Discover the variety of Container technologies on IBM Z and LinuxONE

Wilhelm Mild
IBM Executive IT Architect
IBM R & D Lab Germany

Agenda

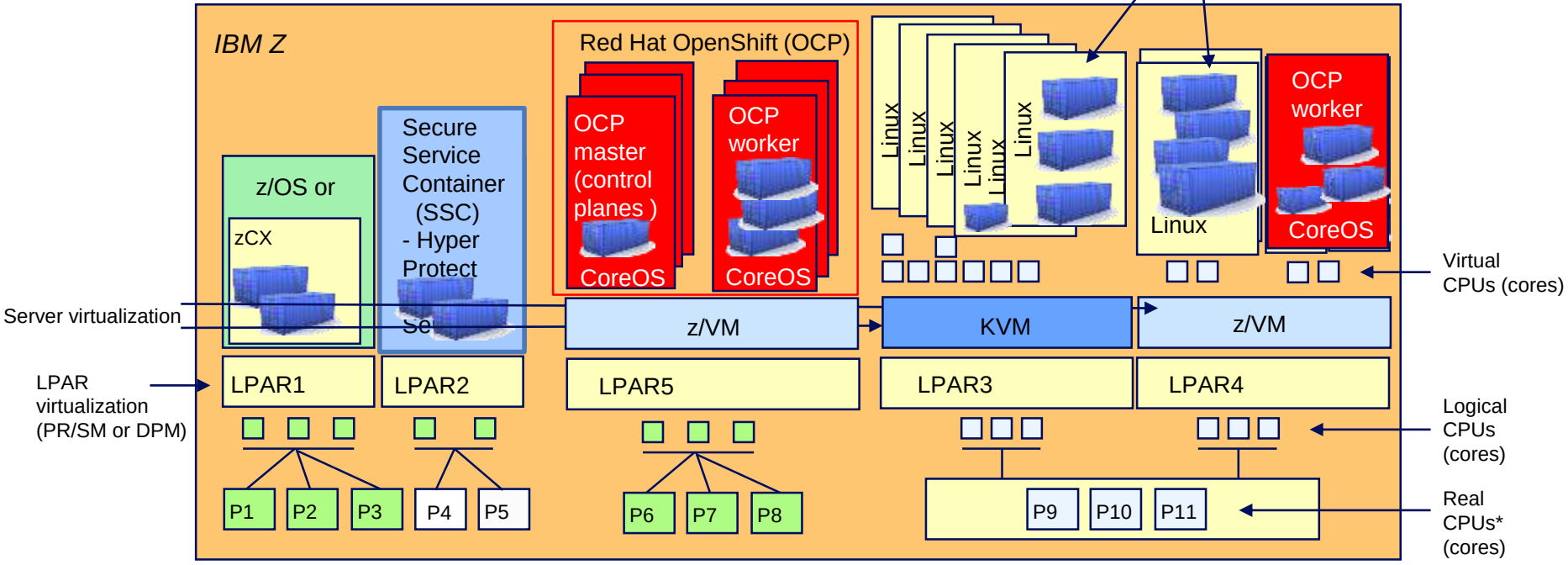
- **Container technologies and Ecosystem**
- **Container Orchestration**

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 environment.

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



P1 – P11 are Central Processor Units (CPU -> core) or Integrated Facility for Linux (IFL) Processors (IFL -> core)

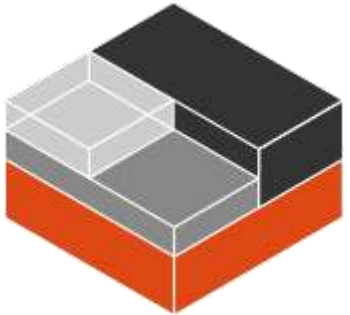
* - One shared Pool of cores per System only

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

Containers in Linux – for application isolation

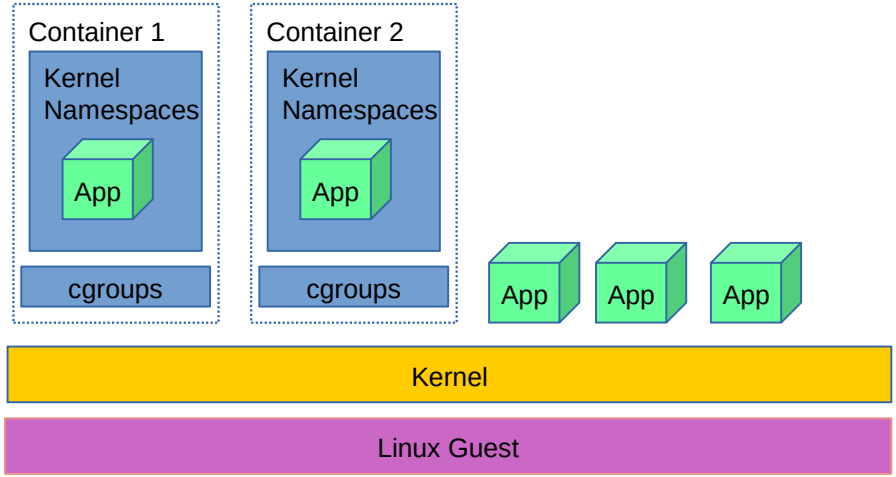
- linuxcontainers.org is the umbrella project behind Linux Containers (LXC), Linux Container management (LXD), Linux Container FileSystem (LXCFS) and Linux cgroup manager daemon (CGManager).
- **The goal was to offer a Linux distro and vendor neutral environment for the development of Linux container technologies.**
- The main focus is system containers, that offer an environment as close as possible as the one you'd get from a VM but without the overhead that comes with running a separate kernel and simulating all the hardware.
  This is achieved through a combination of kernel security features such as namespaces, mandatory access control and control groups (cgroups).

- Container goals and characteristics:
  - Isolated application environments within a Linux OS instance
  - Each container has its own, different address (name) space but same kernel
  - Serve a single task
  - Self contained set of files for applications
  - Startup time and efficiency compare to native execution



Linux control groups and namespaces are used for isolation

- To simplify:
  - “**cgroups**” will allocate & control resources in your container
    - CPU
    - Memory
    - Disk I/O throughput
  - “**namespace**” will isolate
    - process IDs
    - Hostnames
    - User IDs
    - network access
    - interprocess communication
    - filesystems



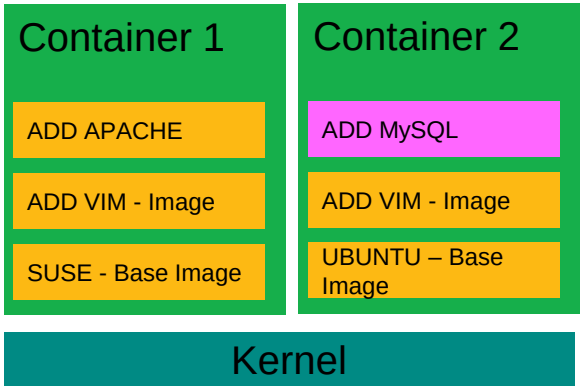
Linux Containers vs. virtual server

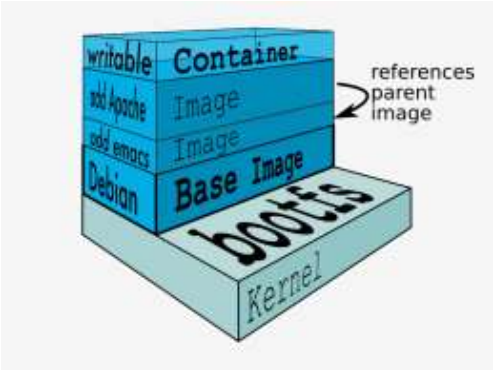
Virtualization, usually provides a **high level of isolation** and security as all communication between the guest and host is **through the hypervisor**.

- It is also usually slower 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**





Docker and Containers

In 2014, Docker teamed with Canonical, Google, Red Hat, and Parallels to create a standardized open-source program libcontainer that allows containers to work within Linux namespaces and control groups (cgroups) without needing administrator access. Docker initially used lxc as underlying technology to communicate with the kernel, today, it uses the libcontainer library.

Docker is one implementation of Linux containers and their management

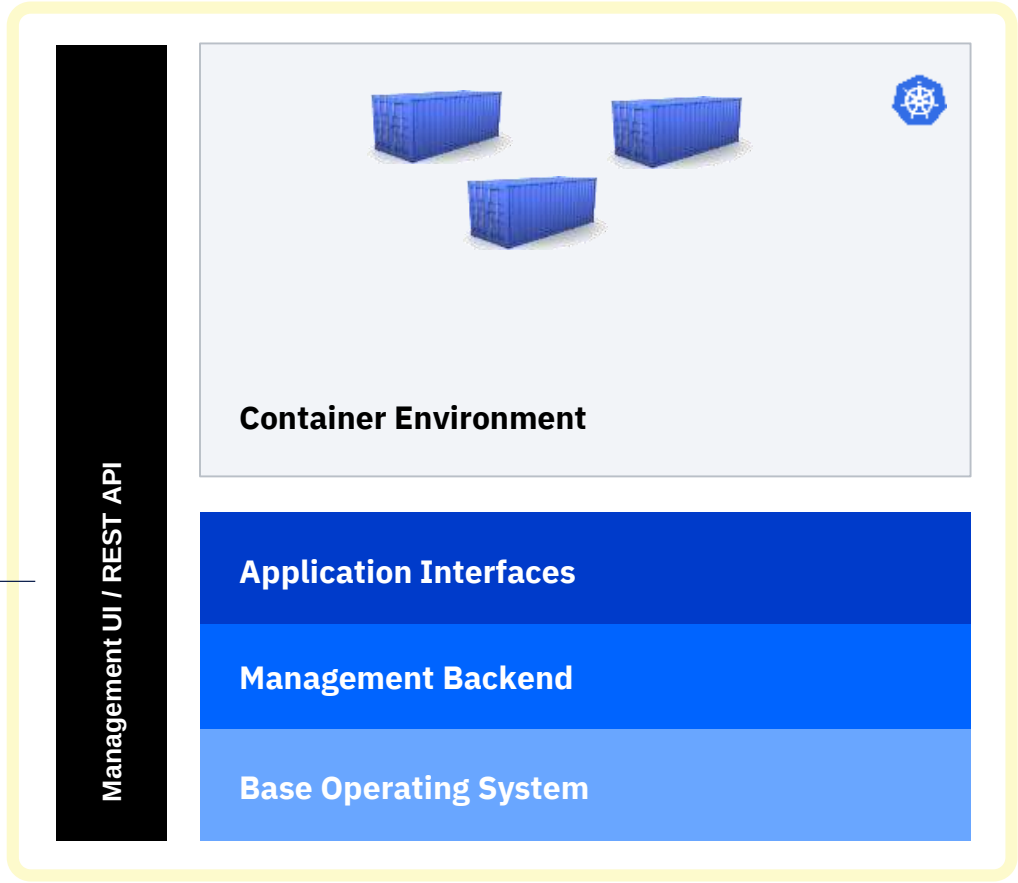
- Open, portable, light-weight run-time and packaging tool
- Container in standard operating environment and delivery vehicle for applications with wildly different requirements
  - Much faster to spin-up and efficient to run than a VM
  - Isolated from each other
- Easily build and ship complex application, without worrying about infrastructure differences or interference from other software stacks
- Quickly and reliably deploy and run applications on many infrastructures
- Essential for horizontally scaling apps on the cloud

IBM Secure Service Container (SSC) – Hyper Protect services everywhere

- **SSC is a special LPAR** and provides simplified mechanism for fast deployment and management of packaged solution
- Provides tamper protection during installation and runtime
- Ensures confidentiality of data and code -at flight and at rest
- Management provided via Remote APIs (RESTful) and web interfaces only
- Enables containers to be delivered via distribution channels

IBM Secure Service Container Appliance

Deploy your container workload in a highly secure environment



Enterprise IBM Hyper protect services based on Containers in SSC

IBM Cloud Hyper Protect Crypto Services
Infuse the highest level of security with data encryption and key management capabilities into your apps. http://ibm.biz/hpcrypto

IBM Blockchain Platform
Deploy Blockchain on IBM Cloud in a Hyper Secure environment on LinuxONE.
https://www.ibm.com/blockchain/platform

IBM Cloud Hyper Protect DBaaS
Retain your data in a fully encrypted client database without the need for specialized skills.
http://ibm.biz/hpdbaas

IBM Hyper Protect Virtual Servers
Create Linux VMs with own public ssh key to maintain exclusive access to code and data
http://ibm.biz/hpvserv

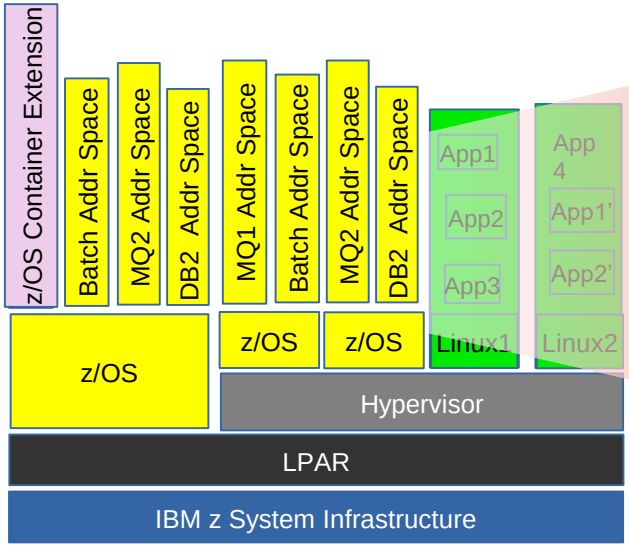
Hyper secure services are based on IBM Secure Service Containers, a special type of Hyper protect LPAR in IBM Z.

