Linux on Mainframes

Past, present and future

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Philadelphia area Linux Users Group

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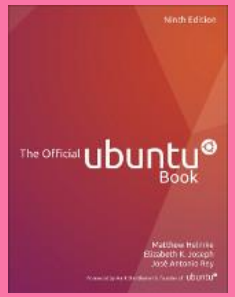
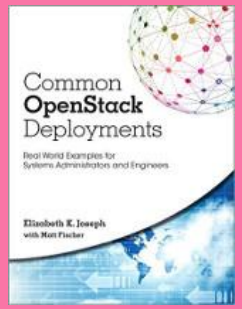
(I talk to techies, I don't know how to sell you a mainframe 🤷‍♀️)

Debian / Ubuntu



OpenStack

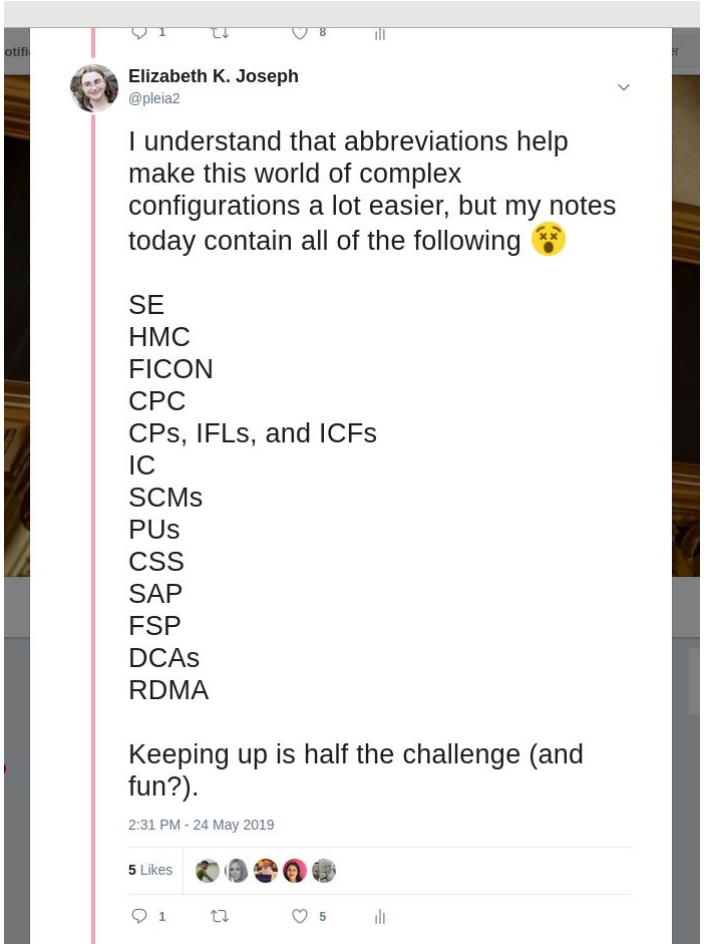


Apache Mesos

Linux on Z

⚠️ !!!Warning!!! ⚠️

Abbreviation Soup Ahead



What is a mainframe?

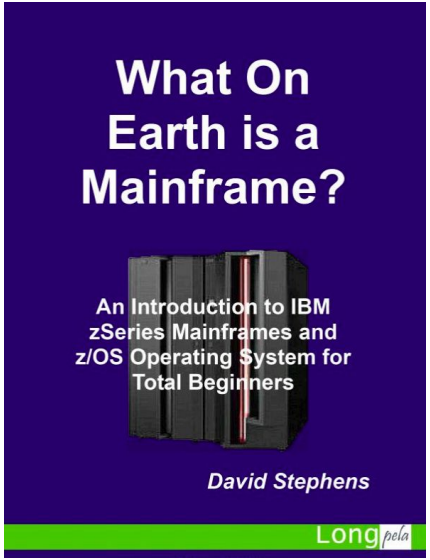
Depends on who you ask.

Traditionally runs z/OS, but increasingly Linux too.

