Linux on the z Platform & Our Modernization Effort

Presented to NY Metro NaSPA Chapter meeting

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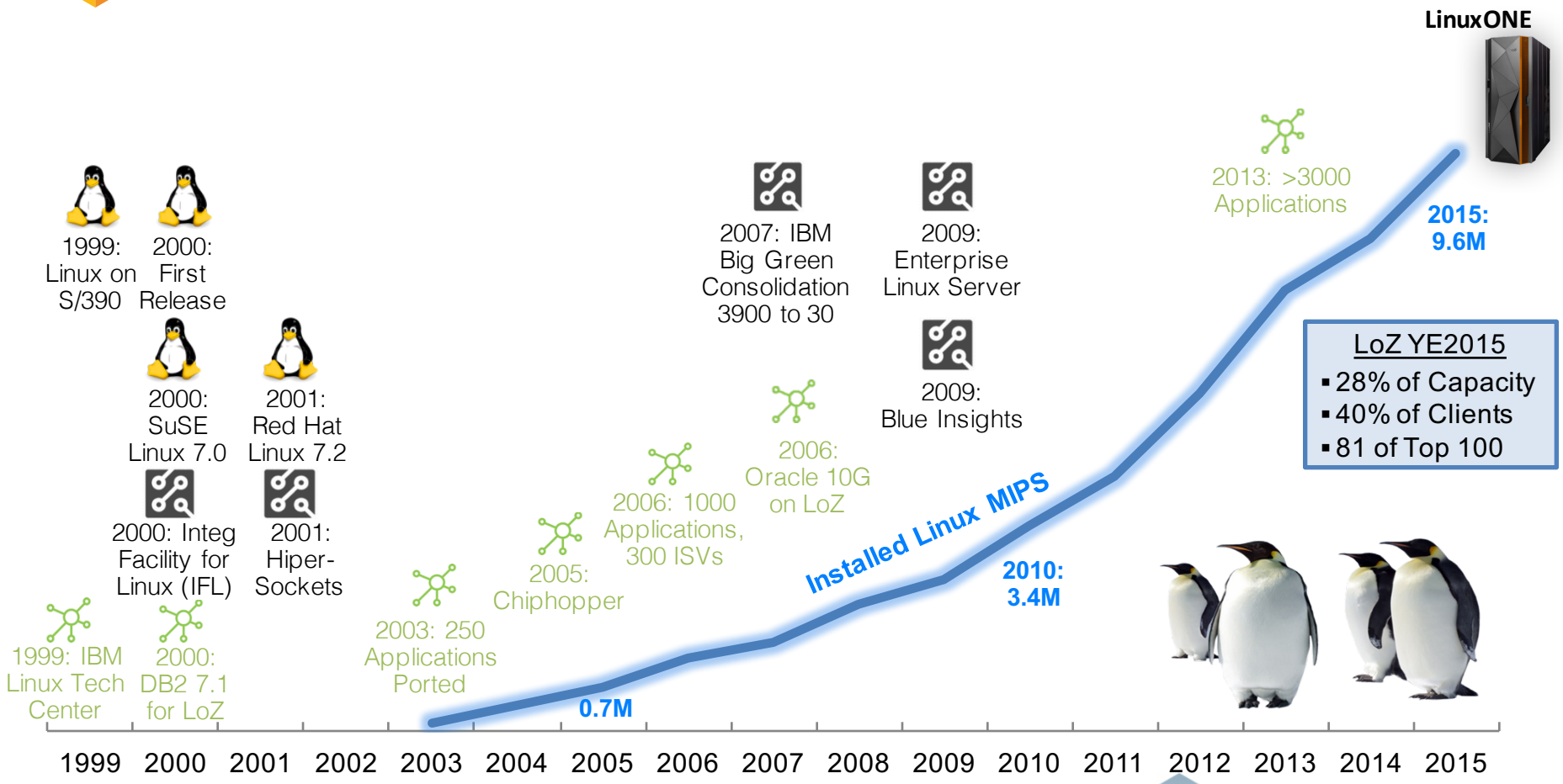
April 27, 2016

Agenda

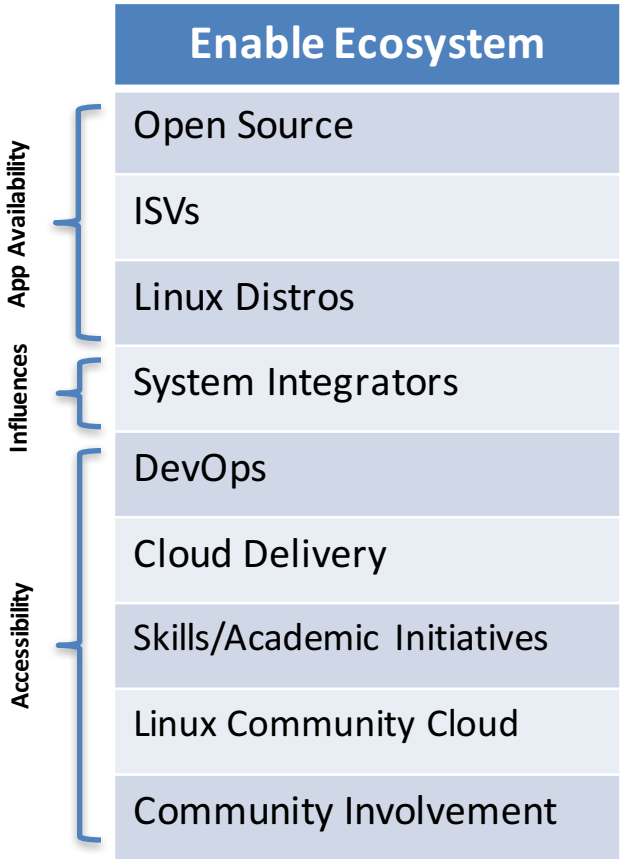
- Our Linux Heritage & now LinuxONE
- Open Source - ISV Ecosystem & Content
- Scalable Financial Trading Analysis & Insights Demo
- Backup - Performance Proof Points vs x86

Our 16-year journey with Linux on the Platform



What's Important in the Linux Strategy moving forward?

Enable Right Workloads
Traditional
Mobile
Analytics / Cognitive
Targeted New Offerings



Strategic Focus

Attract net new clients with LinuxONE leading with platform-differentiated Linux-only focused offerings, aligned with leading open solutions

Expand adoption of Linux in the z Systems install base where clients can build on existing investment, benefit from co-location with the System of Record, & align with the IBM z High Availability / Disaster Recovery strategy

Assist clients to be a CSP within their Enterprise via secure, industrialized Hybrid Cloud capabilities …an **expanded ecosystem**, including open source, for flexibility and choice…
…& industry-leading capabilities for performance, scale, security, availability, and agility

Taking Linux to new heights

UNPRECEDENTED PERFORMANCE
UNMATCHED SECURITY AND RESILIENCY
NEW SOLUTION OFFERINGS
NEW OPEN SOURCE TECHNOLOGIES
EXPANDED ECOSYSTEM
NEW ELASTIC PRICING FOR LINUXONE

IBM LinuxONE Emperor™

Linux **YOUR WAY**

Linux **WITHOUT LIMITS**

Linux **WITHOUT RISK**

IBM LinuxONE Rockhopper™

Introducing IBM LinuxONE™

Linux Without Limits

PERFORMANCE, SCALABILITY

State-of-the-art technology – high speed multi-core processors, simultaneous multi-threading (SMT), single instruction multiple data (SIMD) accelerators, out-of-order processing, transactional memory **AND** LinuxONE is designed to be **more efficient** for large, cache-intensive business workloads and those that require high I/O bandwidth

World's Fastest Commercial Microprocessor

5GHz, >2x faster than the servers typically used in x86 scale-out solutions

Large memory pools with 4 layers of cache

10TB memory

>12 MB cache per core, >4.8x more

PLUS 980 MB per drawer off-chip cache

Huge capacity, with up to

141 processor cores

Massive I/O throughput with

640 dedicated I/O processors

Linux Without Limits

PERFORMANCE, SCALABILITY vs x86 (Haswell)

MongoDB, MariaDB, PostgreSQL up to
2x faster

Compression Spark RDD
4.9x faster

Docker Persistence
4x faster

Heavily Loaded Docker Containers
2x more

Node.js up to
2x faster

Spark Analytics up to
3x faster

A single MongoDB node on our platform scales up to 2TBs with sustained throughput and response time <5ms, while supporting more than 4Billion documents, 470,000 reads / writes per second, *with no sharding required!*

Node.js and multiple MongoDB instances with over 30 Billion web events / day!

https://www.youtube.com/watch?v=VWBNoIwGEjo

Linux without Risks

Designed to ensure highest levels of security and the lowest downtime

Designed for Privileged Identity Management	Designed to Prevent Errors
Designed for Sensitive Data Protection	Designed to Detect & Correct Errors
Designed to Preserve System Security and Integrity	Designed to Recover without Loss

Improved performance over standard secure-key technology
28X

Integrated Cryptography

Highest security certification
EAL5+

Hardware isolation between LPARs

Lower security incursion costs
>15X

Faster problem determination & resolution *45%*

Designed to provide *100%* uptime for decades

IT Analytics
avoid future outages

Core sparing
2 cores reserved

Linux Your Way: Greater flexibility and choice
LinuxONE has enabled key technologies

IBM

Distributions	Hypervisors	Languages	Runtimes	Management	Database	Analytics
Supported Versions	KVM	python	nodeJS	docker	MariaDB	Spark
ubuntu Supported by Canonical	LPAR	Ruby	RAILS	CHEF	PostgreSQL	hadoop
SUSE		php R		puppet labs	mongoDB	
redhat		ERLANG		juju	cassandra	elasticsearch
Community Versions		Scala	OpenJDK	openstack	CouchDB	
debian		Clojure		vmware vRealize Cloud Manager	redis	Apache Solr
fedora		JS				IBM InfoSphere BigInsights
CentOS		OCaml		urban{code}	ORACLE Diamond Partner	
		Java			DB2	BLU Acceleration

Canonical unveils 6th LTS release of Ubuntu with 16.04

THE LINUX FOUNDATION

OPEN MAINFRAME PROJECT

Linux Your Way
IBM LinuxONE Elastic Pricing

On Premise Cloud Model
what you pay depends on what you use for your LinuxONE Deployment

Move from CapEx to OpEX
as deployment models change LinuxONE has adapted to the shift

SIMPLE
Simplified monthly or quarterly billing based on your usage

TCO Aligned
Low entry point and flexible as you deploy

Metered
Based on real usage data ...

