

Linux in the Cloud, on Prem, or... on a Mainframe?

—



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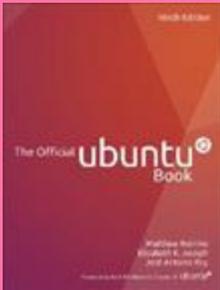
Linux.conf.au

Elizabeth K. Joseph (@pleia2)

Developer Advocate, IBM Z

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

Debian / Ubuntu



OpenStack



Apache Mesos



Linux on Z



But mostly I'm a systems administrator.

Distribute!

Cloud!

OpenStack!

CI/CD!

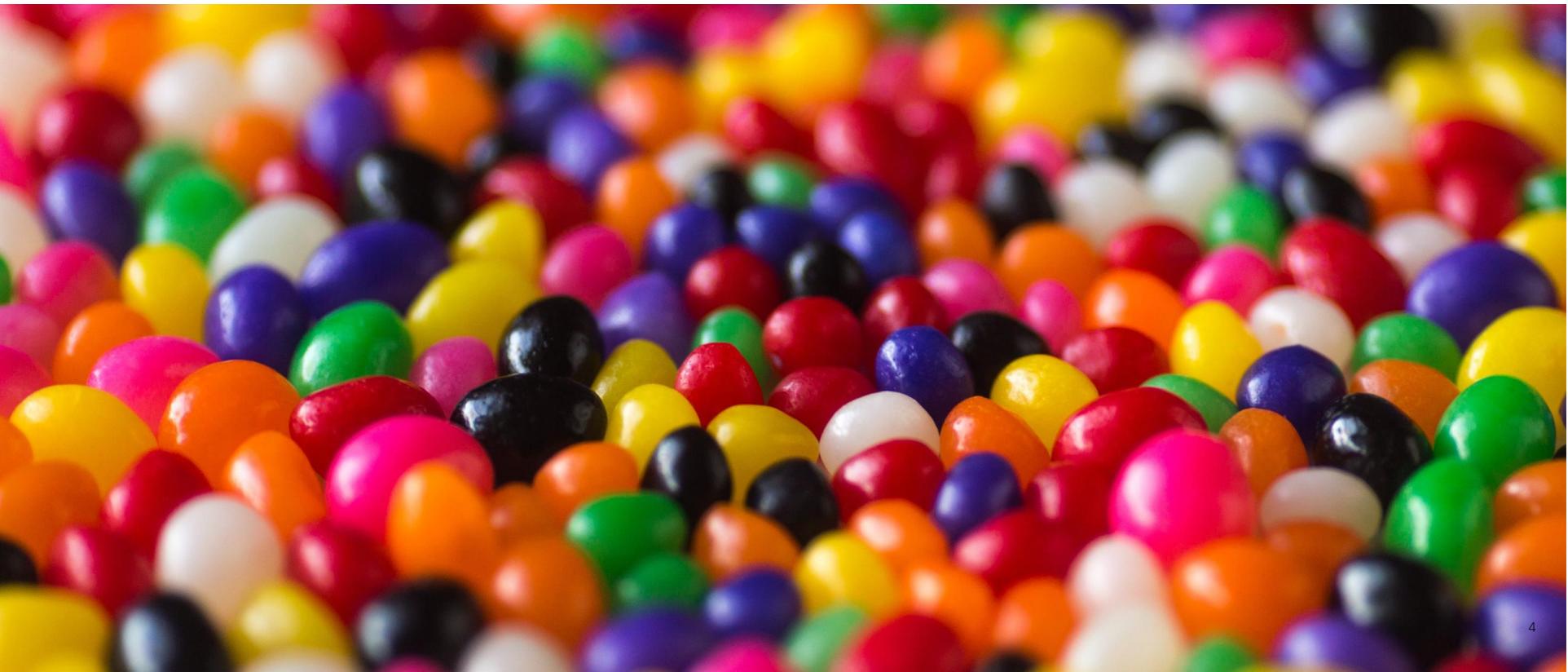
Startups!

Disrupt!