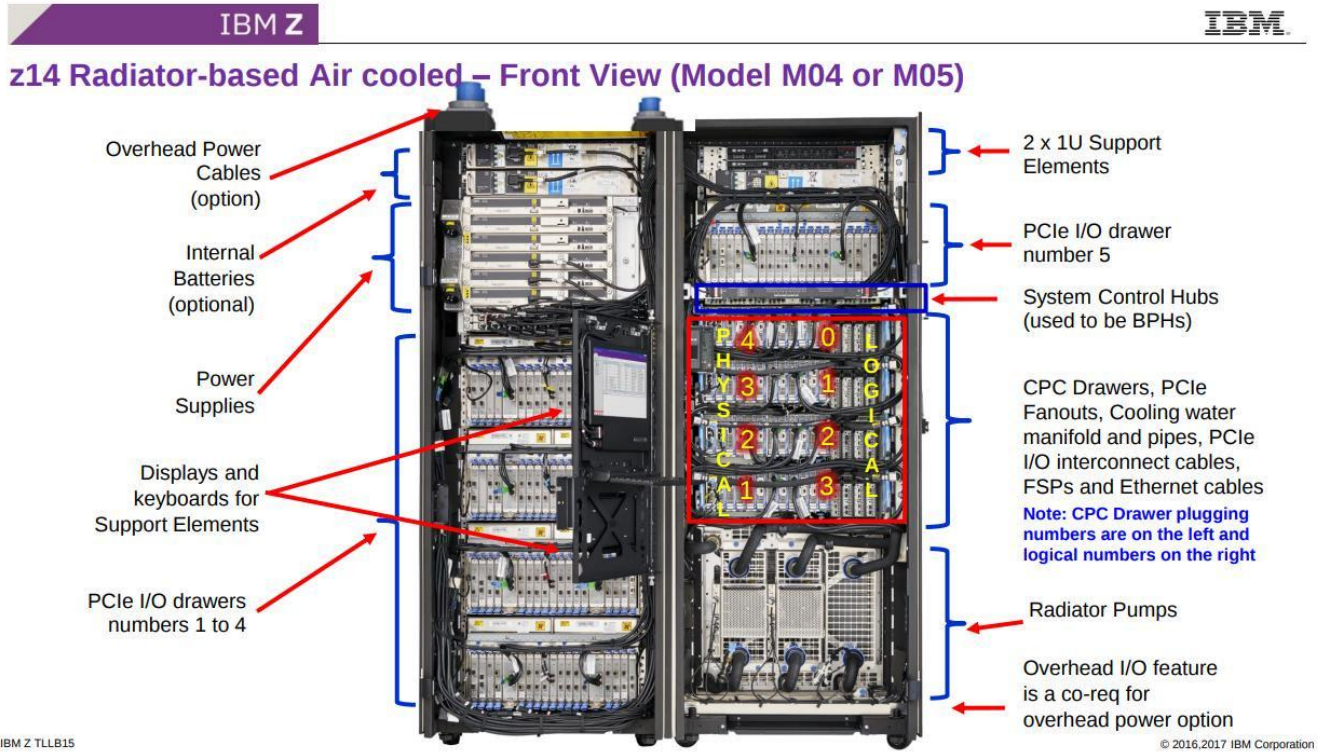
Data, data, data.

Batch processing!

Enterprise-grade hardware and storage.

