z/OS V2.5 IBM Education Assistant

Solution Name: z/OS Container Extensions (zCX) Critical Adoption Items

Solution Element(s): z/OS

August 2021

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Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon many factors, including considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve results similar to those stated here.

Agenda

Trademarks

Objectives

Overview

For each Enhancement:

- Benefits: Who/What/Wow
- Usage & Invocation
- Interactions & Dependencies
- Upgrade & Coexistence Considerations
- Installation & Configuration

Appendix

Trademarks

See http://www.ibm.com/legal/copytrade.shtml for a list of trademarks.

Additional Trademarks:

– None

Objectives

What is zCX?

- Overview
- Licensing + ILMT

Enhancements for V2R5 (Continuous delivery--- so available in V2R4)

- zCX Trial 90
- Docker Proxy
- IPv6
- Inbound Workload Queueing (IWQ)
- Performance (including vector support)
- Large Page
- Consolidated Version
- Constraint Relief
  - Number of disks, size of disks, increase root size on upgrade
  - memory sizes, 1000 Docker containers, ports
- Resource Alerts

What Is IBM z/OS Container Extensions (zCX)?

New function in z/OS 2.4 that enables clients to:

- ✓ Deploy Linux on Z software components as Docker Containers in a z/OS system, in direct support of z/OS workloads
- ✓ Without requiring a separately provisioned Linux server
- ✓ While maintaining overall solution operational control within z/OS and with z/OS Qualities of Service
- ✓ Requires IBM z14 or z15 server with Container Hosting Foundation (feature code 0104)

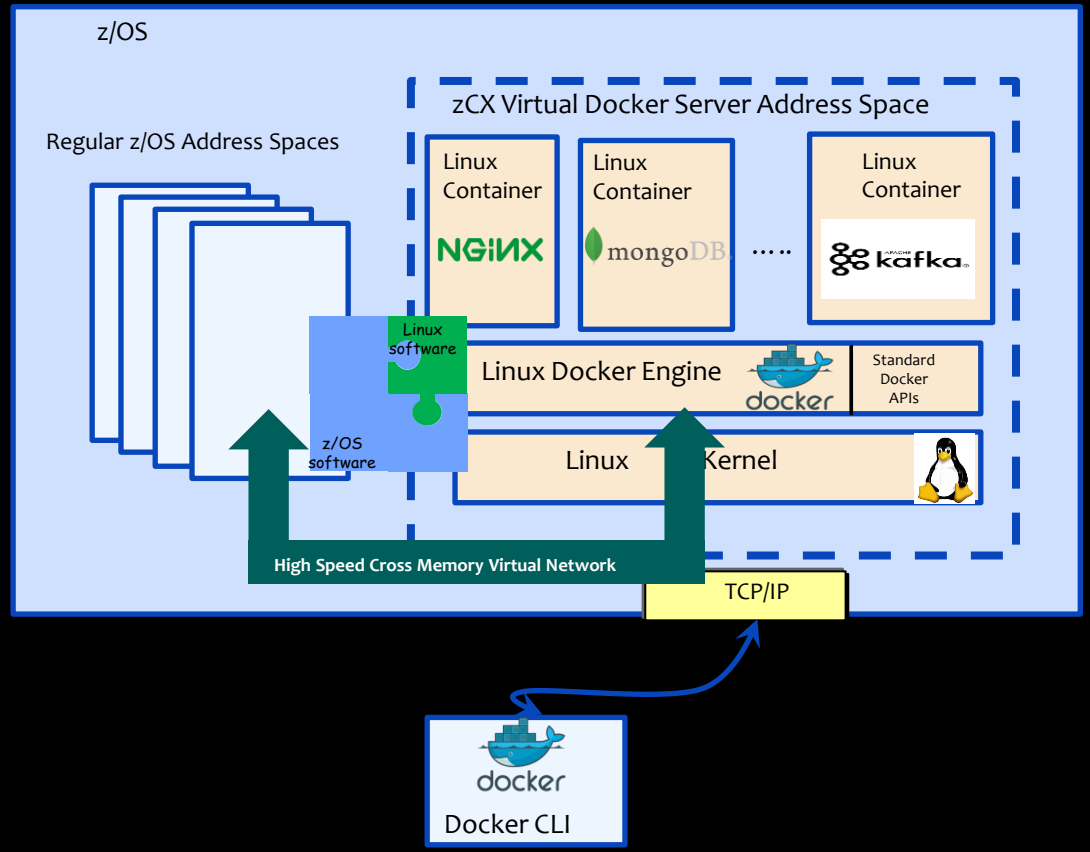
zCX – A turn-key Virtual Docker Server Software Appliance

Pre-packaged Linux Docker appliance
- Provided and maintained by IBM
- Provisioned using z/OSMF workflows

Provides standard Docker interfaces
- Supports deployment of any software available as a Docker image for Linux on Z
- Communications with native z/OS applications over high speed virtual IP network
- No z/OS skills required to develop and deploy Docker Containers

No Linux system administration skills required
- Interfaces limited to Docker CLI
- No direct access to underlying Linux kernel

Managed as a z/OS process
- Multiple instances can be deployed in a z/OS system
- Managed using z/OS Operational Procedures
- zCX workloads are zIIP eligible
  - Running the Acme Air benchmark on zCX, up to 98% of the zCX CPU consumption was measured to be zIIP eligible.*



** * Results were extrapolated from internal IBM benchmarks performed in a controlled environment using a single z14 z/OS 2.4 LPAR with TCP/IP inbound workload queuing (IWQ) for inbound traffic and two zCX containers: one running Node.js and one running a MongoDB database. zIIP eligibility is based on the CPU consumption of the work running on the zCX address spaces and the associated work on the TCPIP and VTAM address spaces. Results may vary.

zCX Enablement - Licensing Considerations

zCX available starting z/OS 2.4

zCX enablement requires an IBM z14 or z15 server with the Container Hosting Foundation (feature code 0104)

Provides service and support for embedded Linux kernel

Single feature required per CPC

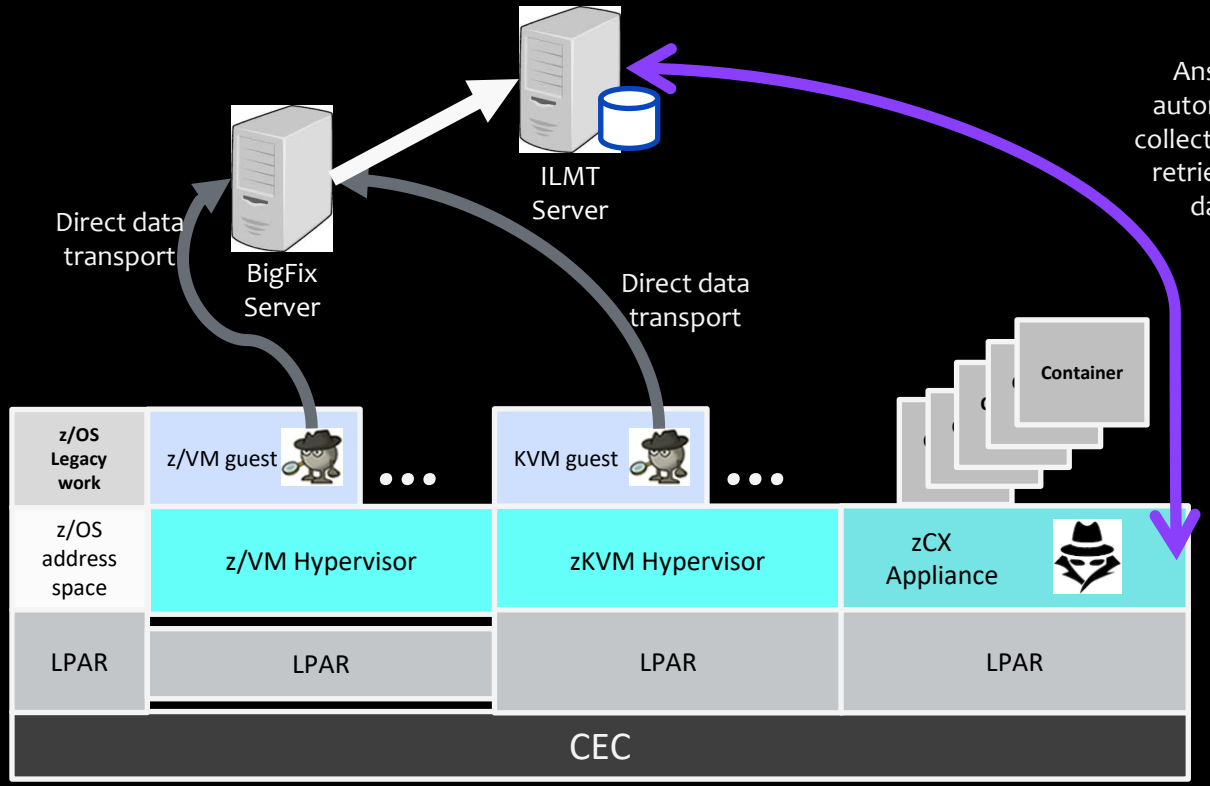
- Unlimited zCX use across CPC
- If you already have this feature code installed for certain SSC based appliances (e.g. IBM HyperProtect Virtual Servers) this also covers zCX use