IBM Db2® Analytics Accelerator is a high-performance component tightly integrated with Db2 for z/OS® for high-speed processing for complex Db2 queries and analytic workloads.
https://www.ibm.com/products/db2-analytics-accelerator

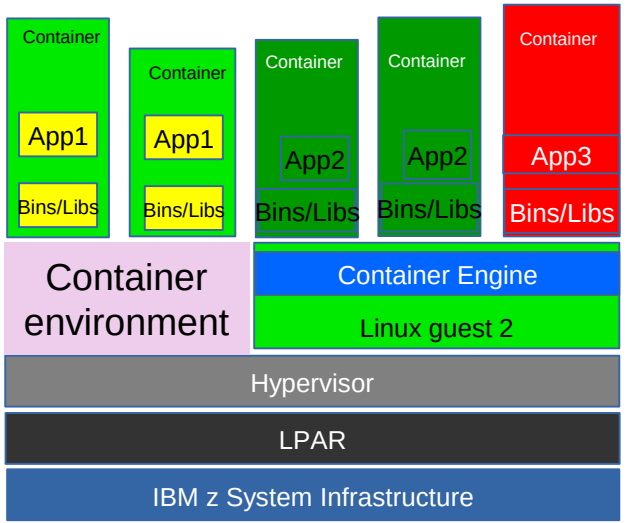
https://www.ibm.com/cloud/hyper-protect-services

Application isolation is long tradition in IBM Z

z/OS and Linux virtualization



Docker Container deployment in Linux



Virtualization:

- Infrastructure oriented
- Virtual server resource management
- Several applications per server
- Isolation per virtual server

Containers:

- Service oriented
- Application management via container
- Solution decomposed into several units
- Dynamic, isolation in container

Container in IBM z/OS Version 2 Release 4

- z/OS V2.4 introduced **IBM z/OS Container Extensions**,
  - **execute Linux® on IBM Z Docker container in z/OS, alongside existing z/OS applications and data.**

- **z/OS Container Extensions**:
  - enable application developers to develop and data centers **to operate popular open source packages, Linux applications, IBM software, and third-party software** together with z/OS applications and data-leveraging industry standard skills.

- Enables the **capability to integrate z/OS more easily into private and multicloud environments**
  - with improvements to deliver a more robust and highly available IBM Cloud™ Provisioning and Management for z/OS and cloud storage access for z/OS data

https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=ca&infotype=an&supplier=897&letternum=ENUS219-344

z/OS Container Extensions– A turn-key Virtual Docker Server

New

Pre-packaged Docker Environment provided by IBM

- Includes Linux and Docker Engine components
- Supported directly by IBM
- Can include clustering and registry capabilities
- Initial focus is on base Docker capabilities
- Competitive price/performance (Exploits zIIPs)

Application developers can deploy software using Docker interface

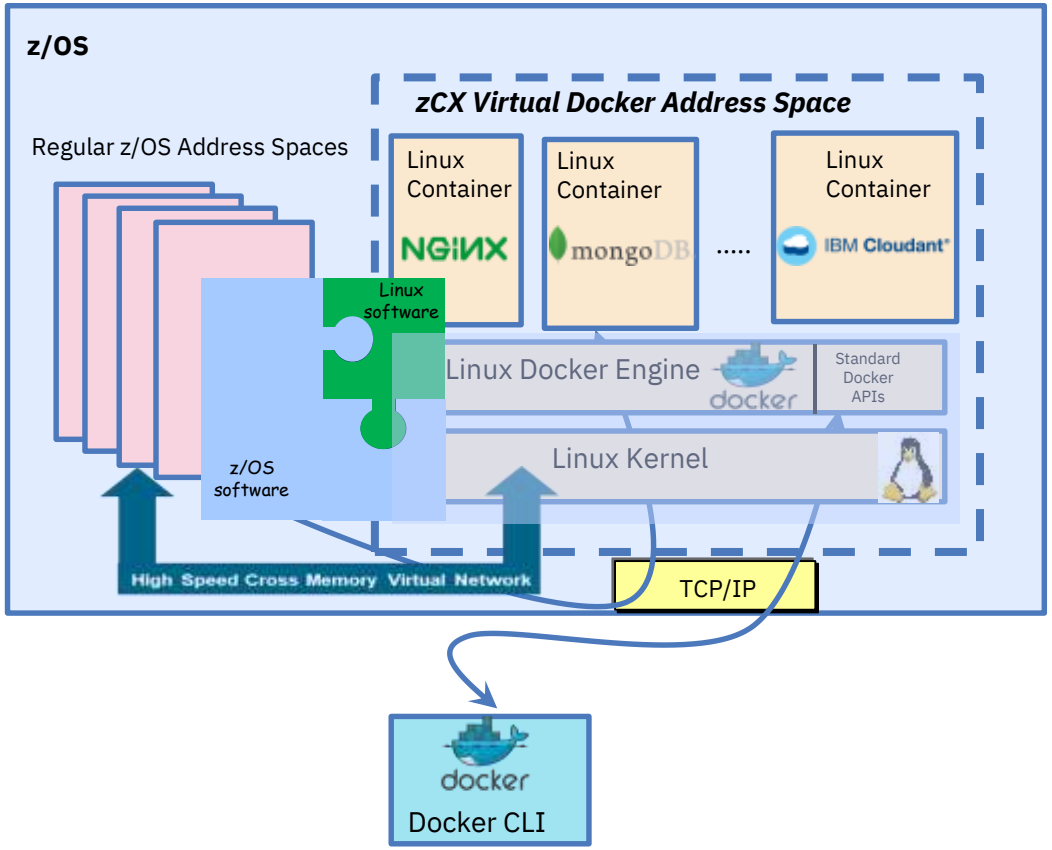
- Any software available as a Docker image (s390x) - growing ecosystem available on Docker Hub
- Any home-grown Linux on Z container images
- Using standard Docker interfaces

Limited visibility into Linux environment

- No root access
- Access as defined by Docker interfaces
- Limited Linux administrative overhead
- Secure virtual network - SAMEHOST

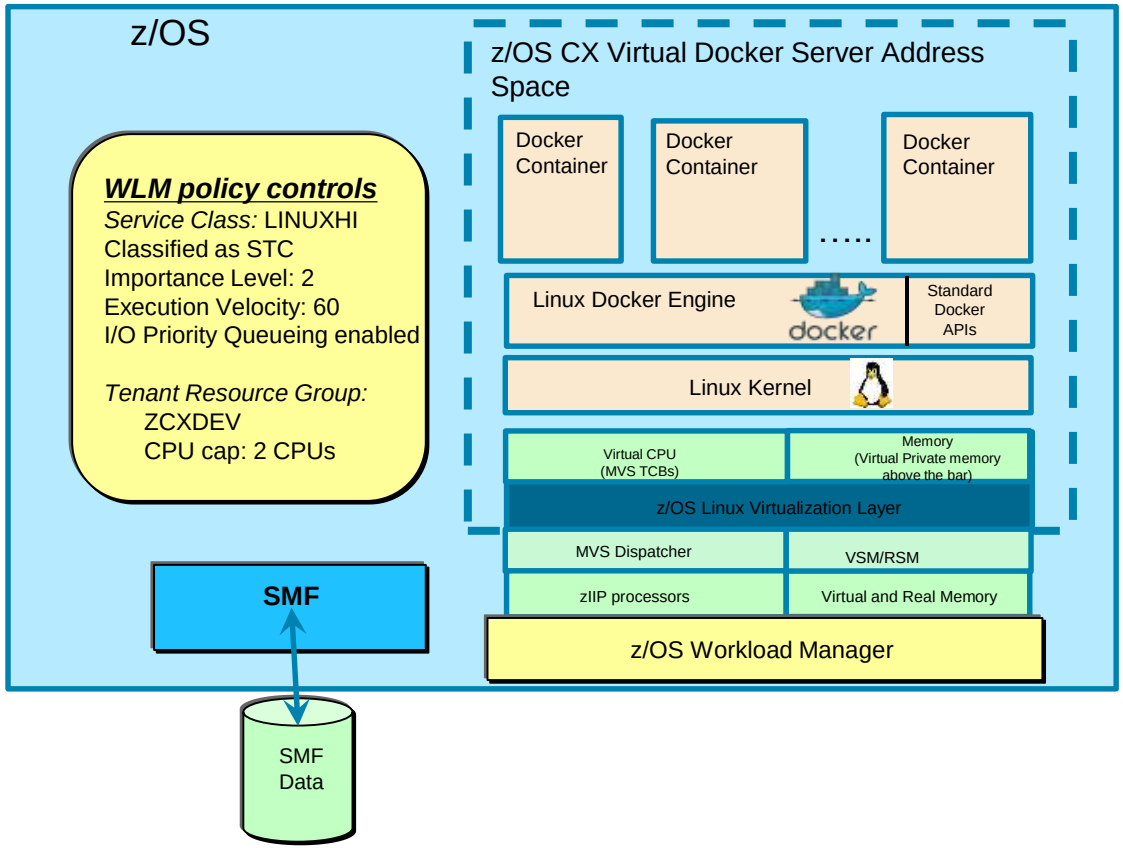
Also provides IBM and ISVs a means of delivering solutions into this environment

- Requires packaging of software as Docker images



IBM zCX - CPU, Memory and Workload Management

- Memory Management
  - Provisioned per zCX Docker Server address space
  - Private, above the 2GB bar Fixed Memory
  - Managed by VSM, RSM
- CPU Management
  - Virtual CPUs provisioned to each zCX Docker Server address space
    - Each virtual CPU is a dispatchable thread (i.e. MVS TCB) within the address space
    - zIIP CPU access via MVS dispatcher
  - A zCX instance can host multiple Docker Container instances
- Normal WLM policy and resource controls extend to zCX Docker Server address spaces
  - Service Class association, goals and Importance levels
  - Tenant Resource Group association
    - Optional caps for CPU and real memory
- Normal SMF data available
  - SMF type 30, 72, etc.
  - Enables z/OS performance management and capacity planning