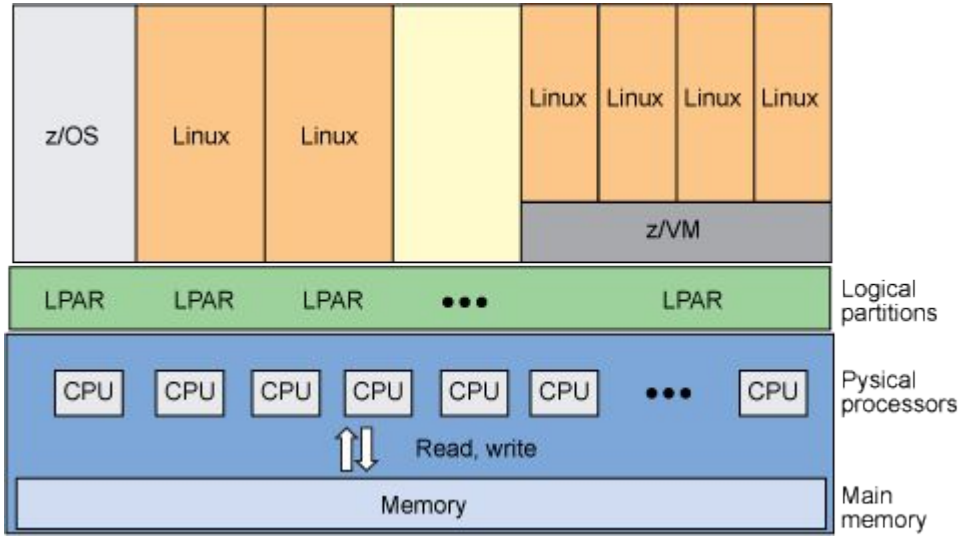


What is a mainframe?



Source:
https://www.ibm.com/developerworks/community/wikis/form/anonymous/api/wiki/33d270cb-c060-40f6-99f3-956c3cb452a3/page/885fd4df-c77d-4bb8-a43b-f4f44100b3ac/attachment/7fd7adad-44dd-43c9-90d7-5c97650da544/media/IBM%20z14%20technology%20Pitch.pdf

How it works with Linux



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

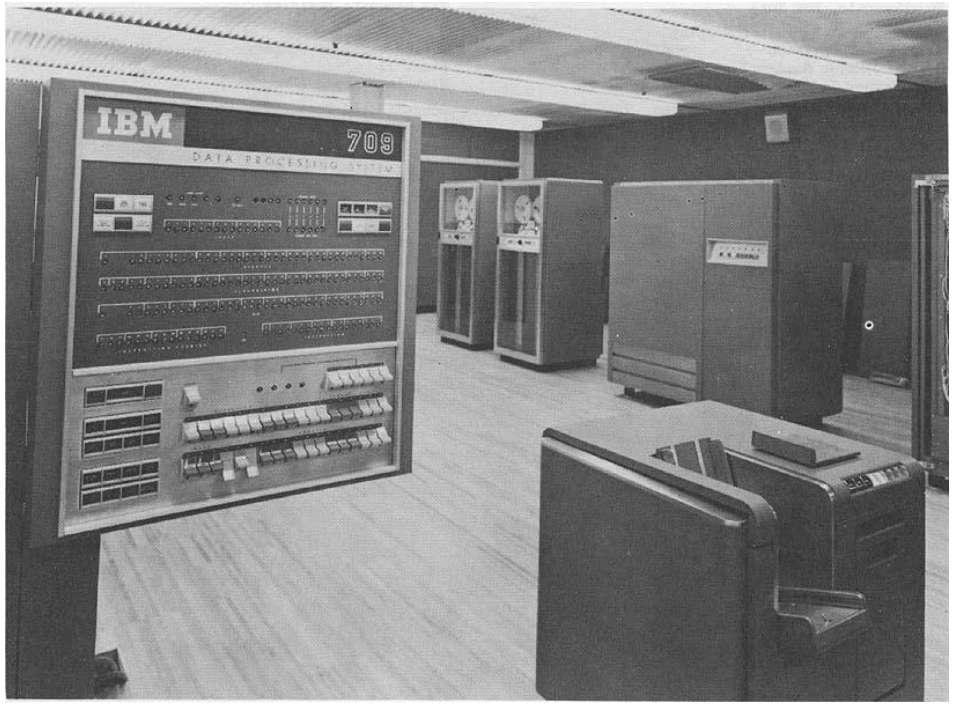
Using z/VM (or KVM!), one or more Linux installs can be put on a single Logical Partition (LPAR).

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.



