What's New in z/OS V2.4

z/OS V2.4 Preview Announce Edition (Preview)

Statements regarding IBM future direction and intent are subject to change or withdrawal, and represent goals and objectives only.

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(CD) - Continuous Delivery items

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z/OS V2.4 Release Overview

Release Themes

Enable new application development processes and optimize existing application investment while providing IBM Z® application-level resiliency and security

AGILITY

in the adoption of new technologies in DevOps, microservices, and consumption models that are delivered as a service to accelerate their time to value

OPTIMIZATION

through the ability to run computing workloads in the most efficient environment

RESILIENCY

to deliver continuity of business services through exploitation of functions such as encryption and high availability

Build Applications and services based on a highly scalable and secure infrastructure that delivers the performance and workload* availability to enable digitally transformation

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z/OS V2.4 Release Overview

z/OS V2.4 Content Overview

Usability and Skills

z/OSMF Desktop, Sysplex management, Software management & workflows; Assembler skill reduction; XCF transport class simplification; …

Scalability & Performance

AMODE 64; Alternate subchannels set for XRC & Linux; Improved dump capture time; Asynch XI for CF cache; …

Availability

TVS Auto Commit; JES2 resiliency; Remote pair flashcopy for XRC; Logger support for GDPS k system; zFS HA improvements; …

Application Development

z/OS Container Extensions, **IBM Open Data Analytics for z/OS**, XML4J; LE support for C++; Unicode V9; NFS support for Unicode; Web enablement toolkit; UTF8 support; xvfb support; …

Systems Management

Container Pricing, zFS file back-up & restore; JES2 enhancements for JES3 migration; z/OS cloud provisioning for z/OS middleware; NFS improvements for SMB; Multiple NFS servers on a system; …

Enhancing Security

Encryption for sequential, basic & large format; Encryption for PDSE; Encryption for JES2 spool; TLS 1.3 support; RACF ACEE privilege escalation; TSO logon time out; MSC console passphrases; OpenSSH V7; …

Networking

CSSMTP support for DBCS; HiperSockets Converged Interface (HSCI) zEncryption Readiness Tool (zERT); …

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z/OS V2.4 Release Overview

Release Highlights

Feature	Description
z/OS Container Extensions	**Workload Enablement:** A solution architect can create a solution to be deployed on z/OS based on components available as Docker containers in the Linux on z ecosystem transparently exploiting z/OS QoS, without requiring z/OS development skills.
Container Pricing for IBM Z	**Pricing Transparency**: As a solution architect, I want the ability to deploy a new solution, co-located or on a new LPAR, without any direct impact to the rolling 4-hour average.
Open Data Analytics on z/OS	**Modernization**: Any application developer can further their mainframe modernization initiative by building business solutions using cognitive, analytic, and well-known building blocks/tools to leverage z/OS qualities of service without requiring deep z-specific skills.

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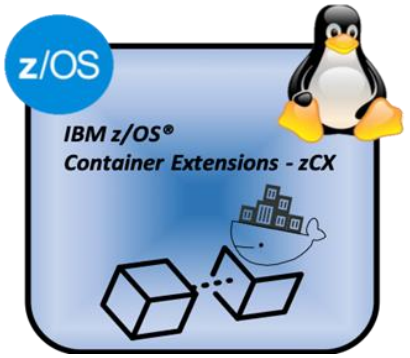
What is z/OS Container Extensions (zCX)?



z/OS Container Extensions is intended to Modernize and Extend your z/OS Applications

Optimization

Co-location of applications ushers in a new level of optimization. The ability to run nearly any Linux on IBM Z Docker container in direct support of z/OS® workloads on the same z/OS® system.

Agility

Access the most recent development tooling and processes available in the Linux on z ecosystem and deploy on z/OS®. Reusing popular Linux skills and patterns.

Operational Efficiency

Retain the operational benefits of z/OS®, mature business processes, and the ability to maintain overall operational control within z/OS® with z/OS® Quality of Service.

- Learn more at: http://ibm.biz/zOSContainerExtensions

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z/OS V2.4 Release Overview

z/OS Container Extensions

- This is the capability to run Linux on z Docker images directly in z/OS
  - Linux distribution and Docker CE provided
  - Service entitled as part of z/OS service entitlement
- IBM software is planned to be licensed and priced in line with Linux on z offering
- Intended for workloads with affinity to z/OS
  - For data or applications
- Provide ease of use in Lifecycle Management of a Docker Appliance
  - z/OSMF Workflow for creation and removal
  - Additional support for applying service
- This workload is planned to be zIIP eligible
- Operational consistency with z/OS

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z/OS V2.4 Release Overview

z/OS Container Extensions (cont.)

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

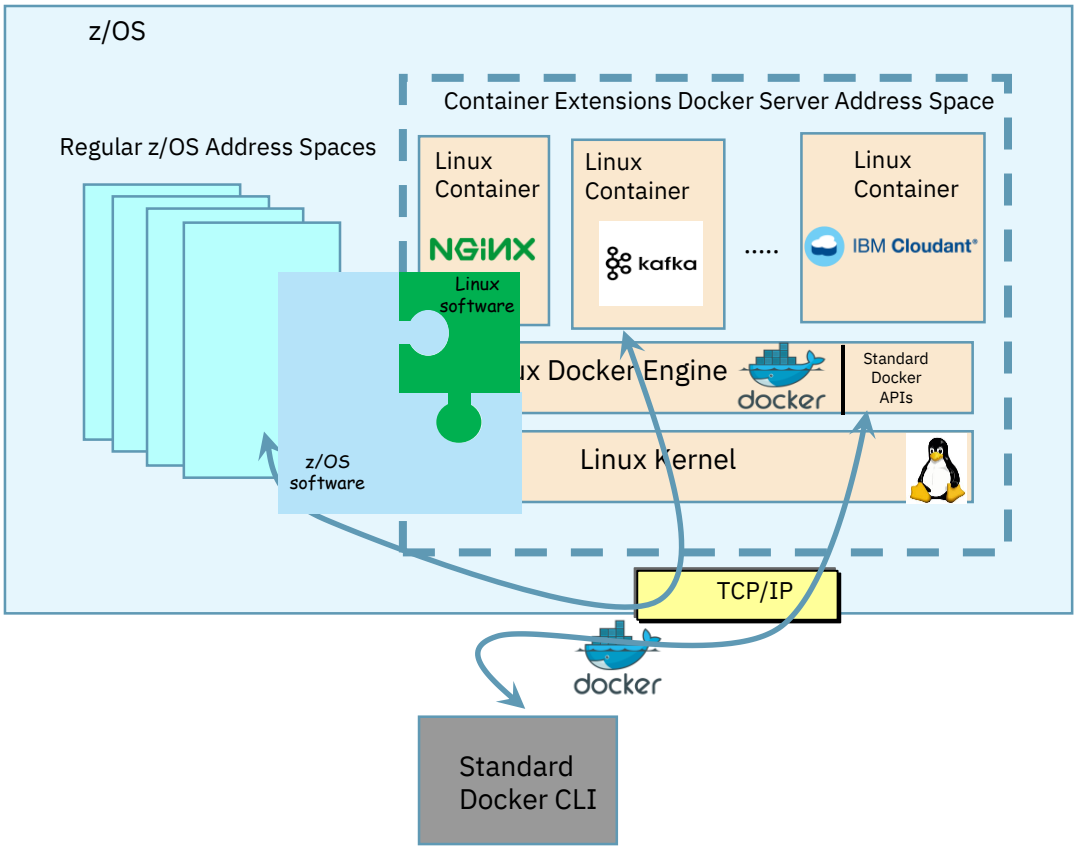
- Any software available as a Docker image on Z System (growing ecosystem available on Docker Hub)
- Any home-grown Linux for Z application packaged as a Docker image
- Using standard Docker interfaces

Limited visibility into Linux environment

- No root access
- Access as defined by Docker interfaces
- Limited Linux administrative overhead

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

- Requires packaging of software as Docker images



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z/OS V2.4 Release Overview

z/OS Container Extensions Qualities of Services

Integrated Disaster Recovery & Planned Outage coordination

- z/OS DR/GDPS for site failures
- Integrated planned outage coordination
- No need to coordinate with non-z/OS administrators

z/OS storage resilience

- Eliminate single points of failure
- Transparent encryption and failure detection with hyperswap
- Configuration validation I/O health checks
- Automatic detection of zHyperlink

z/OS networking virtualization

- Support for VIPAs
- High speed communications

z/OS Workload Management

- WLM service goals and resource caps
- Capacity Provisioning Manager (CPM)
- SMF support for accounting and chargebacks

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z/OS V2.4 Release Overview

What is Container Pricing?

Provides standalone workload pricing within the highly virtualized IBM Z environment. z/OS Solutions are priced based on their business value, with no direct impact to the cost of unrelated workloads.

- Greatly simplified software pricing for qualified solutions
- Flexible deployment and licensing options that support the best technical fit
- Competitive economics that are directly relevant to each solution
- Learn more: https://www.ibm.com/it-infrastructure/z/software/pricing-container

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z/OS V2.4 Release Overview

Container Pricing (CD)

Simple and predictable pricing models unlocked by z/OS technology

- Flexible deployment options that support best technical fit
  - z/OS ability to define tenant resource groups (TRG) to meter workloads
  - SCRT enhancements to utilize RMF TRG data for co-located workload
  - SCRT enhancements to enable full LPAR containers

- Enables Solution Consumption License Charges
  - Utilizes z/OS ability to provide detailed resource consumption metrics
  - SCRT calculates and reports true MSU consumption of a solution

A Technical Pricing strategy for the ecosystem

- SMF enhancements provide:
  - More flexible product registration and usage services
  - Sub-LPAR (TRG) tracking of product usage
- LE wrapper enables easier use of product usage services (IFAUSAGE) in supported languages
- SCRT support allows ISVs to take advantage of z/OS enhancements to track non-IBM products for ISV specific reporting

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What is IBM Open Data Analytics for z/OS?

Solution designed to simplify data analysis. It optimizes the runtime of open source technologies, including Apache Spark, Anaconda and Python to gain insights from data at its source by:

- Incorporating a wide variety of current data on and off z/OS, to reduce latency of insights and derive higher value from analytics.
- Reducing data movement and protecting business data with IBM Z systems crypto cards, which zero out when tampered with. Encrypt your data and analyze it at the source of origin.
- Improving interoperability with its integration with enterprise business applications.
- Integrating data across a heterogeneous environment using modern analytic capabilities commonly used by data scientists everywhere.
- Learn more: https://www.ibm.com/us-en/marketplace/open-data-analytics-for-zos

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z/OS V2.4 Release Overview

IBM Open Data Analytics for z/OS

Spark

- New Features for the option to allow multiple applications to run concurrently without significant system tuning of memory and CPU configurations
- Simplification support with a new z/OSMF dynamic workflow and definition file included inside the Spark package to help you configure Spark
- Enhanced Security with a new Spark option to allow security administrators to specify a fixed port for the PySpark daemon to listen on, making it easier to secure the port

Anaconda

- Apache Maven support for better build automation
- Support for XGBoost that is highly preferred in the industry for its implementation of gradient boosted decision trees designed for speed and performance

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z/OS V2.4 Release Overview

IBM Open Data Analytics for z/OS (cont.)

MDS

- Performance enhancements added for Db2 direct read of linear data sets. This method accesses Db2 data by reading the underlying Db2 VSAM linear data sets directly. This allows read-only access to the data and provides high performance for bulk data access
- Displays an informational message for IOCTL when the connection is outside of the SYSPLEX and provides improvements to Server Trace messages
- New support to ensure that all members in a Virtual Parallel Data group specify the same back-end data source
- New Support added to enable the DataStudio Client to listen for ENF 55 auxiliary storage shortage signals and to throttle storage utilization when an auxiliary storage shortage is signaled
- Support is added for IBM Application Discovery and Delivery Intelligence (ADDI), IBM Rational Asset Analyzer (RAA), and AES Encrypted DRDA Passwords. This enhancement supports the use of IBM RAA and IBM ADDI information for creating virtual maps that can access VSAM and sequential data.

z/OS Infrastructure with Metering and Capping

- The new metering and capping support for z/OS allows the system capacity planner more granular control over CPU and memory consumption for various workloads and enables the system to host new workloads more easily.

