

The Open Ecosystem on Linux on IBM Z  
exploits highest scalability and  
Pervasive Encryption on z14

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# 2018 VM Workshop Greensboro, NC

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**IBM**

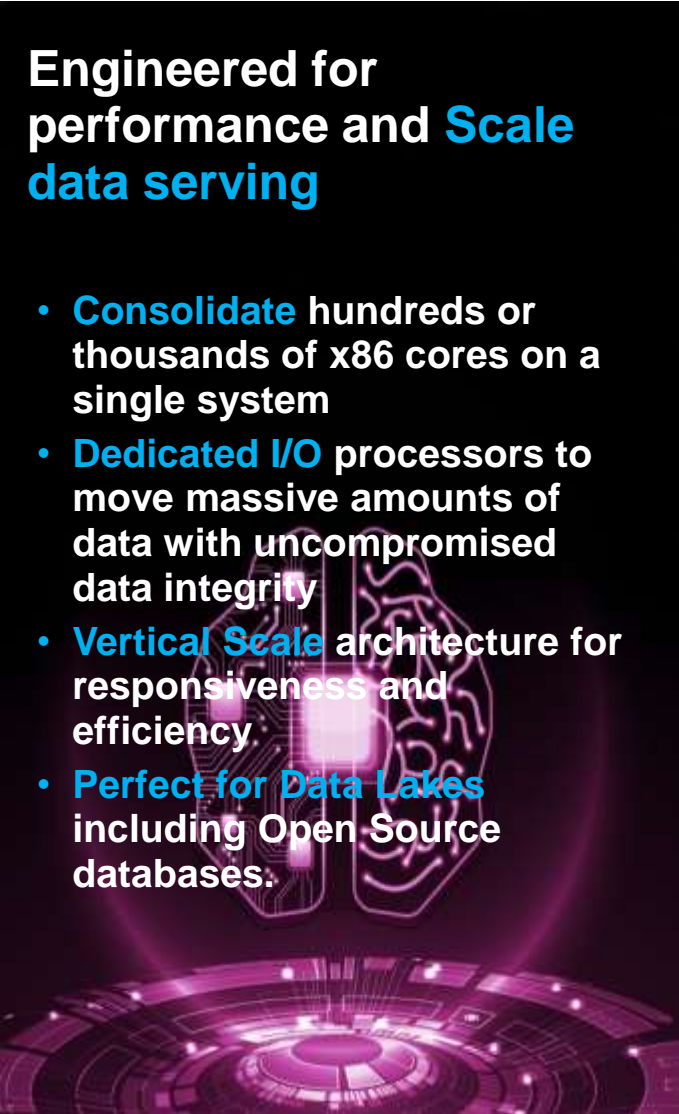
## The Open Ecosystem for Linux on IBM Z continues to grow

- New Open Source solutions
- New Vendor solutions on Linux on IBM Z
- New IBM solutions including Open technologies


**The strength are massive scalability and security on all levels**

# IBM z14 and LinuxONE Emperor II: Engineered for Secure Data Serving


## Engineered for performance and **Scale data serving**

- **Consolidate** hundreds or thousands of x86 cores on a single system
  - **Dedicated I/O** processors to move massive amounts of data with uncompromised data integrity
  - **Vertical Scale** architecture for responsiveness and efficiency
  - **Perfect for Data Lakes** including Open Source databases.
- 

## The world's premier Linux system for **highly secured data serving**

- **Encryption** for data at rest and in flight
  - Industry-leading workload and **certified tenant isolation**
  - **Secure Container** technology to help protect data and applications from internal and external threats
- 

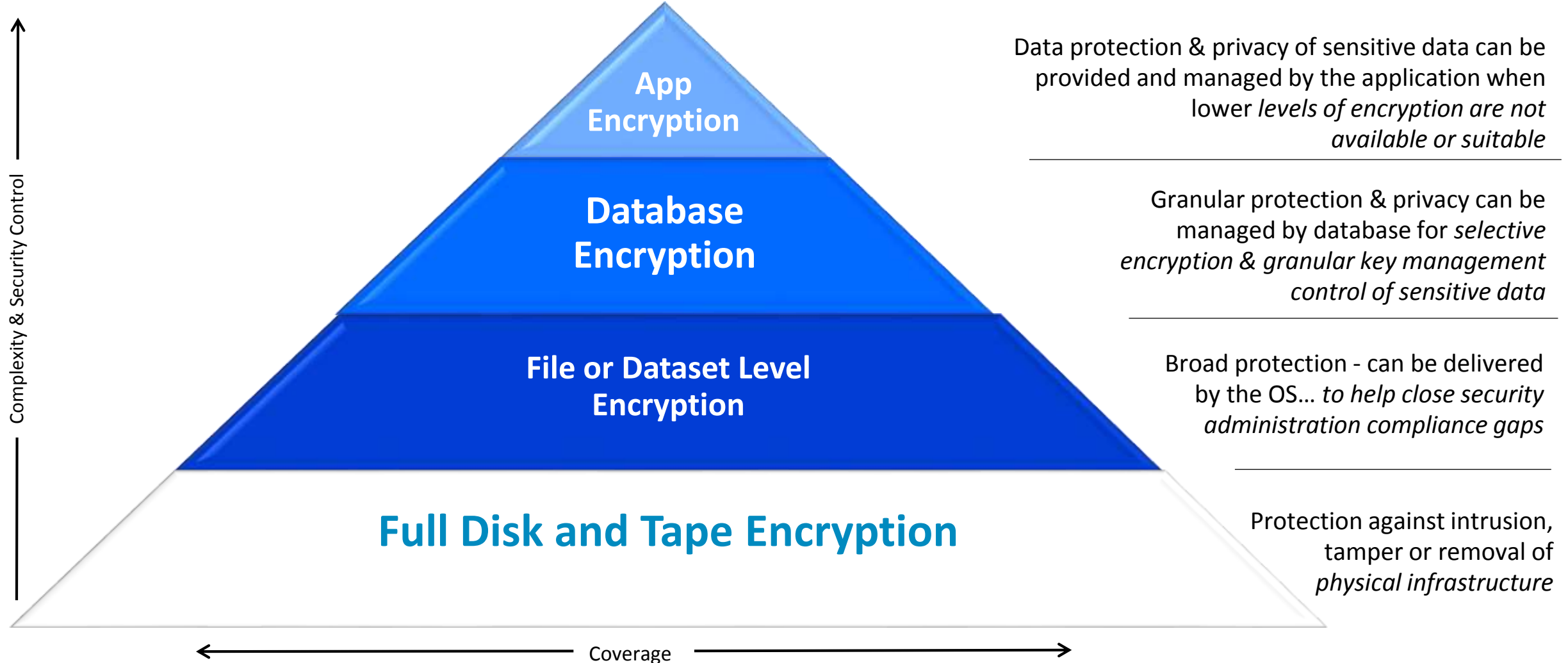
## Foundation for **simplification and next generation apps**

- **Performance at scale** to consistently deliver on client and business demands
  - **Resiliency and reliability** to keep businesses up and running
  - **Support for vast portfolio of IBM, ISV and open source SW** to support new application development and deployment
  - **Optimized** to reduce costs over x86
- 

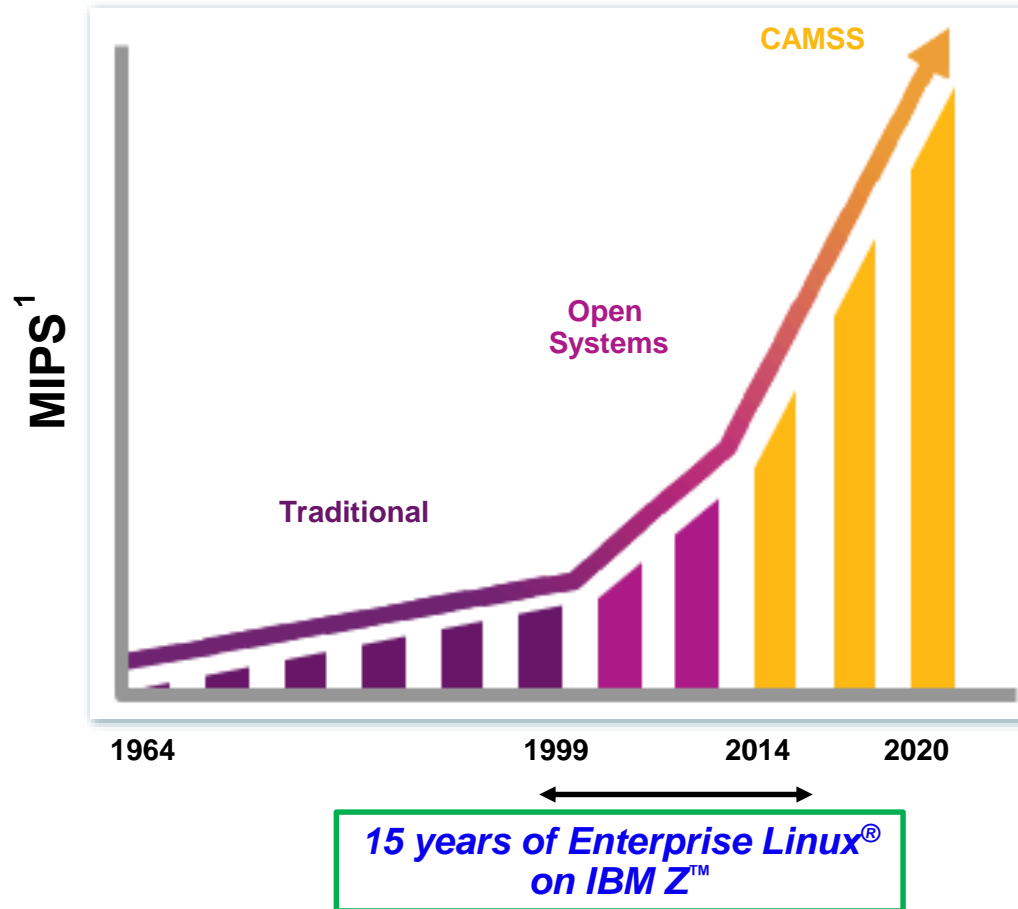
# Robust data protection with IBM z14

## *Multiple layers of independent encryption*

The goal is to have the flexibility to use encryption in multiple layers of the system and to select the appropriate layer(s) of encryption based on security requirements of a particular workload



# New marketplace dynamics drive hyper growth opportunity for the IBM Mainframe



## Traditional

1964–2014

- Batch
- General Ledger
- Transaction Systems
- Client Databases
- Accounts payable / receivable
- Inventory, CRM, ERP

## Linux & Java

1999–2014

- Server Consolidation
- Oracle Consolidation
- Early Private Clouds
- Email
- Java<sup>®</sup>, Web & eCommerce

## CAMSS<sup>2</sup>

2015–2020

- On/Off Premise, Hybrid Cloud
- Big Data & Analytics
- Enterprise Mobile Apps
- Security solutions
- Open Source ecosystem enhancement

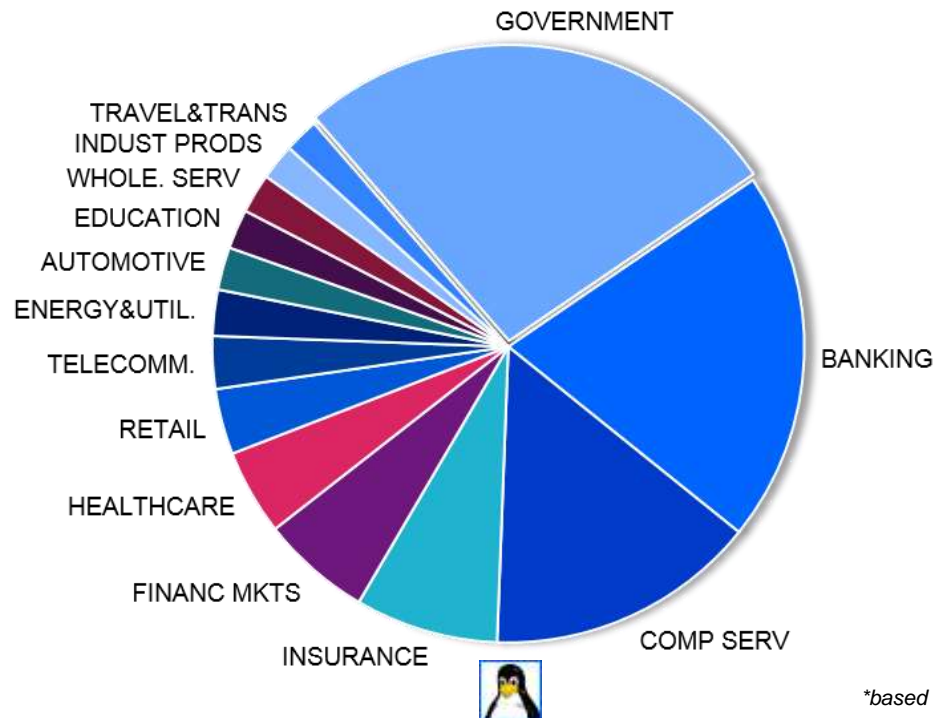
1. MIPS: Millions of Instructions per Second or the metric z uses to measure client workload  
2. CAMSS: Cloud, Analytics, Mobile, Social, Security

# Use of Linux on IBM Z and LinuxONE

- Used in over 60 countries around the globe
- Used in about 22 industries

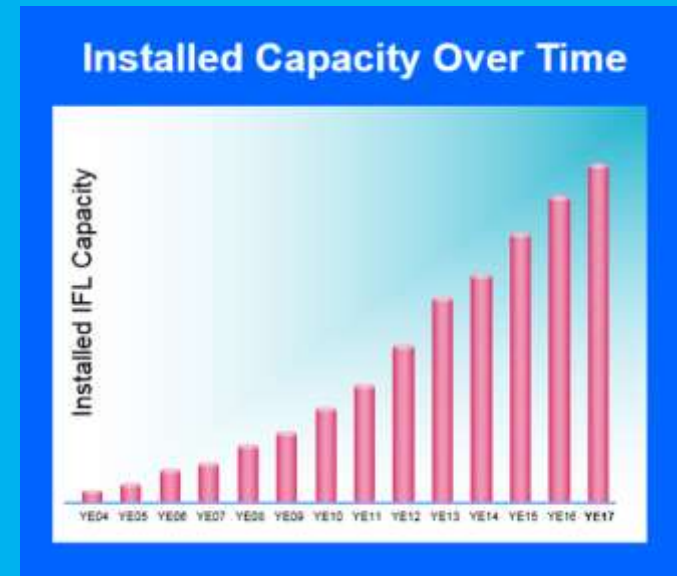
Most used in:

- Government, Banking and Computer Services
- Insurance, Financial Markets and Healthcare
- Energy & Utilities, Automotive,
- Retail, Telecommunication, Education, ...



*\*based on CustNo 4Q2017*

- 91 of the top 100 IBM Z Enterprises are running Linux on Z as of 4Q17 \*
  - Very large installations with up to hundred and more of IFLs in USA, Japan, Brazil, Chile, Mexico and Germany
  - Small installations with 2 IFLs in all countries and on all IBM Z models
- Most clients run Linux co-located with z/OS® or z/VSE® on IBM Z servers



*\*Top 100 is based on total installed MIPS*

# Open source participation is important to the IBM Strategy



*A Dramatic Commitment to Open Technology !*



5 IBMers contributing to Linux & Apache Projects

1999



IBM is a founding member  
500+ organizations participating  
Provides customer-led guidance to cloud standards-defining orgs



IBM a founding member of the newly established foundation  
2.1b npm downloads in the past month

2015  
62k+ IBMers contributing to 150+ Open Orgs



Founder & Platinum Sponsor  
IBM has the largest Cloud Foundry deployment  
IBM has 10 dedicated core contributors



Founder & Platinum Sponsor  
IBM is a top-3 contributor in the past 4 releases  
IBM has 450+ developers & 20 core reviewers

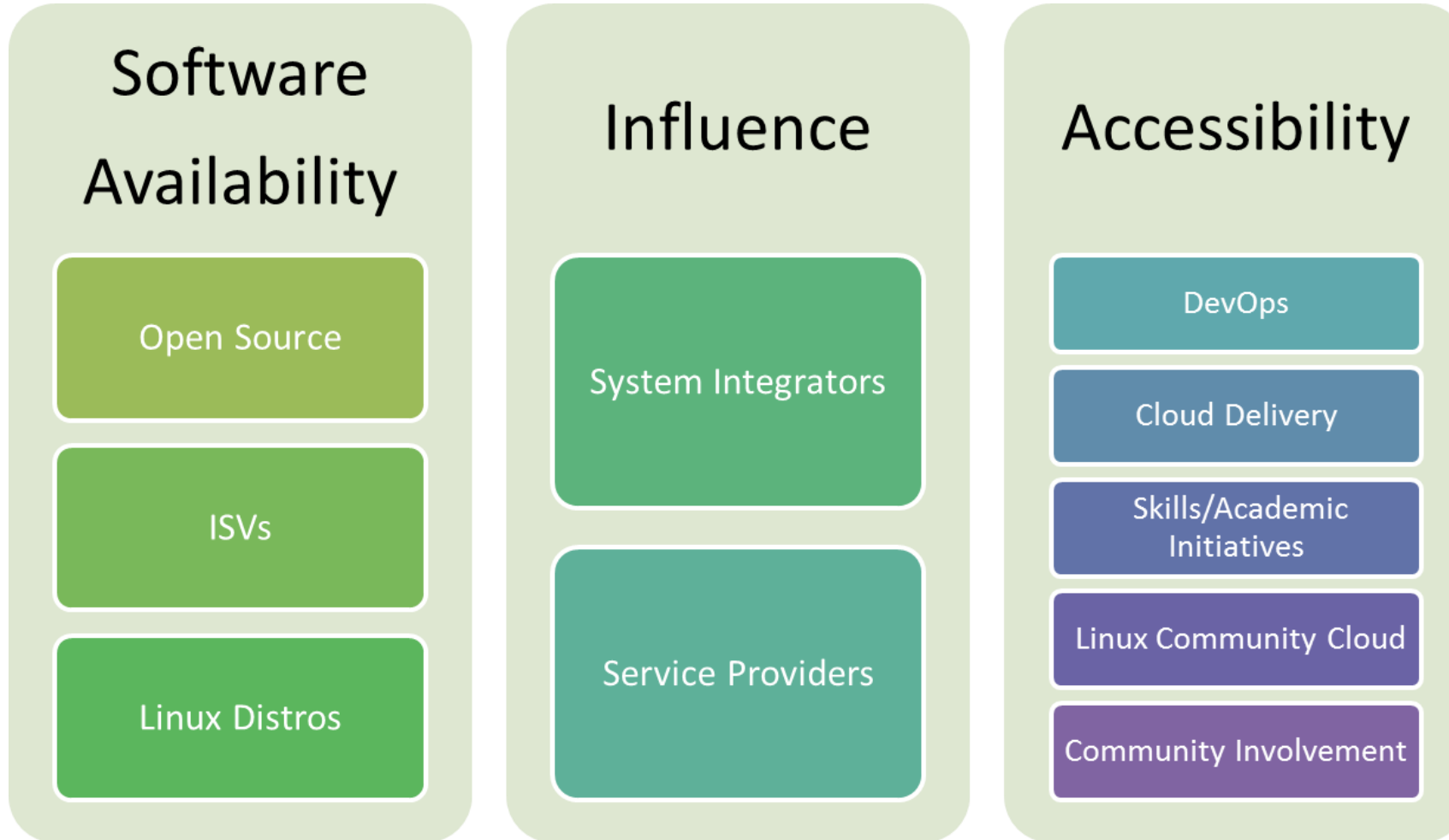


Leading dev of nightly builds for x86, Power & Mainframe systems  
#2 in Commits in 2015 behind Docker

Donation of IBM SystemML machine  
IBM pledged 3,500 devs to Spark across 12 labs  
Education for 1m + data scientists & engineers on Spark.