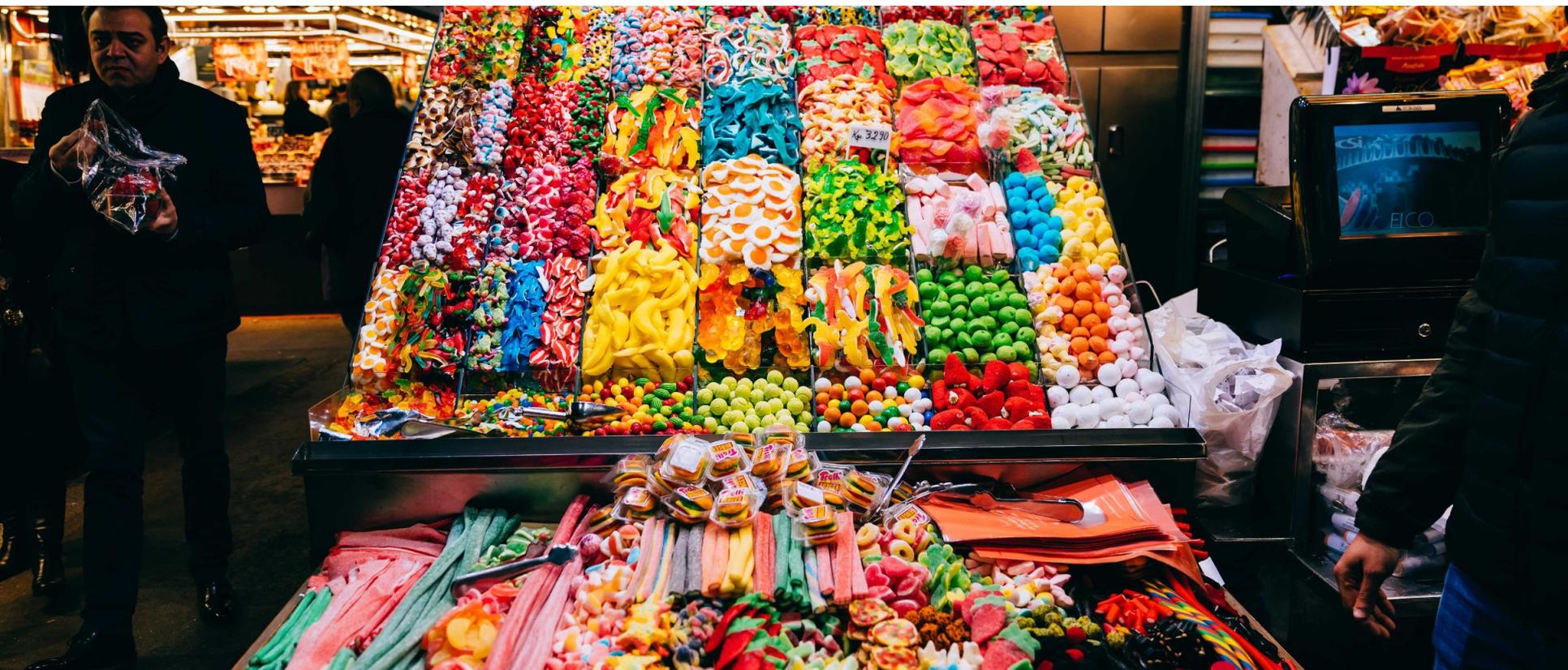
Kubernetes!

So, in the cloud or on premises?

x86 as far as the eye can see.



But there are other things out there! ARM,
Power, RISC-V, IBM Z (s390x... mainframe!)



What is a mainframe?



IBM System 360 (s/360), 1964



IBM z15, 2019

What is a mainframe?

Depends on who you ask.

Traditionally runs z/OS, but increasingly Linux too.

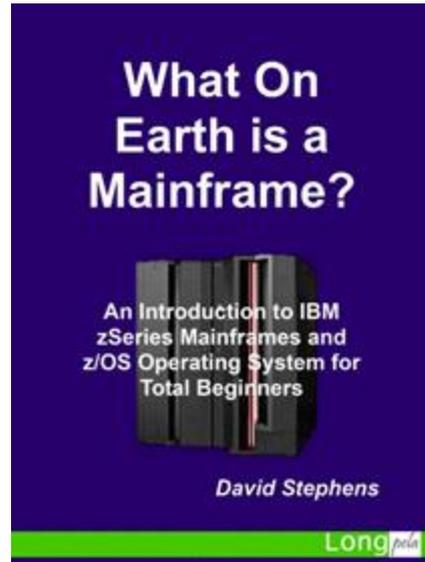
Data, data, data.

Batch processing!

