Where to place workloads on Linux on IBM Z and LinuxONE or on Red Hat OpenShift

Wilhelm Mild
IBM Executive IT Architect
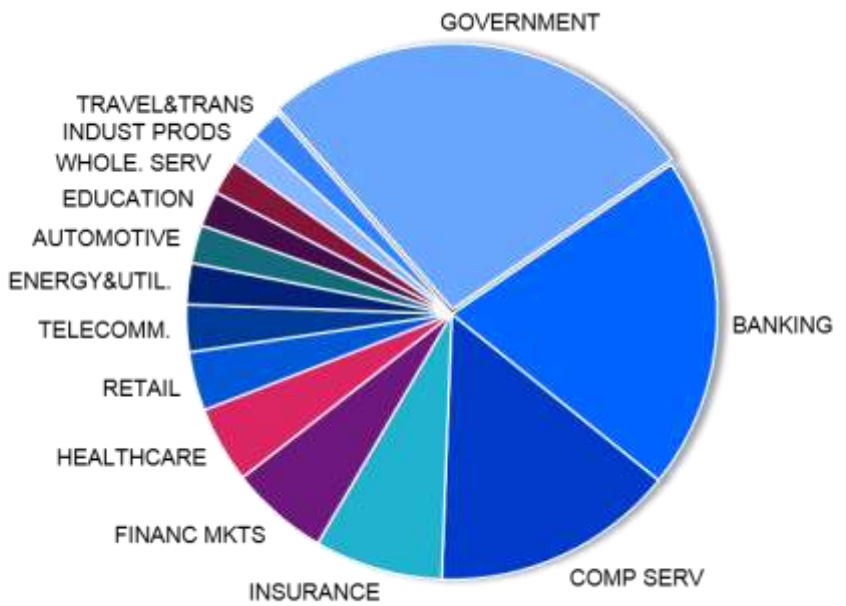Containerization, RH OpenShift on IBM Z & LinuxONE.
IBM R&D Lab Boeblingen, Germany

IBM

Market view of RH OpenShift and Linux on IBM LinuxONE and IBM Z

Installed IFL MIPS growth 22% YTY from 4Q22 to 4Q23

- Used **in over 60 countries** around the globe
- Used in about **22 industries**

GOVERNMENT
TRAVEL&TRANS
INDUST PRODS
WHOLE. SERV
EDUCATION
AUTOMOTIVE
ENERGY&UTIL.
TELECOMM.
RETAIL
HEALTHCARE
FINANC MKTS
INSURANCE
COMP SERV
BANKING

based on CustNo 4Q2023

- 90 of the top 100 IBM zSystems Enterprises are running Linux on zSystems as of 4Q23*
  - Very large installations with up to hundred and more of IFLs in USA, Japan, Brazil, Asia, Mexico and Germany
  - Small installations with 2 IFLs in all countries and on all IBM zSystems models
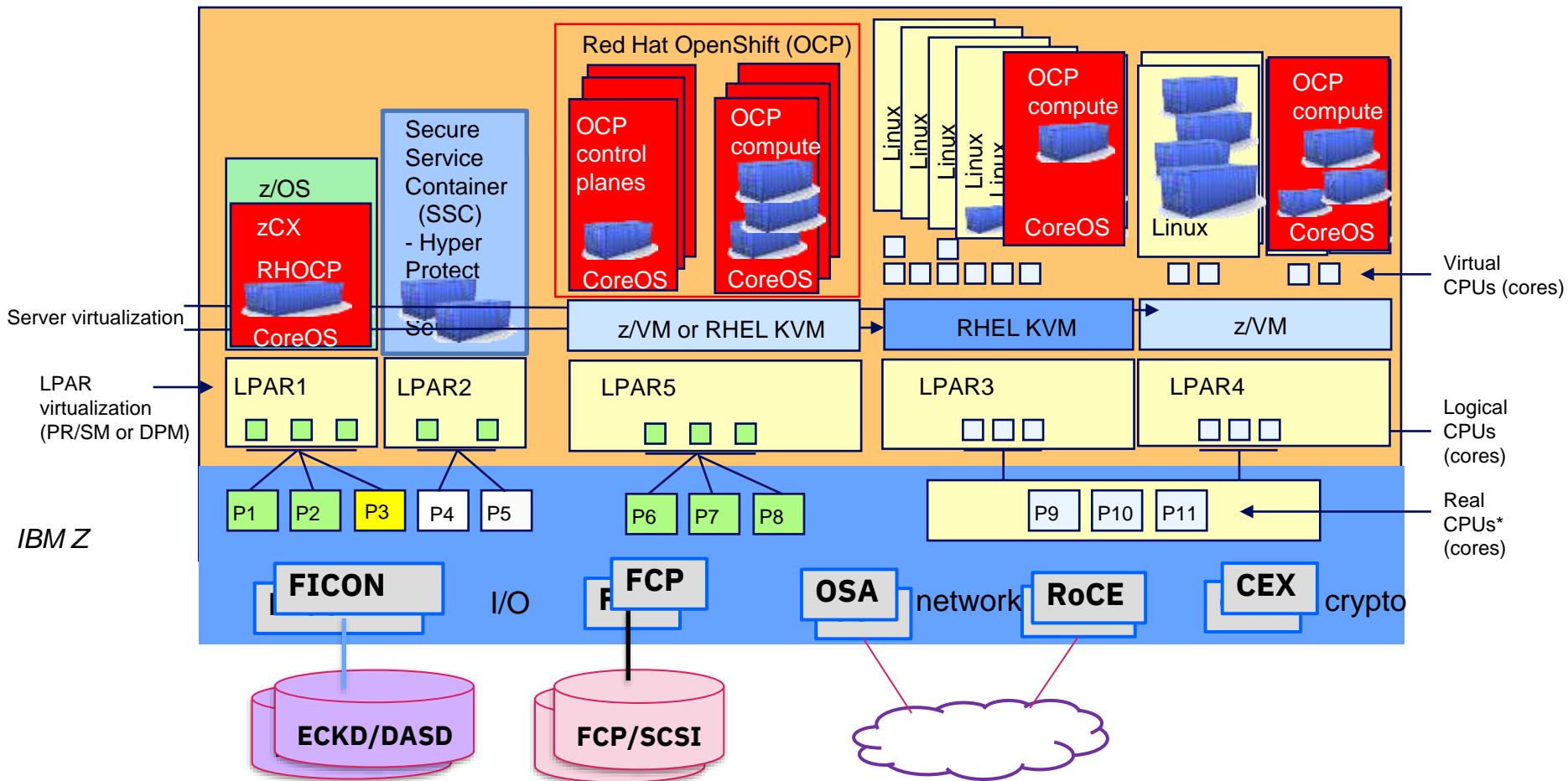- Many clients run Linux co-located with z/OS® on IBM Z
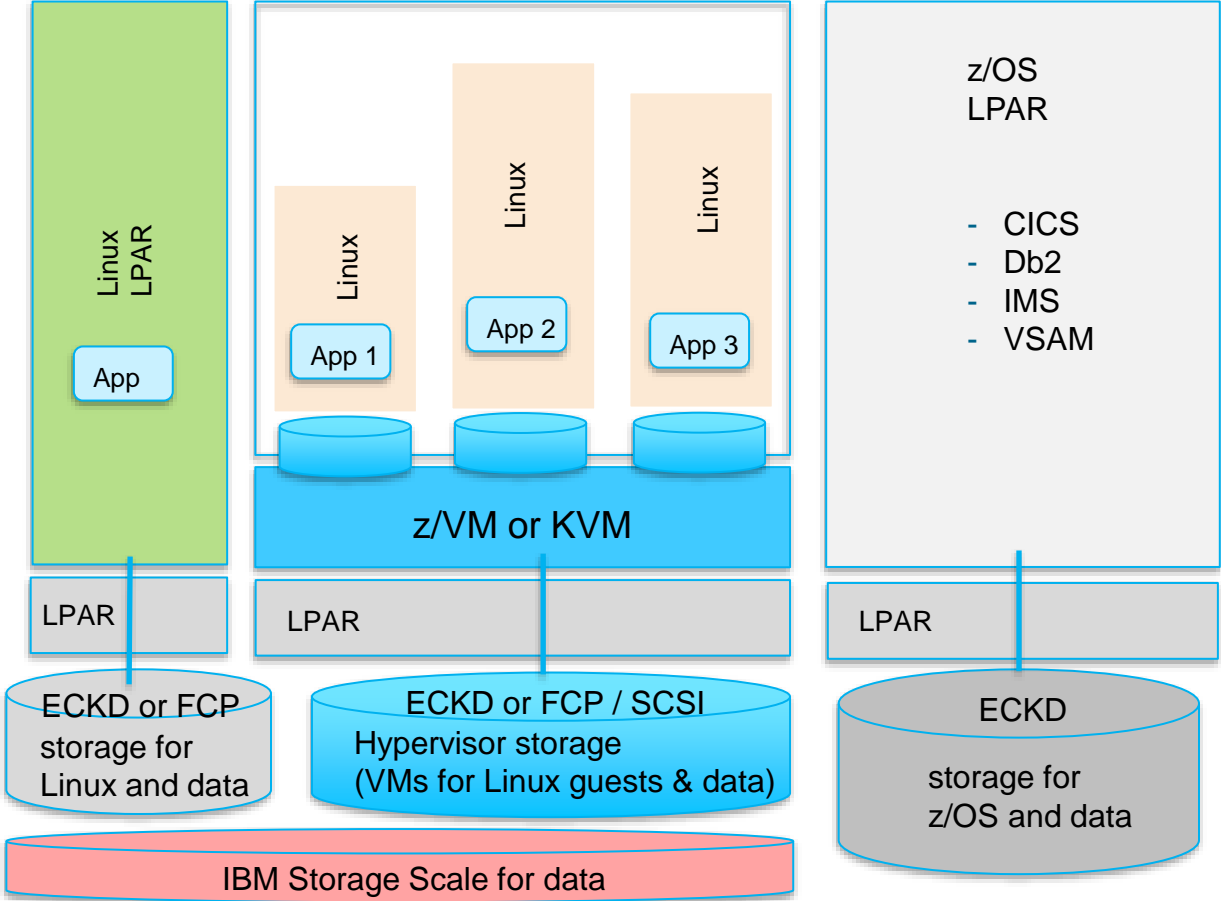

