

# Linux on z Systems - Update

## *Overview and News*



[VMworkshop.org](http://VMworkshop.org)

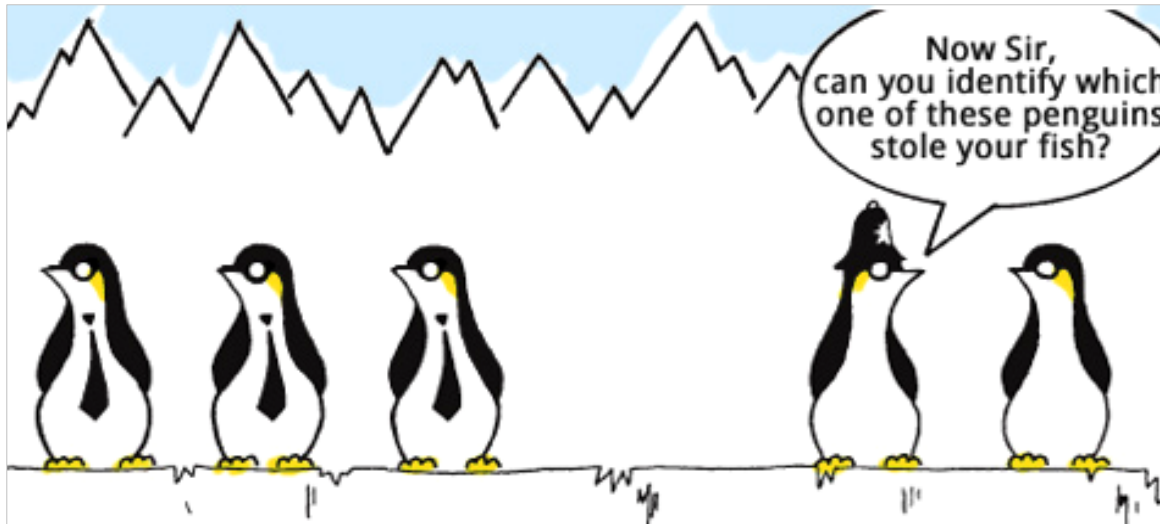


# Linux on z Systems discussion topics

- **Enterprise grade Linux**
- **Linux on IBM z Systems**
- **Latest enhancements and directions**



Linux is Linux,  
but are all Linux infrastructure solutions identical?



**No**

, while Linux is Linux, the underlying infrastructure (hardware and infrastructure software) directly affects the Linux workloads.

# Infrastructure matters because business outcomes matter

**1 in 2**

business leaders don't have access to data they need<sup>1</sup>

**2/3**

of CMOs want better tools<sup>2</sup>

**80%**

Of CIOs are targeting analytics for insights<sup>3</sup>

**1 trillion**

connected objects and devices on the planet generating data by 2015<sup>4</sup>

**2.5 billion**

Gigabytes of data generated every day<sup>5</sup>

**80%**

of the world's data is unstructured<sup>6</sup>

Sources: 1- IBM IBV; 2- IBM IBV, Global CMO Study; 3- IBM CIO Study 2011; 4, 5, 6 - IBM 2013 Annual Report

# Enterprise grade Linux solution

While „Linux is Linux“, the underlying platform is providing differentiation of the Linux solutions.

An “enterprise grade Linux” solution, in our understanding, has defined characteristics:

- **IT simplicity, allowing to run up to hundreds of different workloads in parallel on one server**
- **Easy workload integration of new and existing data and applications**
- **Flexible server provisioning, simple to manage**
- **High productivity, based on efficient systems and life cycle management**
- **Highest resource utilization levels**
- **High levels of quality of service – security, availability, reliability**

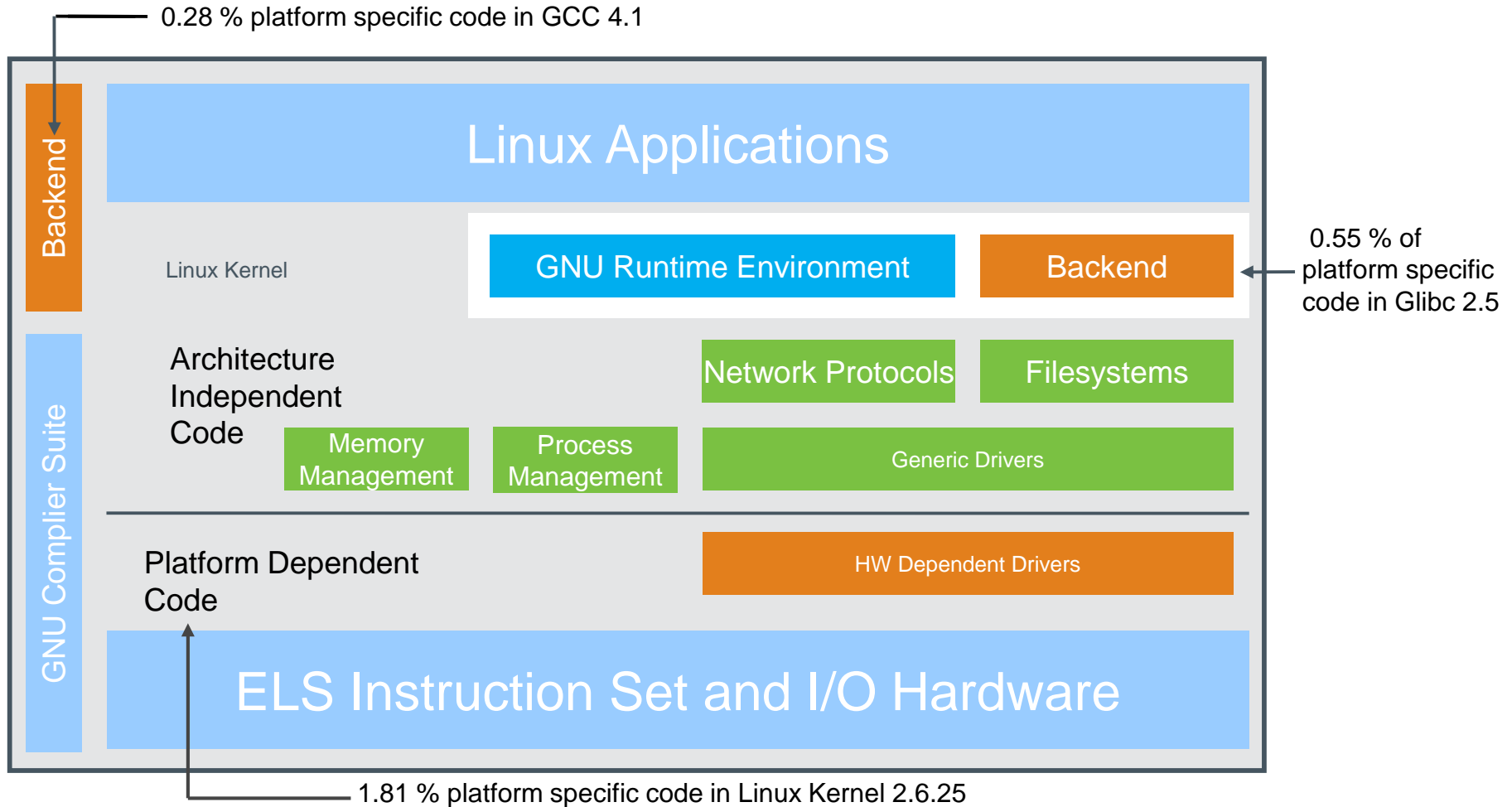
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*“Enterprise-grade isn’t just about specific features, rather it is about delivering a strategy that enables a consistent architectural model with the support and service necessary for [the] ... complex environment that organizations find themselves in.”* - Ben Kepes, contributor to Forbes  
[www.forbes.com/sites/benkepes/2013/12/18/what-does-enterprise-grade-really-mean](http://www.forbes.com/sites/benkepes/2013/12/18/what-does-enterprise-grade-really-mean)

