Overview and Update

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IBM LinuxONE

The cloud you want, with the privacy and security you need

Agenda

The business challenges

Introducing IBM LinuxONE

How LinuxONE helps

Use cases

Next steps

of the **9 Billion**
records breached since 2013,
only 4% were encrypted

your data is at risk

external data protection
is not enough

customers are quick to switch
when services, including
response time and uptime,
don't meet their expectations

downtime costs
brand image, loyalty, and
revenue

the **always on** culture
means customers expect
24x365 service
(or as close as possible)

45% more security incidents due to unauthorized access

average cost of **downtime**
is an estimated
$1-5M/hour

Highest levels of security & privacy

Highly engineered for data & cloud serving

foundation for next-generation apps and data

IBM LinuxONE Generation III portfolio – differ in performance and scale

IBM LinuxONE III Model LT2
Mono-frame

A LinuxONE for everyone

”Right-sized” to fit your needs

Designed for highly secure data and cloud serving

Engineered for performance and scale

Foundation for data serving and next generation applications

IBM LinuxONE III Model LT1
Multi-Frame

Built on decades of proven and trusted IBM technology

Built for cloud with standardization and simplicity

Lower total cost of ownership than x86

Right-sized for your business needs

The IBM LinuxONE Generation III (LinuxONE III) portfolio

LT2 Mono-Frame	LT1 Single-Frame	LT1 Dual-Frame	LT1 Triple-Frame	LT1 Quad-Frame
				
1 – 2 Processor drawers 1 - 4 I/O drawers	1–3 Process drawers 1 – 3 I/O drawers	1 – 5 Processor drawers 1 - 8 I/O drawers	1 – 5 Processor drawers 1 – 12 I/O drawers	1 – 5 Processor drawers 1 – 12 I/O drawers
1 - 65 cores @ 4.5 GHz	1 – 108 cores @ 5.2 GHz	1 - 190 cores @ 5.2 GHz		
64 GB – 16 TB memory	512 GB – 24 TB	512 GB – 40 TB		
Up to 40 logical partitions	Up to 85 logical partitions (LPARs, classified as “hard partitions” for software licensing purposes)			
Up to 8 TB/LPAR	Up to 16 TB/LPARs			
Up to 40 secure enclaves	Up to 85 Hyper Protect Virtual Server secure hosting appliance enclaves			
Up to 2,880 TEE guests	Up to 72 KVM guests per Trusted Execution Environment (TEE) LPAR x up to 85 LPARs = up to 6,120 TEE guests per LT1			
iPDU	Choice of either Intelligent Power Distribution Unit (iPDU) or Bulk Power Assembly (BPA)			
Air-cooled	Liquid-cooled, choice of radiator or customer-supplied water source			
Up to 16 slots for SSDs	Up to 16 IBM Adapter for NVMe carrier cards, each of which can house 1 solid state drive (SSD)			
8U Reserved Space	No option for reserving rack space for storage			

* The max number of drawer will vary based on the configuration

IBM Hyper Protect Virtual Servers on-premises

A secure virtualization platform that protects your critical Linux® applications throughout the DevSecOps lifecycle

Build applications with integrity
Leverage the secure build process to sign images, validate code, and integrate into your CI/CD pipeline

Deploy workloads with trust
Validate the provenance of your applications before deployment

Manage applications with simplicity
Manage your infrastructure without visibility to sensitive code or data – RESTful API deployment

Encrypt & Sign critical solution components
Give your images access to the industry leading FIPS 140-2 level 4 Hardware Security Module for signing and encryption needs

Where it matters

A Secure Infrastructure Foundation

IBM Hyper Protect Virtual Servers serves as both a solution for external clients to securely build Docker based applications on IBM Z and LinuxONE and a foundational component of other IBM solutions

Hyper Protect Digital Assets Platform

Enables custodians, exchanges, & Distributed Ledger Technology i.e. DLT ecosystem partners to protect tokenized assets and validate participants for transactions

Data Privacy Passports

Provides a secure host environment to deploy the Passport Controller used for policy enforcement and data transformation in Data Privacy Passports

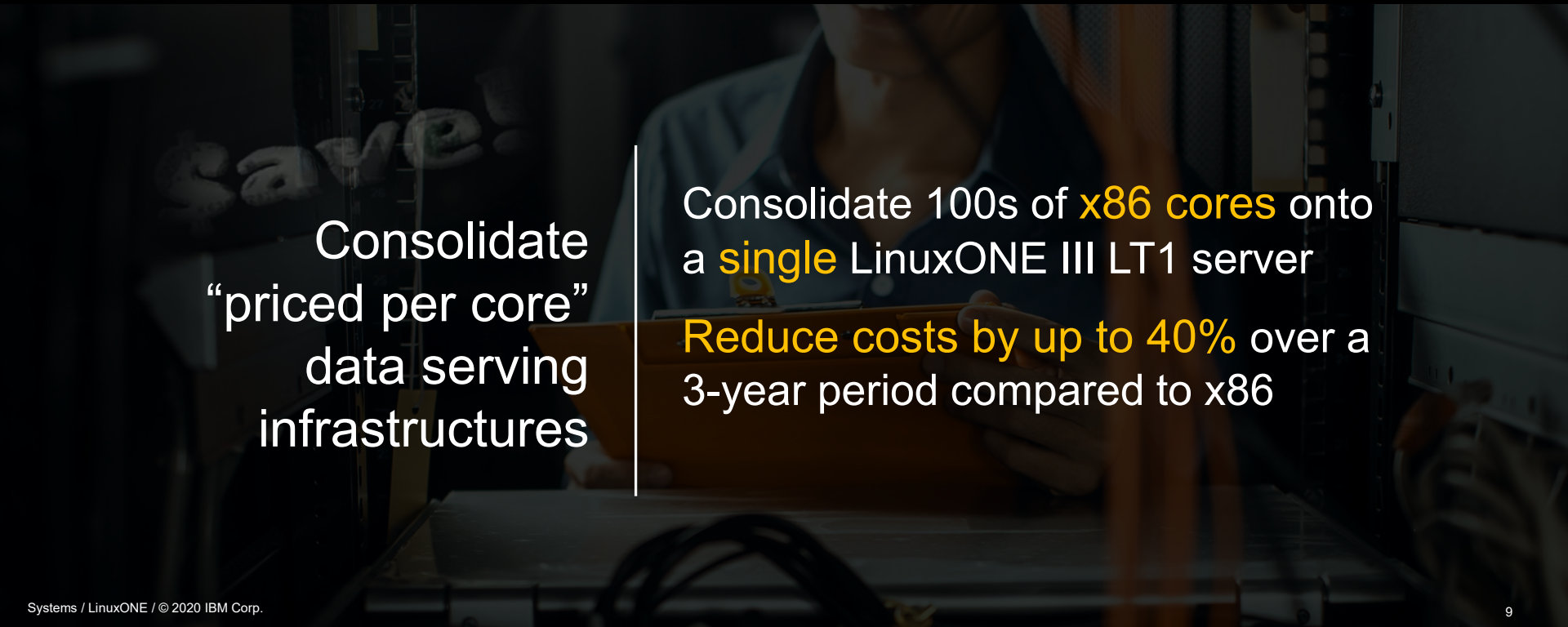
Reduce Regulatory Compliance Scope

Host sensitive workloads that require a high degree of isolation and data protection to meet security & compliance needs for your organization, industry, or geography