Deploying Multiple zCX Address Spaces

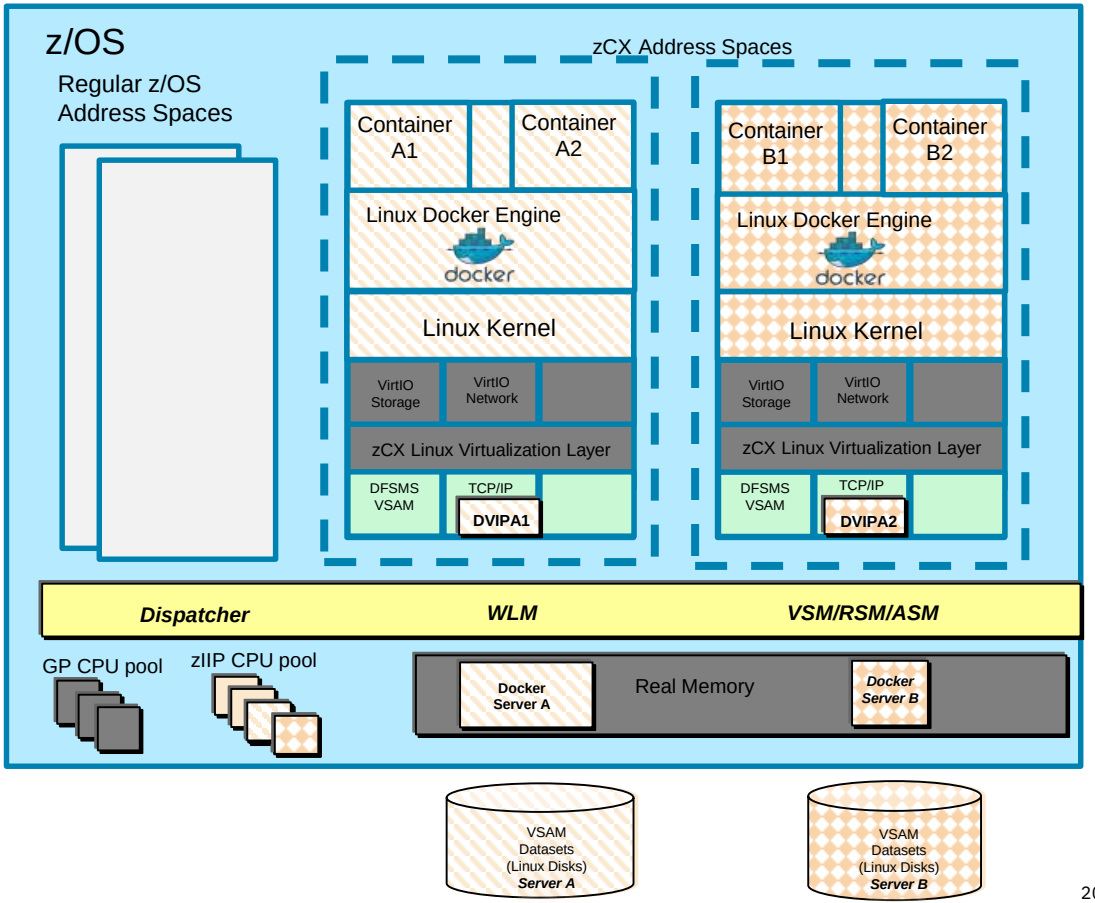
Multiple zCX instances can be deployed within a z/OS system for:

- Isolation of applications (containers)
- Different business/performance priorities (i.e. unique WLM service classes)
- Capping of resources allocated for related workload (CPU, memory, disk, etc.)

Each zCX address space:

- Has specific assigned storage, network and memory resources
- Shares CPU resources with other address spaces
- WLM policy controls can influence resource access

The z/OS Dispatcher, WLM and VSM/RSM components manage access to CPU and memory



IBM zCX - Goals & Qualities of Service

Integrated Disaster Recovery & Planned Outage Coordination	z/OS Storage Resilience	z/OS Networking Virtualization, Security & Availability	z/OS Workload Management, Capacity Planning & Chargeback
Using z/OS DR/GDPS to cover storage used by Linux automatically, integrated restart capabilities for site failures, etc. Integrated Planned Outage Coordination No need to coordinate with non-z/OS administrators when planning a maintenance window, moving workloads to alternate CECs, sites, etc.	Eliminate single points of failure Exploit z/OS VSAM which offers transparent encryption, and failure detection with HyperSwap Configuration validation, I/O health checks, Automatic exploitation zHyperLink and future z/OS Storage enhancements	Support for VIPAs, Dynamic VIPAs allowing for non-disruptive changes, failover, and dynamic movement of the workload. High speed and secure communications with Cross-Memory Virtual Network Interface (SAMEHOST)	WLM: Service Class goals, Business Importance levels, ability to cap resource consumption (CPU and memory) Capacity Provisioning Manager (CPM) support SMF support for accounting and chargeback

Why consider containers on IBM Z ?

- **Highest scalability on one footprint on IBM Z**

- **Most securable platform and containers profit from the capabilities**
- **Encryption performance with the Crypto accelerators and CPACF on each core**
- **New Linux software components and solutions in z/OS**
- **No software-level dependencies** between containers or to the host
- **Re-use** of same components in different Ops scenarios (test, QA, Prod)
- **Micro-services** implementation flexibility

- **Portability and Multi-platform** deployment through generic build description

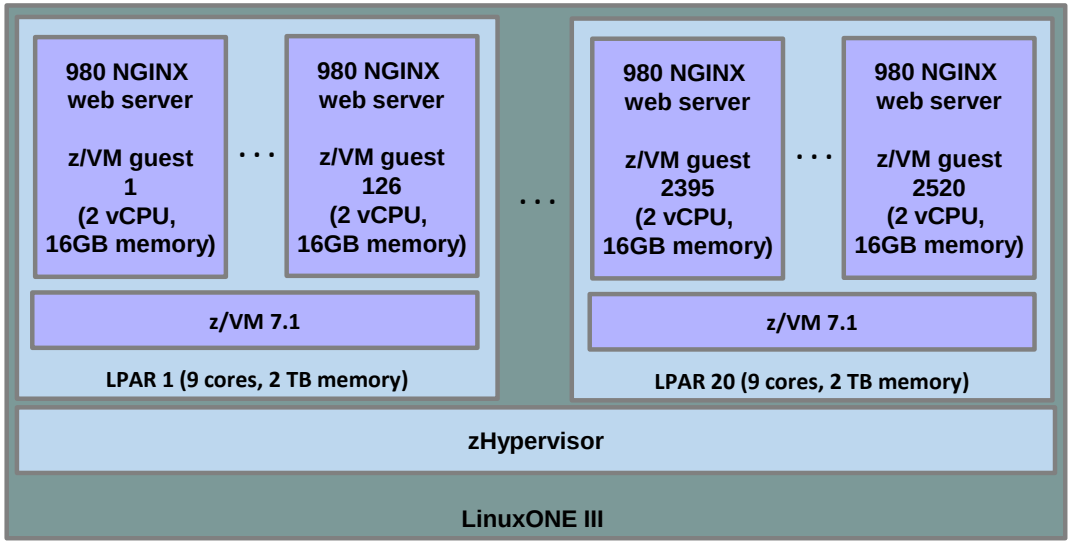
- **High Density** through lightweight container implementations in Linux kernel

- **Bridges Dev to Ops** with consistent tooling and environment

Container Scale-out Performance

Scale-out with Container under z/VM on LinuxONE III

Scale-out to 2.4 million Docker containers in a single LinuxONE III system



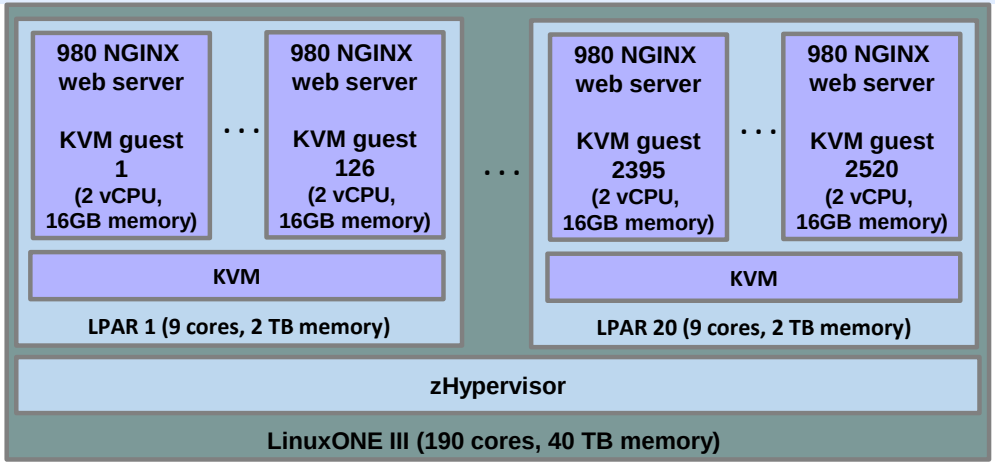
DISCLAIMER: Performance result is extrapolated from IBM internal tests running in a LinuxONE III LPAR with 1 dedicated core and 16 GB memory 980 NGINX Docker containers. Results may vary. Operating system was SLES12 SP4 (SMT mode). Docker 18.09.6 and NGINX 1.15.9 was used.

Container Scale-out Performance

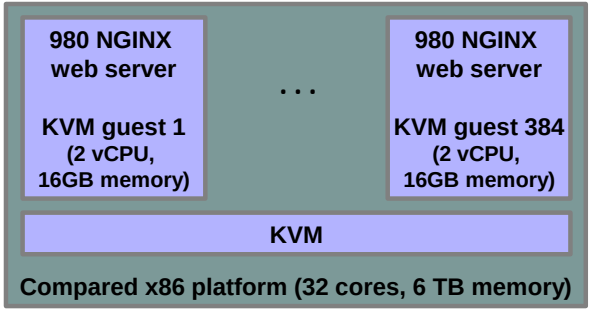
Scale-out under KVM on LinuxONE III versus x86 Skylake

Run up to 6.6x more Docker containers under KVM on a LinuxONE III system versus a compared x86 platform

DISCLAIMER: Performance result is extrapolated from IBM internal tests running 980 NGINX Docker containers in a LinuxONE III LPAR and bare-metal on a x86 server. LinuxONE III measurement configuration: LPAR with 1 dedicated core, 16 GB memory, running SLES 12 SP4 (SMT mode), Docker 18.09.6, NGINX 1.15.9. x86 measurement configuration: 1 Intel® Xeon® Gold 6126 CPU @ 2.60 GHz with Hyperthreading turned on, 16 GB memory, running SLES 12 SP4, Docker 18.09.6, NGINX 1.15.9. Based on the measurement results it is extrapolated that a LinuxONE III server with 190 cores and 40 TB memory can run 2.469 million NGINX Docker containers if configured with 20 LPARs, each having 9 cores, 2 TB memory, and running a KVM 2.11.2 instance with 126 KVM guests, each configured with 2 vCPUs, 16 GB memory, and running 980 dockerized NGINX web server. Based on the measurement results it is extrapolated that a x86 server with 8 Intel® Xeon® Platinum 8156 processors (32 cores in total) and 6 TB memory can run 376 thousand NGINX Docker containers if configured with KVM 2.11.2 with 384 KVM guests, each configured with 2 vCPUs, 16 GB memory, and running 980 dockerized NGINX web server. Results may vary.

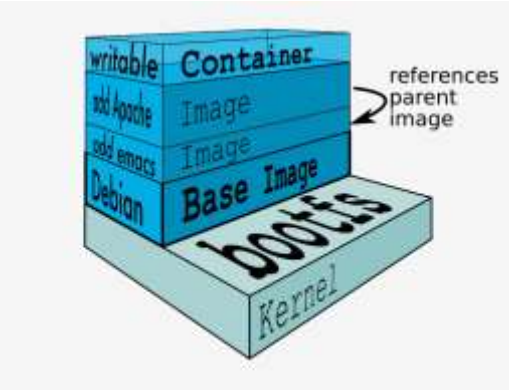


2.4 million Docker container on LinuxONE III w/ 40 TB memory
versus
376 thousand Docker container on a x86 server w/ 6 TB memory

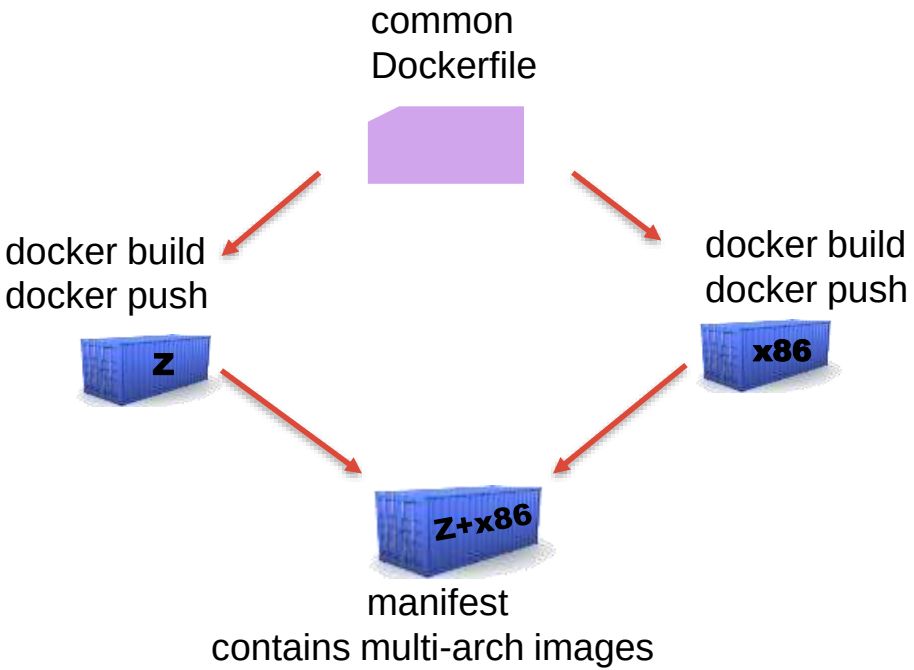


Portability of Container & Multi Architecture support

- **Container user experience (CLI, REST API) is identical across platforms**
- **Container images are not portable**, the source code or a s390x binary must be build and available
- Micro-service architectures often have clean structure and simple individual components
- Containers are often created with Dockerfiles (build descriptions) containing:
  - Specification of the base image
    - If the same distribution is available on s390x, usually simple
    - If the base image is not available, some creativity is required
  - Additional steps to modify the image are often platform independent
    - Add packages (needs to match the base image)
    - Download files, Perform build
- Same Dockerfile can be used for multi-platform builds
- Multi-arch Registry support available using external tools (i.e. manifest tool)
  - http://containerz.blogspot.com.br/2016/07/multi-arch-registry.html