Installed Capacity Over Time

Installed IFL Capacity
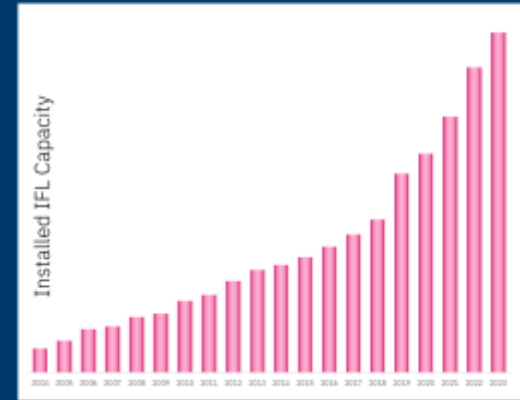
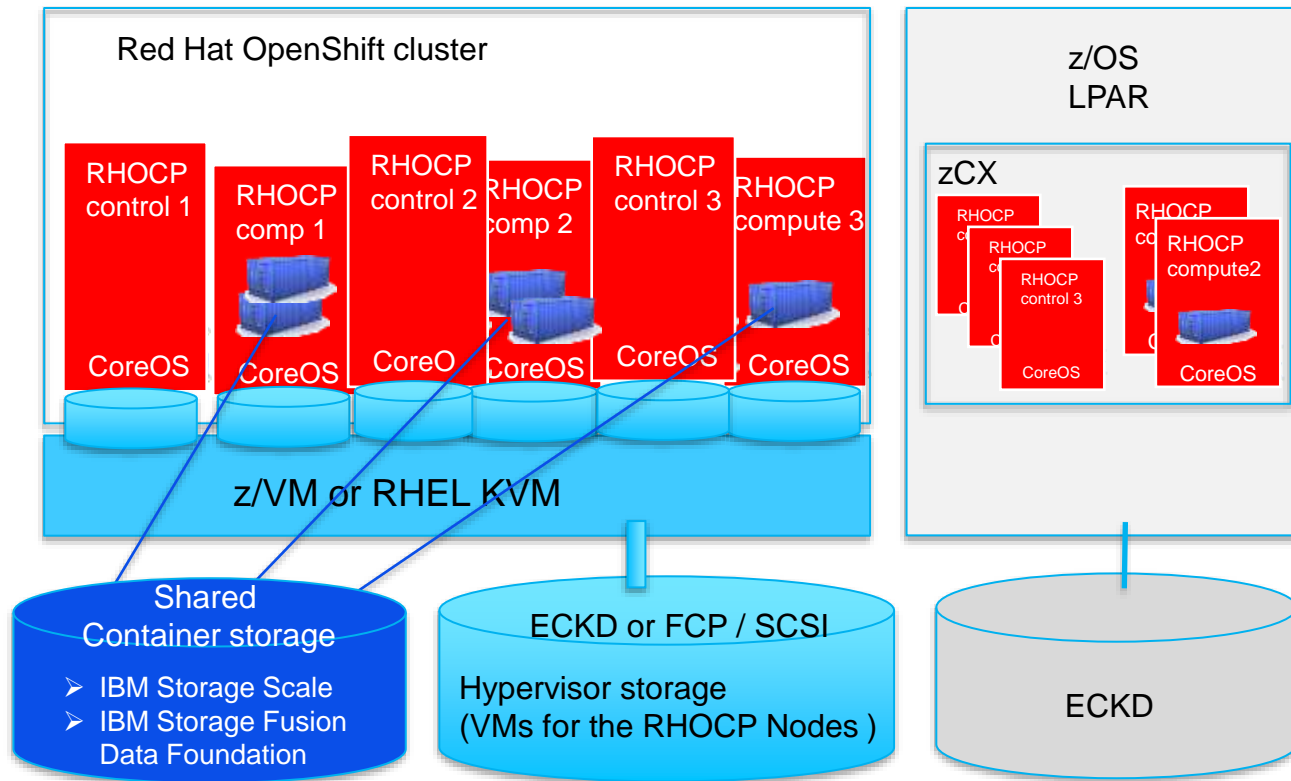*Top 100 is based on total installed MIPS*

IBM Z Virtualization and Container options

Red Hat OpenShift (OCP)

z/OS

zCX

RHOCP

CoreOS

Secure Service Container (SSC) - Hyper Protect

OCP control planes

CoreOS

OCP compute

CoreOS

Linux

Linux

Linux

Linux

Linux

OCP compute

CoreOS

Linux

OCP compute

CoreOS

Server virtualization

z/VM or RHEL KVM

RHEL KVM

z/VM

Virtual CPUs (cores)

LPAR virtualization (PR/SM or DPM)

LPAR1

LPAR2

LPAR5

LPAR3

LPAR4

Logical CPUs (cores)

IBM Z

P1 P2 P3 P4 P5

P6 P7 P8

P9 P10 P11

Real CPUs* (cores)

FICON I/O **FCP**

OSA network **RoCE**

CEX crypto

ECKD/DASD

FCP/SCSI

Linux on IBM Z solution Architecture overview

Red Hat OpenShift solution Architecture overview

Red Hat OpenShift cluster

RHOCP control 1

RHOCP comp 1

RHOCP control 2

RHOCP comp 2

RHOCP control 3

RHOCP compute 3

CoreOS

CoreOS

CoreO

CoreOS

CoreOS

CoreOS

z/VM or RHEL KVM

z/OS LPAR

zCX

RHOCP c

RHOCP c

RHOCP control 3

RHOCP c

RHOCP compute2

CoreOS

CoreOS

Shared Container storage

➤ IBM Storage Scale
➤ IBM Storage Fusion Data Foundation

ECKD or FCP / SCSI

Hypervisor storage
(VMs for the RHOCP Nodes)

ECKD

Requires containerized applications

RH OpenShift Single Node (SNO) and HA implementations

Single Node Cluster

New OCP 4.15

New OCP 4.14

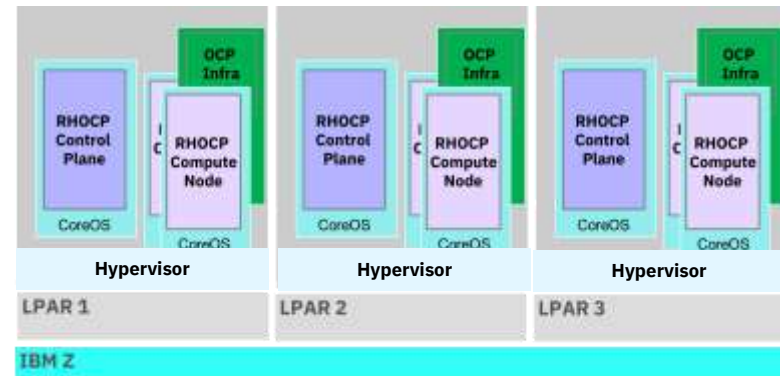### 3 Node Cluster

New OCP 4.15
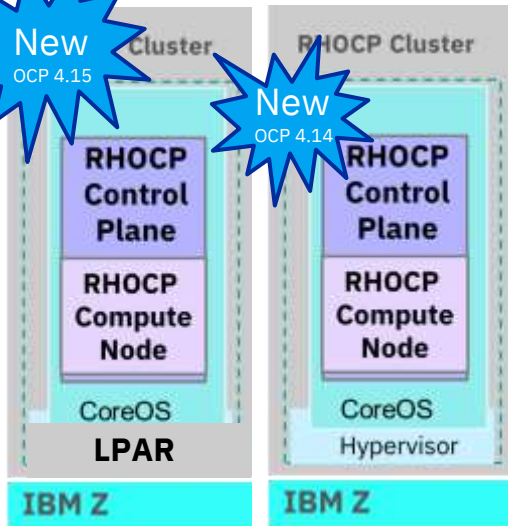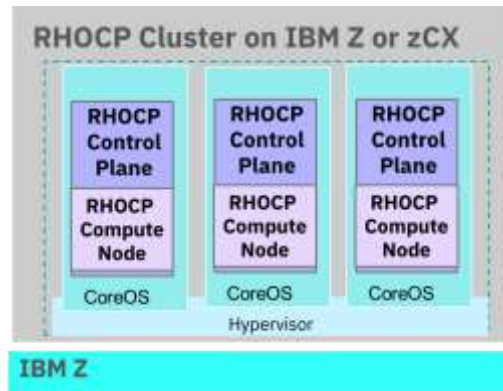
All deployments can be in LPARs without hypervisor

Multi Node Cluster

Value: Lower resource foot-print due to smaller cluster size

- Single Node OpenShift offers both control and compute node capabilities in a single server.
- Single Node OpenShift also allows you to add additional compute nodes to your cluster.
- **No high availability**
- **Requires 2 IFLs** (Integrated Facilities for Linux), with SMT-2 enabled **on installation time**
- **Operation** requires **0.5 IFLs on average**; remaining **1.5 IFLs** required for **keeping SNO OCP stable** and for running some workloads

https://docs.openshift.com/container-platform/4.14/installing/installing_sno/install-sno-installing-sno.html#install-sno-with-ibmz

Linux applications in virtual servers vs. Containerized applications

Virtualization, usually provides a **high level of isolation** and security as all communication between the guest and host is **through the hypervisor**. Linux on IBM Z runs in LPAR or Virtual machines.