Consolidation & Open Source Software Aids Met Office Forecasting to Save Property and Lives

Target Market: Customers using scale out x86 architecture to support database workloads

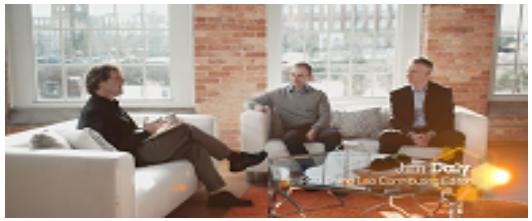
Customer Value: Reduced complexity, improved uptime, capacity for analytics, innovate with open source software for mission critical functions with enterprise grade QoS

Success Story: Building on the previous success of consolidating Oracle from 204 x86 processor cores to only 17 IFLs, UK's national weather service (Met Office) runs mission critical functions on open source

Met Office

"Met Office Global weather analytics need performance, scale, & reliability; LinuxONE is the platform of choice to serve our Global forecast model data & products using open source toolsets & databases". – M J Catlow - Technology Portfolio Lead –

Infrastructure & Operations, Met Office



http://review.centerlinedigital.com/player/watch/56a10711ecf78/Client

LinuxONE: Taking Hybrid Cloud to New Heights - January 2016

- **Advancing LinuxONE:** New hybrid cloud software, distro options, refreshed systems, and community cloud
- **WIRED Takeover:** 97,500+ viewers for WIRED broadcast of leading open source & IBM experts
- **Social Media Reach:** 16.6+ million impressions to date
- **Tech Coverage:** 31 articles so far, including ZDNet, CIO.com and TechWeekEurope
- **Developers Reached:** 350+ developers signed up for new LinuxONE Community Cloud

OPEN MAINFRAME PROJECT

IBM

- Project at www.openmainframeproject.org
- Fill in the online form for more info: https://www.openmainframeproject.org/about/join
- Alternatively contact Scott Nicholas at the Linux Foundation: snicholas@linuxfoundation.org

- Bring together under a formal structure, an open source, technical community with a mutual interest in advancing the surrounding ecosystem and adoption of Linux on the mainframe as an enterprise-grade platform
- Open collaboration across academic, government & corporate partners to advance z Sys as an enterprise-grade platform for Linux.
- Design and develop shared technology elements
- Provide development and test resources through a collaboration hub that lowers barriers to joint development activities
- Provide access to free education and information
- Improve the experience of users of the mainframe platform when running Linux

Supporting Organizations

MARIST
L3C
ubuntu Supported by Canonical
Compuware
ca technologies
East Carolina University
RSM PARTNERS
VICOM Infinity
IBM
bmc
DATAKINETICS DATA PERFORMANCE & OPTIMIZATION
University of Bedfordshire
SUSE We adapt. You succeed.™
SINE NOMINE ASSOCIATES
ADP
Hitachi Data Systems

THE LINUX FOUNDATION

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Time for the next OPEN BREAKTHROUGH

IBM

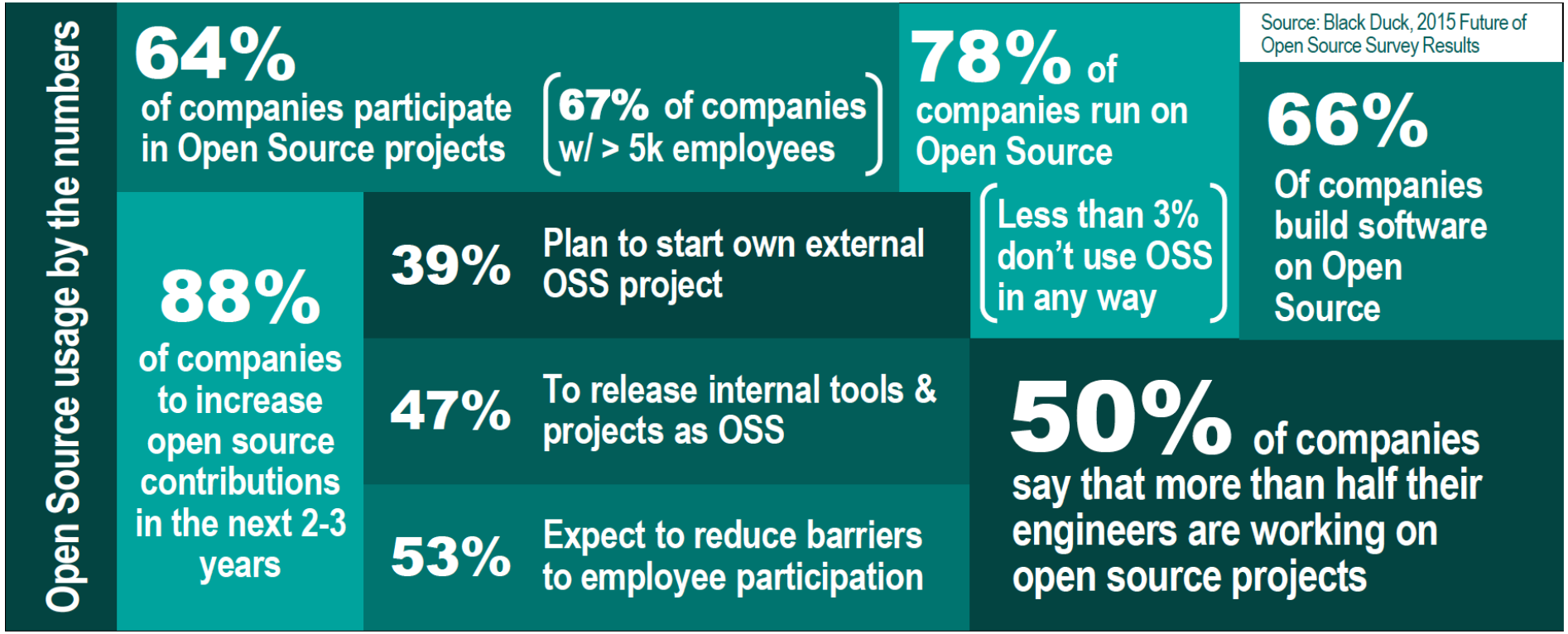
The best of ENTERPRISE COMPUTING

- Dynamic Resource Allocation
- Non-Disruptive Scalability
- Continuous Business Availability
- Operational Efficiency
- Trusted Security
- Data and Transaction Serving

The best of LINUX & OPEN

- Freedom & Agility
- Standards Based
- Speed of Innovation
- Developer Productivity
- Community Collaboration
- Quality of Software
- Open source SW & applications

Open Source in the Enterprise



LinuxONE and IBMz :Open Source & ISV Ecosystem CoC

Activities	Port	Contribute Changes	Test 	Performance Proof Point
Engagement	Educate	Embed Products & Solutions	Client PoC	Partner
Foundational Technologies	Dev Language & Environment	Database & Messaging	Cloud Infrastructure	Big Data & Analytics

One stop shop to find out what is available

https://www.ibm.com/developerworks/community/groups/community/lozopensource/

Open Source & ISV Linux SW Capability

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

Languages and Dev Environment	Databases	Messaging & Streaming
Node.js	MySQL	RabbitMQ
Ruby	PostgreSQL	Apache Kafka
Rails	MariaDB	Logstash (ELK)
Python	MongoDB	Fluentd
LLVM	Apache Cassandra	Apache Flume (1Q)
OpenJDK, *OpenJDK JIT(2Q)*	Redis	Apache ActiveMQ
GCCGO, Golang compiler(1Q)	Apache CouchDB	Apache Apex(Data Torrent)*
oCaml, oCaml native compiler	Cloudant^ (CouchDB based)	Apache NiFi*
Erlang	Apache Geode	IronMQ*
PHP/Zend	CouchBase (2Q)	
R	Hazelcast (4Q)	**Graph DBs**
Clojure	ScyllaDB*	Spark GraphX
Scala	MemSQL*	Neo4j
Swift (Apple) (2Q)	Aerospike*	Pegasus*
BIRT (Eclipse plug-in) (1Q)	Druid*	Titan*
Mono(C#...) [open source for .NET]	Apache Ignite*	

* Requested by Client. Pending input on priority
^ IBM offering

Various sources of input: e.g. BlueMix, Github stats, feedback from: direct client input, IBM client reps, on going research

** Content and priority are subject to change*

Open Source & ISV Linux SW Capability

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

Orchestration/ Deployment	Deployment Management & Config - Monitoring	Machine & Deep Learning	Operating Systems <Enterprise and Open Source>
Docker	Chef	Spark MLLib*	SLES <enterprise>
Docker Swarm	Puppet	SystemML*	RHEL <enterprise>
Docker Compose	Ansible	H2O*	Ubuntu <enterprise> (2Q)
Kubernetes	SaltStack	TensorFlow*	Debian
Apache Mesos (2Q)	Juju	Neon*	Fedoroa
Docker Machine	virt-install	Apache SINGA*	CentOS (ClefOS)
Docker Kitematic	*ElasticBox (3Q)*		OpenSUSE
IaaS & PaaS	cAdvisor		CoreOS*
OpenStack	*Zenoss (2Q)*		RancherOS*
OpenShift	Apache ZooKeeper		
Cloud Foundry (3Q)	DataDog (3Q)		
	Etcd (2Q)		
	Consul (2Q)		

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Open Source & ISV Linux SW Capability

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

Big Data & Analytics	App development & DevOps	Web Application Dev/Perf & CMS	Front End
Hadoop (VeriStorm)	Xerces-c	Apache jMeter	Kibana (ELK)
Elasticsearch (ELK)	XMLSec	Wordpress	D3
Apache Spark	protobuf	Ceilometer	Ionic*
Apache Solr	Doxygen	Apache Tomcat	Graphene*
Apache Storm	ANTLR	HAProxy	Angular (MEAN)
	Apache Maven	NGNIX	Express (MEAN)
	Jenkins	Apache HTTP	Meteor*
Notebooks	Apigility (1Q)	JBoss	
Apache Zeppelin*		Drupal	
Jupyter*		Joomla	
Ipython*		SugarCRM	
Graphite*		Magento	

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Open Source & ISV Linux SW Capability

Ported - verified
Work in progress

Popular Tools and Applications* that have been verified by Sine Nomine Associates

App development & DevOps	System productivity tools	System configuration tools	System libraries
pigz	Bacula	phpMyAdmin	db4
autossh	ipsec-tools	webmin	freetds
eXtplorer-mod	netcat	dhcp_probe	libibverbs
Mono	openVPN	lightttpd	libapreq2
php-mcrypt	ossec-hids	mod-rpaf	libmcrypt
GeoIP	h3270	thttpd	libnet
php-pear-DB	s3270	scsi-target-utils	libsodium
php-php-gettext		HAO	openpgm
mock		heartbeat	pkcs11-helper
Perl Tools(e.g. perl-libapreq2, perl-Net-Ping…)			zeromq

* *Content and priority are subject to change*

LinuxONE 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 LinuxONE 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 LinuxONE and IBM z
  - Users can post questions/comments
  - Provide feedback to the Open Source & ISV Ecosystem team

Emperor

Rockhopper

Support for the LinuxONE & IBM z Open Source & ISV Ecosystem

1. **IBM via the Ecosystem enablement team & LTC (Linux Technology Center)**

2. **Select ISV relationships**
   - **MongoDB, MariaDB, Postgres via 2ndQuadrant, Chef, Puppet, Docker**

3. **Third Party Enterprise Support (coming soon)**

4. **Open Source Products embedded in the distros**

ISV Relationships

2ndQuadrant is excited by combining the world's most advanced open source database, PostgreSQL, with the world's most efficient, trusted and secure server, the IBM z13. The results of up to 2x throughput performance far exceed our goal, and we are pleased to partner with IBM for supporting IBM's customers.