IBM® License Metric Tool (ILMT) Support for zCX

- Licensing for IBM Linux on z software, running in zCX, is the same as Linux on z software running in traditional IBM Z environments
  - Optionally enabled using zCX provisioning or reconfiguration workflows
- ILMT is used to validate capacity for licensing of IBM Linux on z Software
  - Pertains to software procured through IBM Passport Advantage® (PA)
  - Enables PA customers to determine their full and sub-capacity processor value units (PVU) licensing requirements
  - Usage of ILMT is mandatory for sub-capacity pricing
- zCX will report zIIP and GCP capacity and usage metrics to ILMT
  - Treated like IFL and GCP capacity for existing LoZ environments

Additional information on sub-capacity pricing

Interaction Between z and ILMT



z/VM and KVM - BAU

- BigFix/ILMT agent runs at end points
- Scan results transferred to BigFix Server and then to ILMT Server for report generation

zCX

- Disconnected agent embedded on zCX appliance to scan and build data files
- Enabled using zCX workflow option
- Ansible playbooks provided to automate retrieval of scan results to ILMT server (or can be done by user defined process)

- regular agent

- disconnected agent

zCX Enhancements

zCX Enhancements since GA – Timeline View

2019 4Q

- zCX performance enhancements – Phase I
- z/OS Communications Server IWQ zCX support
- ILMT support
- zCX Docker proxy support

2020 1Q

- zCX Trial 90
- Vector (SIMD) support
- zCX Docker proxy – private certificate support

2020 2Q

- Consolidated version command support
- Docker version upgrade

2020 3Q

- 2G/1M z/OS Large Pages support
- Resource shortage alerts (Part 1)
- Constraint relief support

2020 4Q

- Resource shortage alerts (Part 2)
- Support for IPv6 connectivity
- Constraint relief support

zCX is automatically included in z/OS 2.5

zCX was introduced as part of z/OS 2.4

- Several enhancements since GA using Continuous Delivery model
- Delivered using z/OS V2.4 maintenance stream

zCX Trial 90

zCX Trial Support

Enhancements:

- Capability to evaluate zCX for 90 days before buying the Hardware feature code 0104.
- Users will be able to self-initiate the trial on their own z/OS 2.4 system without any involvement from IBM.
- Enforcement of zCX trial terms and informational message indicating number of days left in the trial period.
- Trial initiated on a sysplex basis.

Benefits:

- Users will be able to work with zCX before purchasing the hardware feature code.

zCX Trial Support – Activating zCX Trial

Edit dynamic element parmlib member

- Create a copy of IFAPRD00 or your current active IFAPRDxx member
- Update the member with following definitions:

```
NAME('z/OS')
ID(5650-ZOS)
VERSION(*)
RELEASE(*)
MOD(*)
FEATURENAME('zCX TRIAL90')
STATE(ENABLED)
```

- Issue **SET PROD** command to activate the new member on the system
- Update IEASYSxx member to point to the new activated IFAPRDxx member

Note:

- zCX started task user ID must have write access and search access to the zCX instance registry directory in the z/OS UNIX filesystem.

zCX Trial: Usage & Invocation

- Start zCX
  - zCX will check the enablement of the feature name **zCX TRIAL90**
  - zCX will calculate the remaining time in the trial and display message GLZB021I with the remaining days
    - Example:

```
S GLZ,JOBNAME=ZCX232,CONF='/u/ocoz/zcx_instances/ZCX232/start.json'
$HASP100 ZCX232   ON STCINRDR
IEF695I START GLZ      WITH JOBNAME ZCX232   IS ASSIGNED TO USER
GLZUSER , GROUP SYS1
$HASP373 ZCX232   STARTED
GLZB021I The zCX instance ZCX232 can run in trial mode for 74 more
day(s).
GLZB015I Not licensed for zCX. Diag=0000. 970
zCX Trial Enabled.
```

  - Check the Trial 90 registration with the '**DISPLAY PROD,REG**' command

zCX Trial: Interactions & Dependencies

— Software Dependencies
  - Product Enablement with IFAPRDxx parmlib member

— Hardware Dependencies
  - None

— Exploiters
  - None

zCX Trial: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

zCX Trial: Installation & Configuration

- Setup IFAPRDxx parmlib member for zCX TRIAL90
  - **SET PROD** command to specify the new member as active on the system
- Each user ID associated with zCX started task must have write access in addition to search access to the zCX instance registry directory.

Docker Proxy Support

Docker Registries

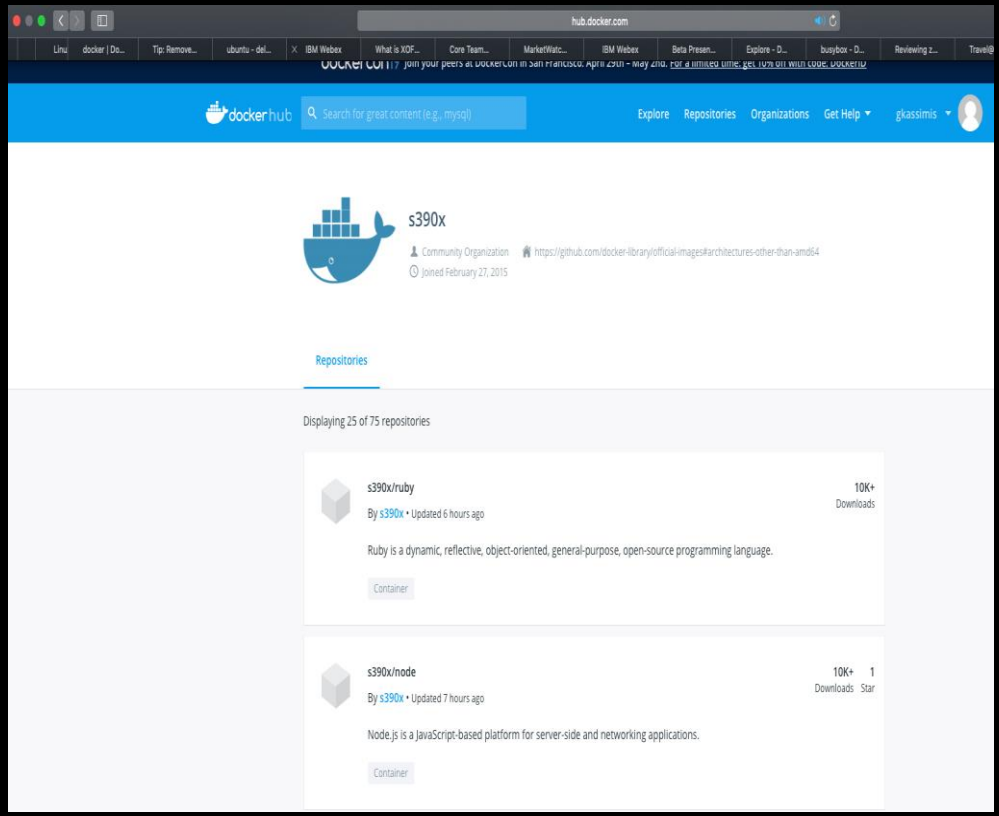
The Docker Registry is a storage and content delivery system for docker images

It's a stateless, highly scalable server side application that stores and distributes Docker images

