20 Years of Linux on the Mainframe

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

"Um..."

“They run Linux!”

Elizabeth K. Joseph
lyz@ibm.com
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.

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 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 Millenix in Germany was an early distro with Red Hat packages and the IBM kernel for mainframes. Other commercial editions quickly followed.

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

Source: [https://en.wikipedia.org/wiki/Linux_on_z_Systems](https://en.wikipedia.org/wiki/Linux_on_z_Systems)
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 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..."
Why did IBM want it?

IBM “Heist” commercial, 2001 [https://www.youtube.com/watch?v=uxg17JlyFas](https://www.youtube.com/watch?v=uxg17JlyFas)
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
Some cool things I learned

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

https://hub.docker.com/u/s390x/
Some cool things I learned, cont.

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

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!

https://twitter.com/pleia2/status/1140649031481167872
https://twitter.com/pleia2/status/1139563222187405313
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