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z/OS V2.4 Release Overview

Release Notes

JES3

- JES3 is planned to be included in z/OS 2.4 and z/OS.next but not beyond that, customers affected can get more information by emailing: JES3Q@us.ibm.com

Tape Support EOL

- IBM has discontinued delivery of z/OS platform products and service on magnetic tape on July 1, 2018

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Hardware Support

IBM z14 Functions & Features (Driver level 36)

System, Processor, Memory
Five hardware models: M01, M02, M03, M04, M05
10 core 5.2GHz 14nm PU SCM
1 - 170 PUs configurable as CPs, zIIPs, IFLs, ICFs, up to 196 Pus
Increased Uniprocessor capacity
Up to 33 sub capacity CPs at capacity settings 4, 5, or 6
CPC Drawers and backplane Oscillator
Enhanced SMT and new instructions for SIMD
Enhanced processor/cache design with 1.5x more on-chip cache sizes
Up to 32 TB DRAM, protected by Redundant Array of Independent Memory (RAIM)
Virtual Flash Memory (VFM)
192 GB HSA
Improved pipeline design and cache management

New features and functions
Announce: Oct. 2nd, 2018

I/O Subsystem, Parallel Sysplex, STP, Security
PCIe Gen3 I/O fanouts with 16 GBps Buses
6 CSS, 4 Subchannel sets per CSS
0 – 5 PCIe I/O Drawer Gen3 (no I/O Drawer)
Next generation FICON Express16S+
25 & 10 GbE RoCE Express2
Integrated Coupling Adapter (ICA SR) and Coupling express LR for coupling links
Support for up to 256 coupling CHPIDs per CPC
CFCC Level 23 (HMC 2.14.1)
Crypto Express6S and CMPSC compression and Huffman Coding compression
STP Enhancement - CTN Split and Merge
STP configuration and usability enhancements (GUI)
IBM zHyperLink Express
OSA-Express7S 25GbE - SR
OSA-Express6S
IBM Secure Service Container

RAS, simplification and others	
L3 Cache Symbol ECC	**Acoustic and thin covers (space saving)**
N+1 radiator design for Air Cooled System	**Drop "Classic" HMC UI**
ASHRAE Class A3 design	**Enhanced SE and HMC Hardware (security)**
Support for ASHRAE Class A3 datacenter	**TKE 9.1 LICC and new Smart cards**
Largesum TCP/IP hardware Checksum (OSA-Express6S)	Pause-less garbage collection
Universal Spare SCM s (CP and SC)	Simplified and enhanced functionality for STP configuration
Enhanced Dynamic Memory Relocation for EDA and CDR	Virtual Flash Memory (replaces IBM zFlash Express)

PR/SM
Up to 170 CPUs per partition
IBM Dynamic Partition Manager updates
Up to 85 LPARs
16 TB Memory per partition

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Hardware Support

IBM z14 ZR1 Functions & Features (Driver level 36)

System, Processor, Memory
One model, one CPC drawer, four available sizes
10 core 14nm PU SCM (5, 6, 7, 8, or 9 active cores per PU SCM)
Up to 30 configurable PUs as CPs, zIIPs, IFL, ICFs, or optional SAPs (up to 6 CPs)
Increased uni-processor capacity
156 Capacity settings
19" Rack, ASHRAE class A3 (for Data Center requirements relief)
Enhanced SMT (for IFLs and zIIPs only) and SIMD
Enhanced processor / cache design with bigger cache sizes
Up to 8 TB of Memory protected by Redundant Array of Independent Memory (RAIM)
16U Reserved (rack space) feature
Up to 40 LPARs
IBM Dynamic Partition Manager
Secure Service Container
LPAR Group Absolute Capping
CPUMF sampling w/o PE Mode enablement

New features and functions
Announce: Oct. 2nd, 2018

I/O Subsystem, Parallel Sysplex, STP, Security
Up to eight (8) PCIe Gen3 I/O fanouts with 16 GBps Busses
New PCIe+ I/O Drawer (up to 4 per system, up to 64 PCIe features)
3 LCSS, 3 Subchannel sets per LCSS
Next generation FICON Express16S+
32K I/O Devices for all FICON features
25 & 10 GbE RoCE Express2
Integrated Coupling Adapter (ICA SR) and Coupling express LR for coupling links
CFCC Level 23 (HMC 2.14.1)
Crypto Express6S and CMPSC compression and Huffman Coding compression
STP Enhancement - CTN Split and Merge
Virtual Flash Memory (512 GB per feature, up to four features)
IBM zHyperLink Express
OSA-Express7S 25GbE - SR
OSA-Express6S
IBM Secure Service Container

RAS, Other Infrastructure Enhancements	
Keyboard Video Monitor Switch, single display console	Ethernet switches replace SCHs
STP Enhancements - Configuration	Rack-Mounted Support Elements (CPC rack)
Key Locks for doors	Tower & Rack-mounted HMCs and TKEs
Support for ASHRAE Class A3 datacenter	**TKE 9.1 LICC and new Smart Cards**

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Hardware Support

Dynamic I/O for Standalone CFs

- Standalone CFs, by definition, have no co-resident z/OS (HCD) images who can make hardware-only Dynamic I/O changes on behalf of the CF partition(s)
- With this support, an MCS Linux-based HCD firmware appliance image will be started on the standalone CF CEC to perform this role – non-DPM
- New firmware communication pathways from the “driving” HCD managing the IODF changes, via the HMC/SE, to the standalone CF CEC, and ultimately the MCS HCD are created and used…
  - For passing the modified IODF
  - For driving the Dynamic I/O activate and associated recovery/management functions
- Remote Dynamic I/O hardware-only activations are performed on the Standalone CF CEC; CF image reacts to these changes just as if they’d been driven through a z/OS-based or zVM-based HCD
- Requires z14 GA2 firmware support at both ends, plus z/OS PTFs at the “driving” z/OS system
  - No new adapter hardware requirements for the Standalone CF CEC
  - One-time enablement POR/IML on CF CEC to move it from GA1 to GA2 and activate the MCS HCD appliance partition for use

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Hardware Support

TS7700 R4.1.2 – Control Unit Initiated Reconfiguration (CUIR) Support for Tape (CD)

- Within a TS7700 grid, when a distributed library (ie cluster) requires service, the operator needs to perform several manual steps that can be very time consuming:
  - Determine the attached hosts
  - Manually vary the devices in the distributed library offline / online on each host
  - Cancel long running jobs or swap to devices in a different distributed library
- With CUIR, when a distributed library requires service, the system can be configured to automate several of the manual steps:
  - New DFSMS support helps to determine the attached hosts
    - DEVSERV QTAPE,device-number,**QHA** - new option surfaces which system(s)/SYSPLEX(s) are connected to a specific device in a distributed library
  - New TS7700 LIBRARY REQUEST command *automatically* varies offline all drives that are online to each attached z/OS host and *automatically* varies the drives back online when the distributed library becomes available again.
  - **NOTE:** Still must manually cancel long running jobs or swap devices to devices in a different cluster.
- Hardware Requirements:
  - All distributed libraries in the TS7700 grid must be at R4.1.2
  - Only supported in a grid configuration (no stand-alone)
- Software Requirements:
  - Only native z/OS LPARs running JES2 are supported

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Hardware Support

ICSF HCR77D0 WD#18 (CD)

- CCA 5.4 and 6.1 support
  - ISO-4 PIN block formats, 3-key TDES keys, New DK directed key derivation
  - Delivered via APAR OA55184
- CCA 6.2 Support
  - CPACF export controls and PCI HSM compliance tagging for 3-key TDES keys
- New EP11 “BSI 2017” compliance mode
- ICSF Security Enhancements
  - KGUP granular update controls and CSFKEYS checking
  - SAF resource name prefixing
  - CSFKEYS permission specification for a user provided list of ICSF services
- ISPF browser for PKDS
- Console command to pause requests & restart ICSF w/ new service libraries
  - Including ARM registration
- Ability to have ICSF start much earlier during IPL process
- ChaCha20 and Poly1305 algorithms (clear key only)
- FIPS compliant key wrapping mechanism for PKCS#11 Wrap Key
- SMF records updated to honor MAXKCVLEN installation option keyword
- Select CCA services enhanced to route requests to regional crypto servers

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z/OS Support Summary

Release	z900/z 800 WdfM	z990/ z890 WdfM	z9 EC z9 BC WdfM	z10 EC z10 BC WdfM	z196 Z114 WdfM	zEC12 zBC12 WdfM	z13 z13s	z14 ZR1	End of Service	Extended Defect Support
z/OS V1.13	X	X	X	X	X	X	X	X	9/16	9/19[2]
z/OS V2.1			X	X	X	X	X	X	9/18	9/21[2]
z/OS V2.2				X	X	X	X	X	9/20[1]	9/23[2]
z/OS V2.3						X	X	X	9/22[1]	9/25[2]
z/OS V2.4						X	X	X	9/24[1]	9/27[2]

Notes:

[1] - All statements regarding IBM's plans, directions, and intent are subject to change or withdrawal without notice.

[2] - Extended support dates are projected and are subject to change or withdrawal without notice.

WdfM - Server has been withdrawn from Marketing

Legend

Defect support provided with IBM Software Support Services for z/OS
Generally supported

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Usability & Skills

Overview, goals and directions

Bring a browser based ecosystem to z/OS Management
- Consistent with other platform User interfaces
- Modern compared to ISPF 3270
- Client platform agnostic – OS, devices etc.
- Exploit graphics and other techniques where appropriate

Develop Applications focused on z/OS unique needs
- Task Oriented
- Reduced effort

Integrate and expand the z/OS ecosystem
- Provide API's for public consumption
- Securely and efficiently

Reduce Reliance on Assembler Skills
- Provide solutions that don't require code where possible
- Support higher level language extensions of z/OS

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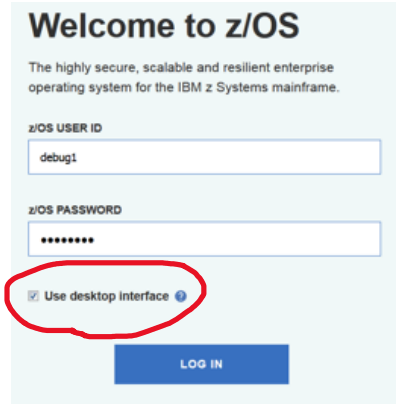
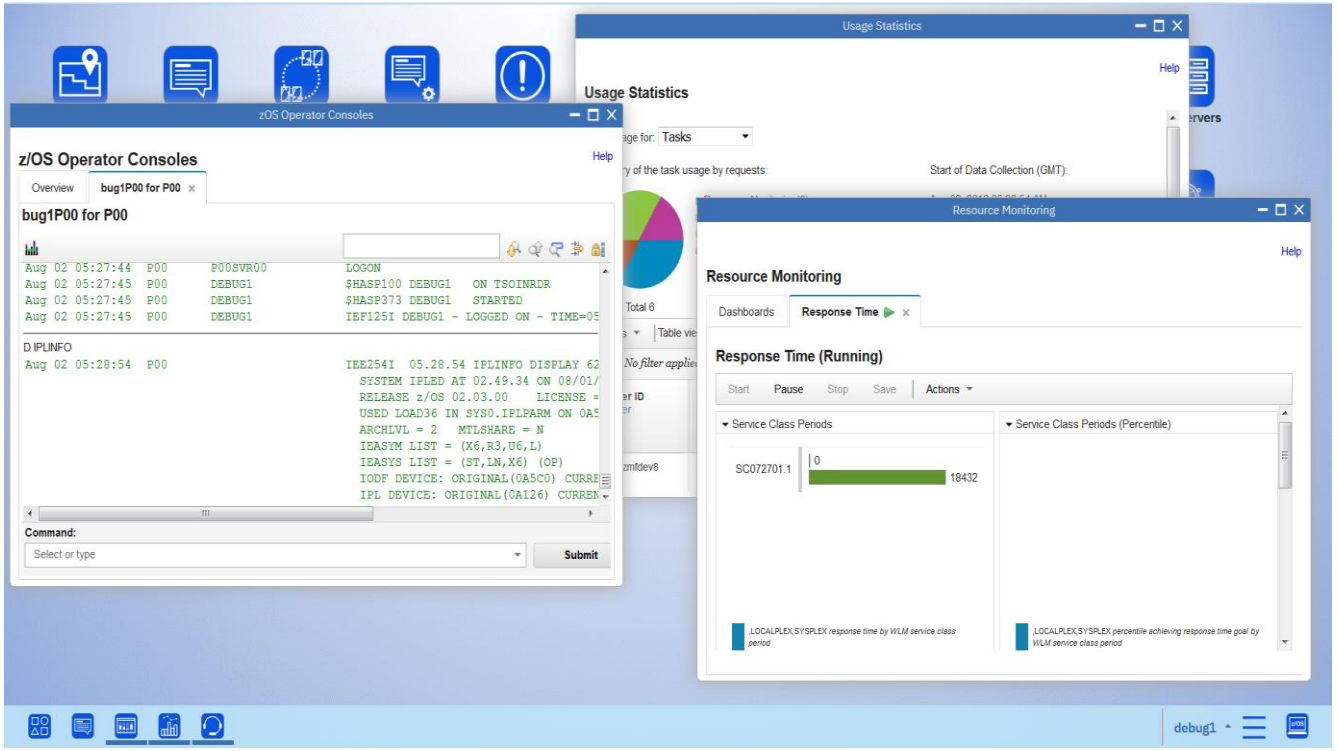
Usability & Skills

z/OSMF Desktop

- z/OSMF a desktop-like user interface, default for z/OS 2.4
- Benefits – Multi-tasking, more screen available, intuitive to new users, customer grouping of items