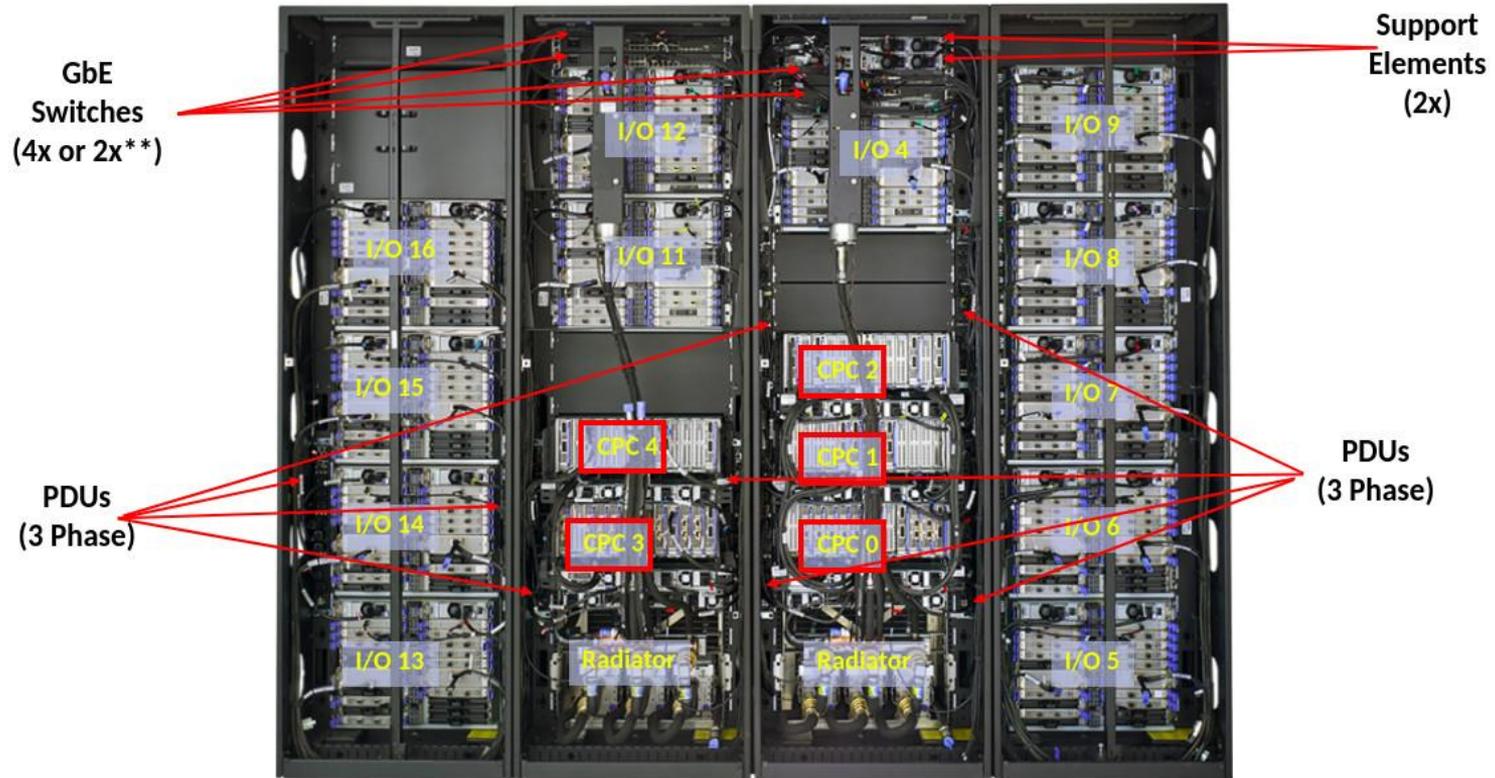
Enterprise-grade hardware
and external storage.

Virtualization? Solved!

Networking? Solved!



What is a mainframe?



What is a mainframe?

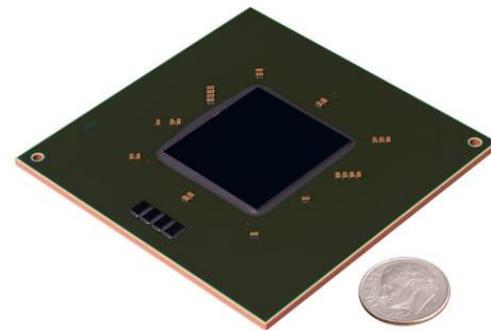
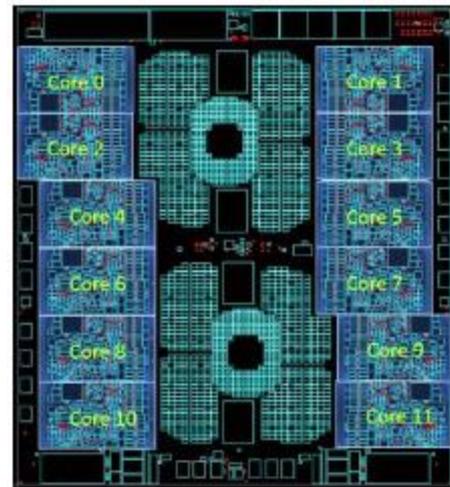
Not x86.

(IBM Z | zArchitecture | s390x)

190 5.2 ghz processor units (PUs), with 12 cores per chip

But also...

- 40TB of RAM
- 60 PCIe control units across 12 PCIe I/O drawers
- 22 dedicated I/O offload processors (SAPs) pre-allocated per system
- <https://developer.ibm.com/blogs/systems-inside-the-new-ibm-z15/>



Storage - DS8900F

The highest end model, the IBM DS8950F Model 996 has nearly 5.9 PB (5,898 TB) maximum physical capacity

But also...



Storwize® V5100/F



Storwize V7000



FlashSystem® 9100



FlashSystem 900



DS8882F



So, what runs on it?

z/OS

z/OS, a widely used mainframe operating system, is designed to offer a stable, secure, and continuously available environment for applications running on the mainframe.

z/VM

As a control program, z/Virtual Machine (z/VM) is a hypervisor because it runs other operating systems in the virtual machines it creates.

z/VSE

z/Virtual Storage Extended (z/VSE) is popular with users of smaller mainframe computers. Some of these customers eventually migrate to z/OS when they grow beyond the capabilities of z/VSE.

z/TPF

The z/Transaction Processing Facility (z/TPF) operating system is a special-purpose system that is used by companies with very high transaction volume, such as credit card companies and airline reservation systems.