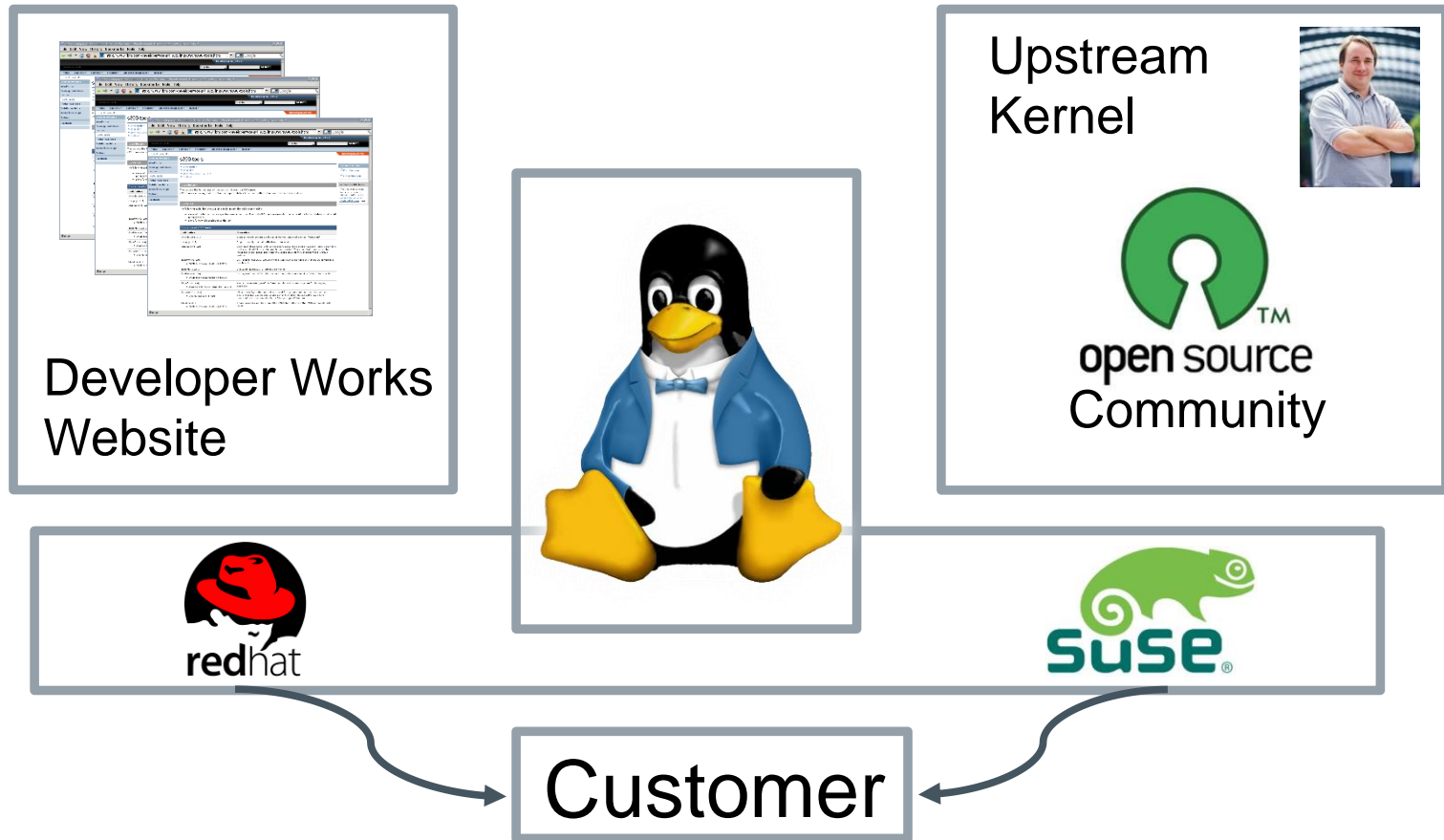
# Structure of Linux on System z

*Many Linux software packages did not require any code change to run on Linux on System z*



# IBM Linux on z Systems Development

IBM Linux on System z Development contributes in the following areas: Kernel, s390-tools, Open Source Tools (e.g. eclipse, ooprofile), GCC, GLIBC, Binutils



# Tested Platforms

The listed distributions are 64-bit distributions; they all include the 31-bit emulation layer to run 31-bit software products.

For latest updates refer to:

<http://www-03.ibm.com/systems/z/os/linux/resources/testedplatforms.html>

Distribution	z13	zEnterprise - zBC12 and zEC12	z114 and z196	System z10 and System z9
<b>RHEL 7</b>	✓ <sup>(1,3)</sup>	✓ <sup>(4)</sup>	✓ <sup>(4)</sup>	X
<b>RHEL 6</b>	✓ <sup>(1,3)</sup>	✓ <sup>(5)</sup>	✓	✓
<b>RHEL 5</b>	✓ <sup>(1,3)</sup>	✓ <sup>(6)</sup>	✓	✓
<b>RHEL 4 (*)</b>	X	X	✓ <sup>(9)</sup>	✓
<b>SLES 12</b>	✓ <sup>(2,3)</sup>	✓	✓	X
<b>SLES 11</b>	✓ <sup>(2,3)</sup>	✓ <sup>(7)</sup>	✓	✓
<b>SLES 10 (*)</b>	X	✓ <sup>(8)</sup>	✓	✓
<b>SLES 9 (*)</b>	X	X	✓ <sup>(10)</sup>	✓

✓ Indicates that the distribution (version) has been tested by IBM on the hardware platform, will run on the system, and is an IBM supported environment. Updates or service packs applied to the distribution are also supported.