-- Simon Riggs, CTO & Founder, PostgreSQL Development at 2ndQuadrant

Chef, the leader in automation for DevOps, today announced it is collaborating with IBM to deliver integration between the Chef 12 Client & Chef 12 Server and IBM's enterprise Linux mainframe offering, Linux on z Systems. "We're experiencing rapid and accelerating adoption of Chef within the enterprise, making integration with IBM z Systems an important feature for our platform …

-- ***Matt Ray, Director of Partner Integration, Chef.***

"We are committed to make MongoDB available on all major platforms and are excited to add support for IBM z Systems' Enterprise Grade Linux and LinuxOne Platform. This announcement is a leap forward for customers who want to deploy modern, mission-critical applications built with MongoDB and take advantage of the performance, scalability and security of IBM's mainframe hardware products."

--- Eliot Horowitz CTO & Founder, MongoDB

Docker is very pleased to be working with IBM to enable the Docker container capability for LinuxONE and IBM z Systems.

-- ***Ben Golub, CEO of Docker***

IBM's z Systems mainframes power some of the most mission critical services available. … Having Puppet run on IBM z Systems not only helps realize these benefits in a mainframe environment, but speaks to the ubiquitous and flexible nature of open source Puppet.

-- ***Nigel Kersten, CIO of Puppet Labs***

"As the ONE default database platform for leading Linux distributors, …, MariaDB is excited to support IBM LinuxONE," stated Patrik Sallner, CEO of MariaDB. "With Linux on IBM z growing at twice the rate of the Linux market overall, there is clear customer demand for open source solutions on IBM's highly scalable and secure platform. These qualities align perfectly with MariaDB's true open source model, which leverages Community innovations …, for on-premise, hybrid and cloud applications."

--Patrik Sallner, CEO, MariaDB Corporation

"It's exciting to see the investment IBM is making into our open source technologies — Elasticsearch, Logstash and Kibana —with Linux on z Systems. This further expands the reach of our technologies in enterprises with mission critical deployments on mainframe systems."

-- ***Shay Banon, CTO & co-founder of Elastic***

Cloud Stack Architecture Leveraging Open Source

Platform as-a-Service

- **OpenShift** (Red Hat)
- **Cloud Foundry** (SUSE, Ubuntu)
- **BlueMix** (Based on Cloud Foundry) IBM

Workload Orchestration

- **IBM Cloud Orchestrator**

Deployment Management

- Chef
- Ansible
- Puppet
- Salt Stack
- Juju

Infrastructure as-a-Service

- **OpenStack**
  - Nova
  - Neutron
  - Cinder

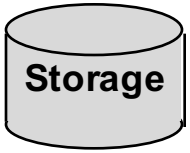
Container Management

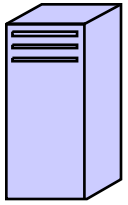
- Docker
- Kubernetes
- Mesos
- LXC LXD

Virtual Infrastructure

- SLES
- Ubuntu
- RHEL
- z/VM
- KVM for IBM z

Physical Infrastructure





Switches

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Innovation lab Industry Use Case Demonstrations

"Scalable Financial Trading Analysis & Insights" LinuxCON August 2015

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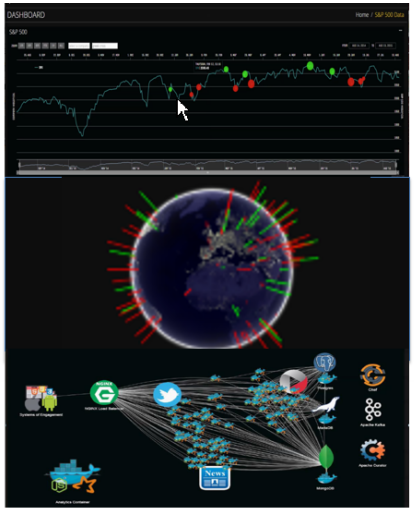
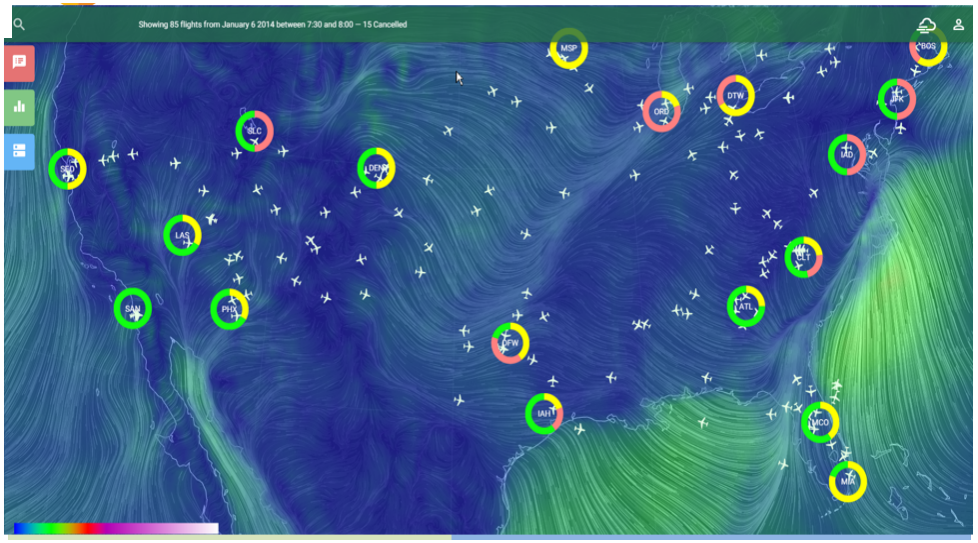


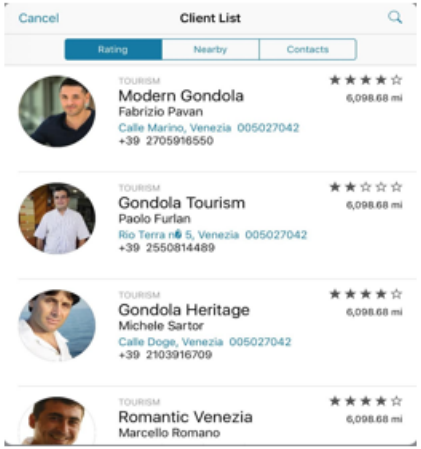
Have you Ever Been Stranded? Extreme Scaling with LinuxONE to resolve your Travel Nightmares – Jan 2016 Wired.com https://youtu.be/1G-Gbv5SsqA

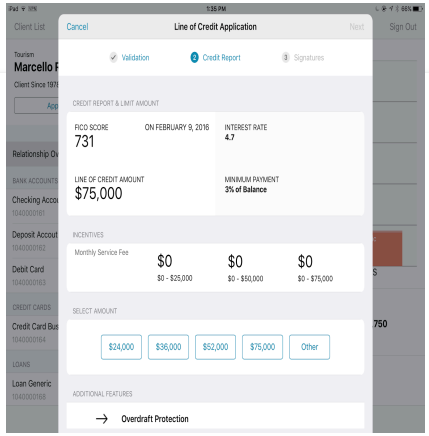


Cognitive Shopping with Blockchain, Deep Analytics, Internet of Things Devices – February 2016 InterConnect

https://www.youtube.com/playlist?list=PLejzQzuteSaraRKTh7Saq9t21ZpKjpE5U

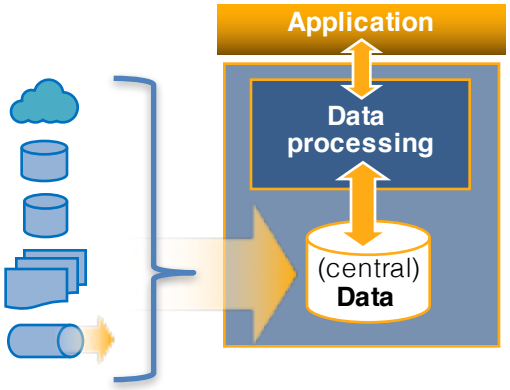
How Fast and Secure Are your Mobile Transactions? -- February 2016 InterConnect https://ibm.box.com/AdviseAndGrowDemoV1





