GS02 - IBM Z News

Hamburg, 23.10.2017

Dr. Manfred Gnirss
Z ATS
IBM Client Center Boeblingen

11th European GSE/IBM Technical
University for z/VSE, z/VM, KVM and
Linux on IBM z Systems

23 – 25 October 2017 in Hamburg

Le Méridien Hotel
Hamburg

© PG / GSE

Trademarks

The following are trademarks of the International Business Machines Corporation in the United States and/or other countries.

BladeCenter*	DFSMShsm	HiperSockets	Ibm.com	LinuxONE Emperor	z13*	z/OS*
CICS*	ECKD	HyperSwap*	IBMZ*	PR/SM	z14	z/VM*
DB2*	FICON*	IBM*	Infiniband*	System Storage*	zEnterprise*	z/VSE*
DFSMSdss	GDPS*	IBM (logo)*	LinuxONE	WebSphere*	zHyperLink	

* Registered trademarks of IBM Corporation

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.

IT Infrastructure Library is a Registered Trade Mark of AXELOS Limited.

ITIL is a Registered Trade Mark of AXELOS Limited.

Linear Tape-Open, LTO, the LTO Logo, Ultrium, and the Ultrium logo are trademarks of HP, IBM Corp. and Quantum in the U.S. and other countries.

Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.

Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

Java and all Java-based trademarks and logos are trademarks or registered trademarks of Oracle and/or its affiliates.

Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc. in the United States, other countries, or both and is used under license therefrom.

UNIX is a registered trademark of The Open Group in the United States and other countries.

VMware, the VMware logo, VMware Cloud Foundation, VMware Cloud Foundation Service, VMware vCenter Server, and VMware vSphere are registered trademarks or trademarks of VMware, Inc. or its subsidiaries in the United States and/or other jurisdictions.

Other product and service names might be trademarks of IBM or other companies.

Notes:

Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.

IBM hardware products are manufactured from new parts, or new and serviceable used parts. Regardless, our warranty terms apply.

All customer examples cited or described in this presentation are presented as illustrations of the manner in which some customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics will vary depending on individual customer configurations and conditions.

This publication was produced in the United States. IBM may not offer the products, services or features discussed in this document in other countries, and the information may be subject to change without notice. Consult your local IBM business contact for information on the product or services available in your area.

All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

Information about non-IBM products is obtained from the manufacturers of those products or their published announcements. IBM has not tested those products and cannot confirm the performance, compatibility, or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

Prices subject to change without notice. Contact your IBM representative or Business Partner for the most current pricing in your geography.

This information provides only general descriptions of the types and portions of workloads that are eligible for execution on Specialty Engines (e.g, zIIPs, zAAPs, and IFLs) ("SEs"). IBM authorizes customers to use IBM SE only to execute the processing of Eligible Workloads of specific Programs expressly authorized by IBM as specified in the "Authorized Use Table for IBM Machines" provided at www.ibm.com/systems/support/machine_warranties/machine_code/aut.html ("AUT"). No other workload processing is authorized for execution on an SE. IBM offers SE at a lower price than General Processors/Central Processors because customers are authorized to use SEs only to process certain types and/or amounts of workloads as specified by IBM in the AUT.

Contents

IBM Z®: Designed for Trusted Digital Experiences

Introducing the IBM z14™ (z14)

Achieving Pervasive Encryption

Designed for a Cognitive World

Systems administration simplified

Operating System Support

Upgradability

IBM Z: Designed for Trusted Digital Experiences

The world's premier system for enabling data as the new security perimeter

- Pervasive encryption
- No application changes
- Protect from internal and external threats

Designed for data serving in a cognitive world

- Speed, scale and reduced latency
- Efficiency for managing data
- Secure and flexible access to data

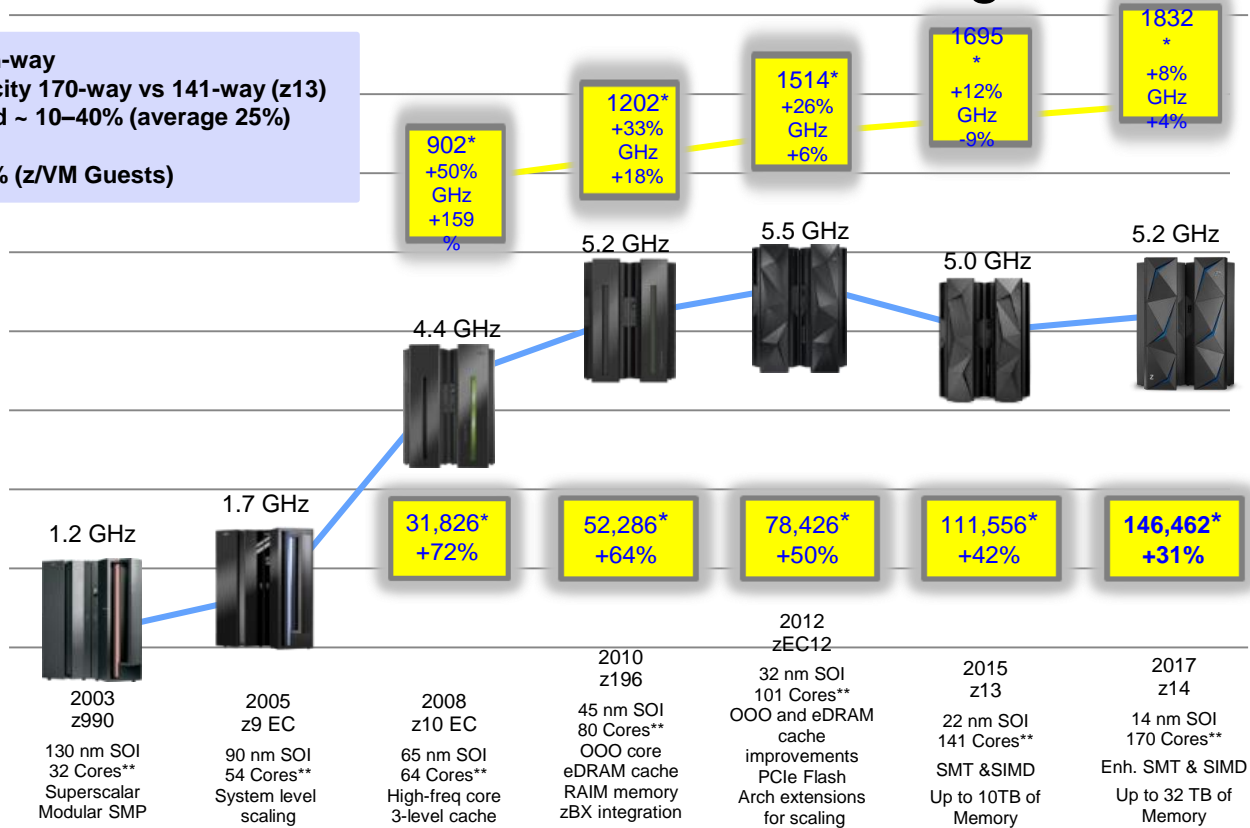## The best infrastructure to support an open and connected world

- 'From anywhere' mobile access
- Simplified sys admin of z/OS®
- Standardization for skills transfer

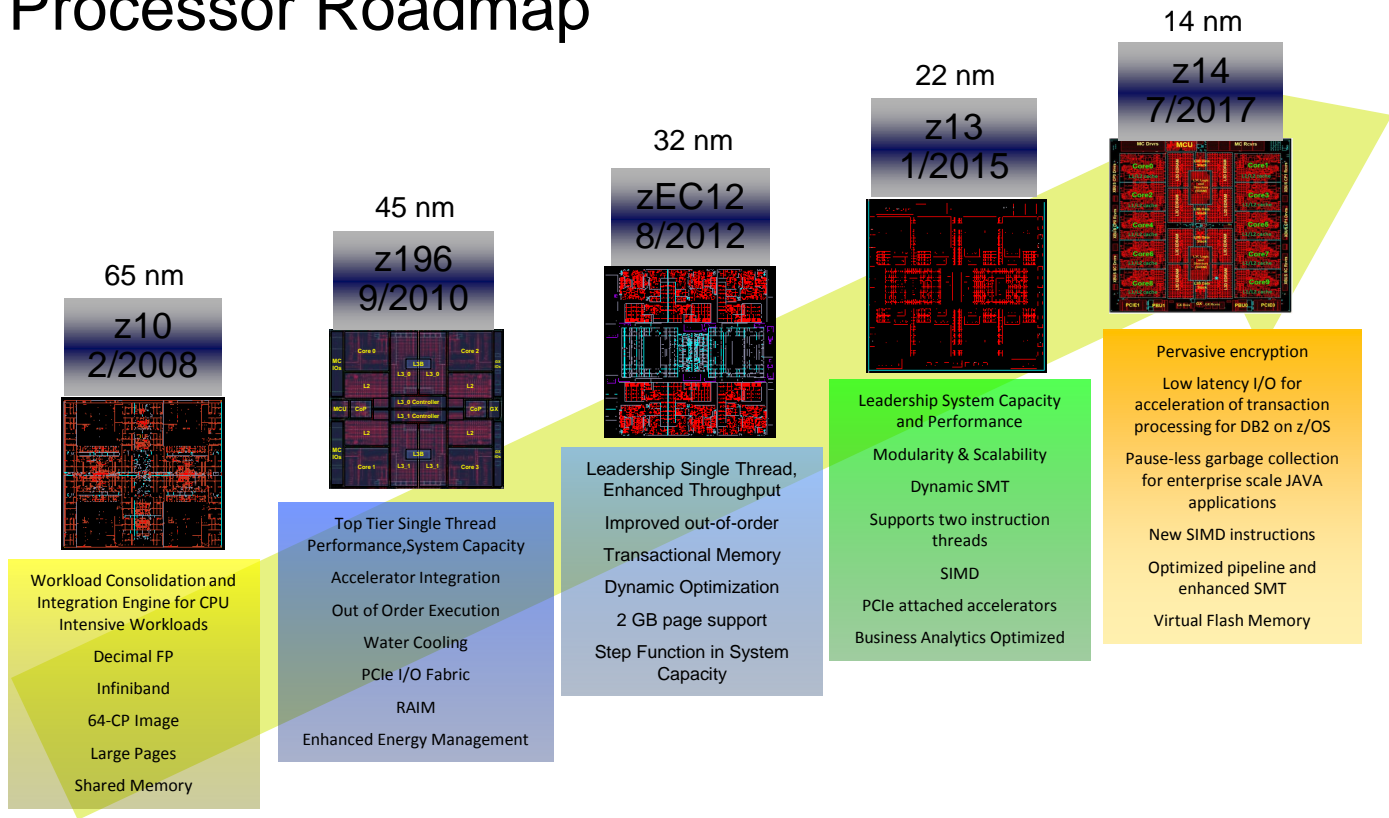# z14 Continues the CMOS Mainframe Heritage

~ 10% for equal z13 n-way
Up to 35% max capacity 170-way vs 141-way (z13)
SMT vs Single Thread ~ 10–40% (average 25%)
   - both zIIP & IFL
SMT z14 vs z13 ~ 15% (z/VM Guests)

GHz / PCI*

902*
+50%
GHz
+159%

1202*
+33%
GHz
+18%

1514*
+26%
GHz
+6%

1695*
+12%
GHz
-9%

1832*
+8%
GHz
+4%

5.2 GHz

5.5 GHz

5.0 GHz

5.2 GHz

4.4 GHz

1.2 GHz

1.7 GHz

31,826*
+72%

52,286*
+64%

78,426*
+50%

111,556*
+42%

146,462*
+31%

2012
zEC12

2010
z196

2003
z990

2005
z9 EC

2008
z10 EC

32 nm SOI
101 Cores**
OOO and eDRAM
cache
improvements
PCIe Flash
Arch extensions
for scaling