X Indicates that the distribution is not supported by IBM on this server.

(\*) The distribution is out of service, extended support is required.

<sup>(1)</sup> Red Hat Hardware Certification statements are available for RHEL 7.0, RHEL 6.6, and RHEL5.11 at: <https://hardware.redhat.com/&quicksearch=z13>

The following kernel-levels are the currently known required minimum-levels for z13:

RHEL 7.1 replaces RHEL 7.0: 3.10.0-229.el7 , please check the [Distribution hints](#).

RHEL 6.6: 2.6.32-504.16.2.el6

RHEL 5.11: 2.6.18-400.el5

<sup>(2)</sup> SUSE YES CERTIFIED Bulletins are available for SLES 12 and SLES 11 SP3 at:

<https://www.suse.com/yessearch/SResults.jsp?bulletinNumber=&keywords=z13>

The following kernel-levels are the currently known required minimum-levels for z13:

SLES 12: 3.12.36-38.1

SLES 11 SP3: 3.0.101-0.40.1

<sup>(3)</sup> The recommended kernel-levels for the Crypto Express5S toleration support are published at: [Distribution hints](#).

<sup>(4)</sup> RHEL 7.1 replaces RHEL 7.0, please check the [Distribution hints](#).

<sup>(5)</sup> Minimum level: RHEL 6.3

<sup>(6)</sup> Minimum level: RHEL 5.8

<sup>(7)</sup> Recommended level: SLES 11 SP3

<sup>(8)</sup> Recommended level: SLES 10 SP4 with latest maintenance updates


<sup>(9)</sup> RHEL 4.8 only. Some functions have changed or are not available with the z196, e.g. the Dual-port OSA cards support to name one of several. Please check with your service provider regarding the end of service.

<sup>(10)</sup> SLES 9 SP4 with latest maintenance updates only. Some functions have changed or are not available with the z196, e.g. the Dual-port OSA cards support to name one of several. Please check with your service provider regarding the end of service.



# Linux on IBM z Systems

*The real alternative to x86 server sprawl*



A full room of servers

versus

One footprint with the size of a refrigerator

**Unmatched Linux capacity**

The image shows a large room filled with many small server racks on the left, and a single, much larger server rack on the right, with a penguin standing next to it. A large orange greater-than sign (>) is placed between the two server racks, indicating that the single rack on the right is equivalent to or greater than the room full of racks on the left.

**It's easy and cost-effective.**

- Dundee City Council

**Great degree of flexibility and scalability.**

- Halkbank

**Quickly and cost-effectively deploy innovative services.**

- Banca Carige

**Maintenance and support effort reduced by at least 65%.**

- Algar Telecom

**Operates even when resources are at 100% utilization.**

- Bank of Tokyo-Mitsubishi UFJ

**Differentiates in level of service and quality of service.**

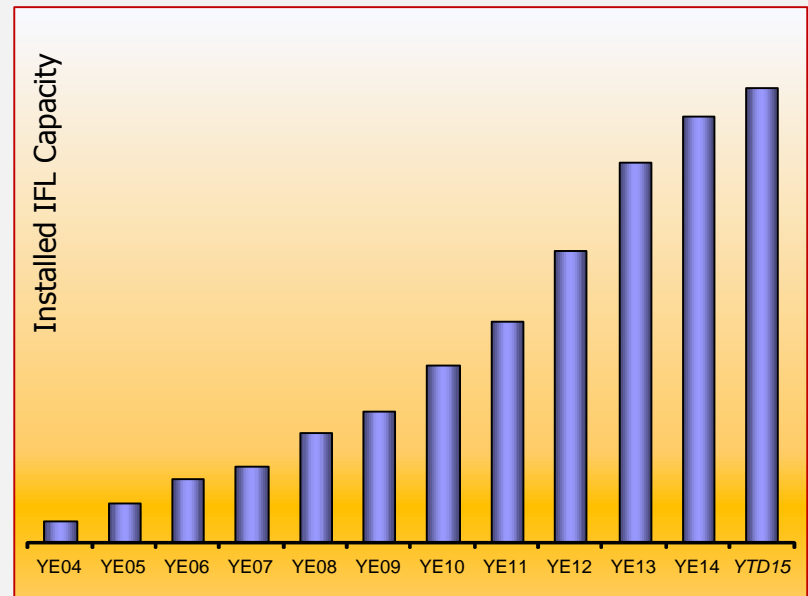
- L3C LLP

# Linux on IBM z Systems in 1Q2015

*Installed Linux MIPS at 45% CAGR\**

- 27.3% of Total installed MIPS run Linux as of 1Q15
- Installed IFL MIPS increased by 13% YTY from 1Q14 to 1Q15
- 39% of System z Customers have IFL's installed as of 1Q15
- 80 of the top 100 System z Customers are running Linux on the mainframe as of 1Q15 \*\*
- 35% of all System z servers have IFLs
- 68% of new FIE/FIC System z accounts run Linux

## Installed Capacity Over Time



\* Based on YE 2003 to YE 2014 \*\*Top 100 is based on total installed MIPS

# Linux on z13

*The enterprise grade Linux solution*

**z13**<sup>1</sup>

<b>Up to 10 TB</b>	>3X more available memory	
<b>Up to 141</b>	Configurable cores	
<b>Up to 85</b>	Configurable LPARs	
<b>IBM zAware</b>	Maximize service levels	Quality of Service
<b>Larger Cache</b>	More workloads per server	
<b>Crypto Express5S</b>	Performance and function	Quality of Service
<b>SMT2, SIMD</b>	Enhanced performance	

z Systems

**Enterprise grade Linux solution:**

<b>IBM GDPS® appliance</b>	<i>Continuous availability &amp; Disaster recovery</i>	Quality of Service
<b>Elastic Storage (IBM GPFS technology)</b>	<i>Clustered file system</i>	Quality of Service
<b>SOD: KVM for z Systems</b>	<i>Open source virtualization</i>	
<b>IBM Infrastructure Suite</b>	<i>Management suite for z/VM and Linux</i>	
<b>IBM Wave for z/VM</b>	<i>Intuitive virtualization management</i>	
<b>IBM z/VM</b>	<i>Virtualization with efficiency at scale</i>	
<b>IBM z13</b>	<i>Unmatched server technology &amp; capacity</i>	Quality of Service