Manifest tool - creates Multi – Architecture Container Images

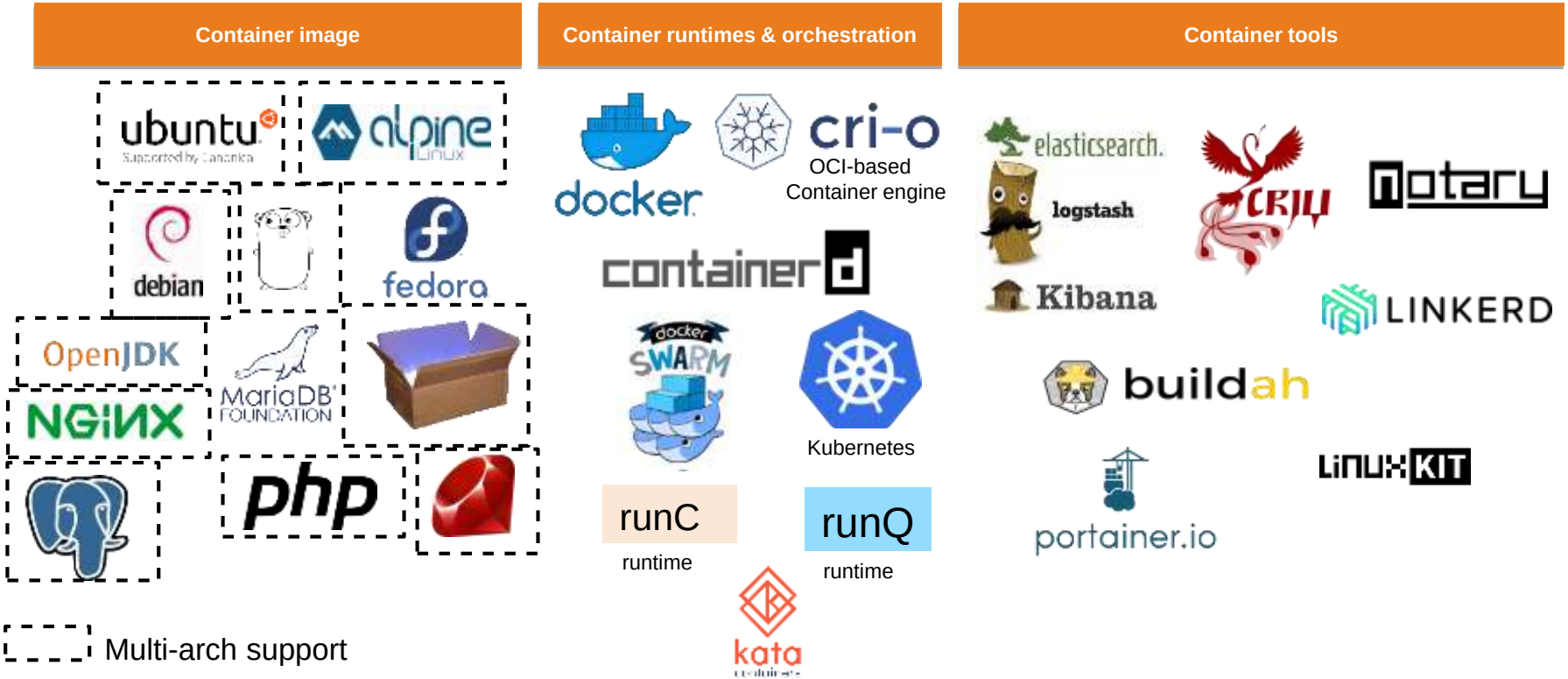



```
image: webapp:latest
manifests:
-
image: webapp-s390x
platform:
architecture: s390x
os: linux
-
image: webapp-amd64
platform:
architecture: amd64
```

Container images on Docker Hub are multi-arch

- lots of images as s390x versions available

Container Ecosystem evolved for IBM Z



The OCI Initiative

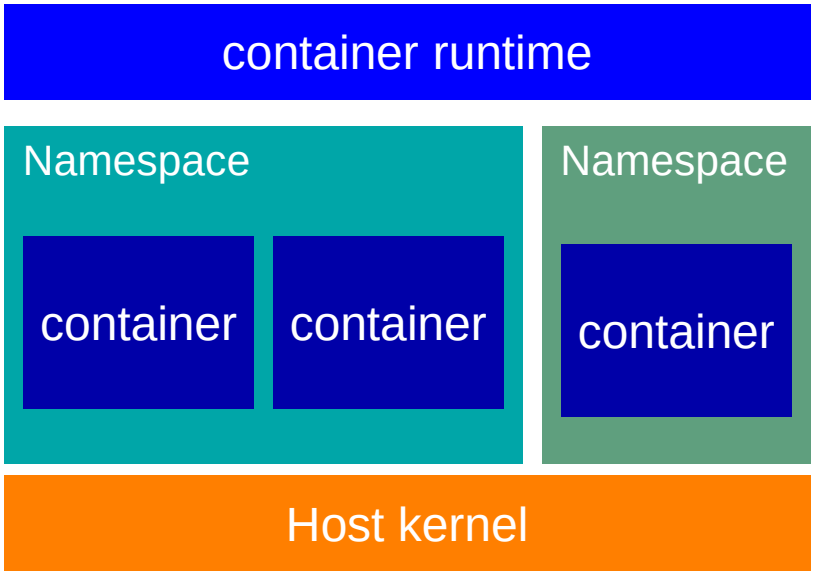
https://www.opencontainers.org/

The Open Container Initiative (OCI) is a lightweight, open governance structure (project), formed under the auspices of the Linux Foundation, for the express purpose of **creating open industry standards around container formats and runtime**.
The **OCI was launched on June 22nd 2015** by Docker, CoreOS and other leaders in the container industry

Two specifications:
Image Specification : define an OCI Image then it will be unpacked into an OCI Runtime filesystem bundle
Runtime Specification: how to run a “filesystem bundle” that is unpacked on disk.
‘runc’ implements the runtime specification

Container components

(1) - runtimes



Containers are processes that run isolated from the other processes on the host:

- The **isolation is achieved by namespaces and cgroups**
- The **host kernel** is **shared** between the host and all containers

Container Runtimes:

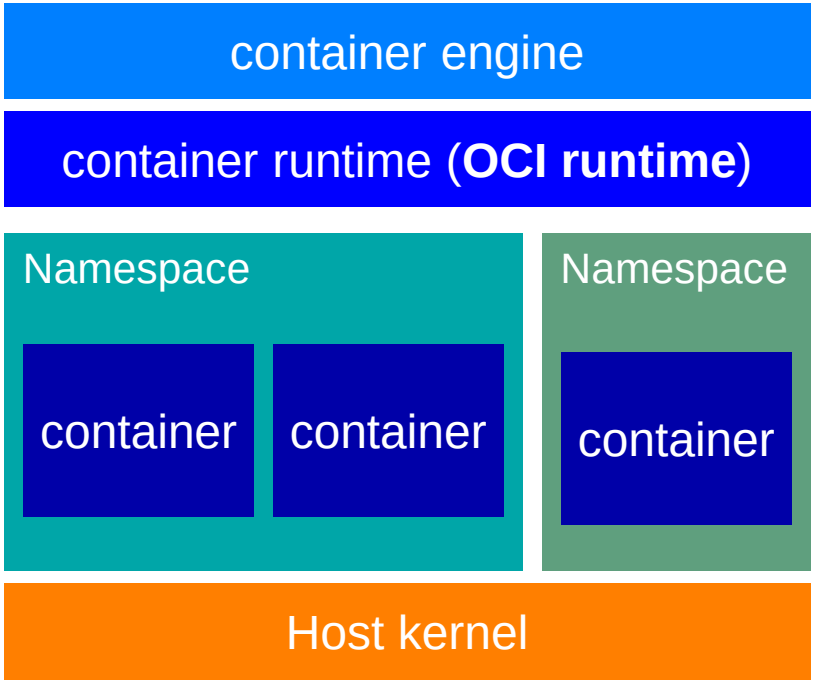
- A container runtime is a lower level component, typically used in a Container Engine but can also be used by hand for testing.

runc is one of the most used container runtimes

Other runtimes beside ‘runc’, e.g. ‘runq’ and ‘Kata’

Container components

(2) Container engines



A **Container engine** manages the container lifecycle

- Pull the image
- Create the container filesystem from image with Copy-on-write strategy
- Run the container
- Logging
- Debugging

Different container engines exist, e.g. Docker, CRI-O, containerd, podman...

Container engines diversity

- A stable, core, performant core container runtime for the cloud
- Has a CRI implementation, and is a CNCF graduated project

- “all the runtime Kubernetes needs and nothing more”; RH created CRI implementation over runc and 2 open libraries; K8s incubator

- Intel Clear Containers + Hyper.sh combined project
- Lightweight virtualization (KVM/qemu) under cri-o and containerd

- Amazon open source project announced Nov 2018; lightweight virt.
- Uses Rust-based VMM instead of qemu; plugs into containerd

- CRI implementation over Sylabs Singularity runtime project
- Userbase traditionally from academia/HPC use cases

Container in Red Hat & OpenShift

Red Hat headed towards a world without any Docker

- **Cri-o** is only one component (the Kubernetes CRI runtime) of OpenShift
- RHEL will not deliver a modern Docker engine; Red Hat will replace it with:
  - **podman** (docker client clone); **skopeo** (registry); **buildah** (docker build..)

Red Hat dedicated customers will not have Docker

Alternative container engine

Red Hat provides an alternative container ecosystem tooling

Available from RHEL 8 and Fedora 29:

- Container deployment: **podman**
- Container building: **buildah**
- Container Registry: **Quay**
- Manage container images and registry: **skopeo**

- Cri-o: container engine used in Red Hat Openshift V4

Container build: Docker vs Podman

> docker build –f Dockerfile .

Daemon: all operations manages by a single deamon. Single point of failure.

Root privileges: all Docker operations have to be conducted by a user (or users) with the same full root authority

Networking: CNR and CNI plugins support

User friendly: straightforward to use and a lot of examples, documentation and tooling available

> podman build –f Dockerfile .

Daemon less: a podman instance pro container

Run container rootless: user without root privileges can start containers

Networking: only CNI plugin support

User friendly: goal to offer the same user experience as docker. Less documentation and not all the flags available for docker are available in podman

These tools are all building OCI compliant container imagers and can be used with different container runtimes.

Deployment: Podman vs. Docker

https://developers.redhat.com/blog/2019/02/21/podman-and-buildah-for-docker-users/

The claim is made:

- **if you have existing scripts that run Docker you can create a docker alias for podman and all your scripts should work**
  (alias docker=podman)

When you first type

'**podman images**' - you might be surprised that you don't see any of the Docker images you've already pulled down – running it as user vs as root.

Podman's local repository is in /var/lib/containers instead of /var/lib/docker

This isn't an arbitrary change; this new storage structure is based on the Open Containers Initiative (OCI) standards.

Setup Podman / Buildah:

There are a few things to unpack here and we'll get into each one separately:

- You install Podman instead of Docker. You do not need to start or manage a daemon process like the Docker daemon.
- The commands you are familiar with in Docker work the same for Podman.
- Podman stores its containers and images in a different place than Docker.
- Podman and Docker images are compatible.
- Podman does more than Docker for Kubernetes environments.

What is buildah and why might I need it?

- *Buildah* can be described as a *superset of podman* commands related to creating and managing container images and it has much finer-grained control over images.
- Dynamic mounts i.e. secrets, volumes, can only be made with buildah

https://github.com/containers/libpod/blob/master/docs/tutorials/podman_tutorial.md

https://github.com/containers/buildah/tree/master/docs/tutorials

You may wish to keep Docker around while you try out Podman.
There are some useful tutorials and an awesome demonstration available.