An Industry Use Case Observation

SINGLE VIEW USE CASE



Data Aggregation

IMPLEMENTATION

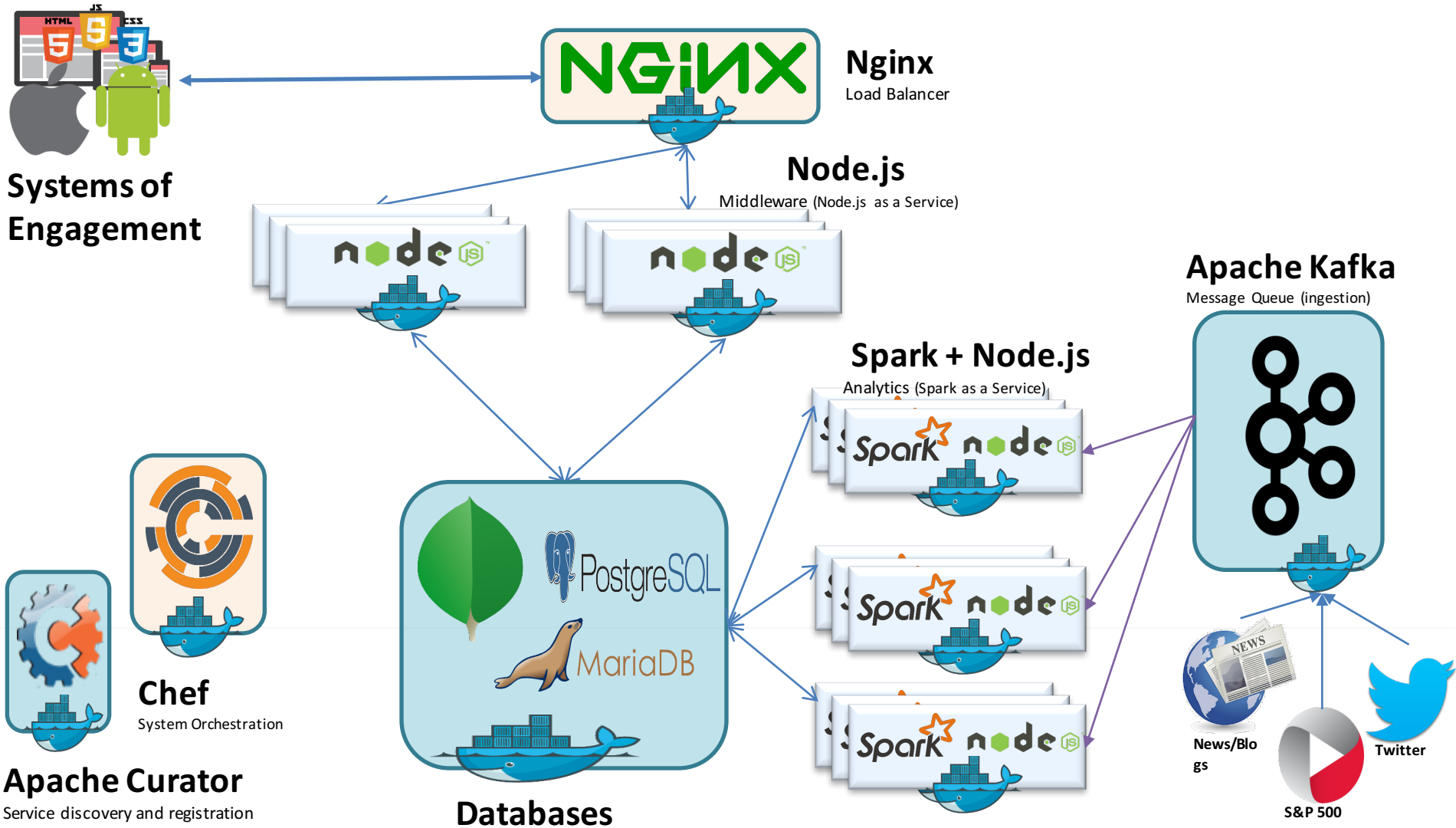
- Industry tends to shard across many server farms
- LinuxONE: Vertical scaling within ***one*** server !
  - Co location data-analytics-insights
  - Extreme virtualization
  - Security
  - Network latency
  - Availability & disaster recovery
  - Apps that don't need to worry about clustering, …

Scalable Financial Trading Analysis & Insights Demo

Deep analytics providing an enhanced and optimized single view experience for the user

USER CRITERIA	ANALYSIS
Why did Stock drop today?	*Diagnostic*
Media and social opinion?	*Sentiment*
Regional opinion?	*Geospatial*
Will the Stock rise or fall?	*Predictive*
Recommendations?	*Prescriptive*
Is this stock a wise investment?	*All of the Above*

Financial Trading Analysis Demo Architecture



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Heavily Loaded Docker Containers
2x more

Node.js up to
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Node.js and multiple MongoDB instances with over 30 Billion web events / day!

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Questions?

Thank you!

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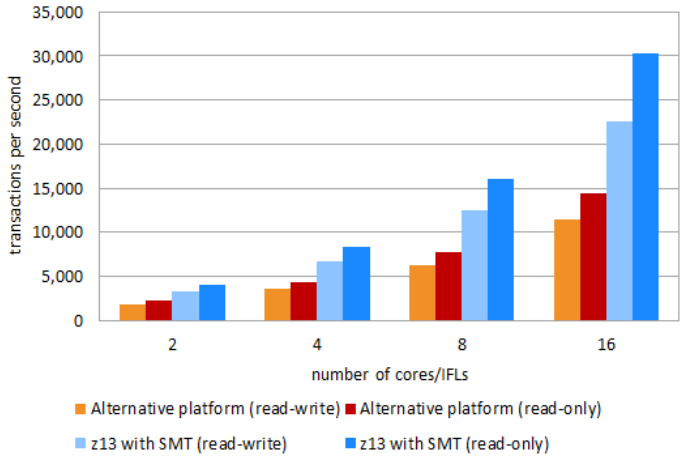
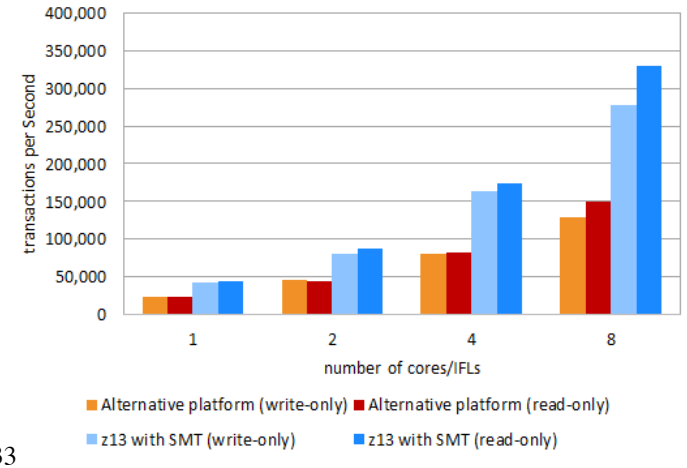
Open Technology SQL Data serving performance

MariaDB 10.1.5



1.8x to 2.1x throughput improvement on Sysbench Benchmark

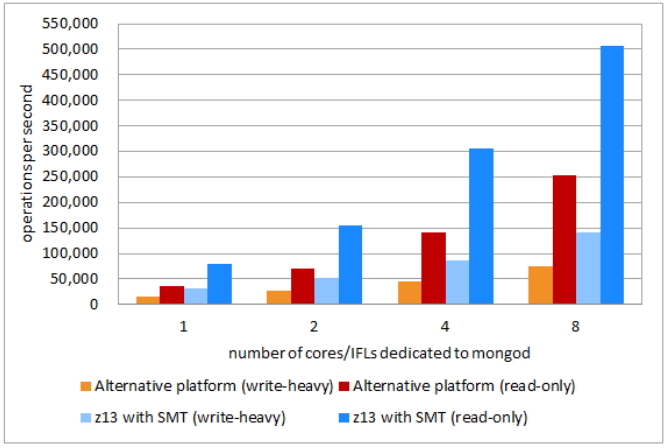
PostgreSQL 9.4



1.6x to 2.2x throughput improvement on pgBench Benchmark

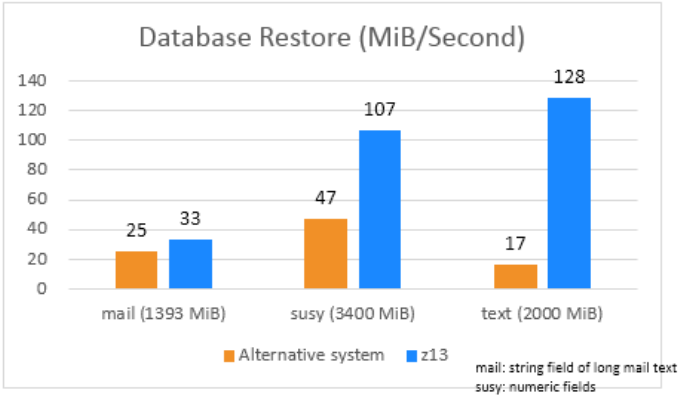
NoSQL Data serving performance: MongoDB

Throughput

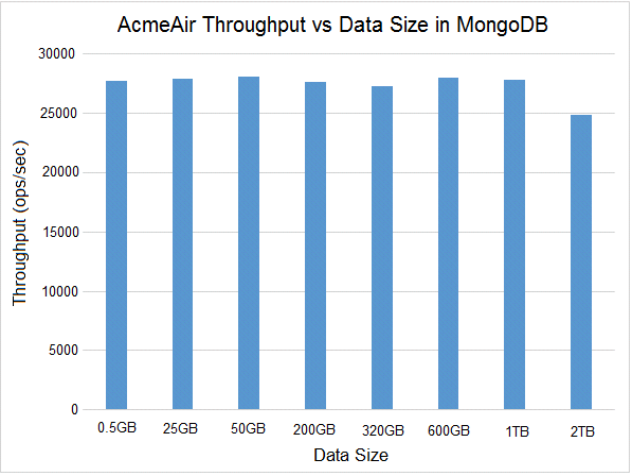


1.9x to 2.1x throughput improvement on YCSB Benchmark

Up to **7.5x** reduction in elapsed-time to compress database: MongoDB, containing large documents



Extreme Scale Up



Consolidate multiple MongoDB servers in one instance

–Largest single node of MongoDB with a footprint of +2TB, processing +4B documents with sustained throughput and response time (<5ms).

–Avoid the overhead, cost and complexity of distributing DB across many servers

LinuxOne system using Node.js and MongoDB can handle over 30Billion web events/day (AcmeAir) !