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Usability & Skills

Sysplex Management

- View sysplex configuration
  - Table and graphical views
    - Physical and logical views, by CPC, by sysplex,
    - Coupling Facility, Links, Structures, etc.
  - Available in z/OS 2.2 and up
- Modify Sysplex configuration
  - Sysplex wide commands and results display
  - Retained across IPL’s
  - Allows review of who took what action when
  - Optionally view commands before issuing them
- Actions include
  - Rebuild structure(s), all structures
  - Duplex structure(s)
  - Reallocate
  - Couple dataset creation, switching
  - CF actions
  - Paths management

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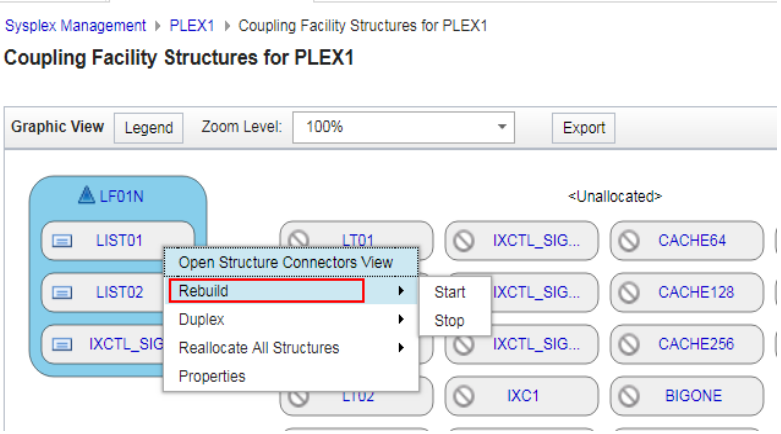
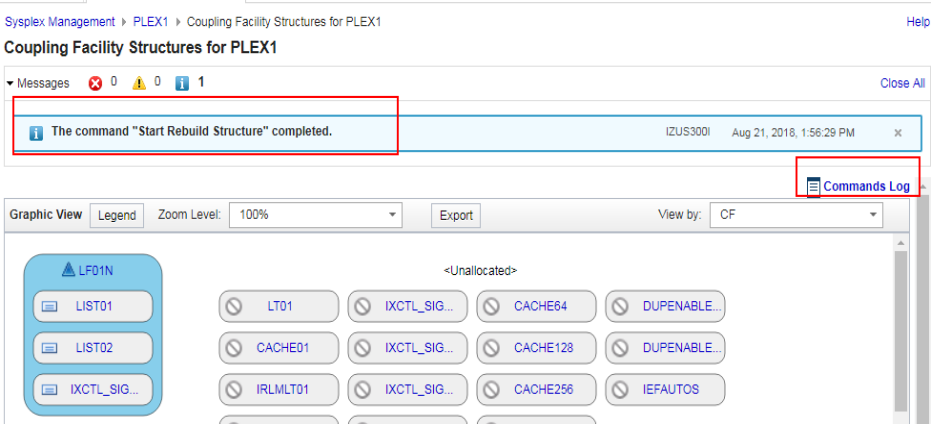
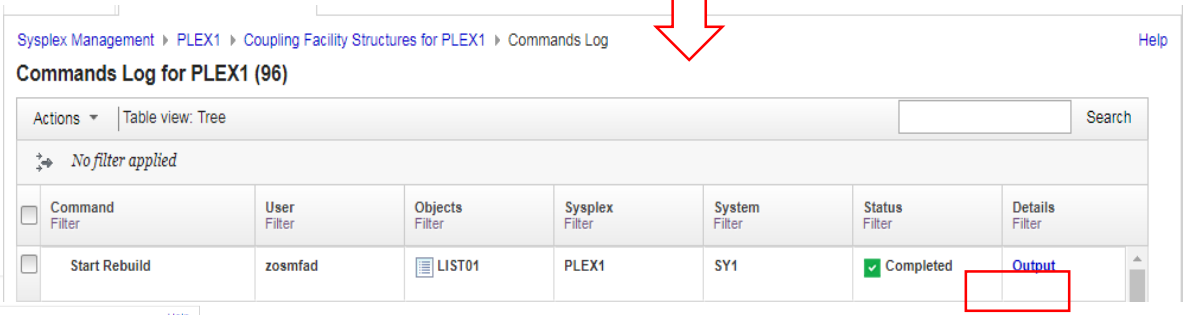
Usability & Skills

Sysplex Management – Modify structures







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Usability & Skills

z/OSMF Software Management

- Ultimate goal is to provide a single approach to software maintenance and management
  - Acquisition
  - New installation
  - Upgrades
  - Fixing a problem
  - Applying preventative maintenance
- An application in z/OSMF to manage software binaries
  - Portable software instances
  - Can be SMP/e or non-smp/e or a mixture
  - Installation via dialog
- Use of z/OSMF Workflows for configuration
  - Standardize the configuration of software
  - Both IBM and non-IBM software
  - Can be instructions or automated or a combination

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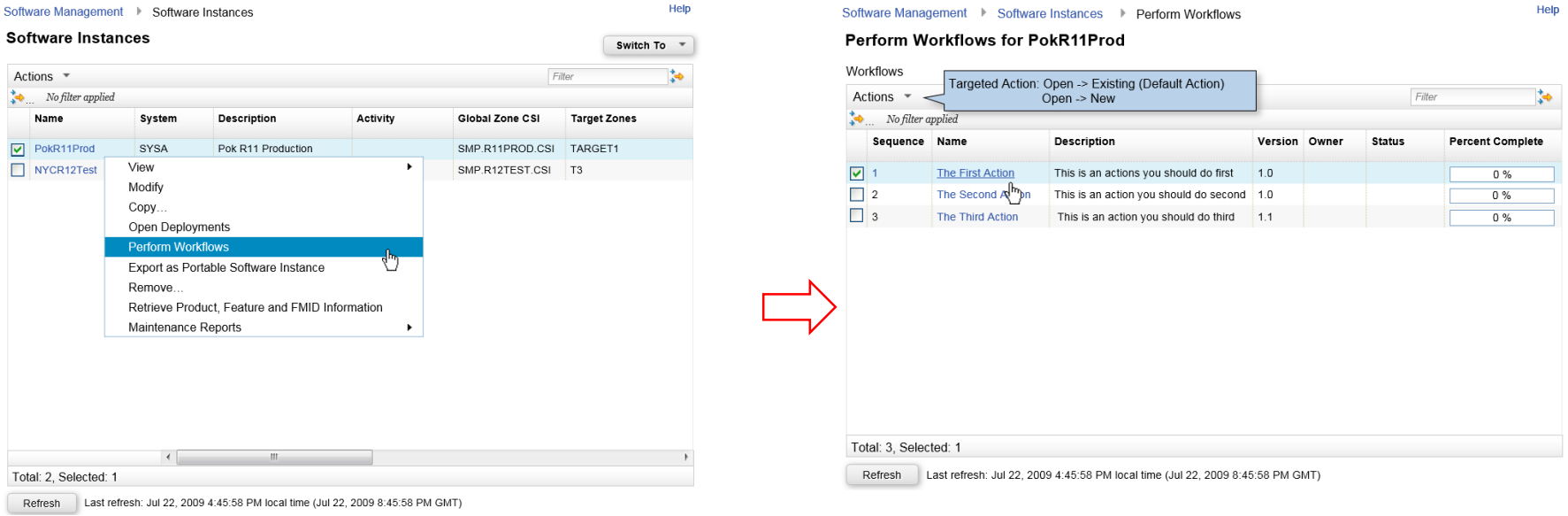
Usability & Skills

z/OSMF Software Management integration with Workflow

- Workflows associated with software instance
- Portable software instance acquisition/download
- Define workflows for a software instance
- Run workflows for a software instance



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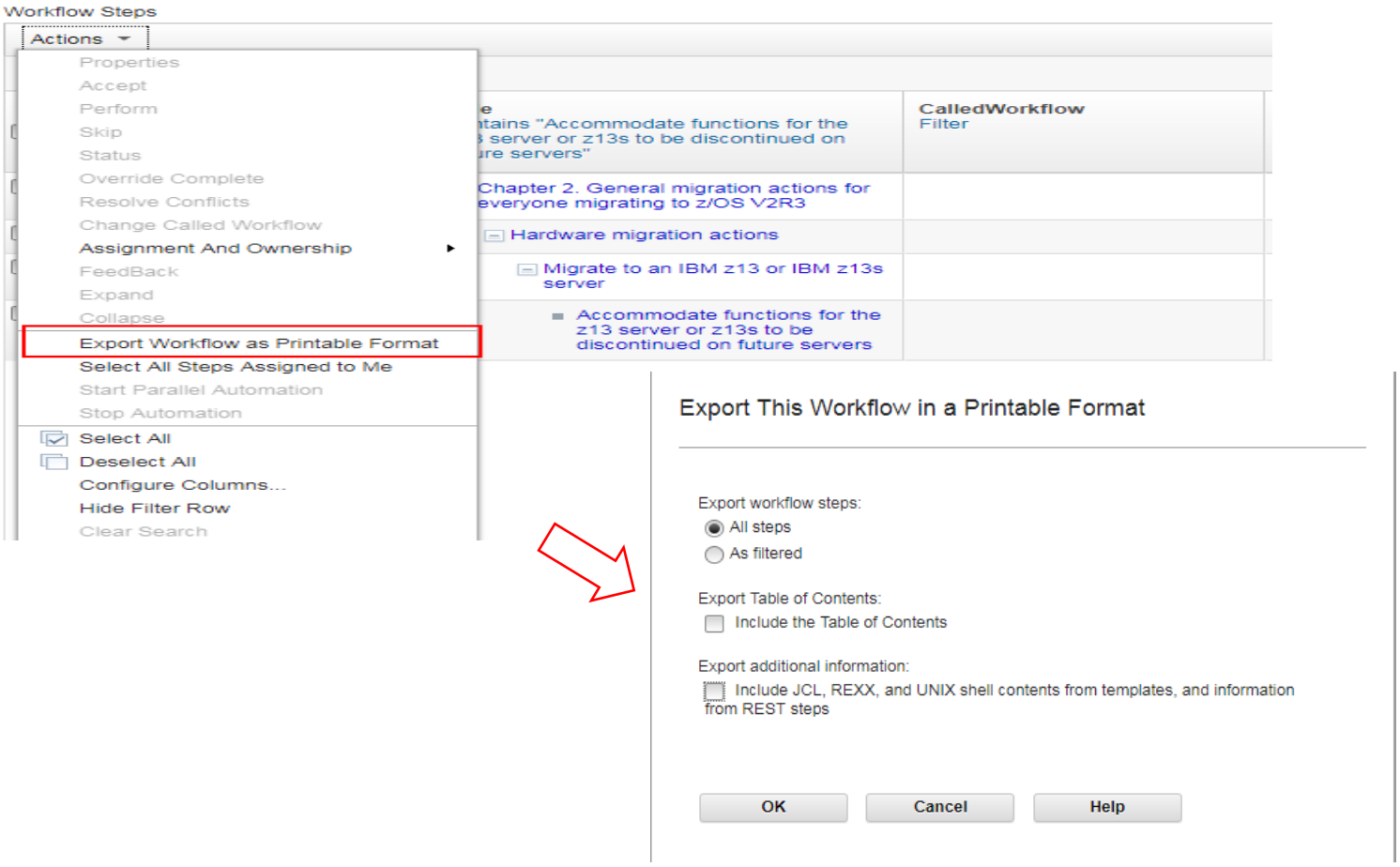
Usability & Skills

Workflow – Export workflow as printable format

- The z/OSMF Workflows task is enhanced to support a new function called “Export Workflow As Printable Format”, which is to export workflow information and steps information into a readable and printable format HTML page via PH00582



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Usability & Skills

z/OS Release Upgrade Assistance

- Generally, the term “migration” will be referred to as “upgrade” as of z/OS V2.4.
- z/OSMF ***z/OS V2.4 Upgrade Workflow*** is planned to be provided from current github location for V2.2 and V2.3 upgrade paths.
  - This Workflow allows for discovering functions used, tailoring information specific to your systems, and verification of many upgrade actions.
  - IBM Strongly recommends that you become familiar with z/OSMF Workflows to take advantage of these benefits!