> It is also usually slower than containers and incurs some **overhead due to the infrastructure emulation**.

Containers, reduce the virtualization overhead, the level of virtualization called "**container virtualization**" was introduced which allows to run **multiple isolated user space instances on the same kernel**.

> **Containers is a layered approach and uses copy-on-write filesystems**
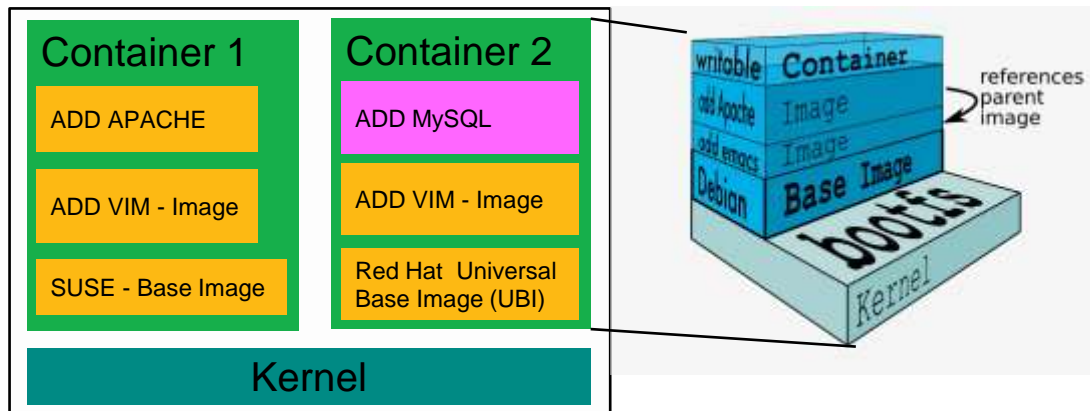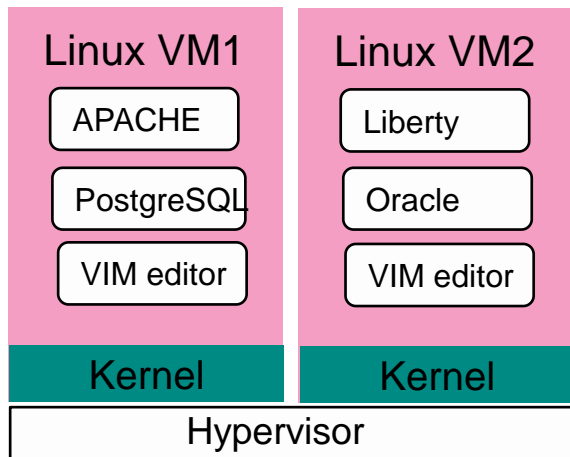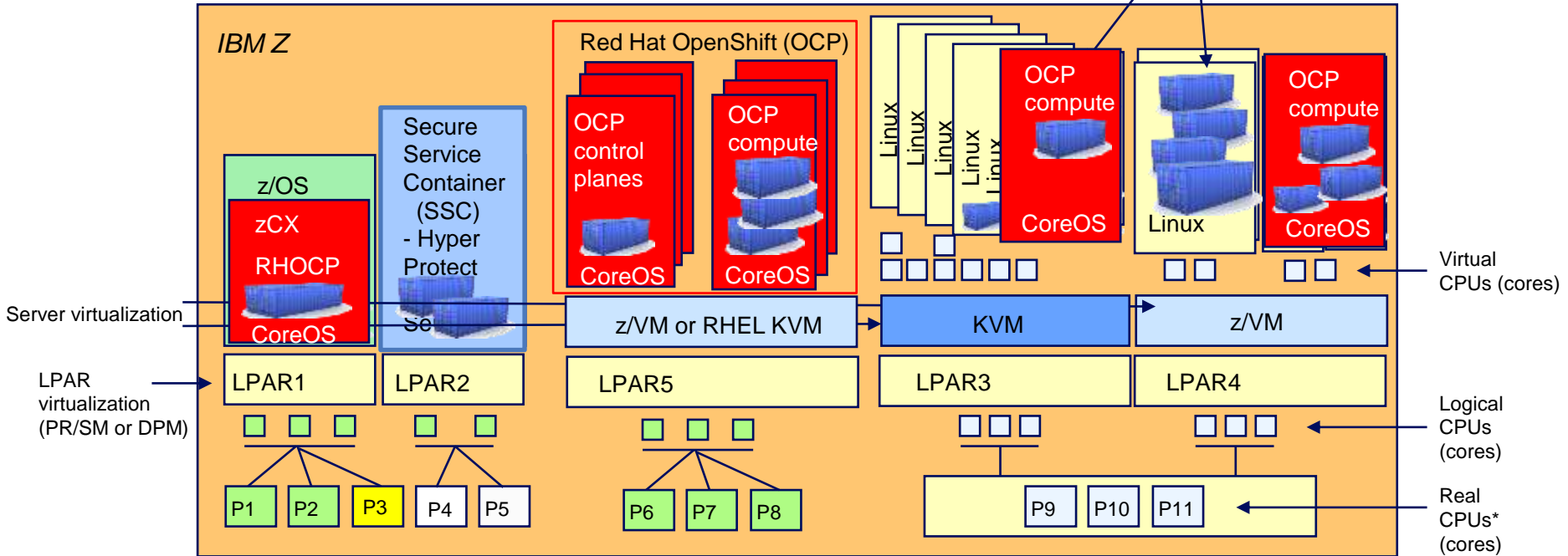

Containers are orchestrated with other tools than VMs

IBM Z Virtualization and Container options

Server virtualization. There are typically dozens or hundreds of Linux servers in a LPAR virtualized using z/VM or KVM or SSC.

Red Hat OpenShift is an Enterprise grade Kubernetes environment. It can be installed in a z/VM or KVM env.

Application isolation. There are typically thousands of Containers in Linux on IBM Z

IBM Z

Red Hat OpenShift (OCP)

z/OS

zCX

RHOCP

CoreOS

Secure Service Container (SSC) - Hyper Protect

OCP control planes

CoreOS

OCP compute

CoreOS

Linux Linux Linux Linux Linux

OCP compute

CoreOS

Linux

OCP compute

CoreOS

Virtual CPUs (cores)

Server virtualization

z/VM or RHEL KVM

KVM

z/VM

LPAR virtualization (PR/SM or DPM)

LPAR1

LPAR2

LPAR5

LPAR3

LPAR4

Logical CPUs (cores)

P1 P2 P3 P4 P5

P6 P7 P8

P9 P10 P11

Real CPUs* (cores)

P1 – P11 are Central Processor Units (CPU -> core) or Integrated Facility for Linux (IFL) Processors   (IFL -> core) or ZIIP cores in z/OS
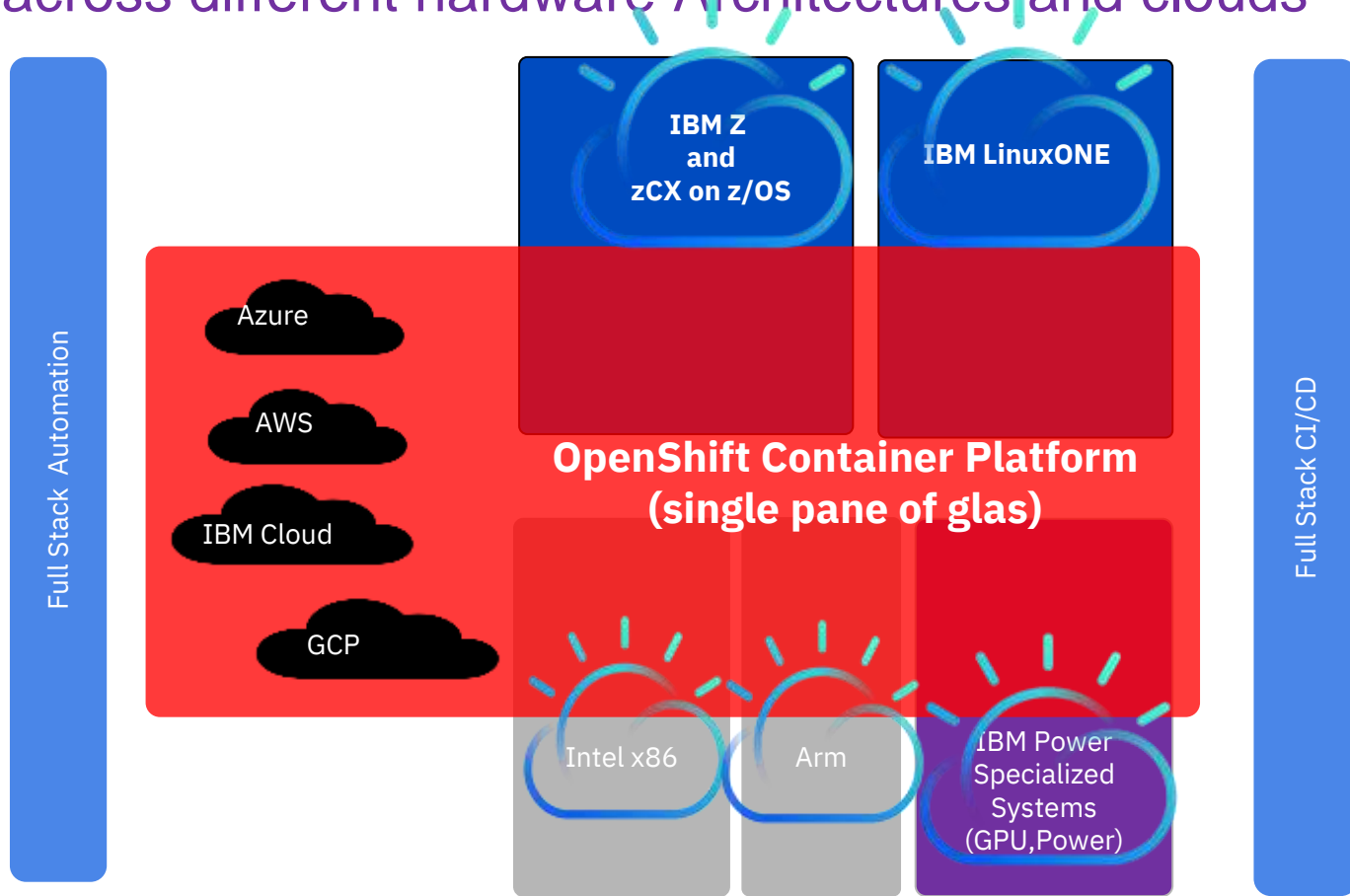
* - One shared Pool of cores per System only