45 nm SOI
80 Cores**
OOO core
eDRAM cache
RAIM memory
zBX integration

130 nm SOI
32 Cores**
Superscalar
Modular SMP

90 nm SOI
54 Cores**
System level
scaling

65 nm SOI
64 Cores**
High-freq core
3-level cache

2015
z13

2017
z14

22 nm SOI
141 Cores**

SMT &SIMD

Up to 10TB of
Memory

14 nm SOI
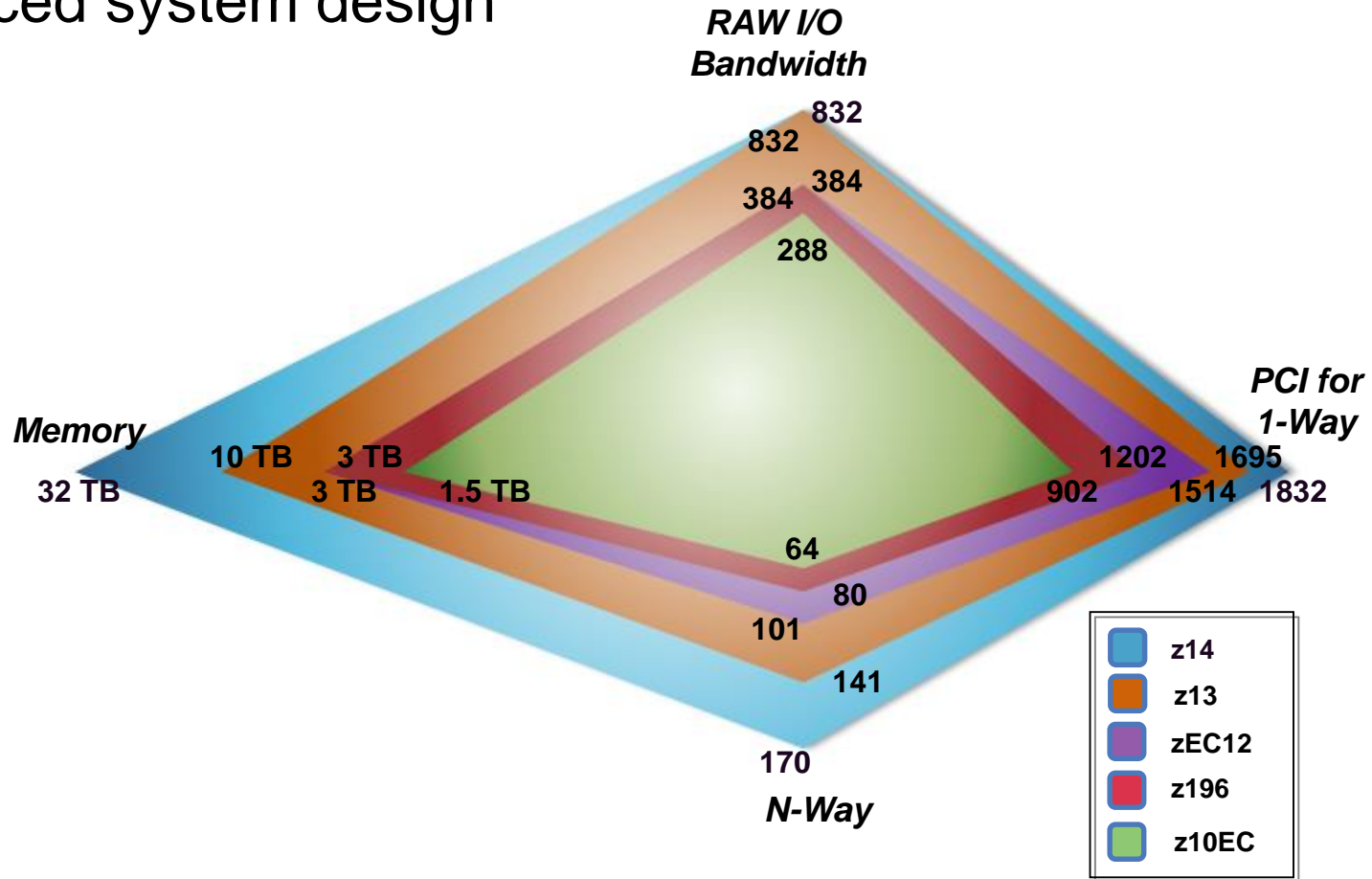170 Cores**

Enh. SMT & SIMD

Up to 32 TB of
Memory

*   MIPS Tables are NOT adequate for making comparisons of IBM Z processors. Additional capacity planning required
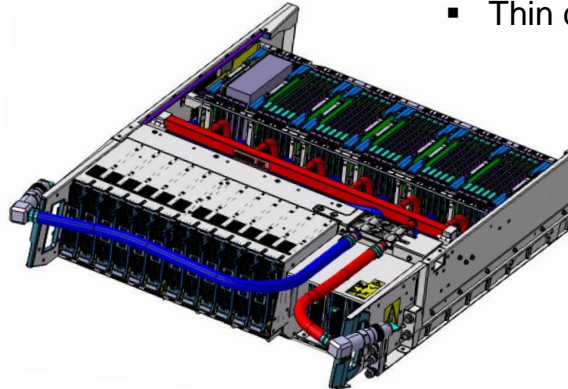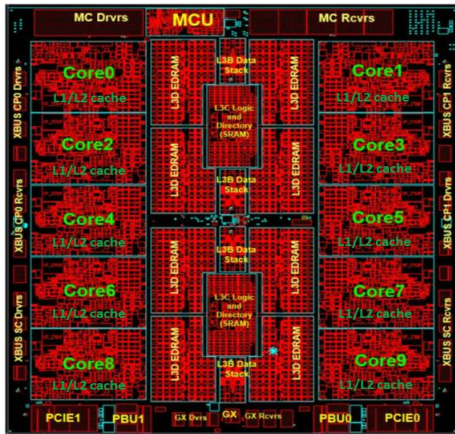** Number of PU cores for customer use

IBM Z – Processor Roadmap

65 nm

z10
2/2008

Workload Consolidation and Integration Engine for CPU Intensive Workloads

Decimal FP

Infiniband

64-CP Image

Large Pages

Shared Memory

45 nm

z196
9/2010

Top Tier Single Thread Performance,System Capacity

Accelerator Integration

Out of Order Execution

Water Cooling

PCIe I/O Fabric

RAIM

Enhanced Energy Management

32 nm

zEC12
8/2012

Leadership Single Thread, Enhanced Throughput

Improved out-of-order

Transactional Memory

Dynamic Optimization

2 GB page support

Step Function in System Capacity

22 nm

z13
1/2015

Leadership System Capacity and Performance

Modularity & Scalability

Dynamic SMT

Supports two instruction threads

SIMD

PCIe attached accelerators

Business Analytics Optimized

14 nm

z14
7/2017

Pervasive encryption

Low latency I/O for acceleration of transaction processing for DB2 on z/OS

Pause-less garbage collection for enterprise scale JAVA applications

New SIMD instructions

Optimized pipeline and enhanced SMT

Virtual Flash Memory

Balanced system design

z14 System Design Changes

- 14 nm Processor with improved SIMD, SMT
- 10 Cores per CP SCM design
- 5 or 6 CP SCMs per Drawer
- Integrated I/O with PCIe Direct Attach
- Single System Controller Chip
- Simplified CPC Drawer SMP Fabric

- Crypto Express6S
- OSA-Express6S
- FICON Express16S+
- RoCE Express2
- IBM zHyperLink Express
- Coupling Express Long Reach
- Radiator Design improvements
- Expanded operating environment (ASHRAE Class A3)
- Thin doors (optional)

z14 Radiator-based Air cooled – Front View (Model M04 or M05)

Overhead Power Cables (option)

Internal Batteries (optional)

Power Supplies

Displays and keyboards for Support Elements

PCIe I/O drawers numbers 1 to 4

2 x 1U Support Elements

PCIe I/O drawer number 5

System Control Hubs (used to be BPHs)

CPC Drawers, PCIe Fanouts, Cooling water manifold and pipes, PCIe I/O interconnect cables, FSPs and Ethernet cables

Note: CPC Drawer plugging numbers are on the left and logical numbers on the right

Radiator Pumps

Overhead I/O feature is a co-req for overhead power option

PHYSICAL   4 0   LOGICAL
            3 1
            2 2
            1 3

Introducing the IBM z14

- **Processor Units (PUs)**
  - 41 (49 for M05) PU cores per CPC drawer ~1832 MIPS/core
  - 33, 69, 105, 141 or 170 PU cores available for characterization
  - Up to 23 SAPs per system, standard plus SAPs are SMT
  - 2 spares designated per system
  - 85 LPARs
  - Sub-capacity available for up to 33 CPs – 3 sub-capacity points (4xx, 5xx, 6xx)
  - Enhanced performance for compression and crypto coprocessor

- **Memory**
  - RAIM Memory design
  - System Min of 512 GB - up to 8 TB / drawer - 192 GB Fixed HSA
  - Up to 32 TB for System and up to 16 TB per LPAR (OS dependent)
  - IBM Virtual Flash Memory (replaces Flash Express)

- **I/O**
  - New PCIe Gen 3 IBM zHyperLink™ technology
  - Last high end server to support InfiniBand® Coupling Features
  - 16 GBps PCIe Gen 3 I/O Interconnects
  - 6 Logical Channel Subsystems (LCSSs) with 4 Sub-channel sets per LCSS

IBM z14
Machine Type: 3906
Models:
M01, M02, M03, M04, M05

Model	Customer PUs	Max Memory
M05	170	32 TB
M04	141	32 TB
M03	105	24 TB
M02	69	16 TB
M01	33	8 TB[1]

z/OS Linux z/TPF z/VM z/VSE

[1] Provides the minimum physical memory required to hold base purchase memory plus 192 GB HSA

IBM z14 10-Core Processor Chip Detail

- Up to ten active cores (PUs) per chip
  - 5.2 GHz (versus 5.0 GHz IBM z13®)
  - L1 cache and L2 cache on core
  - L3 cache on chip – shared by on-chip cores and communicates with cores, memory, I/O and system controller single chip module
- New instructions for Single Instruction/Multiple Data (SIMD)
- Single thread or next generation 2-way simultaneous multithreading (SMT) operation
- Guarded Storage Facility (GSF)
- Compression enhancements – Huffman Coding – in future[1] DB2® indices can take advantage of the compression coprocessor
- Improved instruction execution bandwidth:
  - Pipeline optimization -- Improved instruction delivery, faster branch wakeup, optimized hardware/millicode interaction, reduced execution latency, improved OSC prediction
  - Translator / TLB enhancements
  - New instructions for old and new workloads - i.e. Vector BCD arithmetic (COBOL)
- I/O buses
  - One InfiniBand I/O bus
  - Two PCIe I/O buses
- Memory Controller (MCU)
  - Interface to controller on memory DIMMs, supports RAIM design
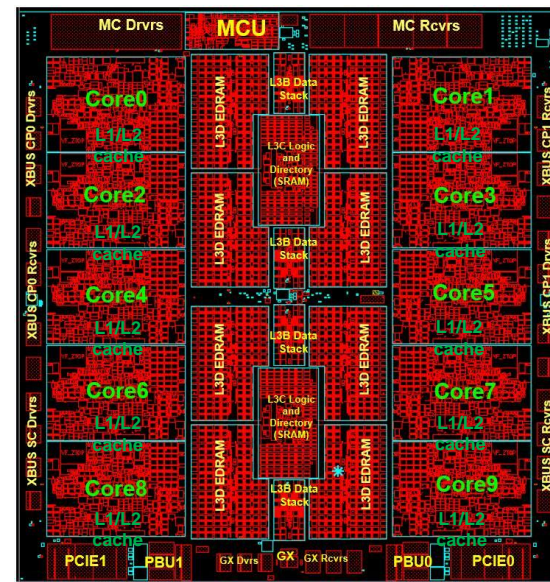
- 14nm SOI Technology
  - 17 layers of metal
  - 6.1 Billion Transistors vs 3.99 Billion on z13
- Chip Area
  - 26.5 x 27.8 mm

[1] IBM's statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM's sole discretion.

z14 Processor Drawer (Top View)

- Each PU SCM:
  - 14nm
  - One Memory Controller per CP Chip
  - Five DDR4 DIMM slots per Memory Controller: 15 total per logical cluster
- Each drawer:
  - Two logical CP clusters (0 and 1)
  - Five PU Chips: 41 active PUs – M01 – M04
  - Six PU Chips: 49 Active PUs – M05
  - One SC Chip (672 MB L4 cache)
  - Populated DIMM slots: 25 DIMMs to support up to 8 TB of addressable memory (10 TB RAIM)
  - Water cooling for PU SCMs, air cooled SC SCM
  - Two Flexible Support Processors
  - Ten fanout slots for PCIe I/O drawer fanouts or PCIe coupling fanouts
  - Four fanout slots for PSIFB coupling link fanouts

Rear

(1)

M05 Only

SC

Front

Logical Cluster 0

Logical Cluster 1
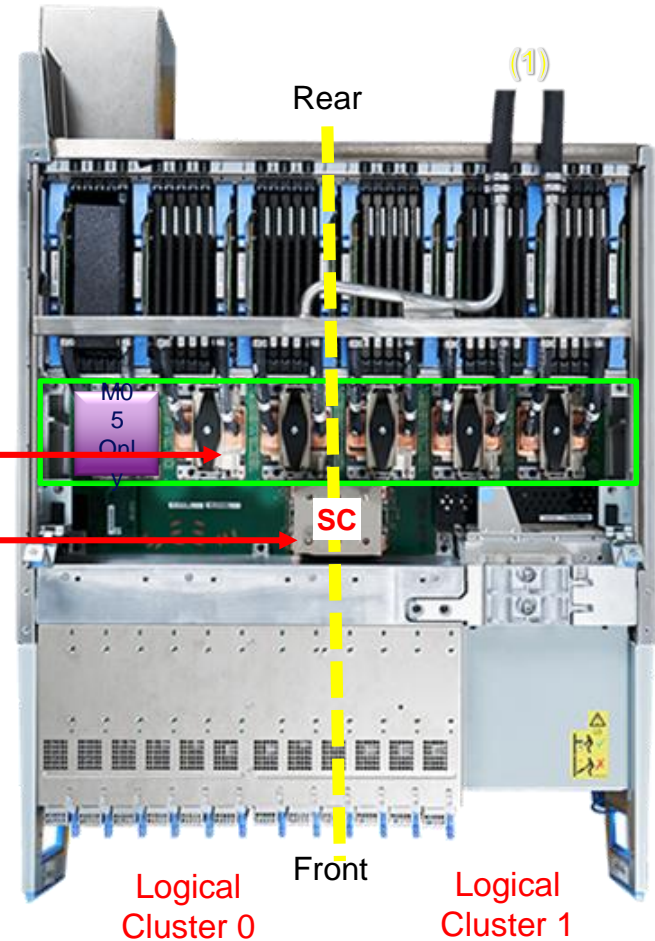
Virtual Flash Memory: What is it – High Level

- The "storage class memory" provided by Flash Express (FC #0402 and #0403) adapters is replaced with Virtual Flash Memory (VFM) which is part of the main memory

- VFM is offered as a priced hardware feature.

  - Customer can buy one to four "units" of VFM via eConfig at initial purchase.

- A "unit" will be 1.5 TB (1536 GB) on z14

  - Approximately same size as a Flash Express pair of adapters

- Much simpler management of VFM resource (HMC task)

- No hardware repair and verify (no cables, no adapters)

- Better performance since no "I/O" to attached adapter takes place*.

- RAS: Memory protected by RAIM and ECC (internal / main memory)

Note: Use cases and exploitation for VFM have not been changed

z14 Processor Enhancements:
Guarded Storage Facility (GSF) for Pause-less Garbage Collection

- Problem:

  - When garbage collection occurs today, all threads running under a JVM must stop

  - Customers are consolidating from multiple to single JVM environments to increase productivity and save money.

  - The consolidation effort generates heap sizes >100GB where garbage collection pauses can take minutes!

  - Long pause times cause transactional application failures and SLA violations.

- Solution:

  - Define flexible new architecture that provides hardware assisted read barriers for guarded storage involved in a garbage collection/compaction event.

