ material, command summaries, how-to's, personal experiences and anecdotes, machine room photos, and just about anything else you think might be of interest. I'll pass them on to Bob.

2.07 Where can I obtain DOS/VS?

I've put the install tape for DOS/VS R34 on my site. It will expand to a 21 Megabyte AWSTAPE file named "DOSREL34.AWS". You will need the *Coverletter* PDF document to install it. Read the relevant postings of the Hercules mailing list first, as the install process is quite obscure.

You can grab those files at:

- <http://www.conmicro.cx/hercules/dosrel34.zip>
- <http://www.conmicro.cx/hercules/dosrel34coverletter.pdf>
- <http://open360.copyleft.de/dos34/install.mails>

2.08 Where can I obtain Linux/390?

The process of downloading and installing Linux/390 is best described by the [Getting Started with Linux/390](#) document. Take a look at, [David Pitts' GCC/EGCS Compiler Page](#) if you need GCC and GNU utilities for OS/390 to bootstrap Linux from source.

2.09 Where can I find documentation?

The [Creating Hercules DASD](#) document describes various methods of creating and loading virtual DASD volumes.

I've produced a document describing how to build an OS/360 system on Hercules, called "OS/360 on Hercules". It can be found at

- <http://www.conmicro.cx/hercos360/>.

This will build an MVT system without TCAM/TSO, but with two 3270 consoles. You will need Malcolm Beattie's "Guide to Using 3270 Consoles and Terminals for Hercules" with this MVT version.

- <http://users.ox.ac.uk/~mbeattie/hercules/3270.html>

The New User Documentation guides can be found at:

- <http://www.kiyoinc.com/hercdoc.html>.

-

IBM provides only current documentation, but many things haven't changed since 1964:

- [IBM BookManager\(r\) BookServer Library](#)
-

3.01 What PC hardware do I need to run Hercules?

It depends how fast you want it to run. A Pentium 200 with 32Mb RAM is probably the minimum practical requirement; 500+ MHz with 128Mb RAM would be much better. Hercules doesn't use any fancy graphics, but it does need a fast processor to achieve a reasonable MIPS rate.

If you can afford a multiprocessor system, so much the better. Hercules makes extensive use of multi-threading to overlap I/O with CPU activity, so you should find that a dual or quad Pentium 200 system will outperform a uniprocessor Pentium 450. My development system is a Compaq ProLiant 6000 with four Pentium Pro 200s, and response time is quite satisfactory.

Hercules does not depend on the Pentium architecture. I've built and run it successfully on a 500 MHz Alpha 21164, and others have run it on SPARC and S/390 (!) Linux systems. (One guy has even run OS/360 under Hercules under Linux/390 under Hercules under Linux/390 under VM/ESA!) The only weirdness about building the package on an Alpha is that you'll get compiler warnings about "unsigned long value, unsigned long long format". You can ignore these warnings.

You will need enough Linux swap space to accommodate your S/390 real storage (main storage plus expanded storage). For maximum throughput, you should set your main and expanded storage sizes high enough to eliminate S/390 paging. S/390 storage is allocated out of Linux virtual storage, so if you can provide enough RAM to eliminate Linux paging as well, then so much the better.

You also need enough hard disk space to accommodate the emulated DASD. A virtual "3330 model 1" disk drive will need about 100 megabytes of space for emulation (a 3330-11 will need about 200 megabytes). A 3380 "single density" model will need about 650MB, and a 3390 model 2 needs about 2GB. If you use the [compressed CKD DASD feature](#), these sizes will shrink dramatically, usually to about 20 to 30 percent of the original size.

3.02 What PC software do I need to run Hercules?

1. For running under Linux, you will need a Linux system with POSIX threads (pthread) support. I will only provide support for Linux 2.2.x kernels with glibc2 (libc6) as supplied in popular distributions such as Red Hat 6.0 or later and SuSE Linux 6.1 or later. My development system runs Red Hat 6.1.
2. You can also run under Windows NT, Windows 2000 or Windows XT, although Hercules isn't quite as polished on the Windows platform.
3. For running under Linux, you will need an egcs C compiler, normally distributed with Linux. See the notes below on this compiler.
4. For Windows, if you wish to rebuild the Windows version of Hercules, you will need the [Cygwin](#) tools from Red Hat.
5. You will also need tn3270 client software for the virtual 3270 console. The tn3270 client can run on the same machine as Hercules, or on any Unix or Windows box with a TCP/IP connection to the Hercules machine.