Secure the application build pipeline

Automate security into the software application build pipeline – from the start

Unrivaled economics through engineering

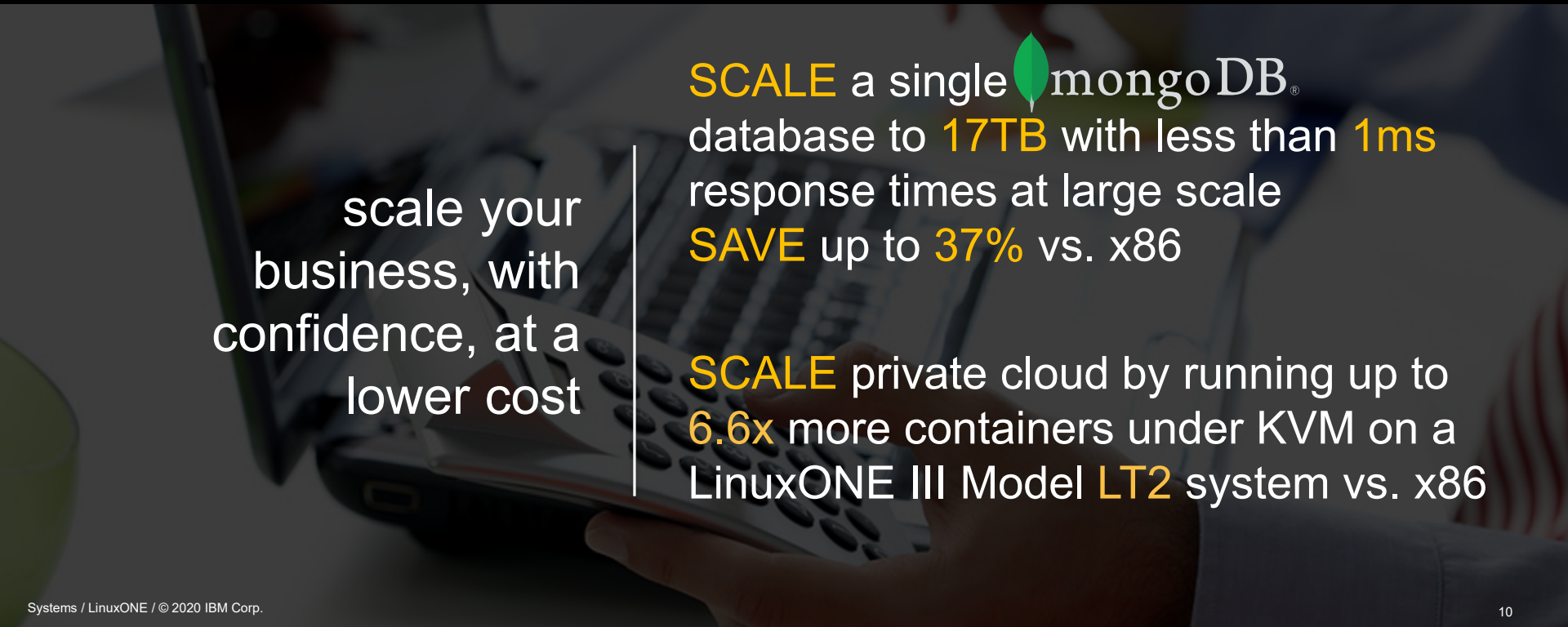


Consolidate "priced per core" data serving infrastructures

Consolidate 100s of x86 cores onto a single LinuxONE III LT1 server

Reduce costs by up to 40% over a 3-year period compared to x86

Performance, scale, and simplicity for lower operational costs



scale your business, with confidence, at a lower cost

SCALE a single MongoDB® database to 17TB with less than 1ms response times at large scale
SAVE up to 37% vs. x86

SCALE private cloud by running up to 6.6x more containers under KVM on a LinuxONE III Model LT2 system vs. x86

Linux on Z Distributions

Linux Distributions & Hardware Certification

	z15	z14 (all models)	z13	z13s	zEnterprise – zEC12, zBC12	zEnterprise – z196, z114	System z10, System z9
	LinuxONE III	Emperor II Rockhopper II	Emperor	Rockhopper			
RHEL 8	●	●	●	●			
RHEL 7	●	●	●	●	●	●	
RHEL 6	●	●	●	●	●	●	●
RHEL 5			●		●	●	●
SLES 15	●	●	●	●	●		
SLES 12	●	●	●	●	●	●	
SLES 11		●	●	●	●	●	●
Ubuntu 20.04	●	●	●	●			
Ubuntu 18.04	●	●	●	●	●		
Ubuntu 16.04	●	●	●	●	●		

Last update 07/08/2020

See www.ibm.com/systems/z/os/linux/resources/testedplatforms.html for latest updates and details, including ***certified Linux distributions by machine***.