  - Whenever a Pointer is loaded from memory, the pointer is checked against a pending GC, and in case of a "hit", the control flow is redirected

  - The Dynamic Runtime can then assist in GC-ing the pointed-to object, before resuming the SW thread.

  - Software exploitation of fast hardware barrier detection and acceleration will allow application threads to run concurrently during the majority of garbage collection events

- Impact:

  - Reduces worst case latency impacts for critical applications like financial trading platforms

  - Maintains SLAs, and keeps IBM Z servers in our customers modernization roadmaps.

z14 "New Build" I/O and MES Features Supported

- **Features – PCIe I/O drawer**

    - **FICON Express16S+ LX, SX (FC #0427, #0428)**

    - **OSA-Express6S: 1 GbE (LX, SX), 10 GbE (LR, SR), and 1000BASE-T (FC #0422, 0423, 0424, 0425, 0426)**

    - **10GbE RoCE Express2 (FC #0412)**

    - **zEDC Express (FC #0420)**

    - **Crypto Express6S (FC #0893)**

    - **Regional Crypto Enablement (RCE) (FC #0901)**

    - **zHyperLink Express (FC #0431)**

    - **Coupling Express LR (FC #0433)**
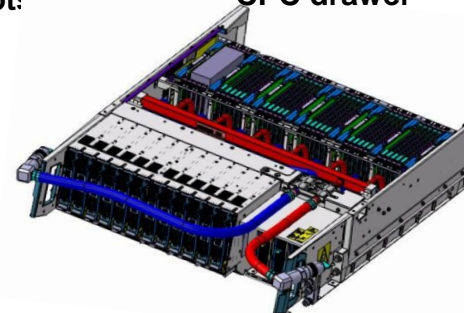
- **PCIe Coupling Link Feature (CPC Drawer PCIe Fanout)**

    - **ICA SR - two 8GBps PCIe Gen3 Coupling Links (FC #0172)**

- **InfiniBand Coupling Features (CPC Drawer HCA Fanouts)***

    - **HCA3-O   two 12x 6GBps** InfiniBand DDR Coupling Links (FC #0171)**

    - **HCA3-O LR four 1x 5Gbps InfiniBand DDR or SDR Coupling Links (FC #0170)**

        *Note: z14 is the LAST server to support InfiniBand features

        **Note: The link data rates do not represent the performance of the links. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

PCIe I/O drawer (FC #4013)

32 I/O slots

CPC drawer

10 PCIe and 4 HCA Fanout I/O slots

z14 Carry Forward I/O Features Supported

- ## Features – PCIe I/O drawer
  - FICON Express16S
  - FICON Express8S
  - OSA-Express5S
  - OSA-Express4S 1000Base-T
  - 10GbE RoCE Express (FC #0411)
  - zEDC Express
  - Crypto Express5S
  - Regional Crypto Enablement (RCE)
  - Coupling Express LR
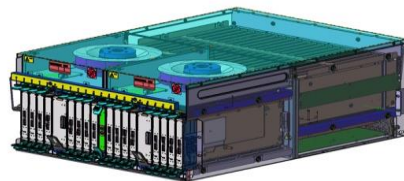
- ## PCIe Coupling Link Feature (Fanout)
  - ICA SR two 8GBps** PCIe Gen3 Coupling Links

- ## InfiniBand Coupling Features (HCA Fanouts)*
  - HCA3-O two 12x 6GBps** InfiniBand DDR Coupling Links
  - HCA3-O LR four 1x 5Gbps** InfiniBand DDR or SDR Coupling Links

PCIe I/O drawer (FC #4013)

32 I/O slots

CPC drawer
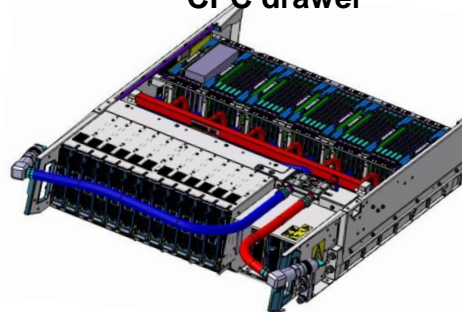
10 PCIe and 4 HCA Fanout I/O slots

*Note: z14 is the LAST IBM Z server to support InfiniBand features
**Note: The link data rates do not represent the performance of the links. The actual performance is dependent upon many factors including latency through the adapters, cable lengths, and the type of workload.

What is IBM zHyperLink™?

- zHyperLink Express is a direct connect short distance IBM Z I/O feature designed to work in conjunction with a FICON or High Performance FICON SAN infrastructure

- IBM zHyperLink™ dramatically reduces latency by interconnecting the z14 CPC directly to the I/O Bay of the DS8880 (models 984, 985, 986 and 988.*)

- zHyperLink improves application response time, cutting I/O sensitive workload response time in half without significant application changes.

NEW

IBM z14 CPC

Up to 5x reduction In latency

IBM DS8880

IBM Z - Today and Future I/O

IBM Z CPC

SSCH

zHyperLink™

20-30 µsec

FICON / zHPF   SAN   FICON / zHPF

145-170 µsec + Interrupt handling +CPU dispatch time
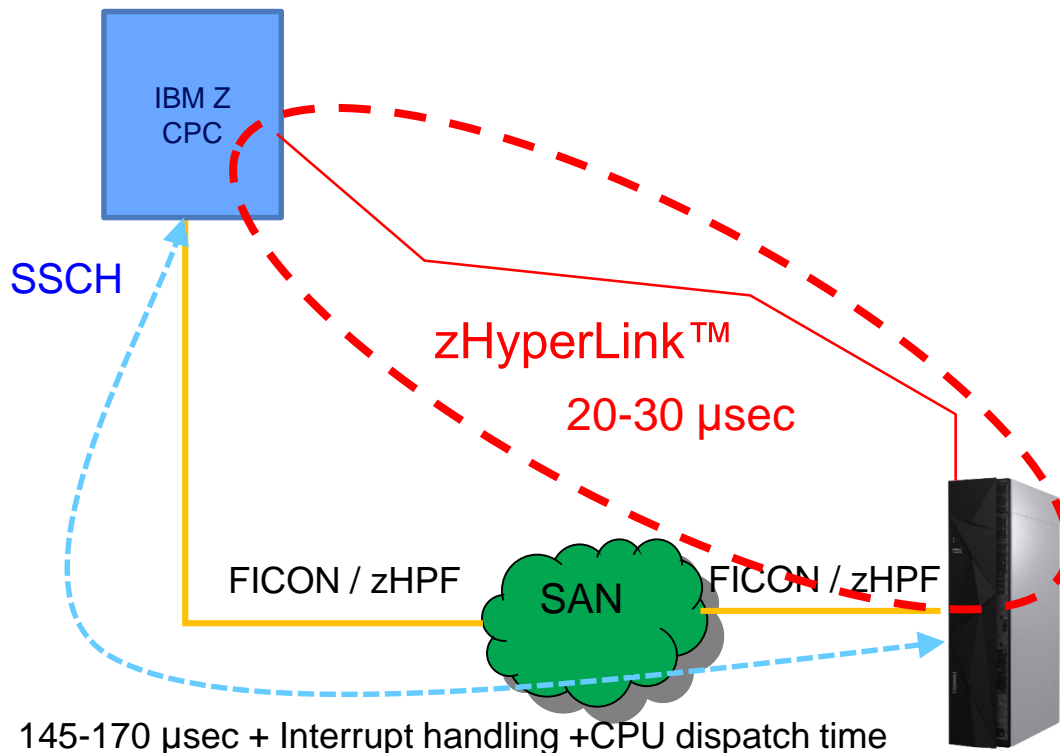
Notes:

• Typically over 80% cache hit ratio on random reads.

• 100% cache hit on writes.

How does IBM zHyperLink™ change the game?

- zHyperLink™ is FAST enough the CPU can just wait for the data

  – No Un-dispatch of the running task

  – No CPU Queueing Delays to resume it

  – No host CPU cache disruption

  – Very small I/O service time

- Operating System and Middleware (e.g. DB2) are changed to keep running over an I/O

- Transparently gives DB2 apps fundamentally better latency than applications on platforms without zHyperLink

  – Excluding 100% in memory databases

- New industry I/O link for Mainframe

IBM Z CPC

zHyperLink

<20 μsec
>50,000 IOOPs/SEC
8 GB/sec

DS8880

SAN

FICON/zHPF
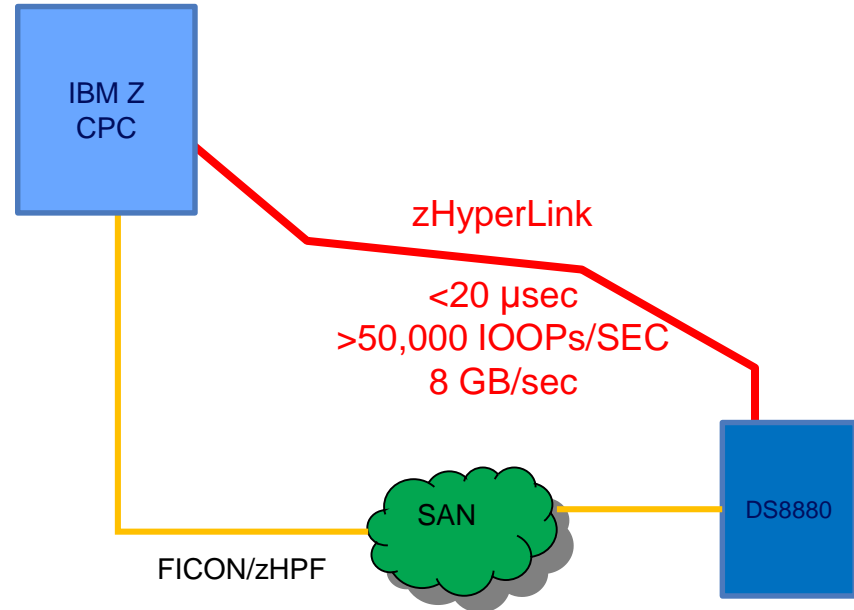
I/O Performance Chart – Evolution to IBM zHyperLink with DS8886

Number of IOOPs (4K block size)

5.3M
3.8M
3.2M
2.4M
2.2M

IBM DS8886
Average latency (µsec)

155   132
184.5
148
20

IOOPs per CHN

106K
95K
315K
62K

0.75
1.6
2.5
3.2
8.0

Single channel BW (GB/s)

■ z14: zHyperLink + FICON Express16S+
■ z14: FICON Express16S+
■ z13: FICON Express16S
■ zEC12: FICON Express8S
■ z196: FICON Express8
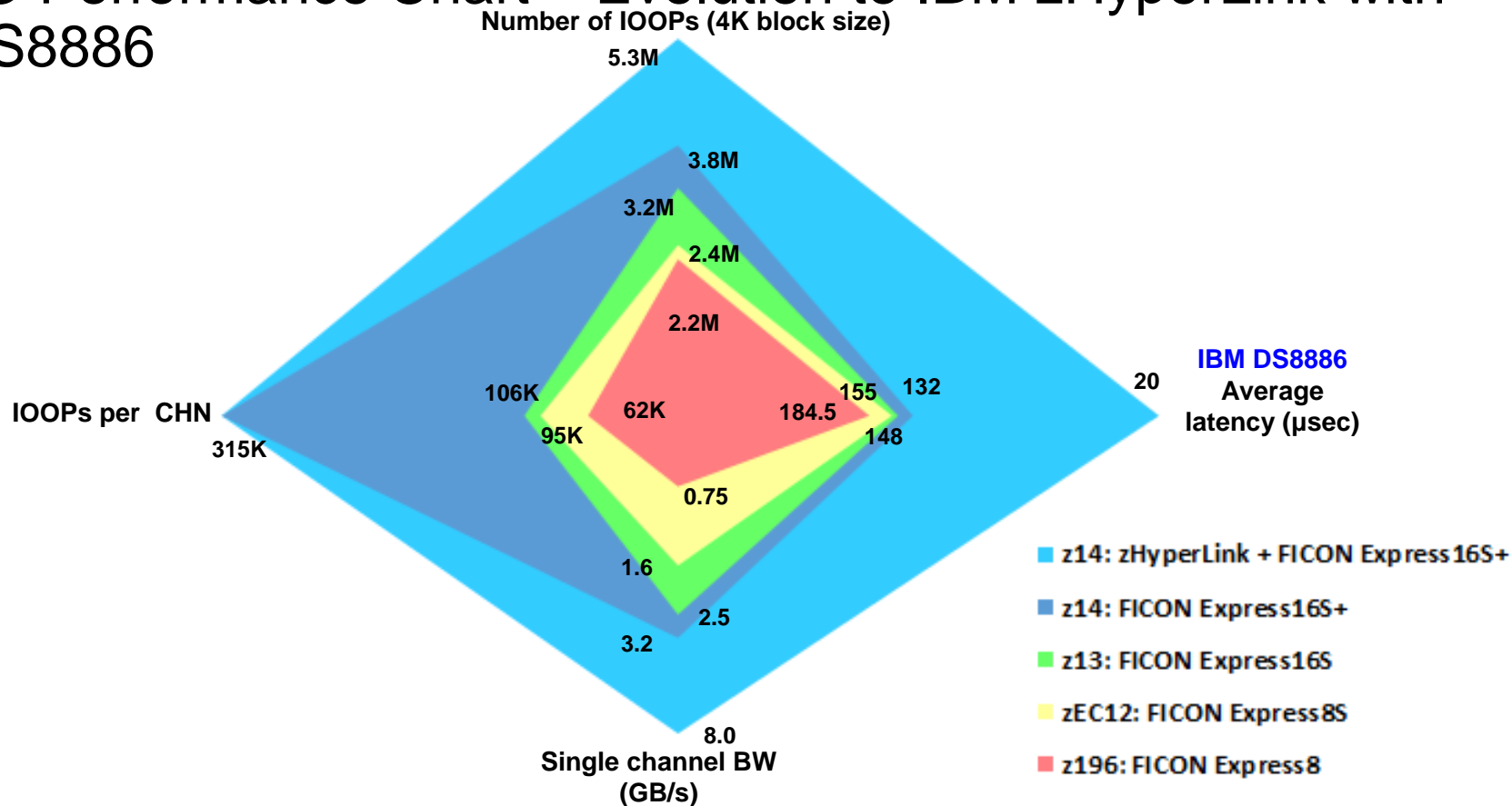
Crypto Functions in the Dedicated Co-processor – new for z14