Availability of Container Tools on IBM Z

Docker is available and supported in

Ubuntu 16.04 and later

RHEL 7.5 - 7.7 via *extras* repository

SLES 15 – SLES 15 SP1

Podman is available and supported in

RHEL 7.5 and later

SLES15 SP1

Docker as community edition:

Ubuntu 16.04 and later

Fedora 28 and later

Red Hat

	docker	podman
RHEL 7.5	1.13	0.9.2
RHEL 7.6	1.13	1.4.4
RHEL 7.7	1.13	1.4.4
RHEL 8	-	1.0.0.2
RHEL 8.1	-	1.4.2

SUSE

	docker	podman
SLES15	17.09	-
SLES15 SP1	18.09.1	1.0.1

Ubuntu

	docker	podman
16.04 LTS	18.09.7	-
18.04 LTS	18.09.7	-

Agenda

- Container technologies and Ecosystem
- Container Orchestration

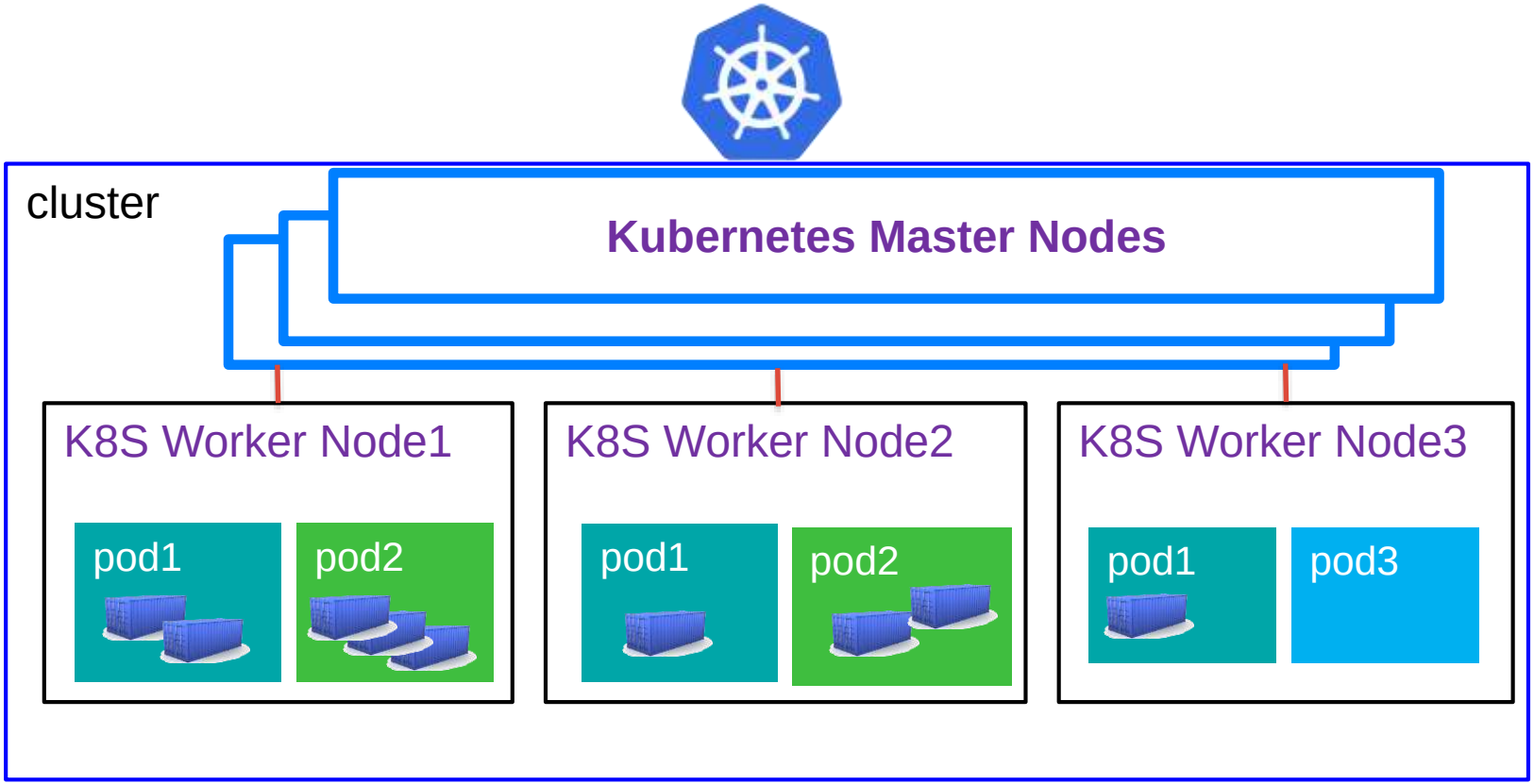
Container Orchestration

- Kubernetes and Docker Swarm build the base ecosystem
  - Based on identical source code
  - IBM Z binaries are built as part of the release process

- Kubernetes and Docker Swarm mixed architecture development and deployment

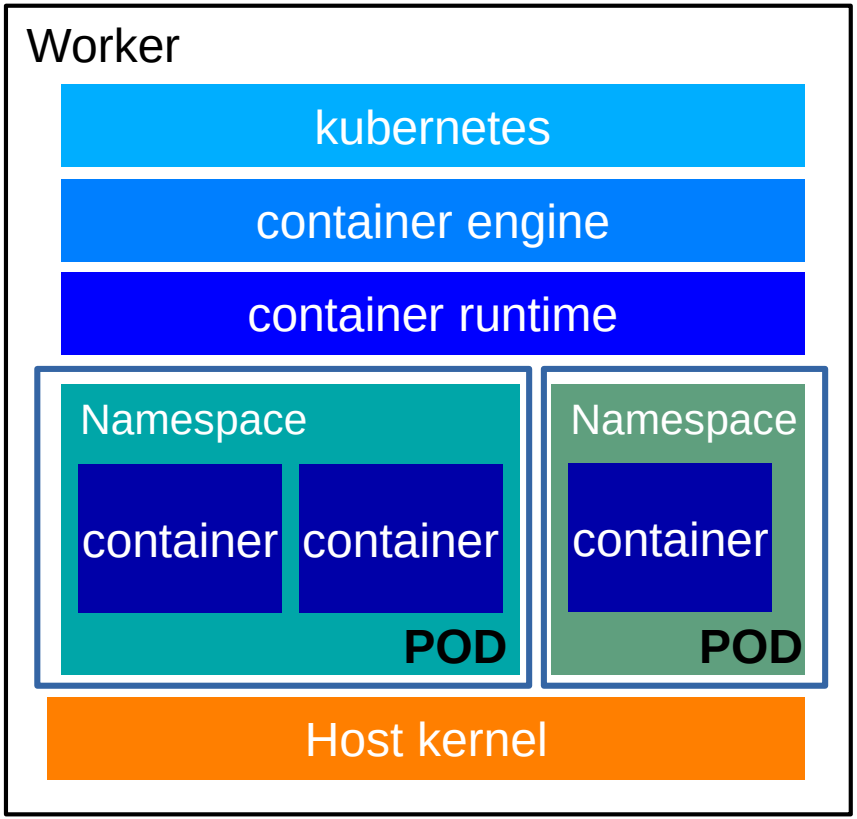
- Docker Hub Content (images) valid for both orchestrators
- Both products run on Linux on Z

Kubernetes (K8S) – defines itself in a cluster format



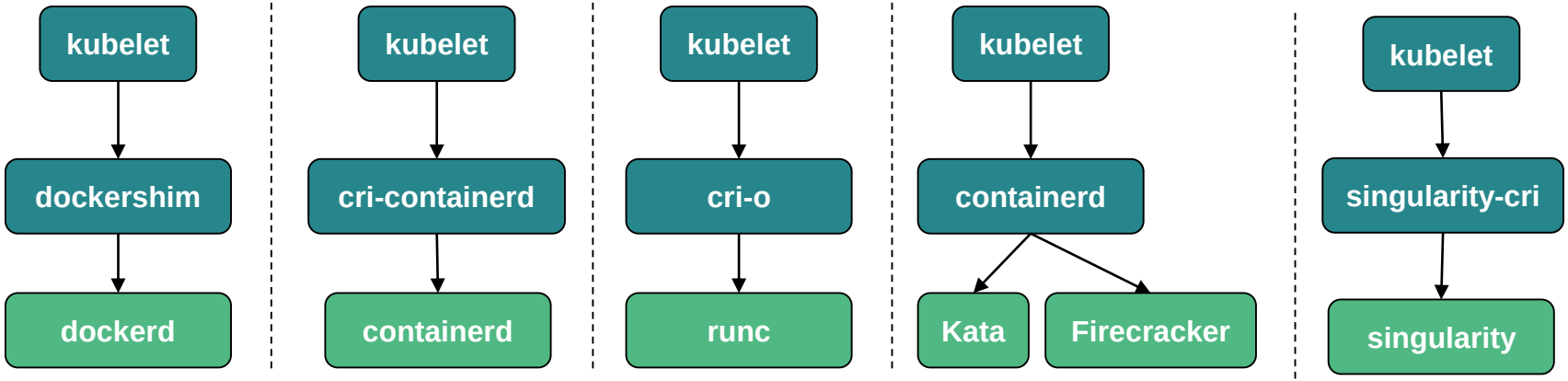
Kubernetes is not running container – it orchestrates them

Kubernetes (k8s) - worker node architecture



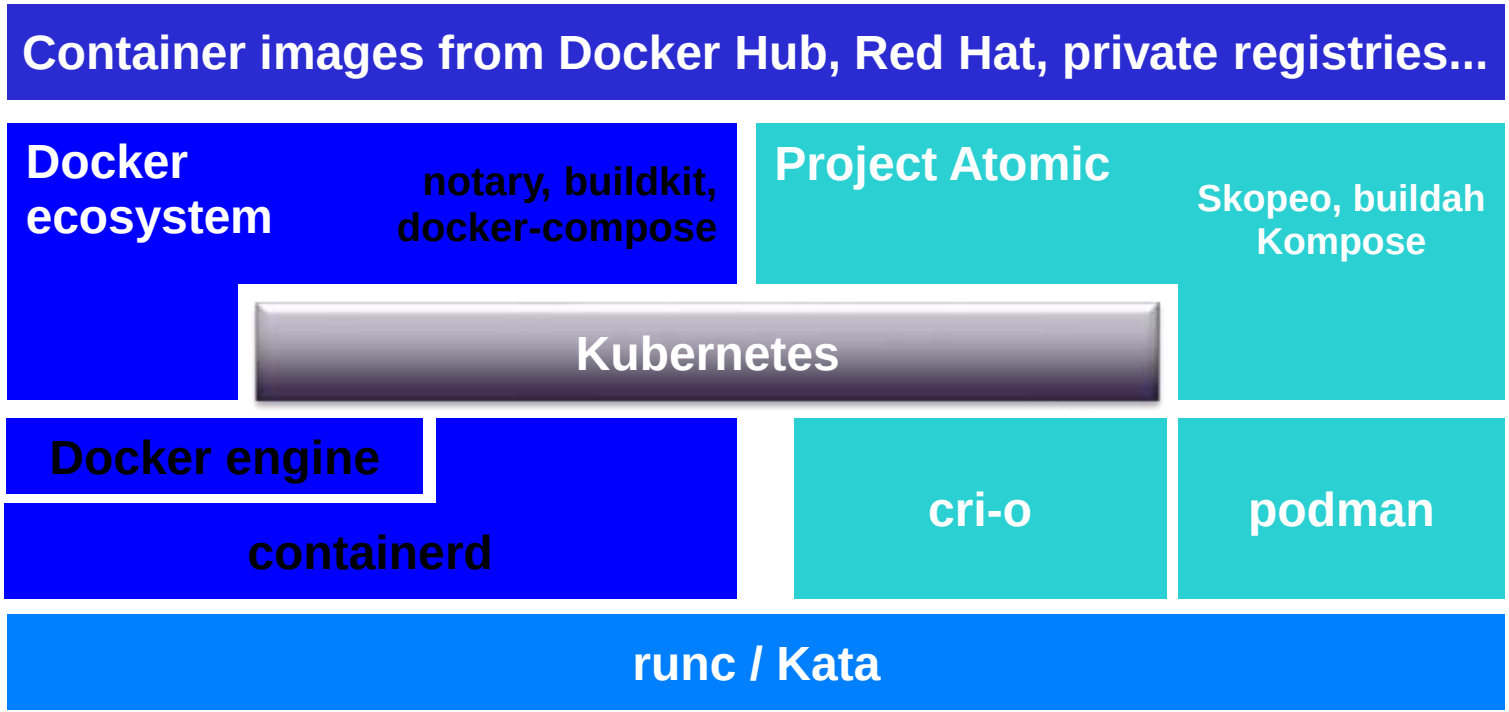
- **Kubernetes** is a container **orchestration** tool for automation, application deployment, scalability and container management
- It groups containers in a unit called **Pod**
- It deploys container using a container engine
- The *kubelet* is the primary “node agent” that runs on each node
- Easy to extend through its API
- Huge ecosystem around Kubernetes API