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

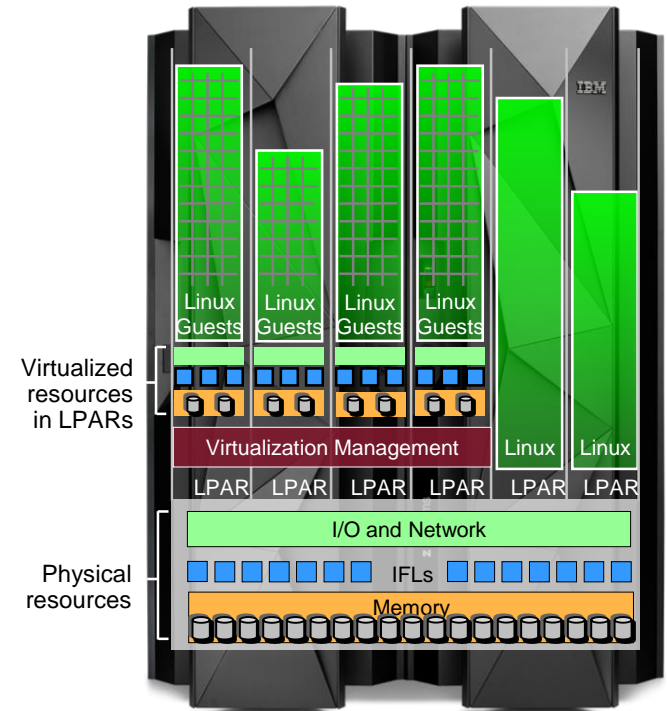
<sup>1</sup> Total capacity improvement over zEC12 of 40+ percent

# IBM Enterprise Linux Server

*Data enter simplicity inside one box*

## An enterprise grade Linux infrastructure solution

- Proven Linux platform with:
  - Data center simplicity
  - Trusted operations
  - Unrivalled economics
- Allows to start small and grow inside the server
- Server and virtualization capabilities to run a large number of workloads
  - Highly efficient and economical
- Designed from the ground up for enterprise-class workloads
  - Unrivalled levels of qualities of service
- Supports all kind of workload deployments
  - Enables cloud, analytics, mobile computing at an attractive price



# IBM zAware V2.0 - Analyze Linux on z Systems

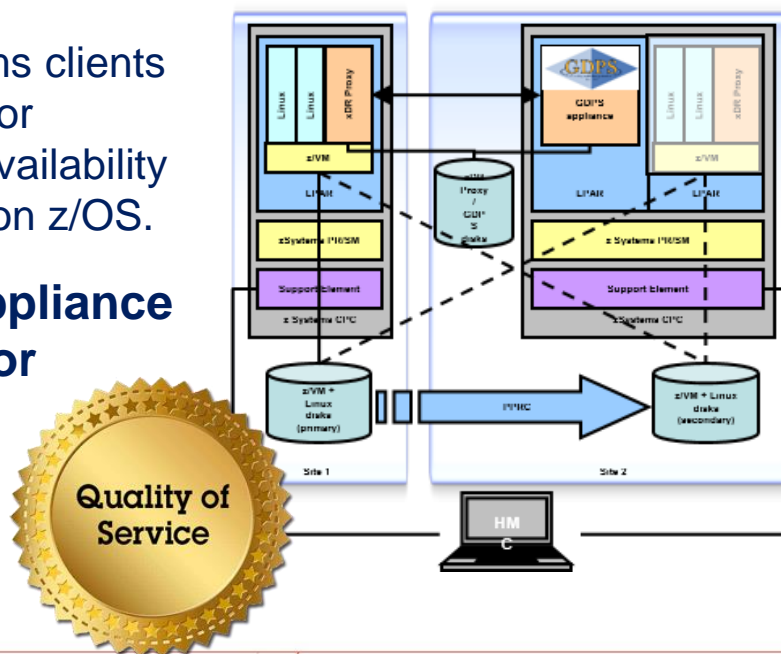
**IBM zAware is available with z13 for Linux on z Systems** to deliver a creative availability solution to help maximize service levels

- Faster insight into the health of the Linux on z images
- Identify unusual system behavior of the Linux on z images
- Support for Linux on z message log analysis
- User can group multiple systems' data into a combined model: by workload (e.g. for all web servers), by solution (e.g. one model for your cloud), or by z/VM host
- Support for native or guest Linux on z images
- IBM zAware delivered on IBM z13 builds on previous IBM zAware function



# IBM GDPS appliance for Linux on z Systems

- **The IBM GDPS appliance for Linux on z Systems will provide high availability in case of system, application or network failure**
- In the first half of 2015, IBM intends to deliver a GDPS/Peer to Peer Remote Copy (GDPS/PPRC) multiplatform resiliency capability for customers who do not run the IBM z/OS operating system in their environment.
- This solution is intended to provide IBM z Systems clients who run IBM z/VM and their associated guests, for instance, Linux on z Systems, with similar high availability and disaster recovery benefits to those who run on z/OS.
- **The implementation of the new GDPS Appliance for Linux will offer business continuity for Linux-only environments.**