Linux on IBM Z Distributions: SUSE

- SUSE Linux Enterprise Server 15
  - 07/2018 SLES 15 GA: Kernel 4.12, GCC 7.1 / 7.3
  - 07/2020 SLES 15 SP2: Kernel 5.3. GCC 7.5 / 9.3
    - EOS 31 July 2028; LTSS: 31 July 2031

- SUSE Linux Enterprise Server 12
  - 10/2014 SLES 12 GA: Kernel 3.12, GCC 4.8
  - 12/2019 SLES 12 SP5: Kernel 4.12, GCC 4.8
    - EOS 31 Oct. 2024; LTSS: 31 Oct. 2027
- SUSE Linux Enterprise Server 11
  - 03/2009 SLES 11 GA: Kernel 2.6.27, GCC 4.3.3
  - 07/2015 SLES 11 SP4: Kernel 3.0, GCC 4.3.4
    - ~~EOS 31 Mar. 2019~~; LTSS: 31 Mar. 2022
- For further details on SLES lifecycles, see https:/ www.suse.com/en-en/lifecycle/

Linux on IBM Z Distributions: Red Hat

- Red Hat Enterprise Linux 8
  - 05/2019 RHEL 8 GA: Kernel 4.18, GCC 8.2.1
  - 11/2020 RHEL 8.3
  - EOS: May 2029; ELS: tbd

- Red Hat Enterprise Linux 7
  - 06/2014 RHEL 7 GA: Kernel 3.10, GCC 4.8
  - 09/2020 RHEL 7.9
  - EOS 30 Jun. 2024; ELS: tbd

- Red Hat Enterprise Linux 6
  - 11/2010 RHEL 6 GA: Kernel 2.6.32, GCC 4.4.0
  - 06/2018 RHEL 6.10
  - ~~EOS 30 Nov. 2020~~; ELS: 30 June 2024

- For further details on RHEL lifecycles, see https:/ access.redhat.com/support/policy/updates/errata

Linux on IBM Z Distributions: Canonical

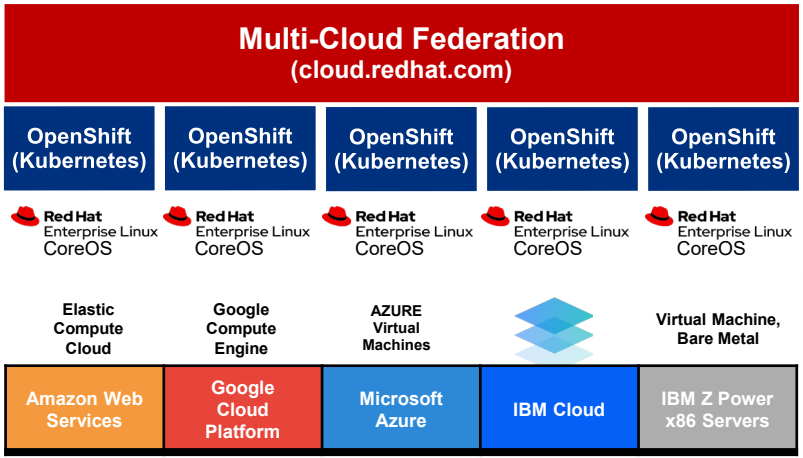
- Ubuntu 20.04 (Focal Fossa)
  - 04/2020 GA: Kernel 5.4, GCC 9.3.0, LTS-Release
  - 08/2020 Ubuntu 20.04.1:
  - EOS: April 2025; ESM: Apr 2030
- Ubuntu 20.10 (Groovy Gorilla)
  - 10/2020 GA: Kernel 5.9, GCC 10.2.0
  - EOS: July 2021

- Ubuntu 18.04 (Bionic Beaver)
  - 04/2018 GA: Kernel 4.15, GCC 7.2.0, LTS-Release
  - 08/2019 Ubuntu 18.04.3
    Kernel 4.15/4.18 GCC 7.2.0
  - EOS: April 2023; ESM: Apr 2028
- Ubuntu 16.04 (Xenial Xerus)
  - 04/2016 GA: Kernel 4.4, GCC 5.3.0+, LTS-Release
  - 02/2019 Ubuntu 16.04.06 LTS
  - EOS: April 2021; ESM: Apr 2024
- Lifecycle
  - Regular releases every 6 months and supported for 9 months
  - LTS releases every 2 years and supported for 5 years
  - LTS enablement stack will provide newer kernels within LTS releases
  - http:/ www.ubuntu.com/info/release-end-of-life

OpenShift 4.6 available on LinuxONE same day as on x86

Red Hat® OpenShift®

Multi-Cluster, Full Stack, Autonomous, Secure



Cloud.redhat.com

- Install new clusters
- View capacity

OpenShift (Kubernetes)

- Full-stack auto-install (Master & Nodes)
- Zero-downtime full-stack updates
- Full-stack configuration of Kubernetes and CoreOS
- Auto-scale cluster nodes

Red Hat Enterprise Linux (RHEL) CoreOS

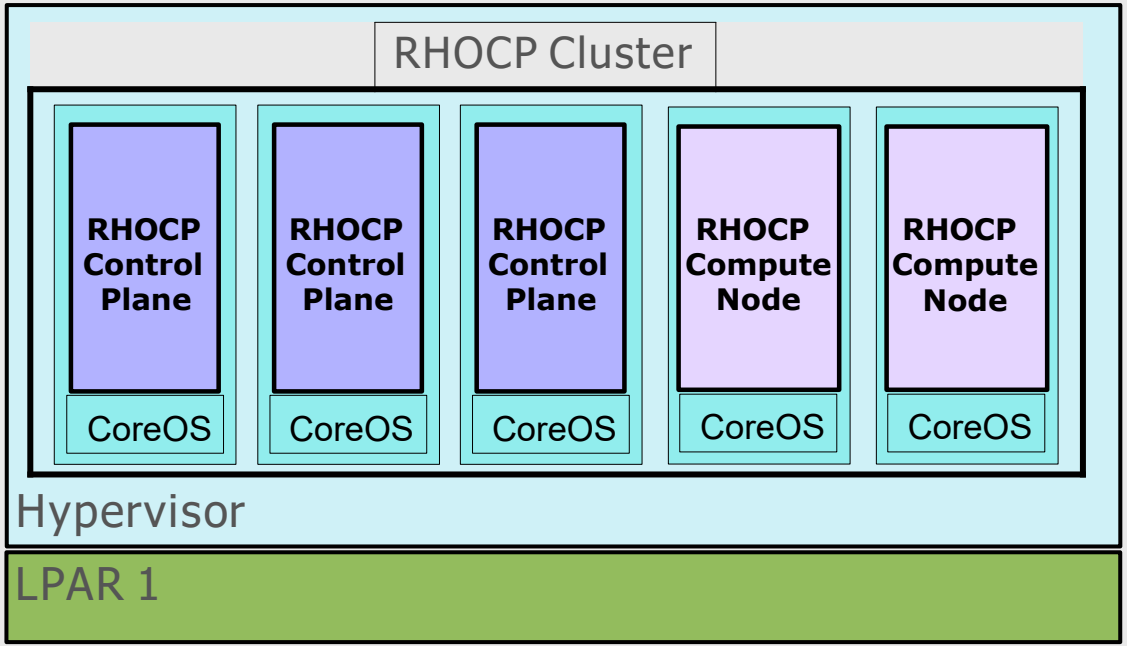
- Secure, immutable container operating system
- RHEL 8 kernel and core libraries
- Autonomous updates & config