Note: - LPARs can be managed by traditional PR/SM in IBM Z and additional with Dynamic Partition Manager (DPM) in LinuxONE

# Red Hat OpenShift - the only Container Platform across different hardware Architectures and clouds

Cross clouds:
- **Development**
- **Automation**
- **Deployment**
- **DevOps**
- **CI/CD**
- **Lifecycle**
- **Management**

Full Stack Automation

Full Stack CI/CD

IBM Z and zCX on z/OS

IBM LinuxONE

Azure

AWS

IBM Cloud

GCP

OpenShift Container Platform (single pane of glas)

Intel x86

Arm

IBM Power Specialized Systems (GPU,Power)

Kubernetes is THE container Orchestration tool
Red Hat OpenShift is trusted enterprise Kubernetes

Kubernetes release

Production Ready

OpenShift release
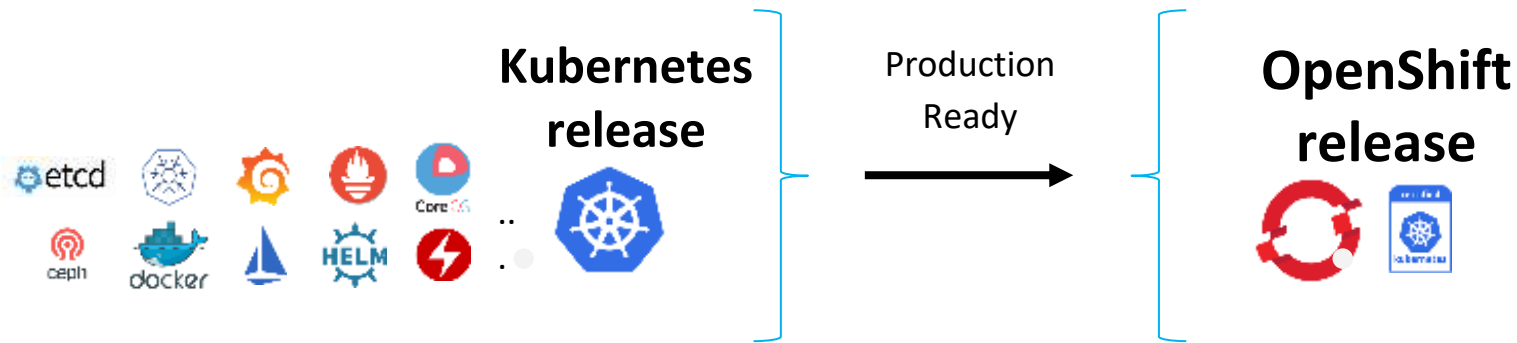
- Hundreds of defect and performance fixes
- 200+ validated integrations
- Certified container ecosystem
- Over 9-years enterprise life-cycle management
- Red Hat is one of the leading Kubernetes contributor since day 1

Some major workload categories for Linux and IBM Z

- **Transactional workload**
  - massive parallel transactional processing
  - highest transactional integrity

- **Data gravity**
  - Data(bases), Data Lakes
  - Oracle, Open-Source Databases, DBaaS
  - Services to existing applications and transactional systems
  - Analytics and BI acceleration on IBM z16

- **Multi-tenancy services with isolation & security**
  - highest isolation in LPARs or VMs
  - DevSecOps with isolation and automation
  - end-to-end encryption in flight and on rest with Crypto accelerators

Transactional workloads

> **Fit well in Linux on IBM Z**

> Highest I/O rates, performant application storage access

> Transactional integrity is high with SoR in z/OS

> Multi tenancy in VMs easier, because of high isolation

> can take advantage of all Linux features and functions and IBM Z exploitation capabilities
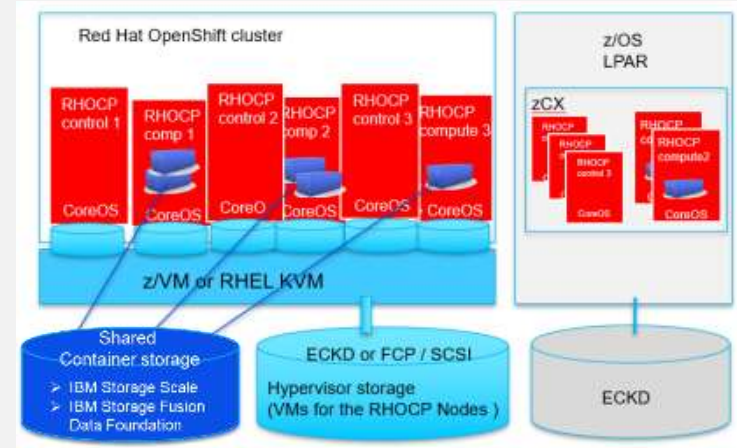
Limitation:

> Update in place more difficult

> HA / DR need separate considerations

Transactional workload

- **Red Hat OpenShift** workload is typically stateless not transactional
- needs application design to be transactional
- isolation for tenancy is lower due to common structures in a Red Hat OpenShift cluster and storage sharing
- the functionality is limited to CoreOS, a subset of the RHEL version
- Enables updates in place per design
  – can be decisive for some use cases
- Service / App HA realized per implementation design of RH OpenShift

(1) Data Gravity – Enterprise databases and Warehouses

> **Enterprise databases fit well in Linux on IBM Z
>   (e.g. Db2, Oracle, PostgreSQL, MongoDB, DWH, …)**

> Highest I/O rates for databases with direct connected storage

> highest isolation in LPAR or VMs

> Multi tenancy in LPAR or VMs, cause of highest isolation and certification

> integrates well with applications via internal networking (e.g. Hipersockets, SMC-D, VSWITCH, shared OSA/RoCE)

> advantage of 3D scalability (vertical, horizontal & combined

Limitation:

> Update in place more difficult

> App HA / DR need separate considerations
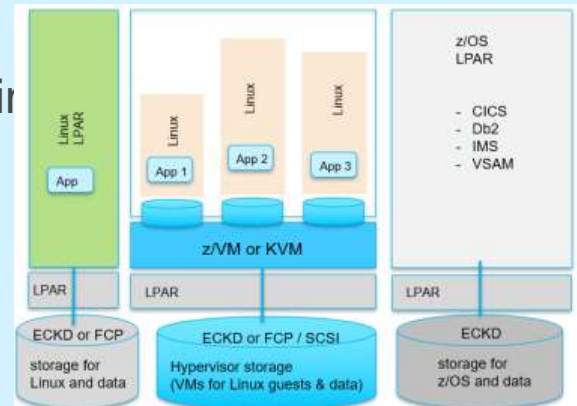
(2) Data Gravity – special purpose databases

- **Red Hat OpenShift** can host dynamic database workloads
- **well suited for stateless applications, caching databases and inquiry** for Mobile and Web Serving services (e.g. MongoDB, …)
- the high dynamic in number of requests is handled automatic by RH OpenShift
- requires shared storage to be accessed from all Compute Nodes with the application
- Updates in place per design
- Service / App HA enabled via RH OpenShift imple
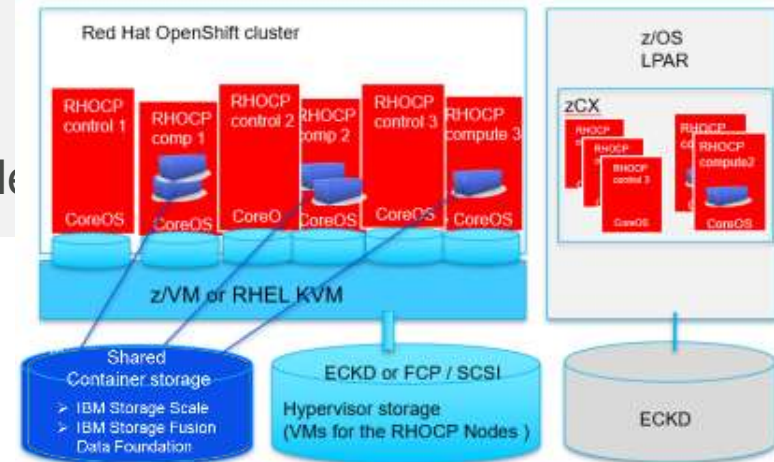
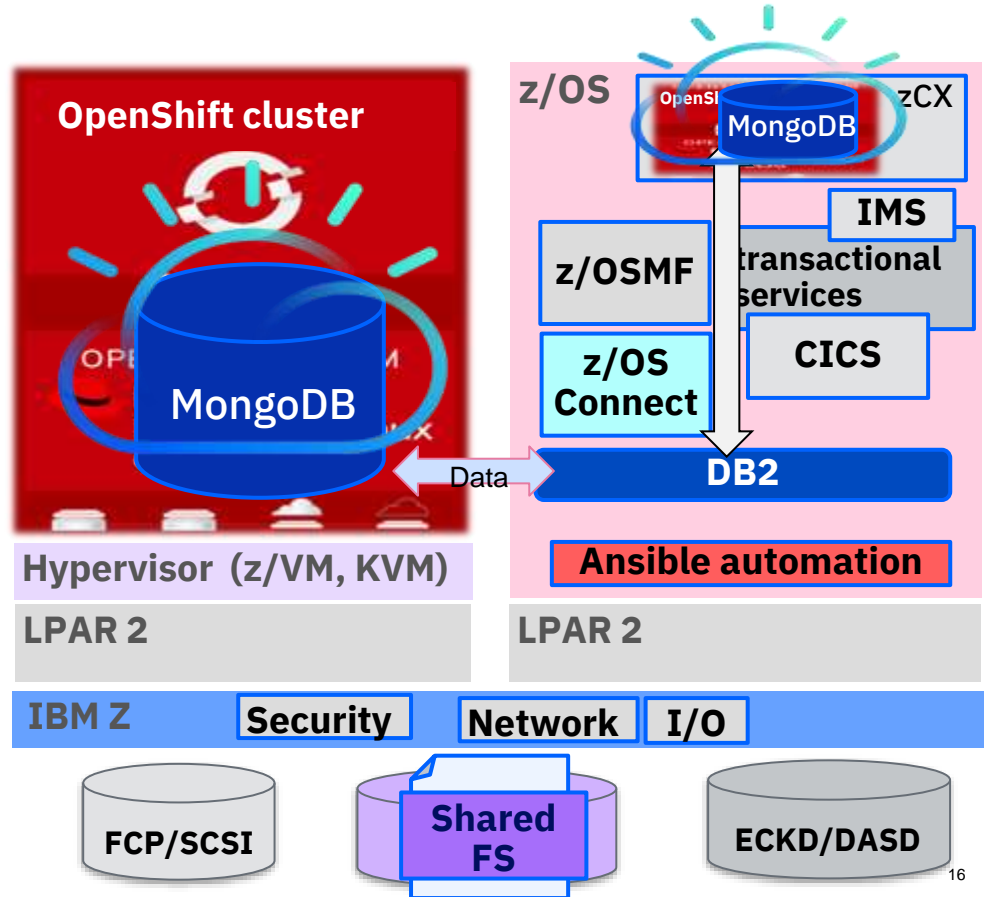# Red Hat OpenShift in z/OS zCX or / and colocation with z/OS