- ***z/OS Migration*** publication in its current form will not be provided.
  - Exported formats for both upgrade paths of the ***z/OS V2.4 Upgrade Workflow*** is planned to be provided in KnowledgeCenter for co-location with the rest of the z/OS books. These files will allow for reading, searching, and printing without z/OSMF.
  - Note that these exported files are not tailored for your environment, so determining applicability and tracking status is not possible if you use the exported formats.

- Workflow support for array type variables via PH03053

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Usability & Skills

Software Management (CD)

- Workflows can be launched from a Software Instance during installation to help with configuration and customization (PH02650)

Software Management installation of ServerPac (SOD)

- IBM's first delivery of a ServerPac as a Portable Software Instance planned for CICS Transaction Server and associated CICS products, which can be installed with z/OSMF.
  - Choosing this option means you will use z/OSMF on your driving system.
- Existing ISPF CustomPac Dialog format will still be offered. Choice is yours.
- Both formats offered in internet download on in DVD.

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Usability & Skills

z/OSMF Display Command (CD)

- z/OSMF supports below syntax for DISPLAY command
  - F IZUSVR,DISPLAY IZU
  - Or
  - D IZU
- Information shown in a Display Command
  - +CWWKB0004I: z/OSMF PARMLIBs DISPLAY 227
    IZU010I The home page of z/OSMF server in SYSTEM(SY1)
    in AUTOSTART_GROUP(IZUDFLT) can be accessed at :
    https://pev048.pok.ibm.com:443/zosmf
    IZU011I The server started at *2018-03-28 06:40:16*
    and has been running for *0(h):2(m):7(s)*

    Current z/OSMF settings
    Source

    HOSTNAME(pev048.pok.ibm.com) IZUPRM3C
    ……

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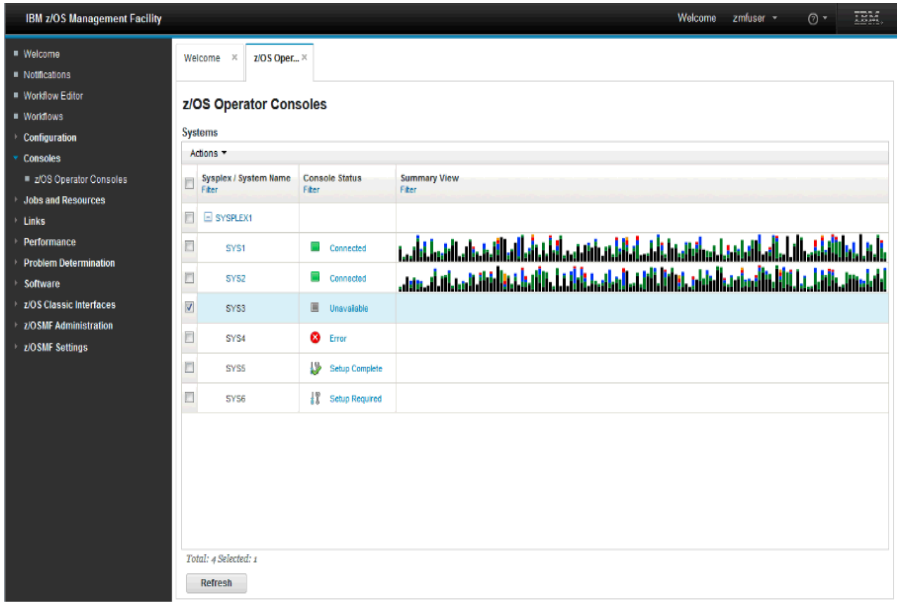
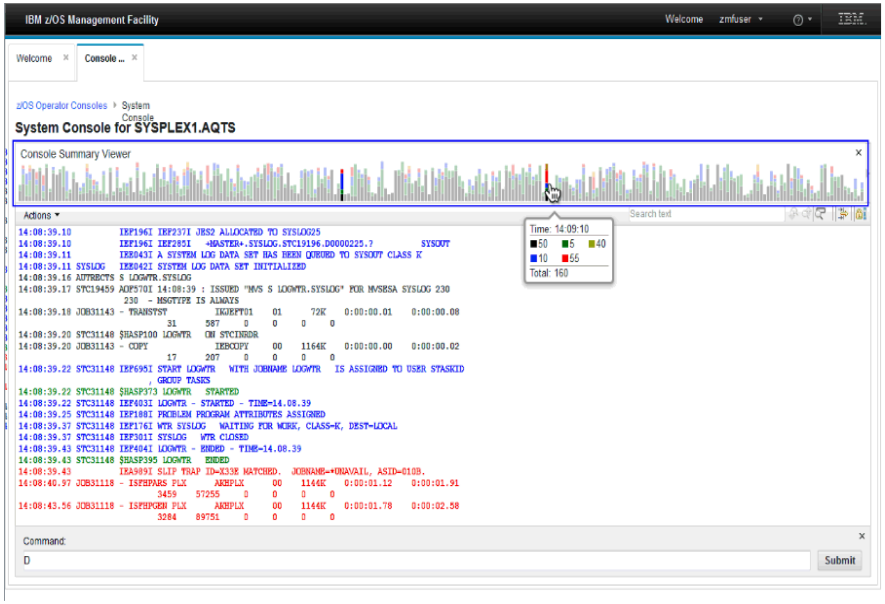
Usability & Skills

Console application (CD)

- Support for WTOR messages
- Improved handling of large amounts of messages





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Usability & Skills

z/OSMF Lite

- **Configuration book planned to be restructured to make it possible to**
  - Allow user complete z/OSMF Nucleus setup in quickly
  - Allow user complete configuration for commonly used services including REST Job, REST File Dataset, REST TSO, Workflow next
- **Security simplification in z/OSMF Lite**
  - IZUSEC security sample will be greatly simplified containing only ALL-MUST-DO setup for Nucleus
  - Every service will have its own security sample job
  - Security requirement will be described more precisely for feature mapping

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Usability & Skills

z/OSMF Updates (CD)

- z/OSMF server is able to detect if the version of z/OSMF started procedure is compatible or not

- z/OS data set and file REST service is enhanced to support:
  - Directory tree walking and filtering results for list/searching
  - Use of regular expressions to replace content when editing data set
  - Display all volume names for listing cross volume data sets
  - Specifying "dsntype" when creating data sets

- z/OSMF allows users to customize the z/OSMF Angel Name

- z/OSMF Workflow task will now support parallel-step workflows. One or more automated steps of a parallel-step workflow can run at the same time

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Usability & Skills

z/OSMF Updates (CD)

- z/OSMF REST TSO/E address space services support initiating TSO/E address spaces and applications on other systems in the sysplex
- The z/OSMF Workflows task supports the ability to use the TSO Rest Services to access any system in a sysplex to run a job, REXX script, or UNIX script in local and remote systems
- The z/OSMF WebISPF (z/OSMF Classic ISPF interface) task supports opening ISPF on remote systems in the local sysplex on which z/OSMF is running
- The default location of the z/OSMF user directory is changed from /var to /global with updated samples (PI92211)
- The z/OSMF Incident Log task is enhanced to support the CASE parameter in addition to the existing PMR number when sending diagnostic data to the IBM support site. The CASE parameter is a new format for problem management.

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Usability & Skills

Assembler Exit Reduction

- Add support to SMFLIMxx
  - Memory limits add filters for SAF, requested memory
  - Memory limits add actions to set dataspace limits and message suppression
- Add Support for JES2 policy based exit reduction
  - Ability to do basic policy based detection and actions
  - Intend more capability in the future

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Usability & Skills

XCF Transport Class Simplification

- Continuing enhancements to earlier work in this space are planned to make XCF transport classes more self-managing and self-tuning, as well as to improve resiliency by avoiding monopolization of message buffer space
  - ***Vision:*** *Customers will no longer need to define, tune, or manage XCF transport classes when configuring their sysplex. The task of configuring XCF communication in a multi-system sysplex is simplified and reduced to defining the number of XCF signal paths needed to support the workload, which will help avoid badly configured sysplex messaging (and outages) as a result.*
- Focus for 2.4 timeframe is autonomic management of transport class “segregation by size” and of the associated message buffer space
  - New automatic _XCFMGD transport class
  - No need for clients to properly “tune” XCF transport class message sizes to match the signaling workload characteristics, to achieve good results
  - Simplification and improved resiliency – avoid performance and resiliency impacts from poorly-tuned transport class sizes
- IXCMG and IXCYAMDA accounting and measurement changes, and accompanying SMF data changes are provided
  - New/improved statistics for reporting message path utilization, signal counts, and no-buffer conditions
- Resiliency support for management of transport classes for “segregation by XCF group” is planned to be deferred to a later deliverable
  - Improved resiliency in the event of “runaway” message senders or “stalled” message receivers, automatically preventing them from monopolizing the available resources in the transport class, protecting other groups that are sharing those transport class resources

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Scalability and Performance

Overview, goals & directions

- Goal is Release to Release Equivalence
- Exploit Hardware features
- Long term continue AMODE 64 and RMODE 64 roadmap items

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Scalability and Performance

AMODE 64 Support / Exploitation

- Exploitation of 64-bit memory, large pages, and non-executable memory
  - RMF Monitor I and II exploitation
  - JES2 Exploitation of 64-bit
  - JES2 Exploitation of read-only and non-executable memory
  - WLM SRM exploitation
  - LE exploitation of read-only and non-executable memory
- z/OS v2.4 no longer allows or supports user-key common storage by default
- 64-bit obtains (IARV64) now support explicit address with the INORIGIN keyword
- SSL RACF Certificate above the bar for AT-TLS 64-bit exploitation
- RHSSSL64 System SSL certificates in 64-bit memory; Comm Server and System SSL

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Scalability and Performance

Alternate Subchannel Set for XRC

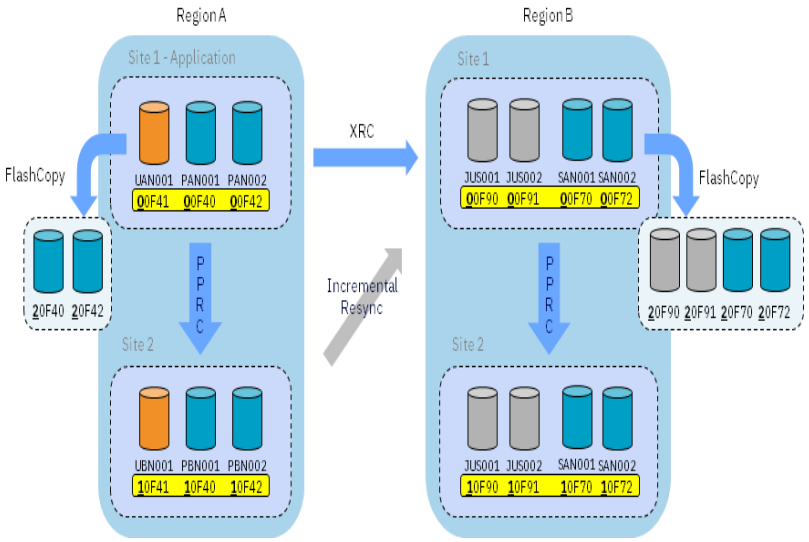
- Alternate subchannel sets for XRC for 4-site support
- XRC Device-based management offline final phase
- Region switch RTO improvements for XRC
- Multi-task volinit enhancements

As a storage administrator, I want to configure XRC using a symmetrical configuration across multiple sites and maximize the number of supported volumes so it's easy to manage the configuration, and limits on the size of the configuration are alleviated, allowing the data center to handle data growth.

- Full exploitation of GDPS 4-site configurations (e.g. 2P4L sites) requires 4 sets of volumes, the use of GDPS/PPRC and GDPS/XRC, and a configuration which supports 4 subchannel sets (zEC12/zBC12 or later processor with appropriate IODF)
- XRC Device Based Management is a pre-req.
- GDPS exploitation of 5-digit device numbers, and 4-site integration, are necessary to support a complete solution.

Planned support includes:

- XRC Device Based Management (Offline Final Phase)
  - As a storage administrator, I want to manage XRC using device numbers so that devices can be offline and duplicate VOLSERs can be supported.
  - Provides the capability for XRC to handle primary volumes that are offline, and possibly never have been online.
- XRC Alternate Subchannel Set
  - As a user of XRC, I require the exploitation of alternate subchannel sets for devices in my XRC configuration in order to accommodate all of my production devices in a single IO configuration for the entire sysplex while maintaining addressibility to the non-production devices.
  - Provides flexibility to add larger numbers of volumes and simplifies the configuration.