Bare Metal, Virtual Machine, IBM Z and Power plus x86, Public Cloud

Red Hat OpenShift Container Platform

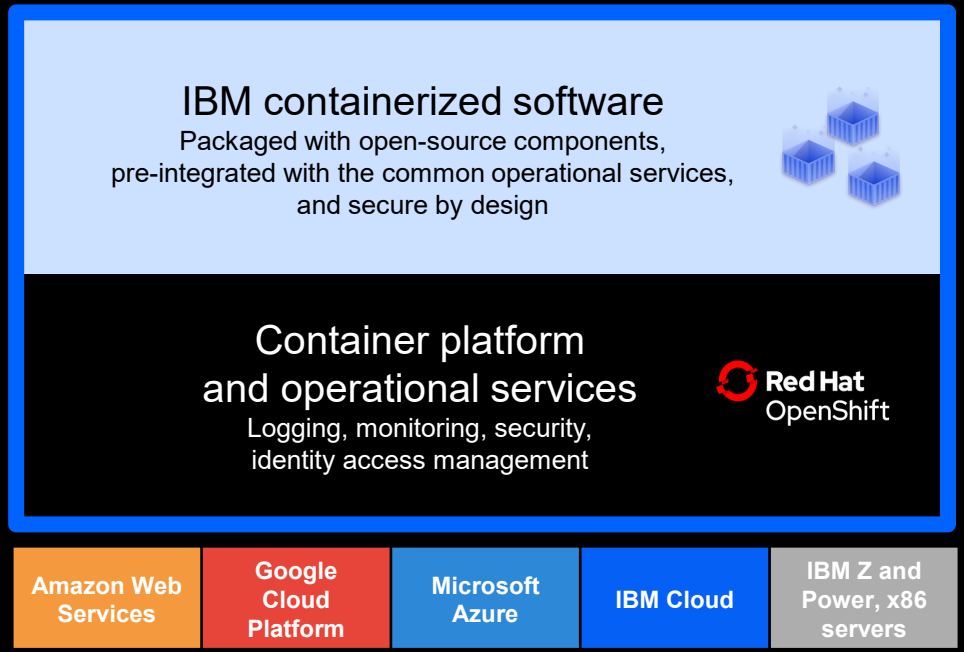
OCP 4.6 Release

- In lockstep with other platforms
- Minimum configuration:
  - z/VM hypervisor
  - OCP cluster nodes run in z/VM guests
- LPAR/KVM support subject to future releases
- Try for yourself:
  - https://try.openshift.com/
  - https://docs.openshift.com/container-platform/4.6/installing/installing_ibm_z/installing-ibm-z.html



IBM Cloud Pak solutions – Enterprise-ready cloud software

A faster, more secure way to move your core business applications to any cloud through enterprise-ready containerized software solutions



Complete, yet simple
Application, data and AI services
Fully modular and easy to consume

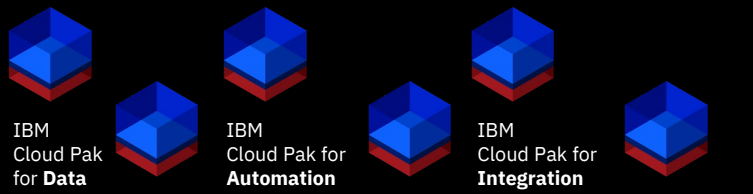
IBM certified
Full software stack support, and ongoing security, compliance and version compatibility

Run anywhere – on-premises, on private and public clouds, and in pre-integrated systems

IBM Cloud Paks 2021

IBM delivers hybrid cloud software that **predict, secure,** and **automate** their businesses. They are packaged as **Cloud Paks** that include: Containerized software, foundational services and Red Hat OpenShift.

2020



Embedded inside each Cloud Pak:

- Containerized software
- Foundational services
- Red Hat OpenShift

2021

Predict

IBM Cloud Pak for **Data**

Secure

IBM Cloud Pak for **Security**

Automate

Automation platform

IBM Cloud Pak for **Business Automation**

IBM Cloud Pak for **Watson AIOps**

IBM Cloud Pak for **Integration**

IBM Cloud Pak for **Network Automation**

WebSphere Hybrid Edition

Modernize

Embedded inside each Cloud Pak:

- Containerized software
- Foundational services
- Red Hat OpenShift

Latest Linux on Z Features & Packages

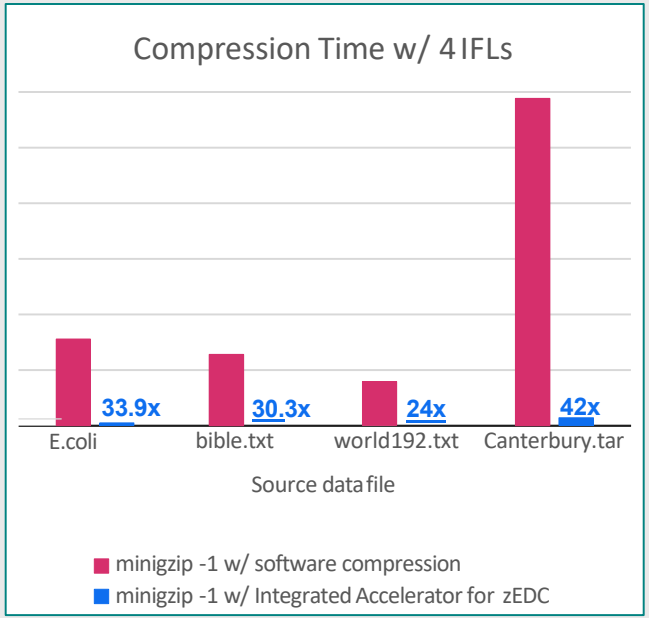
IBM z15 Support: New Vector Instructions

- Reported with new feature flags in `/proc/cpuinfo`
  - `vxp`
  - `vxe2`
- Examples for use of new vector instructions:
  - Vector alignment hints
  - Vector Byte and element swaps
  - Vector substring search in `strstr()` and `memmem()`
- Exploited (among others) in
  - GCC 9.1
  - glibc 2.30
  - LLVM 9.0.0