RHOCP in zCX or
   co-location to z/OS
case with **MongoDB** as:

Inquiry cloud service
- **Unpredicted scalable workload** for Inquiries in RHOCP with accesses z/OS Db2

Aggregation Cloud service
- **Caching database** as bridge to public clouds for incoming data

- **Batch workload** executed in RHOCP with aggregation of different data from services integrating with z/OS

OpenShift cluster

MongoDB

Hypervisor (z/VM, KVM)

LPAR 2

z/OS

MongoDB

zCX

IMS

z/OSMF

transactional services

z/OS Connect

CICS

Data

DB2

Ansible automation

LPAR 2

IBM Z   **Security**   **Network**   **I/O**

FCP/SCSI

Shared FS

ECKD/DASD

16

(3) Data Gravity – Analytics & BI workload

- **Analytics and AI fit well in RH OpenShift**

- parallel requests can be scaled automatically on pod or node base

- dynamic workloads – can be integrated with different cloud services

- requires shared storage to be accessed from all Compute Nodes with the application

- Updates in place per design

- Service / App HA per implementation design
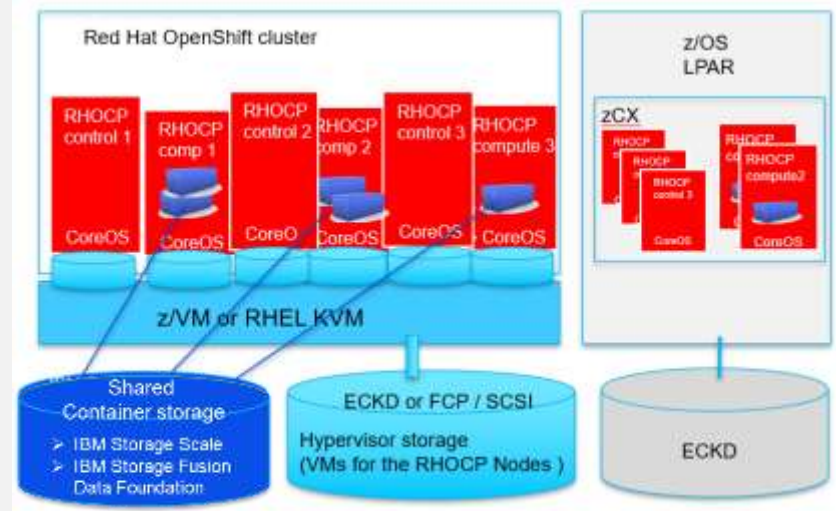
Multi Tenant isolation

> **Multi Tenant certified isolated services fit well in Linux on IBM Z**

> highest isolation in LPARs or VMs and sharing advantage

> advantage of 3D scalability (vertical, horizontal & combined)

> integrates well with external/cloud services & solutions

> accelerated compression & encryption
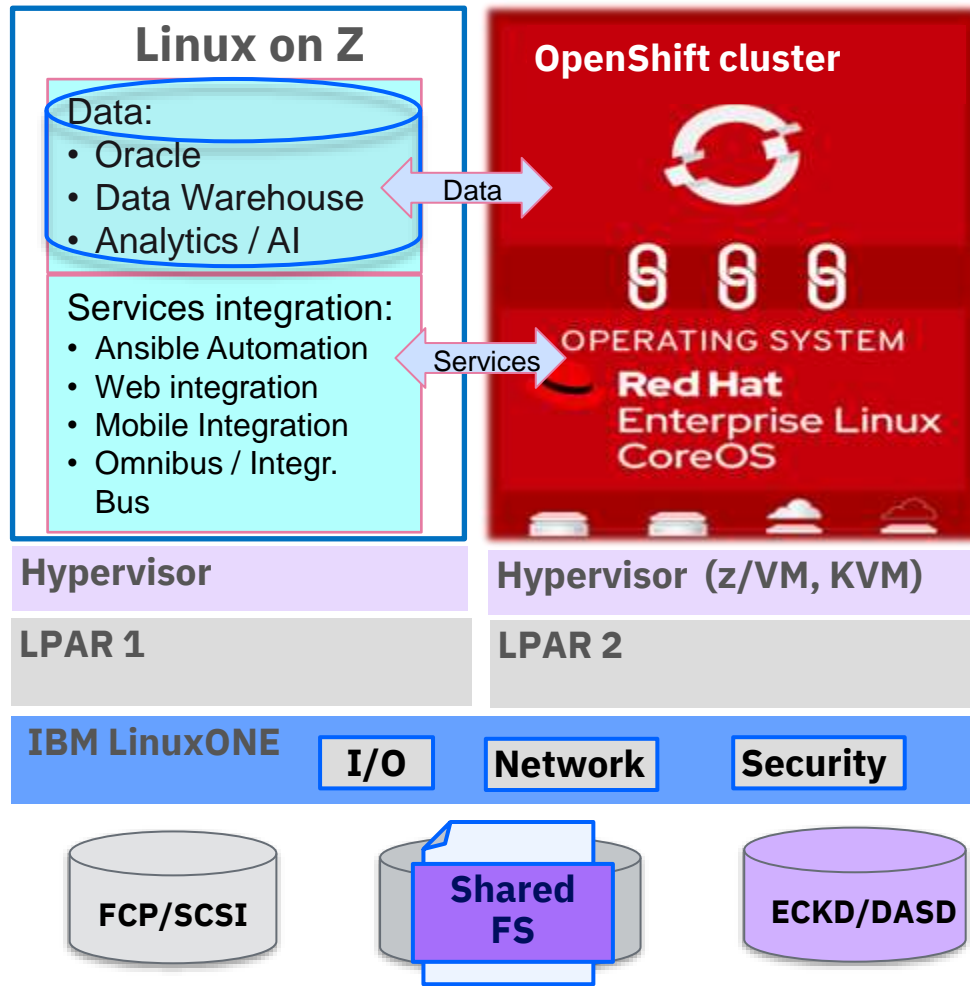
> highest isolation in Crypto (CEX) domains

Limitation:

> Update in place more difficult

> HA / DR need separate considerations
  (GDPS, RHEL HA, …)
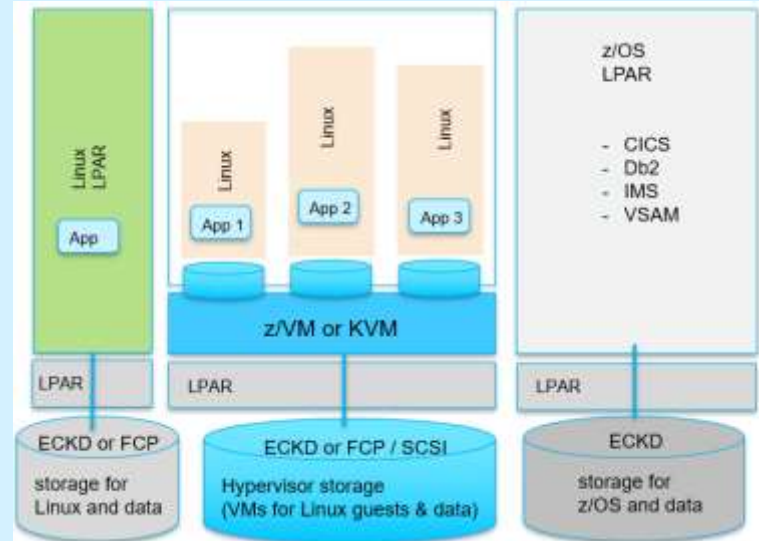
Red Hat OpenShift Container Platform collocated with Linux on IBM Z

- **RHOCP environment integrates with Linux on Z transactional systems**, bidirectional capabilities (e.g. Temenos T24 for banking)