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Scalability and Performance

Alternate Subchannel Set for Linux

- In configurations where Linux for Z is running on the same IBM Z server as z/OS and z/VM, many customers traditionally define the entire I/O configuration in z/OS.
- Therefore, HCD (z/OS) needs to be able to define and dynamically activate I/O configurations for any type of OS on the server.
  - With this support, a configuration administrator can define and dynamically activate an I/O configuration for a partition running Linux for Z without losing any capabilities for z/OS or z/VM operating systems.
  - With this support, an HCD/HCM user can define 3390B and FCP devices to an alternate subchannel set as long as they are not used by z/OS or z/VM, so that he can get relief on usable device numbers in the primary subchannel set.

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Scalability and Performance

Improve SVC Dump Capture Time

- Vision
  - SVC Dump data for larger z/OS systems and address spaces can be captured and written out quickly and without causing workload disruptions due to address space non-dispatchability, or caused by spikes of memory management activity associated with capturing the dump. This support helps unlock customers' ability to successfully exploit large memory on z/OS.
- Value:
  - Reduced address space non-dispatchability window and other workload disruptions caused by dump capture (e.g. real storage consumption spikes, paging spikes), for equivalent size dumps
  - Or alternatively, much larger dumps can be taken, for equivalent levels of disruption.
- Planned support includes:
  - Improved parallelism in dump capture process
  - Capturing global storage in DUMPSRV high-private buffers
  - Parallelism in various dumping modules

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Scalability and Performance

Asynchronous Cross-Invalidate for CF Cache Structures (CD)

- Enables improved efficiency in CF data sharing by adopting a more transactional behavior for cross-invalidate (XI) processing, which is used to maintain coherency/consistency of data managers' local buffer pools across the sysplex
  - Instead of performing XI signals synchronously on every cache update request that causes them, data managers will be able to "opt in" for the CF to perform these XIs asynchronously (and then sync them up with the CF at or before transaction completion)
  - Faster completion of cache update CF requests, and the transactions that depend on them for data sharing, particularly when cross-site distance is involved in the cross-invalidate traffic
- Requires z14 GA2 CFCC support, plus z/OS PTFs on every exploiting system
- Requires explicit data manager exploitation/participation – not transparent
  - Exploitation by Db2 V12 only
- No SMF data changes are provided for CF monitoring/reporting

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Scalability & Performance

Enhanced Capacity management (CD)

- z/OS capacity provisioning manager is enhanced with new commands to set and report on LPAR weights

Larger log stream staging data sets (CD)

- Support for IBM zHyperwrite for logger staging datasets and offload datasets

*** All performance information was determined in a controlled environment. Actual results may vary. Performance information is provided "AS IS" and no warranties or guarantees are expressed or implied by IBM.**

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Scalabilty & Performance

RMF Updates for Hyperlink (CD)

- RMF stores synchronous I/O link statistics on storage controller level in a new data section of SMF 74.8 records (ESS Statistics)
- Cache device related synchronous I/O performance data is collected in SMF 74.5 records (Cache Subsystem Device Activity)
- Reporting on synchronous I/O link statistics per storage controller is added to the RMF Postprocessor ESS report
- Synchronous I/O cache device activity is reported in the RMF Postprocessor CACHE Subsystem Activity report
- New/modified OVW Conditions are provided for synchronous I/O metrics.

2038/2042

- All application API's should support 2038 or greater
- z/OS still does not support setting the TOD beyond 2042, individual components will support
  - SSL 2038/2042 Updates
  - NAS 2038/2042 Updates
- Progress, but not yet at end of job

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Availability

Transactional VSAM (TVS) Auto-Commit Support (CD)

- TVS is an optional z/OS feature that enables batch jobs and CICS transactions to concurrently update shared recoverable VSAM data sets thus reducing the batch window for CICS and other VSAM applications and improving system availability.
  - Currently, to fully exploit TVS, batch applications must be modified to use z/OS Recoverable Resource Services (RRS) to issue sync point commits in order to avoid holding too many locks which could result in elongated CICS response times.
- With the new TVS Auto-commit support, users can avoid making costly source code changes to batch applications and instead TVS will invoke RRS to issue sync points commits on behalf of eligible batch applications based on specified parameters.
  - Specify the TVSAMCOM parameter in the job step JCL OR
  - Specify a system level commit parameter in the IGDSMSxx member of SYS1.PARMLIB.
  - Note: The JCL value will override the value specified in IGDSMSXX.

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Availability

Sick But Not Dead – JES2 Spool Throttling

- JES2 SBND avoidance – SSI provides externals for spool usage resiliency data
- SSI externals can be used by monitoring products for reporting, alerting, etc. in situations where spool resources are nearing their limits

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Availability

z/OS Global Mirror (zGM) Enhancements (CD)

- zGM (aka Extended Remote Copy or XRC) combines hardware and z/OS software for an *asynchronous* remote copy solution that enables critical data to be mirrored between the application and recovery sites while maintaining consistency.
  - Increasing numbers of large enterprises are adopting 4-site DR configurations, with a high availability (HyperSwap) configuration within each region, and some form of DR between regions.
- New XRC enhancements alleviate constraints and allow for more flexible 4-site configurations that enable data center growth while maintaining both high availability and disaster recovery capability without recovery point objective (RPO) increase.
- Device-based Management and Multiple Subchannel Sets (MSS) Exploitation
  - XRC was enhanced to utilize 5 digit device numbers, instead of volsers, to enable MSS exploitation for the volumes in the XRC session.
  - Allowed for more flexible and easier to manage configurations and provided constraint relief for 64K device numbers.
- Remote Pair FlashCopy (RPFC) for XRC
  - XRC was enhanced to allow a FlashCopy between primary volumes at the application site which is then mirrored at the recovery site between secondary volumes without disrupting the mirror or consistency at the recovery site.
  - Enables production data, production point-in-time copies, and backup data to be available at all sites while maintaining both high availability and disaster recovery capability.

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Availability

Logger support for single-system logger for GDPS k-system environments

- GDPS k-systems participate in the sysplex environment, but need to be isolated “as much as possible” from other systems in the sysplex so that they can perform their DR failover automation orchestration, even when the sysplex at large is having problems
- To this end, System Logger single-system scope Couple Data Sets (LOGRY & LOGRZ CDS) support provide clients with an isolated set of logger CDSes used only on the GDPS-k-system, isolating its logger functionality from the remainder of the sysplex
  - But while preserving the ability to take advantage of pervasive sysplex and z/OS log stream capabilities/technologies, such as SMF digital signatures and compression, and also to continue to use similar tools/utilities as currently used throughout the sysplex to extract log data, even on the GDPS k-systems.

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Availability

Logger transport affinity IBM zAware communication (stack affinity) (CD)

- z/OS system logger has been enhanced to allow use of a transport provider name for TCP/IP stack affinity in C-INET configurations when communicating to the IBM zAware server
- This enhancement allows TPNAME(transport-name) to be specified on the z/OS system logger IXGCNFxx ZAI statement
- System logger will use the specified transport-name to set the affinity when establishing the IBM zAware socket communications

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Availability

Online zFS to zFS migration

- Introduced in z/OS V2.3, the BPXWMIGF migration tool provided ability to migrate HFS to zFS transparently.
- In z/OS V2.4, it now supports zFS to zFS migration transparently also.
- Useful in migrating zFS file systems from one volume to another volume, without impacting the application.

zFS High Availability support

- Applications running in a sysplex environment and sharing read-write mounted zFS file systems will no longer be affected by an unplanned outage.
- Unplanned outages will be transparent to the application on other members of the sysplex and will no longer result in zFS file system I/O errors.
- Can be specified:
  - as a mount option on individual mount statements to affected individual zFS file systems
  - globally in IOEFSPRM to enable this support for all read-write mounted zFS file systems
  - dynamically to change already mounted zFS file systems.
- Will be ignored for applications that use zFS file systems in a single system environment.

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DFSMS Unix File Backup (CD)

- Clients want to use the same tools and applications to backup and restore individual z/OS UNIX files residing in z/OS File System (zFS) data sets as other z/OS data sets.
- New enhancements to backup and restore individual z/OS UNIX files residing in zFS (z/OS File System) data sets is integrated into existing DFSMShsm backup / recover and DFSMSdss dump / restore capability, allowing for centralized data management across the z/OS platform.
  - The support is intended to subsume the capabilities provided by the existing IBM Tivoli Storage Manager z/OS UNIX System Services Backup-Archive Client.
  - DFSMS will **not** provide support for z/OS UNIX files found in Hierarchical File System (HFS) data sets.
- Support provided on z/OS V2R3 via the following APARs:
  - DFSMSdss OA52836
  - DFSMShsm OA52703
  - ZFS OA56145
  - USS OA54218
  - RACF OA55165

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JES2 Enhancements for Migration

- JES3 Statement of Direction will lead to migration to JES2
- JES3 to JES2 migration support
  - Disk reader support now in JES2
  - //*ROUTE XEQ JECL support
  - Support for multiple jobs in an NJE job stream

JES2 enhancements

- Checkpoint version improvements
  - Exploit 64 bit storage
  - Improved performance and reduced working set size
- Replace exits with policies
  - JES2 will provide support for conditions and actions
  - Built in to policies that allow actions based on conditions
    Condition: job name is ABC, action: set job class to Q
- Encryption and compression of JES2 managed spool data sets
  - Compression done based on job/SYSOUT class
  - Encryption done based on JCL or RACF profiles
  - Encryption implies compression

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Systems Management

z/OS Cloud Stage 2

- z/OS Cloud provisioning security and RACF simplification
- Sysplex clustered instance
  - z/OS Cloud cluster support
  - z/OS Cloud networking support for sysplex clustered instances
  - DB2 cluster support dependency for DB2 data sharing group workflows
- Common Security XML Descriptor for Cloud
- Metering and capping for memory
  - z/OS Cloud metering and capping support
    - z/OSMF plugins support for metering and capping for memory

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Cloud Storage Access for z/OS

- Cloud storage makes it possible to store practically limitless amounts of data, simply and cost effectively and access it from anywhere in the world using internet protocols.
  - Data and its associated metadata are stored as discrete objects with a unique ID in a flat address space designed to be both scalable and flexible.
  - Cloud storage allows users to reduce the complexity of their data storage environments and to minimize total cost of ownership.
- Transparent cloud tiering (TCT) for DS8000 (CD)
  - TCT developed in conjunction with z/OS and DFSMShsm and provides automated, policy-based, server-less movement of archive and backup data directly to a cloud object storage solution using OpenStack Swift or S3-compatible interfaces.
    - DFSMShsm automatic migration supports TCT via SMS management class policy and continues to automatically recall a data set to primary storage when it is referenced without any parameter changes.
    - TCT supports migrate and recall of data to volumes in both simplex and copy services relationships, including 2-site Metro Mirror, FlashCopy, and Global Mirror. Only MTMM and XRC continue to be restricted.
    - TCT supports encryption to provide security of data in flight.
- OAM Cloud as a Tier (CD)
  - Enhancements to OAM provide a new cloud tier to the existing storage hierarchy
    - Supported is the ability to store and manage primary copies of OAM objects on cloud storage, via public or private cloud infrastructures supporting the Amazon S3 API, and the ability to recall an object stored in the cloud to the disk level of the storage hierarchy.
    - OAM managed backup copies will continue to be supported as they are today to removable media, typically virtual or physical tape.

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Systems Management

Content (Product Documentation) Changes and Enhancements (CD)

General:

- Timely content refreshes will continue after V2.4 GA with as-needed updates. Subscribe to the z/OS library PDFs to receive notifications about updated content.
- The Migration guide is replaced by the Upgrade workflow.
- The "Summary of Message and Interface Changes" (SMIC) is retitled "Release Upgrade Reference Summary" (RURS) and streamlined to contain only the lists of new/changed/deleted messages and the five tables for SMF and SYS1 member changes.
- New content solutions provide assistance for all phases of the user experience for a function.
  - They can consist of a variety of content, including comprehensive content collections in the Knowledge Center (c3s), videos, z/OSMF workflows, podcasts, and other content.
  - Web solutions help you get started with the function and provide links to all of the related content.
  - A new content solution home page helps you browse and use content solutions.
- z/Favorites is updated to highlight new function in V2.4.