Dedicated
Co-Processor
per Core

~**2x** throughput

- SHA-1/2
  ~**3.7x** better throughput
  (on longer data)

- AES-128/256
  ~**1.7x** better throughput
  (on longer data)

- **Reduced overhead**
  on short data (hashing and
  encryption)

- >**4x** throughput for AES

- Special instructions for
  elliptic curve crypto / RSA

---

z196 **zEC12** **z13** **z14**

Co-Processor

▪Hashing hardware:
SHA-1/256/512, GHASH

▪Cipher hardware:
(3)DES, AES

- Pseudo-random number
  generator

- New hashing algorithms,
  e.g. **SHA-3**
- Support for authenticated
  encryption
  (combined encryption and
  hashing, e.g. AES-GCM)
- **True random number generator**
  (e.g. for session keys)

- **New instruction added : KMGCM for end to end implementation of NIST GCM standard. (800-38D)**
- **KIMD / KLMD extended to implement SHA-3 standard. (FIPS 202)**
- **AES throughput improved to 3.5 to 4B/cycle**

Crypto – CPACF AES Performance Evolution

- Throughput comparison

- Payload 4 KB

- Showing z14 advantages
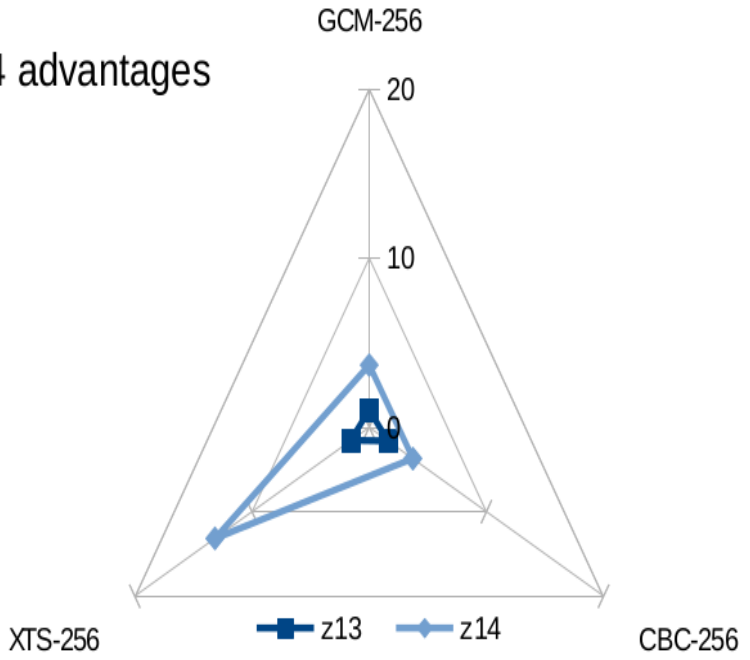
OpenSSL 1.0.2j

OpenSSL 1.1.1
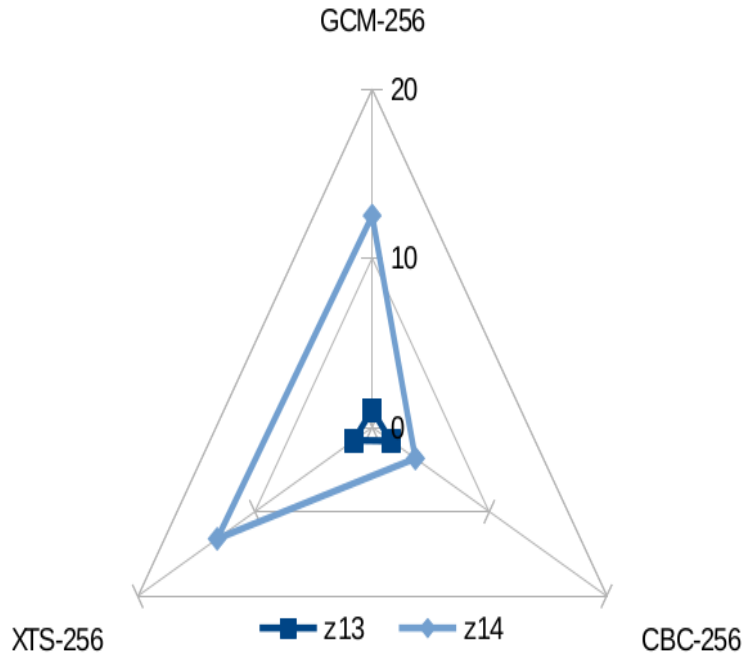
Differentiated Value at the Core

- **Leader in performance and scale**
  - New 10-core Processor Design in 14nm Silicon Technology
  - Up to 170 configurable cores for up to ***35%*** total capacity improvement over the largest IBM z13™ (z13)
  - ***1.5x*** more on-chip cache[1] per core optimized for data serving

- **More performance with innovation that helps the full stack**
  - New instructions in the SIMD Facility gives boost for traditional workloads using decimal arithmetic and new applications like analytics
  - Pause-less garbage collection enables enterprise scale Java® applications to run with fewer and shorter pauses for garbage collection on larger and larger heaps
  - Next generation SMT improves performance up to ***25%*** vs non-SMT for an IFL or zIIP to benefit Linux® and zIIP exploiters

[1] All comparisons are to z13

Designed for Data Protection

Market View

- Nearly 4 million records stolen per day,
  157,364 per hour and 2,623 per minute. [1]

- Of the 9 Billion records breached since 2013
  only 4% were encrypted.[1]

- 1 in 4 companies is likely to experience a breach.[2]

- The greatest security mistake organizations
  make is failing to protect their networks
  and data from internal threats.[3]

The world's premier system
for enabling data as the
new security perimeter

- **Pervasive encryption**
- **No application changes**
- **Protect from internal and external threats**

[1] http://breachlevelindex.com/
[2] https://www.ibm.com/security/infographics/data-breach/
[3] Steve Marsh in article: https://digitalguardian.com/blog/expert-guide-securing-sensitive-data-34-experts-reveal-biggest-mistakes-companies-make-data

The IBM z14 Makes Pervasive Encryption Achievable

- Pervasive encryption gives z clients a simplified way to protect data at a much coarser scale at *industry best performance* – even with no change it runs faster!

- Pervasive encryption provides the ability to encrypt data by policy *without application change*

- Pervasive encryption greatly *simplifies audit* and makes it easier for clients to *pass compliance audits*

Encrypting as much as possible of your data and transactional pipeline helps reduce potential data breach risks and financial losses

App Encryption
Hyper-sensitive data

Database Encryption
Provide protection for very sensitive in-use (DB level), in-flight & at-rest data

File or Dataset Level Encryption
*Provide **broad** coverage for sensitive data using encryption tied to access control for in-flight & at-rest data protection*

Full Disk, Tape & Network
*Provide 100% coverage for in-flight & at-rest data with **zero** host CPU cost*

IBM z14: Performance that Changes the Game for Security

Performance with Integrated Cryptographic Hardware

- *6x* faster encryption for like modes and data sizes with enhanced on-chip (CPACF) cryptographic performance compared to z13[1]

- *2X* the SSL handshake performance on z14 with Crypto Express6S compared to z13 with Crypto Express5S[1]

Datasets automatically protected with z/OS Dataset Encryption

- Protect z/OS data sets[2] automatically throughout their life cycle

- Enforce consistent policy over access to encrypted content

Protection in the sysplex

- Data is encrypted/decrypted at a host and is protected in flight and at rest inside the Coupling Facility (CF)[3]

---
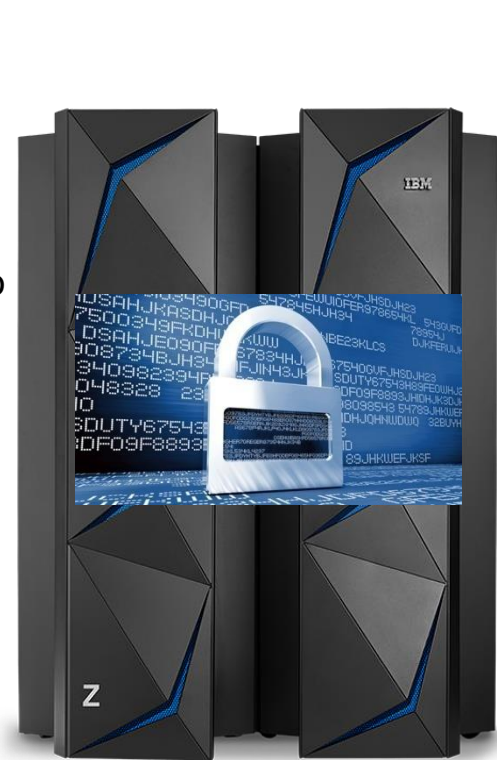
[1] Based on preliminary internal IBM lab measurements on a standalone dedicated system in a controlled environment and compared to the z13. Results may vary.
[2] On October 4th, 2016 IBM announced a Statement of Direction to deliver z/OS dataset encryption capability in z/OS V2.2 (Announcement Letter)
[3] IBM z/OS 2.3 Preview Announcement Letter

Pervasive Encryption with Linux on z14

- **Fast encryption of Linux workloads delivered with near-zero overhead via hardware accelerated encryption of CPACF and new Crypto Express6S**
  - All encryption functions within the Linux kernel and the openSSL, open Cryptoki and GSKIT libraries are benefiting and transparently delivering the performance to the applications and middleware

- **Linux[1] is expected to get enhanced security with the "protected key" encryption for data at-rest**
  - Protected key encryption is processed in the CPACF and stored in a hardware security module (HSM) and enables fast encrypting and decrypting of complete disks (volumes) or selected partitions

- **Linux[1] is expected to be enabled to create true unique cryptographic data using the new true random number generator with CPACF**

More Security Enhancements on IBM z14

- ***Ensure stronger security in the payment card industry*** using Crypto Express6S compliance with security standards

- ***Stronger cryptographic computation*** using True Random Number generator support on CPACF

- ***Performance boost for Java*** with new Galois Counter Mode (GCM) encryption for minimum latency and operation overhead

- New ***audit log application*** and other performance improvements on TKE 9.0

- ***Audit network encryption attributes*** within z/OS network traffic using new z/OS Encryption Readiness Technology (zERT)[1] tool

Designed for Data Serving

Market View

- Cognitive businesses use insight from all data to enhance their digital intelligence and disrupt industries.

- Over 90% of the world's data cannot be Googled.[1]

- Accelerating time to market is essential – success is measure in days, not weeks.

- Data gravity – analyze data where it resides.

Designed for data serving in a cognitive world

- **Speed, scale and reduced latency**
- **Efficiency for managing data**
- **Secure and flexible *access* to data**

[1] SOURCE: http://www.tennessean.com/story/money/tech/2014/05/02/jj-rosen-popular-search-engines-skim-surface/8636081/

Speed and Scale Getting to the Data

FICON Express16S+

- Up to **3x[1]** SIO/sec for small data transfer I/O operations and **25%[2]** SIO/sec increase with mix of large sequential read and write data transfer options

- Batch Elapsed time improves **17%[3]** running I/O intensive batch workloads versus same workload using FICON Express16S on a z13

- Provides increased scalability by increasing number of devices per channel without degrading performance

zHyperLink Express

- A new direct connect short distance link designed to deliver low latency connectivity between z14 and FICON® storage systems

- zHyperLink improves application response time, cutting I/O sensitive workload response time by **up to 50%** without requiring application changes[4]

[1] In laboratory measurements using FICON Express16S+ in an IBM z14 with the zHPF protocol and small data transfer I/O operations, FICON Express16S+ operating at 16 Gbps achieved a maximum of 320,000 IOs/sec. This represents 3x improvement.

[2] In laboratory measurements, using FICON Express16S+ in an IBM z14 with the zHPF protocol and a mix of large sequential read and write data transfer I/O operations, FICON Express16S+ operating at 16 Gbps achieved a maximum throughput of 3200 MB/sec (reads + writes) compared to a maximum of 2560 MB/sec (reads + writes) achieved with FICON Express16S operating at 16 Gbps. This represents an approximately 25% increase.

[3] This response time estimate is based on IBM internal measurements and projections that assume 75% or more of the workload response time is associated with read DASD I/O and the storage system random read cache hit ratio is above 80%. The actual performance that any user will experience may vary.

[4] This performance data was measured in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed.

Improved Speed for Development and Applications on z14

Compilers

- COBOL v6.2 fully support the Packed Decimal Facility to reduce CPU usage for decimal intensive applications by up to *38%*, and on average *19%[1]*

- Automatic Binary Optimizer v1.3 reduces CPU usage of applications built with COBOL v4 (and below) without source recompilation by up to *47%*

- z/OS 2.3 XL C/C++ reduces CPU usage of compute intensive applications on average *13%[2]*

Java SDK 8 SR5

- Faster user response times for Java

- *4.2x* improvement to AES-GCM crypto to enable best-of-breed security for the API-economy using Java

- Pause-less garbage collection baked into the processor, reducing pause times by up-to *3x[4]* for predictable high-perform transaction processing at-scale

- 50+ new instructions on the z14 co-designed and exploited by Java

[1] On z14 over same applications built with Enterprise COBOL for z/OS V6.1 on z14
[2] Over the same general compute intensive applications built with Enterprise COBOL for z/OS V4.2 on z14
[3] IBM Java 8 SR5 on z14 compared to Java 8 SR3 on z13
[4] Using new IBM Java 8 SR5 Pause-less garbage collection feature on z14 compared to using Java 8 SR3 on z13.