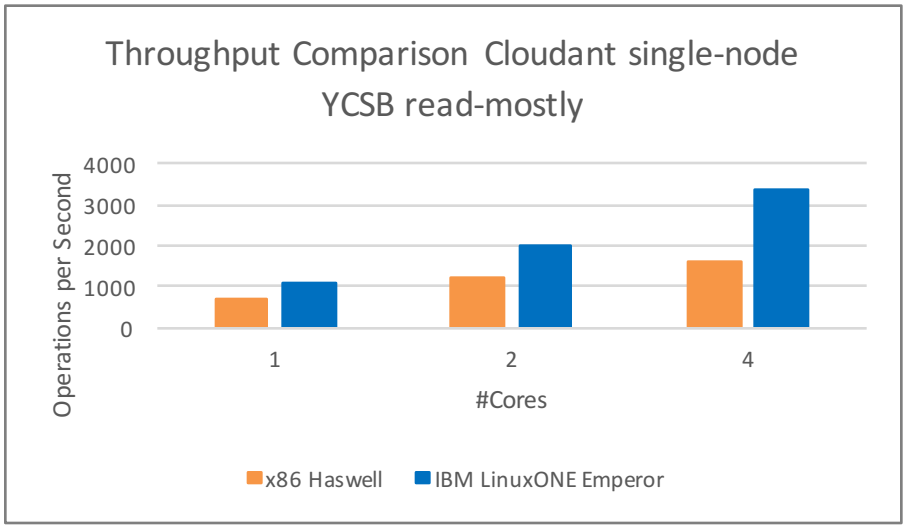
https://www.mongodb.com/mongodb-scale

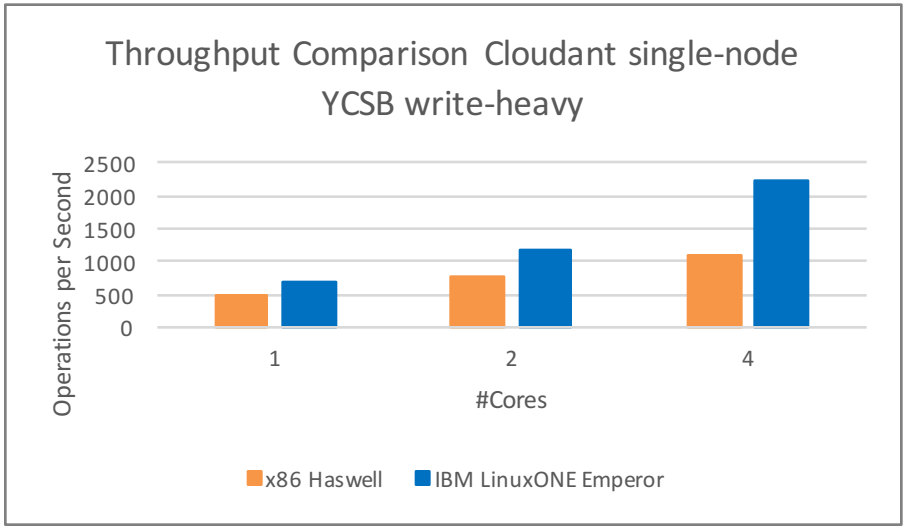
- **Cluster Scale.** Distributing the database across 100+ nodes, often in multiple data centers – *LinuxONE single system scale up-vertical scaling*
- **Performance Scale.** Sustaining 100,000+ database read and writes / second while maintaining strict latency SLAs – *LinuxONE up to 470,000 database read and writes / second*
- **Data Scale.** Storing 1 billion+ documents in the database – *LinuxONE storing 4 billion+ documents in single instance*

DbaaS with Cloudant & LinuxONE (Emperor)

Single Node

Cloudant Local 1.0.0.4 & IBM LinuxONE delivers DBaaS with up to 2x better performance* compared to x86 platform, un-matched resilience, enterprise scalability, virtualization and security



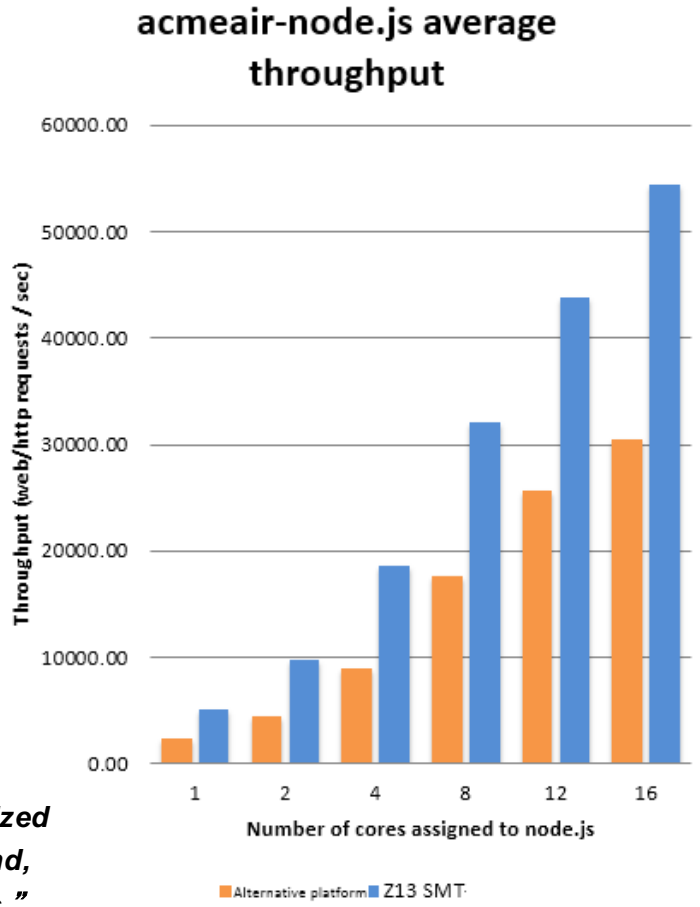


IBM + Cloudant
The Do More Data Layer

Performance results based on IBM internal tests running YCSB 0.4.0 benchmark on Cloudant Local 1.0.0.4. Results may vary. x86 config: 1-4 Intel E5-2699 v3 cores @ 2.30GHz, 768GB memory, and 80 GB local RAID-5 volume on 15K 12 Gbps SAS drives, RHEL 7.1, Oracle JDK 1.8. LinuxONE config: LinuxONE Emperor LPAR with 1-4 dedicated cores, 768GB memory, and 80 GB DASD storage, RHEL 7.1 with SMT/SIMD enabling RPMs, IBM JRE Java 1.8 SR2.

Industry leading runtime capabilities with node.js

- High Performance JavaScript for LinuxONE and IBM z
  - Up to **2.1x** more RESTful web interactions with AcmeAir in node.js with Apache JMeter benchmark setup

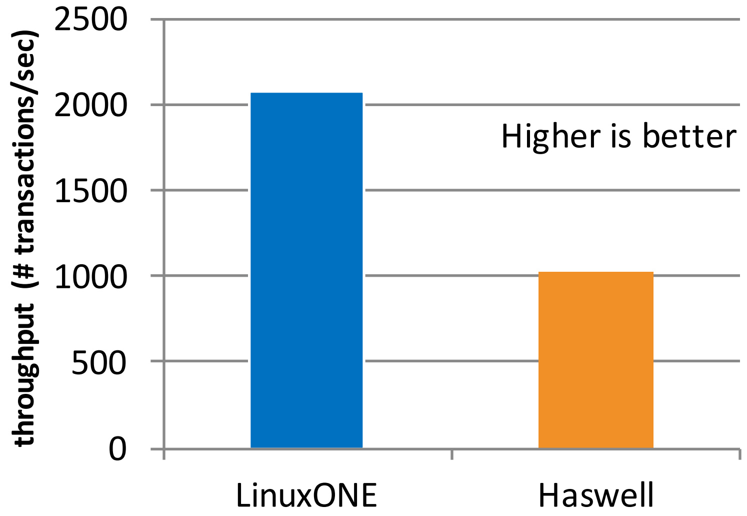


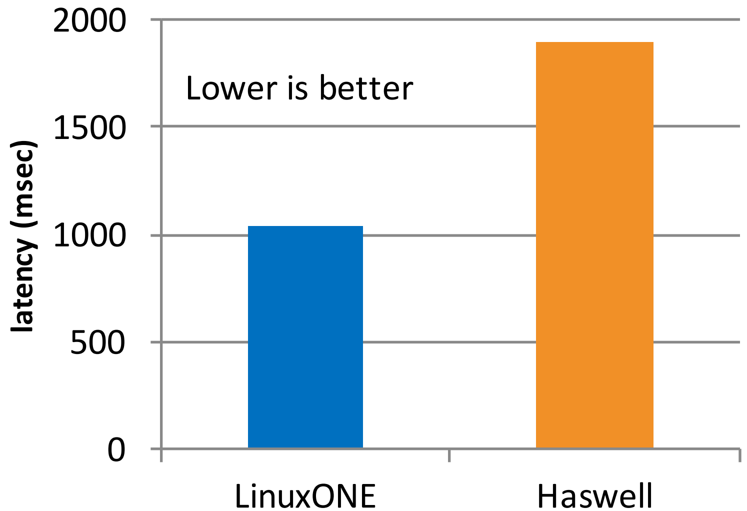
*"LinuxONE can scale to **up to 30B** RESTful web interactions/day with Dockerized Node.js and MongoDB, driving **over 470K** database read and writes per second, while maintaining response-times that are **2x better** than alternative platforms."*

Extreme Virtualization with Docker®!

New Results!!

- **Containers**: simple way to build and deploy SW with Docker currently leading framework
- Single LinuxONE Emperor ran more than 1 Million light Docker containers
  - Workload: busybox httpd server (no NAT)
- LinuxONE Emperor runs **4K *active*** Docker containers on ave **2.0x** better than comparable Haswell-based system!
  - Workload: 50% WAS Liberty 8.5.5.2, IBM JDK 8.0, Apache Solr 4.10.0, and 50% busybox httpd server
  - With ***GOLANG*** now avail on z!
- LinuxONE Emperor can host over 10K Docker containers with mixed (heavy & light) workloads
  - Workload: 4K WAS Liberty 8.5.5.2, IBM JDK 8.0, Apache Solr 4.10.0 plus 6K busybox httpd server (no NAT)





The throughput and response-time for a single Linux host running 4Kcontainers

Disclaimer:
This claim is based on results from internal lab measurements. Performance results may vary depending on the workload and other factors. Benchmark:
- Apache Solr search queries driven by Apache Jmeter* System Stack:
- LinuxONE Emperor (IBM z13): Native LPAR on 36 CPU cores with 755GB memory
- Haswell-based alternative system (Lenovo System x3650 M5 w/ E5-2699 v3 processors) Native Linux on 36 CPU cores with 755GB memory
- Heavy Docker Container: Apache Solr v4.10.0, WebSphere Liberty v8.5.5.2, IBM Java 1.8.0 SR1
- Lightweight Docker Container: BusyBox
- System SW: Docker 1.10.0-dev** w/ aufs storage backend, RHEL7.1***

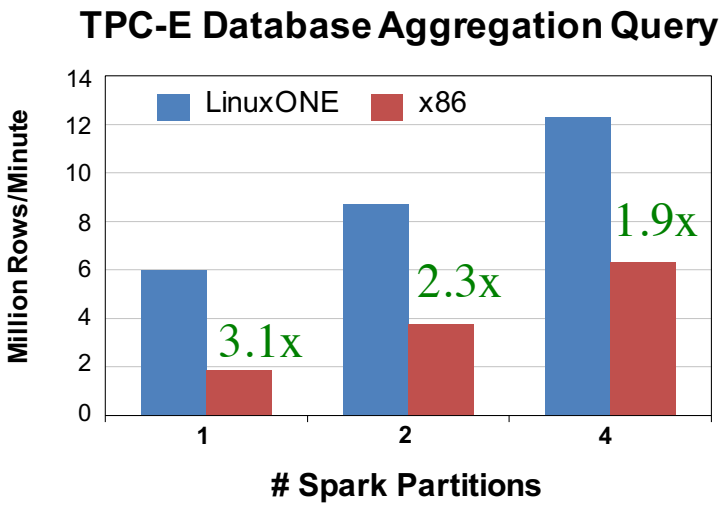
Note:
- Each active container is driven by a client thread in Apache Jmeter, which keeps sending the same Solr query repeatedly to the container to search documents that contain given keywords in a pre-loaded & pre-indexed 46GB Wikipedia snapshot.