# Ecosystem Strategy





# A Rich Open Ecosystem Offering - Greater Flexibility & Choice

Choose the distribution, runtime, hypervisor, database and analytics – it's the Linux you know and love with the openness, flexibility and agility you need for you business.

Distributions	Hypervisors	Languages	Runtimes	Management	Other	Database	Analytics
 Supported by Canonical		   	 	  	 	  	  
		  	 	   	  	  	 
		 	 	   	  	  	 
<p>Community Versions</p>    		   	  	 		 	

# Open Source & ISV Linux SW Capability

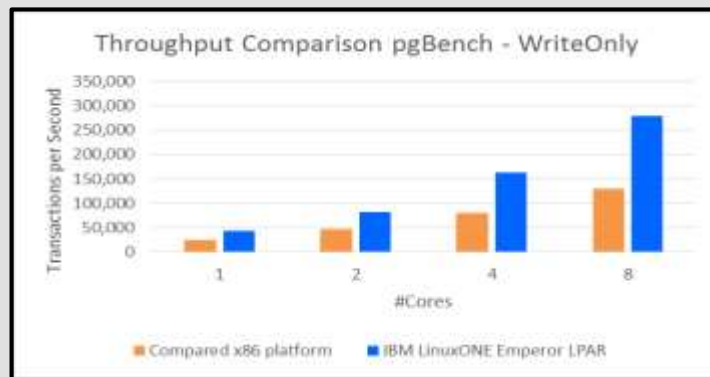
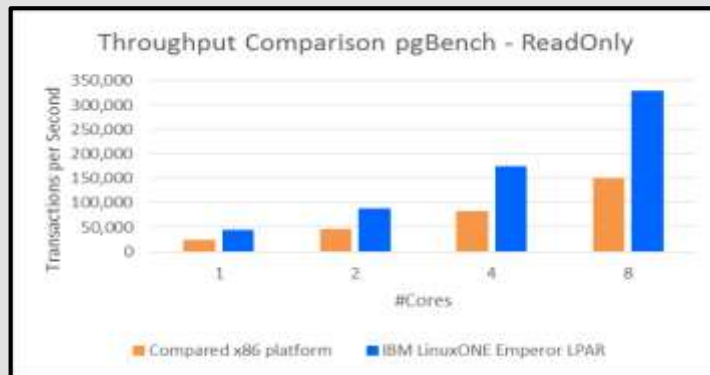
Languages and Dev Environment	Databases	Messaging & Streaming
<p>Node.js</p> <p>Ruby</p> <p>Rails</p> <p>Python, PyPy Python JIT</p> <p>LLVM</p> <p>OpenJDK, OpenJDK 9 (w JIT)</p> <p>GCCGO, Golang compiler</p> <p>oCaml, oCaml native compiler</p> <p>Erlang</p> <p>PHP/Zend</p> <p>R</p> <p>Clojure</p> <p>Scala</p> <p>Swift (Apple)</p> <p>BIRT (Eclipse plug-in)</p> <p>Mono(C#...) [open source for .NET]</p> <p>GOLD(alternate Linux linker)</p> <p>ATLAS BLAS(z13 SIMD Vector Extension)</p> <p>LuaJIT</p> <p>Rust*, JIT* for PHP, Dart*</p>	<p>MySQL</p> <p>PostgreSQL</p> <p>MariaDB</p> <p>MongoDB</p> <p>Redis</p> <p>Apache CouchDB</p> <p>Cloudant (CouchDB based)</p> <p>Apache Geode</p> <p>CouchBase</p> <p>Apache HBase</p> <p>ScyllaDB</p> <p>RethinkDB</p> <p>XtraDB*</p> <p>OrientDB*</p> <p>Hazelcast*</p> <p>MemSQL*</p> <p>Aerospike*</p> <p>Druid*</p> <p>Apache Ignite*</p>	<p>RabbitMQ</p> <p>Apache Kafka</p> <p>Logstash (ELK)</p> <p>Fluentd</p> <p>Apache Flume</p> <p>Apache ActiveMQ</p> <p>Apache Camel</p> <p>Graylog2*</p> <p>Apache Apex(Data Torrent)*</p> <p>Apache NiFi*</p> <p>IronMQ*</p>
		<p><b>Graph DBs</b></p> <p>Spark GraphX</p> <p>Neo4j</p> <p>Pegasus*</p> <p>Titan*</p>

Ported - verified  
 Work in progress (target quarter/half)  
 Work under Evaluation/not started

\* Pending input on priority

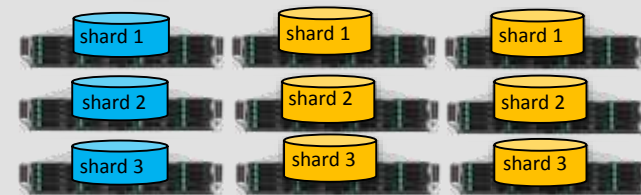
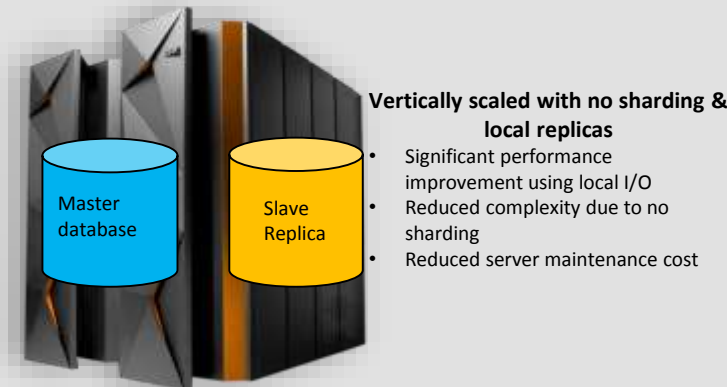
## High-performance Data Serving

- LinuxONE runs the pgBench benchmark on PostgreSQL with much more throughput per core versus a compared x86 platform. As the number of cores increase, LinuxONE also scales better on both reads and writes.



## Enterprise-grade High Availability

- MTBF measured in decades; redundant hardware can be hotswapped without disruption to service
- HyperSwap** technology enables real-time file system replication even across long distance, and automatic failover with only seconds of impact
- Efficiency from no sharding and local slave replicas

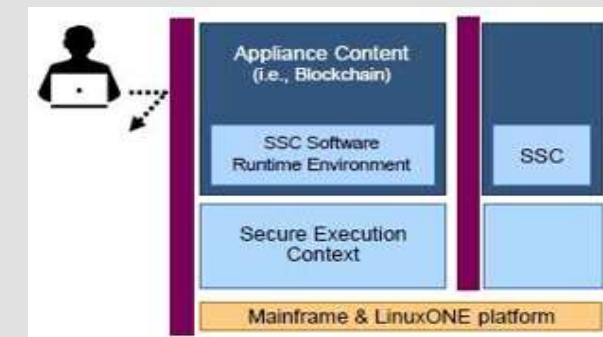


Multiple shards on many x86 servers

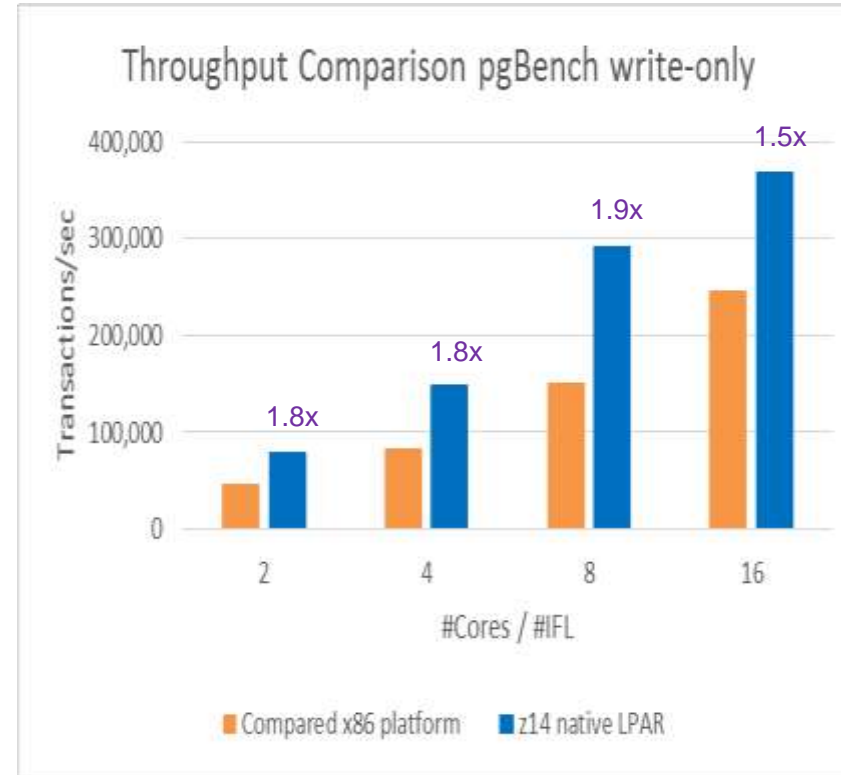
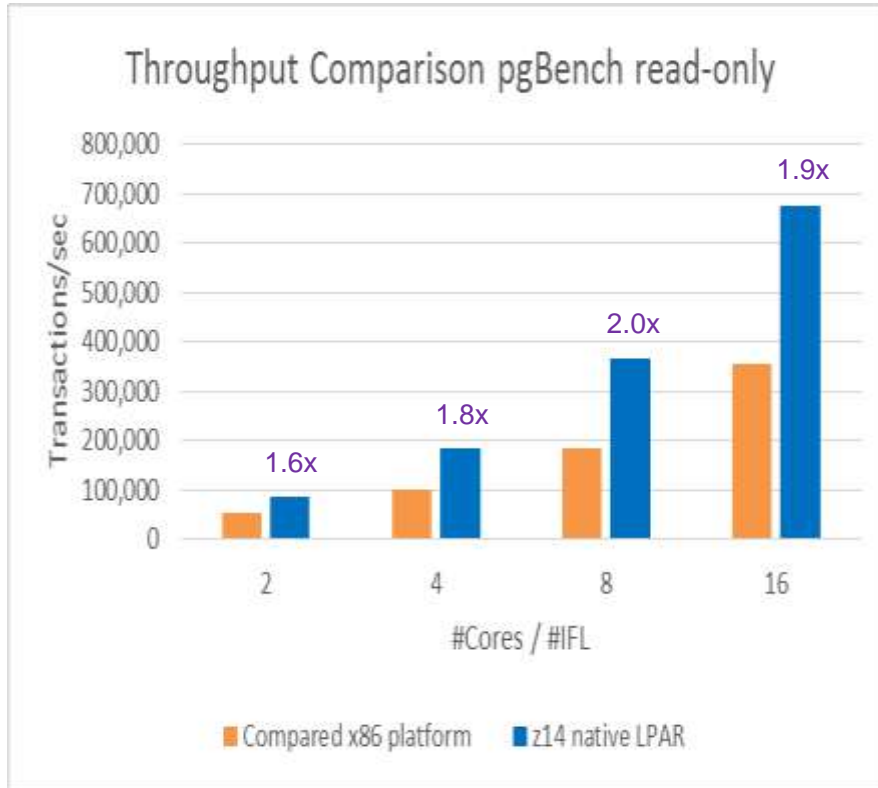
- Increased complexity due to sharding
- Increased server maintenance cost
- Increased development and deployment cost

## Industry Leading Security

- LinuxONE achieved **EAL5+** security certification and meets FIPS, ANSI, PKI, and DK security standards
- Optional Express55 PCIe crypto card add additional crypto capability (Elliptic Curve, SHA3, Visa FPE, etc.)
- Protected-key cryptography provides significantly enhanced security over open-key while offering up to **28X better performance** over standard secure-key technology.
- LinuxONE Secure Services Container** provides
  - simplified mechanism for fast deployment and management of packaged solution
  - tamper protection during container installation and runtime
  - ensure confidentiality of data and code running within the container – both at flight and at rest
  - management provided via Remote APIs (RESTful) and web interfaces
  - enables containers to be delivered via distribution channels



# PostgreSQL performance on z14 vs x86 Broadwell



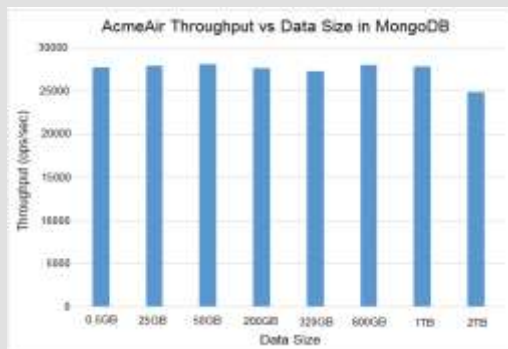
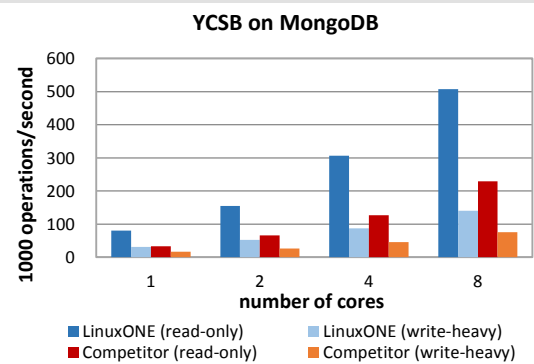
Disclaimer: Performance result is extrapolated from IBM internal tests running pgbench 9.6 benchmark on PostgreSQL 9.6.1 (20 GB database in RAM disk). Results may vary. x86 configuration: 2-16 Intel E5-2697 v4 cores @ 2.30GHz with Hyperthreading turned on, 64GB memory, and 500 GB local RAID-5 HDD storage, SLES12 SP2. z14 configuration: LPAR with 2-16 dedicated IFLs, 64GB memory, and 40 GB DASD storage, SLES12 SP2 (SMT mode).

**Run the pgBench benchmark on PostgreSQL 9.6.1 with up to 2x more throughput per core on a z14 LPAR versus a compared x86 platform**

# Linux on IBM Z or LinuxONE and

## High-performance Data Serving

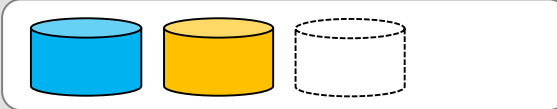
- Much better throughput than competitors
- MongoDB scales up to 2TB with sustained throughput and < 5ms response time, while serving 4+ billion documents, at 460,000 reads/writes per second, with no sharding required!



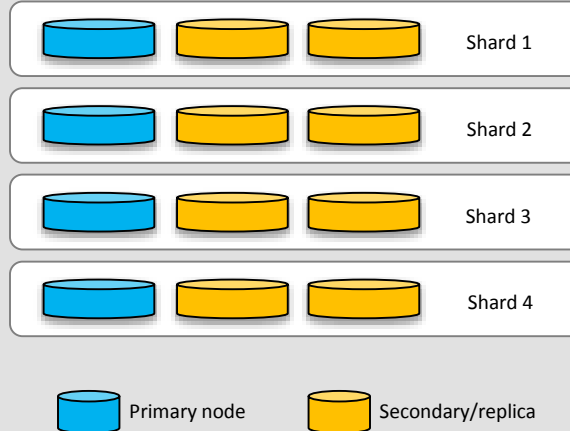
## Enterprise-grade High Availability

- MTBF measured in decades; redundant hardware can be hotswapped without disruption to service
- **HyperSwap** technology enables real-time file system replication even across long distance, and automatic failover with only seconds of impact
- Efficiency from fewer shards and smaller replica sets

### Vertically scaled MongoDB on LinuxONE (no sharding)

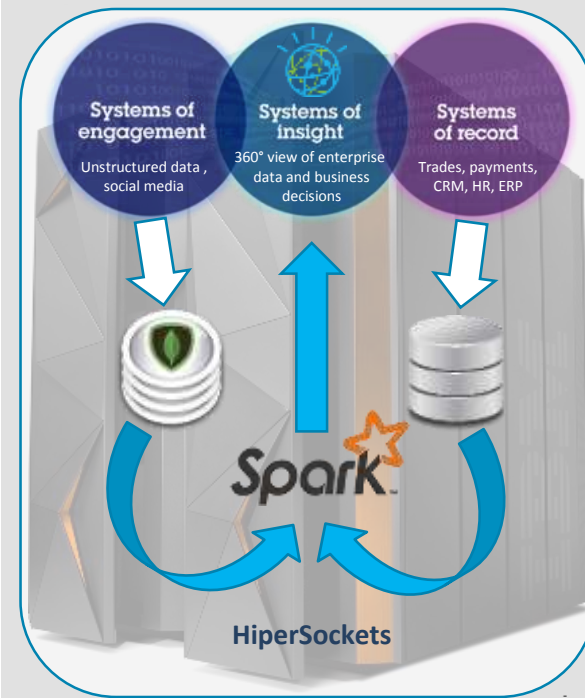


### Multiple shards with minimum replica set on x86

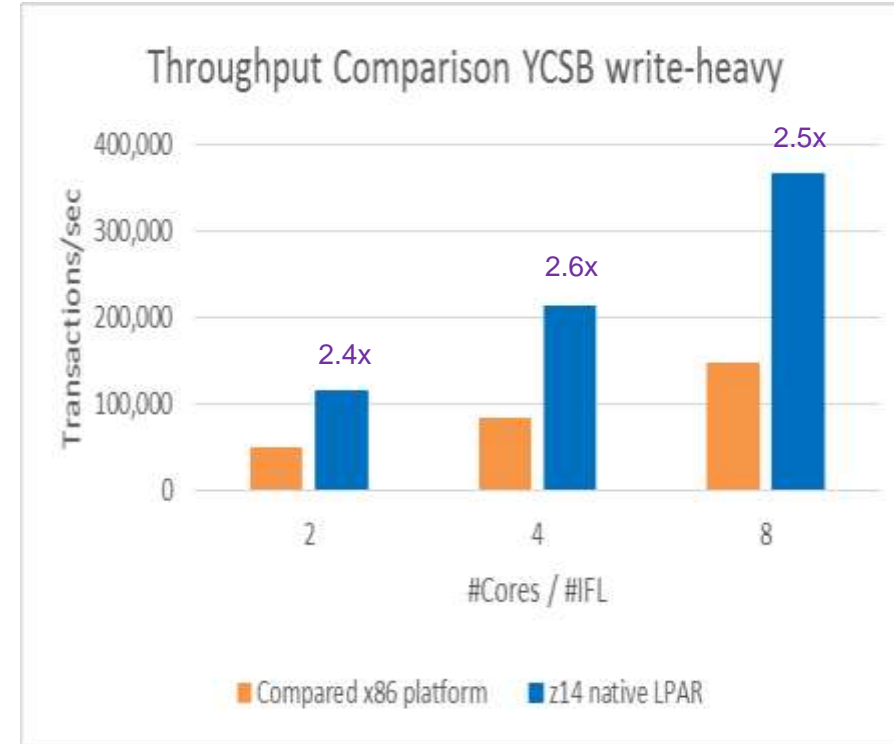
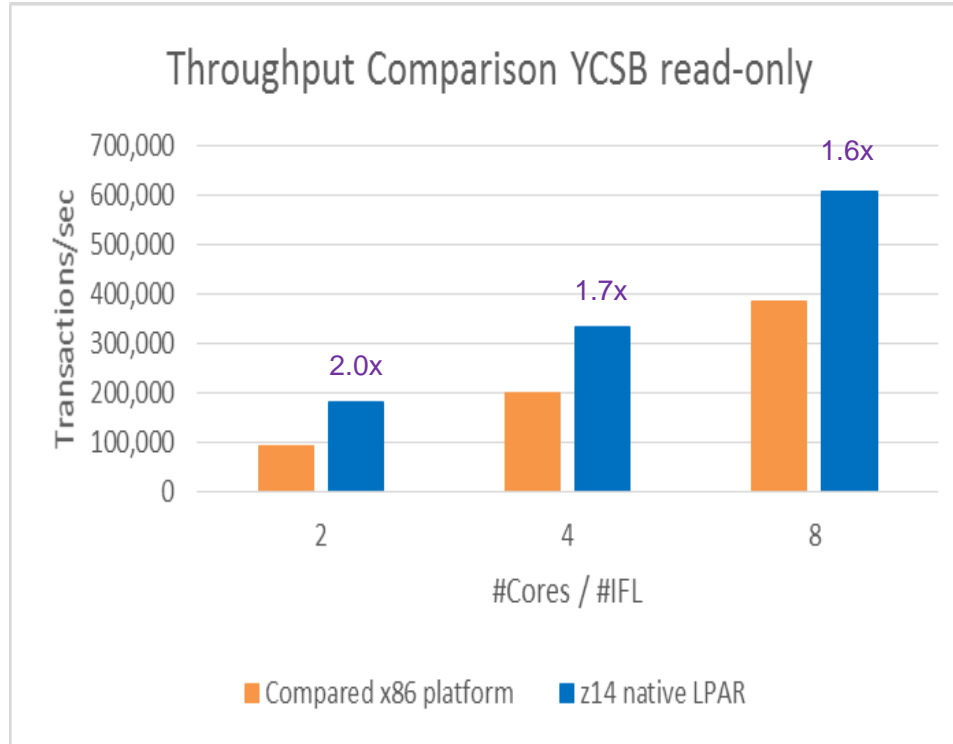