Linux for System z

Several (non-IBM) Linux distributions can be used on a mainframe.

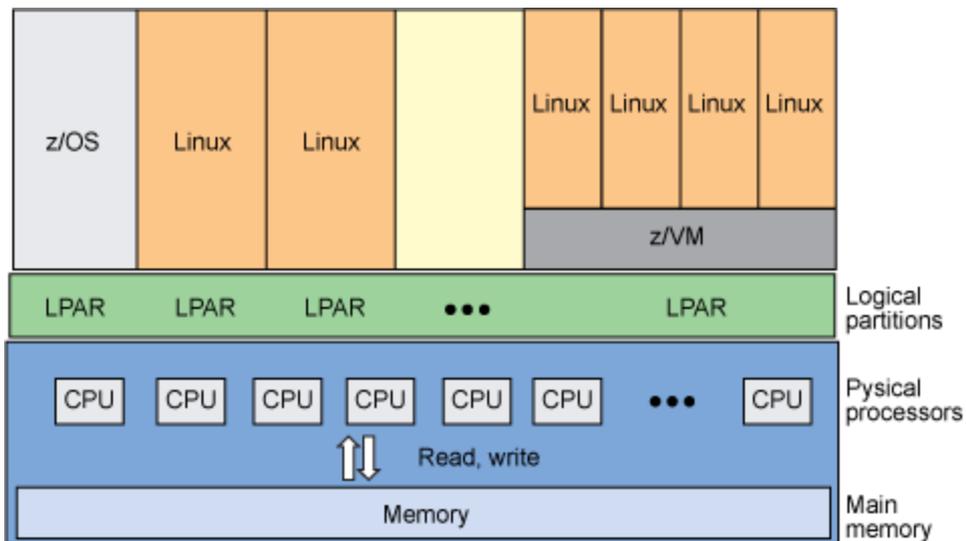
Source:

https://www.ibm.com/support/knowledgecenter/zosbasics/com.ibm.zos.zmainframe/zconc_opsysintro.htm

Modern mainframes run
Linux!

...and they have for 20+ years

How it works with Linux



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

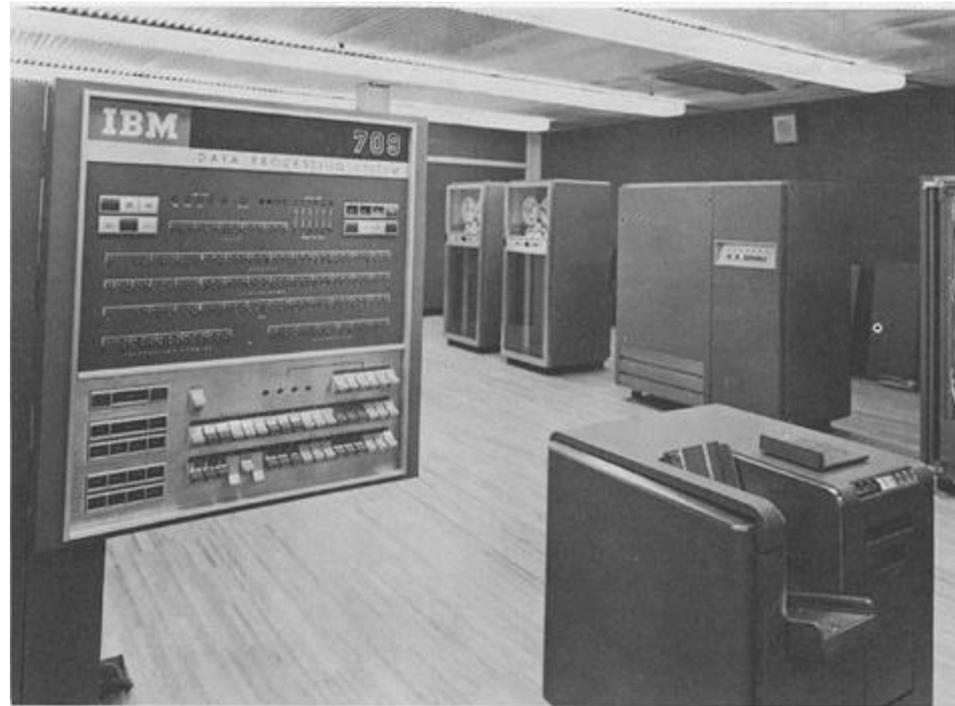
Using z/VM (or KVM!), one or more Linux installs can be put on a single Logical Partition (LPAR).