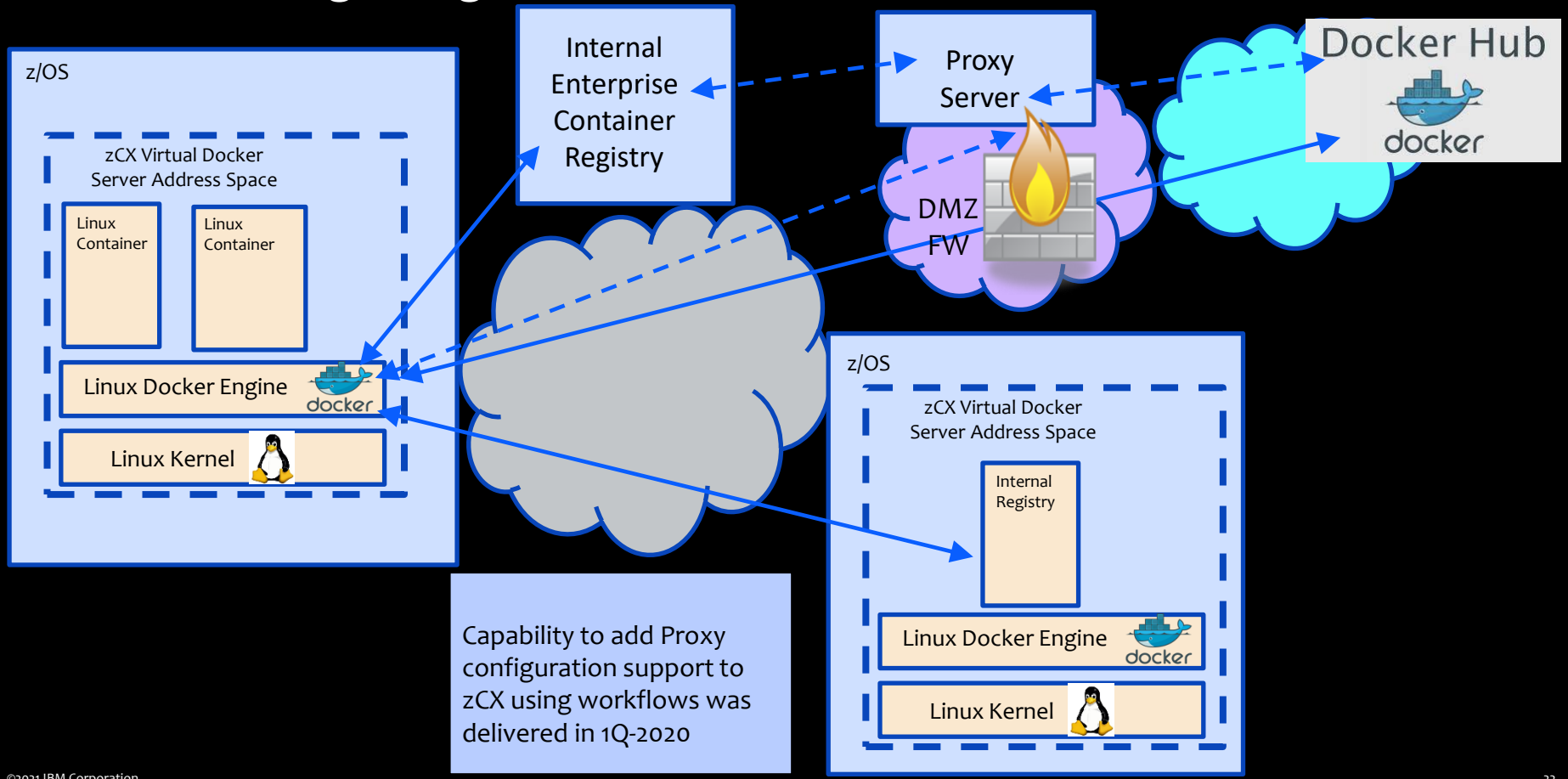
Docker hub is a cloud hosted version of docker registry

Users must connect to this registry in order to load a docker image onto a zCX Appliance.

- Both secure and insecure configurations for connecting to the registry are supported.
- External Docker hub (look for s390x architecture images – this reflects images for IBM Z)
  - https://hub.docker.com/search/?q=&type=image&architecture=s390x
- But you can direct Docker commands to an internal registry (secure or unsecure)
  - Must be specified during zCX provisioning workflow (or reconfiguration workflow)
  - Helps alleviate connectivity issues with accessing external DockerHub or other external registry from your zCX systems



Container Image Registries



Capability to add Proxy configuration support to zCX using workflows was delivered in 1Q-2020

zCX Docker Proxy Support

Enhancements:

- Capability to specify docker proxy server information using zCX provision and reconfigure workflows
  - Ability specify HTTP and HTTPS proxy servers with ports
  - Ability to exclude domain name and IP from using proxy servers
- Capability to specify private CA certificate for zCX docker proxy configuration using zCX provision and reconfigure workflows
  - Absolute path to EBCDIC encoded CA certificate to authenticate with HTTPS proxy server

Benefits:

- Increased security when interacting with the Docker registries for the zCX instance.

Please see zCX Guide for more information

Docker Proxy: Usage & Invocation

- Specify the proxy server endpoints needed in the zCX ***provision*** or ***reconfigure*** workflows
- If proxy servers are governed by a private certificate authority, then those are the certificates to be used in the ***provision*** or ***reconfigure*** workflows

Docker Proxy Support: Interactions & Dependencies

— Software Dependencies
  - None.
— Hardware Dependencies
  - None.
— Exploiters
  - N/A

Docker Proxy: Upgrade & Coexistence Considerations

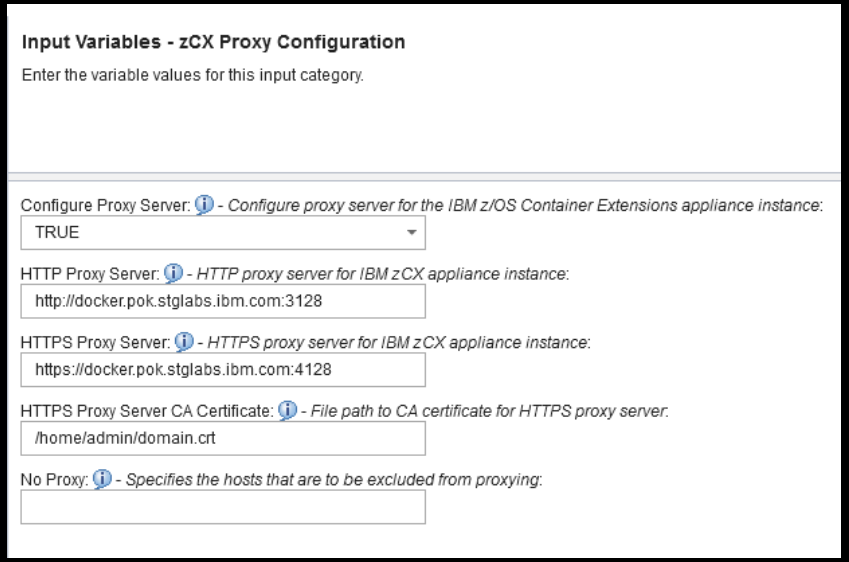
— Do all systems in the sysplex need to be at the new z/OS level?

- No

Docker Proxy: Installation & Configuration

- Provision with the intended docker proxy
- For an existing appliance use the reconfigure workflow, for a new appliance use the provisioning workflow.

- Workflow fields here:



IPv6

zCX IPv6 Support

Enhancements:

- Capability to specify IPv6 address for zCX instance in addition to IPv4 address.

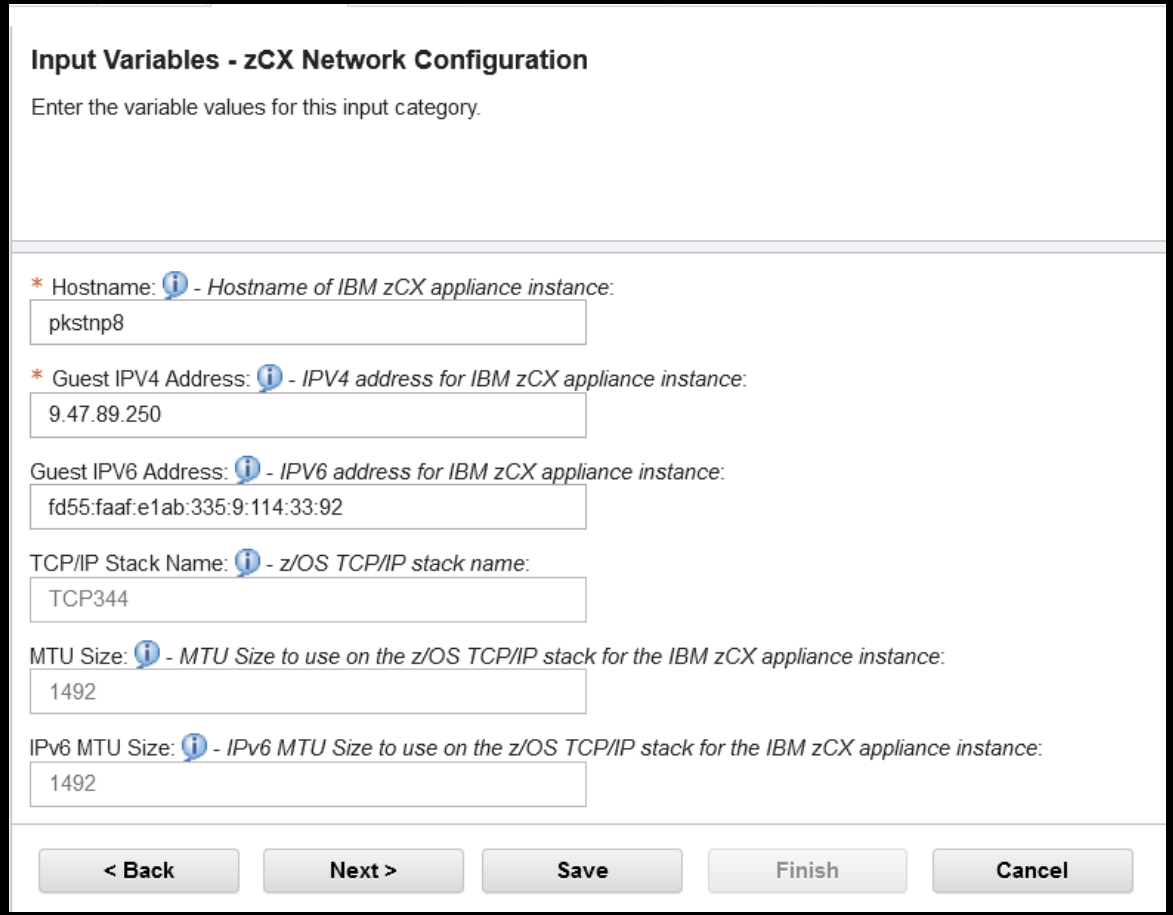
Benefits:

- Allows customer to meet Corporate IT policy and IPv6 enablement network requirements for Enterprise solutions using zCX.