## Benefits of Colocation

- **HiperSocket** technology eliminates the network stack for colocated VMs, reduces network latency
- Up to 3x more analytics performed with Spark—better insights in less time!
- No ETL—critical enterprise data never have to leave the LinuxONE



# MongoDB performance on z14 vs x86 Broadwell



**Run the YCSB benchmark on MongoDB 3.4.1 with up to 2.6x more throughput per core on a z14 LPAR versus a compared x86 platform**

**Disclaimer:** Performance results based on IBM internal tests running YCSB 0.11.0 (write-heavy, read-only) on local MongoDB Enterprise Release 3.4.1 (Database size 5GB). Results may vary. x86 configuration: 36 Intel E5-2697 v4 cores @ 2.30GHz with Hyperthreading turned on (2-8 cores dedicated to MongoDB, 20 or 28 cores dedicated to YCSB), 64GB memory, and 480 GB local RAID-5 HDD storage, SLES12 SP2. z14 configuration: LPAR with 36 dedicated IFLs (2-8 cores dedicated to MongoDB, 20 and 28 cores dedicated to YCSB), 64GB memory, and 120 GB DASD storage, SLES12 SP2 (SMT mode).

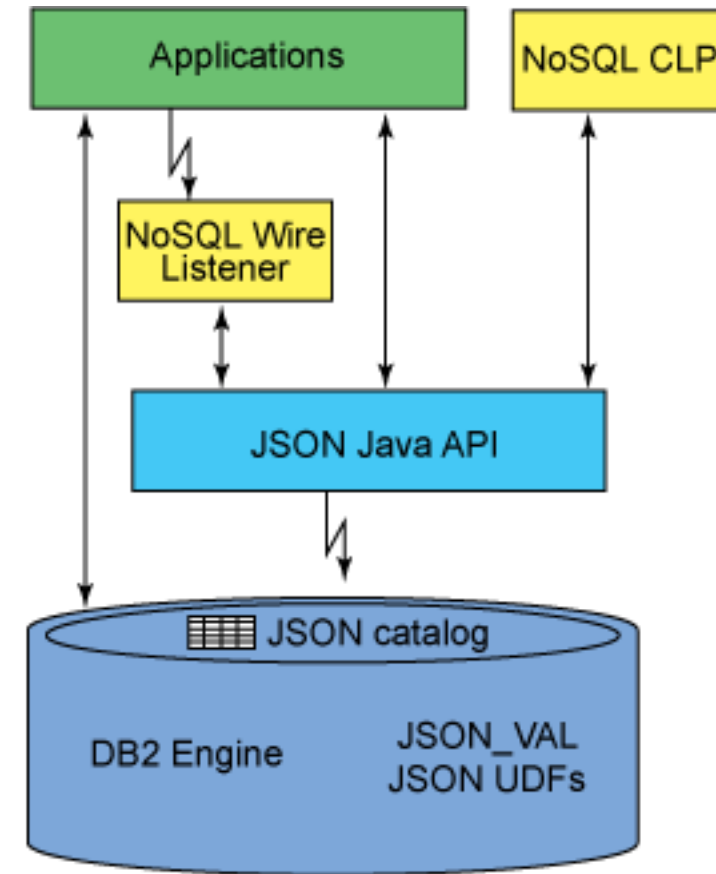
# DB2 JSON – THE access with NoSQL requests to Db2 data

**DB2 JSON** enables developers to write applications using a popular JSON-oriented query language created by MongoDB to interact with data stored in:

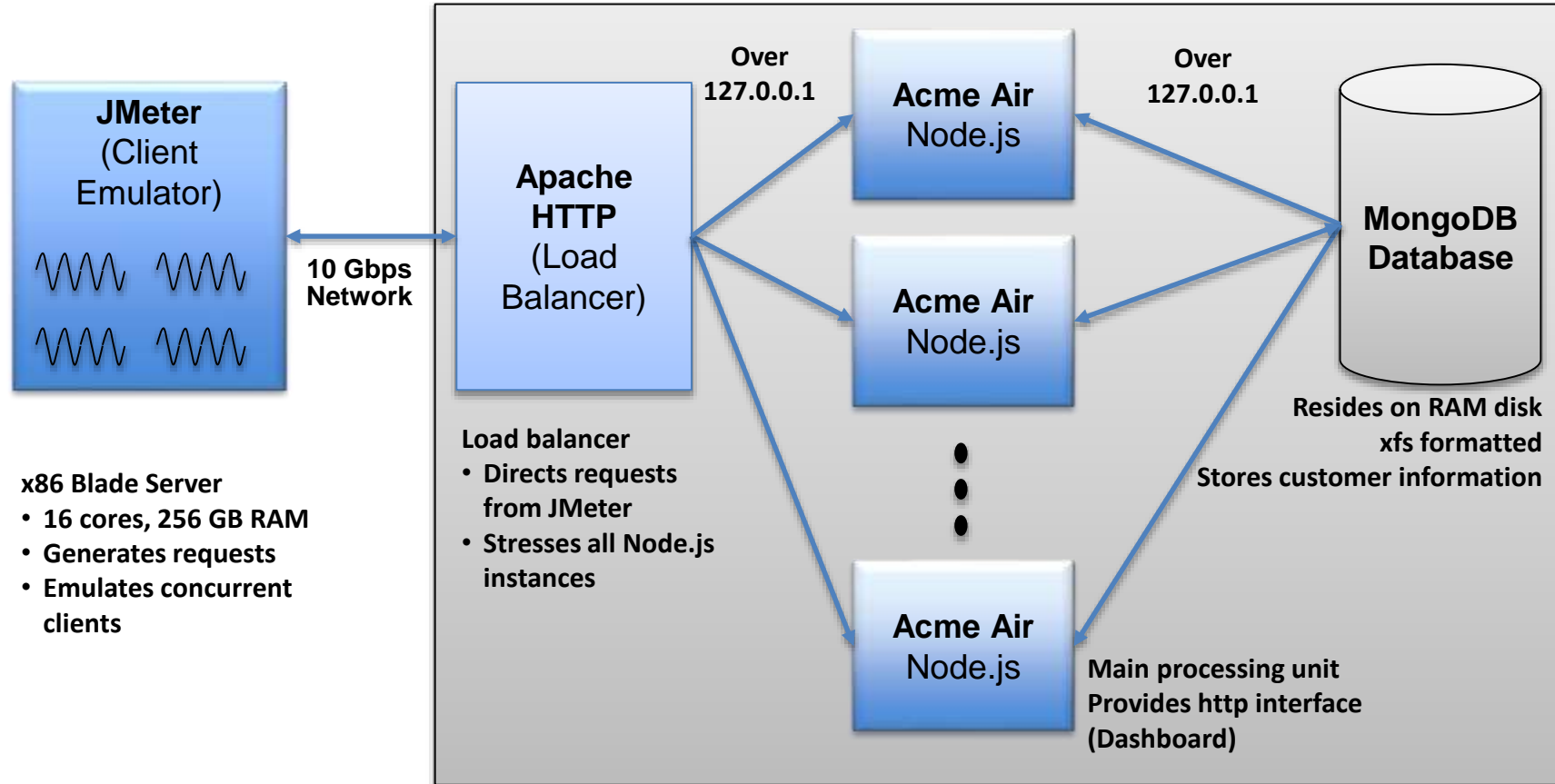
- IBM *DB2* for Linux, UNIX, and Windows
- IBM *DB2* for z/OS.

This driver-based solution embraces the flexibility of the JSON data representation within the context of an RDBMS that provides well-known enterprise features and quality of service.

This allows the access of the DB2 JSON store from a variety of modern languages, including node.js, PHP, Python, and Ruby, as well as more traditional languages such as C, C++, and Perl.



# Node.js applications performance on z14 vs x86 Broadwell Benchmark Setup



- x86 Blade Server**
- 16 cores, 256 GB RAM
  - Generates requests
  - Emulates concurrent clients

- Load balancer**
- Directs requests from JMeter
  - Stresses all Node.js instances

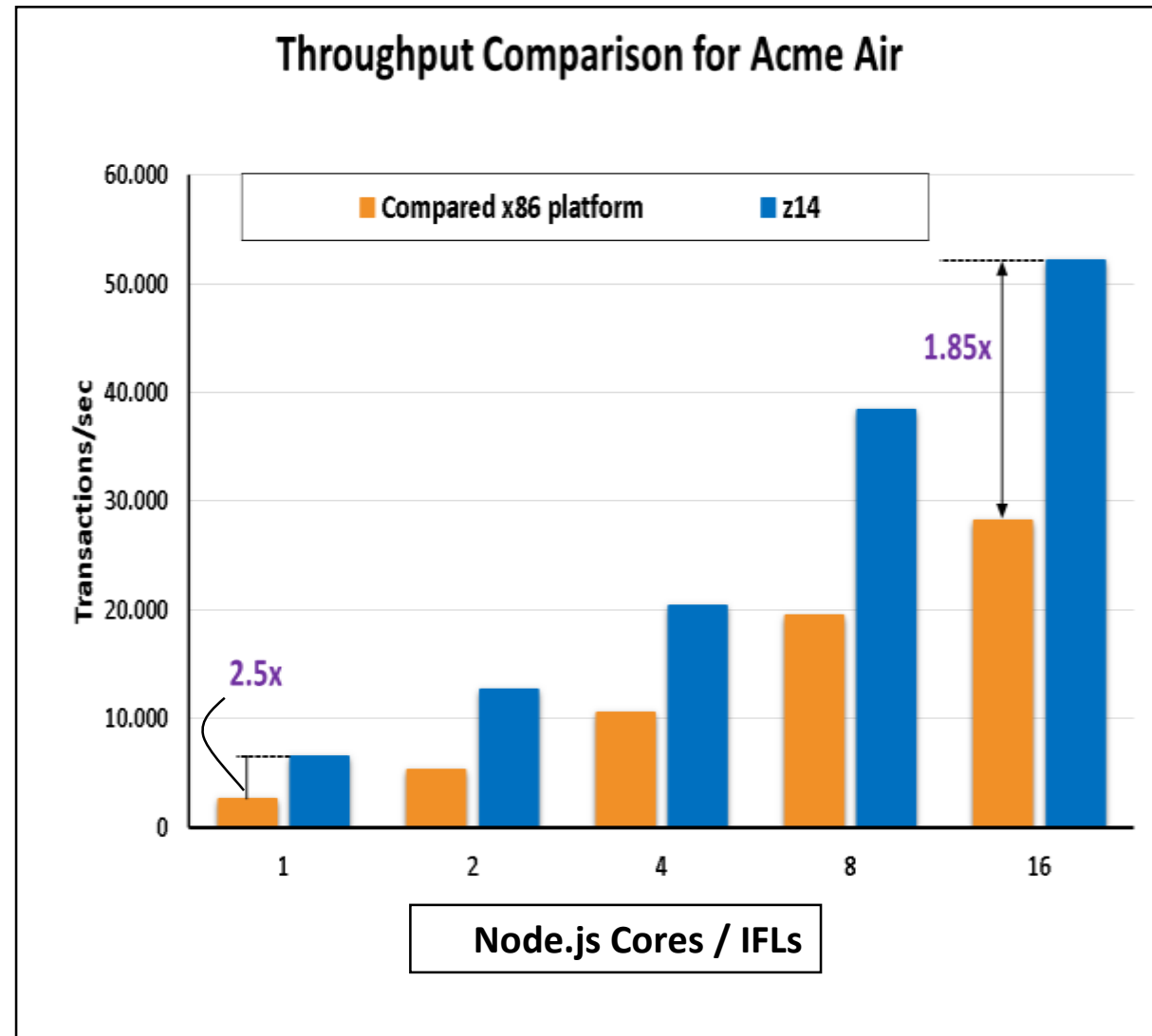
z14 LPAR or x86 Broadwell server



# Node.js Performance on z14 vs x86 Broadwell

*Run the Acme Air benchmark on Node.js 6.10 with up to **2.5x more throughput per core** on a z14 LPAR versus a compared x86 platform*

Disclaimer: Performance results based on IBM internal tests running Acme Air with 10,000 customers on Node.js v6.10.0 against MongoDB Enterprise 3.4.2 driven remotely by 250 JMeter 2.13 threads. Apache HTTP server 2.4.23 was used as load balancer. Results may vary. x86 configuration: 36 Intel E5-2697 v4 cores @ 2.30GHz, Apache HTTP server pinned to 1 core, Node.js pinned to 1-16 cores, MongoDB pinned to 2-4 cores, 768GB memory, SLES12-SP2 with Hyperthreading, application logs and database on the RAM disk. z14 configuration: LPAR with 32 dedicated IFLs, Apache HTTP server pinned to 1 IFL, Node.js pinned to 1-16 IFLs, MongoDB pinned to 2-4 IFLs, 768GB memory, 40 GB DASD storage, SLES12-SP2 with SMT, application logs and database on the RAM disk.



# Linux without Limits – extreme scalability

Differentiate yourself in a world of standards. Lightning fast response times and virtually unlimited scale gives your apps the premium Linux experience they deserve.

MongoDB\*, MariaDB,  
PostgreSQL up to  
**2x faster**

Heavily Loaded Docker  
Containers  
**1.5x more**

Docker Persistence  
**4x faster**

Compression:  
Spark  
Resilient Distrib. Dataset  
**4.9x faster**

Node.js up to  
**2x faster**

Spark Analytics up to  
**3x faster**



- **LinuxONE using Node.js and multiple MongoDB instances handles over 30Billion web events / day!**
- **A single MongoDB node on LinuxONE scales up to 2TBs with sustained throughput and response time <5ms, while supporting >4 billion documents, 460,000 R/W per second with *no sharding required!***

# The Open Ecosystem for Linux on IBM Z continues to grow

- New Open Source solutions

- New Vendor solutions on Linux on IBM Z

- New IBM solutions including Open Technologies

**The strengths are massive scalability and security on all levels**

# Linux ISV Ecosystem Offerings - a part of new Linux in IBM Z solutions

ISV	Solution	Industry	Platform	
Temenos	T24	Banking/Core banking	LoZ	
First Performance Global (FPG)	GogoNogo	Banking/Payments	LoZ	
Tata Consultancy Services (TCS)	BaNCS	Banking/Core banking	LoZ	
Hexanika	Smart Join/Regulation	Banking/GRC Reporting	LoZ	
Anabatics	PocketBank	Banking/Mobile banking	LoZ	
Pennant Technologies	Loaning Factory	Banking/Loans	LoZ	
HPS	PowerCard	Banking/Payments	LoZ	
SAE	Paperless	Retail	LoZ	
ABK Systems	Euro Finance IS	Banking/Payments	LoZ	
GIP	Kidicap Neo	Banking/Payments	LoZ	
Pega Systems	Pega 7	Insurance/CRM/P&C/Life	LoZ&z/OS	
SAP	Insurance Analyzer	Insurance/Performance	LoZ& DB2 z/OS	
SAP	Policy Management	Insurance/Policy	LoZ& DB2 z/OS	
SEP	Sesam	Cross	LoZ	
SCALIX inc	Scalix	Cross	LoZ	
Information Builder	WebFocus	Cross	LoZ	