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

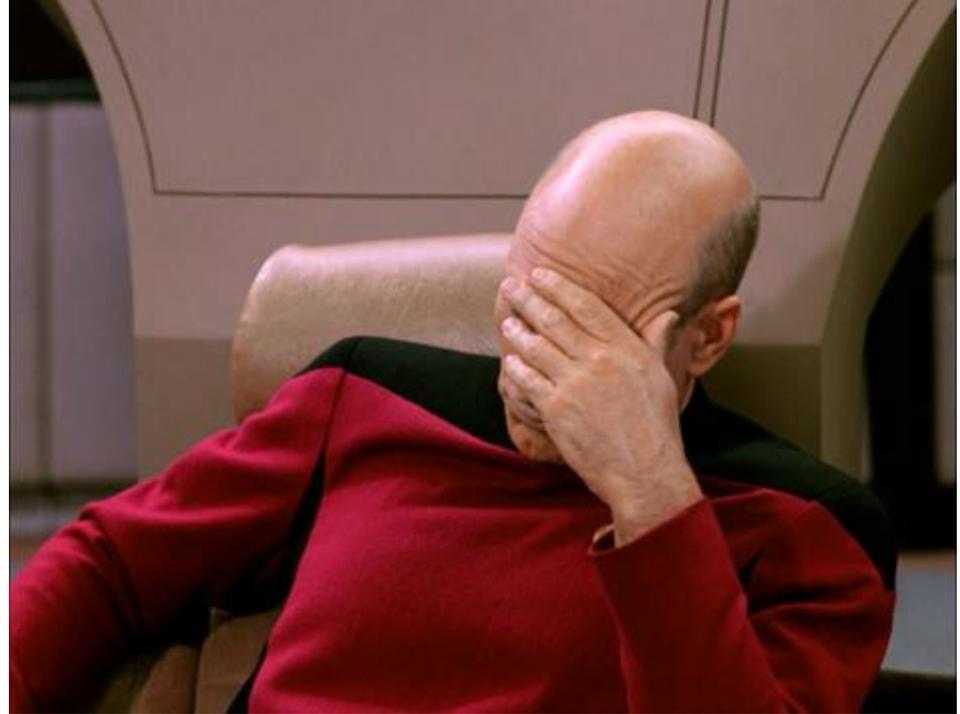


Want to know about all those iterations? Melinda Varian has published a fascinating history, available in several formats, on her website: <http://www.leeandmelindavarian.com/Melinda/>

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 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

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>

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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GO TO.....

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](#)

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 DS8900F.

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

Processors

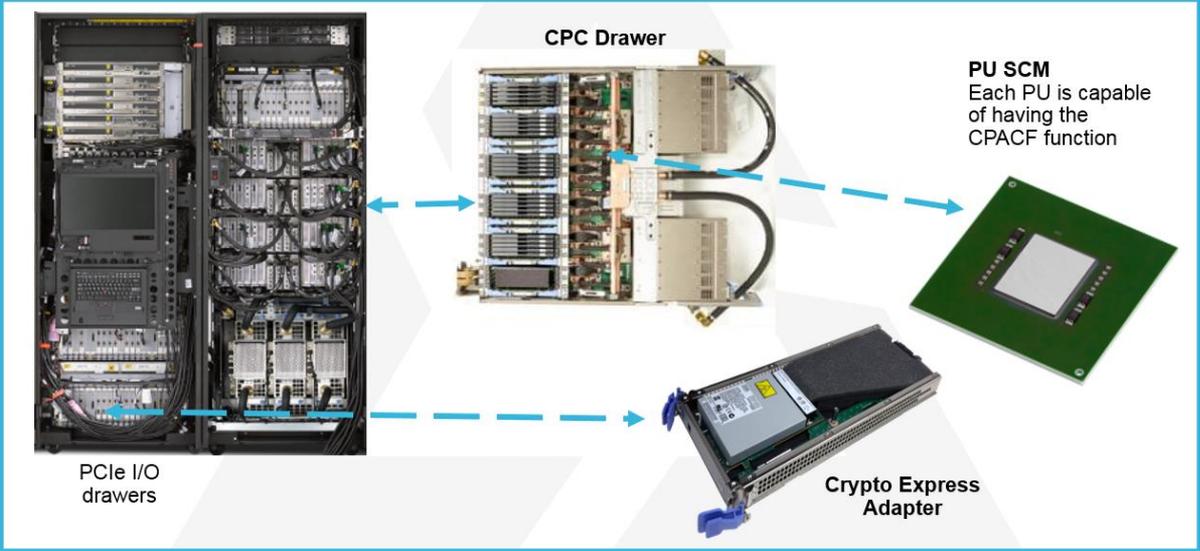
Linux can run on the traditional mainframe Central Processor (CP), but there's also an Integrated Facility for Linux (IFL) processor with some instructions disabled that are used only by z/OS.

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/>

Encryption



LinuxONE

2019, LinuxONE III (z15 with IFLs)



Distributions

Hypervisors

PaaS / IaaS

Languages

Runtimes

Management

Database

Analytics



LPA
R



Community Versions

IBM Cloud Private



LLVM



DPM



SCYLLA



Db2

Your software?

Build it for the
mainframe!