- **RHOCP workload interacts with enterprise data**, like a Data Lake, Oracle or Db2 Data Warehouse

- **RHOCP implements the Front end for Web or Mobile applications**, for high dynamic workloads, scalability, resource sharing and reliability

- **RHOCP extends Linux on Z** Systems of Record with Open-Source technologies

Linux on Z

Data:
- Oracle
- Data Warehouse
- Analytics / AI

Services integration:
- Ansible Automation
- Web integration
- Mobile Integration
- Omnibus / Integr. Bus

Data →

Services →

OpenShift cluster

OPERATING SYSTEM
Red Hat Enterprise Linux CoreOS

Hypervisor

Hypervisor (z/VM, KVM)

LPAR 1

LPAR 2

IBM LinuxONE   **I/O**   **Network**   **Security**

FCP/SCSI

Shared FS

ECKD/DASD

Multi purpose solution and omnichannel

- **The IBM Integration Bus (IIB) and App Connect Enterprise (ACE) fit well in Linux on IBM Z**
  - for more static workloads
  - to enforce standards
  - Multi tenancy in VMs easier cause of high isolation
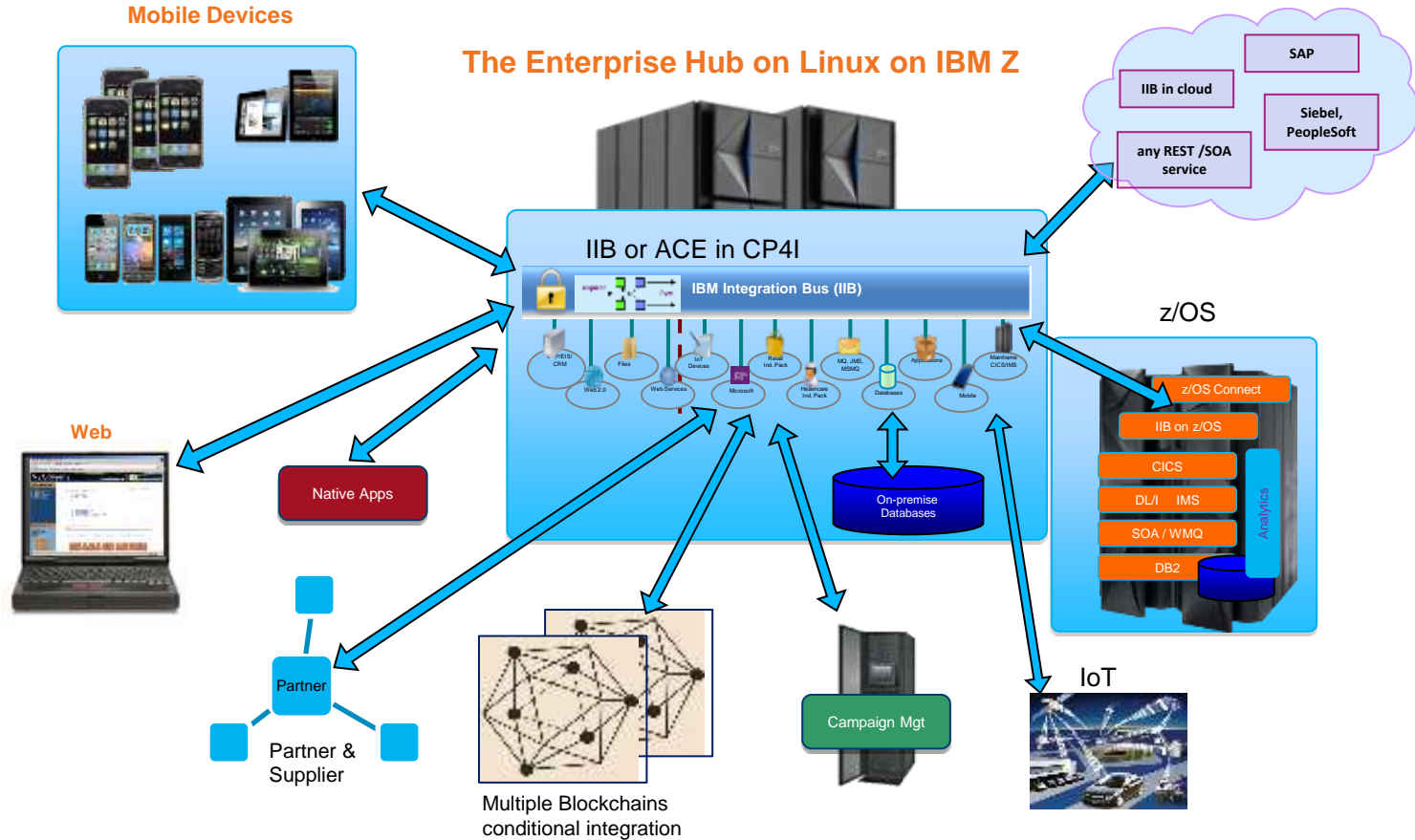 - integrates well with external services (e.g. Mobile, IoT, Blockchain,…)

  Limitation:
  - Update in place more difficult
  - HA / DR need separate considerations

- **The App Connect Enterprise (ACE) fit well in RH OpenShift**
- integrated in Cloud Pak for Integration (CP4I)
- for dynamic workloads - high variations in requests
- requires shared storage to be accessed from all Compute Nodes with the application or central DB
- Updates in place per design
- Service / App scalability & HA per RH OpenShift design

# IBM Integration Hub on Linux on IBM Z or Red Hat OpenShift ?

Web & Mobile Hub, Blockchains, IoT, Hybrid clouds

Mobile Devices

The Enterprise Hub on Linux on IBM Z

SAP

IIB in cloud

Siebel, PeopleSoft

any REST /SOA service

z/OS

IIB or ACE in CP4I

IBM Integration Bus (IIB)

SAP/EIS/ CRM · Files · IoT Devices · Retail Ind.Pack · MQ, JMS, MSMQ · Applications · Mainframe CICS/IMS

Web 2.0 · Web Services · Microsoft · Healthcare Ind.Pack · Databases · Mobile

z/OS Connect

IIB on z/OS

CICS

DL/I   IMS

SOA / WMQ

DB2

Analytics

Web

Native Apps

On-premise Databases

IoT

Partner

Partner & Supplier

Multiple Blockchains conditional integration

Campaign Mgt

Use cases with IBM Q and OpenShift on IBM Z

- Quantum safe security integration

  - **digital signatures** validation like mortgage/credit card approvals

  - **document signing** for Financial Institutions that require decades of retention and validity (e.g mortgages could be 30+ years)

  - **algorithms used for digital signatures** will be invalid (in approx 10-15 years) due to quantum computing. The goal is to dual sign electronic documents so that existing mechanisms can continue to be used, and PQC (**post-quantum cryptography**) can be used where available.

  - **IBM Z algorithms** like Dilithium & Kyber (key encapsulation) can be used for this and signing can be done on existing systems using p12 certs with PKCS11 (via IBM's Enterprise PKCS11 driver) with the HSM backend on a z16 with a CEX8 card. It can be done with z15 & CEX7 too but that only supports 1 Dilithium algorythm, there's newer ones out there only supported on CEX8
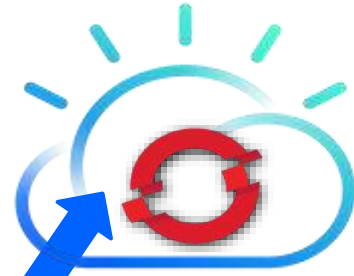
Red Hat OpenShift Container Platform (RHOCP)

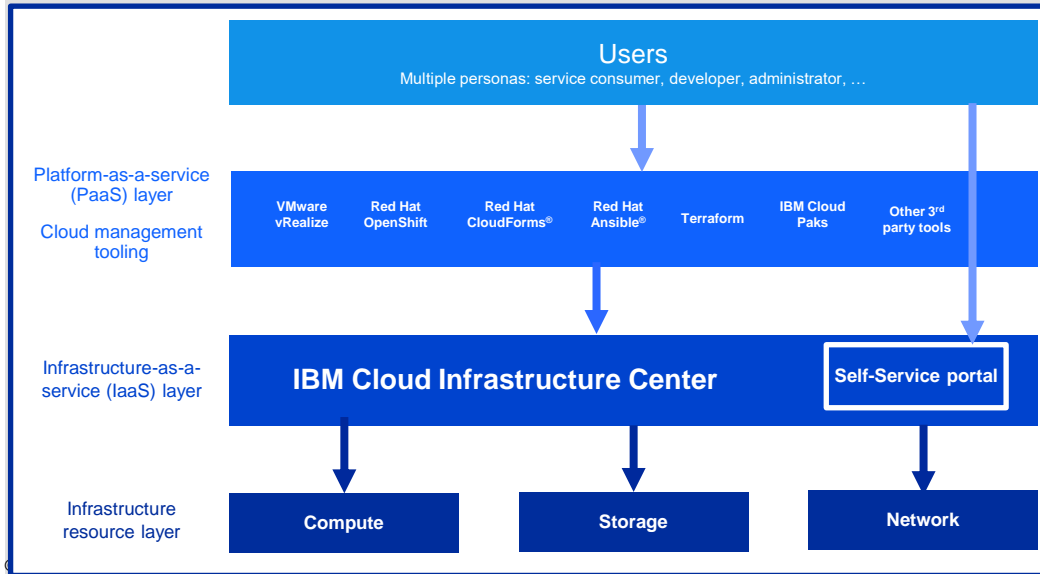to Build, Deploy, Manage Containerized, Cloud Native Apps that can Run Anywhere

Red Hat OpenShift
- The enterprise
    Kubernetes Platform

- Runs on IBM Z, IBM Power,
  x86 and public clouds

- Is THE platform for
  Life cycle management
  of containerized applications

- Has capabilities for extensions
  to manage traditional VMs
  with IBM CP4MCM

Self Service Portal

Build Automation

Deployment Automation

Application Lifecycle Mgt

Service Catalog
Language runtimes, databases, m/w ...

