

20 Years of Linux on the Mainframe

—

"Hey Lyz, do you want to
work on Mainframes?"

"Um..."

"They run Linux!"

Elizabeth K. Joseph

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October, 2019

LISA'19

What is a mainframe?

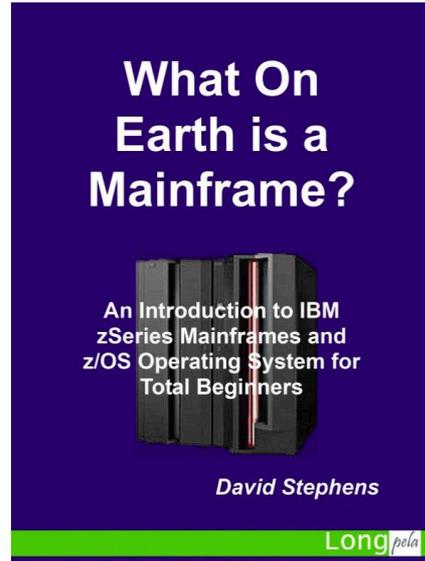
Depends on who you ask.

Traditionally runs z/OS, but increasingly Linux too.

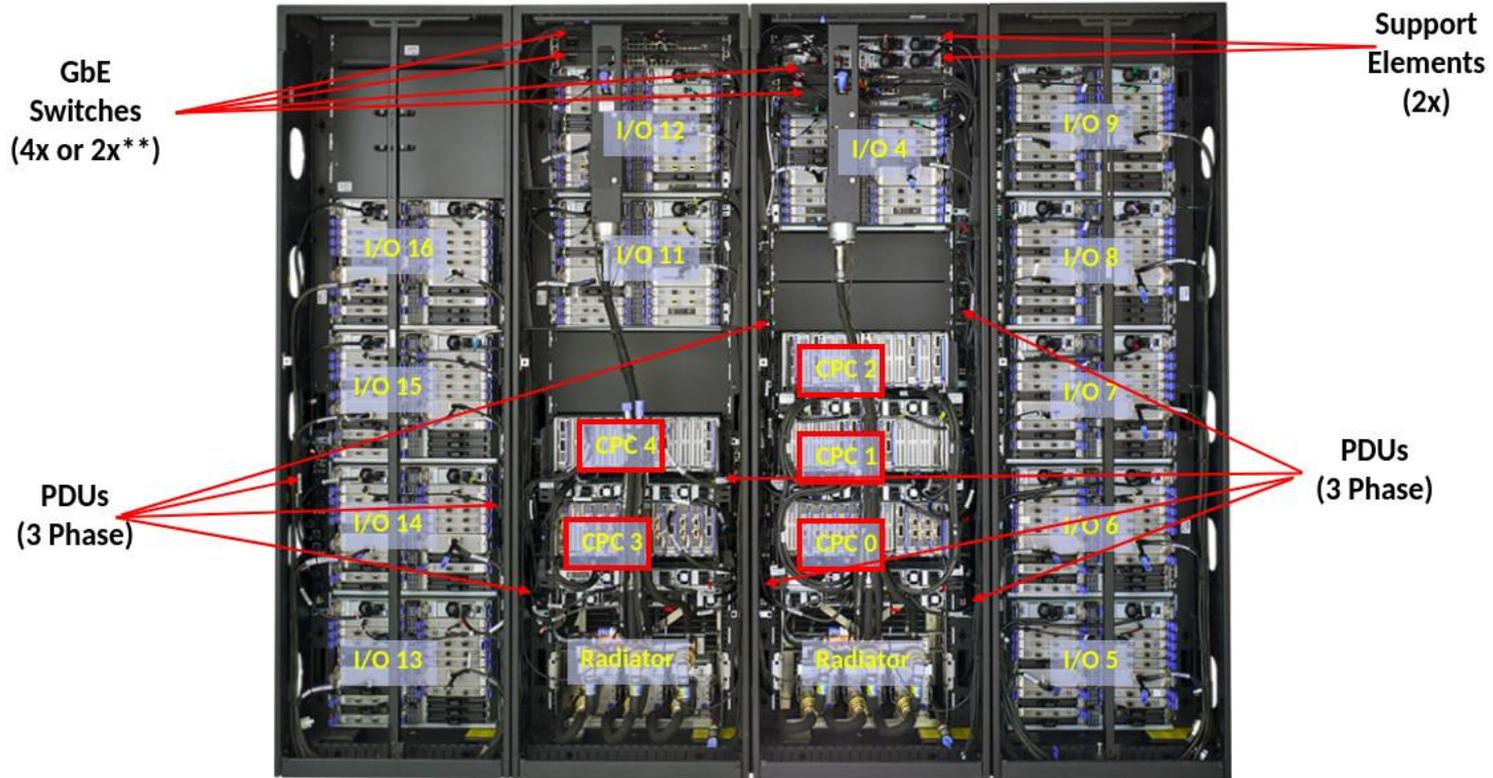
Data, data, data.