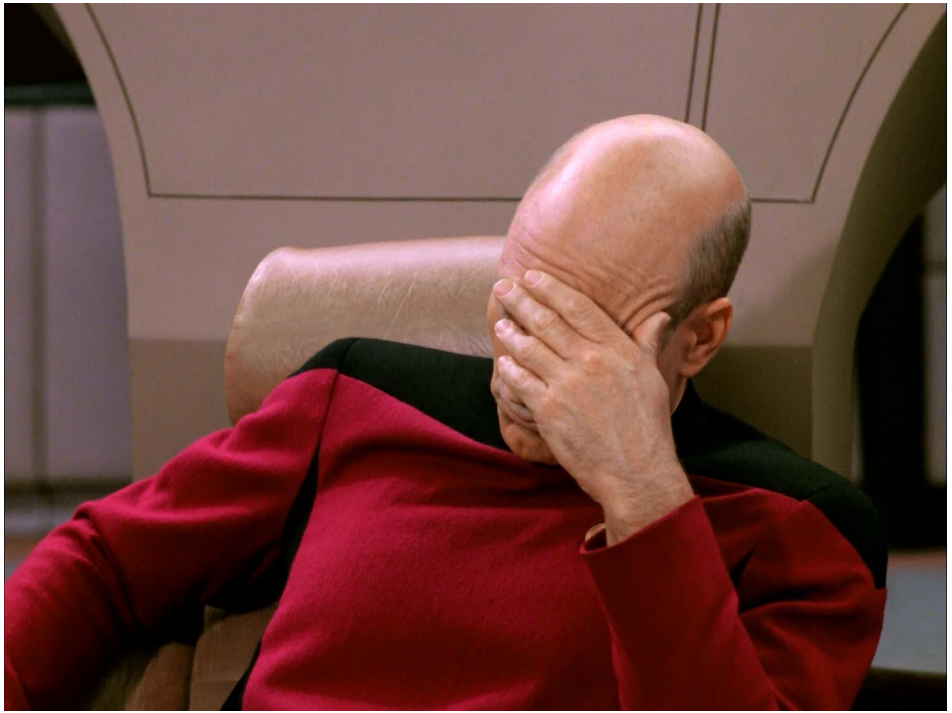
Several iterations later… VM/370, in 1972

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/

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

(paraphrased)

The Doubtful Decade.



But it got better

The Doubtful Decade ended and 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 Linas 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: Linas 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”

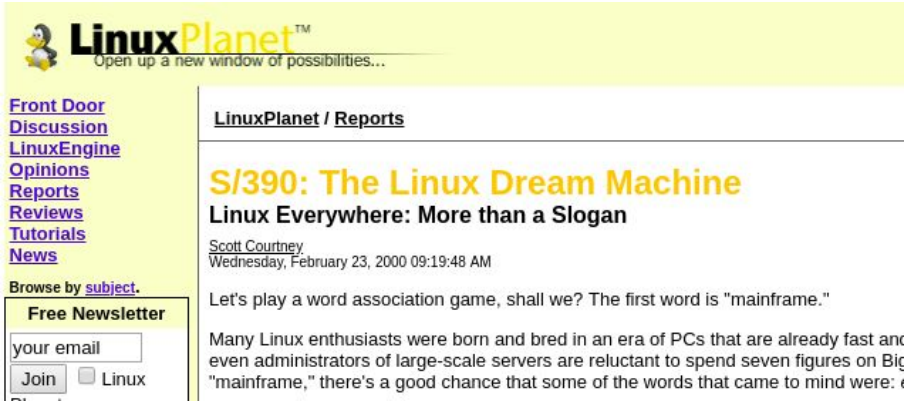
Marist File System was the first Linux distro put together out of Marist College in Poughkeepsie, NY. Think Blue Linux by Millenux in Germany was an early distro with Red Hat packages and the IBM kernel for mainframes. Other commercial editions quickly followed.