Innovation for Analytics with Linux on z

- Massive scale up of JVMs with higher capacity IFLs, pause-less garbage collection and 50+ new instructions co-designed and exploited by Java

- New SIMD instructions improve running analytics on IBM Z with increased parallelism

- A comprehensive portfolio of cognitive and analytics solution is available for Linux, allowing Linux to become the analytics hub in the enterprise

- 32TB of memory for greater processing scale and performance, enables more in-memory workloads and in-line analytics for delivering richer transactional experiences

- Performance, networking and efficiencies running Linux side-by-side with z/OS

Capacity and Features to Manage More Data

- **Up to 32 TB memory**
  - Support new workloads, in-memory databases and efficiently process huge amounts of information for real-time business insights

- **IBM Virtual Flash Memory**
  - Next generation of Flash Express to provide higher levels of availability and performance during workload transitions and spikes

- **Single Instruction Multiple Data**
  - Enhanced math libraries provide performance improvements for analytical workloads

- **Shared Memory Communications – Direct Access Method (SMC-D)**

  FREE

  - Up to *61%* CPU savings for FTP file transfers for z/OS versus HiperSockets®[1]

Efficiency Managing Data Movement to Improve Access time

On-chip compression coprocessor

- Enhancements enable further compression of data including DB2 indices, improving memory, transfer
  and disk efficiency

- In the future[1] DB2 plans to enable new order-preserving compression for DB2 indices using compression coprocessor to support index compression

zEDC

- Compression further reduces cost to pervasively encrypt data with less data to encrypt

- More data active and effective compression with a dedicated compression accelerator

- Disk savings with improved utilization of storage tiers with DFSMSdss™ use of compression

[1] IBM's statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM's sole discretion.

Sharing the Data

OSA-Express6S

- Technology refresh of OSA-Express6S

10GbE RoCE Express2

- Technology refresh used with SMC-R

- Provides increased virtualization / sharing capability allowing RoCE to be extended to more workloads

Coupling Technology Enhancements

- *New* Ethernet based Coupling Links using 10GbE RoCE technology - Coupling Express LR

- Better utilization of Coupling Facility (CF) processors with scalability improvements

- Faster problem resolution with additional CF Request Diagnostics

- Additional physical and logical coupling links offers Coupling Link Constraint Relief

Enterprise Service Agility with Improved IT Economics

- IFL Linux engines will benefit from next generation SMT for improved virtualization performance with up to **25%** vs non-SMT on z14

- 170 configurable Linux cores provide efficiency at scale and improve price/performance

- z14 has a redesigned cache architecture with **1.5x** more on-chip cache per core – compared to the z13

- **3x** memory to support large VM consolidations, provide a higher ceiling for vertical scale needs and to support data-in-memory applications

- FICON Express16S+ with FCP protocol for small data transfer I/O operations achieved a greater than **3x** improvement over FICON Express16S[1]

[1] The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed.

Designed for Simplification

Market View

- 38% of HR managers surveyed said training and developing employees is their greatest staffing concern[1]

- Simplified management of mainframe systems.

- Majority of large enterprises have multiple virtualization technology silos, each managed with its own administrative solutions and skills, which may increase overall operational cost and complexity.[2]

The best infrastructure to support an open and connected world

- **'From anywhere' mobile access**
- **Simplified sys admin of z/OS**
- **Standardization for skills transfer**

[1] Business Management Daily – Dec 21, 2015
[2] IDC – July 2015 #257441

Infrastructure Simplified for a Modern Workspace Experience

Improved user experience with Hardware Management Console

- New security enhancements including multifactor authentication
- New mobile capabilities that push notifications and allow secure monitoring and management from anywhere
- Enhanced tasks with built in guidance and instructions can reduce 'research' time
- Visualization for system time management

Managing z/OS with z/OSMF

- End to end z/OS management including new logon experience
- Simplified process to add new products using portable packages and guided activities
- Tools to simplify management of sysplex infrastructure

Configuration setup with IBM Dynamic Partition Manager

- Quickly and dynamically configure and manage system resources
- Guided storage setup, provisioning, admin – SOD: FICON ECKD™ support
- Provides the foundation that enables IaaS and secure, private clouds
- Ease installation with auto configuration of devices during Linux installation[1]

SOD

[1] Where Linux distro installers exploit function

Next generation Hardware Management Console

Empowering users by providing them with a modern workspace that equips them to securely and confidently manage system hardware from anywhere

Tree structure
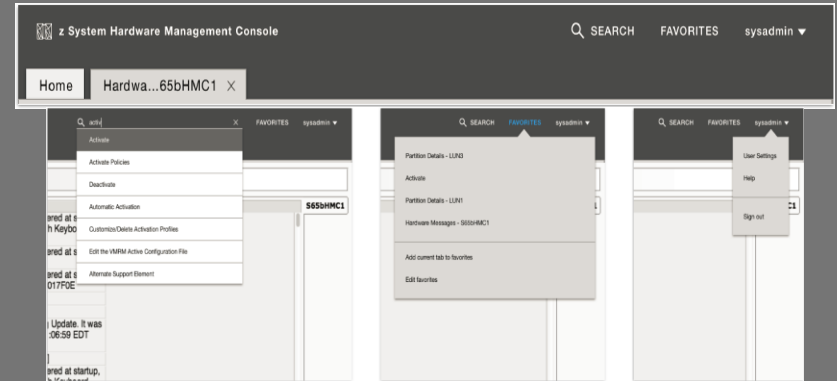
Multi-factor authentication
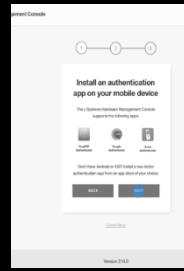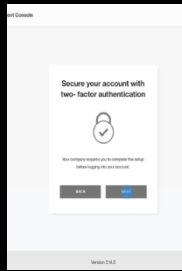
New mobile capabilities

Simplicity with Linux on z Systems
Efficient and economic operation

- Easier system administration using IBM Dynamic Partition Manager with simplified hardware configuration and provisioning tools enables greater time to value

- Comprehensive open source software portfolio with such products as Docker, Go, Chef, Puppet, MongoDB, PostgreSQL, Apache Spark, or Node.js to modernize your applications

- Improved on chip and coprocessor cryptographic performance to ensure your data can be protected from external and internal breaches

- Massive scale up of JVMs with pause-less garbage collection

- 32TB of memory for greater processing scale and performance, enables more in-memory workloads and in-line analytics for delivering richer transactional experiences

- New DBaaS reference architectures to support cloud deployments

Simplicity with Linux on z Systems
Efficient and economic operation

- Run WebSphere Liberty on z14 using clear key encryption can get up to **2.6x** improvement in throughput per core with IBM Java 8 SR5 compared to x86[1]

- Scale-up a MongoDB instance to 17 TB in a single system without database sharding and get **2.4x more throughput** on z14 leveraging additional memory compared to z13[2]

- Scale-out to **2 million Docker containers in a single system**, no application server farms necessary[3]

Secure Service Container
For secure deployment of software virtual appliances

- Simplifies usage – no management of the individual component members
- Easy configuration with APIs and web interfaces

Use cases:

- Integrated Analytics – Investigate and diagnose problems faster, predict and prevent problems and optimize the systems within the z IT environment
- High Security Business Network (HSBN) a fully managed blockchain service running on IBM LinuxONE™ in the IBM cloud delivering a secure, isolated compute environment ideally suited for workloads with sensitive data.
- z/VSE Network Appliance designed for faster internal LPAR to LPAR communications between z/VSE and Linux environments

Value of Secure Service Container:

- *Industry leading isolation from peers*
- *Protection of data from privileged administrators*
- *Automatic encryption of data and code (at-rest and in-flight)*
- *Validates application code reducing tampering or malware risk*

Operating Systems Exploiting Hardware Innovation

IBM z/OS Version 2.3		- z/OS policy controls to use pervasive encryption to protect user data and simplify the task of compliance - z/OSMF will be available all the time. The logon experience will be improved as well as the initial landing page and facilities will be added to make administration of z/OSMF easier, to aid onboarding new users - z/OSMF enhanced to support workflow extensions for IBM Cloud Provisioning and Management for z/OS in order to provide a simple, consumable approach for self-service provisioning and rapid delivery of aaS, further enabling for the API economy
z/VSE Version 6		- Performance and functional enhancements for online processing plus faster I/O with FICON Express16S+ with link rate of 16 Gbps - Improved network performance with OSA Express6S and security with firewall functionality, including z/VSE® Network Appliance deployable in the IBM Secure Service Container - Better and faster HW Encryption with Crypto Express6S - Wide portfolio using z/VSE Connectors and Linux on z - More capabilities will be available with the upcoming z/VSE V6.2 [1]
Linux		- Multithreading with next generation SMT helps allow for per core software savings - Ability to host and manage more workloads for service agility and improved IT economics - Hardware accelerated encryption improve cryptographic functions inside Linux, openSSL, openCryptoki and GSKIT - Secure Service Container, based on Linux, can be used for isolated partitions to protect data and applications - Linux distributions from Canonical, Red Hat and SUSE to your selection
z/TPF		- Management of extreme transaction volumes up to hundreds of thousands of transactions per second - Fast / consistent response across predictable and unpredictable peaks - Low cost per transaction for large applications - Centralized database handling routines to effectively manage databases - HiperDispatch workload balancing to optimize processor utilization

[1] z/VSE Announcement Preview

Hypervisors and Virtualization for IBM Z

PR/SM-LPARs IBM DPM

- Virtualization is **built into the DNA of IBM Z**
- PR/SM™ **manages and virtualizes all** the installed and enabled system resources as a single large SMP system
- **Full sharing/partitioning of the installed resources** with the highest levels of efficiency and utilization
- **Scale up or scale out on demand** with support for up to 85 partitions
- IBM Dynamic Partition Manager **simplifies provisioning and management experience**
- Assured **workload isolation** with the highest EAL5+ security certification
- New **dynamic optimization and scalability** enhancements

z/VM v6.4

IBM Wave for z/VM

- **Enables extreme scalability, security and efficiency** creating cost savings opportunities by taking by exploiting Guest Enhanced DAT to allow guests to take advantage of large (1MB) pages
- **Ease Migration** with upgrade in place infrastructure provides a seamless migration path from previous z/VM releases (z/VM 6.2 and z/VM 6.3) to the latest version
- **Operational improvements** by enhancing z/VM to provide ease of use
- **SCSI** for guest attachment of printers, disk drives, scanners and other peripherals, and host or guest attachment of disk drives
- IBM Wave for z/VM **simplifies the management** of virtual Linux servers from a single user interface

KVM for IBM Z

- Support new analytics workloads with **Single Instruction Multiple Data (SIMD)** for competitive advantage
- High compute capacity with support for **Simultaneous Multithreading (SMT)** to meet new business requirements
- Improved problem determination and high availability setup to **reduce down time** and quickly react to business needs
- Secure and protect business data with **Crypto exploitation**
- **Technology developed by IBM ....product offered by Linux Distribution partners**

Integrate Systems of Record and Systems of Engagement in one z14

- Performance benefits with optimized, internal communication between the workloads

- Impressive throughput with large cache, elimination of network traffic handling and high I/O bandwidth

- Operational efficiency in streamlined infrastructure

- Centralized management of the workloads done by an all-encompassing solution

- Improved security with smaller network infrastructure for fewer points of attack

- On demand growth by simply adding additional system resources
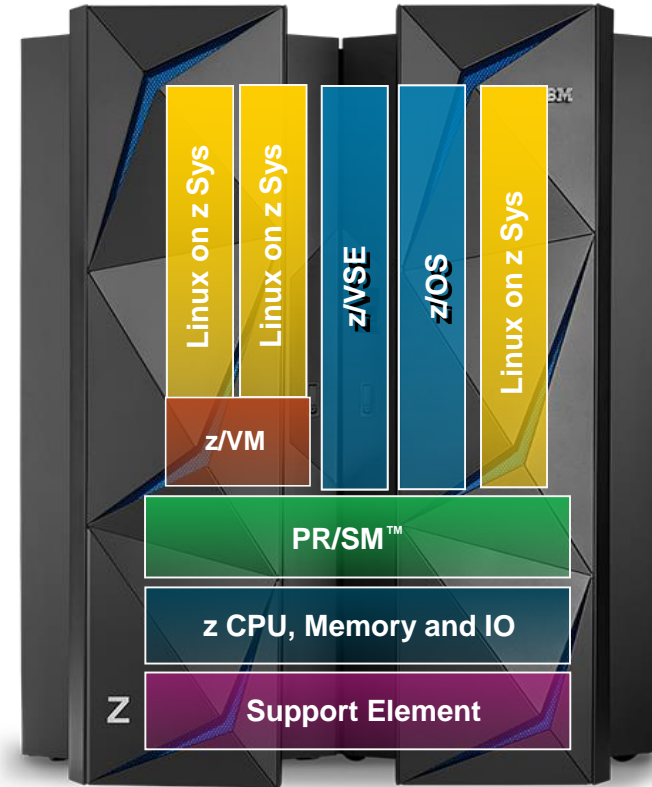
Protecting Your Investment in Technology

- **Designed to protect your investment**
  - Offering upgrades from IBM z13 and IBM zEnterprise® EC12 (zEC12) to the z14

- **Full upgradeability within Models M01 – M04**
  - No upgrade to Model M05
  - No upgrade from any IBM LinuxONE Emperor™

- **On demand offerings offer temporary or permanent growth when you need it**

IBM z14 – Creating Leadership for Digital Trust

- Designed with pervasive encryption for piece of mind that data and privacy is always protected

- Designed with improvements in speed, efficiency and access improvements to both serve up data to build services and new offerings and to perform analytics and insight on the data because this is where it resides