Batch processing!

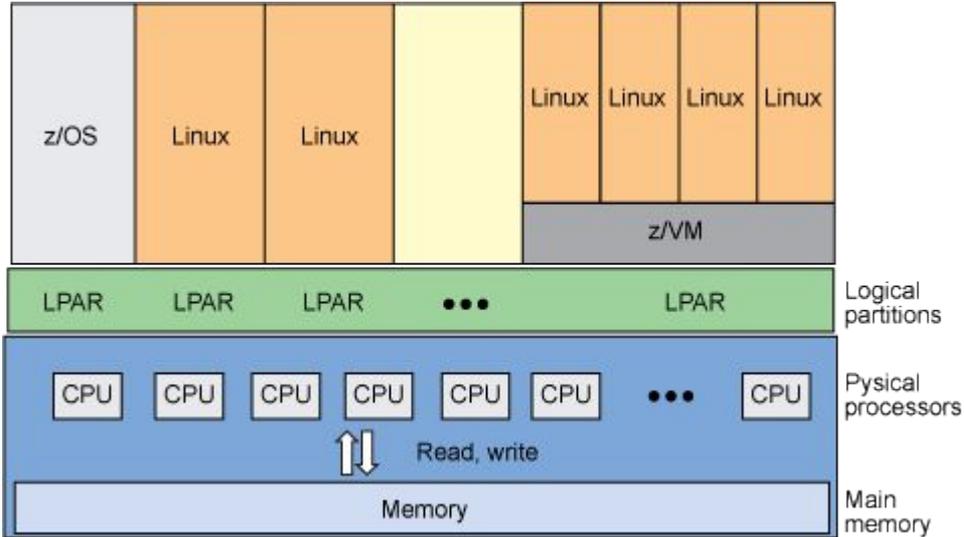
Enterprise-grade hardware
and storage.



What is a mainframe?



How it works with Linux



There is always some kind of virtualization being used for Linux on Z.

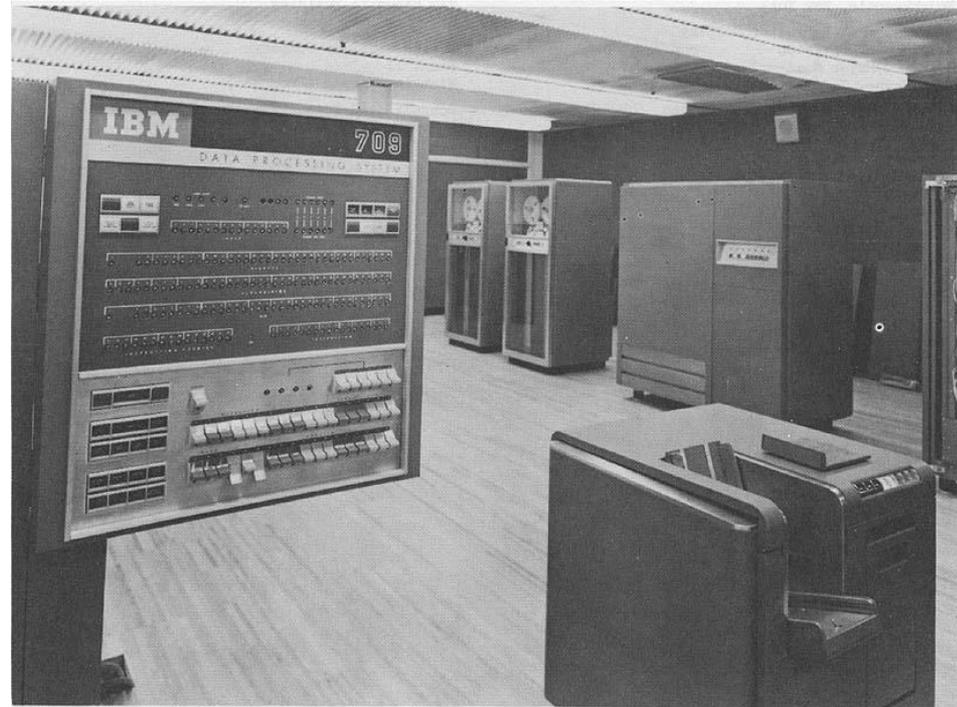
Using z/VM (or KVM!), one or more Linux installs can be put on a single Logical Partition (LPAR).