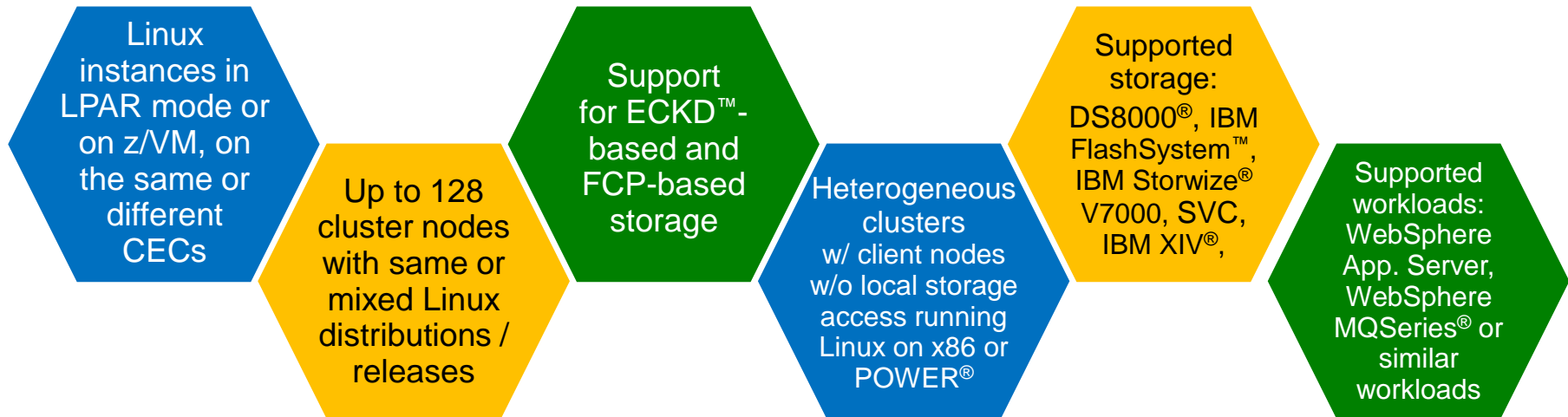
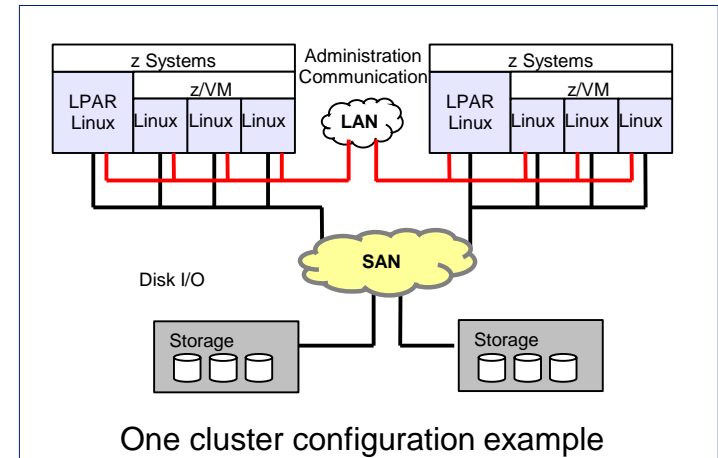
# IBM Spectrum Storage for Linux on z Systems

*Based on IBM GPFS technology*



## Robust clustered file system

- Concurrent high-speed, reliable data access from multiple nodes
- Extreme scalability and accelerated performance
- Smooth, non disruptive capacity expansion and reduction



# IBM FlashSystem & Linux on z Systems

*Highest Reliability, Maximum Performance*

## Now you can leverage the “Economies of Scale” of Flash

- Accelerate Application Performance
- Gain Greater System Utilization
- Lower Software & Hardware Cost
- Save Power / Cooling / Floor Space
- Drive Value Out of Big Data



*IBM FlashSystem is certified ([see SSIC](#)) to attach to Linux on z to meet your business objectives*

## Performance of Linux on z with FlashSystem

I/O bound relational databases, like Oracle, can benefit from IBM FlashSystem over spinning disks.

- **21x** reduction in response times\*
- **9x** improvement in IO wait times\*
- **2x** improvement in CPU utilization\*

*New FlashSystem 900 and z Systems FiconExpress16s I/O cards can provide an even higher throughput*

## Why IBM FlashSystem for Linux on System z?

### Extreme Performance

Cut IO Wait Time  
80%+

Latency Under 100 Microseconds

3X increase IOPS

### Enterprise Reliability

Highest Reliability levels

Purposed-built, Enterprise Architecture

### Macro Efficiency

No application Or architecture Changes

Reduce floor space, power & cooling

Benefits & economics out weigh disk

### IBM MicroLatency™

Servers, Applications and Databases are FASTER!