IBM z15 Support: Deflate

19.10 8.1 12 SP5 15 SP1 LPAR z/VM KVM

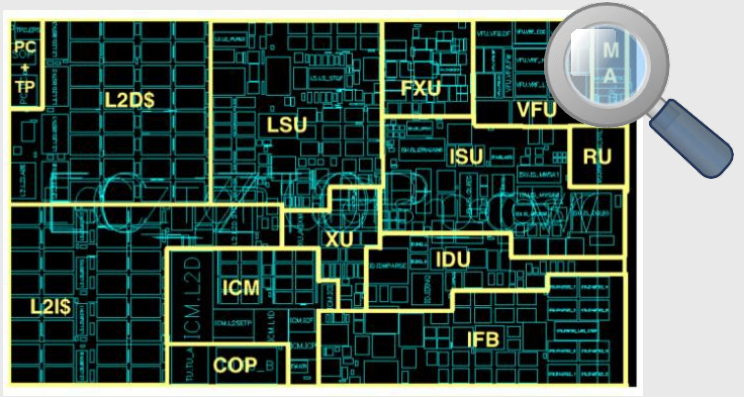
- Data compress and uncompress through new instruction
- Compression equivalent to `gzip -1`
  - `-1` is fastest, `-9` slowest, default is `-6`
- Can be exploited e.g. by `zlib`, `gzip`, Java et al
- Compress data with zlib on IBM z15 with 4 processors up to 42x faster as compared to software compression
- Linux enablement:
  - Java: Use Java 8 SR6 FP16 on any Linux distribution
  - Reported with new feature flag in `/proc/cpuinfo`: `dflt`
  - Use env variable `DFLTCC_LEVEL_MASK` to enable for arbitrary compression levels
  - See here for further details on usage



E.coli=entire genome, bible.txt=KJV text, world192.txt=CIA Fact Book, Canterbury.tar=Canterbury Corpus

IBM z15 Support: CPACF

- New Message Security Assist MSA9 for *Elliptic Curve Cryptography*(ECC)
- Supports
  - message authentication
  - generation of elliptic curve keys
  - scalar multiplication
- Used with SSL/TLS protocol
  - securing client-server network connection
  - handshake establishes the secure connection
- TLS v1.2 and v1.3 support ECDH (key exchange) and ECDSA (signature)



z15 Processor Unit

- Supported curves:
  - ECDSA (sign/verify) P256, P384, P521 Ed 25519, Ed448
  - ECDH (key exchange) P256, P384, P521, X25519, X448
- Performance
  - Up to 20x key exchange operations
  - Up to 38x sign operations
  - Up to 10x verify operations

IBM z15 Support: Secure Boot for SCSI IPL

- Ensure that only code is loaded during IPL that is
  - signed by a trusted distribution vendor (currently: Red Hat, SUSE or Canonical)
  - unmodified
- Kernel image and `zipl` boot record must be signed
- `zipl` tool creates signature entries for SCSI IPL
- New switch on HMC enables secure boot
- Firmware checks signatures and stops IPL on mismatch

- `/sys/firmware/ipl/has_secure` indicates support
- `/sys/firmware/ipl/secure` indicates IPL using secure boot
- zipl option `secure="auto/0/1"`

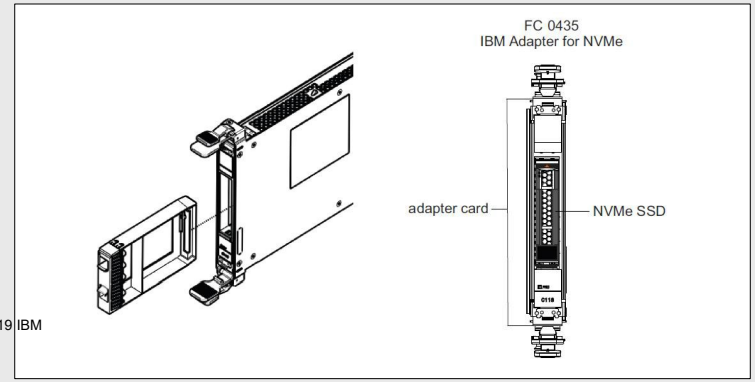
1	disable secure boot
2	enforce secure boot
`auto`	enable secure boot if system supports it and image/stage3 signed

- Support available in

  Linux kernel 5.3

IBM LinuxONE support for NVMe drives

- IBM Adapter for NVMe
  - Carrier card for industry standard U.2 NVMe drives
    - Common capacities up to 16 TB per drive
    - 1 drive per carrier, up to 16 cards per CEC
  - Available for IBM LinuxONE starting with Emperor II and Rockhopper II



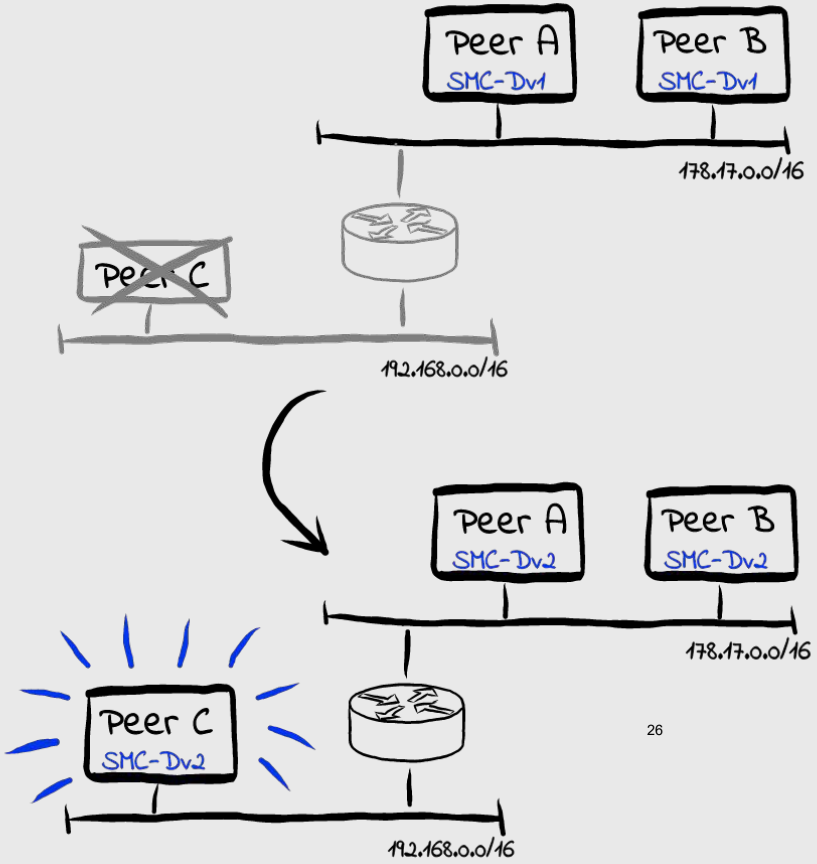
- NVMe drive characteristics
  - Low-cost, low-latency, high-throughput storage
  - PCI direct-attached (no SAN)
    - No cabling, switches, etc. required
  - No virtualization or shared access: can use one drive only in one LPAR/VM
- Linux on Z support for NVMe
  - Uses standard Linux NVMe driver
  - Always apply latest service levels!