Using Processor Resource and System Manager (PR/SM) a single Linux instance can be installed on a single LPAR.

Image source: <https://www.ibm.com/developerworks/library/l-systemz/>

Once upon a time
mainframes lacked
time-sharing

Papers discussing time-sharing
were published as early as
1959, but Compatible
Time-Sharing System (CTSS) was
first demoed by MIT on an IBM
709 in 1961.



Several iterations later... VM/370, in 1972



Want to know about all those iterations? Melinda Varian has published a fascinating history, available in several formats, on her website: <http://www.leeandmelindavarian.com/Melinda/>

The Doubtful Decade

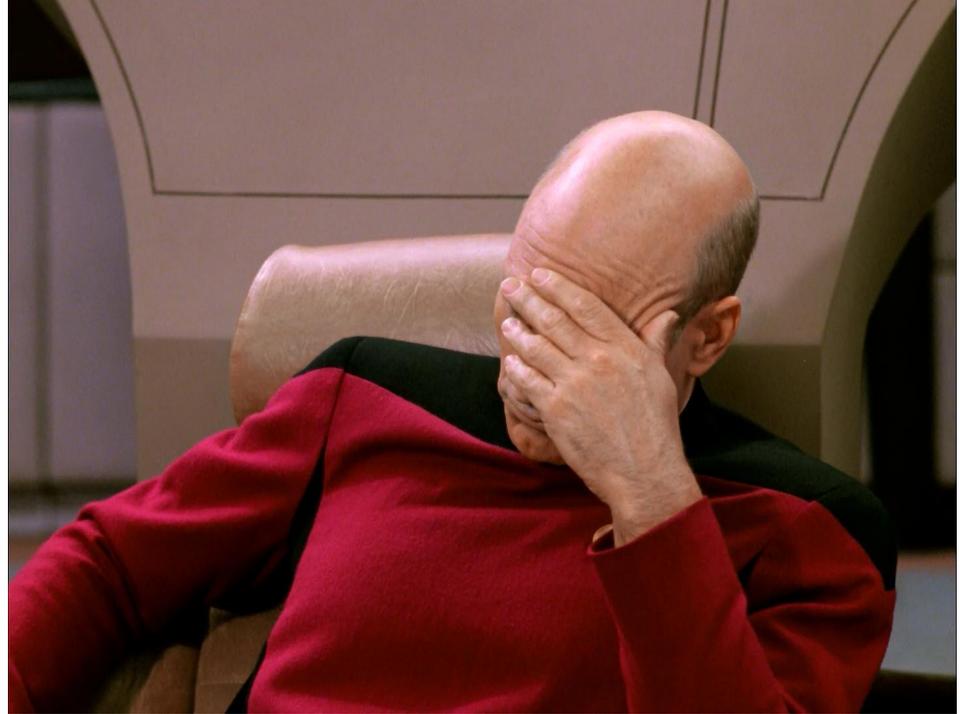
IBM: **“I don’t think anyone needs VMs”**

(paraphrased)

But it got better!

VM community thrived, along with the technology and support from IBM.

In 1994 experimental TCP/IP support was added to VM, adding a key component to supporting Linux 5 years later.



Linux Origins: Bigfoot

Developed by Linus Vepstas in 1998-1999 as a community effort.

“the **Bigfoot (i370)** port was started first, but is currently stagnant for essentially political, social, and market reasons.”

Source: Linus Vepsta's site on Linux on s390

<https://linas.org/linux/i370.html>

Why did the community want it?