Find it all at the z/OS Internet Library:
https://www.ibm.com/servers/resourcelink/svc00100.nsf/pages/zosInternetLibrary

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Systems Management

Content (Product Documentation) Changes and Enhancements (CD)

Search:

- Search catalog function is fully integrated into KC for z/OS V2.4. In addition to searching the entire release, you can search at the element/feature library level or within an individual book.
- Looking up messages is easier than ever with two new LookAt-based options:
  - The "IBM Z: Look@ Knowledge Center" online tool lets you conduct targeted message searches within or across products in KC.
  - With the new LookAt API, you can look up messages in KC4z using a KC based version of the original LookAt facility.
- KC4z has a new component that "normalizes" HTML content to improve search.

KC4z:

- KC4z is upgraded to 2.0 and now has the same look and feel as the online IBM Knowledge Center.
- V2.4 includes a new workflow to help you provision the KC4z plug-ins that you obtain from the FTP site.
- The content repository for KC4z is expanded to include several software products.

Find it all at the z/OS Internet Library:
https://www.ibm.com/servers/resourcelink/svc00100.nsf/pages/zosInternetLibrary

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Systems Management

IBM Operational Server Certificates (CD)

- IBM plans to replace a number of server certificates (SSL) over the course of 2018
- These are for things like:
  - RECEIVE ORDER and download servers
  - Shopz
  - Testcase, ecurep, Blue Diamond
- Recommendation:
  - Install certificates as soon as convenient
    - DigiCert Global Root CA (link)
    - DigiCert Global Root G2 (link)
- For more information, see the WSC flash: WSC Flash

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Systems Management

zlsof Extended Processing (CD)

- Enhancements have been provided to the zlsof (list open files) utility of z/OS UNIX System Services that show extended processing information, including start time, elapsed time, CPU time, thread number, state of the process read-write open mode, and other related information.
- In addition, the zlsof utility can generate output in JSON (JavaScript Object Notation) format, enabling clients to parse and build reports

NFS Server (CD)

UNICODE conversion support based on mount system attributes.

- Support for sharing of compressed data sets requires no configuration changes to the NFS Server and is transparent to end users.

OpenSSH Direct CPACF Support (CD)

- Improved performance using direct CPACF instructions
- This function is mutually exclusive with FIPS 140-2 compliance

True Random Number Generation for z/OS Unix (CD)

- Simplified configuration for random numbers when running on IBM z14

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Systems Management

Infoprint Server updates

- Dynamic configuration enables configuration changes without stop/restarting of the Infoprint Server daemons
  - Dynamic-Configuration is now the default

- Infoprint Central (web browser application) enhancements
  - Increase message classes up to 36 for PSF and AFP Download Plus work selection criteria
  - Provide predictable UID for Infoprint Central's Apache web server task so WLM can be used to manage the task resources
  - A secure connection to the Apache server will be the expected default (SSL usage and https:)

- Improve diagnostics
  - SAF denied accesses will be logged to the Infoprint Server log

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Systems Management

SDSF – System Display and Search Facility

- Many new primary commands in last several releases
- New user guide available
- New functions for JES2 spool encryption, and resiliency
  - Reporting on encryption
  - Reporting on spool and control block usage

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AT-TLS support for TLS V1.3 (SOD)

- Planned support for the latest TLS version standard
- Improves the performance and security of TLS-protected traffic
- AT-TLS will be enhanced to allow new System SSL TLS 1.3 features to be exploited via policy enhancements (transparently to software depending on AT-TLS for their TLS support)

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HiperSockets Converged Interface (HSCI) (CD)

- HiperSockets Converged Interface (HSCI) allows configuration of HiperSockets on z/OS without defining additional network interfaces.
- Specifying the new AUTOIQDC keyword in the TCP/IP profile dynamically and transparently adds a HiperSockets interface that is converged with the OSA interface, and is treated as one interface by the layers above.
- TCP/IP will automatically use HiperSockets when the peer is co-located on the same CPC and reachable over HiperSockets
- This provides two major benefits:
  - Supports layer 2 connectivity from z/OS to Linux and the z/VM HiperSockets bridge
  - Simplifies the move of a z/OS instance to another CPC by removing the requirement for reconfiguring the HiperSockets interface to match the IP subnet(s) on the new CPC.

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Networking

z/OS Encryption Readiness Technology (zERT) (CD)

- zERT positions the TCP/IP stack as a central collection point and repository for cryptographic protection attributes for:
  - TCP connections that are protected by TLS, SSL, SSH, IPsec or are unprotected
  - Enterprise Extender connections that are protected by IPsec or are unprotected
    - Each peer-to-peer UDP port is considered a separate EE connection
- zERT discovers the security sessions and their attributes via:
  - Stream observation (for TLS, SSL and SSH) – the TCP/IP stack observes the protocol handshakes as they flow over the TCP connection
  - Advice of the cryptographic protocol provider (System SSL, OpenSSH, TCP/IP's IPsec support)
- Reported through new SMF 119 records via:
  - SMF or
  - New real-time NMI services

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Networking

z/OS Encryption Readiness Technology (cont.) (CD)

- zERT Discovery
  - Attributes are collected and recorded at the connection level
  - SMF 119 subtype 11 “zERT Connection Detail” records
  - These records describe the cryptographic protection history of each TCP and EE connection
  - Measures are in place to minimize the number of subtype 11 records, but very large numbers of these records could still be generated depending on the network traffic into and out of the z/OS system

- zERT Aggregation
  - Attributes collected by zERT discovery are aggregated by security session
  - SMF 119 subtype 12 “zERT Summary” records
  - These records describe the repeated use of security sessions over time
  - Aggregation can greatly reduce the volume of SMF records while maintaining the fidelity of the information – well suited for reporting applications

- zERT plug-in for z/OSMF provides an easy to use UI for querying data reported in SMF 119 subtype 12 records

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Networking

IBM Configuration Assistant renamed **IBM Network Configuration Assistant** (CD)

Network Configuration Assistant support for alternate Configurations (CD)

- The Network Configuration Assistant is enhanced to support TCP/IP profile alternate configurations
- Alternate configurations can be used for planned or unplanned outages, failover or flexibility in moving z/OS images

Multiple installation support for Network Configuration Assistant (CD)

- The Network Configuration Assistant is enhanced to enable you to install multiple configuration files in a single action.
- With this support, you no longer have to enter and act on a separate installation panel for each file in a group to be installed.
- You can use this new action on any installation panel that has more than one file listed on it.

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Networking

Inbound Workload Queueing (IWQ) Support for IPSEC (CD)

- In support of OSA-Express6S, z/OS Communication Server's Inbound Workload Queuing (IWQ) support (enabled with INBPERF DYNAMIC WORKLOADQ) for QDIO interfaces (OSD CHPID type) is enhanced to add a new input queue in support of IPSEC network traffic.
- With IWQ enabled, OSA-Express6S will direct IPSec traffic for protocols ESP and AH to the IPSec input queue.
- The OSA-Express6S separation of the IPSec protected traffic from non-IPSec protected traffic provides for an optimal Communications Server processing environment for both types of traffic

Code page enhancements for CSSMTP (CD)

- The Communications Server SMTP (CSSMTP) mail client is enhanced to support multibyte character sets and to provide improved code page support for characters in the mail subject line
- Enhancements are intended to facilitate migration from SMTPD to CSSMTP

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Security

Pervasive Encryption

- z/OS V2.4 plans to continue to drive pervasive encryption efforts within an enterprise:
  - z/OS policy-based encryption options that can help clients protect their critical business data have been enhanced to support additional z/OS data set types, including PDSE.
  - Also supported is JES2 encryption of JES managed data sets on SPOOL.
  - Both enhancements allow users the ability to encrypt data without application changes and simplify the task of compliance.

RACF Enhancements

- Improved PassTicket security
  - Today, a PassTicket key can either be masked and stored in the RACF database, or encrypted, and stored in ICSF.
  - Enhancements in RACF provide new capabilities to facilitate the use of encryption with ICSF as the key store for PassTicket keys in order to provide enhanced PassTicket keys security and protection against cyber attacks. The new functions include:
    - Command and programming interfaces to report on the method of protection for PassTicket keys, and, for encrypted keys, the ICSF key label name.
    - A function to convert masked keys to encrypted keys without needing to change the keys.
    - The ability to use pre-existing keys in ICSF for application PassTickets.

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RACF Enhancements

- Enhanced RACF usability and threat detection
  - RACF is enhanced to enable clients to extend the "RACF schema" to store security-relevant information within the RACF database, where existing reporting tools and programming interfaces can be used to manage and retrieve the data.
    - RACF users can add custom fields to RACF general resource and DATASET class profiles in a consistent fashion with the existing ability for user and group profiles. For all profile types, the ability to validate the value of a field using a System REXX program is also provided.
    - RACF users are allowed to retrieve DATASET class profile fields using the R_admin callable service (IRRSEQ00) and the IRRXUTIL rexx interface.
    - RACF's IRRXUTIL rexx interface is enhanced to allow retrieval of a general resource class definition from either the static or dynamic Class Descriptor Table (CDT). The current SETROPTS settings for the class can be optionally requested.
  - RACF also can detect changes to a user's security environment, including change in privileges.
    - A new message is issued when such a modification is detected.
    - Exceptions can be defined for trusted applications in order to suppress the message for users of such an application.

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Security Standards

- OpenSSH is the predominant secure terminal and file transfer program on open source systems and encrypts all traffic to eliminate eavesdropping, connection hijacking, and other attacks.
- To maintain currency and ensure z/OS clients have the latest enhancements and fixes, z/OS OpenSSH is updated to the openssh.com 7.6p1 level.
- With Open SSH 7.6p1, significant new features include:
  - Support for new key exchange (KEX) algorithms, including:
    - diffie-hellman-group14-sha256
    - diffie-hellman-group16-sha512
    - diffie-hellman-group18-sha512
    - curve25519-sha256
  - Support for new ssh-ed25519 and ssh-ed25519-cert-v01 key algorithms.
  - Support for the new chacha20-ploy1305 cipher.
  - Enhancements to the SMF Type 119 subtype 94 and 95 (ssh / sshd connection started) records will include a section that identifies the IP addresses and ports for the connection.
  - Elliptic-curve DSA (ECDSA) keys are now supported in key rings and in FIPS mode.
  - Key ring keys will now use System SSL for signature creation and verification.
  - A new ssh-proxyc command is added, which can be used by the ssh client to connect through SOCKS5 proxy servers.

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Security

Logger support for more granular security controls for logstreams

- Ability to permit logstream write-only access
- Reading, deleting, or modifying a logstream can be defined with a higher privilege level than basic write access
- Enhanced security options for logstram WriteOnly access

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Security

User Key Common Requestors update (CD)

- A new healthcheck, slip trap, and SMF reporting are available to identify users of user key common storage.

MCS passphrases (CD)

- z/OS Console Services is enhanced to enable the use of MCS logon passphrases (long passwords) through security policy profile specification.

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Application Development

Web enablement toolkit (CD)

- New sample program for JSON text-rendering
- HWTJDEL service enables JSON deletion
- HTTP proxy support has been enhanced to provide both basic authentication to “authenticating” proxy servers and AT-TLS interoperability support for proxy users
- The JSON parser can now parse and perform various other services on text in Unicode. The parser will auto-detect if the text is in EBCDIC (codepage IBM-1047) or UTF-8 (codepage IBM-1208) encoding and process the text appropriately.
- New HWTJSENC service can be used to manually set the encoding.
- New HWTJGENC service can be used to retrieve the encoding used to parse the document.
- The user application can now limit the search scope of a JSON text by using the new SearchType value, HWTJ_SEARCHTYPE_SHALLOW. This value limits the depth of the search and does not consider content within any nested object(s). This additional scoping can greatly improve the performance cost of searching JSON.

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Application Development

Upgraded X-Windows Virtual Frame Buffer (CD)

- An upgraded version of X-Windows Virtual Framebuffer (Xvfb) has been provided. Formerly included in IBM Ported Tools for z/OS product, this delivers Xvfb X11R6.9 and is now included as part of the z/OS program product. Xvfb is an in-memory display server and enables a customer to run graphical applications without a physical display device. It is especially useful when testing an X-Windows server without using real hardware.

iconv Utility (CD)

- New **-**B option allow for the removal of the BOM (Byte-Oriented Mark) from the beginning of Unicode (UTF-8, UTF-16 and UTF-32) byte streams, useful when converting data from Unicode to other CCSIDs.

Program Management Binder (CD)

- New option called STRIPSEC=IGNEXP (Ignore Export) will remove unreferenced sections (CSECTs) even though they are in the exported symbols table. This has the potential of reducing the size of the program object or load module.

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Application Development

Unicode Services (CD)

- New utility called CUNMITG4 has been provided
- Allows user to create the binary files associated with user-defined conversion tables with composition characters on both sides (the "from" and the "to" sides) of the table.
- Will allow customers to implement solutions that meet certain regional IT standards associated with surnames and first names.