The supported and recommended tn3270 clients for Hercules are:

For Linux: x3270 for Unix

x3270 is included with most Linux distributions, or you can download it from <http://www.geocities.com/SiliconValley?Peaks/7814>

For Windows: Vista tn3270

Vista tn3270 can be obtained from <http://www.tombrennansoftware.com/>. The very modest license fee charged for this excellent 3270 emulator helps to support an independent software developer.

Other tn3270 clients, such as QWS3270, IBM Personal Communications, Attachmate Extra, or Dynacomm Elite should also work in most cases, but be aware that some tn3270 clients have bugs that make them unusable as "mainframe" consoles.

3.03 What sort of MIPS rate can I expect?

With the performance enhancements that began around release 1.60, thanks to work by Juergen Dobrinski, Valery Pogonchenko, and Jan Jaeger, you should now see an execution speed of around 0.8 to 1 MIPS, even on a Pentium 200. That's enough to run OS/360 (MFT or MVT) with a response time similar to that of a 3033 from the 1970's. It's also fast enough to run VSE/ESA with an acceptable response time.

If you want to run OS/390 instead of OS/360, you'd better get a gigahertz Pentium III. On a fast dual Pentium III, it's now not unusual to see 5 MIPS or better.

Typical I/O rates of around 50 EXCPs/second are reported on average hardware, with rates over 500/second achievable with hardware RAID.

3.04 Which C compiler should I use to build Hercules?

You *must* use the egcs C compiler. I am using the version that came with Red Hat 6.1 and it seems to work OK. The version number reported by the Linux command `cc -v` is: `egcs-2.91.66 19990314/Linux (egcs-1.1.2 release)`. If your compiler is version 2.9 or higher, it is EGCS-based, and should work fine, as EGCS version 1 is just another name for gcc version 2.9.

The older gcc compiler is known to produce incorrect code for some 64-bit (unsigned long) integer operations. I have had reports that earlier versions of egcs produce strange results too.

If you have both an old gcc and egcs compilers installed, use the `CC` parameter on the "make" command to force it to choose the correct compiler:

```
make CC=egcs . . .
```

Red Hat 7.0 ships with two versions of gcc. If you don't do anything special, you get gcc 2.96, which will not compile the Linux kernel, so they included 2.91 as well as kgcc. If you encounter problems when building Hercules with the 2.96 compiler, try `make CC=kgcc` instead. I would appreciate reports as to how well the 2.96 compiler works, as it is a development snapshot, and lots of folks, including the GCC development team and Linus Torvalds, were very unhappy that Red Hat included it in their distribution.

3.05 Why do I get an unexpected fixed-point divide exception (program check 0009 or abend 0C9) on a CVB instruction?

You are using an old gcc compiler. You must use the newer egcs-based compiler instead. See previous question for the required compiler level.

3.06 Do you plan to port Hercules to other platforms?

No. We simply do not have the resources to support more than these operating systems.

It should be noted however that we do make efforts to ensure Hercules builds and runs on several different operating system platforms (mostly just Linux, Windows and Apple right now), but we of course simply cannot guarantee that it will run on every operating system platform out there.

If you want to make Hercules run on FreeBSD, Solaris, Linux 2.0.x, or whatever, then by all means go ahead. I welcome reports of any bugs or problems you find, but I probably won't fix problems if it means introducing platform-specific code, and I will not be able to test new releases against other platforms. Folks who have gotten it compiled on the BSDs report that the hardest part is removing the Linux-specific tape support.

The Hercules code is not intended to be specific to Intel hardware, so if you find any issues or faults related to running on other hardware (SPARC, Alpha, PPC...) under Linux 2.2, then I'm likely to be receptive to fixing that sort of problem. Issues related to Unix variants are less likely to be fixed however.

4.01 How can I create a virtual DASD volume (a disk pack)?

The [Creating Hercules DASD](#) document describes various methods of creating and loading virtual DASD volumes for your system. These are the "disk packs" for your operating system.

4.02 Can I read a tape that was created on a mainframe?

Yes, indirectly. The mainframe tape must be converted to AWSTAPE format and then downloaded to your PC. The *tapeconv.jcl* file in the Hercules directory contains a sample program that you can run under OS/390 on your mainframe system. It reads a file from tape and converts it to AWSTAPE format.