# Modernization with new ISVs Temenos & Hexanika

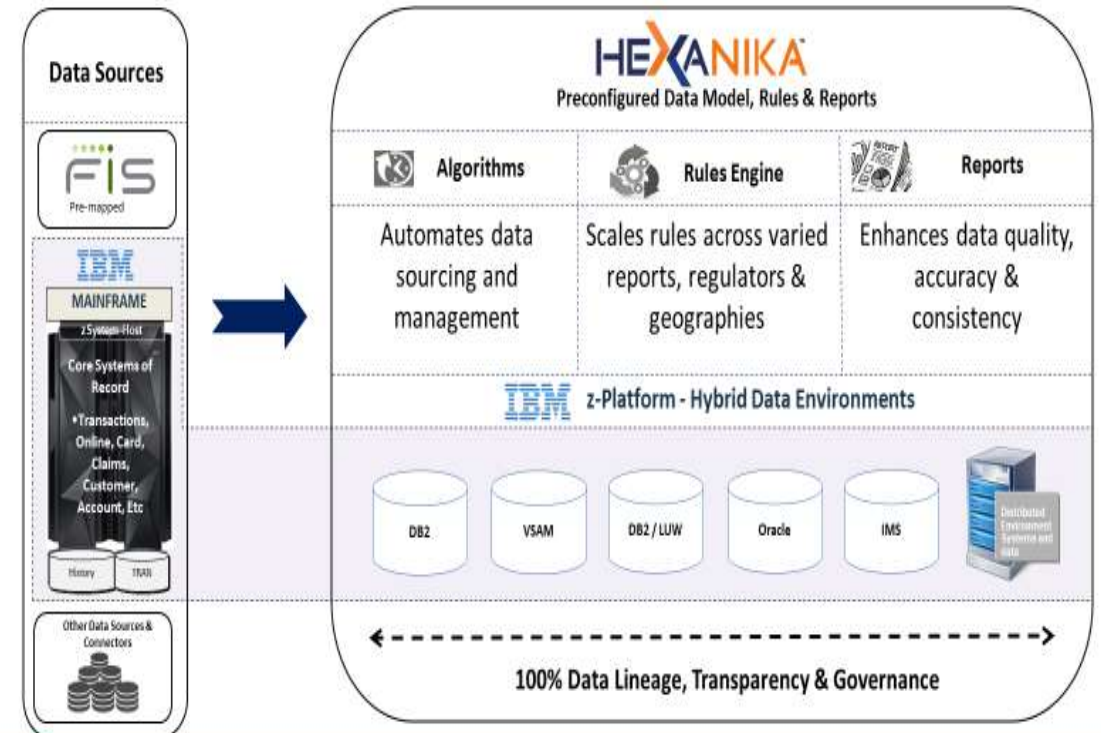
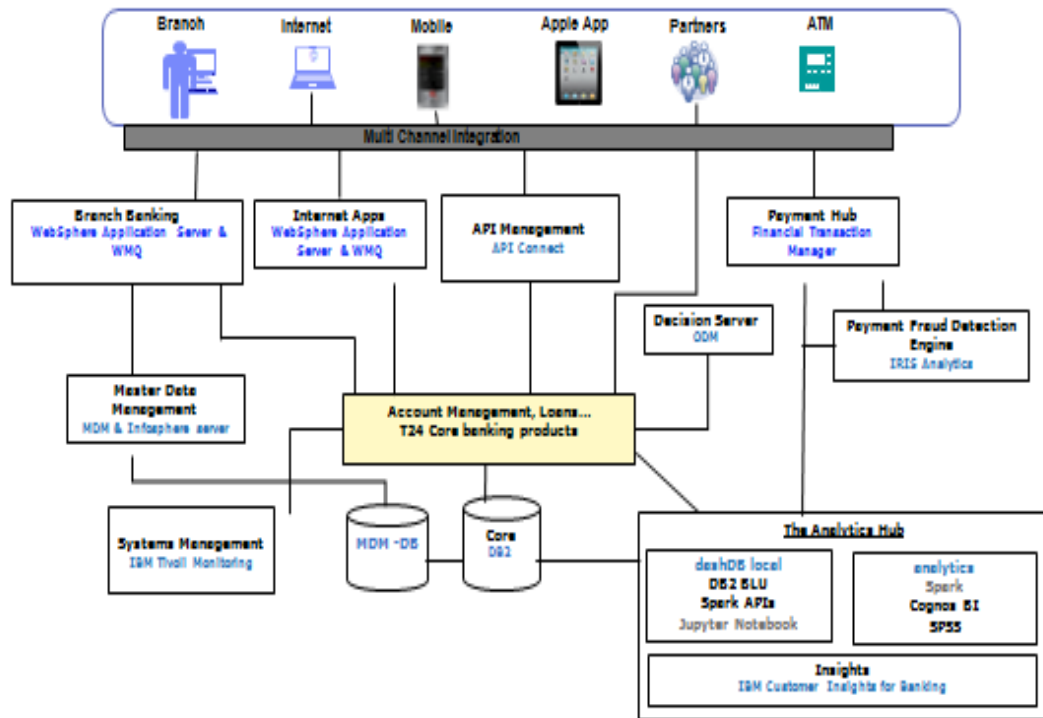
## Temenos Core Banking

Temenos market leading provider of banking software systems to retail, corporate, universal, private, Islamic and microfinance & community banks  
 Temenos T24 supported on z/OS with IBM SW stack and Linux on z (Oracle and IBM stack)

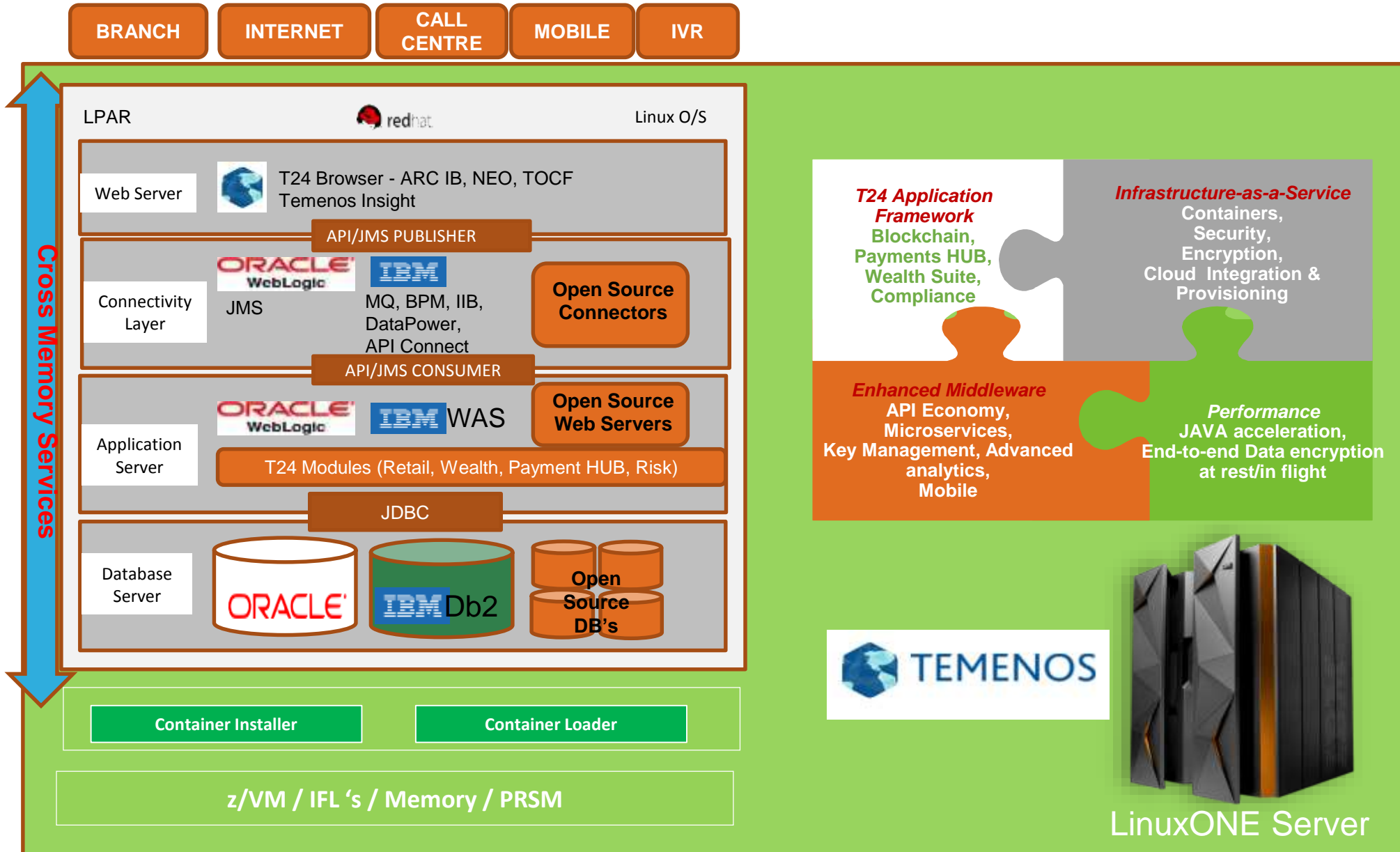
## Hexanika Regulatory Compliance

- FinTech Big Data software company, which developed an E2E solution for financial institutions to address data sourcing and reporting challenges for regulatory compliance.
- Hexanika runs on Linux on z & being enabled for z/OS with Spark analytics

## Temenos T24 Architecture



# Temenos T24 Retail Banking architecture on IBM LinuxONE



# The Open Ecosystem for Linux on IBM Z continues to grow

- New Open Source solutions
- New Vendor solutions on Linux on IBM Z
- New IBM solutions including Open Technologies

**The strength are massive scalability and security on all levels**

# DevOps and Agility in Development: New technologies with Linux on IBM Z

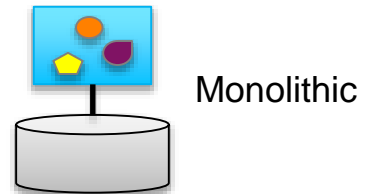
## Development Process



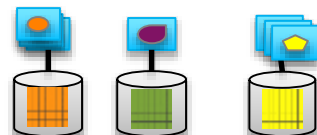
## DevOps



## Application Architecture



## Microservices



## Deployment Packaging

### Physical Servers



## Containers



## Application Infrastructure

### Datacenter



### Hosted

## Cloud



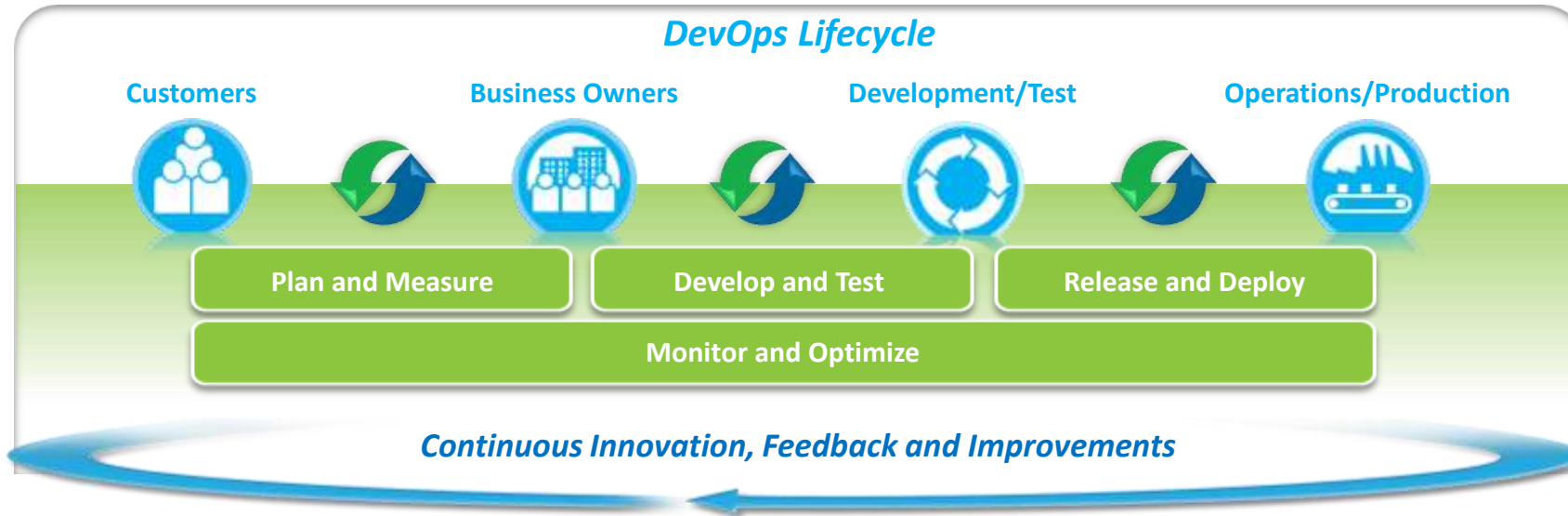
on Linux on z



# What is DevOps



*DevOps* - Enterprise capability for **continuous service delivery** that enables clients to **seize** market opportunities and **reduce time to customer feedback**.



**Accelerate Software Delivery – i.e Open source Git, Ansible, Jenkins, integrate with IBM RTC**

Expanding collaboration to include customers, LOB and others to eliminate organization silos

**Balance speed, cost, quality and risk**

Automating manual processes across delivery lifecycle to eliminate waste/delays and compliance tracking

**Reduce time to customer feedback**

Enabling a customer feedback loop for continuous improvement

# Splunk Enterprise – DevOps to turn Machine Data Into Answers on IBM Z

## Confirm support for your computing platform

1. Find the operating system on which you want to install Splunk Enterprise in the **Operating system** column.
2. Find the computing architecture in the **Architecture** column that matches your environment.
3. Find the type of Splunk software that you want to use: Splunk Enterprise, Splunk Free, Splunk Trial, or Splunk Universal Forwarder.
4. If Splunk software is available for the computing platform and software type that you want, proceed to the [download page](#) to get it.

## Unix operating systems

Operating system	Architecture	Enterprise	Free	Trial	Universal Forwarder
Solaris 10 and 11	x86 (64-bit)				X
	SPARC				X
Linux, kernel version 2.6 and later	x86 (64-bit)	X	X	X	X
Linux, kernel version 3.x and later	x86 (64-bit)	X	X	X	X
PowerLinux, kernel version 2.6 and later (includes Big Endian and Little Endian versions)	PowerPC				D
zLinux, kernel version 2.6 and later	s390x				X

<http://docs.splunk.com/Documentation/Splunk/7.0.1/Installation/Systemrequirements>

The IBM Common Data Provider for z Systems (CDPz) data sources in z/OS can capture and forward from:

- SYSLOG/OPERLOG
- JOBLOGs, with custom mapping of WebSphere and CICS JOBLOGs
- SMF Records
- NetView for z/OS logs
- Unix System Services syslogd and files

CDPz can send the data to any target that can receive data over an IP port. It provides custom integration for the following software products:

- IBM Operations Analytics for z Systems
- The Elastic Stack (ElasticSearch, Logstash, Kibana)
- **Splunk**

[https://www.ibm.com/support/knowledgecenter/SSGE3R\\_1.1.0/com.ibm.cdpz.doc/welcome.html](https://www.ibm.com/support/knowledgecenter/SSGE3R_1.1.0/com.ibm.cdpz.doc/welcome.html)

# IBM Java, JVM Version 8.0.5 (IBM Java 8 SR5)

## Pause-less Garbage Collection

- Up to 10x reduction in GC pause times

## Improved application ramp-up

- Up-to 50% less CPU to ramp-up to steady-state

**The mainframe is  
not a coffee  
machine.**

**But it does do  
awesome Java.**



## Java™ on System z®? Naturally.

Two pervasive technologies ..... combine for powerful performance.....that everybody's talking about.

There are **9 million** Java developers

**15%** increase in application performance

**5x** faster DB-response time

**20%** greater processing capacity

z/OS is probably the most efficient place to run Java.

You put the code where the data is, and you get to remove any network latency...

80% of the world's corporate data resides on or originates on the **mainframe**

when DATEV eG ported business rules from a distributed server into CICS® Java

I've been impressed of late with the mainframe's Java support. It runs fast. It runs on the zAAPs. It runs all sorts of Java things without any recoding effort.

Since the z9 was introduced, Java performance has exploded five times and it hasn't finished on that curve...