- Designed to be open and industry standard to bridge the skills gap and make the infrastructure easier to manage
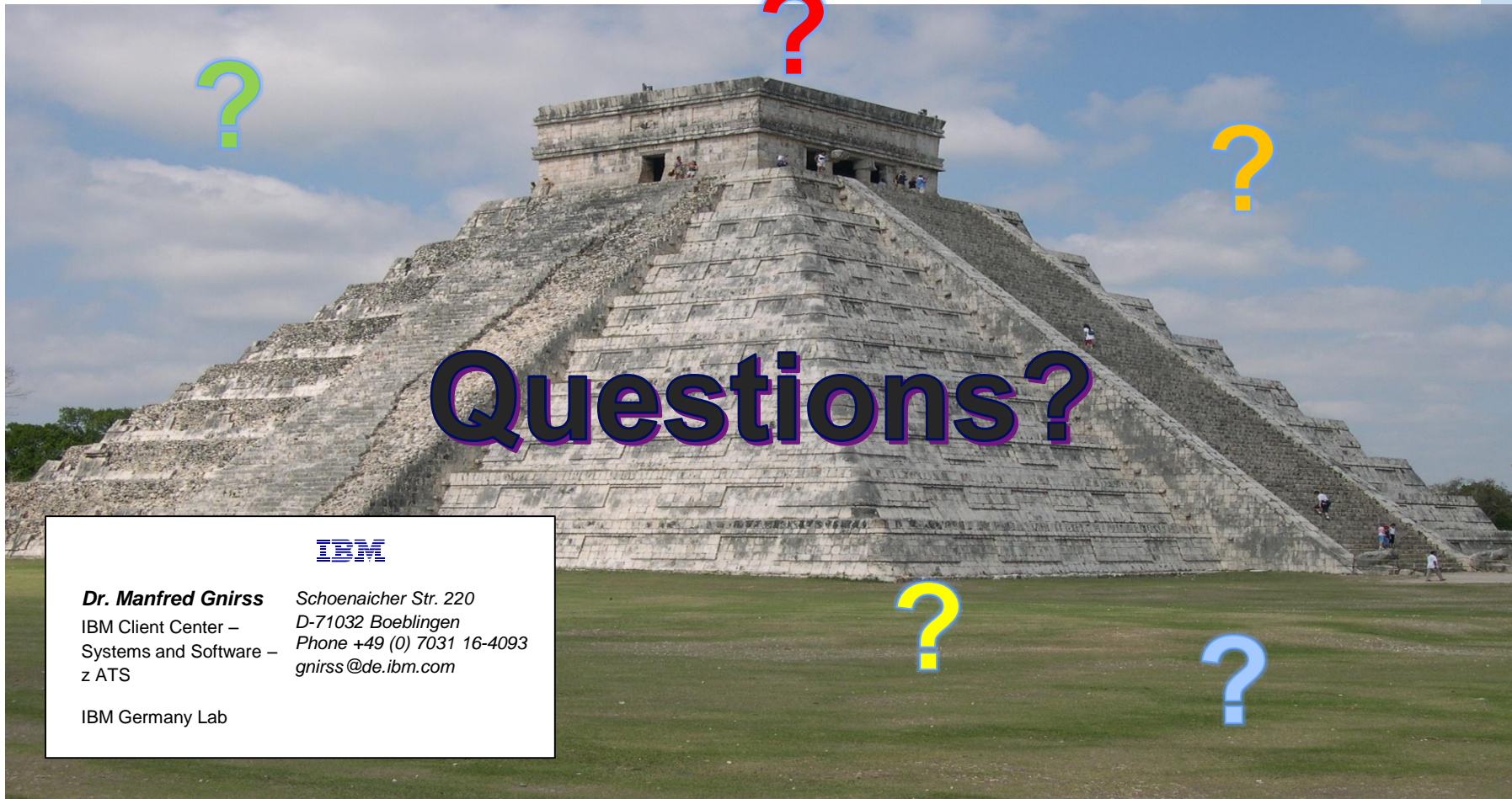
Questions?

Dr. Manfred Gnirss
IBM Client Center –
Systems and Software –
z ATS

IBM Germany Lab

Schoenaicher Str. 220
D-71032 Boeblingen
Phone +49 (0) 7031 16-4093
gnirss@de.ibm.com

Backup slides

Designed for Data
I/O options that protect, access, share

Pervasive Encryption

New CF Encryption

New Crypto Express6S

Enhanced Speed of CPACF

Payment Card Industry (PCI) HSM

New TKE 9.0

Getting to Data

New zHyperLink Express

New IBM Virtual Flash Memory

New FICON Express16S+

zHPF – Extended Distance II

zEDC Express

Accessing the Web

New 10GbE RoCE Express2

New OSA-Express6S

HiperSocket

SMC-D

Clustering to Protect

New Coupling Express LR

ICA SR

InfiniBand Coupling Links – LR and SR

Plus: improved CF scalability, constraint relief and diagnostic enhancements

IBM zHyperLink Express
Speed Matters: Breakthough I/O link technology

- A new direct connect short distance link designed to deliver low latency connectivity between z14 and FICON storage systems

- zHyperLink improves application response time, cutting I/O sensitive workload response time by *up to 50%* without requiring application changes[1]

Typical Client Use Cases:

- Performance improvements are achieved seamlessly *without need for application changes*

- Dramatic *improvement in data access* for OLTP workloads

- Faster DB2 index splits helps *reduce the batch processing window* for heavy insert work

- Better client experience with lower I/O latencies

- Additional business opportunities for top line growth with more functional applications

[1] This response time estimate is based on IBM internal measurements and projections that assume 75% or more of the workload response time is associated with read DASD I/O and the storage system random read cache hit ratio is above 80%. The actual performance that any user will experience may vary.

New Networking Enhancements

OSA-Express6S	10 GbE RoCE Express2	z/OS Encryption Readiness Technology (zERT) for Networking[1]
▪ OSA-Express6S for direct connection to network ▪ Technology refresh	▪ Technology refresh for RoCE ▪ Provides increased virtualization / sharing capability allowing RoCE to be extended to more workloads	▪ Tool that reviews cryptographic attributes to determine what's been encrypted within z/OS network traffic ▪ Provides information that is critical to security auditors via a new SMF119 record

[1] zERT does not require a z14

Coupling Facility Enhancements

- Ethernet based Coupling Links using 10GbE RoCE technology

  – *New* Coupling Express LR and Integrated Coupling Adapter (ICA SR)

- Better utilization of Coupling Facility (CF) processors with scalability improvements

- Faster problem resolution with additional CF Request Diagnostics

- Additional physical and logical coupling links offers Coupling Link Constraint Relief

Shared Memory Communications Architecture

Memory-to-memory communications *using high speed protocols and direct memory placement of data for faster communications*

FREE

Shared Memory Communications
Remote Direct Memory Access (SMC-R)

- ***New*** RoCE Express2 enables SMC-R
- Helps to reduce both latency and CPU resource consumption
- Up to ***50%*** CPU savings for FTP file transfers across z/OS systems versus standard TCP/IP [1]

Shared Memory Communications
Direct Memory Access (SMC-D)

- Optimizes LPAR to LPAR inter-system operating system communications
- Valuable for communications within a single server without requiring extra hardware
- Up to ***61%*** CPU savings for FTP file transfers for z/OS versus HiperSockets[2]

Any z/OS TCP sockets-based workload can **seamlessly** use SMC without application changes
SMC Applicability Tool (SMCAT) helps assess benefit for your environment

RoCE Express feature) vs. standard TCP/IP (10GbE OSA Express4 feature). The actual CPU savings any user will experience may vary.
** 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.

Shared Memory Architecture
Faster communications that preserve TCP/IP qualities of service

- Shared Memory Communications – Direct Memory Access (SMC-D) optimizes z/OS for improved performance '***within-the-box'*** communications versus standard TCP/IP over HiperSockets or Open System Adapter

Typical Client Use Cases:

- Valuable for multi-tiered work co-located onto a single IBM Z server without requiring extra hardware
- Any z/OS TCP sockets based workload can seamlessly use SMC-D without requiring any application changes
- With z/VM 6.3 or higher guest exploitation, you can understand the value for your z/OS SMC-R and SMC-D workloads before going into production

SMC Applicability Tool (SMCAT) is available to assist in gaining additional insight into the applicability of SMC-D (and SMC-R) for your environment

*Up to **61%** CPU savings for FTP file transfers across z/OS systems versus HiperSockets**

*Up to **9x** improvement in throughput with more than a **88%** decrease in CPU consumption and a **90%** decrease in response time for streaming workloads versus using HiperSockets**

*Up to **91%** improvement in throughput and up to **48%** improvement in response time for interactive workloads versus using HiperSockets**

* 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.

Optimize Server to Server Networking – Transparently
Exploitation of RDMA over Converged Ethernet (RoCE)

- Designed to take advantage of high speed protocols and direct memory placement of data for faster communications

- Increased sharing / virtualization with *new* 10Gbe RoCE Express2 feature

Typical Client Use Cases:

- Helps to reduce both latency and CPU resource consumption over traditional TCP/IP for communications across z/OS systems

- **Any** z/OS TCP sockets based workload can **seamlessly** use SMC-R without requiring any application changes

- With z/VM 6.3 or higher guest exploitation, you can understand the value for your z/OS workloads before going into production

SMC Applicability Tool (SMCAT) is available to assist in gaining additional insight into the applicability of SMC-R (and SMC-D) for your environment

Up to 50% CPU savings for FTP file transfers across z/OS systems versus standard TCP/IP *

Up to 48% reduction in response time and 10% CPU savings for a sample CICS® workload exploiting IPIC using SMC-R versus TCP/IP **

Up to 40% reduction in overall transaction response time for WAS workload accessing z/OS DB2 ***

Up to 3X increase in WebSphere® MQ messages delivered across z/OS systems ****

Memory for the Digital enterprise
Turbo charge system performance with mega memory

- Up to 32TB of memory to support new workloads, data-in-memory applications, efficiently process huge amounts of information for real-time business insights.

- In memory databases are critical to enable faster insightful analysis by enabling correlations and other analyses not otherwise made possible.

- Large memory can aid compression by providing large buffers to stage processing.

- Shift in new types of applications, that perform random access on data versus sequential access, require more data in memory to sustain SLAs.

- Large VM consolidations can use memory to provide a higher ceiling for vertical scale needs.

IBM Virtual Flash Memory Cuts Away at Availability Lapses

- Next generation of Flash Express to provide **higher levels of availability and performance**
- Moved to RAIM storage – **doesn't require PCIe slots**
- Slashes latency for critical application processing such as **diagnostics collection**

Typical Client Use Cases:

- **Improve availability and performance** during workload transition and spikes
- **Faster, less disruptive** diagnostics with faster first failure data capture time
- **Less paging** with use of pageable large pages for Java or DB2
- **Cost effective, resilient solution** for overflow of MQ shared queues in Coupling Facility

zEnterprise Data Compression (zEDC)
Helps you keep more active data

Capture new opportunities with lower cost of keeping data online

- Efficiently **compress active data** using a dedicated compression accelerator
- **Industry standard compression** for cross platform data distribution

Typical Client Use Cases:

- **Disk savings** with improved utilization of storage tiers with DFSMSdss use of compression
- **Compression for sequential files** with less CPU costs
- **Automatically leverage** when archiving data with Content Manager OnDemand

---

DFSMShsm*™
*Use up to **58%** less disk space and up to **80%** less CPU compared to using DFSMShsm with the COMPACT keyword **BSAM/QSAM****

*Compress data up to **4X**, with up to **80%** reduced CPU **

IBM Content Manager OnDemand V9.5***
*MIPs reduction of up to **75%** when compared to existing software based compression*

Connect:Direct for z/OS 5.2****
*Up to **80%** reduction in elapsed time for z/OS to z/OS file transfers*

---

*   Measurements for comparisons were completed as part of a formal performance evaluation on a dedicated, isolated test system.
**   These results are based on projections and measurements completed in a controlled environment. Results may vary by
     customer based on individual workload, configuration and software levels
***Results based on internal controlled measurements using IBM Content Manager OnDemand and various document types.
     Results may vary by customer based on individual workload, data, configuration, and software levels.
**** Achieve up to up 80% reduction in elapsed time for z/OS to z/OS file transfers with minimal CPU increase.
     Results vary by data set type and characteristics of the data

IBM z14 Functional Comparison to IBM z13

Performance and Scale	• Uniprocessor Performance • System Capacity • SMT • SIMD • Cache • Models • Processing cores • Granular Capacity • Memory • Compression	• New up to 10% performance improvement over IBM z13 (z13)[1] • New up to 35% system total z/OS capacity performance improvement over z13[1] • New 2nd generation SMT delivers virtualization benefits for Linux and up to 25% performance improvement for Linux on z Systems® and zIIP workloads vs non-SMT on z14 • New instructions for perform boost to traditional workloads and new analytics workloads versus SIMD on z13 • New z14 has 1.5x more on-chip cache per core versus z13 • Five models with up to four CPC drawers (z13 also has five CPC models and four drawers) • New up to 170 cores to configure, up to 141 on z13 • New up to 269 capacity settings versus 231 on the z13 • New up to 32 TB RAIM memory versus 10 TB RAIM memory on z13 • New improvement in CMPSC compression and Huffman Coding compression ratio using zEDC Express versus z13
Virtualization	• LPAR virtualization • RoCE adapter • Simplified LPAR management	• 85 partitions – same as z13 • New 10 GbE RoCE Express2 with additional virtual functions (VFs) per physical port (10GbE Exoress on z13) • Enhanced IBM Dynamic Partition Manager allows for config and mgmt of system resources– new support for z/VM and for ECKD disk
Infrastructure Efficiency	• Networking • HiperSockets and SMC-D • FICON • zHPF • IBM zHyperLink • Forward Error Correction • FICON dynamic routing • LCSS/Subchannel sets • WWPN • HMC • Pause-less garbage collection • Upgradeability • IBM Virtual Flash Express	• New OSA-Express6S with improvements over z13 using OSA-Express5S • Up to 32 HiperSockets (same as z13) **and** memory-to-memory communications with SMC-D offers within-the-box communications for z/OS • New FICON Express16S+ will provide an increase in I/O rates over FICON Expresss16S • zHPF extended distance II offers faster remote site recovery with improved I/O service time improvement when writing data remotely (GDPS® HyperSwap®) same as z13 • New IBM zHyperLink - New short distance z14 channel that can be installed on IBM DS8880 System Storage® for lower latency not on z13 • Industry standard FEC for optical connections for substantially reduced I/O link errors same as z13 • Dynamic Routing allows for sharing of switches between FICON and FCP without creating separate virtual switches same on z13 • Up to six LCSS and 4 Subchannel sets – same as z13 • I/O serial number migration allows keeping same serial number on replacement server same as z13 • New next generation HMC with simplified panels, new mobile capabilities, security enhancements (including multi-factor authentication), easier help panels – not on z13. (No Classic Style User Interface on z14) • New enterprise scale JAVA applications to run without periodic pause for garbage collection on larger & larger heaps • Upgradeable from z13 and zEnterprise EC12 (zEC12) • New memory replacement for Flash Express helping improve availability – available only on z14
Resiliency and Availability	• Coupling – HCA-3 • Coupling – ICA SR • Coupling Express LR • STP • Sparing • Rack Mounted Accessories • Environmentals	• Coupling with HCA-3 InfiniBand Coupling Links – long and short distance – same as z13 • Short distance coupling with PCIe-based links (ICA SR) – same as z13 • New Coupling Express LR – Coupling Express LR will be available on z13 • New Simplified STP management with HMC enhancements not available on z13 • Enhanced integrated sparing on z14 and z13 reducing the number of on site service and maintenance events • Rack-mounted HMC and TKE options to save space in the data center • Optional non raised floor, overhead cabling, water cooling and DC power plus New ASHRAE A3 ration – (not ASHRAE rating on z13)
Security	• Cryptographic Coprocessor • Crypto Express • IBM Secure Service Container • Secure Console Access	• CPACF for improved performance and new true Random Number Generator versus z13 • Nes Crypto Express6S with performance increase plus new algorithms for elliptic curve, SHA, VISA FPE versus z13 Crypto Express5S • Secure deployment of software virtual appliances • Protection of sensitive data by using Transport Layer Security (TLS) support in the Open Systems Adapter-Integrated Console Controller (OSA-ICC)