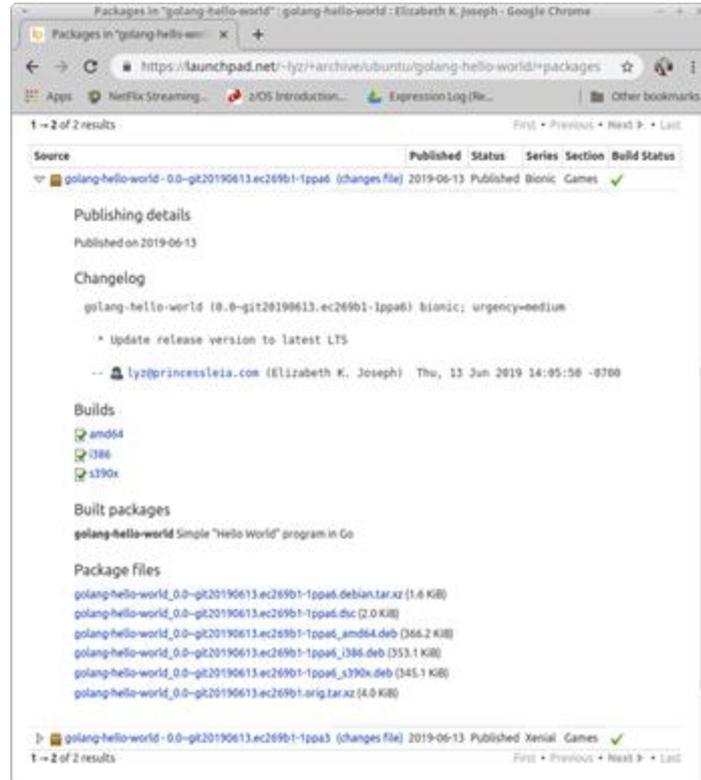
Unleash the power to innovate with IBM **LinuxONE**[™] Community Cloud



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>

Self-Service s390x: Ubuntu PPAs



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

Self-Service s390x: openSUSE Build Service

The screenshot displays the openSUSE Build Service interface for the 'snappy' package. The page is organized into several sections:

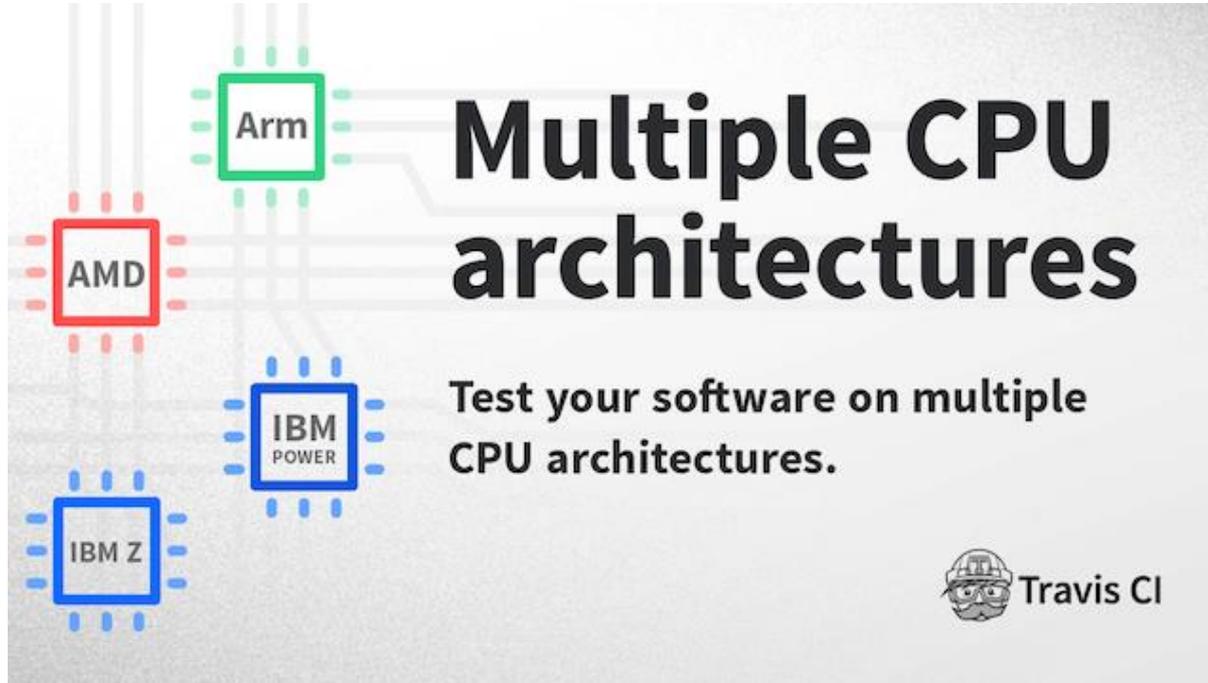
- Navigation:** Downloads, Support, Community, Development.
- Project Path:** openSUSE Build Service > Projects > home:markjp:branches:openSUSE:Factory:zSystems > snappy
- Actions:** Sign Up | Log In
- Overview:** Repositories, Revisions, Requests, Users, Advanced
- Package Description:** A fast compressor/decompressor library. Snappy is a compressor/decompression library. It does not aim for maximum compression, or compatibility with any other compression library; instead, it aims for very high speeds and reasonable compression. For instance, compared to the fastest mode of zlib, Snappy is an order of magnitude faster for most inputs, but the resulting compressed files are anywhere from 20% to 100% bigger. On a single core of a Core i7 processor in 64-bit mode, Snappy compresses at about 250 MB/sec or more and decompresses at about 500 MB/sec or more. Do NOT submit it to factory without asking or the package will be yours to maintain.
- Source Files:** (show unmerged sources) Table with columns: Filename, Size, Changed, Actions.
- Latest Revision:** Mark Post (markjp) committed 8 days ago (revision 1). Browse Source.
- Build Results:** Build Results, Rptmd Results. Summary for 'snappy' showing build status for various architectures.