David Hodgson, techrepublic.com

Scott Chapman, cmg.org

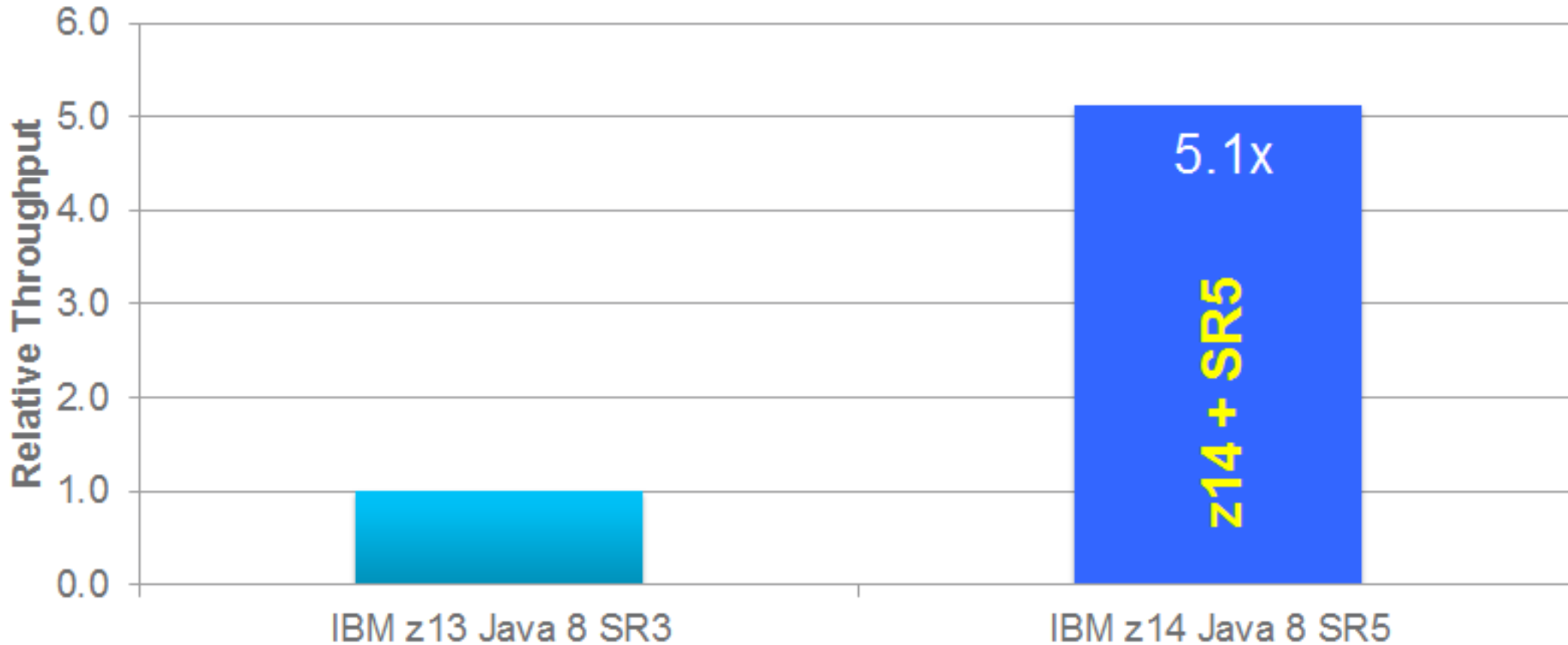
Scott Fagen, enterprisesystemsmedia.com



random

celerator

# Liberty DayTrader 3 – Linux on Z – AES-GCM z13 vs z14



**IBM z14 + Java 8 SR5 AES-GCM cryptography up to 5.1x better throughput over z13 + Java 8 SR3**

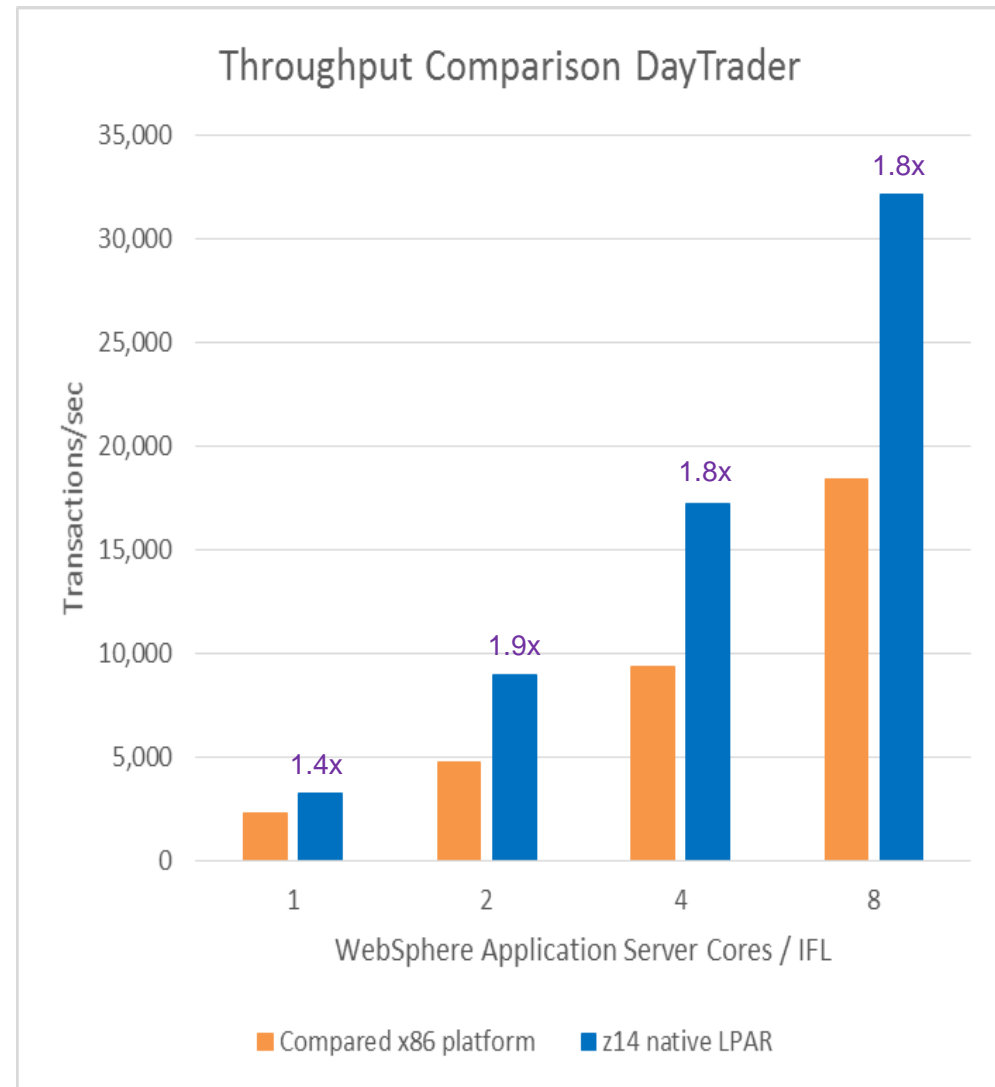
(Controlled measurement environment, results may vary)

IBM Liberty 8.5.5.9 with IBM Java 8 SR3, SR5  
IBM z13 + IBM z14 – SLES 12 SP1 – 4 IFLs SMT-2  
DayTrader 3

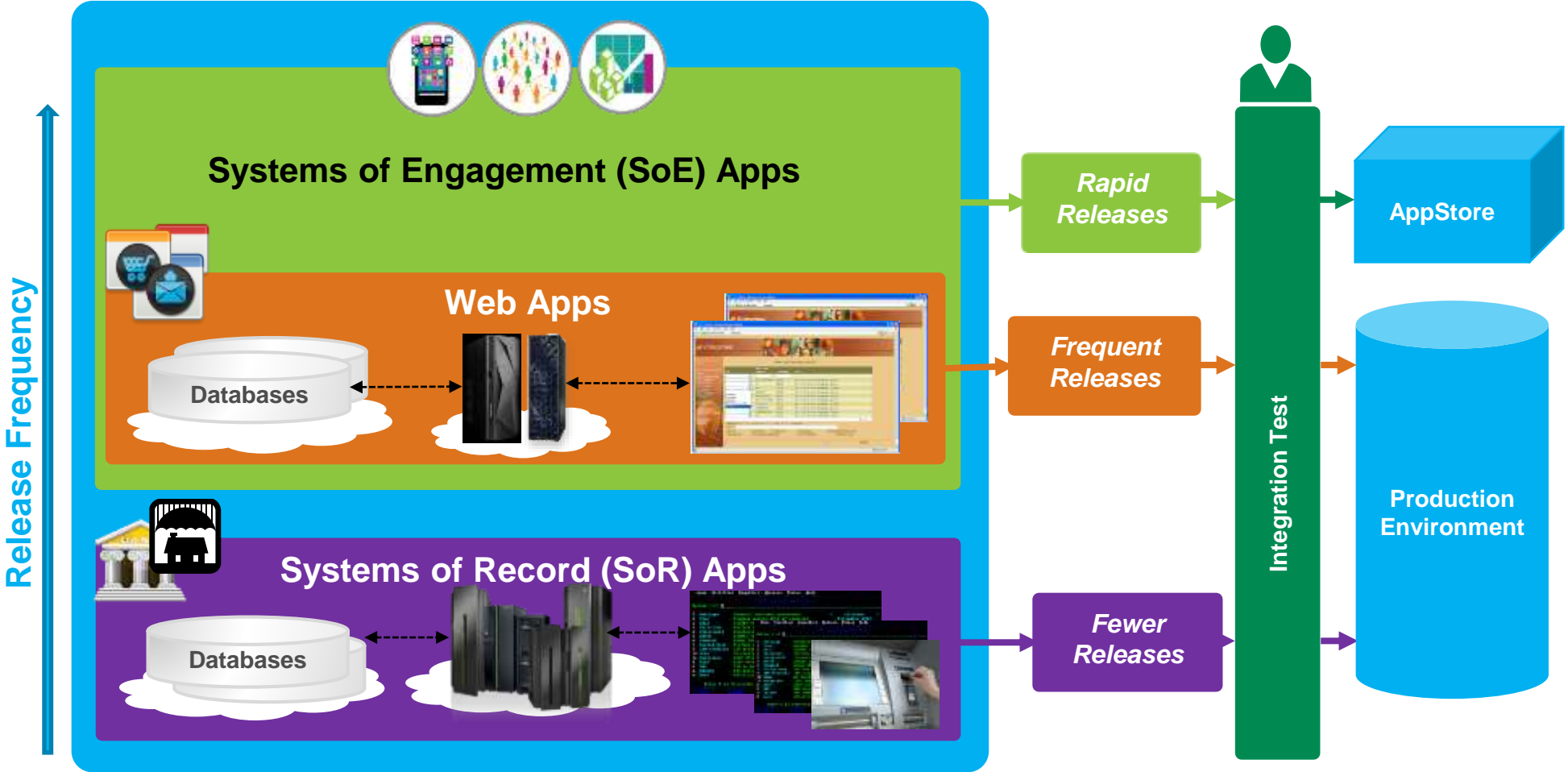
# WebSphere Application Server Performance on z14 vs x86 Broadwell

**Run the DayTrader benchmark on WebSphere Application Server 8.5.5.9 with up to 1.9x more throughput per core on a z14 LPAR versus a compared x86 platform**

**Disclaimer:** Performance results based on IBM internal tests running Daytrader 3 web application benchmark on Websphere Application Server WAS 8.5.5.9 with IBM Java 1.8.0 (SR3). Database DB2 LUW 11.1.1.1 located on the same system was used to persist application data. Half of the compute cores for each system variation under test were bound to DB2, the other half to WAS. The workload was driven remotely by Apache JMeter to trade 10000 stocks among 15000 users. The utilization of the workload was adjusted by the number of driver threads. Results may vary. x86 configuration: 2-16 Intel(R) Xeon(R) CPU E5-2697 v4 @ 2.30GHz, 1.5TB fast TruDDR4 2400MHz Memory, and 400GB local HDD storage, SLES12 SP2 with Hyperthreading enabled. z14 configuration: LPAR with 2-16 IFLs, running under SLES12 SP2 (SMT mode), 64GB memory, 80GB DASD storage, HyperPAV=8.



# Multi-speed IT → Systems of Record Application Release Cycles are Far Slower than Mobile Application Release Cycles



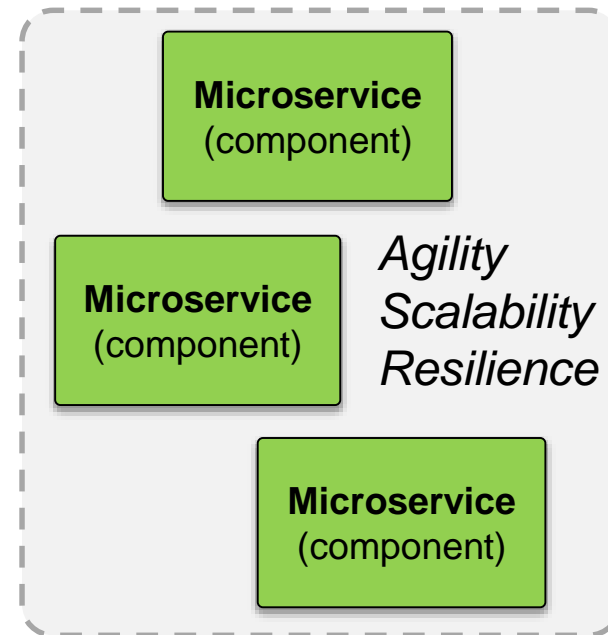
# Microservices for application flexibility



Simplistically, microservices architecture is about **breaking down** large silo applications into more **manageable fully decoupled pieces**



Monolithic application



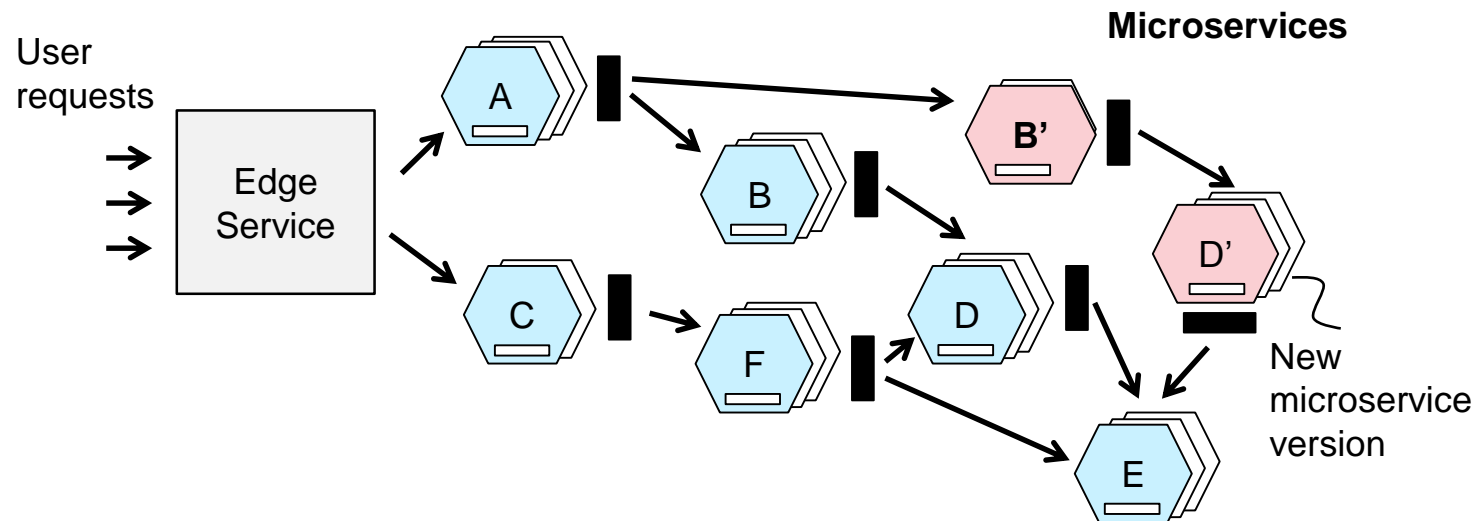
Microservices application

# Workload flexibility with Microservices



It is clear how the Microservices principles work in concert to enable *agility* – *what's not to love about them?*

- The challenge: While updating each individual Microservice is simplified, the complexity shifts to managing a large system of Microservices



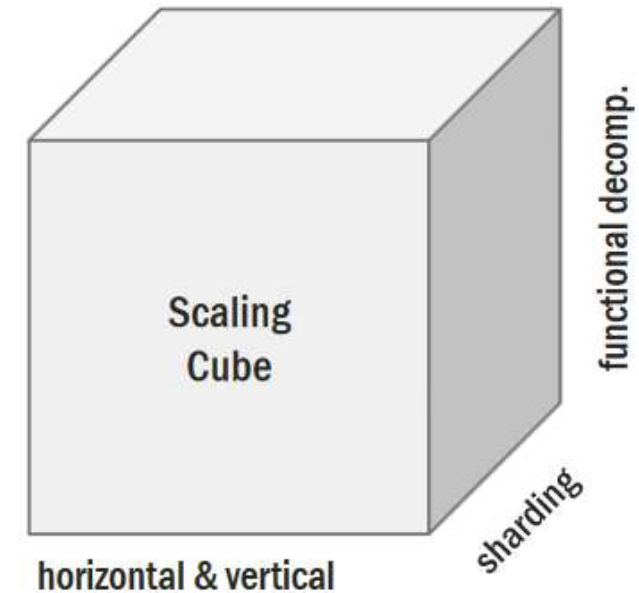


# Microservices – Best Fit for IBM Z

## Independent Scaling

Each microservice can be scaled independently

- ✓ Identified bottlenecks can be addressed directly
- ✓ Data sharding can be applied to microservices as needed
- ✓ Parts of the system that do not represent bottlenecks can remain simple and un-scaled



## Stable & standardized : Endpoints

Communication between microservices is often standardized using

- ✓ HTTP(S) – battle-tested and broadly available transport protocol
- ✓ REST – uniform interfaces on data as resources with known manipulation means
- ✓ JSON – simple data representation format
- ✓ REST and JSON are convenient because they simplify interface evolution



# Microservices implementation in Containers

Containers, a form to build, ship, and run **Microservices** applications in “containers”.  
Developers & SysAdmins love the **flexibility and standardization** of Docker containers



Standardization → Application encapsulation

Package, ship, and run applications flexible  
The Docker Hub Registry has 5,000+ “Dockerized” applications

## Lightweight

Containers are “light” users of system resources, **smaller** than VMs, start up **much faster**, and have **better performance**



## Ecosystem-friendly

A **new industry standard**, with a vibrant ecosystem of partners.  
750+ community contributors; 50,000 third-party Docker projects on GitHub

## User-friendly

Developers build with ease and ship **higher-quality applications**  
SysAdmins deploy workloads based on **business priorities** and policies.



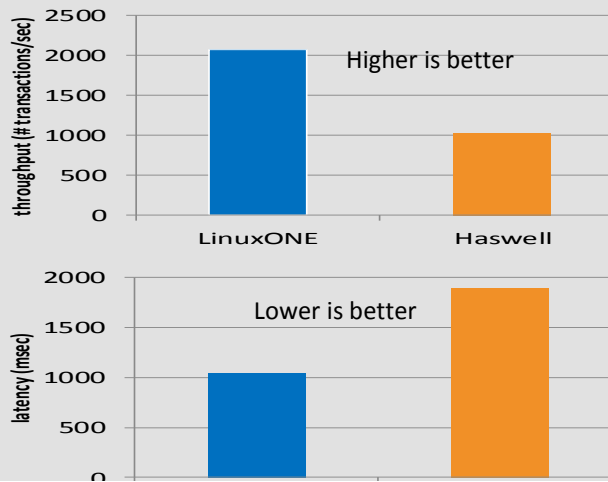
# Linux on IBM Z or LinuxONE and



# Containers

## Extreme Virtualization with Containers

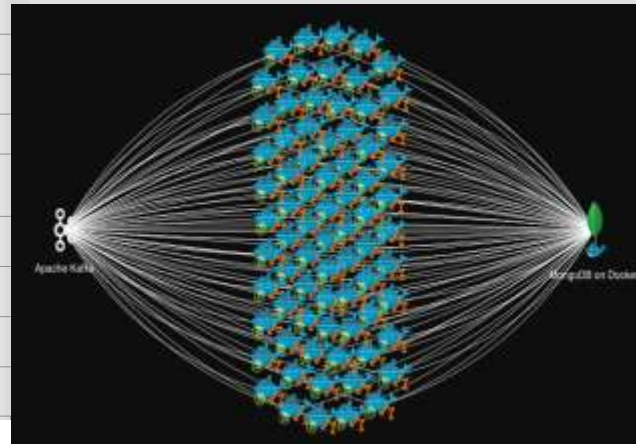
- A single LinuxONE Emperor ran more than **2 Million** containers
  - Workload: busybox httpd server (no NAT)
- LinuxONE Emperor runs **2000+** containers on avg **2.0x** better than a compared Haswell-based system
  - Workload: Apache Solr
- LinuxONE Emperor can host over **10k** containers
  - Workload: 4k Apache Solr + 6k busybox httpd server (no NAT)



The throughput and response-time for a single Linux host running 4096 containers

## Multi-Layer Auto Scaling

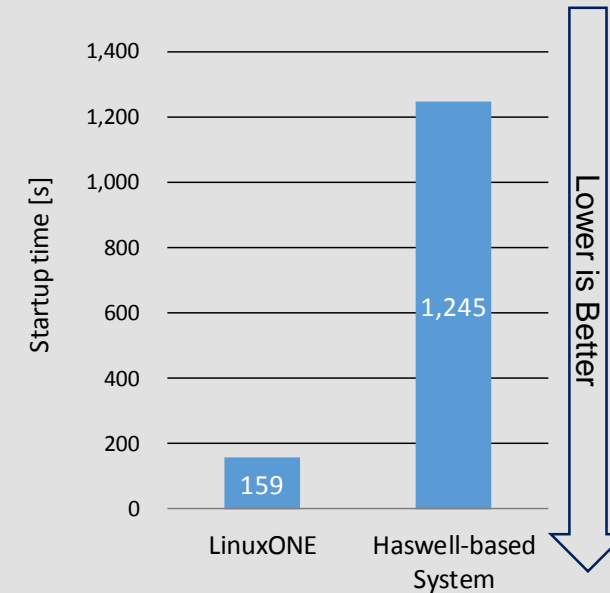
- Manage multiple virtualization layers to minimize the amount of resources to meet a SLA for a wide range of workload demand.
  - Start a set of containers when an application-level bottleneck is detected
  - Start a Docker Engine daemon in the same host when a daemon-level bottleneck is detected
  - Start an OS when an OS-level bottleneck is detected
  - Adjust the hardware resources such as CPU, memory, and I/O dynamically when a HW-level bottleneck is detected according to the workload demand



## Extreme Agility with Containers

- LinuxONE Emperor can start containers **7.8x faster** than a compared Haswell-based system.
  - Workload: nginx
- Significant agility to adapt to dynamic workload behavior