Language Environment Improvements (CD)

- CEEDUMP and IPCS LEDATA Verbexit improvements show full service level information in the traceback section, when users use the SERVICE compiler option to specify the service level string of COBOL, PL/I or XL C/C++ programs.
- Language Environment-enabled applications can now be rolled back when they are terminated using a POSIX-defined terminating signal and when there are no registered signal handlers. This allows applications to no longer commit in-progress updates in situations with unhandled terminating signals

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Application Development

Cloud Provisioning and management for z/OS (CD)

- Composite templates, shared resource pool and sysplex placement
- Simplify security setup for cloud provisioning. A new sample IZUPRSEC is provided.
- Consume REST APIs described in the OpenApi 1.0 specification.

VSAMDB (CD)

- New data store for BSON and JSON objects in VSAM KSDS
- Sysplex data sharing via VSAM RLS
- Includes indexing with VSAM alternate keys

cp Utility Enhancements (CD)

- Copy load modules from MVS data sets to Unix directories and vice versa while maintaining ALIAS information

WebSphere Application Server (CD)

- WAS Liberty for embedders is updated quarterly with the latest upgrades and service

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Requirements

z/OS Requirements

- z/OS accepts requirements through Request for Enhancements (RFE)
  - Any customer can open a requirement on any part of the operating system at this URL https://www.ibm.com/developerworks/rfe/
- You can also search and vote on RFE's at that location
  - You need an IBM ID
  - Go to the search tab
  - Brand: Servers and System Software, z Software, z/OS
- z/OS also accepts requirements through user groups like SHARE

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Continuous Delivery

Continuous Delivery

- z/OS embraces continuous delivery through new function APARs
- Get weekly emails when APARs close with MyNotification: start at https://www.ibm.com/support/entry/portal/support
- Look on the web, updated monthly: https://www-03.ibm.com/systems/z/os/zos/installation/zosnfapars.html

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Continuous Delivery

4Q2017 Continuous Delivery Overview (link to announcement)

- Performance
  - z/OS V2.3 Performance
  - VSAM RLS upgrade locking and constraint relief
- Container pricing
- Transparent Cloud Tiering
  - DFSMShsm enhancements
- IBM Cloud Provisioning and Management for z/OS

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Continuous Delivery

1Q2018 Continuous Delivery Overview (link to announcement)

- TS7700 R4.1.2
- RMF Enhancements
- z/OSMF Enhancements
- NFS Server: Encryption Support
- Tape Support EOL
- OpenSSH CPACF Support
- IBM Operational Server Certificates
- HiperSockets Converged Interface
- z/OS Encryption Readiness Technology
  - zERT Aggregation
- User Key Common Requestors

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Continuous Delivery

2Q2018 Continuous Delivery Overview (link to announcement)

- What's new with the z14 Model ZR1
- z/OSMF Enhancements
- Continuous delivery for ID
- Content Solution Feature
- Inbound Workload Queueing (IWQ) support for IPSEC
- IBM Cloud Provisioning & Management

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Continuous Delivery

3Q2018 Continuous Delivery Overview (link to announcement)

- Simplify and modernize the user experience to enhance productivity
  - IBM z/OSMF
    - Desktop option
    - Other enhancements
  - Network Configuration Assistant support for multiple location TCP/IP configuration
- Enhancing availability, scalability, and performance
  - IBM zHyperwrite data replication
  - zlsof extended processing information
  - Enhanced Capacity Management
- Enhanced security and data protection
  - MCS passphrases
- Improved content delivery
  - Obtaining z/OS content for IBM Knowledge Center for z/OS
  - IBM z/OS Search Scope Catalog
  - IBM Z: Look@ Knowledge Center Message Lookup Facility
- Enhanced code page support
  - Code page enhancements for CSSMTP
  - NFS Server Unicode support
- Improving application development
  - VSAMDB
  - JSON text-rendering sample program
  - Web Enablement Toolkit delete element support
  - cp utility enhancements
  - True random number generation for z/OS UNIX

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Continuous Delivery

4Q2018 Continuous Delivery Overview (link to announcement)

- Simplify and modernize the user experience to enhance productivity
  - z/OSMF Sysplex Management Task modify support
  - z/OSMF Operator display command support
  - z/OSMF Export workflows as printable items
  - z/OSMF Define array variable in workflows
  - z/OSMF Operator console support for WTORs
- Enhanced security and data protection
  - ICSF WD#18
  - zERT Network Analyzer
- Improving application development
  - Upgraded X-Windows Virtual FrameBuffer
  - Support for compressed data sets by NFS server
  - Iconv utility enhancements
  - Web Enablement toolkit HTTP proxy enhancements
  - Enhancements to program management binder
  - Serviceability enhancements to Language Environment dumps
- Enhancing availability, scalability, and performance
  - RPFC for XRC GA
  - DFSORT additional exploitation of zHPF
- z/OS platform software installation improvements

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Continuous Delivery

1Q2019 Continuous Delivery Overview (Link to announcement)

- Simplify and modernize the user experience to enhance productivity
  - Multiple installation support for Network Configuration Assistant
- Improving application development
  - Web Enablement Toolkit support for Unicode character set in JSON parser
  - Web Enablement Toolkit support for new JSON search scope
  - Unicode Services support for composition characters on both sides of a user-defined conversion table
  - New default behavior for terminating signals in Language Environment-enabled Applications

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Note: *The statements of direction in this presentation have been edited for brevity.*

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February, 2019 – z/OS V2.4 is planned to be the last release in which JES2 will support the z11 level for checkpoint data sets. z22 mode was introduced in z/OS V2.2. IBM recommends you migrate toz22 mode if you have not already done so.

February, 2019 – In Software Announcement 217-246, dated July 17, 2017, IBM announced that JES2 is the strategic Job Entry Subsystem (JES) for the z/OS Operating System and that JES3 would continue to be supported and maintained. To date, IBM has made significant investment in JES2 by delivering unique functions such as email support in JCL, spool migration and merge, and dynamic checkpoint expansion and tuning to make management easier. In z/OS V2.4, IBM plans to deliver in JES2 Spool Encryption and a new user exit alternative based on defining policies that allow exit programs to be implemented in a parameterized rule-based approach. To help JES3 to JES2 migration efforts, JES2 has added functionality, including dependent job control, deadline scheduling, 8-character job classes, and interpreting JES3 JECL control statements. For z/OS V2.4, additional function to aid in migrations is planned, including Disk Reader capability and enhanced JES3 JECL support in JES2 (ROUTE XEQ). Today, as a result of our strategic investment and ongoing commitment to JES2, as well as continuing to enhance JES3 to JES2 migration aids, IBM is announcing that the release following z/OS V2.4 is planned to be the last release of z/OS that will include JES3 as a feature.

If you are one of the clients who remains on JES3, IBM encourages you to start planning your migration. For questions, contact jes3q@us.ibm.com.

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February, 2019 – IBM's first delivery of a ServerPac in z/OSMF Software Management portable software instance format is planned for CICS Transaction Server and associated CICS products. Initially, IBM intends to allow you to choose to order ServerPac for CICS and associated products in either the new z/OSMF portable software instance format or the existing CustomPac Dialog-based format. The z/OSMF portable software instance format is designed to be installed using z/OSMF Software Management. The requirements for using the CustomPac Dialog-based format remain unchanged, and this is the first of many offerings that are planned to be delivered in the PSI format. For both formats, IBM plans to continue to offer delivery via internet download or on DVD. This initial offering of an IBM ServerPac in a z/OSMF portable software instance represents the next step in IBM's collaboration with other leading z/OS platform software vendorsto deliver a consistent package format intended to be used with z/OSMF software management as a common installer.

February, 2019 – z/OS V2.4 is planned to be the last release to support the VTAM Common Management Information Protocol (CMIP). CMIP services is an API that enables a management application program to gather various types of SNA topology data from a CMIP application called the topology agent that runs within VTAM. IBM recommends using the SNA network monitoring network management interface (NMI) to monitor SNA Enterprise Extender and High Performance Routing data.

February, 2019 – IBM intends to add support for the TLS V1.3 protocol, as specified in RFC 8446, to z/OS Cryptographic Services' System SSL component and to the z/OS Communications Server’s Application Transparent TLS (AT-TLS) function. This support is intended to make the latest and most secure TLS standard available to use by any z/OS System SSL application and any application that accesses System SSL through AT-TLS.

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February, 2019 – Starting in z/OS V2.4, IBM intends to no longer provide the z/OS Migration publication,GA32-0889, in its current format. Since z/OS V2.2, the preferred method for learning about migration actions has been the z/OS Migration Workflow. Discovering, performing, and verifying many migration actions through the z/OSMF Workflow function instead of a more traditional book format allows for a tailored and specific upgrade path associated with a particular system. Starting with the z/OS V2.4 release and later, IBM intends to continue to provide migration tasks in a z/OSMF Workflow, as well as a single exported file. By providing the z/OS V2.4 migration materials in both formats, users still can enjoy the advantages of a z/OSMF Workflow as well as being able to search, browse, and print in a more traditional format. With the removal of the traditional z/OS Migration publication, GA32-0889, it is strongly recommended that you plan for your next upgrade by having z/OSMF ready to use in at least one location in your enterprise. Notice that the exported format of the z/OS migration materials that can be easily read or printed for those without any z/OSMF capabilities will not be tailored for any environment. When the z/OS workflow for migration is provided for z/OS V2.4, it is to be renamed the z/OS Upgrade Workflow to better identify that each z/OS release contains a higher level of functionality than the prior release. In general, the term upgrade will be used in place of migration . The z/OS Upgrade Workflow is planned to be provided using the git repository for IBM/IBM-Z-zOS, which today hosts the z/OS Migration Workflows.

February, 2019 – z/OS V2.4 is planned to be the last release to support the ISPF Workstation Agent (WSA),also known as the ISPF Client/Server Component. WSA is an application that runs on yourlocal workstation and maintains a connection between the workstation and the ISPF host. It is primarily used to transfer files between the workstation and the host. IBM recommends usingmore current file transfer solutions such as those provided by the Zowe Dataset Explorer, z/OSFTP, and similar file transfer mechanisms. These solutions have more capabilities, including the ability to provide secure communications.

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November, 2018 – IBM intends to deliver a new cloud tier to OAM's existing storage hierarchy, which will provide the ability to store and manage primary copies of OAM objects on cloud storage, via public or private cloud infrastructures supporting the Amazon S3 API, and the ability to recall an object stored in the cloud to the disk level of the storage hierarchy. OAM managed backup copies will continue to be supported as they are today to removable media, typically virtual or physical tape

November, 2018 – OSA Support Facility (OSA/SF) is an element of z/OS that has been used to configure devices on Open Systems Adapter (OSA) cards used for the SNA protocol and to support and manage all OSA features. OSA/SF in z/OS has both a graphical user interface as well as a REXX API. On EC12/BC12 systems, IBM introduced support to configure these devices on the latest generation OSA adapters (OSA Express5S) and to support and manage these adapters exclusively using the Hardware Management Console (HMC), with no capability to configure or manage devices on these adapters provided in the z/OS OSA/SF application. The OSA/SF on the HMC functionality can be used to configure and manage OSA-Express4S and newer generation adapters. With this statement of direction, IBM is announcing that z/OS V2.3 is planned to be the last release of the operating system to support the OSA/SF functionality. No change to the OSA cards' strategic importance to z/OS is meant by this change. z/OS continues to support the networking operational use of OSA adapters.

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May, 2018 – The Software Configuration and Library Management (SCLM) component of ISPF, which is a component of z/OS, is a library system that provides services uniquely related to the ISPF environment. IBM is declaring that the SCLM component is functionally stabilized. While it will continue to be maintained and supported, it won't be enhanced with new features in the future. IBM recommends that clients consider migrating to IBM Rational Team Concert Enterprise Extensions (RTC/EE) or Git with IBM Dependency Based Build (DBB) when looking for improved capabilities.

For additional details on RTC Enterprise Extensions, see the Enterprise Platforms Extensions website.

For additional details on DBB, see the IBM Dependency Based Build website.

May, 2018 – z/OS V2.3 is planned to be the last release of the operating system to support the DFS/SMB (Distributed File System / Server Message Block) functionality. IBM had previously announced that NFS (Network File System) is the strategic file sharing protocol for the z/OS platform. In order to help clients shift to use NFS technology, IBM plans to deliver new function on existing levels of the operating system, including installation, security, availability, and operational enhancements. These planned enhancements will enable clients to more easily migrate to NFS prior to upgrading to the next release of z/OS.