IPv6: Usage & Invocation

- IPv4 network is always required; an IPv6 network will be optional in addition to the IPv4 network
  - An IPv4 AND an IPv6 DVIPA will be needed for each zCX instance.
- An IPv6 network needs to be enabled on the z/OS system.
- Workflows that provision the zCX instance have been adjusted to allow an IPv6 IP address to be used by the zCX instance.
- IPv4 and IPv6 addresses can be mixed into a single zCX instance.
- Insert the IP address into the workflow when using the *provision* workflow.

IPv6: Workflow Panel



IPv6: Interactions & Dependencies

— Software Dependencies
  - None.
— Hardware Dependencies
  - None.
— Exploiters
  - n/a

IPv6: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

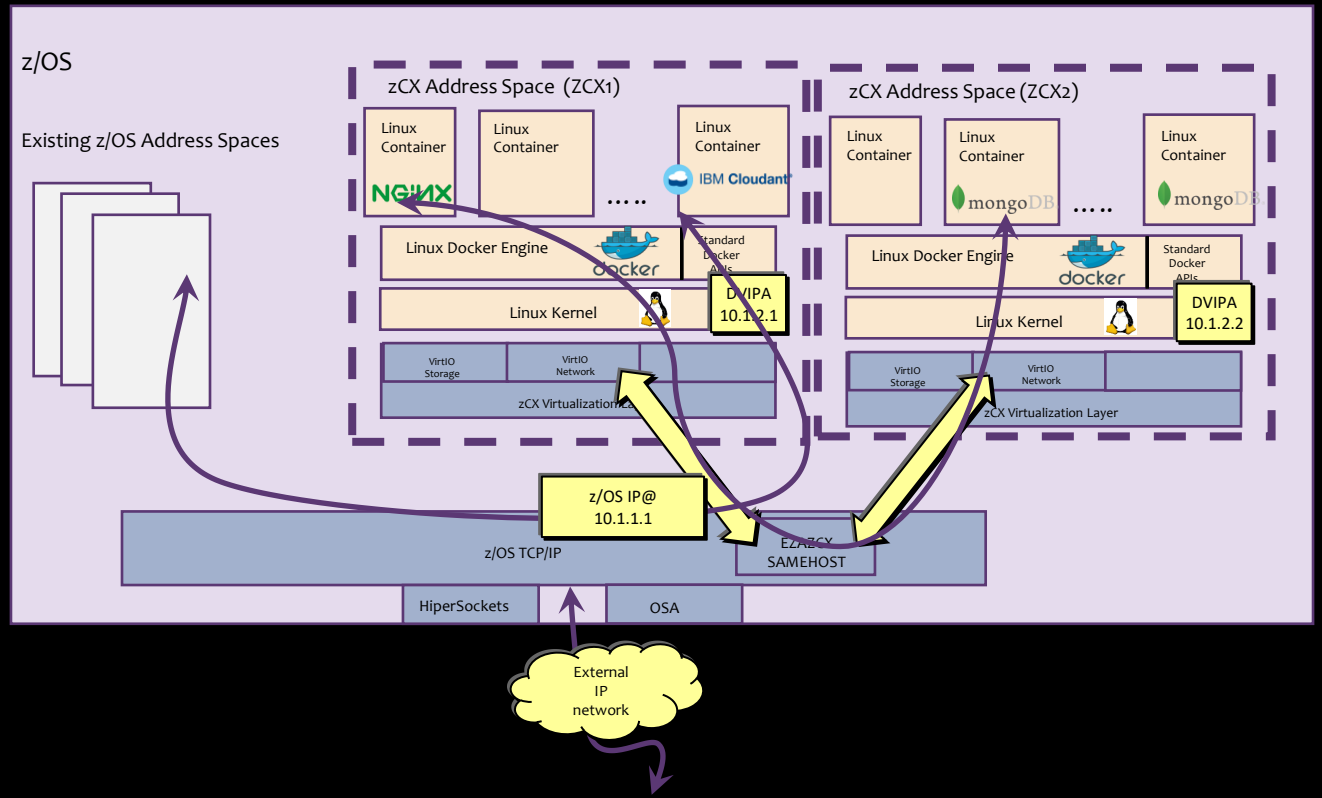
IPv6: Installation & Configuration

— IPv6 network address

- zCX Network Overview
- Configuring application-instance DVIPAs

Inbound Workload Queuing (IWQ) Support for zCX

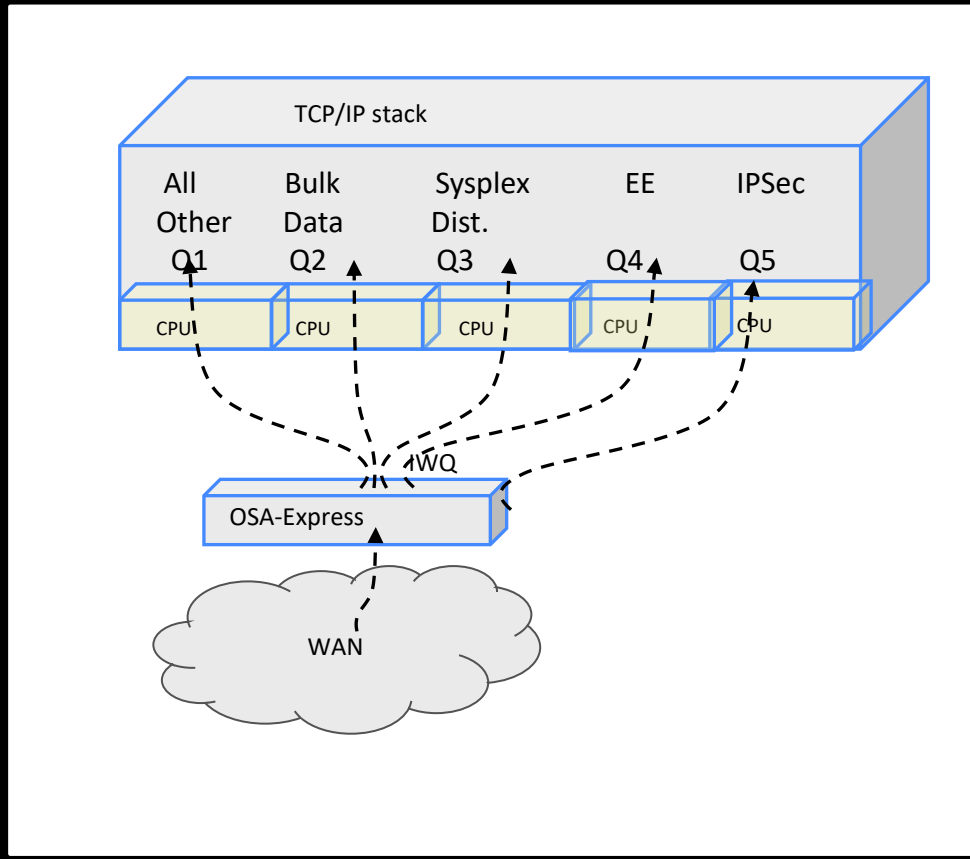
IBM zCX –High Speed Virtual IP Network- SAMEHOST



Background information: Inbound Workload Queueing(IWQ)