Diversity of CRI Runtimes to Kubernetes today



kubelet --container-runtime {string}
--container-runtime-endpoint {string}

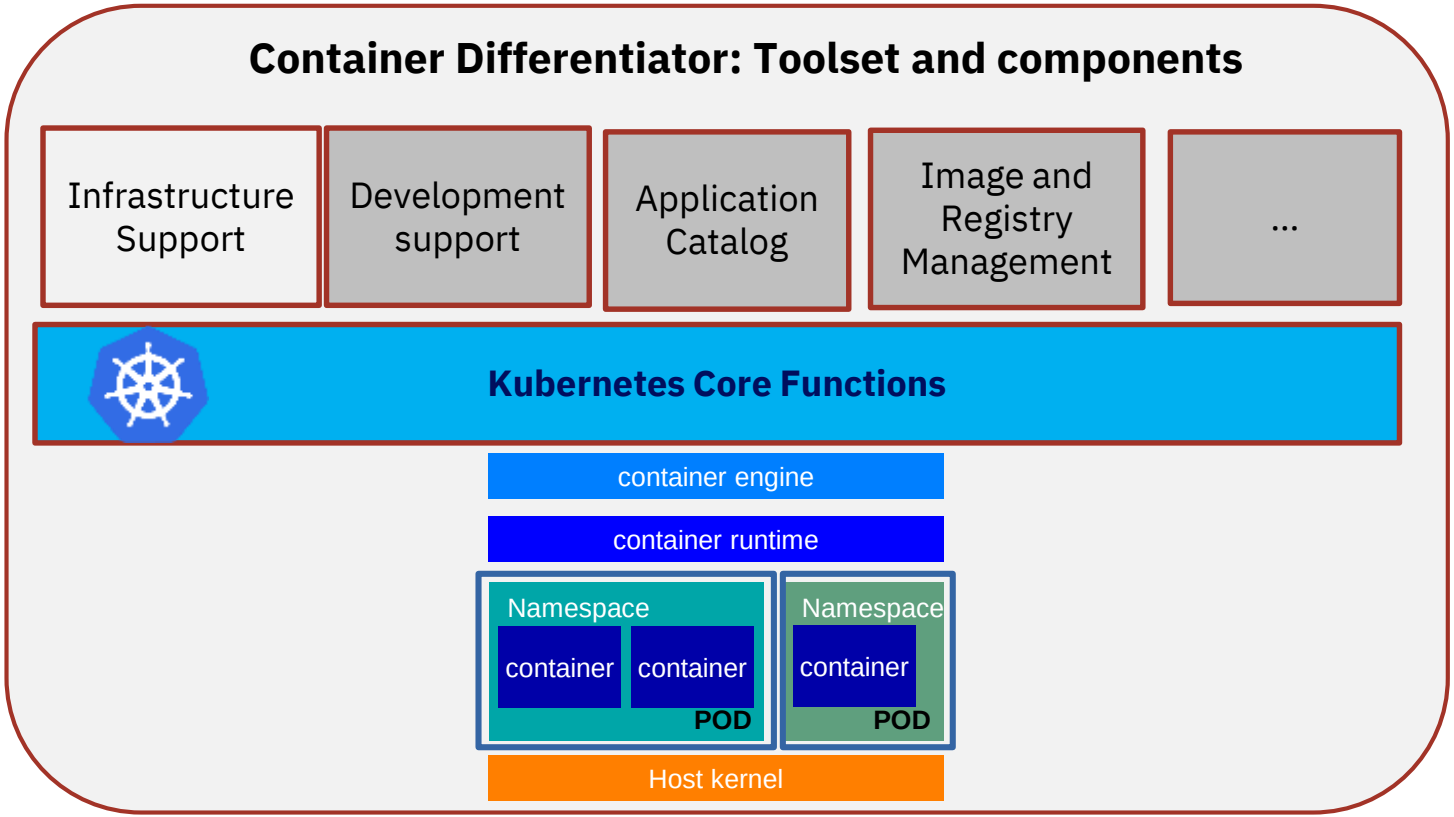
Container orchestration ecosystem with K8S



[1] https://www.docker.com/why-docker
[2] https://www.projectatomic.io/

Kubernetes APIs are used in all Orchestration products

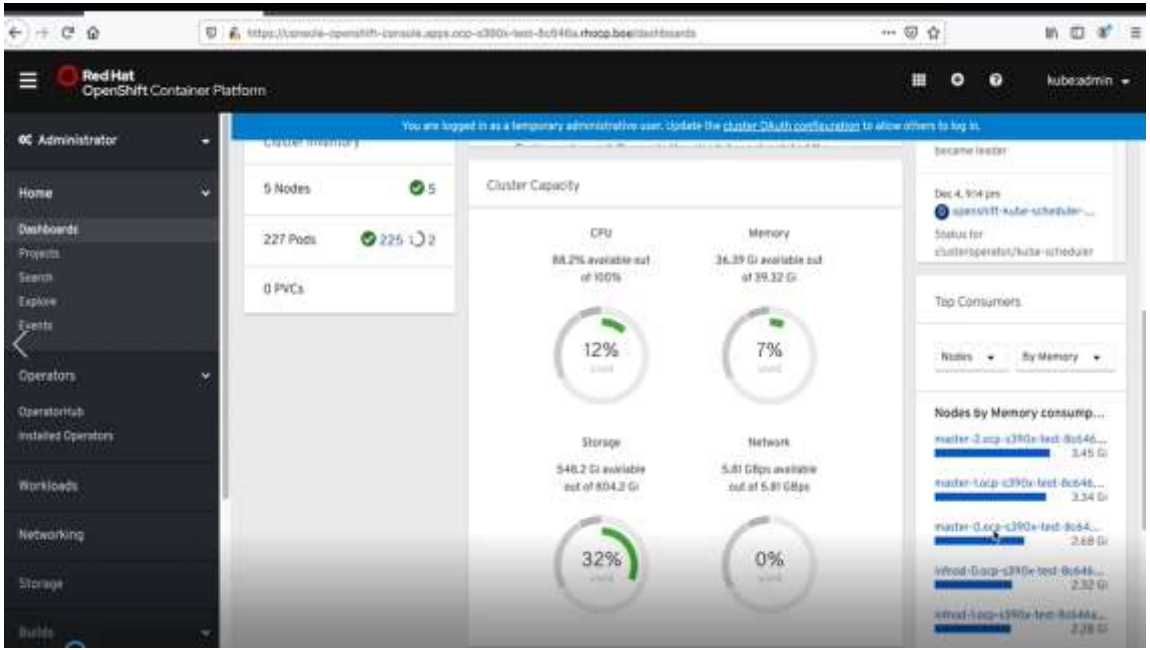
(i.e. OpenShift, Cloud Foundry, IBM Cloud Private)



Red Hat OpenShift Container Platform available for Linux on Z & LinuxONE

New

- OpenShift brings together the core open source technologies of Linux, containers and Kubernetes.



Available:
Red Hat OpenShift V4.2 for IBM Z and LinuxONE
Announced by Ross Mauri
Feb 13, 2020

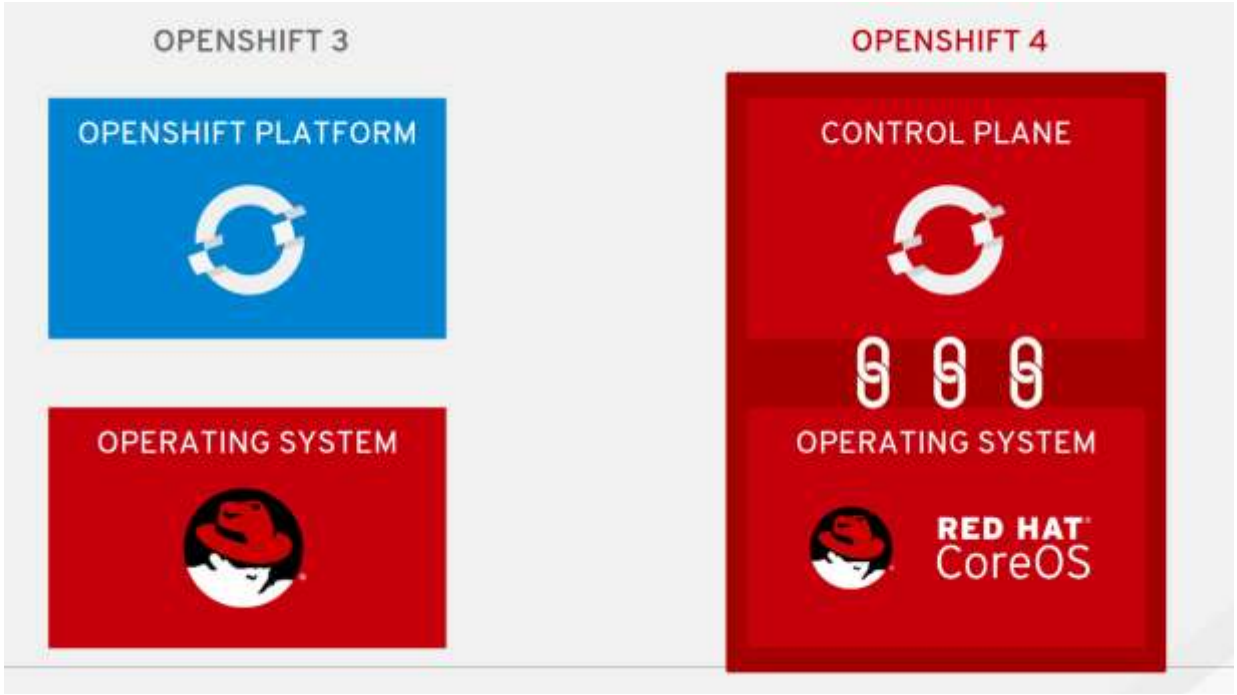
Red Hat OpenShift V4.3 available since April 30.

http://www.ibm.com/blogs/systems/red-hat-openshift-now-available-ibm-z-linuxone

https://developer.ibm.com/blogs/willie-tejada-redhat-openshift-ibmz/

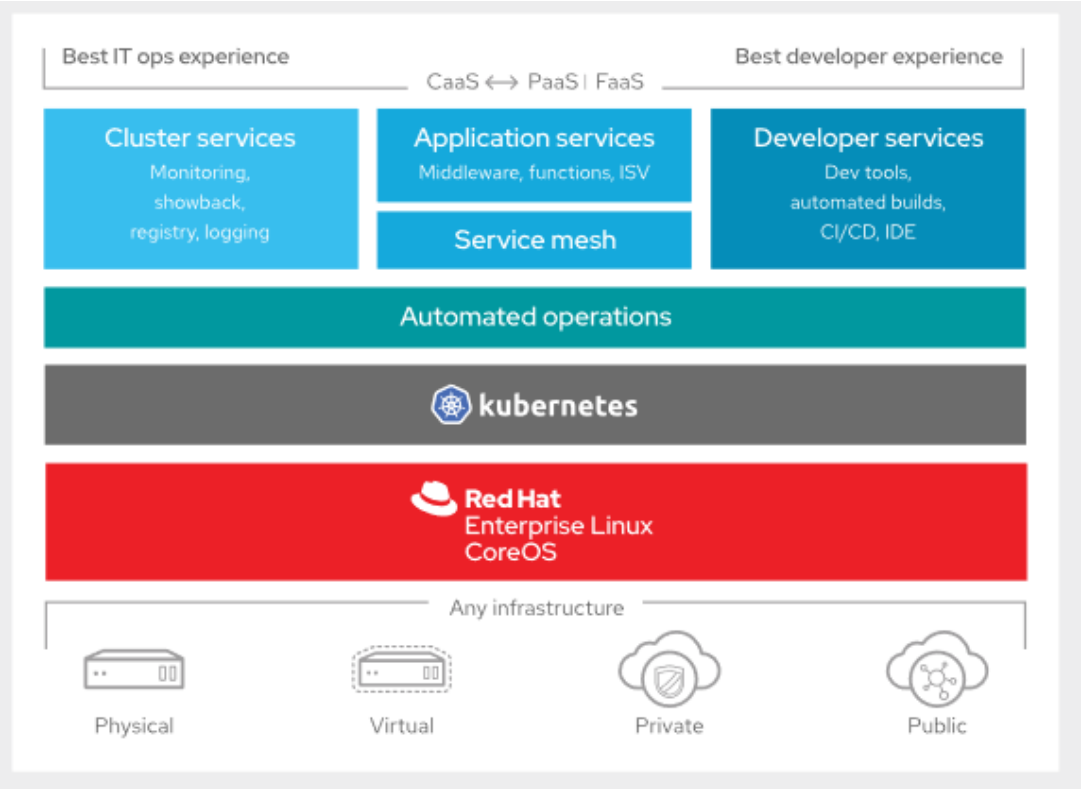
Red Hat OpenShift - Immutable Infrastructure

Immutability = repeatability
Immutability = auditability



https://blog.openshift.com/wp-content/uploads/Red-Hat-OpenShift-4.0-Roadmap-Public-Feb-2019-Ali.pdf

Red Hat OpenShift V4



https://www.redhat.com/cms/managed-files/cl-openshift-4-datasheet-f16726wg-201905-en.pdf

Red Hat OpenShift V4

OpenShift is a layered system designed to expose Container images and Kubernetes concepts, with a focus on easy composition of applications by a developer.

https://docs.openshift.com/container-platform/4.1/architecture/architecture.html

What Are the Layers?