** The docker runtime was modified to increase a thread count limit, to avoid connection time-out, and to separate a dockerinit binary from a docker binary.
*** A modified Linux 4.3.0 kernel to support more than 1024 network bridge ports was installed on RHEL 7.1.

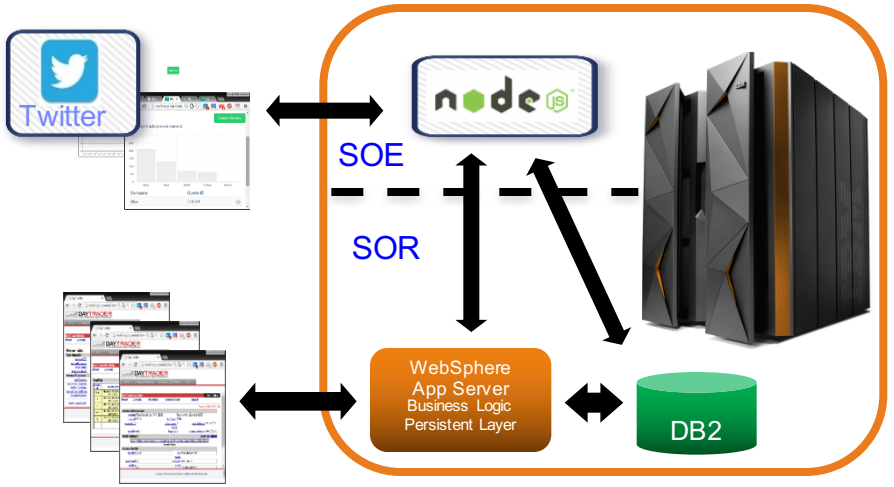
Spark

SOR+SOI+SOE-in-a-Box with LinuxONE

Co-located SOR, SOI, and SOE for right-time insights and richer engagement



Apache Spark co-located on LinuxONE drove ***up to 3x*** *faster than Spark running off- platform on x86 for aggregation analytical query*

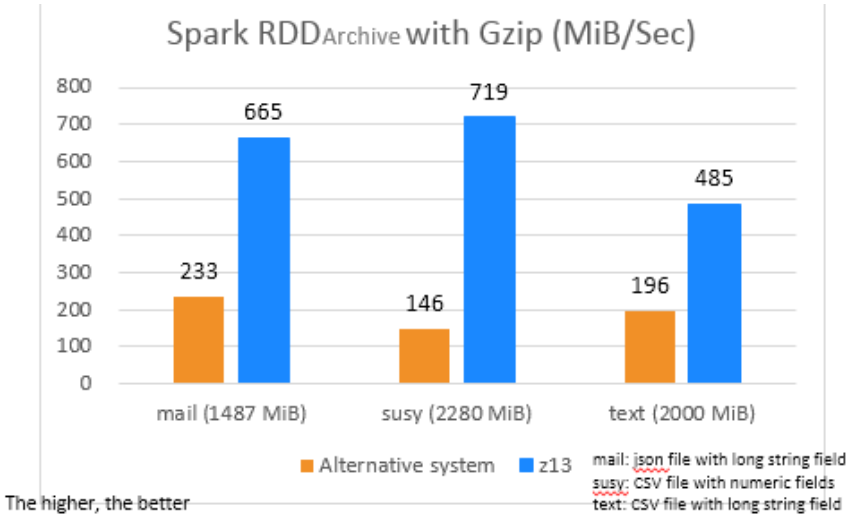


Co-locating ***Node.js on LinuxONE*** *vs. x86 results in* ***60% Faster*** *Response Time* ***2.5x better*** *Throughput*

HW Compression

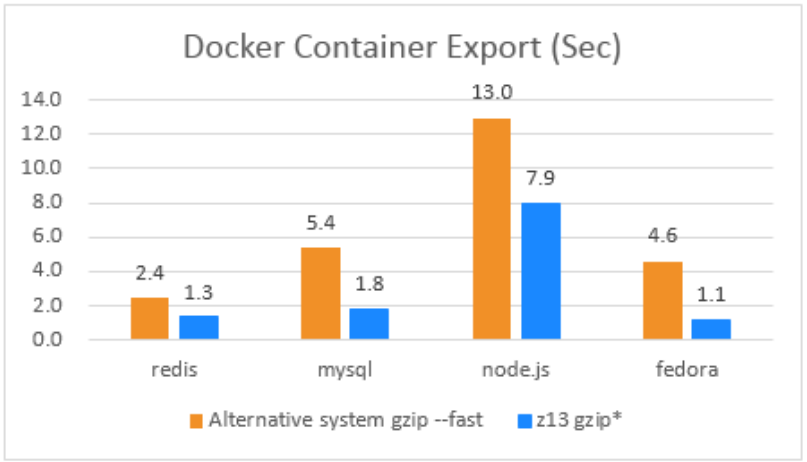
- Up to **7.5x** reduction in elapsed-time to compress database: MongoDB, containing large documents

- Up to **4.9x** better throughput archiving Spark RDD on z13 with zEDC vs. software gzip compression



The higher, the better

- Up to **4x** reduction in elapsed time to compress Docker containers on z13 with zEDC vs. SW gzip



The lower, the better

* Uses zEDC GenQWE gzip or gunzip.

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DB2*	ECKD	GPFS	Ibm.com	LinuxONE Emperor	XIV*	z/OS*	z/VSE*
DB2 Connect	FICON*	HiperSockets	IBM (logo)*	LinuxONE Rockhopper	z13		z/VM*

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Backup

World's leading businesses run on IBM z

92

of the top 100 worldwide banks

10

out of 10 of the world's largest insurers

23

of the top 25 US retailers

23

out of 25 of the world's largest airlines

Processing the world's transactions & data

30 billion

business transactions processed on the mainframe per day

80 percent

of the world's corporate data resides or originates on mainframes

91 percent

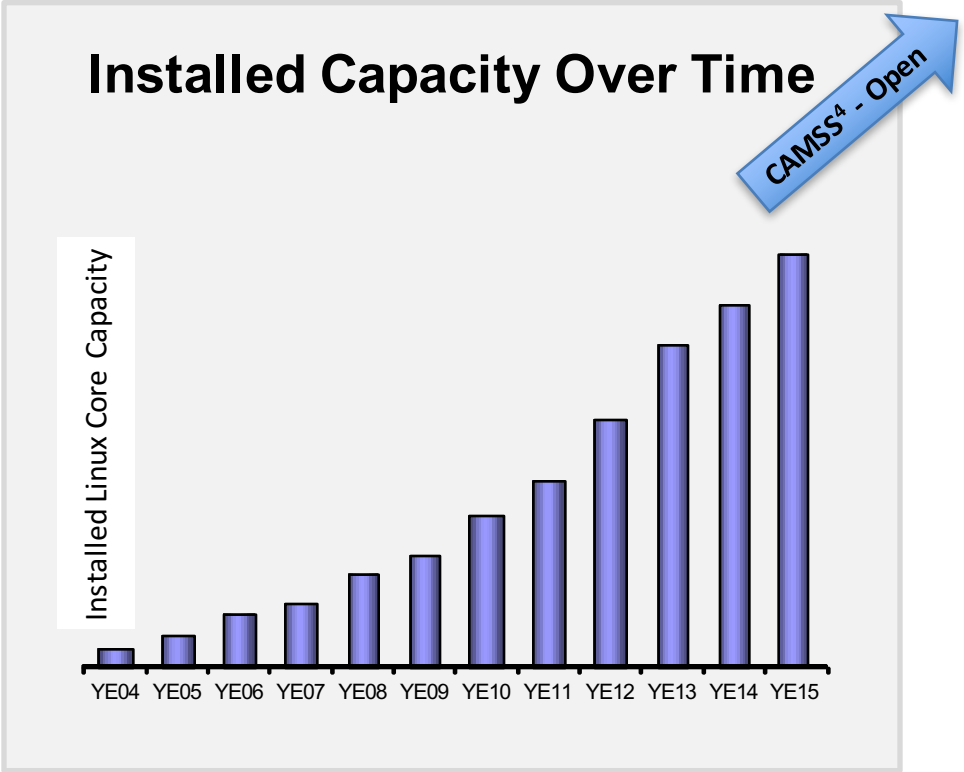
of surveyed CIOs said that new customer-facing applications are accessing the mainframe

55 percent

of all enterprise applications need the mainframe to complete transactions

Linux on IBM z as of 4Q15

- 16 years of Enterprise Linux® on z Systems™
- 40% of customers have Linux cores
- 28% of total installed capacity[1] run Linux
- 81% of the top 100 customers running Linux on the mainframe[3]
- 65% of new accounts run Linux
- Linux core[2] capacity increased 17% from 4Q14 to 4Q15