The startup time of 1024 containers with 1 daemon and 64 clients



# IBM Db2 Warehouse (formerly dashDB Local)

## Benefits of dashDB Technology with Fast Deployment into Private Cloud Environment

Private or Virtualized  
Private Cloud



Docker Container  
Technology



dashDB Technology



MPP with  
Automatic Scaling



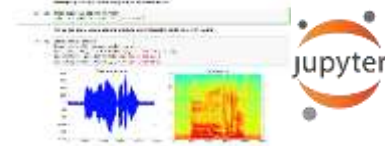
- Highly flexible data warehouse
- Optimized for fast and flexible deployment into **private or virtual private clouds**
- Uses **Docker** container technology
- Built on top of **dashDB technology**, it shares the benefits of
  - **BLU Acceleration in-memory columnar technology**
  - **Oracle Compatibility**
- **Massively Parallel Processing (MPP)** with automated scaling capabilities to increase infrastructure efficiency

# Db2 Warehouse (dashDB Local) - In-database Analytics for Spark

<https://www.youtube.com/watch?v=nAD4RgI5MNk>

❑ A DWH talking Spark **out-of-the-box** offering lot's of **new possibilities**

❑ **Interactive DWH data exploration**



❑ **Interactive Data Science** with ML libraries



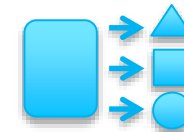
❑ **Operationalize**: Deploy your Spark application in a **scalable** and **secure multi tenant** environment



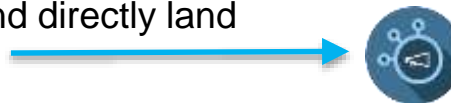
❑ **Modernize** your **SQL** applications with integrated **ML**



❑ **ELT**: Run **complex** feature **extraction** and **transformation** in DWH



❑ **Real-Time Analytics**: **subscribe** and directly land **stream data** into your DWH



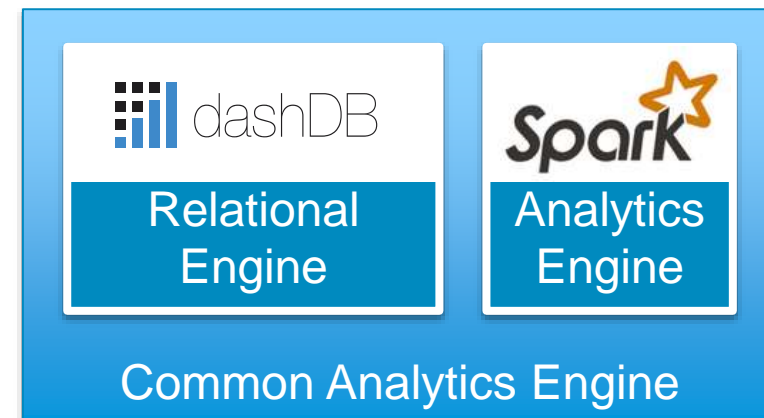
❑ **Data Sources**: Read data from other data formats and sources, such as **object store**



❑ **Deploy & run** your **Python** data processing via REST



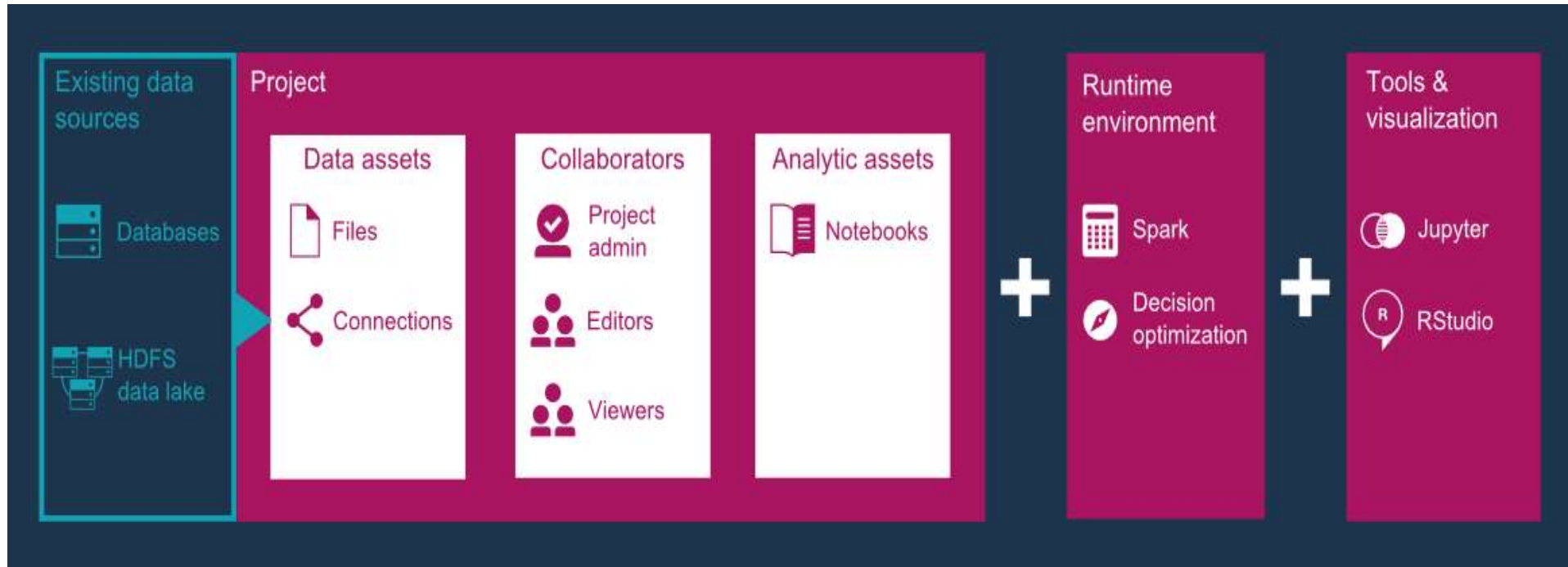
**End-to-End: Creating -> Deploying -> Hosting** your analytic solutions



# Data Science Experience (DSX) local

## Analytics and Machine Learning for Linux on IBM Z or LinuxONE - available since 10/2017

- out-of-the-box on premises enterprise solution for data scientists and data engineers.
- offers a suite of data science tools, such as Spark, Jupyter and Zeppelin notebooks, that are integrated with IBM technologies



<https://datascience.ibm.com/docs/content/local/overview.html>

New

# Docker Enterprise Edition on IBM Z

## The Safest Way to Run Apps with the Most Secured and Reliable System



Usable  
Security



App Secrets



Dev/Ops  
Workflow



Secure by  
default runtime



Trusted  
Delivery



Image Signing  
& Verification



Image  
Scanning



Encryption at  
Rest



TLS Encryption



Infrastructure  
Independent



Users & RBAC



Physical



Virtualization



Public Cloud



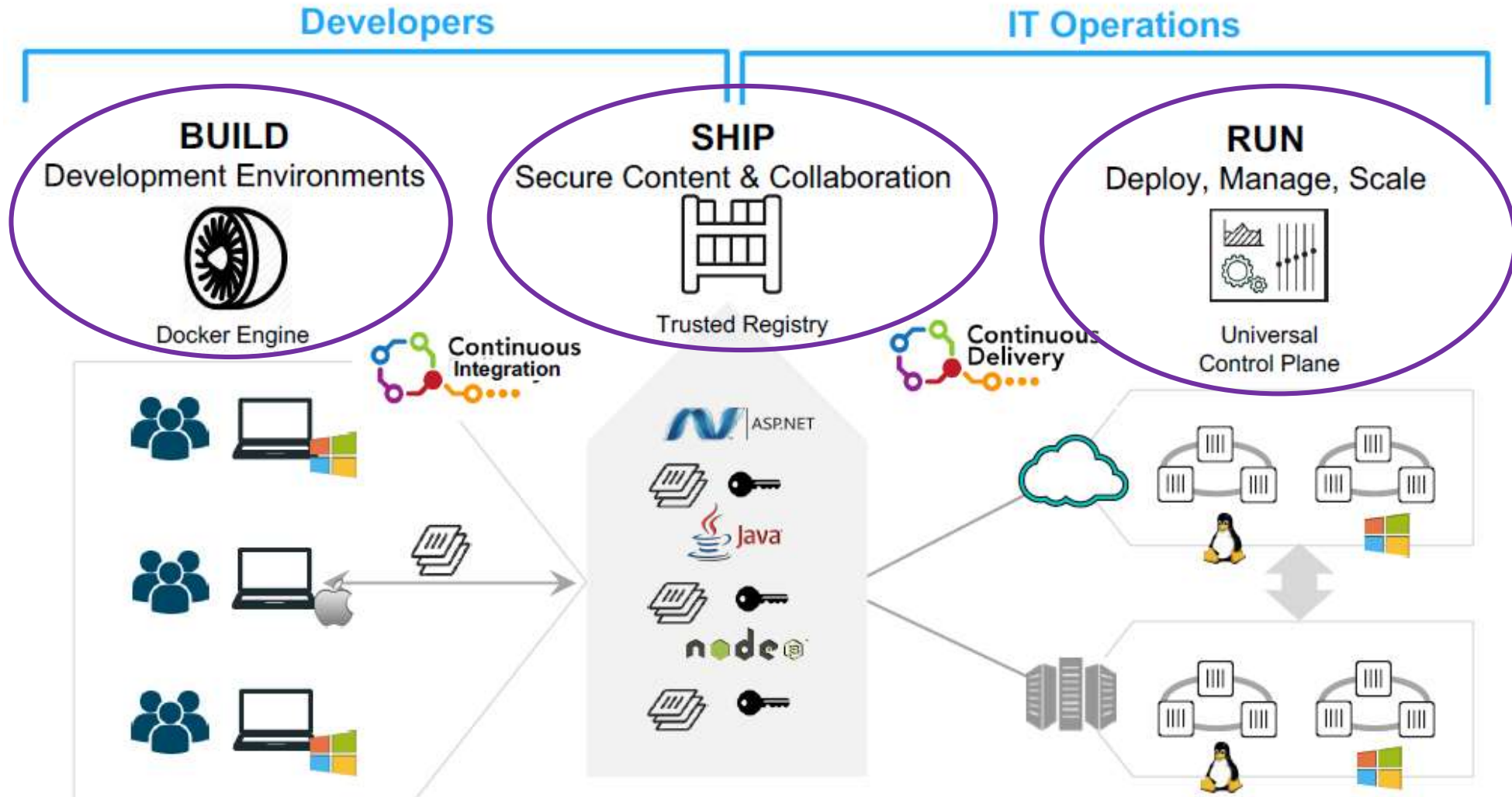
Safer Apps



Secure  
Service  
Container

# Docker Enterprise Edition (EE) for Linux on IBM Z and LinuxONE

Flexibility, DevOps, Application isolation, rapid scalability & deployments



<https://www.youtube.com/watch?v=Acj0NMENkck>



New

# IBM Secure Service Container (not Docker )

*Delivering secure digital experiences that can change the world*



Secure  
Service  
Container

- Simplified, fast deployment and management of packaged solutions
- Tamper protection during appliance installation and runtime
- Confidentiality of data and code running in appliance – at flight and at rest
- Management via Remote APIs (RESTful) and web interfaces



## The Right Access for the Right Users

### IBM Secure Service Container

#### Protects Against Misuse of Privileged User Credentials

*Operating environments and data are protected against access and abuse by root users, system administrator credentials, and other privileged user access*

## Insecurity of Privileged Users

**80%**

*Of threats are internal<sup>1</sup>*

**58%**

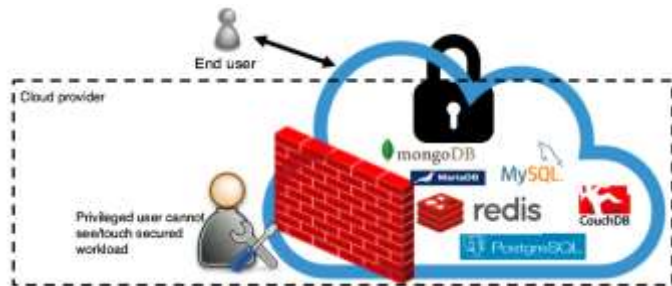
*Of IT Operations and Security Managers believe their organizations are unnecessarily granting access to individuals beyond their roles and responsibilities<sup>1</sup>*

<sup>1</sup> <https://www.forcepoint.com/resources/industry-analyst-reports/2016-study-insecurity-privileged-users>

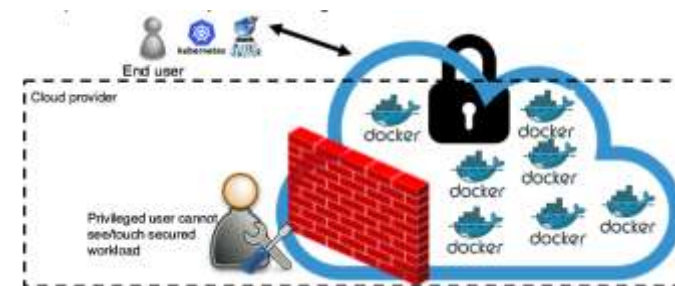
# Use cases for Containers and Secured Service Containers (SSC) are Hyper secure DBaaS , Secure sCaaS & Blockchain



**DBaaS:** Run databases in hyper-secure infrastructure offering private and secure system-of-record qualities of service in a public cloud setting



**sCaaS:** SoD: Run mission-critical workloads in hyper-secure infrastructure offering private and secure system-of-record qualities of service in a public cloud setting

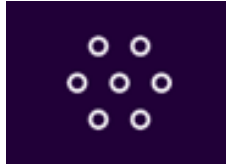


Run **IBM Blockchain** on a secure, tamper-proof hyper-secure infrastructure in a public and private cloud offering



# IBM Cloud Private

## - a multi-cloud solution using seamless experience



**Choice with consistency**



**Hybrid integration**



**DevOps productivity**



**Powerful, accessible data and analytics**



**Cognitive solutions**

### 1 | Public

Maximize on cloud economics and agility.

### 2 | Dedicated

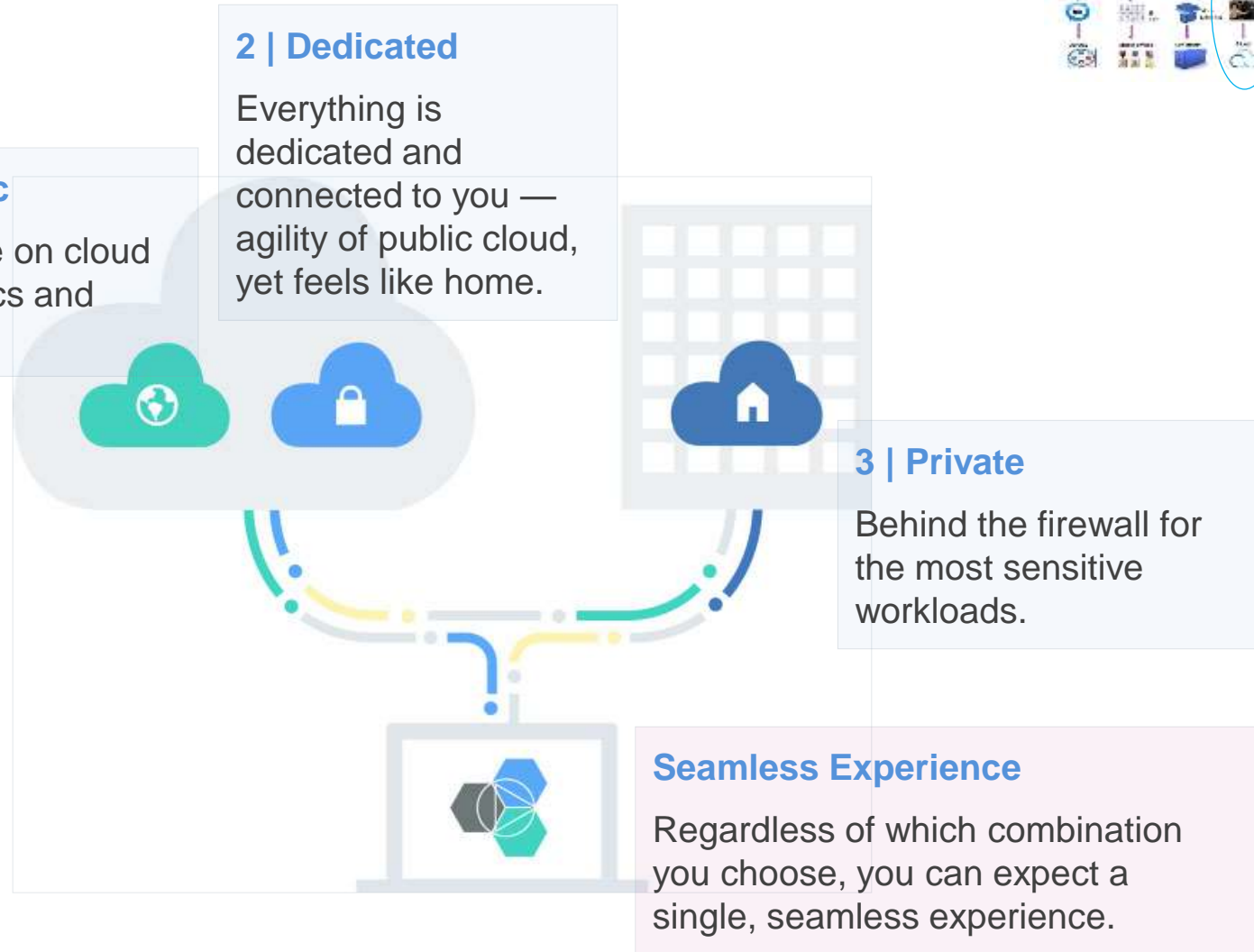
Everything is dedicated and connected to you — agility of public cloud, yet feels like home.

### 3 | Private

Behind the firewall for the most sensitive workloads.

### Seamless Experience

Regardless of which combination you choose, you can expect a single, seamless experience.