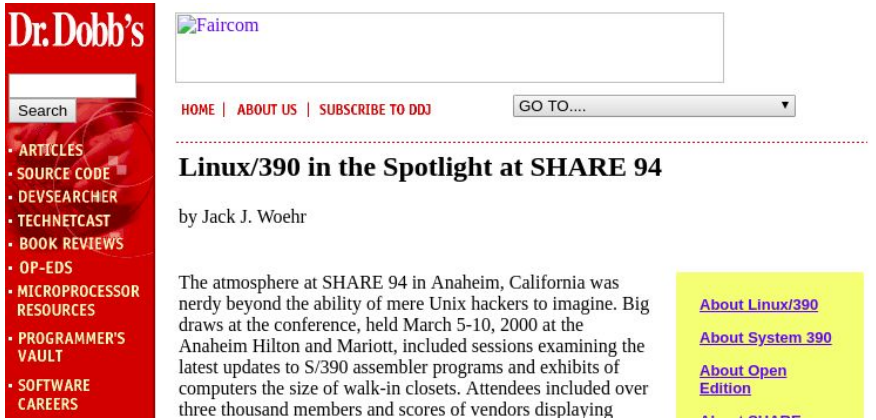
Source: https://en.wikipedia.org/wiki/Linux_on_z_Systems

This is the current, actively developed iteration that all the major platforms are part of today.

Why did IBM want it?

IBM “Heist” commercial, 2001 https://www.youtube.com/watch?v=uxg17JlyFas





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

Sidebar: s390? s390x?

s390 is 31-bit, for older mainframes.

...though sometimes people use it as an inaccurate shorthand for the IBM mainframe architecture

s390x is 64-bit, for modern mainframes (post 2000).

In 2015 with the Linux Kernel 4.1, Linux on Z became only compatible with 64-bit z/Architecture machines, but they are still backwards compatible with 31-bit applications.

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/developerworks/community/forums/html/topic?id=5dee144a-7c64-4bfe-884f-751d6308dbdf

Distributions

(Official)

Red Hat Enterprise Linux

SUSE Enterprise Linux

Ubuntu

Other Distributions

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

LinuxONE: Linux-only Mainframes

LinuxONE

2015, Emperor and Rockhopper (z13 with IFLs)

IBM LinuxONE Emperor™

IBM LinuxONE Rockhopper™

LinuxONE

2018, Emperor II and Rockhopper II (z14 with IFLs)

Meet the LinuxONE family

IBM Emperor II

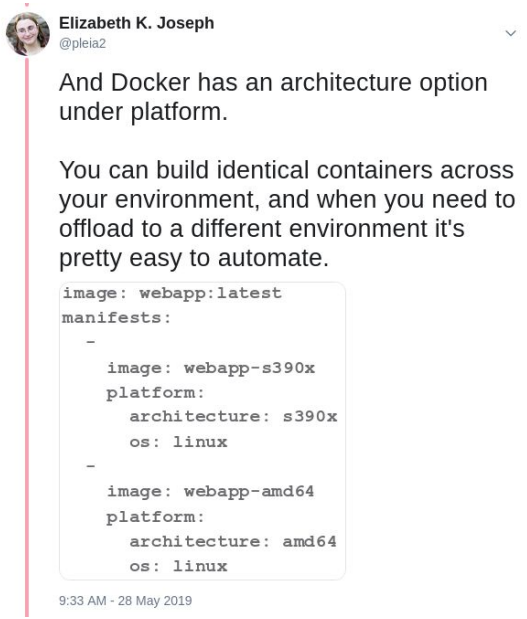
This top-of-the-line Linux system is engineered to help you deliver premium cloud services with pervasive encryption, lightning speed, and massive scalability.

IBM Rockhopper II

The newest Linux server in the LinuxONE family offers many of the Emperor II's capabilities – and is sized to fit any cloud data center, from a startup to an established bank.