- The Container service provides the abstraction for creating container images.
- Kubernetes provides the cluster management and orchestrates containers
  - **Container Runtime Interface** (CRI) - how K8S talks with a container engine
  - **Container engines -** implement the CRI interface (OCI compliant)

OpenShift Container Platform adds:

- Source code management, builds, and deployments for developers
- Managing and promoting images at scale as they flow through your system
- Application management at scale
- Team and user tracking for organizing a large developer organization
- Networking infrastructure that supports the cluster

Red Hat OpenShift Deployment options

Red Hat OpenShift 4 (OCP) aims to deliver the automation experience of a native public cloud container platform while retaining the flexibility of a multi-cloud, enterprise-class solution.

- **Installer Provisioned Infrastructure (IPI)**

On supported platforms, the installer is capable to provision the underlying infrastructure for the cluster.
Via the installer create all components, networking, machines, and operating systems for the cluster.

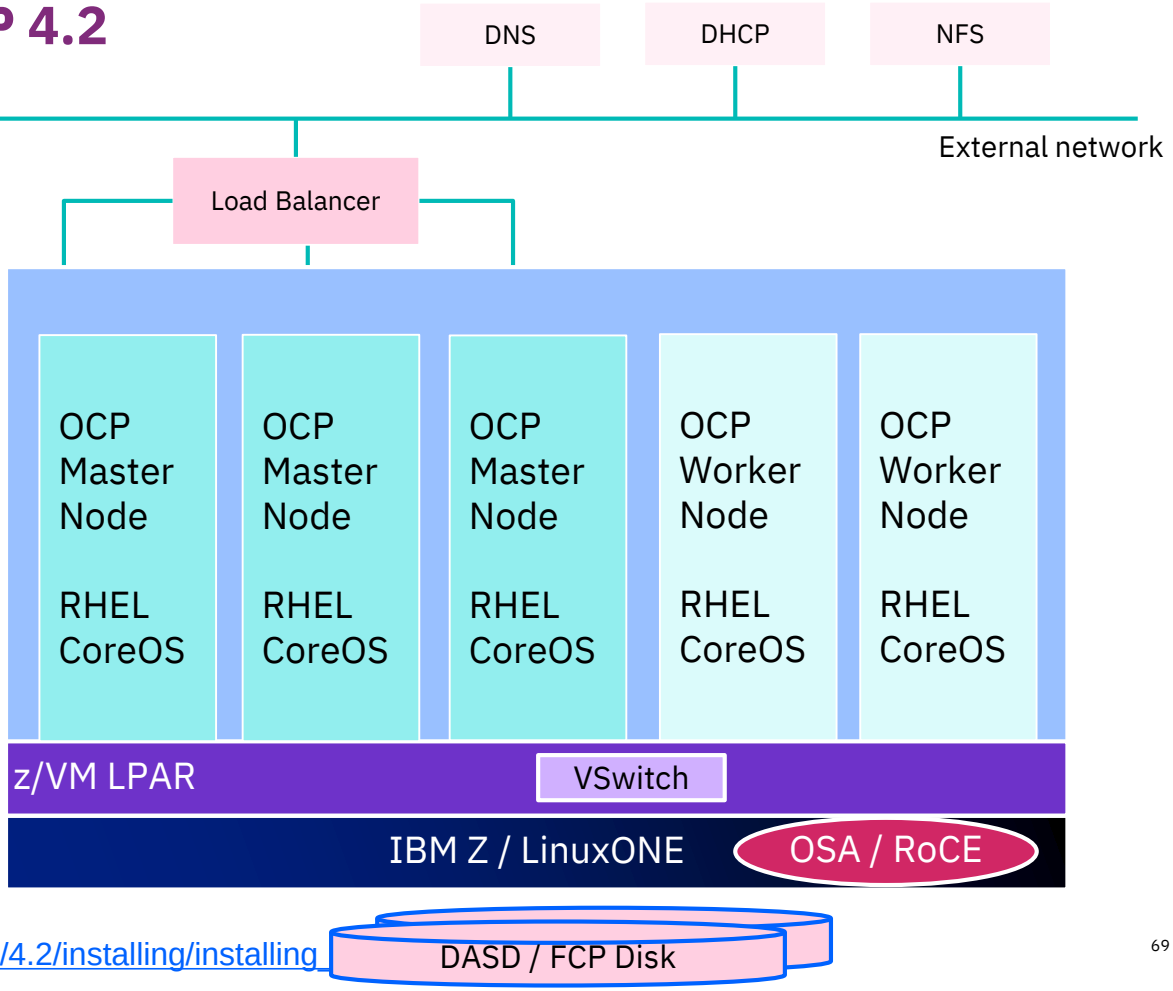
- **User Provisioned Infrastructure (UPI)**

For platforms or in scenarios where installer provisioned infrastructure would be incompatible, the platform administrator has to provision the infrastructure using the cluster assets generated by the install tool.
Once the infrastructure has been created, OpenShift 4 is installed, maintaining its ability to support automated operations and over-the-air platform updates.

Minimum operational OCP 4.2 cluster on z/VM Layout

Characteristics:

- UPI deployment with z/VM
- Based on CoreOS only
- Automatic through deployment server for installation (temporary, i.e. z/VM guest)

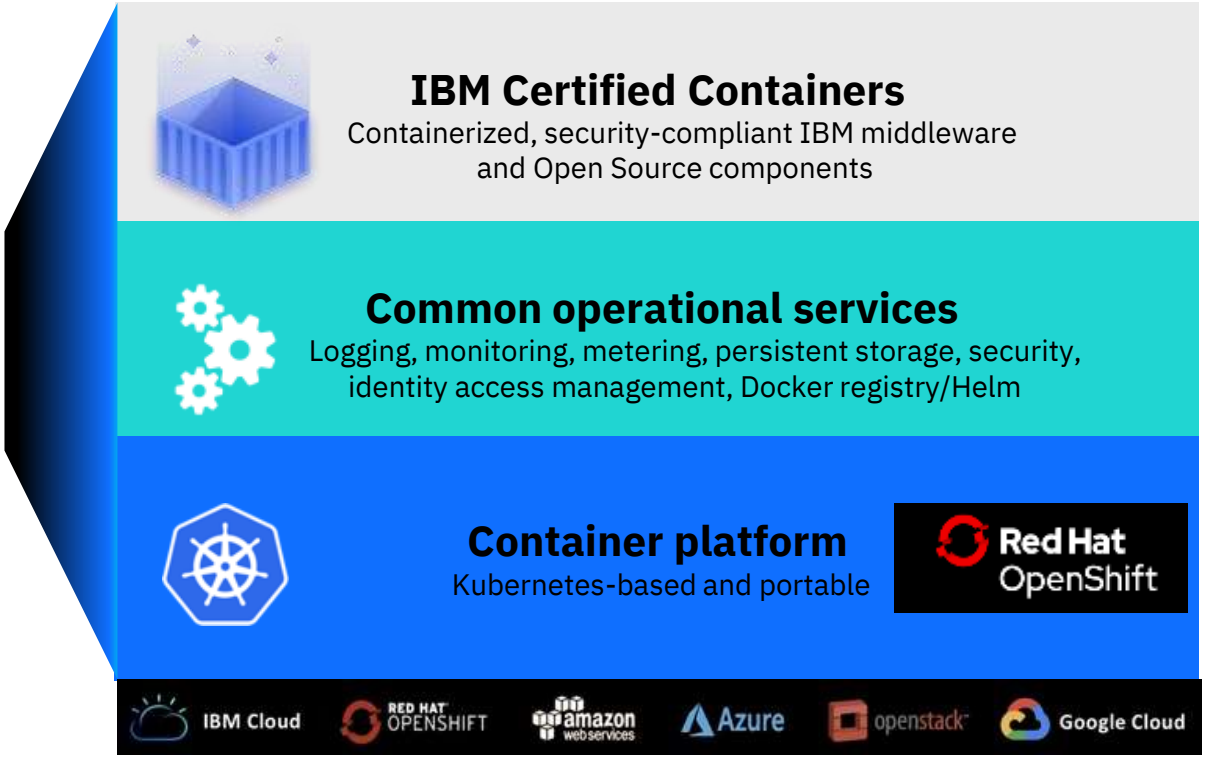


https://docs.openshift.com/container-platform/4.2/installing/installing_

IBM Cloud Paks – IBM Software in Container

Enterprise-grade, modular middleware solutions giving clients an open, faster, more reliable way to move, build, and manage on the cloud

Pre-integrated for cloud use cases



https://www.ibm.com/cloud/paks/

Cloud Paks – Pre-integrated for cloud use cases

Today, IBM offers clients the first six Cloud Paks…

Cloud Pak for Applications


Developer & DevOps Tools


Modernization Toolkit


Frameworks and Runtimes

Build, deploy, and run applications

Red Hat OpenShift

Cloud Pak for Data


Organize


Analyze


Collect

Collect, organize, and analyze data

Red Hat OpenShift

Cloud Pak for Integration


API Lifecycle


Messaging and Events


App and Data Integration

Integrate applications, data, cloud services, and APIs

Red Hat OpenShift

Cloud Pak for Automation


Content


Operational Intelligence


Workflow and Decisions

Transform business processes, decisions, and content

Red Hat OpenShift

Cloud Pak for Multicloud Management


Multicluster


App and Infrastructure


Security and Compliance Management

Multicloud visibility, governance, and automation

Red Hat OpenShift

Cloud Pak for Security


Federated Search and Investigation


Incident Response


Security Orchestration and Automation

Connect security data, tools, and teams

Red Hat OpenShift

Infrastructure

IBM Z®
IBM LinuxONE™

IBM Power Systems™

IBM cloud™

AWS™
Azure™
Google Cloud™

IBM z/OS Cloud Broker

- **Connects z/OS services running on an IBM Z backend to a frontend private cloud platform** providing self-service access and consumption of these services to developers

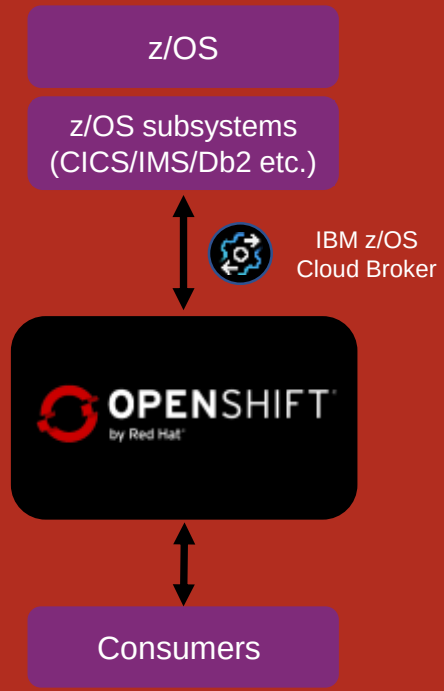
Provides self-service access to managed IBM Z resources to all flavors of application developers

Centralization and automation of IBM Z operations to provide Z resources to agencies or clients in their hybrid cloud

Improve time to value through efficiencies in development and deployment

https://www.ibm.com/support/z-content-solutions/cloud-broker/

Support for OpenShift Platform GA: 4Q 2019



Summary: Why Containers work -- Separation of Concerns

Dan the Developer

- Worries about what's "inside" the container
  - His code
  - His Libraries
  - His Package Manager
  - His Apps
  - His Data
- All Linux servers look the same

Oscar the Ops Guy

- Worries about what's "outside" the container
- Logging
- Remote access
- Monitoring
- Network config
- All containers start, stop, copy, attach, migrate, etc. the same way