Filename	Size	Changed	Actions
1.1.7.tar.gz	1.04 MB	2018-02-08	
base64.conf	11 Bytes	2015-07-29	
snappy-pcfile.patch	2.43 KB	2018-02-08	
snappy.changes	4.53 KB	2018-02-08	
snappy.spec	3.07 KB	2018-02-08	

Architecture	Status
SLE_12_SP2	x86_64 failed
SLE_12_SP3	aarch64 succeeded
	ppc64le succeeded
	s390x succeeded
	x86_64 succeeded
SLE_12_SP4	aarch64 succeeded
	ppc64le succeeded
	s390x succeeded
	x86_64 succeeded
SLE_15	s390x succeeded
openSUSE_Factory	i586 succeeded
	x86_64 succeeded
openSUSE_Factory_ARM	armv7l succeeded
	aarch64 succeeded
openSUSE_Factory_PowerPC	ppc64 succeeded
openSUSE_Factory_zSystems	ppc64le succeeded
ems	s390x succeeded
openSUSE_Leap_15.0	x86_64 succeeded
openSUSE_Leap_15.1	x86_64 succeeded
openSUSE_Leap_42.3	x86_64 succeeded

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

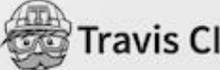
Self-Service s390x: Travis CI



The image is a promotional graphic for Travis CI. It features a light gray background with a grid of faint lines. On the left side, there are four stylized CPU chip icons: a red-bordered square labeled 'AMD', a green-bordered square labeled 'Arm', a blue-bordered square labeled 'IBM POWER', and a blue-bordered square labeled 'IBM Z'. Each icon has small colored dashes around its perimeter representing pins. To the right of these icons, the text 'Multiple CPU architectures' is written in a large, bold, black sans-serif font. Below this, the text 'Test your software on multiple CPU architectures.' is written in a smaller, bold, black sans-serif font. In the bottom right corner, there is the Travis CI logo, which consists of a stylized character wearing a hard hat and safety glasses, followed by the text 'Travis CI'.

Multiple CPU architectures

Test your software on multiple CPU architectures.



See: <https://blog.travis-ci.com/2019-11-12-multi-cpu-architecture-ibm-power-ibm-z>

Cryptography in the Cloud, powered by mainframes

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>



Kubernetes

SUSE

<https://developer.ibm.com/storage/2019/03/01/kubernetes-1-12-on-suse-linux-using-kubeadm/>

Red Hat

<https://www.ibm.com/blogs/systems/get-ready-for-red-hat-openshift-on-ibm-z-and-linuxone/>

Ubuntu

<https://ubuntu-on-big-iron.blogspot.com/2019/08/deploy-cdk-on-ubuntu-s390x.html>

Sine Nomine Associates with OpenShift Origin

<https://www.sinenomine.net/products/linux/OpenShift>

ICU IT Services

"integrating their traditional zOS environments with new (private) cloud environments."

Orchestration across your fleet with the huge Kubernetes tooling ecosystem.

Run the same workloads, with the same tools, on premises and in the cloud.

Integration with traditional z/OS environments, such as running containerized workloads close to their large data environments (DB2 on z/OS or Oracle on Linux on z) to reduce latency.

Working with z/OS



Open Mainframe Project projects:

<https://www.openmainframeproject.org/projects>



Zowe website: <https://www.zowe.org/>

Zowe Overview (November 2018):

<https://www.youtube.com/watch?v=NX20ZMRoTtk>

Zowe Webinar (22 February 2019):

