Exploring 20 Years of Linux and Open Source on the Mainframe

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#ossummit  @pleia2
• Debian and Ubuntu
• OpenStack
• Apache Mesos
• ...and now mainframes? Yep!
What is a mainframe?
What is a mainframe?

Data, data, data.
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

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
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.

Once upon a time mainframes lacked time-sharing

Papers discussing time-sharing were published as early as 1959.

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.

This was a big step forward, previously they had been focused on the proprietary IBM Systems Network Architecture (SNA) for connecting servers.
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](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](https://en.wikipedia.org/wiki/Linux_on_z_Systems)
Why did IBM want it?

IBM “Heist” commercial, 2001 [https://www.youtube.com/watch?v=uxg17JyFas](https://www.youtube.com/watch?v=uxg17JyFas)
ComputerWorld (Denmark): Linux on IBM S/390 mainframe
Oct 12, 1999, 01:52 UTC (19 Talkbacks) (Other stories by J.O.S. Svendsen)

"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 3labs.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
### 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 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/](https://www.ibm.com/community/z/open-source-software/)
Encryption

PU SCM
Each PU is capable of having the CPACF function

CPC Drawer

Crypto Express Adapter

PCle I/O drawers
How it's used on Linux

Security for Linux on System Z
http://www.redbooks.ibm.com/abstracts/sg247728.html

- dm-crypt
- OpenSSL and libcrypto (including for ssh, scp, sftp, Apache mod_ssl...)
- IPSec

And the open source libica crypto library for s390x https://github.com/opencryptoki/libica
LinuxONE

2019, LinuxONE III (z15 with IFLs)
Distributions
- Red Hat
- SUSE
- Ubuntu
- KVM
- OpenSUSE
- Fedora
- CentOS

Hypervisors
- LPAR

PaaS / IaaS
- Docker
- Kubernetes
- LXD

Languages
- Python
- Node.js
- Ruby
- PHP
- Go
- Scala
- Clojure
- OCaml
- Java
- Swift
- Lua

Runtimes
- CHEF
- Ansible
- EZT Framework
- SaltStack
- OpenJDK
- LLVM
- Apache Tomcat
- Apache Zookeeper

Management
- Puppet
- Juju
- MySQL
- MongoDB
- Elasticsearch
- Solr
- Sysdig
- Terraform
- PostgreSQL
- MariaDB
- Anaconda

Database
- RethinkDB
- Redis
- Couchbase

Analytics

Community Versions
- Debian
- OpenStack
- OKD
- Mesos
- JS

Hypervisors
- LPAR
- DPM

https://www.ibm.com/community/z/open-source-software/
## Verified Software List

<table>
<thead>
<tr>
<th>Packages</th>
<th>RHEL 8.x</th>
<th>Ubuntu 20.x</th>
<th>SLES 15.x</th>
<th>Dockerfile/Image</th>
<th>RHEL 7.x</th>
<th>Ubuntu 18.x</th>
<th>SLES 12.x</th>
<th>Ubuntu 16.x</th>
<th>New Test</th>
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<tbody>
<tr>
<td>Alfresco</td>
<td>5.x</td>
<td>NA</td>
<td>5.x</td>
<td>5.x image</td>
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<td>5.x</td>
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<tr>
<td>Ansible</td>
<td>Latest</td>
<td>Distro</td>
<td>Latest</td>
<td>Image</td>
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<tr>
<td>Apache ActiveMQ</td>
<td>Latest</td>
<td>Distro</td>
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<td>Download</td>
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</tr>
<tr>
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<td>2.x, 3.x</td>
<td>2.x, 3.x</td>
<td>NA</td>
</tr>
</tbody>
</table>

Docker Hub

**alpine**

- Updated 18 minutes ago
- A minimal Docker image based on Alpine Linux with a complete package index...

**postres**

- Updated 18 minutes ago
- The PostgreSQL object-relational database system provides reliability and data...

**node**

- 10M+ Downloads
- 6.6K Stars
- 10M+ Downloads
- 8.1K Stars
- 10M+ Downloads
- 9.0K Stars
Easy porting: Java and Go

Java has been a staple of mainframe technology for decades now.

Some of the first open source tooling brought to the mainframe was around Java, as Trevor Eddollswrites in a recent blog post:

"If you are working with IMS and like using Java, you can use Spring Boot, Hibernate, JPA, and ORM."

And continues:

"They [IBM] also created a Maven plugin for authoring CICS bundles, which can be used directly in a Java application build toolchain. And they created a Gradle plugin for authoring CICS bundles, which can be used directly in a Java application build toolchain."


Support for s390x was added as experimental in Go 1.7 https://golang.org/doc/go1.7 (2016)

Today, if your application is written in Go, there’s a pretty good chance it’ll compile and run fine on Linux on Z.

The crypto/aes package in Go uses hardware-based encryption: "The AES operations in this package are not implemented using constant-time algorithms. An exception is when running on systems with enabled hardware support for AES that makes these operations constant-time. Examples include amd64 systems using AES-NI extensions and s390x systems using Message-Security-Assist extensions."
Integration Layers

Swagger is being used extensively as we tie traditional z/OS workloads with modern front-ends.

COBOL has native support for XML and JSON, allowing for Enterprise COBOL being run on the mainframe to directly interact with front-ends.

A Linux Foundation Project, the Open Mainframe Project:

"is intended to serve as a focal point for deployment and use of Linux and Open Source in a mainframe computing environment. The Project intends to increase collaboration across the mainframe community and to develop shared tool sets and resources. Furthermore, the Project seeks to involve the participation of academic institutions to assist in teaching and educating the mainframe engineers and developers of tomorrow."

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

Here at the summit, Joe Winchester did a session on “How Open Mainframe Project’s Zowe is Opening up the Mainframe. Who Says You Can’t Teach Old Dogs New Tricks.” keep an eye out for the recording!

Zowe is a new open source software framework that provides solutions that allow development and operations teams to securely, manage, control, script and develop on the Mainframe like any other cloud platform. Zowe is the first open source project based on z/OS.
Traditional interaction: ISPF

(Interactive System Productivity Facility)
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

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


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

Automation and scripting, including CI/CD pipelines!
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
Other Open Mainframe Projects

Ambitus

Ambitus fosters a community that will help educate developers about all open source technologies on z/OS

Anomaly Detection Engine for Linux Logs (ADE)

ADE detects anomalous time slices and messages in Linux logs (either RFC3164 or RFC5424 format) using statistical learning.

Atom language syntax highlighting for z/VM

Helping connect the next generation with mainframe and open source, the internship program has helped students over the past several years become contributors to open source on mainframe, as well as develop the skills for a long career in technology.
Other Open Mainframe Projects

Feilong

Feilong is an open source z/VM cloud connector project under the Open Mainframe Project umbrella that will accelerate the z/VM adoption, extending its ecosystem and its user experience.

Mentorship Program

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Polycephaly

Polycephaly enables developers to build z/OS source code files with Jenkins and Git.
Other Open Mainframe Projects

And more new projects!

- cobol-programming-course
- software-discovery-tool
- omp-education

GitHub Project: https://github.com/openmainframeproject
Your software?

Build it for the mainframe!
Self-Service s390x: Ubuntu PPAs

https://princessleia.com/journal/2019/06/building-a-ppa-for-s390x/
Self-Service s390x: openSUSE Build Service

https://build.opensuse.org/
Self-Service s390x: Travis CI

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
Thank you!

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