[1] For average LSPR workloads running z/OS 1.13. Official performance data are available and can be obtained online at LSPR (Large Systems Performance Reference) website at: https://www.ibm.com/servers/resourcelink/lib03060.nsf/pages/lsprindex?OpenDocumen. Actual performance results may vary by customer based on individual workload, configuration and software levels.

IBM z14 Functional Comparison to IBM zEC12

Category	Features	Details
Performance and Scale	▪ Uniprocessor Performance ▪ System Capacity ▪ SMT ▪ SIMD ▪ Cache ▪ Models ▪ Processing cores ▪ Granular Capacity ▪ Memory ▪ Compression	▪ New up to **22%** performance improvement over IBM zEnterprise EC12[1] ▪ New up to **89%** system total z/OS capacity performance improvement over zEC12[1] ▪ SMT delivers up to 55% price performance improvement for Linux on IBM z Systems and up to 55% price performance improvement for zIIP workloads versus single threaded only on zEC12 ▪ Vector processing (SIMD) model provides construction of richer, complex analytics models, increased programmer productivity, faster analytics to traditional workloads versus no SIMD on zEC12 ▪ New z14 has up to 88% more on-chip cache per core versus zEC12 ▪ Five models with up to four CPC drawers (zEC12 also has five CPC models and four books) ▪ New up to 170 cores to configure, up to 101 on zEC12 ▪ New up to 269 capacity settings versus 161 on the zEC12 ▪ New up to 32 TB RAIM memory versus 3 TB RAIM memory on zEC12 ▪ New improvement in CMPSC compression and Huffman Coding compression ratio using zEDC Express versus zEC12
Virtualization	▪ LPAR virtualization ▪ RoCE adapter ▪ Simplified LPAR management	▪ 85 partitions versus 60 on zEC12 ▪ New 10 GbE RoCE Express2 with additional virtual functions (VFs) per physical port (versus dedicated 10GbE Express on zEC12) ▪ Enhanced IBM Dynamic Partition Manager allows for configuration and management of system resources– new support for z/VM and for ECKD disk versus no DPM on zEC12
Infrastructure Efficiency	▪ Networking ▪ HiperSockets and SMC-D ▪ FICON ▪ zHPF ▪ IBM zHyperLink ▪ Forward Error Correction ▪ FICON dynamic routing ▪ LCSS/Subchannel sets ▪ WWPN ▪ HMC ▪ Pause-less garbage collection ▪ IBM Virtual Flash Express	▪ New OSA-Express6S with improvements over zEC12 using OSA-Express5S ▪ Up to 32 HiperSockets (same as zEC12) **and** memory-to-memory communications with SMC-D offers within-the-box communications for z/OS (SMC-D not on zEC12) ▪ New FICON Express16S+ and increased FICON subchannels to 32K versus FICON Express 8S and 24K on zEC12 ▪ zHPF extended distance II offers faster remote site recovery with improved I/O service time improvement when writing data remotely (GDPS HyperSwap) versus zHPF only on zEC12 ▪ New IBM zHyperLink - New short distance z14 channel that can be installed on IBM DS8880 System Storage® for lower latency not on zEC12 ▪ Industry standard FEC for optical connections for substantially reduced I/O link errors not available on zEC12 ▪ Dynamic Routing allows for sharing of switches between FICON and FCP without creating separate virtual switches not on zEC12 ▪ Up to six LCSS and 4 Subchannel sets – versus four LCSS and 3 subchannel sets on zEC12 ▪ I/O serial number migration allows keeping same serial number on replacement server not on zEC12 ▪ New next generation HMC with simplified panels, new mobile capabilities, security enhancements (including multi-factor authentication), easier help panels – not on zEC12. (No Classic Style User Interface on z14) ▪ New enterprise scale JAVA applications to run without periodic pause for garbage collection on larger & larger heaps not on zEC12 ▪ New memory replacement for Flash Express helping improve availability – available only on z14
Resiliency and Availability	▪ Coupling – HCA-3 ▪ Coupling – ICA SR ▪ Coupling Express LR ▪ STP ▪ Sparing ▪ Rack Mounted Accessories ▪ Environmentals	▪ Coupling with HCA-3 InfiniBand Coupling Links – long and short distance – same as zEC12 ▪ Short distance coupling with PCIe-based links (ICA SR) – not available on zEC12 ▪ New Coupling Express LR – Coupling Express LR – not available on zEC12 ▪ New Simplified STP management with HMC enhancements not available on zEC12 ▪ Enhanced integrated sparing on z14 reducing the number of on site service and maintenance events not on zEC12 ▪ Rack-mounted HMC and TKE options to save space in the data center not available on zEC12 ▪ Optional non raised floor, overhead cabling, water cooling and DC power plus New ASHRAE A3 ration – (not ASHRAE rating of zEC12)
Security	▪ Cryptographic Coprocessor ▪ Crypto Express ▪ IBM Secure Service Container ▪ Secure Console Access	▪ CPACF for improved performance and new true Random Number Generator not on zEC12 ▪ Nes Crypto Express6S with performance increase plus new algorithms for elliptic curve, SHA, VISA FPE versus zEC12 Crypto Express4S ▪ Secure deployment of software virtual appliances not on zEC12 ▪ Protection of sensitive data by using Transport Layer Security (TLS) support in the Open Systems Adapter-Integrated Console Controller (OSA-ICC) not on zEC12

[1] For average LSPR workloads running z/OS 1.13. Official performance data are available and can be obtained online at LSPR (Large Systems Performance Reference) website at: https://www.ibm.com/servers/resourcelink/lib03060.nsf/pages/lsprindex?OpenDocumen. Actual performance results may vary by customer based on individual workload, configuration and software levels.

# Data Center Planning and Service Updates

- Save space in the data center using options such as 1U rack-mounted HMC and TKE or new thin, non-acoustic cover that can shorten the system depth ~15.5" and reduce weight ~108 lbs

- Gain flexible possibilities for the data center with *non-raised-floor option,* overhead power and cabling

- Managing energy usage in the data center – using air cooling with radiator-based system, optional water cooling or optional HV DC power

NEW
New – lowering costs and raising RAS with ASHRAE A3 envelope

- A renewable, custom-engineered shipment packaging – completely compostable for less waste

Customer chilled water saves approximately 2KW (6.6%) on a maximum configuration

Specialty Engines Expand the Use of the Server
While lowering the cost of ownership
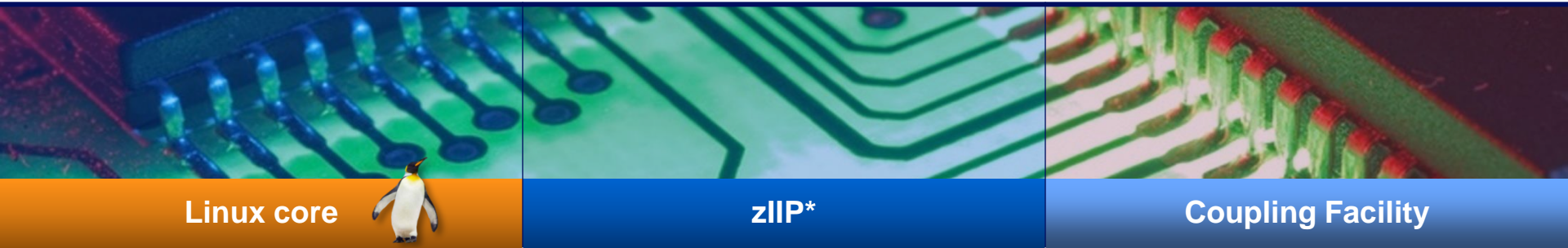
Linux core

- Dedicated Linux core on IBM Z

- ***IT optimization and cloud computing*** delivering enhanced economics

- Supported by z/VM and KVM virtualization, tooling such as IBM Wave and third parties and the Linux distributions

zIIP*

- ***Relieves*** central processors of running specific workloads

- Optimized for strategic web based applications with support for ***Java and XML*** processing

- Focused on data and supporting workloads can help ***connect, manage, extend, and protect*** data
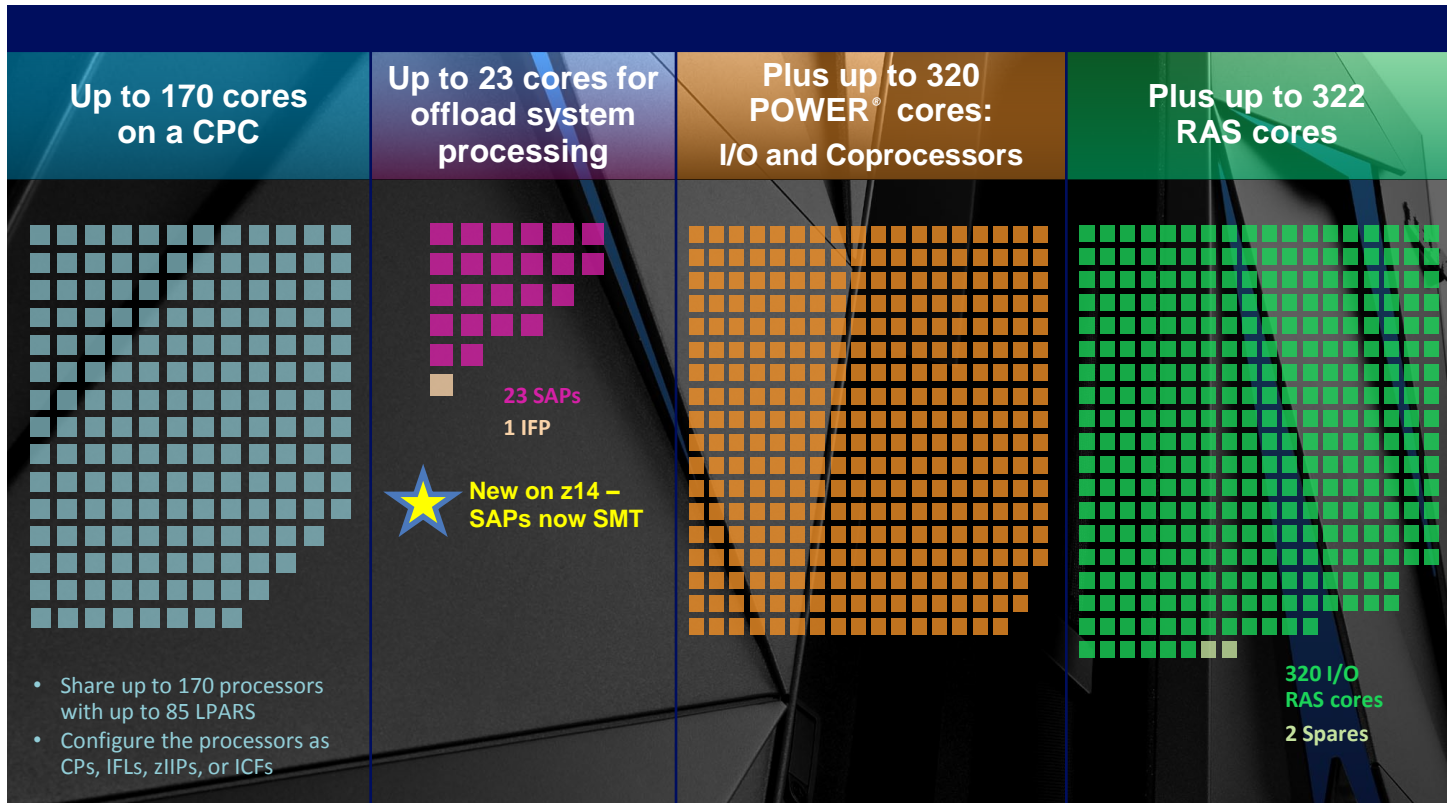
Coupling Facility

- CF allows multiple processors to access the same data

- ***New PCIe*** based long range coupling links

- Coupling Facility (CF) traffic is ***protected in-flight and at-rest*** in the CF by policy driven host-based encryption

Linux cores and zIIPs get throughput increase with simultaneous multithreading

Integrated System Design for z14
I/O and coprocessors bring RAS, cost savings and added compute power to workloads

Up to 170 cores on a CPC	Up to 23 cores for offload system processing	Plus up to 320 POWER® cores: I/O and Coprocessors	Plus up to 322 RAS cores