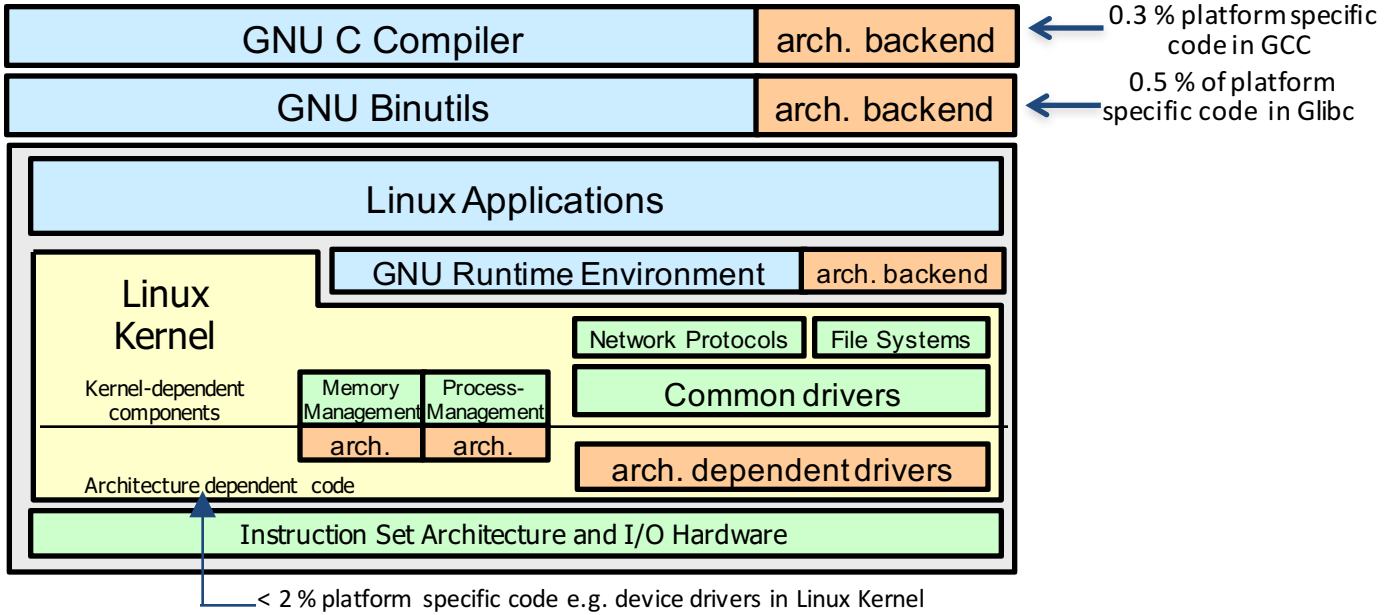


1. Capacity or MIPS: Millions of Instructions per Second or the metric z uses to measure client workload
2. Linux core or IFL: Integrated Facility for Linux or the terminology used to describe a processor core. z13 has on average 7 cores/CPU chip
3. Top 100 is based on total installed MIPS
4. CAMSS: Cloud, Analytics, Mobile, Social, Security

http://www-03.ibm.com/systems/z/os/linux/success/

Linux is Linux is Linux – even on our platform!

Many Linux software packages did not require any code changes to run Linux on z Systems!



Linux on z Systems is not a special Linux

- Pure ASCII environment!
- Does not need any other OS to run on a mainframe
- Not a replacement for any other OS on IBM z Systems
- SuSE, RedHat and **Ubuntu**

Linux on z platform

- Legendary dependability
- Designed for multiple diverse workloads executing concurrently
- Highly scalable – up or out
- Rich security features
- Proven high volume data acquisition and management
- Advanced virtualization capabilities

Where to get Open Source Packages

Assets	Where to get it?
Ansible	https://github.com/linux-on-ibm-z/docs/wiki/Building-Ansible
AntLR	https://github.com/linux-on-ibm-z/docs/wiki/Building-AntLR
Apache Cassandra	https://github.com/linux-on-ibm-z/docs/wiki/Building-Cassandra
Apache Geode	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-Geode-1.0.0
Apache HTTP	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-HTTP-server
Apache Kafka	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-Kafka
Apache Maven	https://github.com/linux-on-ibm-z/docs/wiki/Building-Maven
Apache Active MQ	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-ActiveMQ
Apache Spark	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-Spark-1.5-on-SLES-12
Apache Solr	https://github.com/linux-on-ibm-z/docs/wiki/Building-Apache-Solr
Ceilometer client	https://github.com/linux-on-ibm-z/docs/wiki/Building-Python-Ceilometer-client
Chef client & server	https://github.com/linux-on-ibm-z/docs/wiki/Building-Chef-client-12.1.2 https://github.com/linux-on-ibm-z/docs/wiki/Building-Chef-server-12.0.4
CouchDB	https://github.com/linux-on-ibm-z/docs/wiki/Building-CouchDB

Where to get Open Source Packages

Assets	Where to get it?
Docker	http://www.ibm.com/developerworks/linux/linux390/docker.html
Docker Compose	https://github.com/linux-on-ibm-z/docs/wiki/Building-Docker-Compose
Docker Private Registry	https://github.com/linux-on-ibm-z/docs/wiki/Building-Docker-Distribution
Dockerfile examples	https://www.ibm.com/developerworks/community/forums/html/topic?id=1b477437-0f63-496c-8e3b-e18e06353d43
Docker Swarm	https://github.com/linux-on-ibm-z/docs/wiki/Building-Docker-Swarm
Doxygen	https://github.com/linux-on-ibm-z/docs/wiki/Building-Doxygen
Drupal	https://github.com/drupal/drupal/blob/7.x/INSTALL.txt
Elasticsearch	https://github.com/linux-on-ibm-z/docs/wiki/Building-Elasticsearch
Erlang	https://github.com/linux-on-ibm-z/docs/wiki/Building-Erlang
Fluentd	https://github.com/linux-on-ibm-z/docs/wiki/Building-Fluentd
Go (GCCGO)	https://github.com/linux-on-ibm-z/docs/wiki/Building-gccgo
HAProxy	https://github.com/linux-on-ibm-z/docs/wiki/Building-HAProxy
Joomla	https://github.com/linux-on-ibm-z/docs/wiki/Building-Joomla
Kubernetes	https://github.com/linux-on-ibm-z/docs/wiki/Building-Kubernetes

Where to get Open Source Packages

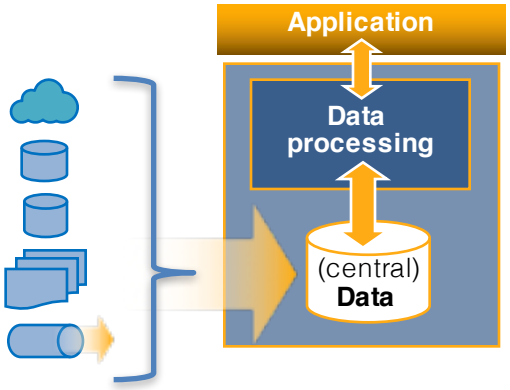
Assets	Where to get it?
Kibana	https://github.com/linux-on-ibm-z/docs/wiki/Building-Kibana
Logstash	https://github.com/linux-on-ibm-z/docs/wiki/Building-Logstash
MariaDB	https://github.com/linux-on-ibm-z/docs/wiki/Building-MariaDB-10.0
MongoDB	https://github.com/linux-on-ibm-z/docs/wiki/Building-MongoDB https://github.com/linux-on-ibm-z/docs/wiki/Building-MongoDB-3.0-on-RHEL-6-and-SLES-11
MySQL	https://github.com/linux-on-ibm-z/docs/wiki/Building-MySQL
Neo4j	https://github.com/linux-on-ibm-z/docs/wiki/Building-Neo4j
Node.JS	http://www.ibm.com/developerworks/web/nodesdk/
oCaml Interpreter	https://github.com/linux-on-ibm-z/docs/wiki/Building-oCaml-interpreter
PostgreSQL	https://github.com/linux-on-ibm-z/docs/wiki/Building-PostgreSQL-9.4-on-SLES12 https://github.com/linux-on-ibm-z/docs/wiki/Building-PostgreSQL-9.4-on-RHEL7 https://github.com/linux-on-ibm-z/docs/wiki/Building-PostgreSQL-9.4-on-SLES11 https://github.com/linux-on-ibm-z/docs/wiki/Building-PostgreSQL-9.4-on-RHEL6

Where to get Open Source Packages

Assets	Where to get it?
Protobuf	https://github.com/linux-on-ibm-z/docs/wiki/Building-ProtoBuf
Puppet	https://github.com/linux-on-ibm-z/docs/wiki/Building-Puppet
Python	https://github.com/linux-on-ibm-z/docs/wiki/Building-Python-2.7.9 https://github.com/linux-on-ibm-z/docs/wiki/Building-Python-3.4.3
R	https://github.com/linux-on-ibm-z/docs/wiki/Building-R
RabbitMQ	https://github.com/linux-on-ibm-z/docs/wiki/Building-RabbitMQ-on-SLES https://github.com/linux-on-ibm-z/docs/wiki/Building-RabbitMQ-on-RHEL
Ruby-on-Rails	http://guides.rubyonrails.org/getting_started.html
Redis	https://github.com/antirez/redis/blob/unstable/README.md
Ruby	https://github.com/linux-on-ibm-z/docs/wiki/Building-Ruby
Snappy-Java	https://github.com/linux-on-ibm-z/docs/wiki/Building-Snappy-Java
SugarCRM	https://support.sugarcrm.com/Documentation/Sugar_Versions/6.5/CE/Installation_and_Upgrade_Guide/
V8	https://github.com/linux-on-ibm-z/docs/wiki/Building-V8-libraries
Xerces-C	https://github.com/linux-on-ibm-z/docs/wiki/Building-Xerces
XMLSec	https://github.com/linux-on-ibm-z/docs/wiki/Building-XMLSec

An Industry Use Case Observation

SINGLE VIEW USE CASE



Data Aggregation

IMPLEMENTATION

- Industry tends to shard across many server farms
- LinuxONE: Vertical scaling within ***one*** server !
  - Co location data-analytics-insights
  - Extreme virtualization
  - Security
  - Network latency
  - Availability & disaster recovery
  - Apps that don't need to worry about clustering, …

Scalable Financial Trading Analysis & Insights Demo

Deep analytics providing an enhanced and optimized single view experience for the user

USER CRITERIA	ANALYSIS
Why did Stock drop today?	*Diagnostic*
Media and social opinion?	*Sentiment*
Regional opinion?	*Geospatial*
Will the Stock rise or fall?	*Predictive*
Recommendations?	*Prescriptive*
Is this stock a wise investment?	*All of the Above*