Download the AWSTAPE file to your PC (making sure to choose *binary* format for the download), and then add the downloaded filename to the Hercules configuration file as a virtual tape device. You will then be able to read the tape file from the virtual tape drive located on your PC.

Note: The "tapeconv" program will not correctly process input tapes whose block size exceeds 32760. One symptom of this may be the message:

```
"ADRY011E I/O ERROR - DEVICE NOT ATTACHED. 0000,NA,00...00,0000"
```

...when attempting to restore from tape originally created using the default DF/DSS block size. The solution is to re-create the dump tape with DCB=BLKSIZE=32760.

4.03 Can I attach a PC tape drive to Hercules?

Yes. Hercules can read and write tapes on SCSI drives. I have tested this with 4mm DAT, QIC-1000, and 9-track drives.

4.04 Can I connect a mainframe tape drive to my PC and have Hercules read/write the tapes?

Yes. It is possible to obtain 9-track open reel drives and 3480-type cartridge drives which attach to the SCSI bus. Hercules makes these appear to the operating system as channel-attached 3420 or 3480 devices, making it possible to read and write real mainframe tapes.

4.05 Can I create Assembler programs without a mainframe?

Yes. If you want to write Assembler (BAL) programs to run on Hercules, but you don't have access to a mainframe, then there are two interesting products that you can run on your PC to assemble programs:

The "Tachyon 390 Cross Assembler" (<http://www.tachyonsoft.com/tachyon>)

With this assembler, you can produce S/390-compatible object decks using your Linux or Windows PC. A high degree of HLASM compatibility, coupled with the ability to perform complex assemblies at lightning speed, make this a product which is well worth looking at. I have tried this assembler and it is truly amazing.

The "Dignus Systems/C Compiler" (<http://www.dignus.com/>)

This is a C compiler which runs under Windows or Linux and generates mainframe assembler code which you can then assemble using the Tachyon assembler.

Sam Golob wrote a fascinating review of these two products in the September 1999 issue of NaSPA Technical Support magazine.

5.01 What architectural features are implemented?

The following standard features have been implemented:

- Address-Limit Checking
- Commercial Instruction Set
- Decimal Instructions
- Hexadecimal Floating-Point Instructions
- 24-bit and 31-bit addressing
- Key-Controlled Protection
- Page Protection
- Low-Address Protection
- Dynamic Address Translation
- 370-XA Channel Subsystem
- Channel Indirect Data Addressing
- Program Controlled Interruption (PCI)
- Channel Program Suspend/Resume
- Dual Address Space (ESA/390 only, for now)
- Access Register Mode
- Home Space Mode
- Branch and Save
- Conditional Swapping
- TOD Clock, Clock Comparator, and CPU Timer
- MVCS/MVCP/MVCK/MVCSK/MVCDK instructions
- TB/TPROT instructions
- LURA/STURA instructions
- BAKR/PC/PR/PT instructions
- Linkage Stack
- Compare and Form Codeword and Update Tree instructions

The following optional features have been implemented:

- Access-List-Controlled Protection
- Branch and Set Authority
- Broadcasted Purging
- Checksum instruction
- Compare and Move Extended instructions
- Dynamic Reconfiguration
- Expanded Storage
- Halfword-Immediate instructions
- Branch-Relative instructions
- Incorrect-Length-Indication Suppression
- Interpretive Execution (SIE)
- Move Inverse
- Move Page (Facility 2)
- MVS assists
- Operational Extensions: Console Integration
- Private Space

- Set Address Space Control Fast
- Service-call-logical-processor (SCLP) facility
- Square Root
- Storage-Protection Override
- Storage Key assist
- String instructions
- Subspace Group
- Compare Until Substring Equal
- Concurrent Sense
- Suppression on Protection with Virtual-Address enhancement
- Extended TOD clock
- Compression
- Perform Locked Operation
- Vector Facility
- Multiple Controlled Data Space (VM dataspaces)
- Extended Translation
- Extended Translation Facility 2
- Store System Information
- 64-bit operations
- Cancel I/O Facility
- Program Event Recording
- Guest PER enhancement

The following standard feature has not yet been implemented:

- Clear I/O (full functionality for S/370)

The following standard feature has been partially implemented:

- Binary Floating-Point instructions

The following optional features have been partially implemented:

- Channel-Subsystem Call
- VM/370 assists

The following features are not yet implemented, either due to lack of documentation, limited host system capability, or lack of supporting hardware:

- The virtual memory feature of the System/360 Model 67
- Asynchronous Data Mover Facility
- Asynchronous Pageout Facility
- Coupling Links
- ESCON
- EMIF (ESCON Multiple Image Facility)
- Extended Sorting
- External Time Reference
- ICRF (Cryptography)
- Operational Extensions: Automatic Reconfiguration, Storage Reconfiguration, SCP-initiated Reset, Processor Availability

- PR/SM
- Sysplex Timer (ETR)

Hercules is compliant with IBM's ALS-1, ALS-2 and ALS-3 architectural level sets to the degree necessary to run all OS/390 versions through 2.10 and known versions of z/OS in both ARCHLVL 1 and ARCHLVL 2 mode, and Linux and z/VM in both ESA/390 and z/Architecture mode.

5.02 Which models are not emulated?

The following models and special features are not emulated:

- System/360 Model 20s (significantly different architecture)
 - System/360 Model 44 (low-cost, scientific machines)
-

6.01 Who are the Herculeans?

The following people are among those who have contributed to this project, either as coders or as testers or both:

[Roger Bowler](#) (original author)

[Jay Maynard](#) (current maintainer)

[Jan Jaeger](#)

[Volker Bandke](#)

David Barth

[Malcolm Beattie](#)

Mario Bezzi

Vic Cross

Juergen Dobrinski

Fritz Elfert

Tomas Fott

Steve Gay

Roland Goetschi

Glen Herrmannsfeldt

Brandon Hill

Gabor Hoffer

Dan Horak

Soren Jorvang

Willem Konynenberg

John Kozak

Nobumichi Kozawa

Peter Kuschnerus

Paul Leisy

Albert Louw

Peter Macdonald

Rick McKelvy

Dave Morton

Mike Noel

Andy Norrie

[Dutch Owen](#)

Reed H. Petty

Jim Pierson

Valery Pogonchenko

Emerson Santos

Axel Schwarzer

Paul Scott

Daniel Seagraves

Greg Smith

John Summerfield

Mark Szlaga

Adam Thornton

["Fish" \(David B. Trout\)](#)

Ronen Tzur

Bernard van der Helm

Kris Van Hees
Ivan Warren
Matt Zimmerman

And thanks for support and encouragement from:

Tim Alpaerts
Bertus Bekker
Giorgio de Nunzio
Rick Fochtman
Alex Friis
Sam Golob
Cory Hamasaki
Tony Harminc
Richard Higson
Jim Keohane
Sam Knutson
Mike Ross
Daniel Rudin
Rich Smrcina
Henk Stegeman
Mark S. Waterbury

If anyone feels they have been unfairly omitted from either of these lists, please let me (Jay Maynard) know.

7.01 Where can I obtain technical support?

If your question and/or concern is not addressed in this FAQ, please post your question to the Hercules-390 forum:

Files and archives at:

<http://groups.yahoo.com/group/hercules-390>

Community email addresses:

Post message: mailto:hercules-390@yahoogroups.com?subject=Hercules_Question

Subscribe: <mailto:hercules-390-subscribe@yahoogroups.com?subject=Subscribe>

Unsubscribe: <mailto:hercules-390-unsubscribe@yahoogroups.com?subject=Unsubscribe>

List owner: <mailto:hercules-390-owner@yahoogroups.com?subject=Hercules>

The Hercules-390 forum is your primary source for Hercules support, and you are strongly encouraged to subscribe. We have a vibrant, active community of over 3200+ members, many of which are very knowledgeable in many different areas of mainframe technology, both from a hardware point of view as well as from an operating system and software point of view.

In addition to the main Hercules-390 forum, other more specialized Hercules forums also exist to provide more focused support for a variety of popular IBM mainframe operating systems, such as DOS, VM, and MVS.

** Note! The use of Yahoo! as host for the Hercules-390 and related forums should in no way be interpreted as an endorsement of the Yahoo! service.*

If you have any comments and questions, please join the Hercules discussion group at <http://groups.yahoo.com/group/hercules-390>

<http://www.conmicro.cx/hercules/hercules.html><http://www.conmicro.cx/hercules/hercules.html>

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