18.04 7.8 8.0 12 SP4 15

SMC-Dv2

LPAR z/VM

- **Recap:**
  - **SMC-Dv1** provides intra-CEC communication for TCP traffic using Internal Shared Memory (ISM) devices
  - Superior performance (low latency, high throughput) at reduced CPU consumption
  - *However*:
    - Peers must be in **same IP subnet**
    - Devices need to be **paired using PNET IDs**
- **SMC-Dv2**
  - Peers can be in ***any* IP subnet**
  - **No PNET IDs required**
    ⇒ Simplified configuration
  - Requires z15 or LinuxONE III
  - Support available in Linux kernel 5.10

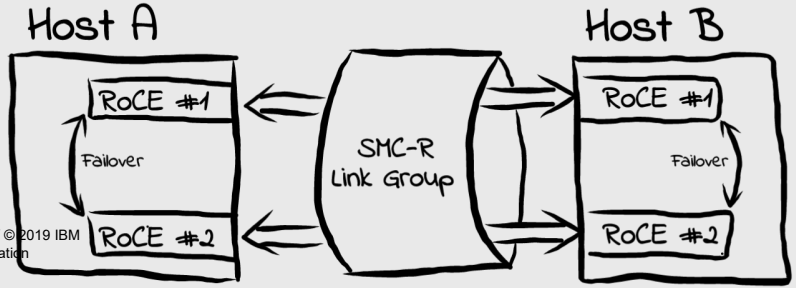


SMC-R / smc-tools

SMC-R Link Group Support

LPAR z/VM 20.10 8.3

- Transparently moves connections between links in link group upon link failure - think channel bonding for SMC-R
- Compatible to z/OS
- Reference Architecture:
  - 2x OSA for IP connectivity
  - 2x RoCE for RDMA
- Support available in Linux kernel 5.8



smc-tools v1.5

- Utilities in support of SMC-R and SMC-D
- Latest additions:
  - New tools `smcd/smcr`, e.g

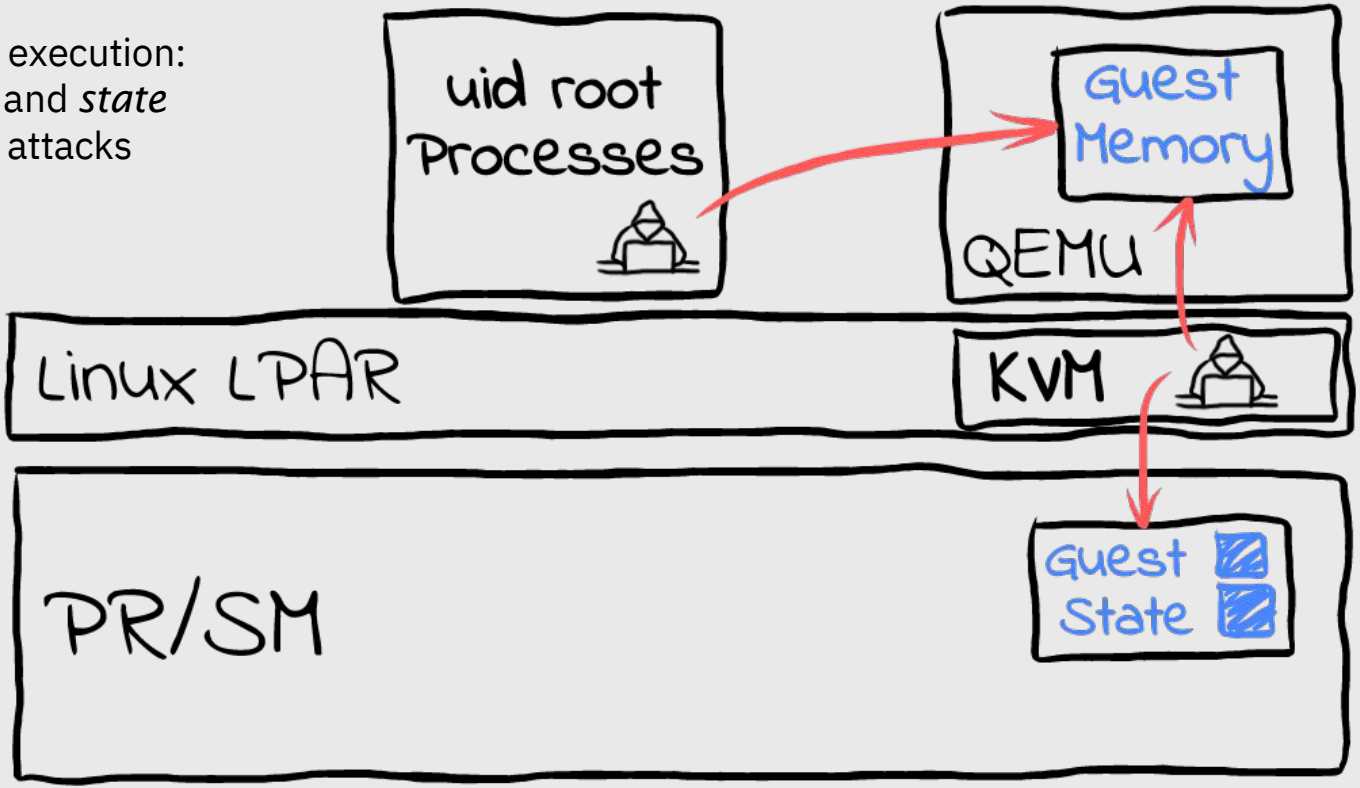
```
$ smcd info
  Kernel Capabilities
  SMC Version:       2.0
  SMC Hostname:      tux
  SMC-D Features:    v1 v2
  SMC-R Features:    v1

  Hardware Capabilities
  SEID:              IBM-SYSZ-ISMSEID0000...
  ISM:               v1 v2
  RoCE:              v1
```