RED HAT OPENSHIFT

Kubernetes
Container Orchestration

CoreOS /
Red Hat Enterprise Linux

Container Runtime

Physical   Virtual   Private   Public
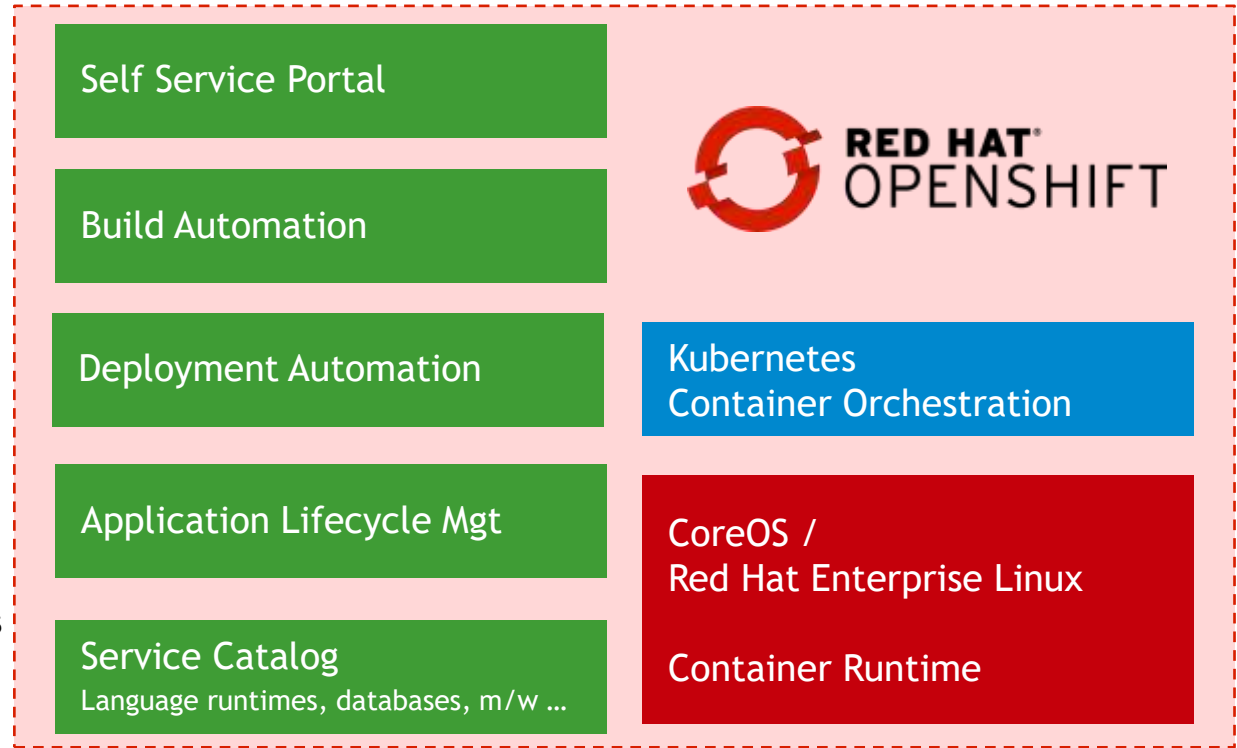
IBM Cloud Infrastructure Center – runs on-premise

Infrastructure-as-a-Service
for IBM zSystems and IBM® LinuxONE

Foundation for scalable Infrastructure-as-a-Service (IaaS) management of traditional and cloud workloads across the enterprise and hybrid cloud

Users
Multiple personas: service consumer, developer, administrator, …

Platform-as-a-service (PaaS) layer

Cloud management tooling

| VMware vRealize | Red Hat OpenShift | Red Hat CloudForms® | Red Hat Ansible® | Terraform | IBM Cloud Paks | Other 3rd party tools |

Infrastructure-as-a-service (IaaS) layer

IBM Cloud Infrastructure Center | Self-Service portal |

Infrastructure resource layer

| Compute | Storage | Network |

IaaS layer for Red Hat OpenShift deployments (hybrid cloud stack)

Guest provisioning for noncontainerized workloads

Conclusion:
When to use Linux on IBM Z
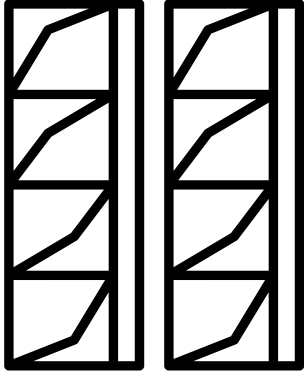
"I want to extend core services with Open Source, secure and high performance !"

- **Establish an enterprise database on Linux with 3D scalability**

- **Integration and messaging solutions** for zero downtime services with IBM spectrum Scale Storage and GDPS

- **Content management solutions**

- **Co-locate core services in low latency with Open Source services**

- **Integrate** traditional applications **with Cloud services** (private or public)

- **Integrate existing core HA/DR with Linux workloads (GDPS&xDR)**

- **Consolidate workloads and databases** to fewer servers

- **Extend the highest security** from traditional to Linux workloads

- **Leverage AI and Open Source** technologies on IBM Z

Conclusion:
When to adopt Containers & Red Hat OpenShift on IBM Z

"I need my cloud in my data center!"
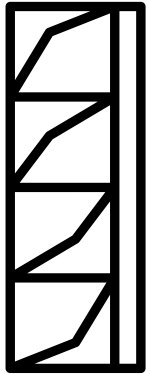
- **Modernize existing applications**, build Microservices and Containers
- **Integrate** traditional applications **with Cloud services** (private or public)
- **Enable a cloud-based delivery model in z/OS zCX**
- **Develop once** for all platforms (with ArgoCD)
- **Deploy and Run** apps where they fit best
- **Enable auto scalability** of workloads
- **Enable continuous operation** / high availability **per design**
- **Co-locate core services with private cloud services**
- **Consolidate workloads** to fewer servers
- **Extend security** from traditional to cloud services (crypto, txn security)
- **Leverage AI and Open Source** technologies on IBM Z

Performance Proof Points
Scale-up encrypted I/O operations with FCP

On IBM z16, scale up your I/O intensive Linux application and protect your data at rest with up to 12 million read-only I/O operations per second and 10 million R/W operations per second to an **encrypted filesystem** with FCP attached storage

DISCLAIMER: Performance results is extrapolated based on IBM internal tests running the fio 3.19 benchmark tool. The fio benchmarking tool was run with 128 parallel threads using 8 volumes on FS9200 equally distributed over the two nodes and file size of 150GB on each volume. z16 configuration: LPAR with 12 dedicated IFLs, 64 GB memory, RHEL 8.5 (SMT mode) running fio 3.19. Two FICON Express 32S cards and Linux XFS file system encrypted with luks2 per LPAR. Results may vary.
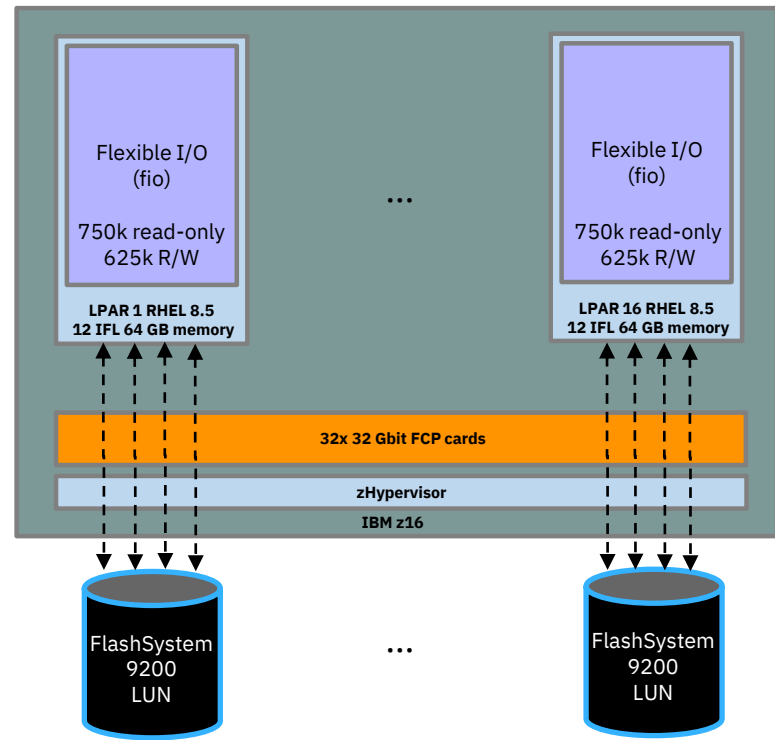
Maximum number of HTTPS transactions with complex microservices on IBM z16

With IBM z16, execute up to 20 billion HTTPS transactions per day with **OLTP microservice applications** running on RedHat OpenShift Container Platform