“Why? Good question. One we've asked ourselves many times. Why do you do the things you do? If you think about it, you can probably find a hundred rationalizations for what your gut makes you to do. Here's some of ours:

- Stunt
- To Learn
- Because Its There
- Because Its Knarly, Duude!
- I/O
- Address Spaces and Access Lists
- VM
- The Business Model”

Source: <https://linas.org/linux/i370-why.html>

Linux Origins: Linux for S/390

Linux for S/390 began when “IBM published a collection of patches and additions to the Linux 2.2.13 kernel on December 18, 1999, to start today's mainline Linux on Z. Formal product announcements quickly followed in 2000”

Marist File System was the first Linux distro put together out of Marist College in Poughkeepsie, NY. Think Blue Linux by Millenux in Germany was an early distro with Red Hat packages and the IBM kernel for mainframes. Other commercial editions quickly followed.

Source: https://en.wikipedia.org/wiki/Linux_on_z_Systems

Linux for S/390 is the current, actively developed iteration that all the major platforms are part of today.

Including SUSE Enterprise Linux, the first, still supported, commercial distribution

S/390: The Linux Dream Machine

Linux Everywhere: More than a Slogan

Scott Courtney

Wednesday, February 23, 2000 09:19:48 AM

Let's play a word association game, shall we? The first word is "mainframe."

Many Linux enthusiasts were born and bred in an era of PCs that are already fast and even administrators of large-scale servers are reluctant to spend seven figures on Big "mainframe," there's a good chance that some of the words that came to mind were:

ComputerWorld (Denmark): Linux on IBM S/390 mainframe

Oct 12, 1999, 01:52 UTC (19 Talkbacks) (Other stories by [J.O.S. Svendsen](#))

[*Linux Today* reader [Hans Schou](#) writes:]

"Friday 8 october 1999 there was a story in the Danish Computerworld about IBM had ported Linux to the S/390 mainframe.

For some people this would not be amazing, as there was a posting to the Linux Kernel list back in march 1999, where a guy asked about DMA buffers and address space. The posting came from 3dlabs.com and the rumor began that IBM was porting Linux to mainframe.

I called IBM today and they confirmed that the development was going on, but they did



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 Faircom

Linux/390 in the Spotlight at SHARE 94

by Jack J. Woehr

The atmosphere at SHARE 94 in Anaheim, California was nerdy beyond the ability of mere Unix hackers to imagine. Big draws at the conference, held March 5-10, 2000 at the Anaheim Hilton and Marriott, included sessions examining the latest updates to S/390 assembler programs and exhibits of computers the size of walk-in closets. Attendees included over three thousand members and scores of vendors displaying

[About Linux/390](#)

[About System 390](#)

[About Open Edition](#)

Why did IBM want it?



IBM "Heist" commercial, 2001 <https://www.youtube.com/watch?v=uxg17JlyFas>

20 Years of Linux

Networking

Between Linux LPARs, HiperSocket is used for communication between VMs rather than TCP/IP for speed, responsiveness and reliability.

Storage

Linux can connect and interface with to the storage servers, like the DS8880 and DS8888.

Portions of Linux rewritten to take advantage of hardware I/O capabilities reducing load from the Central Processor (CP).

Processors

Linux can run on the traditional mainframe Central Processor (CP), but there's also an Integrated Facility for Linux (IFL) processor with some instructions disabled that are used only by z/OS.

Open Source

There are few barriers to compiling for s390x (though it is big-endian), so new open source software is being compiled for the platform every day.

Validated open source software list:

<https://www.ibm.com/community/z/open-source-software/>

LinuxONE

2015, 2017, 2019



Official Distributions



But also...

- Debian
- Fedora
- Slackware
- CentOS (ClefOS)
- Gentoo

Distributions

Hypervisors

PaaS / IaaS

Languages

Runtimes

Management

Database

Analytics



LPAR



Community Versions

IBM Cloud Private



DPM

SCYLLA



Db2

Some cool things I learned



Elizabeth K. Joseph

@pleia2

First discovery? We live in a world of unreliable x86 hardware that we forgot was unreliable x86 hardware.

10:22 AM - 14 May 2019

<https://twitter.com/pleia2/status/1128349919608066048>



Elizabeth K. Joseph

@pleia2

And Docker has an architecture option under platform.

You can build identical containers across your environment, and when you need to offload to a different environment it's pretty easy to automate.

```
image: webapp:latest
manifests:
  -
    image: webapp-s390x
    platform:
      architecture: s390x
      os: linux
  -
    image: webapp-amd64
    platform:
      architecture: amd64
      os: linux
```

9:33 AM - 28 May 2019

<https://twitter.com/pleia2/status/1133410939523411968>

<https://hub.docker.com/u/s390x/>

Some cool things I learned, cont.