<https://www.youtube.com/watch?v=XixEltbRmds>

Traditional interaction: ISPF

(Interactive System Productivity Facility)

```
Menu Utilities Compilers Options Status Help
-----
ISPF Primary Option Menu
Option ==> 

0 Settings      Terminal and user parameters      User ID . . : Z51005
1 View          Display source data or listings   Time . . . : 14:42
2 Edit          Create or change source data      Terminal . . : 3278
3 Utilities     Perform utility functions         Screen . . . : 1
4 Foreground    Interactive language processing   Language . . : ENGLISH
5 Batch         Submit job for language processing  Appl ID . . : ISR
6 Command       Enter TSO or Workstation commands  TSO logon : DBPROCBG
7 Dialog Test   Perform dialog testing            TSO prefix: Z51005
8 LM Facility   Library administrator functions   System ID : S0W1
9 IBM Products IBM program development products  MVS acct. : FB3
10 SCLM         SW Configuration Library Manager  Release . . : ISPF 7.3
11 Workplace    ISPF Object/Action Workplace

----- Other Functions -----

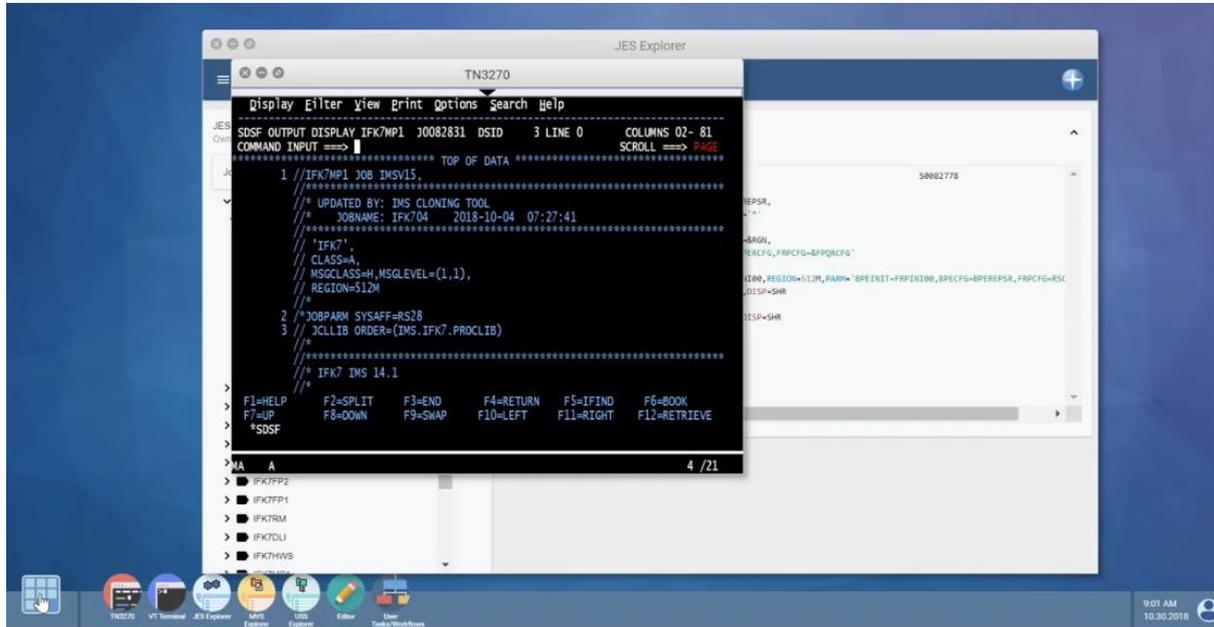
SD SDSF        View output
U  Unix        Unix Shell Prompt
UF Unix Files  Unix Services
D2 DB2I        DB2 Interactive functions
DM DB2ADM     DB2 Administration
F  File Manager File Manager for z/OS
IS ISMF        Disk Storage Management
SM SMP/E       Software Installation and Management
IP IPCS        Debug System Dumps and Traces
HC HCD         System Device Management
FD FM/DB2      File Manager/DB2
FI FM/IMS      File Manager/IMS

Enter X to Terminate using log/list defaults

F1=Help      F2=Split      F3=Exit      F7=Backward  F8=Forward  F9=Swap
F10=Actions  F12=Cancel

TCP00446      004/014
```

Modern interaction: Zowe Web Desktop



- Desktop-like environment, in your web browser
- Includes a 3270 terminal
- Provides GUI-based explorers for files and datasets with ways to manipulate data

Modern interaction: Zowe CLI

Modern command line tool

- Execute zowe commands from standard MacOS/Linux terminal
- Includes core commands for interacting with mainframe-specific needs (TSO, batch processing)
- Extendable for your specific needs, or those of vendors who wish to offer support for their tooling

Can build IDE extensions, a Visual Studio Code extension already exists.

Automation and scripting, including CI/CD pipelines!

Example usage, Using the Zowe CLI to edit a data set:

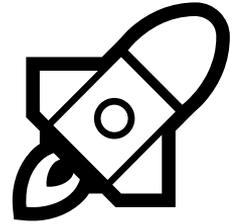
<https://docs.zowe.org/stable/user-guide/zowe-getting-started-tutorial.html#using-the-zowe-cli-to-edit-a-data-set>

Modern interaction: Zowe API

API gateway that can abstract out the various number of services running on the mainframe that you may wish to interact with: job services, dataset services, and more

Open source and vendor products are now leveraging the API for new products that interact with the mainframe

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.

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 one architecture

The title of this talk
is a false dichotomy.

You don't need to
choose.

Questions?

Elizabeth K. Joseph
Developer Advocate, IBM Z

—

Twitter: @pleia2

Email: lyz@ibm.com