DISCLAIMER: Performance result is extrapolated from IBM internal tests running in an IBM z16 LPAR with 24 dedicated IFLs, 560 GB memory and DASD storage the Acme Air microservice benchmark (https://github.com/blueperf/acmeair-mainservice-java) on Red Hat OpenShift Container Platform (RHOCP) 4.9 using RHEL 8.4 KVM. On 4 RHOCP Compute nodes 4 Acme Air instances were running in parallel, each driven remotely from JMeter 5.2.1 with 384 parallel users. The KVM guests with RHOCP Compute nodes were configured with 12 vCPUs and 64 GB memory each. The KVM guests with RHOCP Management nodes and RHOCP Infrastructure nodes were configured with 4 vCPUs and 16 GB memory each. Results may vary.
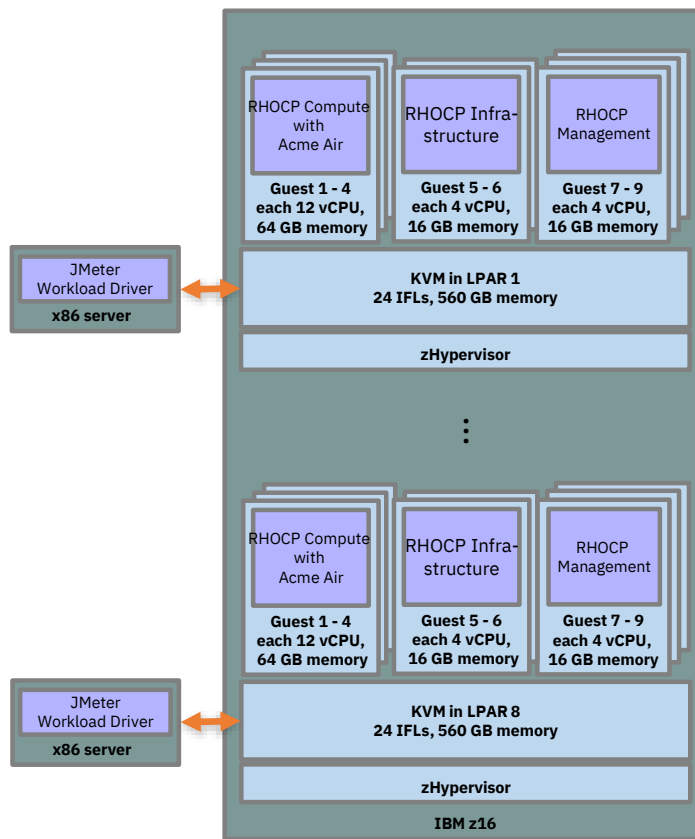
Scale-out Red Hat OpenShift Container Platform Compute Nodes and NGINX Pods on IBM z16

On IBM z16, scale-out to **512** Red Hat OpenShift Container Platform Compute Nodes and deploy up to **100.000** NGINX pods

DISCLAIMER: Performance result is extrapolated from IBM internal tests running in an IBM z16 LPAR with 24 dedicated IFLs, 1536 GB memory and FS9200 storage NGINX pods on Red Hat OpenShift Container Platform (RHOCP) 4.10 running on a RHEL 8.5 KVM host. 64 RHOCP Compute nodes with 230 NGINX pods were running in parallel. The KVM guests with RHOCP Compute nodes were configured with 2 vCPUs and 16 GB memory each. The KVM guests with RHOCP Management nodes were configured with 16 vCPUs and 128 GB memory each. Results may vary.
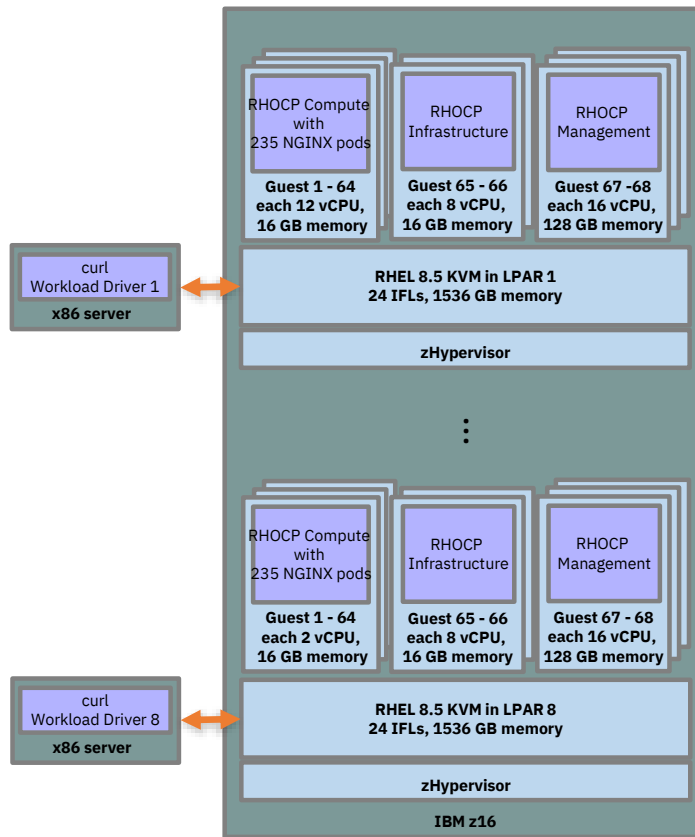
Conclusion:

Solutions are

a few steps ahead...

- Secure Data serving
- Dynamic workloads
- Multi-tenant environments
- Secure Cloud
- Blockchain integration

https://www.ibm.com/case-studies/search

zCX Resources

Getting Started

IBM Form #: SG24-8457-00

Use Cases
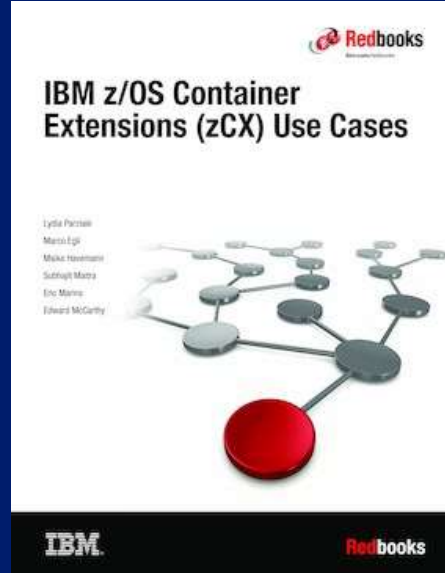
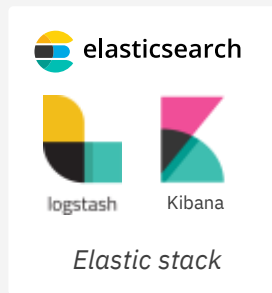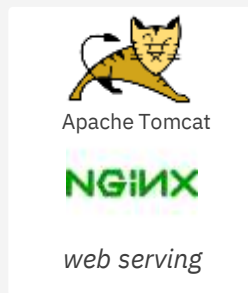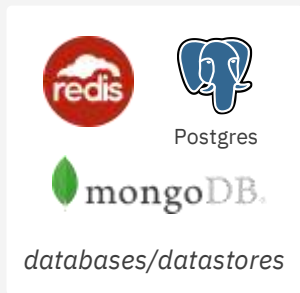IBM Form #: SG24-8471-00

IDC - The Road to Hybrid Multicloud

▪ Cloud adoption is not a destination. It is a journey with tremendous rewards for those who are willing to face daunting challenges on this path of digital transformation.

▪ The Holy Grail in cloud computing is a frictionless, hybrid multicloud that provides consistent experience and unified management across multiple public clouds, private clouds, and even traditional infrastructure.

▪ While such an idealistic state may never be attainable, enterprises need to continuously move towards this goal in small but deliberate steps. The infographic in this blog post presents a roadmap for the hybrid cloud journey, which involves three phases – single cloud, multiple clouds, and hybrid multicloud.

https://blogs.idc.com/2020/08/21/the-road-to-hybrid-multicloud/

IBM Z and LinuxONE Container Registry

foundational distros*

languages

registries, scanners

dashboards, UIs

shell, utilities

CI/CD infrastructure

messaging

* Red Hat base image available at Red Hat Marketplace
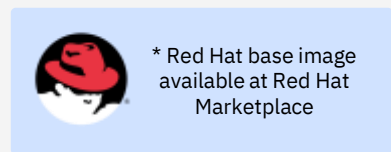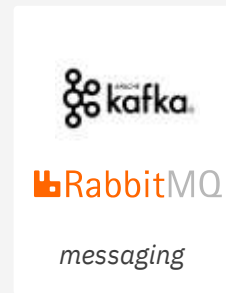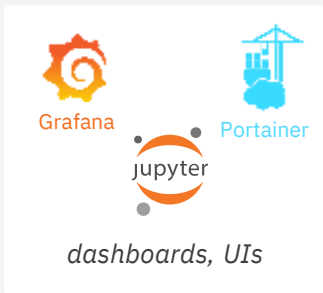
Many images, multiple versions, chosen based on customer input

databases/datastores

web serving

Elastic stack

Top 10 Containers

- Kafka
- Development-workspace
- Elasticsearch
- Logstash
- Ubuntu
- Grafana
- OpenJDK
- Alpine
- Portainer
- Tensorflow

Images in the pipeline

Official interface made available end of October, 2021

https://ibm.biz/BdfAdW

Questions?

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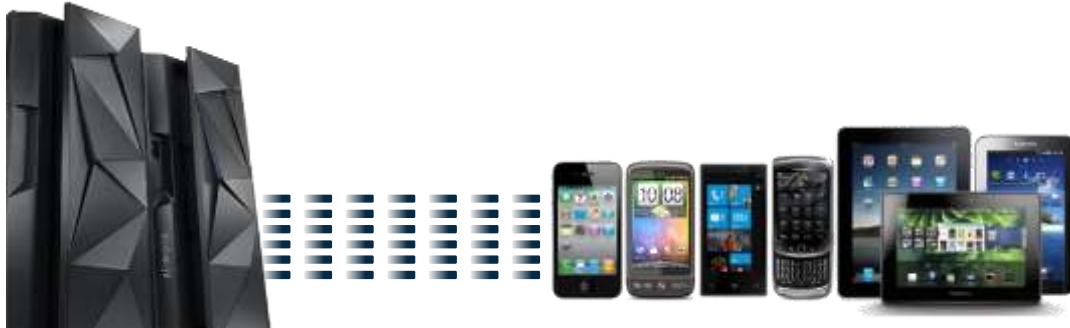
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