Elizabeth K. Joseph
@pleia2

One of the reasons I hopped on board with this [#LinuxONE](#) adventure was how integrated the tooling was with existing open source solutions.

Want to use the in-processor crypto? It's not an awkward, bolted-on, IBM-only solution. You just configure [#OpenSSL](#) to use it. [#IBMZ](#)

```
locate the OpenSSL distribution in this directory: /etc/pki/tls
Make a backup copy of the configuration file
Example 4-4 Backup copy of the openssl.cnf
[root@tso1nx2 ~]# ls -la /etc/pki/tls/openssl1.cnf
-rw-r--r-- 1 root root 12376 Sep 25 14:25 /etc/pki/tls/openssl1.cnf
[root@tso1nx2 ~]# cp -p /etc/pki/tls/openssl1.cnf /etc/pki/tls/openssl1.cnf.backup
[root@tso1nx2 ~]# ls -al /etc/pki/tls/openssl1.cnf
-rw-r--r-- 1 root root 10923 Sep 25 14:25 /etc/pki/tls/openssl1.cnf
-rw-r--r-- 1 root root 10923 Sep 25 14:26 /etc/pki/tls/openssl1.cnf.backup
Some ibmca related content must be appended to the openssl.cnf file. This code
with the openssl-ibmca package. Therefore, locate the ibmca package (Example
look for a file called openssl1.cnf.sample.s390x.
Example 4-5 Locate the ibmca sample file
[root@tso1nx2 ~]# find / -name openssl1.cnf.sample.s390x -type f
/usr/share/doc/openssl-1.0.0/openssl1.cnf.sample.s390x
[root@tso1nx2 ~]# ls -al
-rw-r--r-- 1 root root 1396 Mar 31 04:35
/usr/share/doc/openssl-1.0.0/openssl1.cnf.sample.s390x
4. Now, append the ibmca-related configuration lines to the OpenSSL configuration
(Example 4-6).
```

8:54 AM - 17 Jun 2019

<https://twitter.com/pleia2/status/1140649031481167872>



Elizabeth K. Joseph
@pleia2

Cloud or on-prem [#mainframe](#)? Turns out you don't strictly have to choose in order to take advantage of hardware-driven cryptographic key handling and encryption.

This week I wrote an article with [@mentorafrika](#) about [#IBMCloud](#) [#HyperProtect](#) Services!



IBM Cloud Hyper Protect Services: Protect your organizatio...

Powered by LinuxONE, IBM Cloud Hyper Protect Services provide a proven, hardware-driven cryptography back end to quickly and efficiently encrypt all of your data.

developer.ibm.com

9:00 AM - 14 Jun 2019

<https://twitter.com/pleia2/status/1139563222187405313>
<https://developer.ibm.com/blogs/hyper-protect-services-protect-your-org-from-internal-and-external-threats/>

So, what does Linux on the mainframe excel at?

- Hardware cryptographic functions, with both a cryptographic co-processor on every processor AND a FIPS 140-2 Level 4 certified Hardware Security Module (HSM), Crypto Express Card for secure key handling.
 - Full virtualization (not paravirtualization) with decades of experience behind it
 - Offloading of I/O to a separate machine (DS8800, DS8880, DS8888...)
 - Redundant... everything. You can even cluster mainframes with Geographically Dispersed Parallel Sysplex (GDPS), which can be used for Linux VMs
 - Hot-swappable hardware, including memory and processors
- Consolidation of resources into one box instead of a fleet of x86 machines, conserving resources used to manage individual servers (non-trivial)



Elizabeth K. Joseph
@pleia2

Specifically I've learned that things like storage and networking are Solved Problems in a mainframe infrastructure. Those are key pieces that go wrong in distributed systems and you end up burning tons of unscheduled time on them. It seems easier, until you get into the details.

9:34 AM - 24 Jun 2019

<https://twitter.com/pleia2/status/1143195614076796928>

Unleash the power to innovate with IBM **LinuxONE**[™] Community Cloud



The IBM LinuxONE Community Cloud provides a no charge, self-provisioned SUSE or Red Hat virtual machine on an IBM LinuxONE Enterprise Server (s390x architecture) to develop, test and run your apps.

<https://developer.ibm.com/linuxone>