# IBM Cloud Private (ICp) addresses enterprise use cases

## Use Case #1

Modernize and optimize existing applications

## Use Case #2

Opening up enterprise data centers to work with cloud services

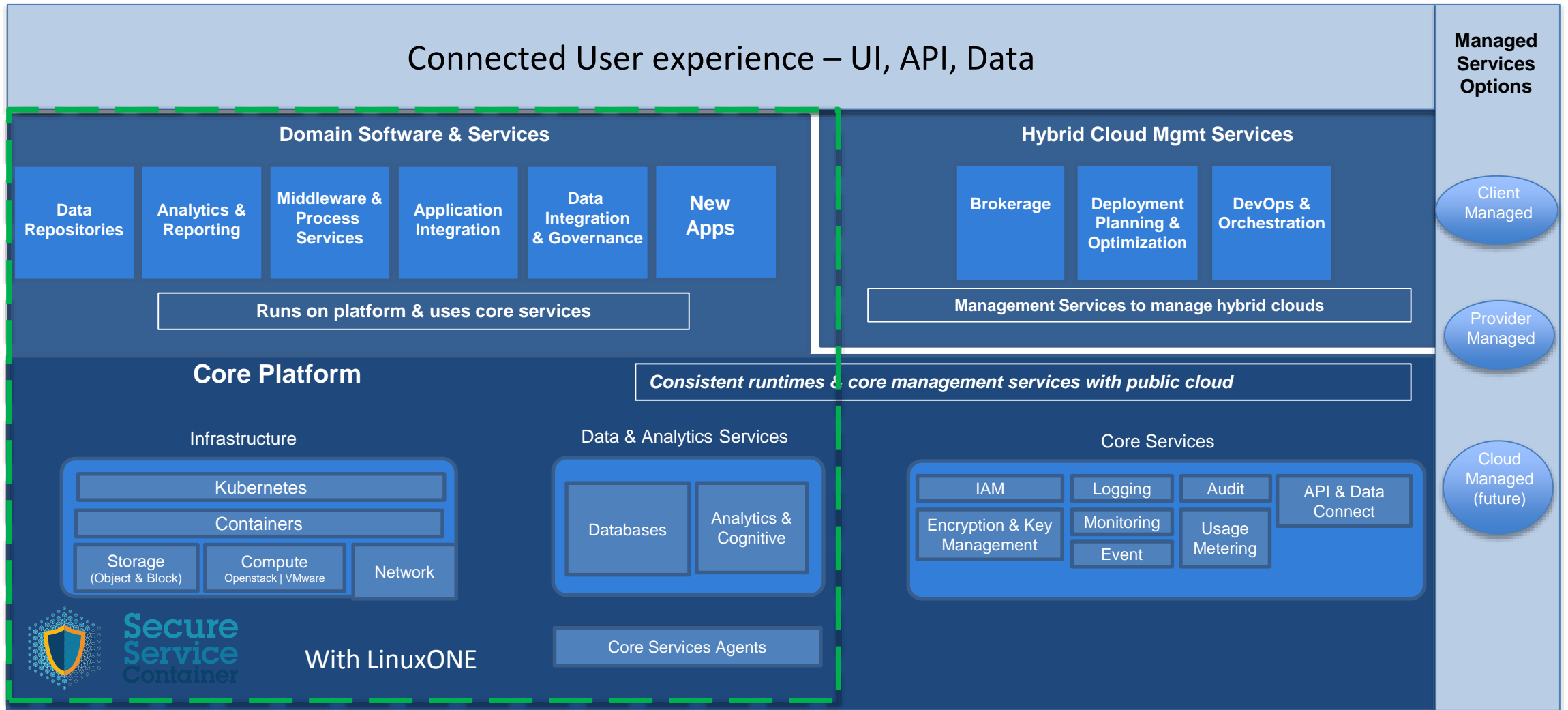
## Use Case #3

Create new cloud-native applications



IBM Cloud Private

# IBM Cloud Private Architecture on LoZ / LinuxONE



- Integrated cloud platform for enterprise workloads which need to be run in a customer controlled and secure environment

## The security dream ...

what if you could just encrypt all data in-flight and at-rest

- at no cost
- w/o changing applications
- w/o changing data management
- by pushing a single button



Well, that will remain to be a dream.

But with **pervasive encryption and IBM z14 technology** we make a large step in that direction.

# Pervasive Encryption with IBM Z

*Technical Foundation – Linux on z related*

## IBM z14 -- Designed for Pervasive Encryption

- ✦ CPACF – Dramatic advance in bulk symmetric encryption performance
- ✦ CryptoExpress6S– Doubling of asymmetric encryption performance for TLS handshakes

## Linux on z and LinuxONE -- Full Power of Linux Ecosystem combined with IBM z14 Capabilities

- ✦ dm-crypt – Transparent volume encryption using industry unique CPACF protected-keys
- ✦ Network Security – Enterprise scale encryption and handshakes using z14 CPACF and SIMD
- ✦ Secure Service Container – Automatic protection of data and code for virtual appliances

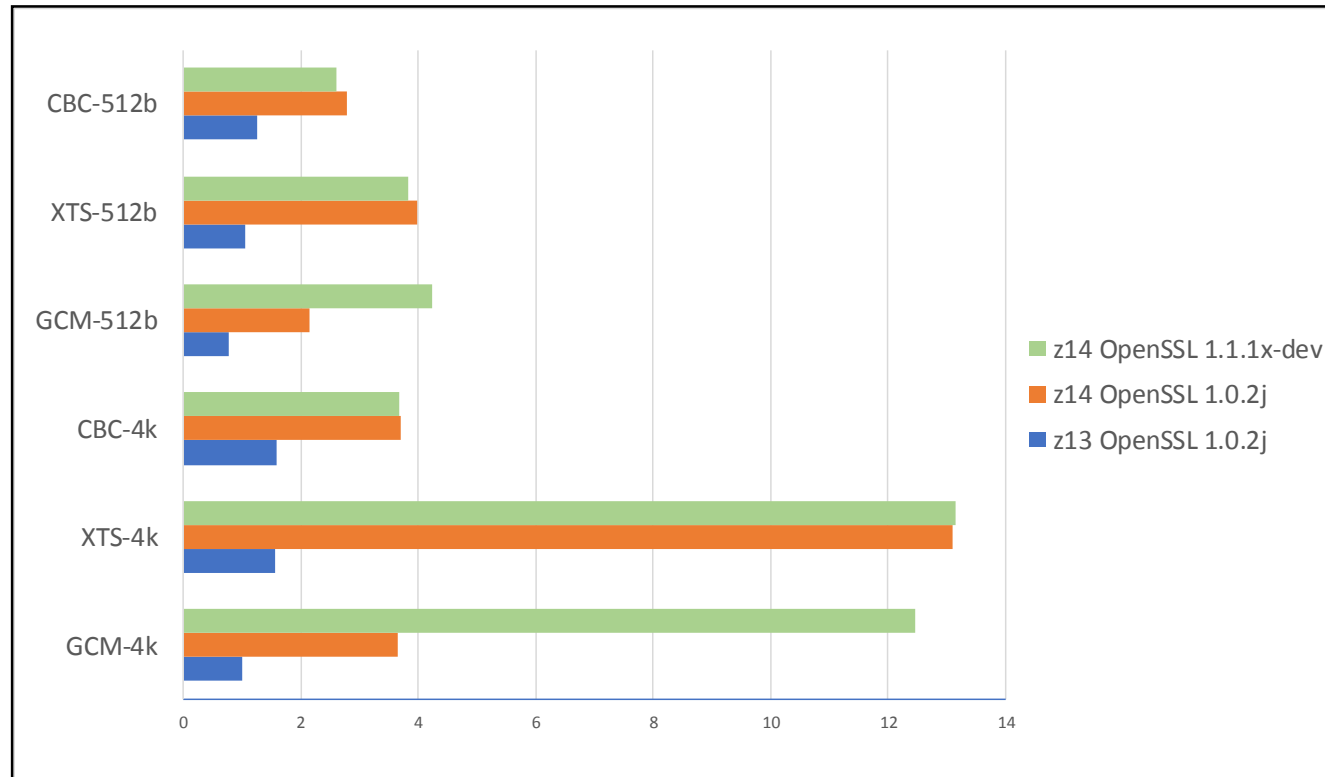
## z/VM – New: Encrypted paging support

# IBM z14 HW optimization: CPACF relative performance – OpenSSL AES-256 encryption

## Performance that Changes the Game for Security

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

**2x** the SSL handshake performance on z14 with Crypto Express6S compared to z13 with Crypto Express5S<sup>1</sup>




- **SLES 12.2+, single core**
- **OpenSSL speed with 4k and 512b payloads**
- **All numbers relative to GCM-4K**
- **OpenSSL 1.0.2j as included with SLES 12.2+**
- **OpenSSL 1.1.1x development version**
- **Larger payload helps throughput**



# Pervasive Encryption with Linux on z: Data in Flight

- **openSSL and libcrypto**
  - de-facto standard TLS & crypto libraries
  - used by many open source projects (including Apache, node.js, MongoDB)
  - exploitation of z Systems CPACF and SIMD code by libcrypto (w/o ibmca engine)
  - focus on TLS 1.2 and 1.3 ciphers
  - no z Systems specific configuration required
- **IPsec**
  - bulk encryption and authentication implemented by kernel crypto
  - transparently uses CPACF
- **GSKit**
  - IBM C library for TLS and crypto
  - e.g. used by IBM HTTP Server (IHS)
  - uses IBM z CPACF
  - future release will use new z14 CPACF instructions
- **Java 8 / JCE**
  - exploitation of IBM Z CPACF and SIMD code
  - future release update will use z14 CPACF instructions



openssl  
patches  
submitted  
upstream  
but not yet  
accepted

# Pervasive Encryption for Data at Rest on Linux on Z

- **dm-crypt: block device / full volume encryption**
  - uses kernel crypto
  - granularity: disk partition / logical volume
  - new protected key option
- **ext4fs with encryption option: file system encryption**
  - uses kernel crypto
  - granularity: file, directory, symbolic link
- **Spectrum Scale (GPFS) with encryption option: file encryption**
  - uses GSKit or CryptoLite (aka Clic)
  - granularity: file
- **NFS v4 with encryption option: encryption of file transport**
  - uses kernel crypto
- **SMB v3.1: encryption of file transport**
  - uses kernel crypto
- **DB2 native encryption: data base encryption**
  - uses GSKit



kernel crypto  
automatically uses  
CPACF for AES if the  
module `aes_s390` is  
loaded

GSKit and latest  
versions of Clic use  
CPACF for AES



# Use Case 1: Mongo DB Server

“As a user I want to run a no-SQL DB service using an existing open source DB where all data in flight and at rest is transparently encrypted”

## data in flight:

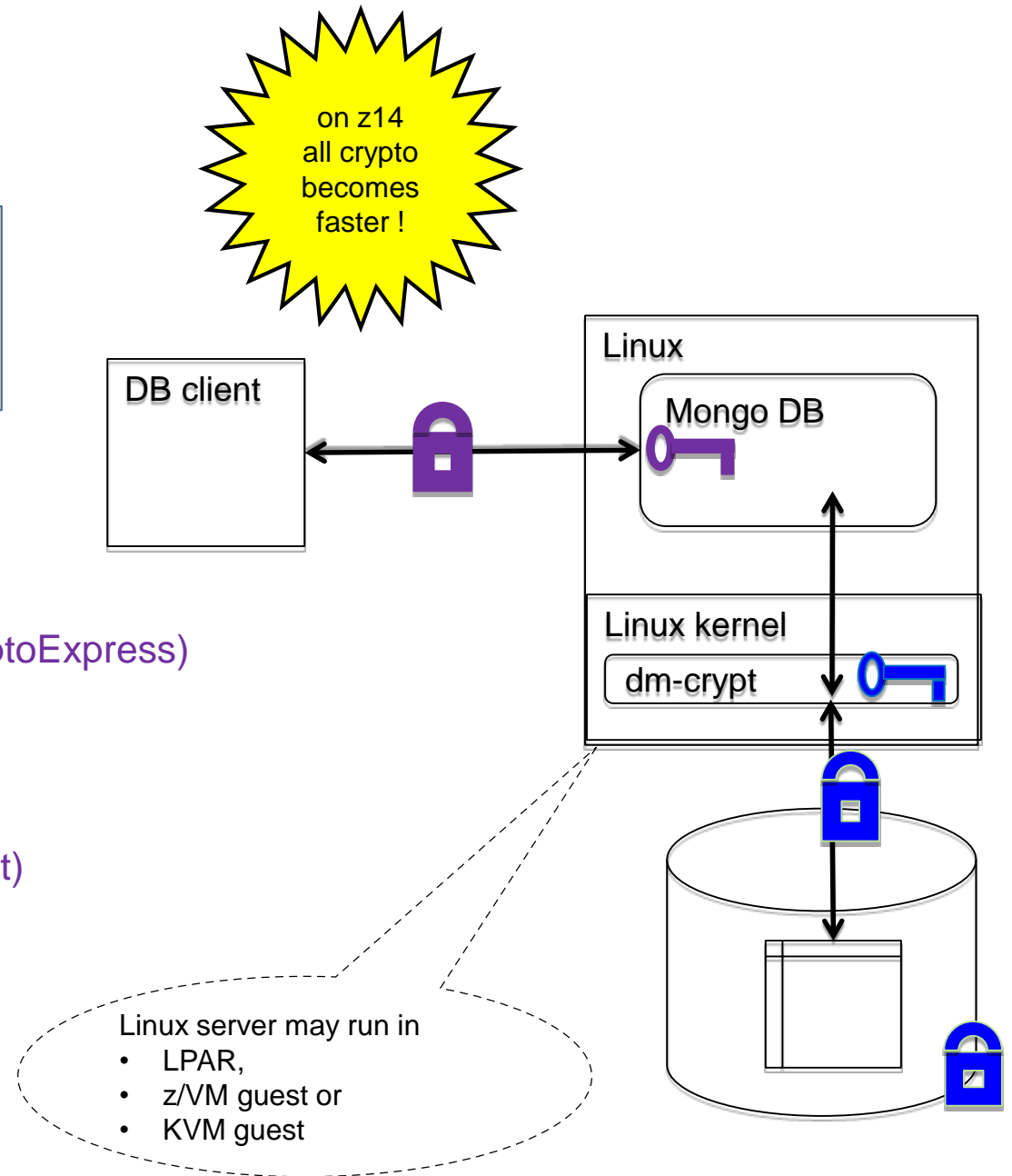
- encrypted connection by DB server (-> openssl)
- encrypted Linux sessions via ssh (-> openssl)
- *transparent* usage of CPACF by openssl
- symmetric (CPACF) and asymmetric encryption (SIMD or CryptoExpress)

## data at rest

- end-to-end volume level encryption by Linux kernel (dm-crypt)
- *transparent* usage of CPACF by Linux kernel
- protected key option possible

## secure manner of key generation

- CPACF true random numbers are fed in kernel entropy pool



# Use Case 2: Mobile Server Farm in a Trusted HV

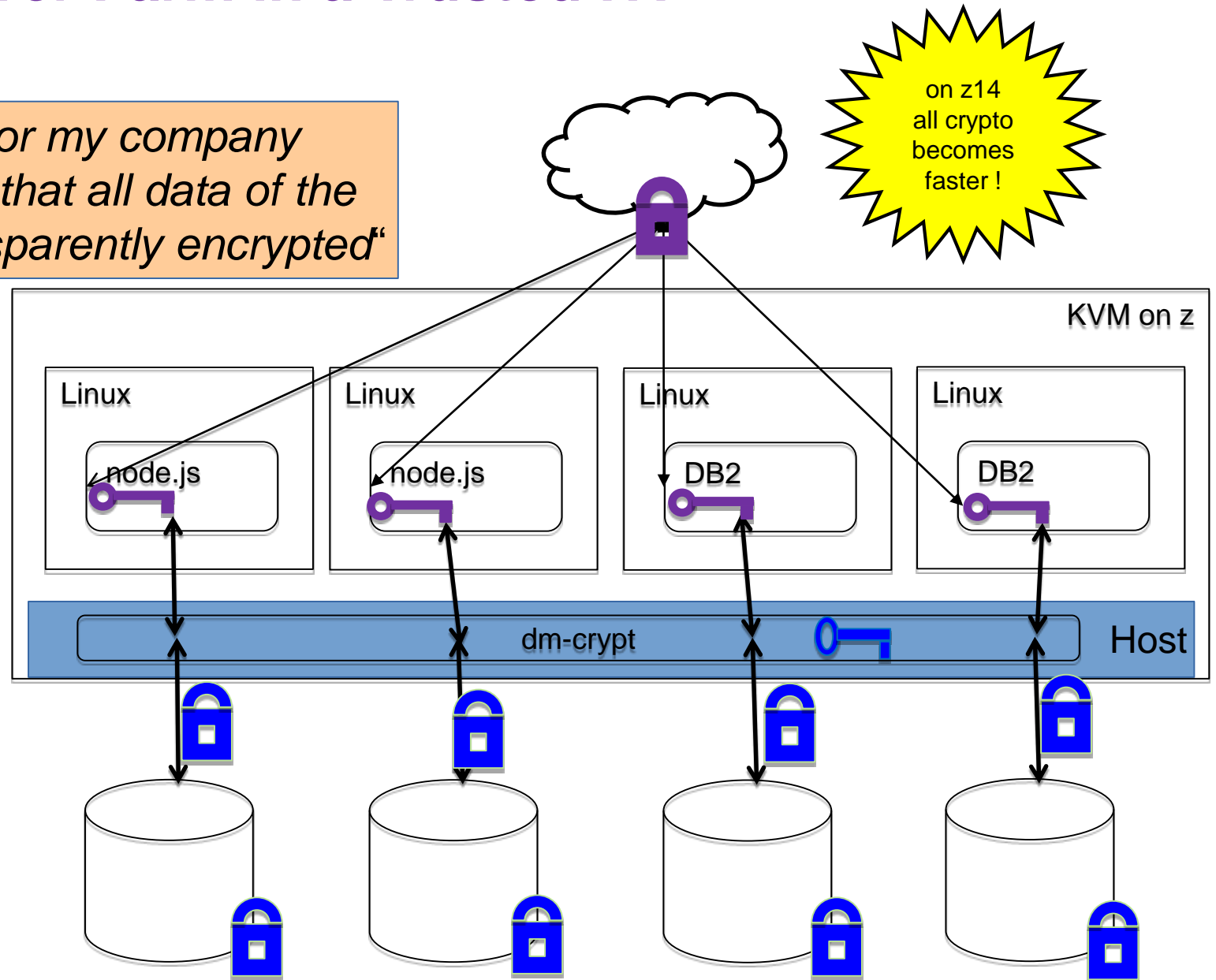
*“As an operator of a data center for my company I want to host a server farm such that all data of the provisioned servers shall be transparently encrypted”*

## data in flight:

- per guest NW encryption in node.js or apache or DB2
- transparent usage of CPACF and SIMD via openssl or GSKit

## data at rest:

- end to end encryption of all real volumes by KVM
- transparent usage of CPACF via kernel and dm-crypt
- protected key option possible



# Linux on IBM Z Technology: Not a “box” but “Linux Your Way”

**IBM**

The Open Mainframe Project

Open-Source Community Contributions

IBM Research Projects: DREAM ALS Challenge

IBM Linux Technology Centers

Open Access to LinuxONE Community Cloud

Academic Initiative and Training Programs

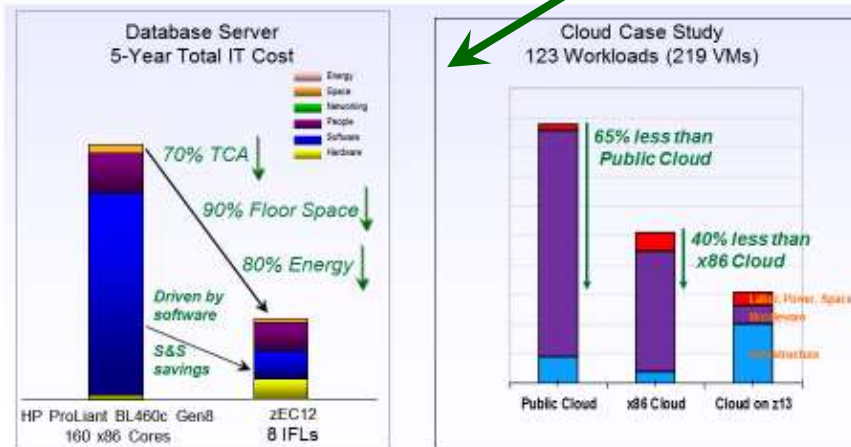
**AN OPEN ECOSYSTEM**  
to fuel innovation and progress

**LinuxONE™**

“Linux Your Way” means a commitment to:

- An Open Source Ecosystem
- Unmatched TCA with unmatched scale
- The best performance

## Linux and z Systems: The Most Efficient Platform for Cloud and Consolidation



Delivering the fastest virtual Linux servers on the planet to users for less than \$0.70 per day

**Linux WITHOUT LIMITS**

Differentiate yourself in a world of standards. Lightning fast response times and virtually unlimited scale gives your apps the premium Linux experience they deserve.