Some cool things I learned

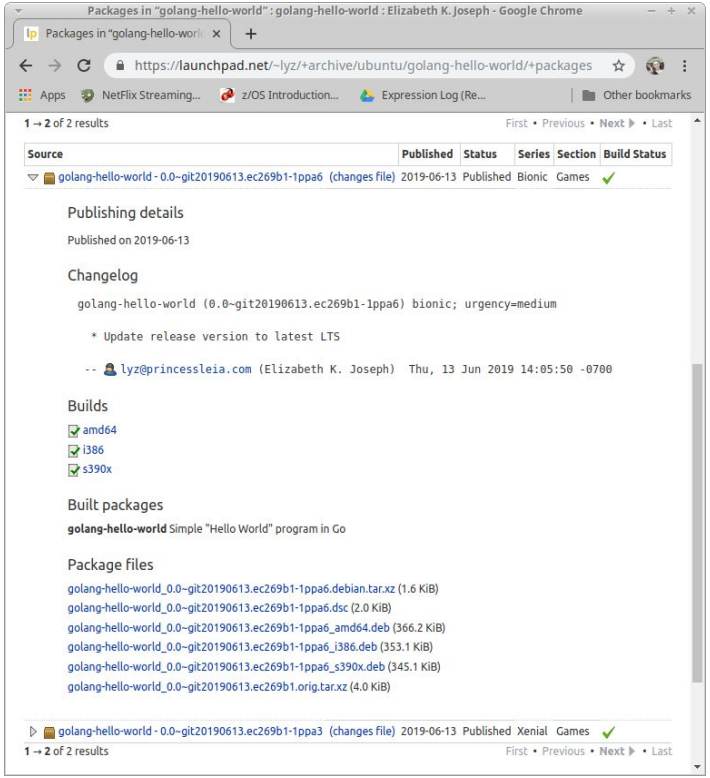
https://twitter.com/pleia2/status/1128349919608066048