  - New tool `smc_chk` to verify setup/peer capabilities

```
$ smc_chk -C 192.168.2.95 -p 23
  Live test (SMC-D and SMC-R)
    Failed  (TCP fallback), reasons:
      Client:  0x03010000  Peer does
                           not support SMC
```

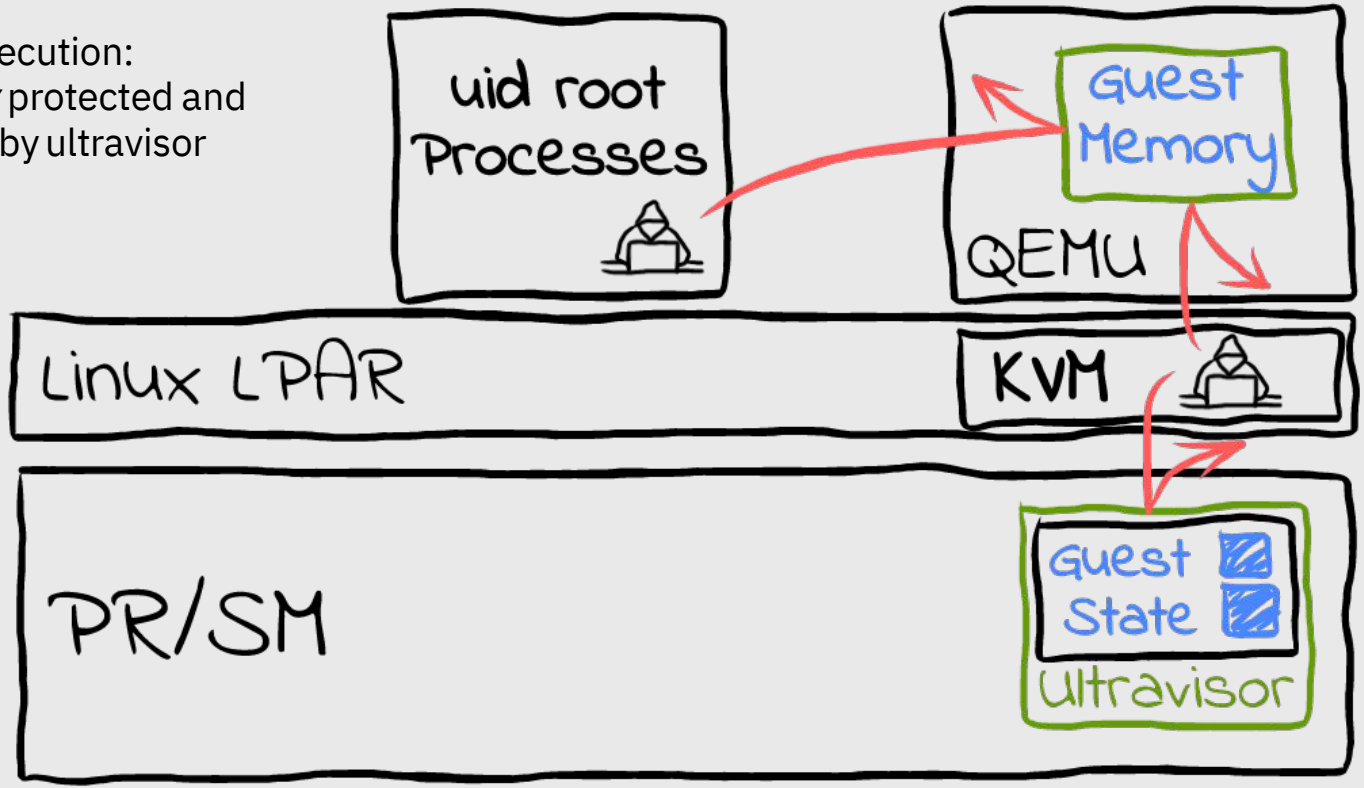
IBM z15 Support: Secure Execution

Without secure execution:
Guest *memory* and *state*
at risk of inside attacks



IBM z15 Support: Secure Execution (*continued*)

With secure execution:
Guest *memory* protected and
state shielded by ultravisor



IBM z15 Support: Secure Execution (*continued*)

- Allows users to run their Linux workloads with maximum privacy by protecting system memory.
- Not even the system administrator can access customer data
  ⇒ Protection against insider attacks
- Allows customers to run sensitive workloads on and off premise with the same level of data protection
- Reduces the efforts of a cloud service provider to establish and document procedures for compliance and certification

- What is IBM Secure Execution for Linux?
  - Orderable feature of IBM z15 or LinuxONE III (feature code 115)
  - End-to-end memory protection realized in hardware
  - Trusted firmware controlling the separation and isolation of virtual machines
  - CA-certified public private keys to form a chain of trust
- What else is needed?
  - By the machine owner: a Linux operating system with KVM supporting IBM Secure Execution (RHEL 8.3, SLES 15 SP2, Ubuntu 20.04)
  - By the workload owner: a Linux operating system which supports running as KVM guest in an IBM Secure Execution virtual machine (RHEL 7.8, RHEL 8.2, SLES 12 SP5, SLES 15 SP2, Ubuntu 20.04)

Met Office

Ensuring timely delivery of essential weather data to millions of customers

The UK Meteorological Office migrated its meteorological databases from x86 systems to a resilient, high-performance and scalable IBM® LinuxONE platform—ensuring it can handle massive peaks in requests.

A single team supports a large number of core Linux apps
Cuts operational costs through database consolidation
Ensures millions of customers can access critical weather data 24x7

“We can bet the business on LinuxONE—and I can sleep easily in the knowledge that we can absolutely rely on our data delivery systems.”

Graham Mallin, Executive Head of Technology at the Met Office

Origins of the LinuxONE Community Cloud

- Mission:
  - The public cloud exists to provide access to IBM z based Linux servers for developers, testers and enthusiasts to try and experience.
  - Individuals can sign up for 120 days at a time and get the ability to deploy Linux server of their choice, or experience IBM OpenShift Container Platform (OCP) based services.
    - A valid email address is required, plus affirm standards of use agreement
  - The L1CC has been used by many academic programs, special events (hackathons) and the 2020 IBM Master the Mainframe Contest.
- Beginnings:
  - Developed as a joint project between IBM and Marist College, starting in 2015.