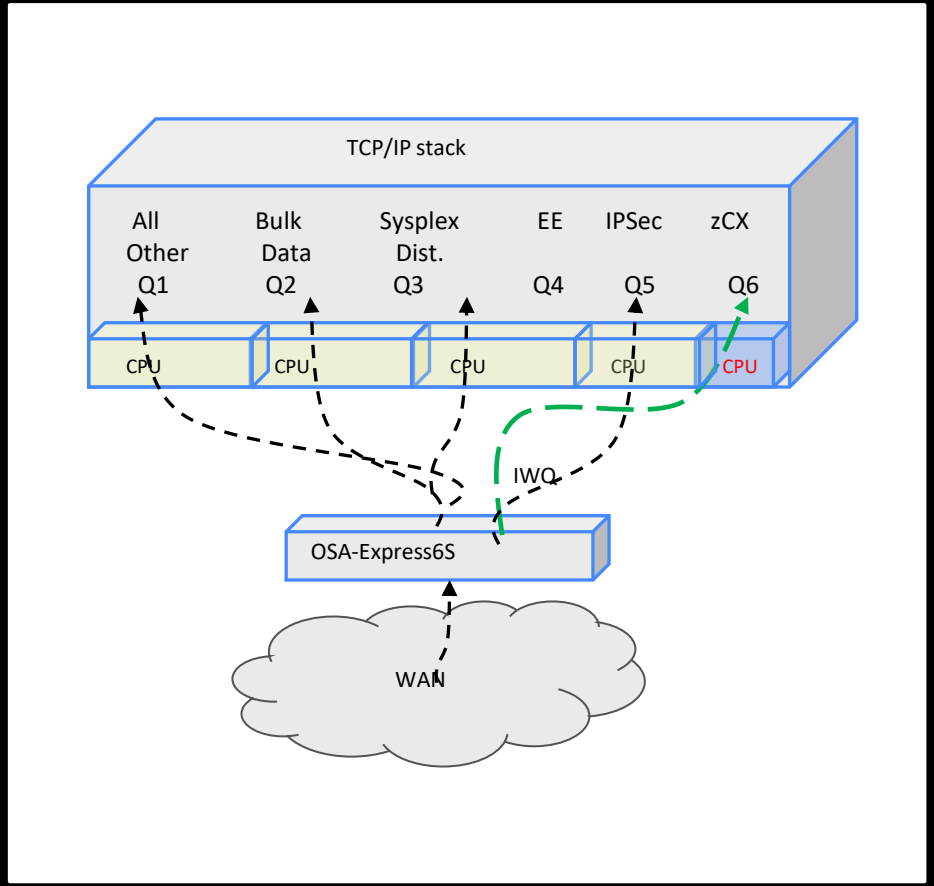
- OSA separates inbound packets and routes them over four different ancillary input queues on the same interface
  - Bulk data (such as FTP)
  - Sysplex Distributor (SD)
  - Enterprise extender (EE)
  - IPSec traffic
  - All other traffic (primary)

- z/OS can service each queue concurrently using separate processors
  - Packets remain in order
  - Improves performance by minimizing delays for each traffic pattern
- Enabled via:
  INBPERF DYNAMIC WORKLOADQ on IPAQNET and IPAQNET6 INTERFACE statements (only)



Inbound workload queueing for zCX traffic

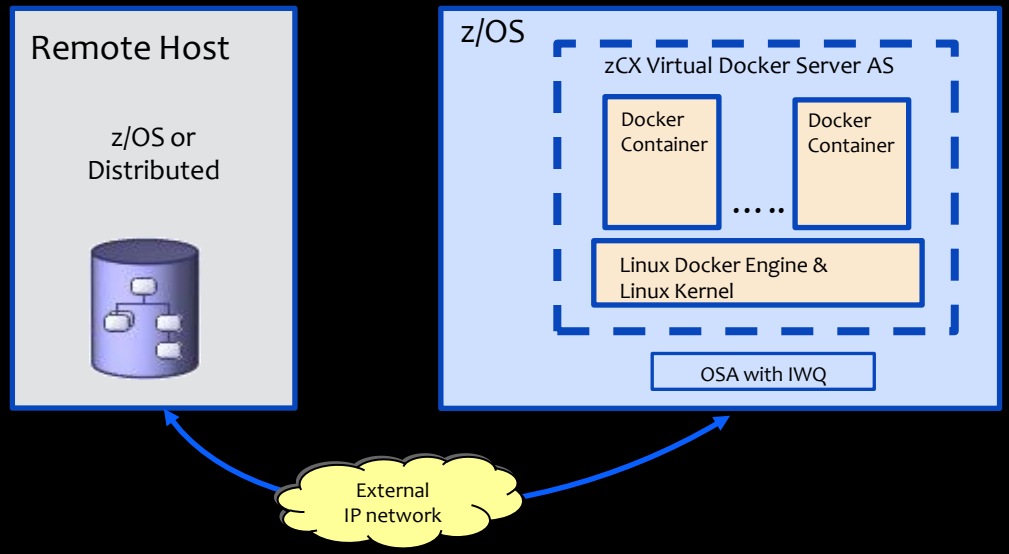
- New ancillary input queue for inbound zCX traffic serviced on its own processor
  - Inbound zCX traffic processing is optimized
  - Enabled for zIIP processing
  - Requires OSA Express6S or higher
  - For customers who already use IWQ with OSA-Express6S or OSA Express7S and apply the IWQ zCX enablement PTFs, the IWQ zCX function (input queue) will automatically be enabled
- There are no new configuration options required



IBM zCX Communications – Considerations for external network communications

zCX communications with other hosts (clients, servers, z/OS or distributed)
- All communication must traverse external network

Configure Inbound Workload Queuing (IWQ) on OSA-Express
- Better preserve order of packets delivered to zCX and utilize zIIPs for more network processing
- Reduced network latency for interactive workloads by 26% while improving network transaction rates by 34%
- Move nearly 40% of network processing for request/response workloads to zIIPs



Inbound Workload Queueing (IWQ) Support for zCX

Enhancements:

- New ancillary queue for inbound traffic into the zCX
- Enabled for zIIP processors

Benefits:

- Optimized traffic processing
- Improved network transaction rates
- Move much more of the network processing onto zIIPs
- Faster processing of network requests for lower costs

IWQ Usage & Invocation

— Once setup, will be used by zCX automatically

IWQ: Interactions & Dependencies

— Software Dependencies

- N/A

— Hardware Dependencies

- OSA Express 6S or 7S.

IWQ: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

IWQ: Installation & Configuration

- Enable Inbound Workload Queueing (IWQ) in TCP/IP profile
  - Specify the INBPERF parameter with the DYNAMIC setting on the INTERFACE statement for the IPAQENET or IPAQENET6 interface.
  - In addition, you must specify the WORKLOADQ subparameter and the VMAC parameter.
- If IWQ is already enabled, then nothing more to do! Support is automatically enabled for zCX.

zCX Performance Enhancements

zCX Performance Enhancements

Enhancements:

- Provides significant scaling and zIIP eligibility improvements by dramatically reducing switching from zIIPs to GCPs:
  - The more virtual CPUs (VCPs), the greater the benefit
  - Nearly eliminated context switches from zIIPs to GCPs
    - Reduced path length and overall CPU consumption
  - Reduced internal latch contention
  - **Transparent enablement** once maintenance is applied

Benefits:

- Internal measurements with 16 VCPs showed up to a
  - ***50% ETR improvement***,
  - **double digit ITR improvements**
  - **much smoother scaling**

zCX Vector Support

Enhancements:

- Capability to exploit latest vector/SIMD instructions set that the z architecture processors support and gain associated performance benefits.

Benefits:

- Ability to run docker containers in zCX that exploit vector/SIMD instructions.
- Ability to deploy container images with dependencies on vector instructions like images built with Red Hat Universal Build Images (UBI).

Performance: Usage & Invocation

— Performance enhancements

- None -‘baked’ into the code

— Vector Support

- SIMD/vector instructions occurring in various containers.

Performance: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

Performance: Installation & Configuration

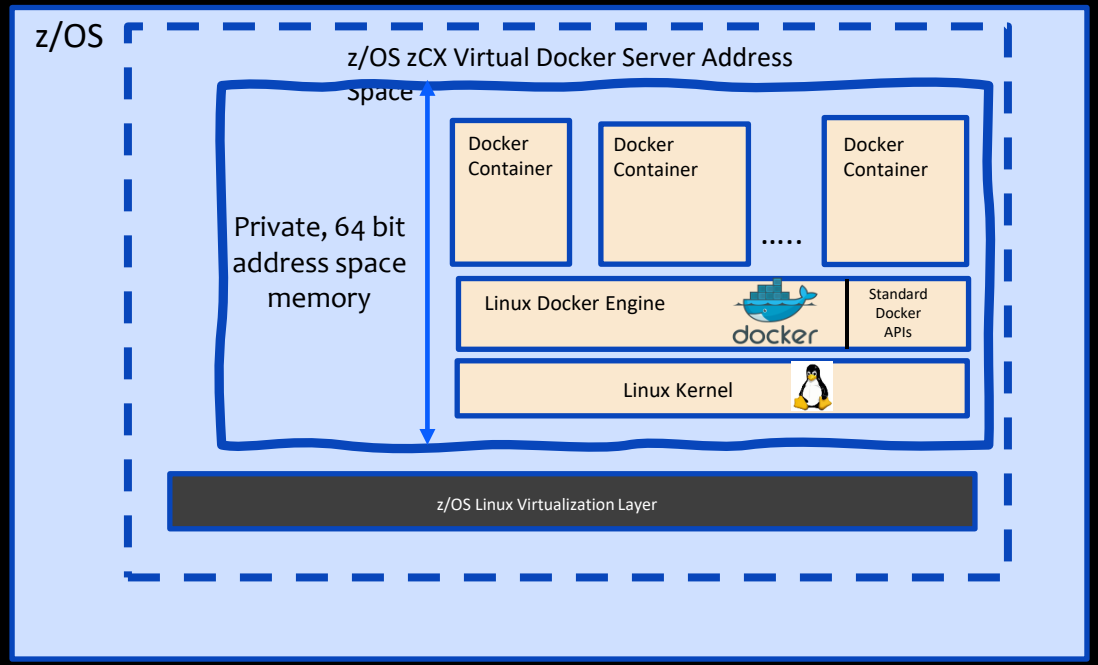
— None. Automatically included.