Go FROM 7 milliseconds to 700 microseconds

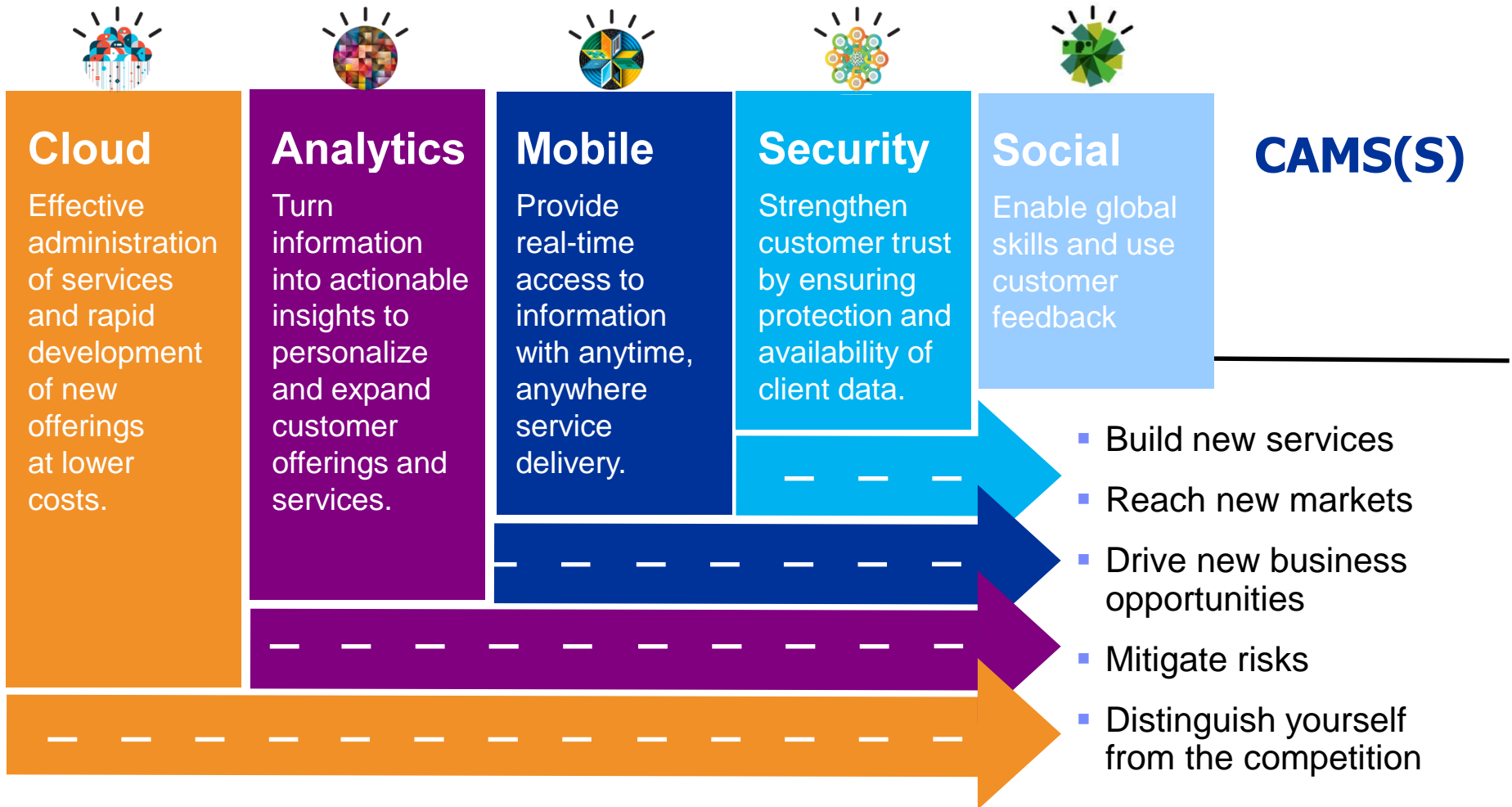
45X FASTER

\* IBM internal test results with IBM FlashSystem 820 and FiconExpress4s



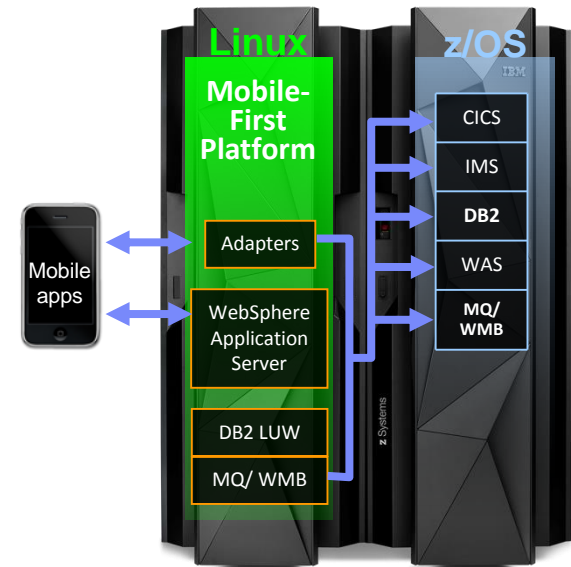


# Mobilize the Mainframe with CAMSS



# Connecting Mobile Apps on z Systems

- **Server side software components and adapters for channeling z Systems to mobile devices** with IBM MobileFirst Platform Foundation
- **Mobile application support** with WebSphere Application Server on z Systems
- **Mobile protocol connectivity with core z Systems applications** including CICS, IMS, TPF, MQSeries, WMB and DB2



*“IBM [MobileFirst Platform Foundation] provides us with ready-to-use adapters that easily connect to existing web services and applications. The solution integrated seamlessly with our existing environment of IBM WebSphere Application Server and IBM DB2 database software, so we could get to work on development sooner rather than later.”*

- Dominik Weitz, Software Developer, ABK-Systeme GmbH

IBM MobileFirst Platform Foundation, formerly known as IBM Worklight, IBM WebSphere Application Server and IBM DB2 are running on Linux on z Systems

# The ultimate JavaScript environment: Node.js

## Node.js and Linux on z Systems

### High Performance

- Highly scalable, event-driven platform with non-blocking I/O
- Thousands of concurrent connections with minimal overhead
- Unified JavaScript ecosystem for client and server
- Up to 29% better performance over Intel on AcmeAir\*
- One of the fastest growing eco-systems

### z Systems Connectivity

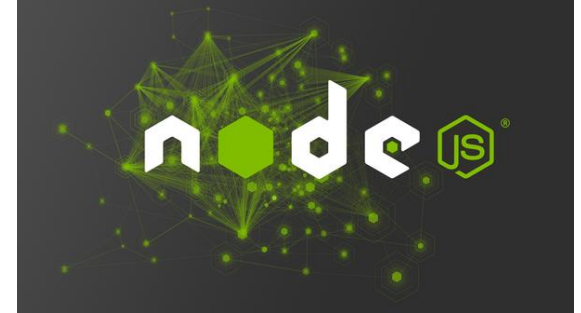
- Co-locate Node.js applications for reduced latency accessing z/OS data/services

### Security and Dependability

- Leverages the trusted environments of z Systems to maximize security and uptime of critical Node.js applications.

### Unified Diagnostics and Monitoring with IBM SDKs for Java®

- Compatible with latest Joyent Node.js v0.10.\* releases



### Core Strength

- Node is *FAST and highly concurrent*
- Node is built for I/O
- Node is perfect for APIs
- Node powers full-stack JS

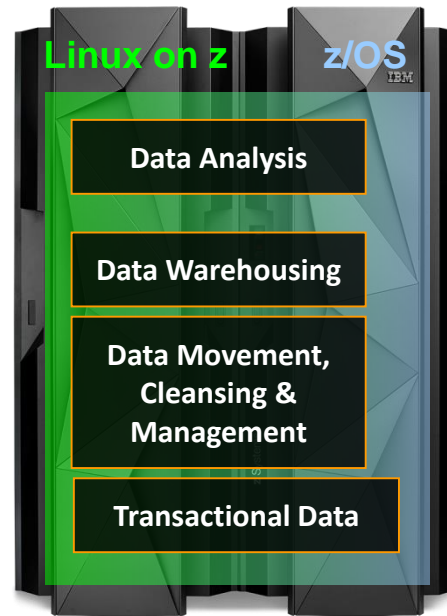
### Integration with JSON APIs

[IBM SDK for Node.js Version 1.1](#)  
for Linux on z Systems

# Building an Infrastructure for real-time Analytics

## Real-time “integration of analytics and transaction processing” increases customer value with every interaction

- Deliver real-time insights at the point of impact
- Manage data lifecycle and governance
- Eliminate redundancy and avoid ETL (*Extract, Transform, Load*)



## IBM Software examples

- Cognos BI
- SPSS
- Query Management Facility
- DB2
- DB2 Analytics Accelerator
- InfoSphere® Warehouse
- InfoSphere Information Server
- InfoSphere Data Replication
- InfoSphere Master Data Mgmt
- DB2
- IMS, VSAM
- Non IBM, e.g. Oracle

*“Cognos generates insightful reports and sophisticated dashboards, providing quick and accurate information to senior management. We are now adding more reporting functionality - on business revenue, credit data, loan risks, and so on - to make Cognos the complete decision-support system for Sicoob.”*

- Paulo Nassar,  
IT Processing and Storage Infrastructure Manager, Sicoob

IBM Cognos Business Intelligence and additional analytics software is running on Linux on z Systems