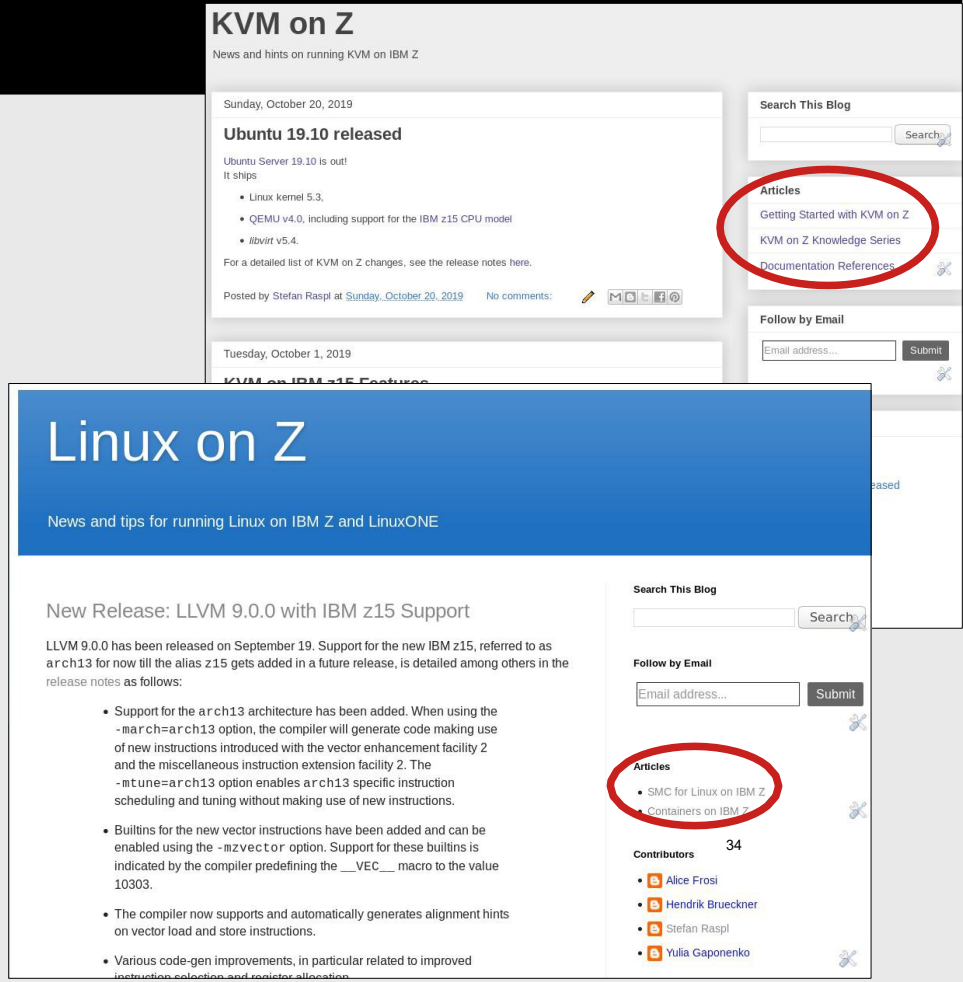
LinuxONE Community Cloud - Today

- Current L1CC resides on LinuxONE Emperor III (z15 technology)
  - Three hypervisors running z/VM 7.1
    - Two in SSI cluster, one in 4-way SSI cluster
  - IBM Cloud Infrastructure Center level 1.1.1
    - One controller, three host nodes (compute nodes)
    - All running on RHEL 7.8 servers
  - First L1CC to use it for cloud technology
  - Went production in August 2020
- OCP (Red Hat OpenShift Container Platform) option was added to registration in September 2020
  - Allows people to try out environment for a short time

Staying Up-To-Date

Blogs

- Very latest news from the development team
  - KVM on Z: http://kvmonz.blogspot.com/
  - Linux on Z & containers: http://linux-on-z.blogspot.com/
- Focus primarily on upstream submissions, which will end up in Linux distributions later
- Also features in-depth articles on specific topics
- Provided by Linux on Z development team



References

Documentation

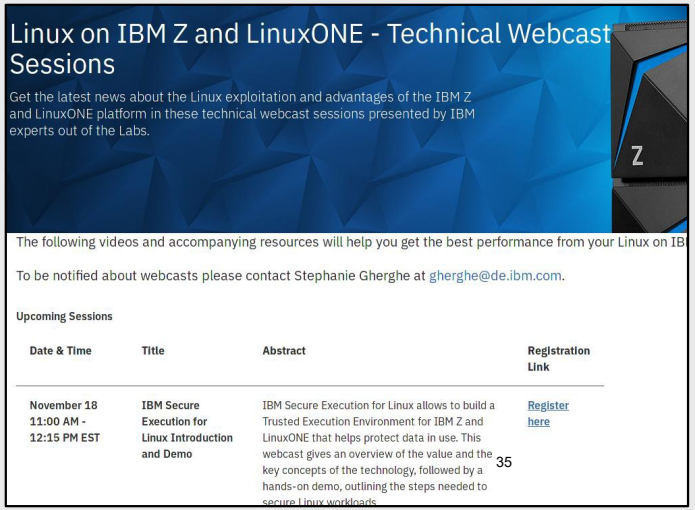
- Linux on Z and LinuxONE Knowledgecenter
  https://www.ibm.com/support/knowledgecenter/linuxonibm/liaaf/lnz_r_main.html
- Videos explainers
  https://www.ibm.com/support/knowledgecenter/linuxonibm/liaaf/lnz_r_videos.html

Webcasts

- In-depth sessions right from the Linux on Z development team
- Recordings available
  http://ibm.biz/Linux-on-IBMZ-LinuxONE-Webcasts

Blogs

- Primary places for news and updates
  - *Linux on Z, including containers:* *http:/ linux-on-z.blogspot.com/*
  - *KVM on Z*: http:/ kvmonz.blogspot.com/



Next Steps

Discuss your options

- Schedule an Expert Consultation or on-site workshop

Learn more

- Read "10 Reasons Why LinuxONE" paper by the Robert Frances Group
- Watch LinuxONE provides a more secure Blockchain (3:43)
- Secure Service Containers https://www.ibm.com/us-en/marketplace/secure-service-container
- Read the "Scaling the Digital Mountain: A Path to a Secure, Agile, and Efficient Organization" paper by Solitaire Interglobal, Ltd
- Review the labor and resource usage savings in LinuxONE environments paper
- Calculate the TCO savings of LinuxONE vs. x86

Try before you buy on the LinuxONE Community Cloud

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