Build once…(finally) run anywhere*

- A clean, safe, hygienic and portable runtime environment for your app.
- No worries about missing dependencies, packages and other pain points during subsequent deployments.
- Run each app in its own isolated container, so you can run various versions of libraries and other dependencies for each app without worrying
- Automate testing, integration, packaging…anything you can script
- Reduce/eliminate concerns about compatibility on different platforms, either your own or your customers.
- Cheap, zero-penalty containers to deploy services? A VM without the overhead of a VM? Instant replay and reset of image snapshots? That's the power of Docker

Configure once…run anything

- Make the entire lifecycle more efficient, consistent, and repeatable
- Increase the quality of code produced by developers.
- Eliminate inconsistencies between development, test, production, and customer environments
- Support segregation of duties
- Significantly improves the speed and reliability of continuous deployment and continuous integration systems
- Because the containers are so lightweight, address significant performance, costs, deployment, and portability issues normally associated with VMs

Open-source containerized Software for Linux on IBM Z & IBM LinuxONE

https://www.ibm.com/developerworks/community/forums/html/topic?id=5dee144a-7c64-4bfe-884f-751d6308dbdf

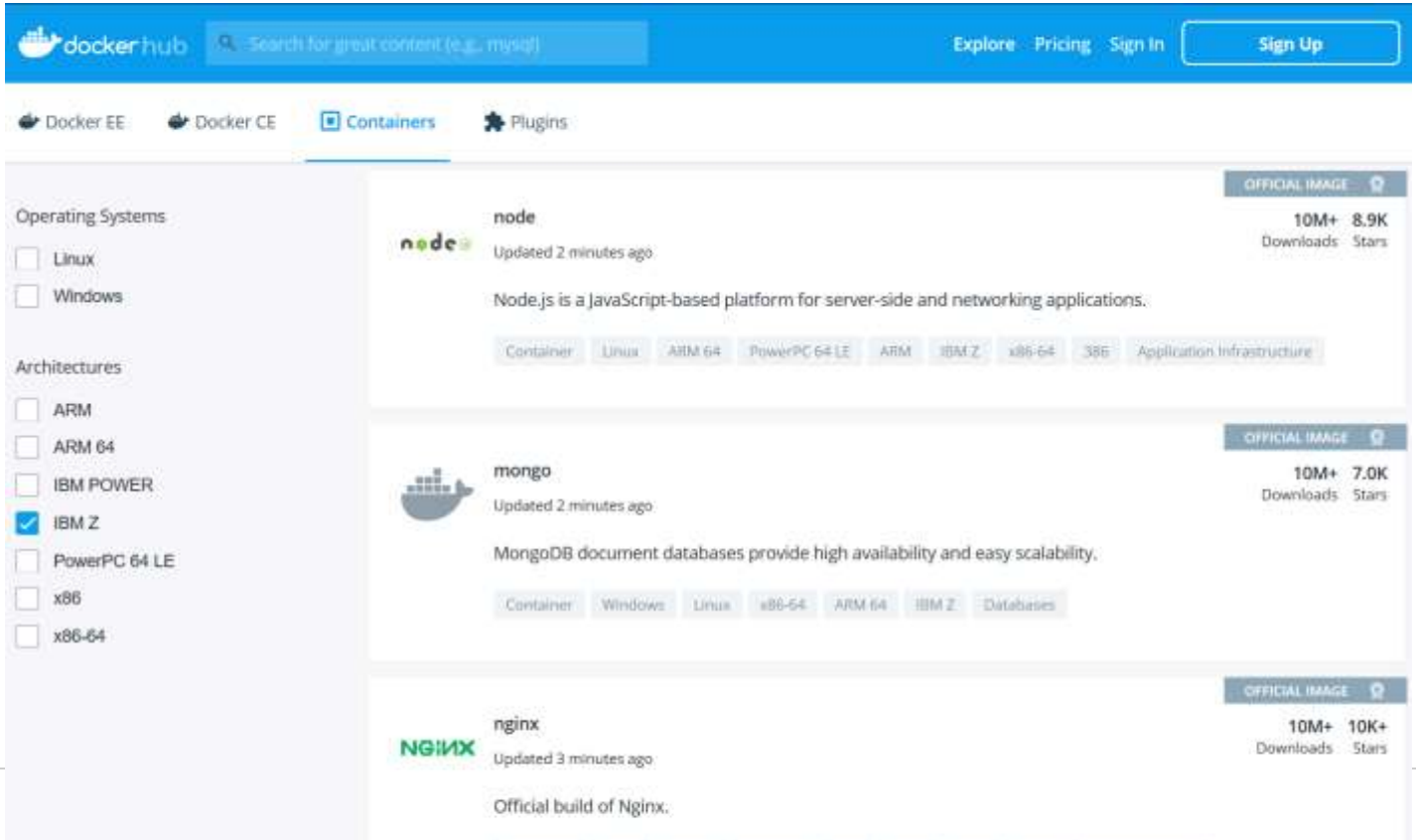
The table provides up-to-date information on open source packages that have been ported and/or validated on corresponding distro versions by IBM.

Package	Ubuntu 18/18.x	SLES 15.x	RHEL 7.x	Dockerfile/image	SLES 12.x
Akka	Latest	Latest	Latest	NA	Latest
Alfresco	5.x	5.x	5.x	5.x, image	5.x
Anaconda	NA	NA	4.x	NA	4.x
Ansible	Distro, Latest	Latest	Latest	Latest, image	Latest
AntLR	Distro, 3.x, 4.x	NA	3.x, 4.x	4.x, image	3.x, 4.x
Apache ActiveMQ	Distro, Latest	Latest	Latest	5.x, image	Latest
Apache Camel	Latest	Latest	Latest	NA	Latest
Apache Cassandra	2.x, 3.x	3.x	2.x, 3.x	3.x, image	2.x, 3.x
Apache Flume	1.x	1.x	1.x	1.x, image	1.x
Apache Geode	Latest	Latest	Latest	1.x, image	Latest
Apache HTTP	Distro, 2.4	Distro,2.4	Distro,2.4	2.x, Image	Distro,2.4
Apache Ignite	Latest	Latest	Latest	2.x, Image	Latest
Apache JMeter	Distro, Latest	Latest	Latest	5.x, image	Latest
Apache Kafka	Latest	Latest	Latest	2.x, image	Latest
Apache Maven	NA	NA	download	3.x, Image	download
Apache Mesos	1.x	1.x	1.x	1.x, image	1.x
Apache Spark	2.x	2.x	2.x	2.x, image	2.x
Apache Solr	8.x	8.x	8.x	8.x, Image	8.x
Apache Storm	2.x	2.x	2.x	2.x, Image	2.x
Apache Tomcat	Distro, Latest	Distro,Latest	Distro,Latest	9.x, Image	Distro,Latest
Apache Zeppelin	0.8.x	0.8.x	0.8.x	0.8.x, image	0.8.x
Apache ZooKeeper	Distro, Latest	Latest	Latest	3.x, Image	Latest
Apgility	1.5.x	1.5.x	1.5.x	1.5.x, image	1.5.x
Beats	NA	NA	7.x	7.x, Image	7.x
BIRT	NA	NA	NA	NA	NA

Docker-Hub containerized software for Linux on IBM Z & IBM LinuxONE

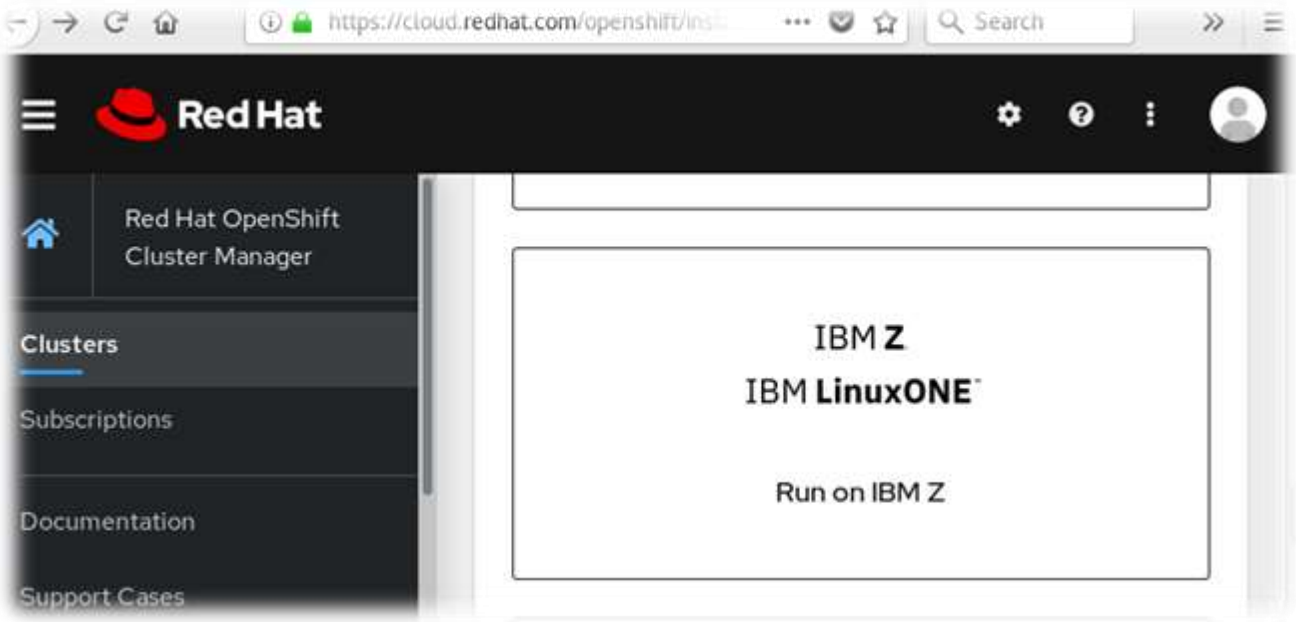
https://hub.docker.com/search?q=HTTPd&type=image&architecture=s390x

The search provides public container images that have been built for Linux with version of Linux on Z and LinuxONE



Where can I download OCP V4 for IBM Z ?

try.openshift.com
cloud.redhat.com



Questions?

Wilhelm Mild

IBM Executive IT Architect

IBM Deutschland Research & Development GmbH
Schönaicher Strasse 220
71032 Böblingen, Germany

Office: +49 (0)7031-16-3796
wilhelm.mild@de.ibm.com

Notices and disclaimers

- © 2019 International Business Machines Corporation. No part of this document may be reproduced or transmitted in any form without written permission from IBM.
- **U.S. Government Users Restricted Rights — use, duplication or disclosure restricted by GSA ADP Schedule Contract with IBM.**
- Information in these presentations (including information relating to products that have not yet been announced by IBM) has been reviewed for accuracy as of the date of initial publication and could include unintentional technical or typographical errors. IBM shall have no responsibility to update this information. **This document is distributed "as is" without any warranty, either express or implied. In no event, shall IBM be liable for any damage arising from the use of this information, including but not limited to, loss of data, business interruption, loss of profit or loss of opportunity.** IBM products and services are warranted per the terms and conditions of the agreements under which they are provided.
- IBM products are manufactured from new parts or new and used parts.
  In some cases, a product may not be new and may have been previously installed. Regardless, our warranty terms apply."
- **Any statements regarding IBM's future direction, intent or product plans are subject to change or withdrawal without notice.**
- Performance data contained herein was generally obtained in a controlled, isolated environments. Customer examples are presented as illustrations of how those
- customers have used IBM products and the results they may have achieved. Actual performance, cost, savings or other results in other operating environments may vary.
- References in this document to IBM products, programs, or services does not imply that IBM intends to make such products, programs or services available in all countries in which IBM operates or does business.
- Workshops, sessions and associated materials may have been prepared by independent session speakers, and do not necessarily reflect the views of IBM. All materials and discussions are provided for informational purposes only, and are neither intended to, nor shall constitute legal or other guidance or advice to any individual participant or their specific situation.
- It is the customer's responsibility to insure its own compliance with legal requirements and to obtain advice of competent legal counsel as to the identification and interpretation of any relevant laws and regulatory requirements that may affect the customer's business and any actions the customer may need to take to comply with such laws. IBM does not provide legal advice or represent or warrant that its services or products will ensure that the customer follows any law.

Notices and disclaimers continued

- Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products about this publication and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products. IBM does not warrant the quality of any third-party products, or the ability of any such third-party products to interoperate with IBM's products. **IBM expressly disclaims all warranties, expressed or implied, including but not limited to, the implied warranties of merchantability and fitness for a purpose.**
- The provision of the information contained herein is not intended to, and does not, grant any right or license under any IBM patents, copyrights, trademarks or other intellectual property right.
- IBM, the IBM logo, ibm.com and [names of other referenced IBM products and services used in the presentation] are trademarks of International Business Machines Corporation, registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at "Copyright and trademark information" at: www.ibm.com/legal/copytrade.shtml