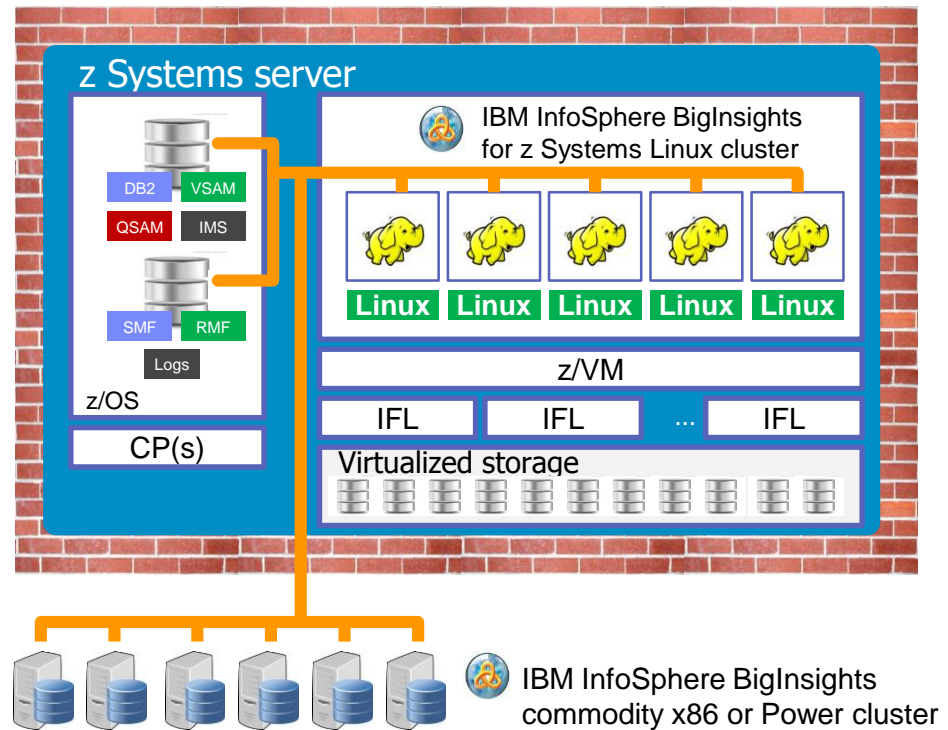
# IBM InfoSphere BigInsights for Linux on z Systems

*New ways of thinking, transformative economics*

- Leverage the power of Hadoop on z Systems
- Drag-and-drop extracts from z Systems sources
- Protect sensitive data
- Faster application delivery
- Seamless interoperability

## IBM InfoSphere® System z Connector for Hadoop

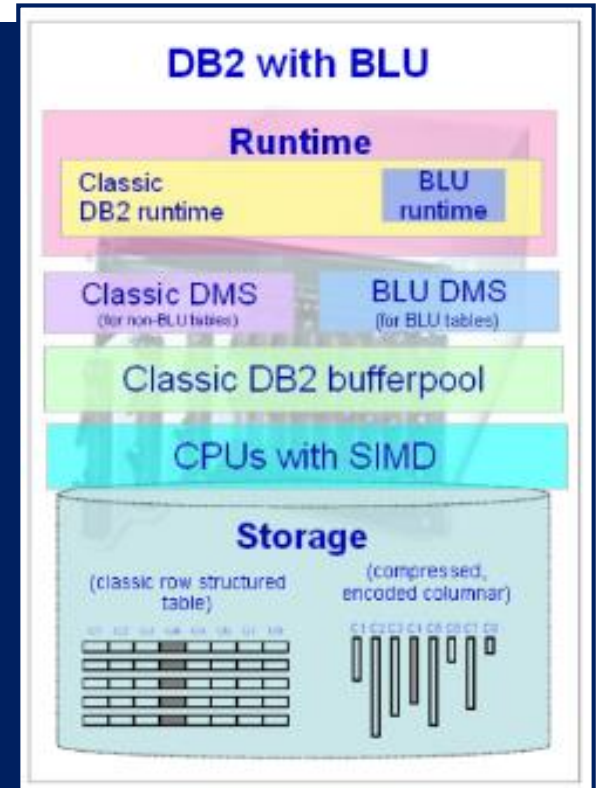
*Fast and seamless data  
connectivity between a variety of  
mainframe data sources and  
IBM InfoSphere BigInsights*



# DB2 w/ BLU Acceleration for Linux on z Systems

*Super Simple. Super Fast.*

- **Large order of magnitude benefits**
  - Performance
  - Storage savings
  - Time to value
- **New technology in DB2 for analytic queries**
  - CPU-optimized unique runtime handling
  - Unique encoding for speed and compression
  - Unique memory management
  - Columnar storage, vector processing
  - Built directly into the DB2 kernel
- **Revolution or evolution**
  - BLU tables coexists with traditional row tables
    - in same schema, storage, and memory
  - Query any combination of row or BLU tables
  - Easy conversion of tables to BLU tables
    - Change everything, or change incrementally



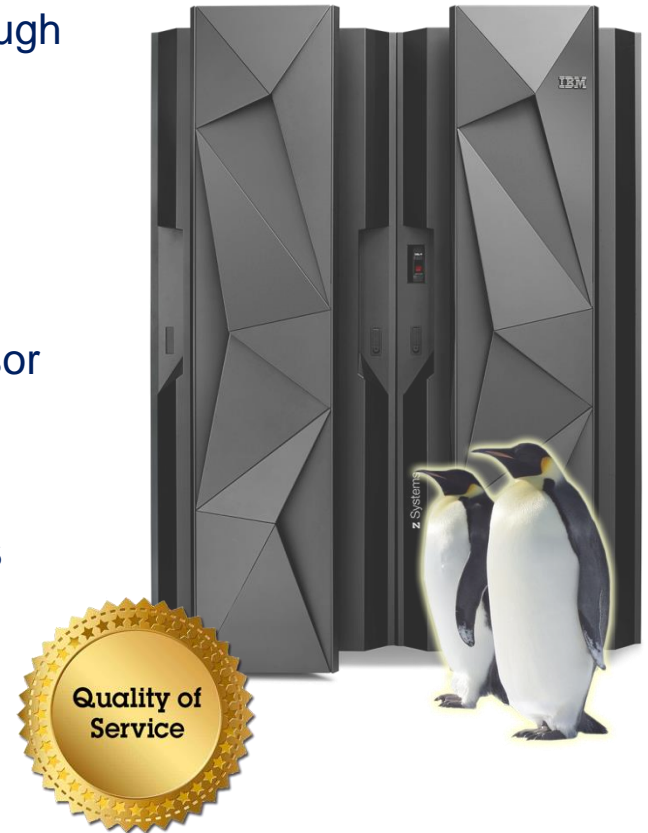
- No SQL
- Can be up to 100x faster than traditional row-organized DB2 (typically 35 – 73x)