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May, 2018 – z/OS V2.3 is planned to be the last release to include the SMP/E Planning and Migration Assistant (PMA). The set of functions provided by PMA, which was introduced in 1998, has largely been supplanted by newer functions provided by Shopz and by z/OSMF Software Management or duplicate other functions available in SMP/E. For those functions, IBM recommends you use the replacements instead. However, no replacements are planned for the Intermediate Product Migration Changes report or for the PMA ISPF tables.

May, 2018 – IBM intends to deliver DFSMS support to back up and restore individual z/OS UNIX files residing in zFS (z/OS File System) data sets. This support will be integrated in the existing DFSMShsm and DFSMSdss backup and restore capability, allowing for centralized data management across the z/OS platform. When available, the DFSMShsm Backup and Recover support will subsume the capabilities provided by the existing IBM Tivoli Storage Manager z/OS UNIX System Services Backup-Archive Client. However, the planned DFSMS support will not back up or restore individual z/OS UNIX files found in Hierarchical File System (HFS) data sets, given that HFS functionality has been stabilized and given the impending withdrawal of HFS in a future release of the operating system.

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November, 2017 – z/OS V2.3 plans to be the last release of the operating system to provide support in OpenSSH for the following functions. Many of these changes are being driven by the OpenSSH community as a response to providing improved security for the entire industry:

- SSH Version 1 protocol (also referred to as SSH-1)
- Running without privilege separation for sshd (SSH Daemon)
- Support for the legacy v00 OpenSSH cert format
- Support for pre-authentication compression by sshd (SSH Daemon). SSH clients will either need to support delayed compression mode or otherwise compression will not be negotiated
- Support for Blowfish and RC4 ciphers and the RIPE-MD160 HMAC (Hash Message Authentication Code)
- Accepting RSA keys smaller than 1024 bits

In addition, z/OS V2.3 plans to be the last release of the operating system to have enabled at run time the following functions by default:

- Support for the 1024-bit Diffie Hellman key exchange, specifically diffie-hellman-group1-sha1
- Support for ssh-dss, ssh-dss-cert-* host and user keys
- Support for MD5-based and truncated HMAC algorithms, specifically hmac-sha1-96
- Support for the Triple DES cipher, specifically 3des-cbc, in the SSH client's default algorithm proposal

November, 2017 – IBM intends to extend the capabilities of GDPS to the IBM Db2® Analytics Accelerator for z/OS, V7.1 deployment on IBM Z (Accelerator on IBM Z). The initial support will be in GDPS / Multi-Target Metro Mirror. GDPS/MTMM consists of a multisite sysplex cluster with all critical data synchronously mirrored and provides Continuous Availability and Disaster Recovery (CA/DR) protection for customers with two sites separated by up to 200 fibre kilometers.

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July, 2017 – z/OS V2.3 is planned to be the last release of the operating system to provide national language translation in languages other than Japanese. As such, the handful of z/OS elements that provide message and panel translation to Chinese (Simplified and Traditional), Danish, Dutch (Netherlands), French (including Canadian French), German (including Swiss German), Italian, Korean, Norwegian, Portuguese (Brazilian), Spanish, and Swedish today, will no longer provide translations into these languages in the release after z/OS V2.3.

July, 2017 – z/OS V2.3 is planned as the last release to include the z/OS BookManager READ and Library Server base elements, the latter of which includes the BookRead API. Over time, IBM's platform for delivering product documentation to customers has evolved to IBM Knowledge Center technology, and production of documentation formats that are supported by BookManager Read and Library Server has greatly diminished. IBM recommends now using IBM Knowledge Center for z/OS (KC4z), which was introduced as a base element of z/OS in version 2.2, to maintain local repositories of product documentation and serve content.

July, 2017 – For several decades, z/OS has offered two spooling subsystems. JES2 (formerly HASP) and JES3 (formerly ASP). JES2 is used by the majority of z/OS customers and has evolved into nearly a superset of functionality over JES3. IBM is affirming that JES2 is the strategic Job Entry Subsystem for z/OS. New function in spooling subsystems will be primarily developed only for JES2. JES2 supports unique features in the area of availability such as spool migration, online merging of spool volumes, and in the area of function such as support for email notification when a job completes and soon in the area of security with encryption of spool data.

JES3 continues to be supported and maintained with its current function.

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July, 2017 – Removal of support of YES setting for VSM ALLOWUSERKEYCSA DIAGxx parmlib parameter. z/OS V2.3 will be the last release of z/OS to support the YES setting for the ALLOWUSERKEYCSA DIAGxx parmlib parameter. If you run any software that requires the setting of this parameter to YES, the software will need to be changed to no longer require the setting of this parameter to YES. All IBM provided software should not require this setting. If you have any other non-IBM provided software that requires this setting, contact the owner of the software regarding this usage.

July, 2017 – Removal of support for obtaining user key CSA/ECSA Storage. z/OS V2.3 will be the last release of z/OS to support the usage of the GETMAIN, CPOOL, and STORAGE OBTAIN interfaces to obtain user key (8-15) CSA/ECSA storage. If you have any software that obtains user key CSA/ECSA storage, the software will need to be changed to no longer require this capability.

July, 2017 – Removal of support for changing ESQA Storage to user key. z/OS V2.3 will be the last release of z/OS to support the usage of the CHANGKEY interface to change ESQA storage to user key (8-15). If you have any software that changes ESQA storage to user key, the software will need to be changed to no longer require this capability.

July, 2017 – Removal of support for creating SCOPE=COMMON data spaces in user key. z/OS V2.3 will be the last release of z/OS to support the usage of the DSPSERV CREATE interface to create a SCOPE=COMMON data space in user key (8-15). If you have any software that creates a SCOPE=COMMON data space in user key, the software will need to be changed to no longer require this capability.

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February, 2017 - z/OS V2.3 will be the last release of z/OS to support the Server-Requester Programming Interface (SRPI). SRPI was introduced in TSO/E in the 1980s to provide a programming interface that enhances the environment of IBM workstations communicating with IBM mainframes running z/OS. Customers with applications using SRPI should start using TCP/IP for z/OS to provide similar function. Documentation for SRPI is available in *TSO/E Guide to the Server-Requester Programming Interface,* SA22-7785, and this publication as well as documentation for SRPI-related functions, such as the MVSSERV command, will be removed.

February, 2017 - This is a statement of direction to notify Infoprint Server clients of a planned change in default behavior in a future release. IBM intends to enable dynamic configuration as the default behavior. This change in default behavior will be mandatory and not reversible. You can disregard this statement if you already enabled dynamic configuration. See the Infoprint Server Customization publication (SA38-0691) for details on how to enable and the advantages of enabling dynamic configuration.

Some advantages of enabling dynamic configuration include:

- Authorized administrators can use the Infoprint Server ISPF panels or the Printer Inventory Definition Utility (PIDU) to view and change the dynamic attributes rather than editing the /etc./Printsrv/aopd.conf file.
- If you change an attribute in the system configuration definition, with a few exceptions, you do not need to stop and restart Infoprint Server for the change to take effect.
- You can configure Infoprint Server to start and stop individual daemons.
- You can benefit from new functions in Infoprint Server that require dynamic configuration. For example, you can use the MVS system logger function.

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IBM's Statements of Direction

February, 2017 - IBM intends to extend the ServerPac offering to provide the capability for it to support products packaged in ways that currently make them unavailable in ServerPac, including products that are not packaged using SMP/E. ServerPac will be designed to support packages with SMP/E-packaged products, non-SMP/E-packaged products, and a combination of both. This improvement will be intended to enable you to standardize your installation processes for the IBM products available for the z/OS platform. ServerPac will initially continue to use the existing ISPF-based CustomPac Dialog for installation.

In this announcement, statements of direction appear for three new, related functions.

February, 2017 - The release after z/OS V2.3 is planned to be the last release of the operating system to support the HFS (Hierarchical File System) data structure used by the z/OS UNIX environment. IBM has provided equivalent if not superior functionality with the z/OS File System (zFS). Customers should migrate from HFS to zFS using the utilities provided in the operating system to convert their entire file system hierarchy.

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IBM's Statements of Direction

October, 2016 - In the future, IBM intends to provide a linkage between z/OSMF Software Management's deployment function and z/OSMF workflows so a workflow can be initiated by a deployment operation. z/OSMF already supports one workflow calling another workflow. The new function will be designed to allow workflows to be used to manage installation-related and deployment related tasks by linking from package-level workflows to product-level and component-level workflows as needed to help you perform these activities both for initial installation (for example, on a test system) and later deployments to additional systems (such as application test, application development, and production systems).

- Also, IBM intends to extend the ServerPac offering to provide the capability for it to support
- products packaged in ways that currently make them unavailable in ServerPac, including
- products that are not packaged using SMP/E. ServerPac will be designed to support packages with SMP/E-packaged products, non-SMP/E-packaged products, and a combination of both. This improvement will be intended to enable you to standardize your installation processes for the IBM products available for the z/OS platform. ServerPac will initially continue to use the existing ISPF-based CustomPac Dialog for installation.

December, 2015 - z/OS V2.3 is planned to be the last release to support the Batch Runtime component. The z/OS Batch Runtime component provides the framework for Java™ interoperation with COBOL and PLI, with transactional updates to IBM DB2® and Transactional VSAM. It is recommended that you use IBM WebSphere® Application Server JSR 352 instead.

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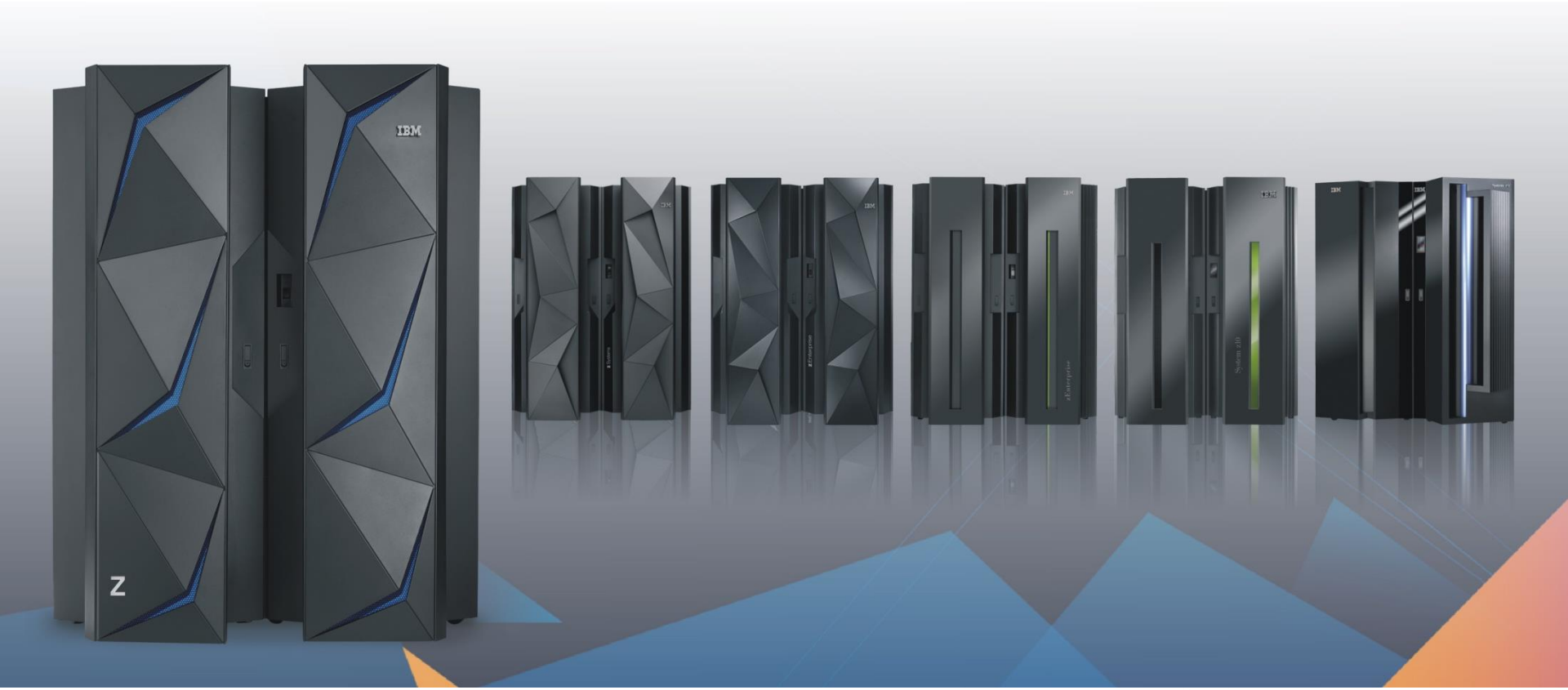

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