23 SAPs

1 IFP

⭐ **New on z14 – SAPs now SMT**

320 I/O RAS cores

2 Spares

- Share up to 170 processors with up to 85 LPARS
- Configure the processors as CPs, IFLs, zIIPs, or ICFs

# IBM z14 the Cornerstone for a Trust Economy

Pervasive Encryption

On-chip cryptographic coprocessor performance for *6x* faster encryption for like modes and data sizes

Crypto Express6S with *2x* the SSL handshake performance

No application changes using DFSMS

Protection of database data according to secure policy with z/OS dataset encryption, CF encryption, z/VM encrypted hypervisor paging and z/TPF transparent database encryption

Secure deployment of software appliances including tamper protection with IBM Secure Service Container

**IBM z14
Machine Type: 3906
Models:
M01, M02, M03, M04, M05**
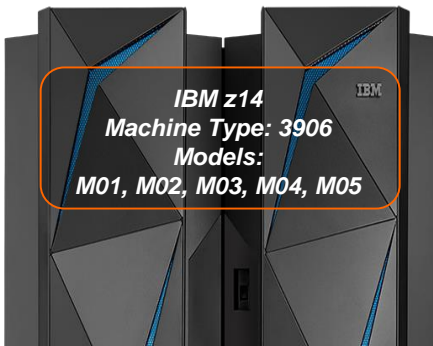
Intelligence and Insight

Support data-in-memory applications and new workloads using *3x* (32 TB) memory

Enhanced math libraries with SIMD

Massive scale up of JVMs with pause-less garbage collection

zIIP SMT performance for Java-based analytics (e.g. Spark)

Open and connected

Scaling improvements with 170 configurable cores

Improved virtualization for Linux with next generation SMT

Data serving enhanced with *1.5x* more on-core cache

Reduced latency for workloads with FICON Express16S+

Latency reduction with direct link between server and DS8880 using IBM zHyperLink

OSA-Express6S

Data center planning enhancements improve floor space and raise RAS

New PCIe based long range coupling links

zBX and zManager – Hybrid Computing Environment
*Support for multi-platform infrastructure with single resource management*

Effective March 31, 2017:

- Model conversations to the IBM zEnterprise BladeCenter® Extension (zBX) Model 004 will no longer be available from IBM 2458 Model 002 or IBM 2458 Model 003

- IBM will no longer support any hardware MES features applied to an existing zBX Model 004

Processor / Memory - Single Core C, C++ and Fortran Workloads

- gcc-7.1-170324-rev246462 with highest machine optimization (-O3 -march=z13 on z13 versus -O3 -march=z14)

- Overall throughput improvement is 16% (both SIMD enabled)

Industry Standard benchmark study

-O3 -march=z13 on a z13 (base) versus -O3 -march=z14 on a z14
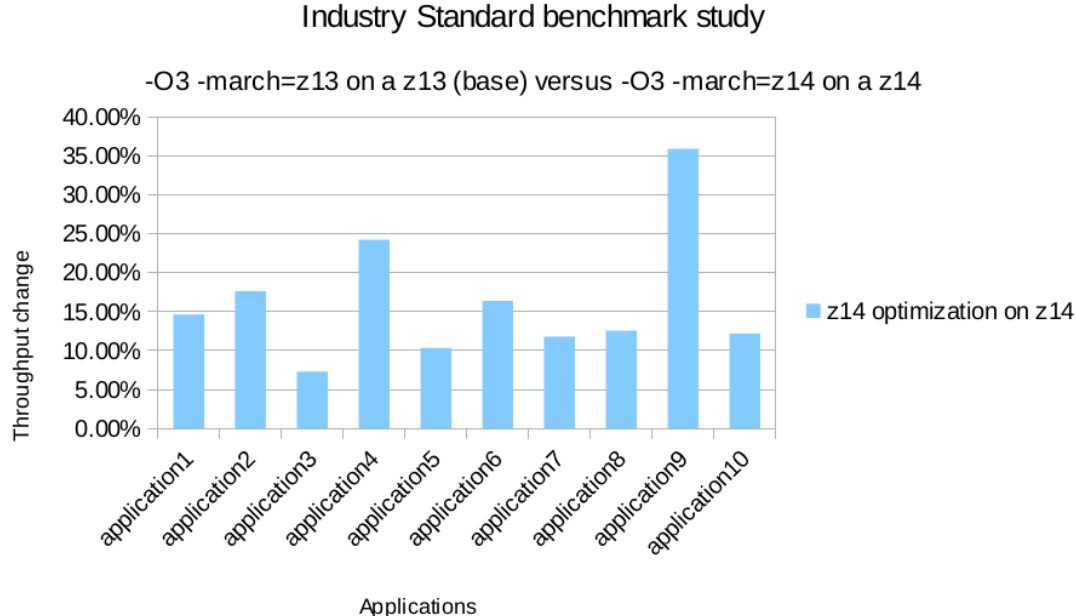
Disk

- z14 FICON Express 16S+ versus z13 FICON Express 16S

  - FICON Express 16S+ is supposed to allow much more IOPS than its predecessor

  - With both FCP/SCSI and FICON/ECKD the expected triple IOPS on a single host channel number could be achieved

  - Higher IOPS rates can improve throughput in situations where many I/Os (most likely short requests) are issued

    - Database workloads could benefit from this

  - I/O benchmarks showed throughput increase of up to 30% in all disciplines (sequential read and write, random read and write)
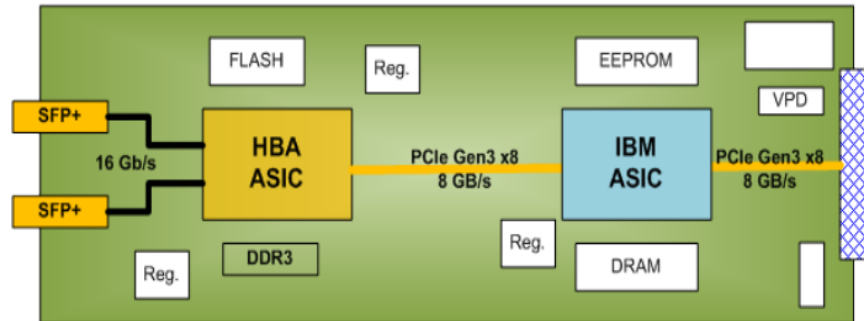
Network

- z14 OSA Express 6S versus z13 OSA Express 5S

  - Small throughput improvements and small latency gains in many benchmark scenarios

  - Customers will see it most likely as equal


- z14 HiperSockets versus z13 HiperSockets

  - Throughput improvements up to 40%

  - Latency improvements up to 30%

  - Largest benefits when 2 LPARs use processors on different drawers
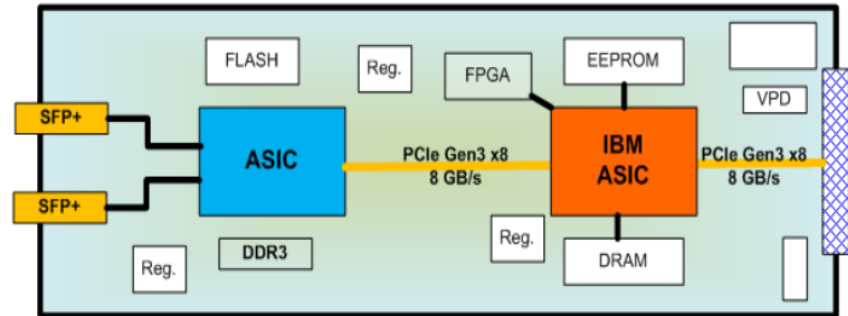
- z14 RoCE Express 2 versus z13 RoCE Express (using TCP/IP)

  - Throughput and latency more stable

  - If 2 servers are connected via a 10Gbps card in shared mode the throughput and latency of HiperSockets can be reached

Crypto – Real Cost of Disk Encryption

- Huge CPU savings with z14 compared to z13
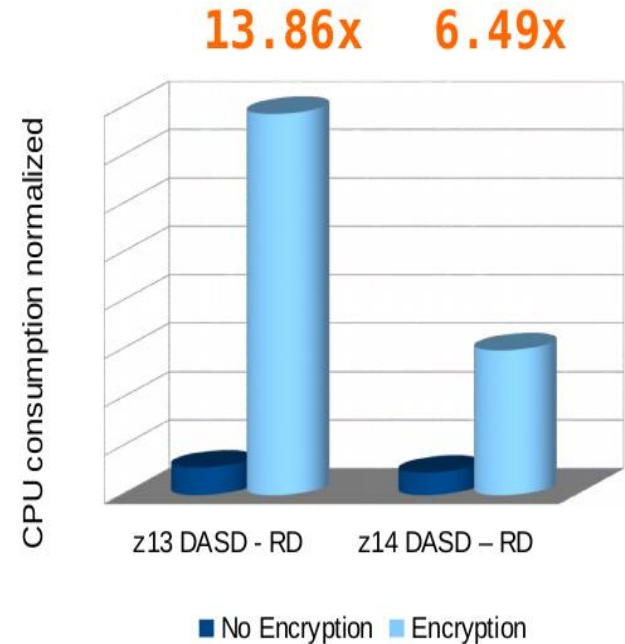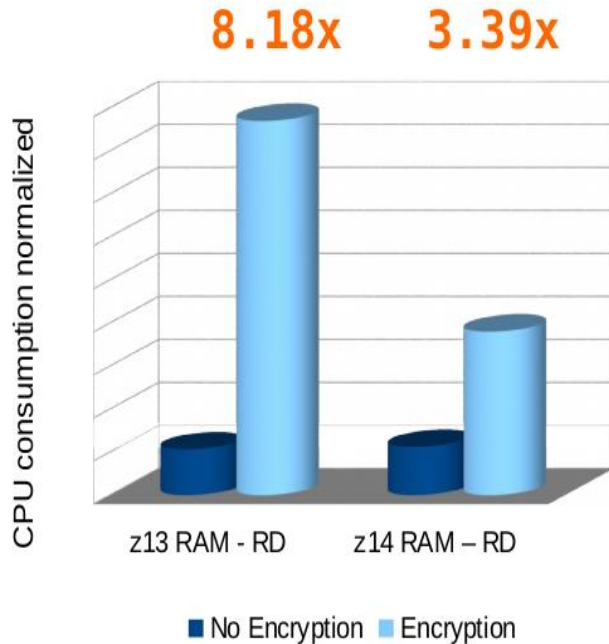
Processor Unit (Core) Locations: Customer, SAP, IFP and Spare

z14		1st Drawer				2nd Drawer				3rd Drawer				4th Drawer			
Model	Cust PUs	Cust PUs	SAPs	IFP	Spare	Cust PUs	SAPs	IFP	Spare	Cust PUs	SAPs	IFP	Spare	Cust PUs	SAPs	IFP	Spare
M05	170	42	6	0	1	43	6	0	0	43	6	0	0	42	5	1	1
M04	141	35	5	0	1	36	5	0	0	36	5	0	0	34	5	1	1
M03	105	35	5	0	1	36	5	0	0	34	5	1	1				
M02	69	35	5	0	1	34	5	1	1								
M01	33	33	5	1	2												

- PUs can be purchased as CPs, IFLs, Unassigned IFLs, zIIPs, ICFs or Additional SAPs
  - zAAPs no longer available fulfilling the statement of direction
  - zIIP to CP purchase ratio is 2:1
  - Additional SAPs + Permanent SAPs may not exceed 39
  - Any un-configured PU can act as an additional Spare PU
  - CPs and zIIPs initial placement in 1st drawer working up
  - IFLs and ICFs initial placement in highest order drawer working down
- Upgrades available from any lower model to any higher any models
  - Achieved via Concurrent Drawer Add from model M01 to model M04
  - Upgrade to model M05 from any other model not supported. M05 is factory built only.

CPACF - SHA-3, SHAKE algorithms

- SHA-3 was standardized by NIST in 2015 (FIPS Pub. 202) as an alternative to SHA-2

- SHA-2 is still acceptable and there is no indication that SHA-2 is vulnerable or that SHA-3 is more or less vulnerable than SHA-2.

- CPACF is introducing support for the four SHA-3 hashing algorithms

  - SHA3-224

  - SHA3-256

  - SHA3-384

  - SHA3-512

- And the two extendable output functions as described by the standard

  - SHAKE-128

  - SHAKE-256

- The SHAKE variants are known as an extendable output functions and allow generating hash values of user-specified lengths. Note however that they are not approved as hash functions.

- These algorithms are exposed to applications via the ICSF One-Way Hash Generate callable service (CSNBOWH)

CPACF - True Random Number Generation (TRNG)

- CPACF is adding support for TRNG

- TRNG is an improvement over Deterministic RNG in the sense that the numbers generated are more random. However, this comes with a performance penalty.

- ICSF will use the best of both worlds and take a hybrid approach to random number generation. TRNG will be used to seed a DRNG which will then be used to generate random numbers.

- Random numbers may be obtained/used via the following ICSF callable services:

  - PKCS #11 Pseudo-Random Function (CSFPPRF)

  - Random Number Generate (CSNBRNG, CSNBRNGL)

  - PKCS#11 services when generating a clear key

    z14 CPACF Performance
    CPACF encryption rates for like modes and data sizes on z14 are up to six times faster than z13.

    Based on preliminary internal IBM lab measurements on a standalone dedicated system in a controlled environment and compared to the z13. Results may vary.

CPACF - GCM Improvements

- CPACF introduced a HW instruction to perform Galois Counter Mode encryption

- Previously, multiple hardware instructions had to be invoked to achieve GCM

- A single HW instruction enables better performance

- CPACF GCM is exposed to applications via the following ICSF callable services:

  - Symmetric Key Encipher (CSNBSYE)

  - Symmetric Key Decipher (CSNBSYD)

  - PKCS #11 Secret Key Encrypt (CSFPSKE)

  - PKCS #11 Secret Key Decrypt (CSFPSKD)

Notes:

1. CPACF enhancements are available to all system products/components.

2. GCM and SHA-3 improvements will be included in the crypto performance whitepaper