# Linux on z13

*The enterprise grade Linux solution*

## **Qualities of Service, Operational Simplification and Greater Savings**

- **Securely transfer more data** across the internet through cryptographic performance improvements
- **Lower cost per workload, less operational effort** based on higher processing capacity in a single footprint
- **Better performance and throughput**, performance improvement per core through multithreading and processor improvements
- **Huge memory** for applications with very large memory requirements (consolidation) and **in-memory analytics** through 3x more memory and larger caches
- **More configuration flexibility** for workloads



# Outstanding Scalability

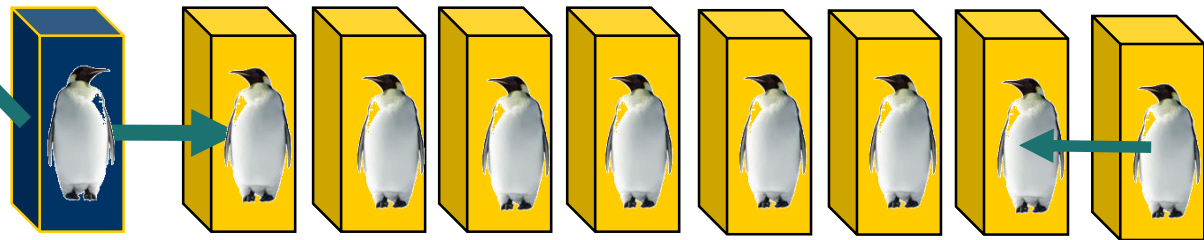
*Potential for economic growth and flexible configuration*

- Highest levels of resource sharing – including the over-commitment, cooperative memory management, I/O bandwidth
- In-memory emulated storage achieves data transfers on memory-speed
- Very fast internal I/O connections, no external networking
- Dynamically add processors, memory, I/O adapters, devices and network cards ... no disruption



- Unused resources for peak utilization are provided to other virtual servers during off-peak hours ... automatically

**Scale horizontally**



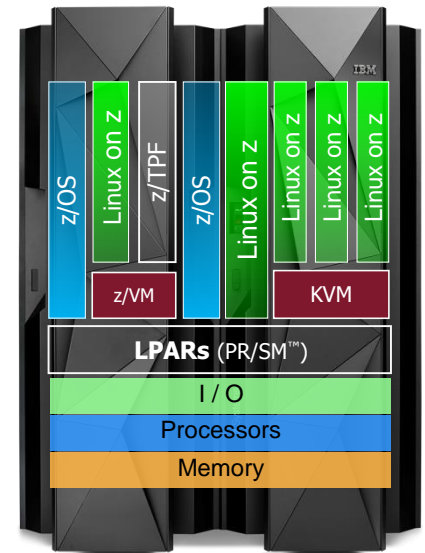


## SOD\* for Linux:

# New software distribution of KVM for z Systems

## New software distribution of KVM on z Systems that can augment z/VM's support of Linux on z Systems

- In addition to the continued investment in z/VM, IBM intends to support a Kernel-based Virtual Machine (KVM) offering for z Systems that will host Linux on z Systems guest virtual machines.
- The KVM offering will be software that can be installed on z Systems processors like an operating system and can co-exist with z/VM virtualization environments, z/OS, Linux on z Systems, z/VSE and z/TPF.
- The KVM offering will be optimized for z Systems architecture and will provide standard Linux and KVM interfaces for operational control of the environment, as well as supporting OpenStack interfaces for virtualization management, enabling enterprises to easily integrate Linux servers into their existing infrastructure and cloud offerings.



# Standardized virtualization for IBM z Systems

*SOD\* at IBM z13 (z13) announcement for KVM for z Systems*

- **Expanded audience for Linux on z Systems**
  - KVM on z Systems will co-exist with z/VM
  - Attracting new clients with in house KVM skills
- **Support of modernized open source KVM hypervisor for Linux**
  - Provisioning, mobility, memory over-commit
  - Standard management and operational controls
  - Simplicity and familiarity for x86 Linux users
- **Optimized for z Systems scalability, performance, security and resiliency**
  - Standard software distribution from IBM
- **Flexible integration with cloud offerings**
  - Standard use of storage and networking drivers (including SCSI disk)
  - Off-the-shelf OpenStack and cloud drivers



A new hypervisor choice for z Systems



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# Open Source Priorities in 2015

## Databases-Messaging



**GEMFIRE**



## Cluster Computing



## Dev Languages-Environments



## Cloud Infrastructure



Looking at various sources of input: e.g. BlueMix, Githubstats, feedback from: IBM client reps, direct client input e.g. zBLC, on going research

Green port/test done  
open source versions

# Clients run many workloads on Linux on z Systems



Database deployment

- [EVERTEC](#) (Oracle)
- [L3C LLP](#) (Oracle)
- [Dundee City Council](#) (Oracle)
- [Met Office](#) (Oracle)
- [America First Credit Union](#) (DB2)
- [SinfoniaRx](#) (DB2)
- [Marist College](#) (DB2)



Web application and SOA infrastructure

- [BTMU](#)
- [Nationwide](#)
- [Halkbank](#)
- [Renfe](#)
- [Bank of New Zealand](#)



Real-time insights

- [Sicoob](#)
- [White Cube](#)
- [Bankia](#)
- [Miami-Dade County](#)
- [IBM](#)



... and much more

- [ABK-Systeme GmbH](#) (MobileFirst P.F.)
- [Banca Carige](#) (MobileFirst P.F.)
- [German Pension Fund](#) (Content Mgt)
- [BCBS Minnesota](#) (SAP)
- [Baldor](#) (SAP)
- [Porto Alegre](#) (Maximo)
- [City a. County of Honolulu](#) (Maximo)
- [IBM](#) (Connections/Notes)

More cases: [ibm.com/systems/z/os/linux/success/index.html](http://ibm.com/systems/z/os/linux/success/index.html)



# Linux on z Systems

*means an enterprise grade Linux solution*

While „Linux is Linux“, z Systems server and virtualization technologies provide an enhanced Linux solution

## Having an enterprise grade Linux solution brings:

- IT simplicity to run hundreds of workloads on one server
- Workload integration inside a single server
- Flexible server provisioning and growth inside the server
- High productivity through efficient life cycle management
- High utilization of shared resources
- Highest levels of security and quality of service – including business continuity

Linux on z Systems provides security, availability, and scalability to deploy (consolidate) all kinds of workloads



# Questions



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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.

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