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

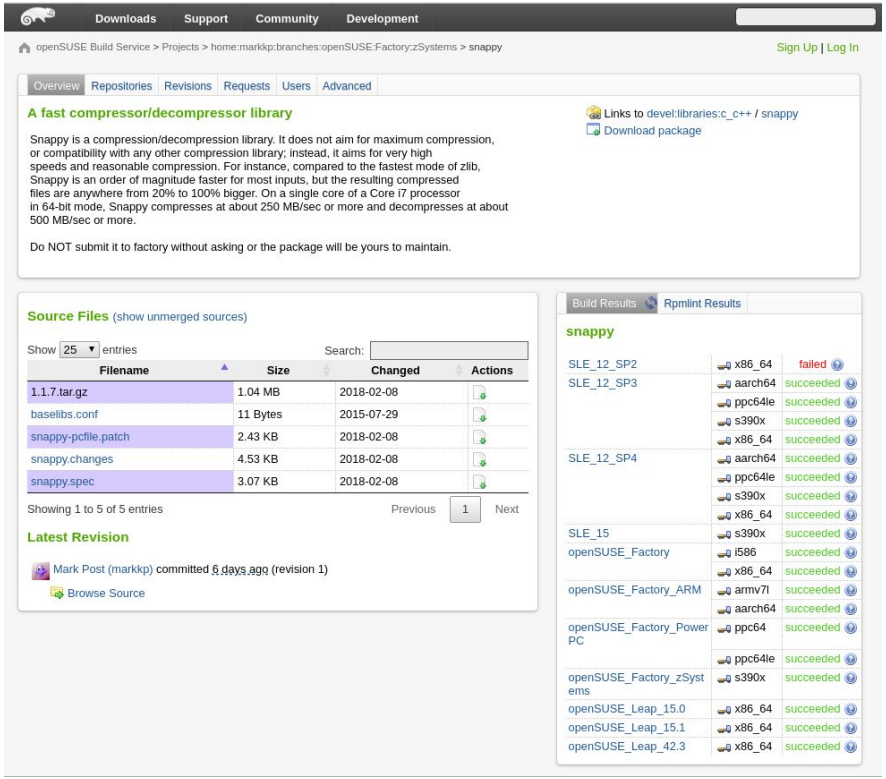
https://hub.docker.com/u/s390x/

Self-Service s390x: Ubuntu PPAs



See: https://princessleia.com/journal/2019/06/building-a-ppa-for-s390x/

Self-Service s390x: openSUSE Build Service



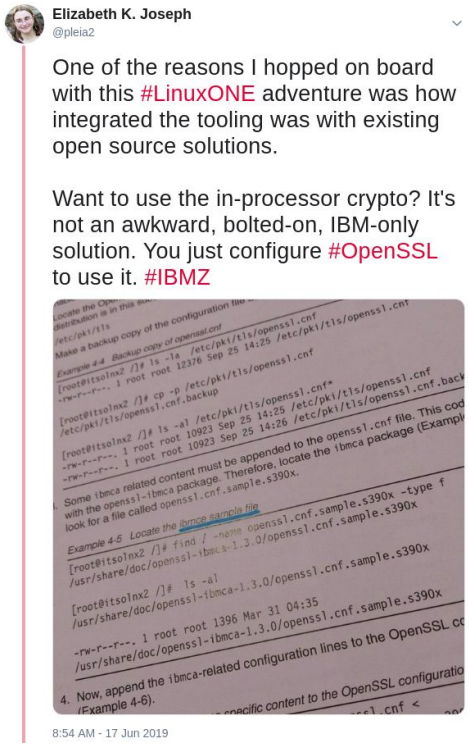
Source: https://build.opensuse.org/

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

Some cool things I learned, cont.



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

https://twitter.com/pleia2/status/1139563222187405313

https://developer.ibm.com/blogs/hyper-protect-services-protect-your-org-from-internal-and-external-threats/

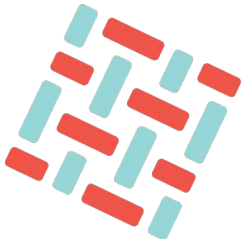
Cryptography in the Cloud, powered by Linux on Z

IBM Cloud Hyper Protect Services: Crypto, DBaaS, Virtual Servers, and Containers (soon)

https://www.ibm.com/cloud/hyper-protect-services

IBM Blockchain Platform

https://www.ibm.com/cloud/blockchain-platform

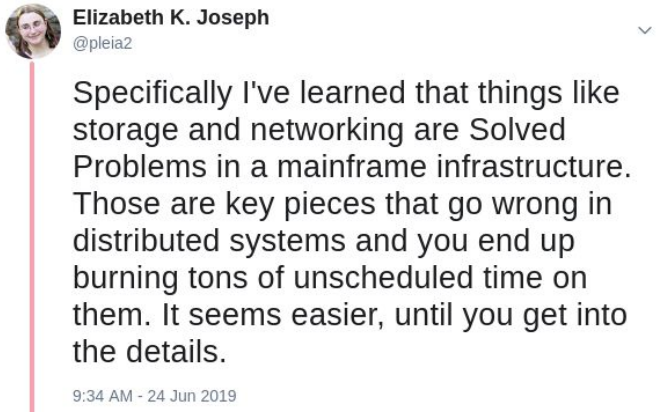


HYPERLEDGER FABRIC

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)



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

The Future!

Energy Savings

Paul Newton: The world can’t take all the x86 machines we’ll need at the rate server farms are growing.

Me: Cost or, like, the planet?

PN: Yes.

We will encrypt more stuff

Need for fewer impactful data breaches (stolen data is useless if it’s encrypted!)

More laws and regulations around access and use of customer data.

In addition to the FIPS 140-2 Level 4 HSM, Linux on Z is Evaluation Assurance Level (EAL) 4+ (the Z mainframes themselves are 5+)

Further Architecture Diversification

We’re now seeing an increase in hardware architectures, not a decrease!

Every year we have more compelling reasons to not solely depend upon x86 (Meltdown, Spectre…)

Thank you.

Elizabeth K. Joseph

Developer Advocate, IBM Z

—

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Resources

Melinda Varian's Home Page (for "VM and the VM Community: Past, Present, and Future" paper):
http://www.leeandmelindavarian.com/Melinda/

Linux on the IBM ESA/390 Mainframe Architecture:
https://linas.org/linux/i370.html

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

Meet the Mainframe with Esmeralda Quintana:
https://www.youtube.com/watch?v=C1YGE7m33iQ

LinuxONE Community Cloud: https://developer.ibm.com/linuxone

Credits

Paul Newton

Jenn Francis

Anna Shugol

Matthew Cousens

Leon Kiriliuk

Jeff Bisti