Large Page Support

zCX Capacity Planning - Memory

Memory for each zCX instance

- Specified at provisioning time, fixed memory above the bar, 4K pages by default
- Amount of memory needed will depend on the type of containers/software you are deploying
- Minimum: 2GB, typically more will be needed based on workload
- Be aware that the whole memory is allocated as fixed memory by zCX at startup!
  - Need to ensure this much memory is available on the system
  - Tenant Resource Groups can be defined with memory limits that govern the maximum amount of fixed memory one or more zCX instances can use – when zCX starts a check is made to ensure we will not exceed this limit
- If the containers deployed in zCX drive virtual memory usage above the amount of fixed memory specified, Linux will begin to page to its swap disks, significantly impacting performance and driving requirements for larger swap datasets.



Large Page Support

Enhancements:

- Ability to specify z/OS page frame sizes for backing the zCX guest storage/memory using provisioning and reconfiguration workflows.
  - Choice of 2GB, 1MB, or 4K pages
  - Can indicate that multiple sizes should be attempted (starting with largest frame size)
    - Useful for scenarios where zCX may be restarted on another z/OS system with different memory configuration/availability

Benefits:

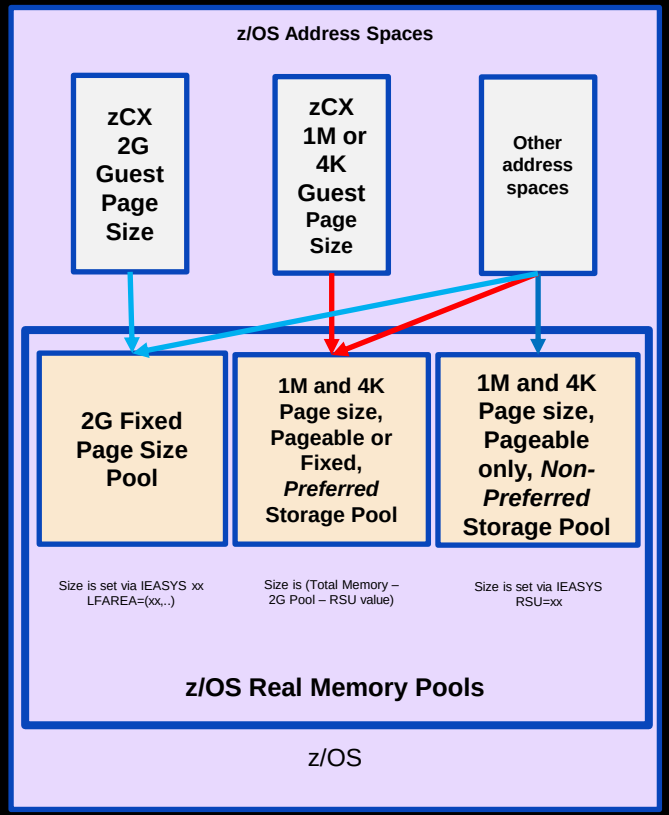
- Provides performance improvements for memory intensive zCX workloads.
- Ability for z/OS system programmer to control the memory utilization on the system.
- Increased throughput for transactions.

IBM zCX – Guest Memory Page Frame Size

- Provides the ability to back the Linux guest memory with 2G fixed, 1M fixed, or 4K fixed pages
  - Larger pages reduce Translation Lookaside Buffer (TLB) misses and Translation Table sizes
  - 2G and 1M pages save about 8MB of Translation Table space for every 2GB of memory
  - Note that 2G pages must be allocated at IPL time!
- Has additional performance improvements
- Internal benchmarks performed in a dedicated controlled environment showed the following improvements compared to a zCX without Large Page support applied:

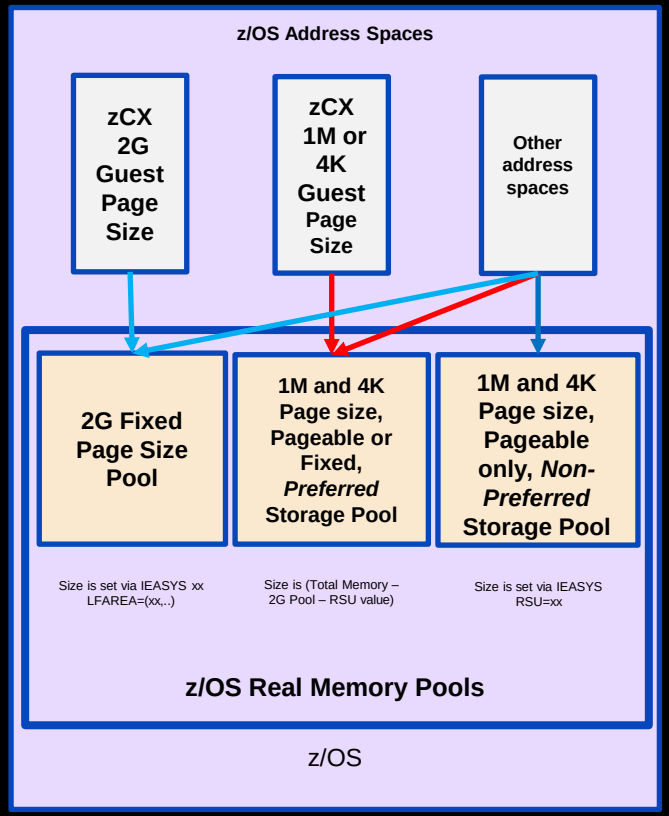
Page Size	% ITR Range	% ETR Range
2G	9 - 13	4 - 6
1M	7 - 10	3 - 5
4k	0.3 - 1	0 - 2

IBM zCX – Guest Memory Considerations



- Memory size is a function of what the containers require plus 1GB
  - See the zCX documentation for rules of thumb to calculate the real and swap memory sizes
  - Provide enough memory so Linux does not page. Note that Linux uses excess memory for file and buffer caches so more memory may or may not be better depending on usage
  - Docker has control limits for container CPU and Memory
  - **Note:** Linux acts like it's on its own machine and aggressively buffer file I/O even for low value content! As such, you may not need as much memory as you think. Check Linux monitors to determine the buffer size used. Testing with a smaller size may yield similar results.
- Fixed zCX High Private (>Bar) is used for guest memory
  - >Bar virtual storage MEMLIMIT control does not apply
  - Prior to Large Page support, only a 4K real page size can be used
  - Only preferred (non-reconfigurable) real storage from the 2G fixed page size or 1M/4K preferred page pool can be used
- z/OS will start paging and swapping out address spaces when the fixed storage threshold for non-2G page storage is reached
  - Can negatively impact other work on the system
  - Plan for the preferred storage that will be required
    - The appliance will not start if it will cause the fixed storage threshold to be reached
    - WLM Resource Group Memory Pools can be used to limit address space fixed storage consumption
  - IEAOPTxx OPT parameters related to the fixed storage threshold
    - IRA405I(2) controls the fixed percentage of the non-2G preferred and reconfigurable storage when message IAR405I is issued
    - MCCFXTPR controls the fixed percentage of the non-2G storage when the system will start to take action to control fixed large consumers
      - The default is 80% fixed of all non-2G preferred and reconfigurable (non-preferred) storage

IBM zCX – Guest Memory Page Frame Size

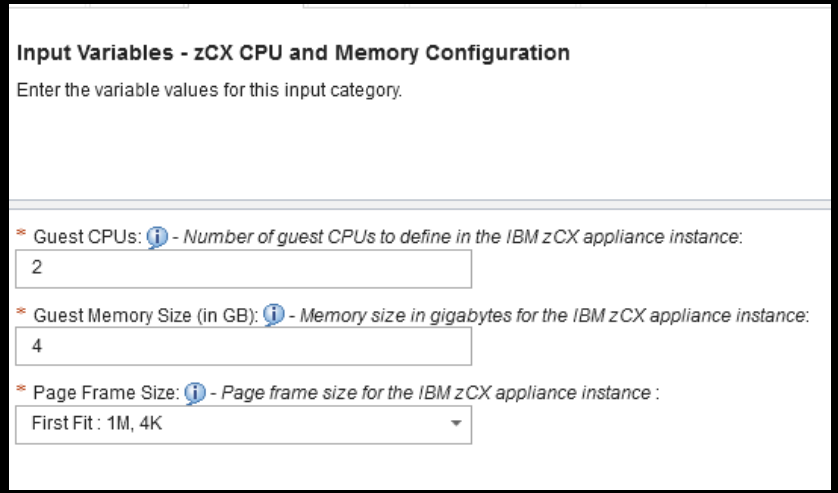


How to choose a page size:

- 2G fixed pages
  - **Best performance: (All benchmarks should be performed with 2G pages)**
    - Reduces TLB misses and page table storage as one 2GB page contains 524,288 4k pages and 2048 1M pages
  - Least flexible
    - The storage is pre-allocated at IPL time via the 2G LFAREA parameter and cannot be used for any other storage pool
    - If storage consumption is an issue, then it may not be the best choice for instances that come and go as others may not be able to use the 2G memory
    - Cannot be used when z/OS is a z/VM guest
- 1M fixed frames
  - Improved performance over 4K but noticeably less than 2G
    - Reduces TLB misses and page table storage as a 1M page contains 256 4K pages
    - On z/VM, provides a dramatic performance improvement over 4k frames and is highly recommended
  - Good flexibility
    - Good choice for appliances that come and go as storage can be reused as 4k if needed
    - 1M LFAREA parameter is only a maximum value as there is no dedicated 1M page pool
- 4K frames
  - Worst performance - not recommended as a first choice unless a sandbox appliance
  - Best availability - add as a second choice in case your first choice is unavailable
- Recommendations
  - Use 2G pages for appliances that are always up or when reusing memory is not an issue
  - Pick a combination of sizes starting with your first choice and the system will use the first one that is available (i.e. 2G, 4K)
  - Automate for cases where the best size was not available but should have been.