**LinuxONE™**

- 30B RESTful web interactions per day with over 470K database read and writes per second
- Scale out: 8K virtual servers in a single system, tens of thousands of containers.
- Scale up: Supports tens of thousands of concurrent users; run test, dev and production in a single system. Shared resources and shared development environments mean greater productivity.
- Built for speed: The industry's fastest processor, biggest I/O pipe, 10TB memory, four levels of cache...and more to deliver sub-second end user response time to thousands of concurrent users.
- On-demand resourcing: Spin up containers and virtual servers in minutes. Add physical resources automatically (permanently or temporarily) in seconds. Enjoy automated resource provisioning and reallocation. Run at 100% utilization.

2x better performance for open SQL and NoSQL database

Largest single DB node with response times under 5ms; avoid cost, complexity, and overhead of sharding

# Summary: Best Fit solutions on Linux on IBM Z

The comprehensive ecosystem is based on solutions from IBM, ISVs and open source.

- Cognitive and analytics solutions, Database solutions, Data management solutions

Cognitive and solutions on IBM Z provides a modern, cost-competitive infrastructure with offerings ready for analytics and big data initiatives across all of your data sources

- Integration and messaging solutions

Integrated systems and applications deliver a differentiated customer experience

- Content management solutions

Enterprise Content Management puts business content to work and allows organizations to realize new value

- DevOps and application development

Virtualized, integrated solutions for application development leverage IBM Z servers and Linux for agile and innovative next generation apps

( [ibm.com/it-infrastructure/z/os/linux](http://ibm.com/it-infrastructure/z/os/linux) )

- Container solutions

Take advantage of the capacity, security and reliability of IBM Z

- Blockchain solution

Takes advantage of the cryptography, security and reliability of Z

- Mobile and Web serving solutions

Sync existing IBM Z apps and queries via API connectivity to next gen apps, mobile and cloud environments

- Security and availability solutions

A full range of security features, z14 enables pervasive encryption, and applications are available from IBM, vendors and open source

- Open software solutions

The growing ecosystem of open source software on IBM Z helps on the innovation and quality of service of next gen apps

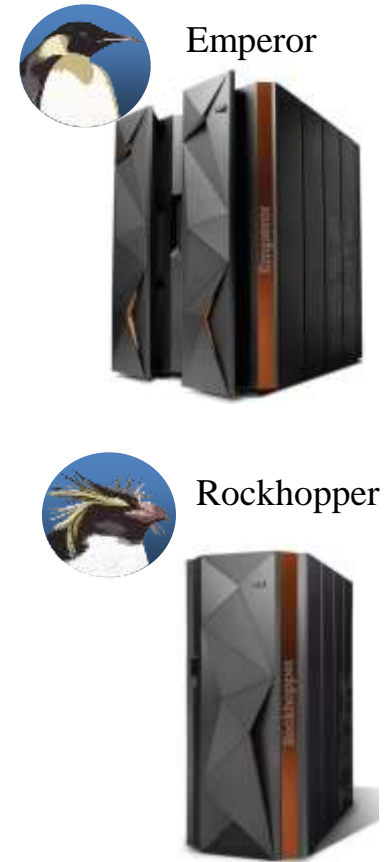
- Vendor software solutions

IBM Business Partners and independent software vendors (ISV) offer a broad range of software and solutions, incl. SAP, Oracle, Temenos

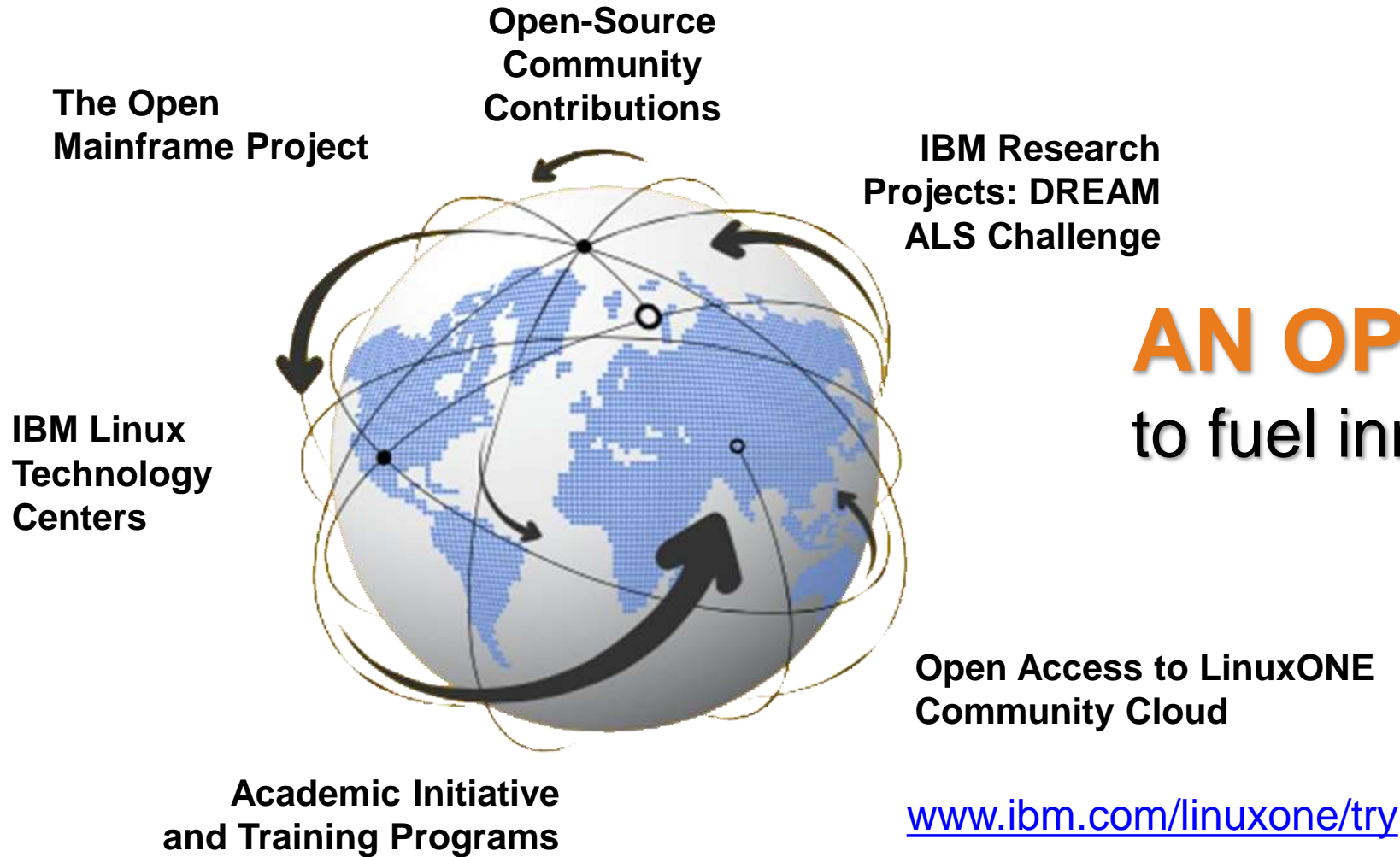
# Linux and IBM Z

## Open Source & ISV Ecosystem Community

- One stop shop to find out what is available
  - <https://www.ibm.com/developerworks/community/groups/community/lozopensource/>
- Information on all open-source software
  - Recipes for building the software on Linux and IBM Z
  - Pointers to binaries if available
  - Other related news and information
- Build recipes and how-tos on GitHub
  - <https://github.com/linux-on-ibm-z/docs/wiki/>
- Open to every one interested in Linux and IBM Z
  - Users can post questions/comments
  - Provide feedback to the Open Source & ISV Ecosystem team
- **We look forward to hearing from you!**



# Linux on IBM Z and LinuxONE – the Open Ecosystem



**IBM LinuxONE™**

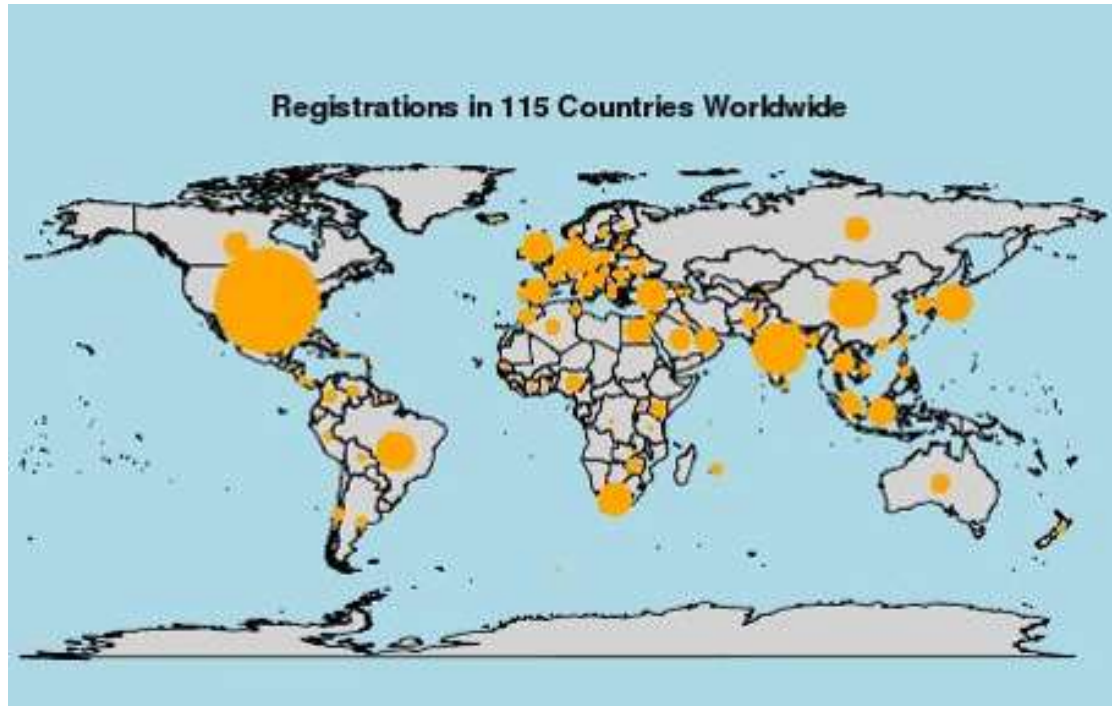
**AN OPEN ECOSYSTEM**  
to fuel innovation and progress

[www.ibm.com/linuxone/try](http://www.ibm.com/linuxone/try)



# IBM LinuxONE Community Reach

Over 3300 Registered Users WW



# The Open Mainframe Project

<https://www.openmainframeproject.org/>

THE **LINUX** FOUNDATION **PROJECTS**



[HOME](#) [ABOUT](#) [RESOURCES](#) [BLOG](#) [NEWS](#) [EVENTS](#) [COMMUNITY](#) [CONTACT](#)



## OPEN MAINFRAME PROJECT

The focal point for deployment and use of  
Linux and Open Source on the mainframe



Join the Conversation  
on Slack



Join the Conversation on  
Discourse



Get the Code



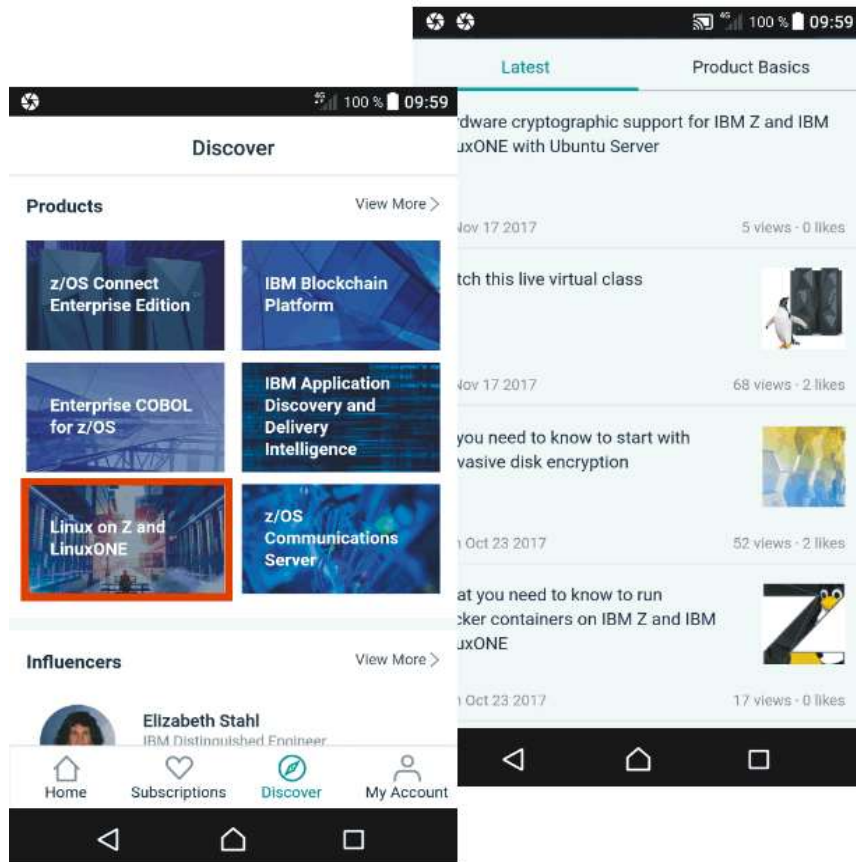
Try Linux on Mainframe  
Free for 120-days

By proceeding to the trial, you will be  
leaving the [openmainframeproject.org](https://www.openmainframeproject.org)  
website

# Mobile App: IBM Doc Buddy V2 – Aggregation of IBM Z information

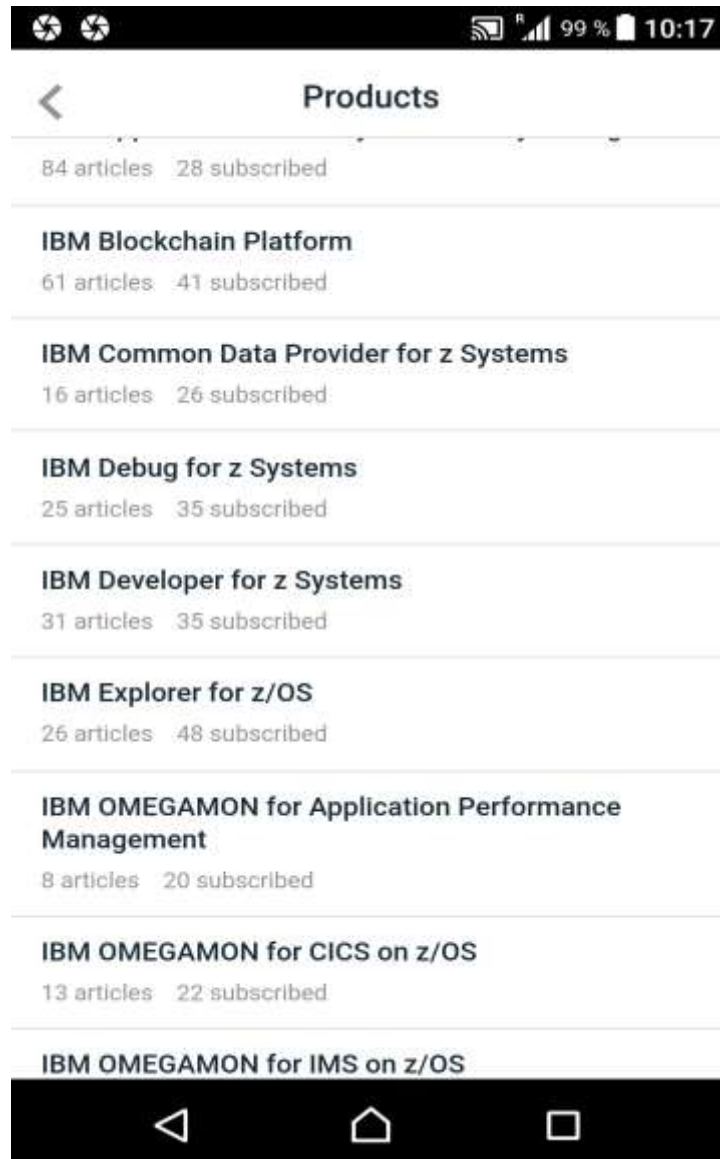
IBM Doc Buddy V2 aggregates existing Z information including:

- Blogs
- Videos
- Social media messages
- Thought leader opinions – Influencers
- IBM Knowledge Center topics



Currently 7,000+ users.

# Z Products



- Obtain IBM Doc Buddy from [Apple App Store](#) or from [Google Play](#)
- Subscribe to product columns



# Questions?



**Wilhelm Mild**  
*IBM Executive IT Architect*

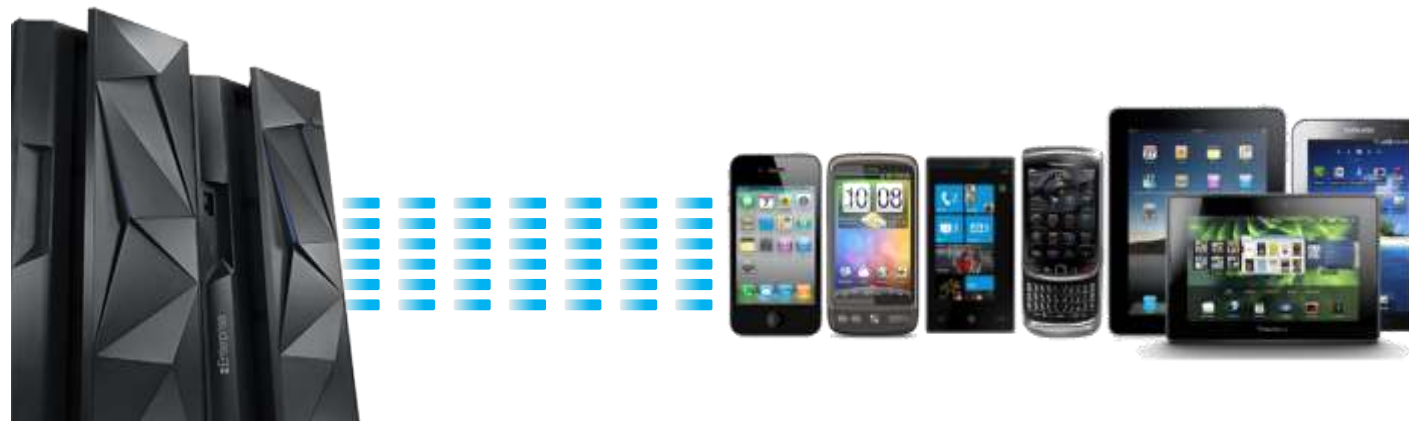


IT Architecture  
 Chief/Lead IT Architect



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