Large Page: Usage & Invocation

- Capacity planning for memory on the system (e.g., LFAREA defined).
  - Determine size of zCX memory; select page frame size
  - Adjust WLM tenant resource groups/IEAOPTxx members as needed
- Reconfigure zCX memory using the workflows
- Workflow screen shot



Large Page: Interactions & Dependencies

— Software Dependencies
  - Must use provision or reconfigure zCX workflows to update.

— Hardware Dependencies
  - None.

— Exploiters
  - N/A

Large Page: Upgrade & Coexistence Considerations

- Do all systems in the Plex need to be at the new z/OS level?
  - No
  - Remember, if planning on system automation consider the memory availability of the system that will restart the zCX instance. Always specifying 4K page frame size in the first fit list will help ensure the instance can be restarted.
- DEFAULT is to use the 4K pages to allocate memory in existing workflows.
  - Must reprovision in order to take advantage of the new large page support .

Large Page: Installation & Configuration

- Large pages must be available on the system
- Discussion of planning for memory capacity: Planning for zCX, Memory considerations

Large Page: Startup Messages

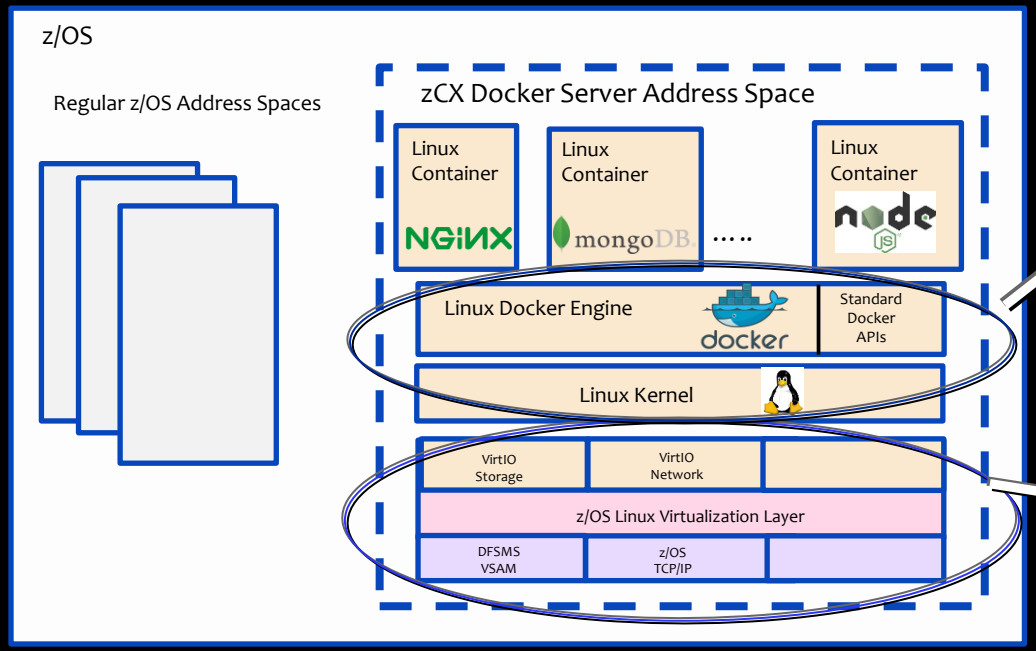
```
$HASP373 ZCXYGGA  STARTED
IEF403I ZCXYGGA - STARTED - TIME=15.25.43
GLZB025I zCX instance ZCXYGGA: Initialization has started. Code date 2/11/21
IEE252I MEMBER CTIGLZ00 FOUND IN USER.PLX9.PARMLIB
GLZB027I zCX instance ZCXYGGA: Allocating guest memory.
GLZB023I zCX instance ZCXYGGA:
Guest storage size 4GB.
Backed by 4096 1M fixed pages.
GLZB027I zCX instance ZCXYGGA: Loading guest image.
GLZB022I zCX instance ZCXYGGA version information  810
Bootloader:           xxxx                private
                      3.7.1               1.0
Current Appliance:    HEAD                private
Current Appliance:    HEAD                private
                      3.6.1               1.8.5
                      20190919T223900Z
Available Appliance:  oa58598             private
                      3.7.1               1.9.9
                      20191202T130914Z
Virtualization Layer: HBB77C0   UJ90006   12/11/20
                      Started on 2021/02/25 15:25:43
Workflows Performed:
Provision:            N/A       N/A       N/A
Reconfigure:          1.0.24    OA60452   2021/02/09 12:39
Upgrade:              N/A       N/A       N/A
Add Data Disks:       N/A       N/A       N/A
GLZB027I zCX instance ZCXYGGA: Starting virtual CPUs.
GLZB001I zCX instance ZCXYGGA initialization is complete. Code date 12/11/20
GLZB027I zCX instance ZCXYGGA: IPLing guest and starting Docker services.
GLZM004I zCX Docker services for instance ZCXYGGA are available.
```

Large Page: Display

```
F <jobname>,DISPLAY,CONFIG
GLZC003I Configuration information for zCX instance <jobname>
File Path: /oc4z/shared/zcx_instances/ZCXYGGA/start.json
FFDC Path: /oc4z/shared/zcx_instances/ZCXYGGA/FFDC
Dump Path: /oc4z/shared/zcx_instances/ZCXYGGA/FFDC/zcx-guest.dmp
Memory size:            4GB
Number of CPUs:         2
Number of Disks:        6
Number of Networks:     1
CTRACE Parmlib Member: CTIGLZ00
Memory Pages:           4096
Memory Page Size:       1M fixed
```

Consolidated Version Support

z/OS Container Extensions Components



zCX z/OSMF Workflows:
Shipped as a new element of z/OS in new FMID: HZDC7C0 which includes:
- z/OSMF Workflows: 5752-SCCWF

zCX Docker Appliance:
Shipped as a new element of z/OS in new FMID: HZDC7C0 which includes:
- Linux Kernel & Docker Engine: 5752-SCCDE

z/OS Virtualization Layer:
Shipped in z/OS Base in BCP Base HBB77C0

zCX Consolidated Version Command Support

Enhancements:

- Provide version information about all the components used to provision and bring up the zCX instance in one message (GLZB022I) on the system console and in JES joblog.
- Provide an operator command support to display information about versions of zCX software being used at any given time.
  - Modify <zcx_job_name>,display, version
- Additionally, Docker is upgraded to version 19.03.6 with this support

Benefits:

- Simplifies Customer and IBM zCX service experience.

Consolidated Version: Usage & Invocation

- Consolidated Version Support
  - Message GLZB022I displayed:
    - » At zCX startup
    - » Or With '`modify <zcx_job_name>,display,version`' command

Consolidated Version: Usage & Invocation - message template

```
GLZB022I zCX instance job_name version information
Bootloader:           bootloader version information
Current Appliance:    current appliance version information
Available Appliance:  available appliance version information
Virtualization Layer: virtualization layer version information
                      Started on yyyy/mm/dd hh:mm:ss
Workflows Performed:
Provision:            provision workflow version information
Reconfigure:          reconfigure workflow version information
Upgrade:              upgrade workflow version information
Add Data Disks:       add data disks workflow version information
```

Consolidated Version: Usage & Invocation - message example

```
SY1  modify zcx232,display,version
SY1  GLZB022I zCX instance ZCX232 version information
Bootloader:           HZDC7C0            oa59934
                      3.12.0             1.2.1
Current Appliance:    oa60513            private
                      3.15.0             1.15.6
                      20201117T132050Z
Available Appliance:  oa60513            private
                      3.15.0             1.15.6
                      20201117T132050Z
Virtualization Layer: HBB77D0   HBB77D0   02/26/21
                      Started on 2021/03/03 15:05:30
Workflows Performed:
Provision:            2.0.34    OA59865   2021/01/21 15:43
Reconfigure:          N/A       N/A       N/A
Upgrade:              N/A       N/A       N/A
Add Data Disks:       N/A       N/A       N/A
```

Consolidated Version: Interactions & Dependencies

— Software Dependencies
  - None
— Hardware Dependencies
  - None
— Exploiters
  - None

Consolidated Version: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

Consolidated Version: Installation & Configuration

— N/A

Constraint Relief

zCX Constraints Relief Support

Enhancements:

- Ability to specify zCX guest memory size up to 1024GB in zCX
- Capability to run up to 1000 Docker containers in a single zCX instance*
  - *Depends on the workloads and zCX instance resource allocation
- Ability to increase the root VSAM LDS allocation size on an upgrade
- Capability to allocate up to 245 user data and swap data disks per zCX instance
- Capability to use port 80 and 443 on each zCX instance external IP address
- Capability to allocate disk devices up to 1024GB each

Benefits:

- Ability run large containerized workloads on zCX
- Ability for z/OS system programmer to control the resource utilization on the system

Constraint Relief: Usage & Invocation

- To set the zCX Guest memory up to 1024GB → provision and reconfigure workflows
- Containers per zCX appliance from 200 to 1000 → add more resources as needed
- To increase the root VSAM LDS allocation size up to 1024GB → upgrade workflow
- To add 10 data disks and 5 swap disks at a time - up to 245 total disks per zCX instance → Add data disk workflow
- Ports 80 and 443 on a zCX appliance instance IP address → the zCX instance IP must be specified on the docker run command
- To allocate disk devices up to 1024GB each → provision and add data disk workflows

Constraint Relief: Interactions & Dependencies

— Software Dependencies

- OA60920/UJ05116, shipped at the end of Q1 2021

— Hardware Dependencies

- None

— Exploiters

- None

Constraint Relief: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

- No

Constraint Relief: Installation & Configuration

— N/A

Resource Alerts

zCX Resource Shortage z/OS Alerts

Enhancements:

- Capability to monitor zCX resource usage and constraints using native z/OS facilities (i.e. WTOs, GLZ* messages).
- Set aside additional zCX guest memory (real) for “must-complete” systems tasks in zCX, and for crash kernel dump program to capture FFDC data.

Benefits:

- Pro-active z/OS alerts using native z/OS facilities (i.e. WTOs).
- Ability to identify zCX resource shortages before they cause performance issues.
  - Informational, Warning, and Critical shortage messages

Resource Shortage Alerts

zCX resource shortage z/OS alerts

- Proactive z/OS alerts for zCX resource shortages
- Automated monitoring and alerts for used memory, root disk space, user data disk space, and swap space
- Messages sent to z/OS system log or operations log when resource usage thresholds are reached (50%, 70% and 85% utilization)

Resource Shortage Alerts - Message

GLZM011I zCX instance <jobname> alert: <resource> <severity>.
Utilization at <percent>%.

<jobname>: the jobname of the zCX instance
<resource>: the resource being monitored and indicated in the alert message. This can be: memory, swap disk, root disk, or data disk.
<severity>: the changed severity of the resource being monitored. This can be: critical, warning, or normal.
<percent>: the current percentage of utilization of the resource being monitored. This is an integer.

The <severity> and <percent> are related in the following way:
- severity normal has utilization percentage in the range of 0%-69%
- severity warning has utilization percentage in the range of 70%-84%
- severity critical has utilization percentage in the range of 85%-100%

The message is generated only if there is a change in the resource utilization percentage that updates its severity in the following way:
- message of severity normal if its last severity was critical or warning with utilization percentage <= 65%
- message of severity warning if its last severity was normal or critical with utilization percentage <= 80%
- message of severity critical if its last severity was normal or warning

Example:

```
SYI GLZM011I zCX instance ZCX232 alert: root disk critical.
Utilization at 95%.
```

Resource Alerts: Usage & Invocation

— Resource Shortage

- No user action or manual invocation. The new message GLZM011I will be displayed on console when the specific thresholds are met.

Resource Alerts: Interactions & Dependencies

— Software Dependencies
  - None
— Hardware Dependencies
  - None
— Exploiters
  - None

Resource Alerts: Upgrade & Coexistence Considerations

— Do all systems in the sysplex need to be at the new z/OS level?

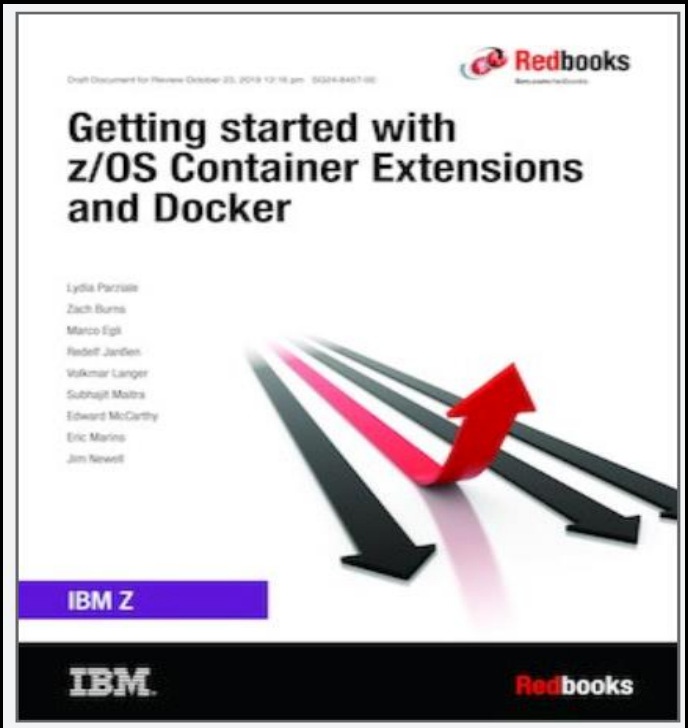
- No

Resource Alerts: Installation & Configuration

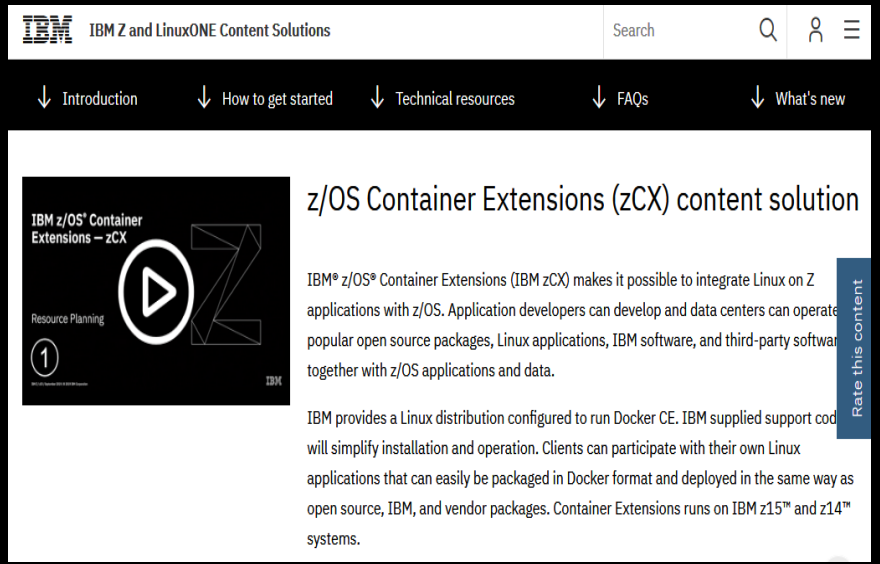
— N/A

Appendix

Redbook link

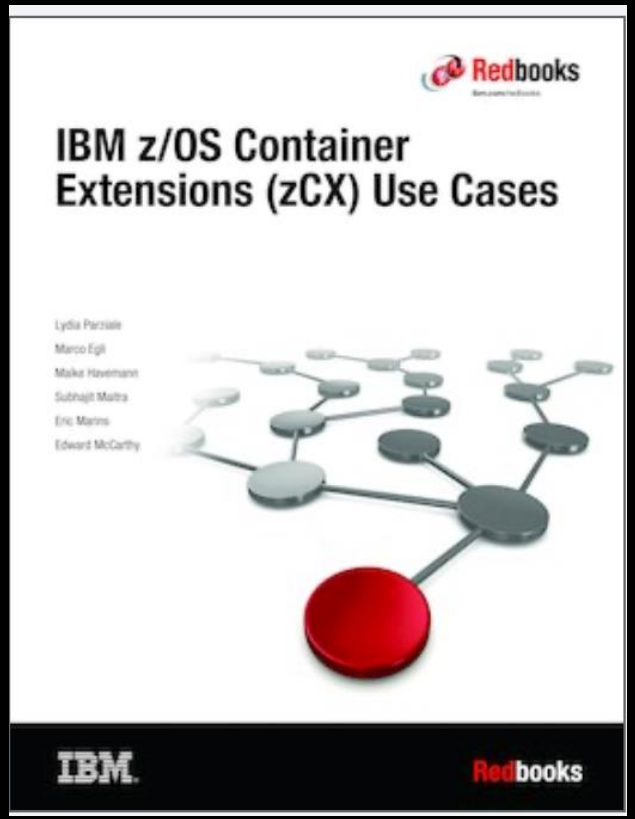


z/OS Containter Extensions (zCX) link



IBM z/OS Container Extensions (zCX) Use Cases Redbook

Table of contents



Thank you