"Scalable Financial Trading Analysis & Insights"
LinuxCON August 2015

IBM

Input Data

S&P DOW JONES INDICES

Historical S&P 500 Index

YAHOO! AlchemyAPI An IBM Company

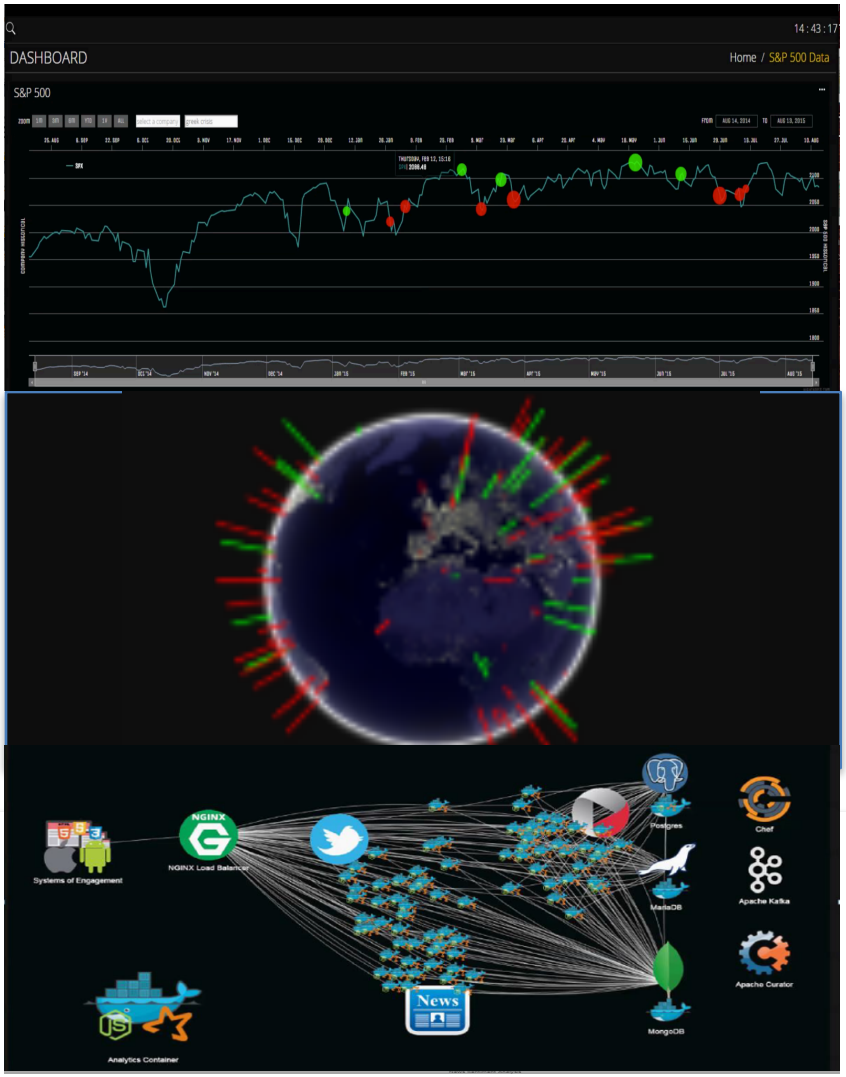
News Feed

Sentiment Analysis

Trade Transactions

Geospatial Analysis

Visualization Dashboard



Open Source Content

mongoDB

Spark

MariaDB

PostgreSQL

node.js

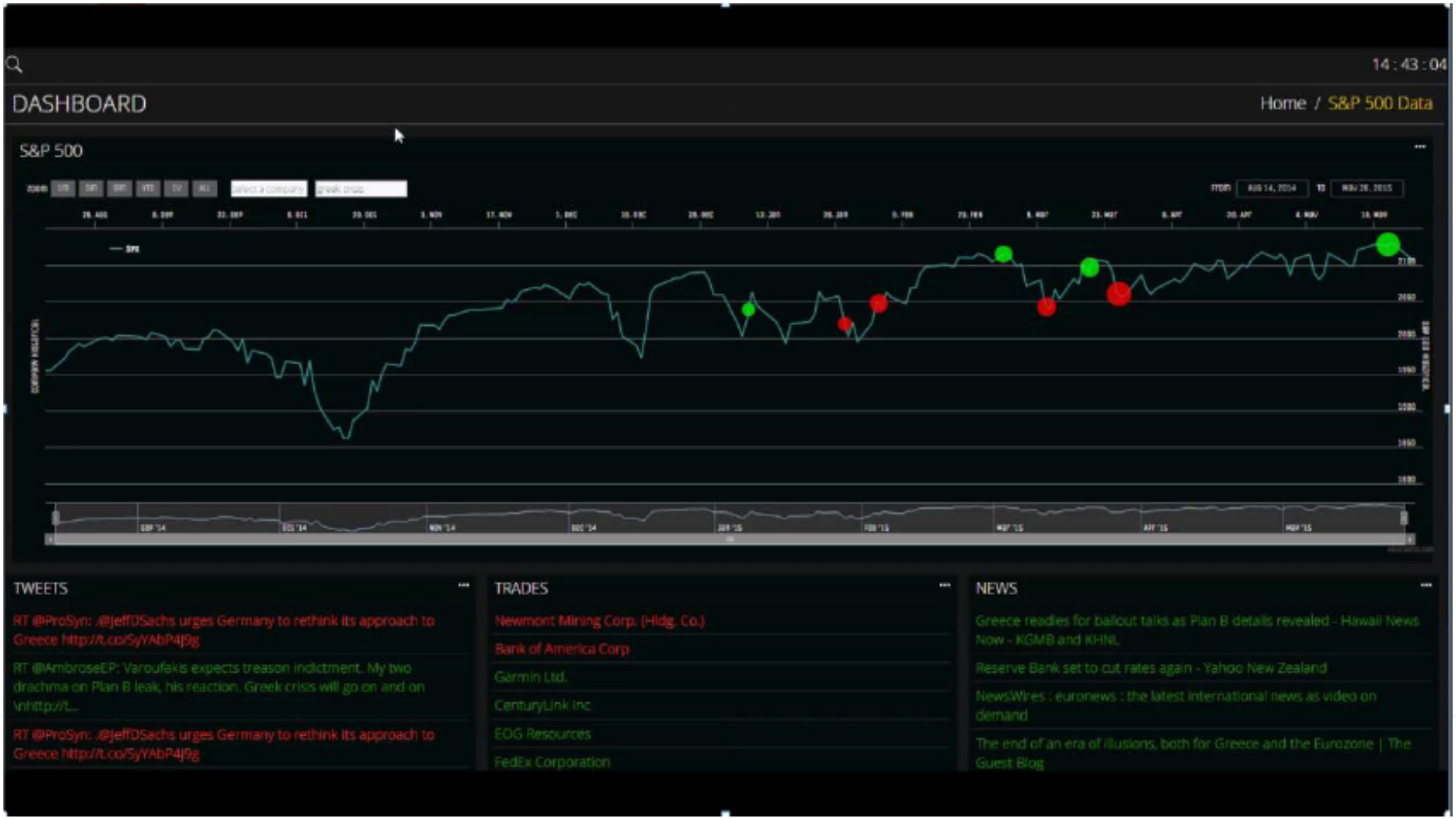
docker

Apache Kafka
A high-throughput distributed messaging system.

NGINX

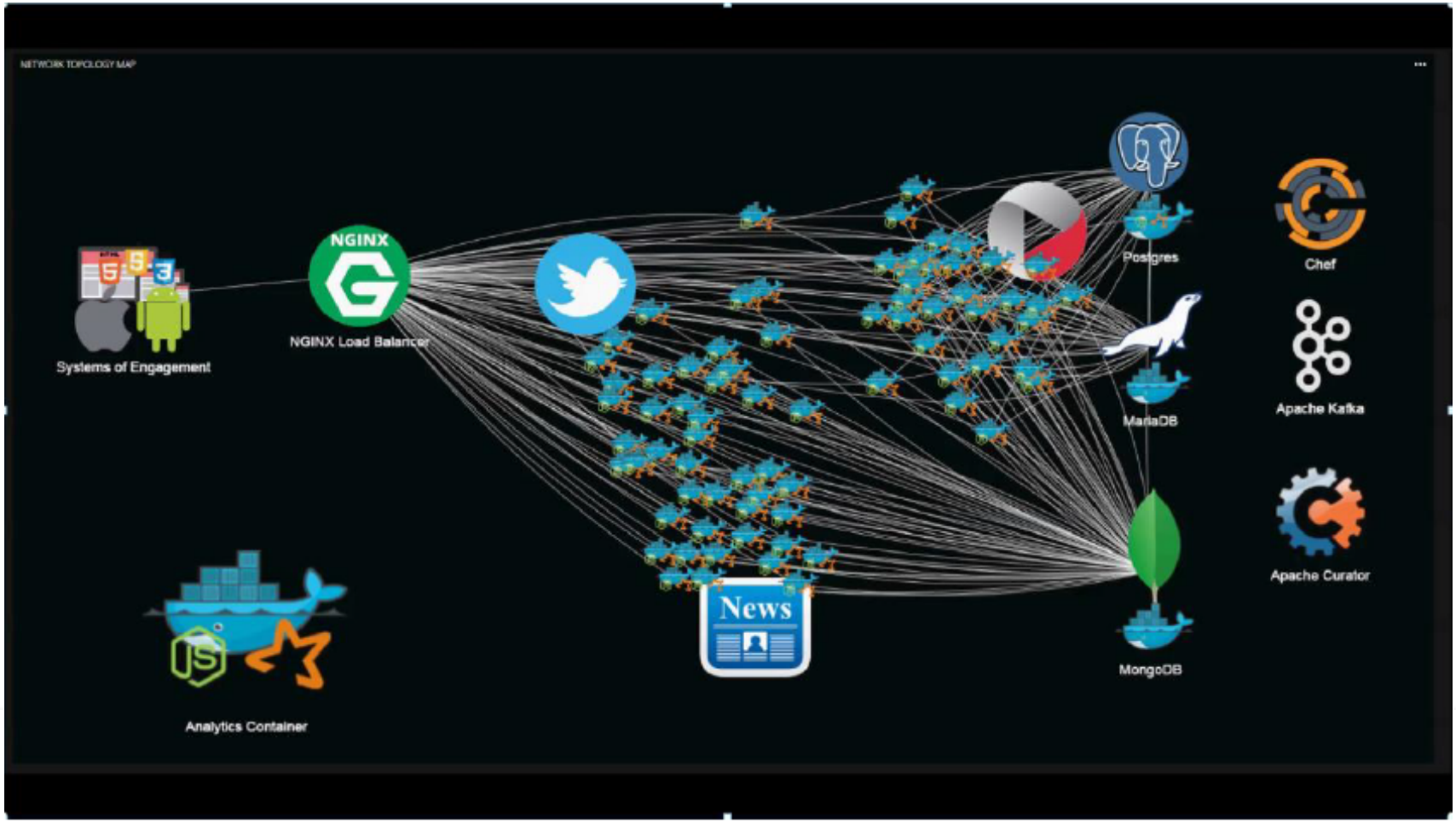
CHEF

S&P 500 Financial Data with Spark Analytics on News Feeds & Tweets

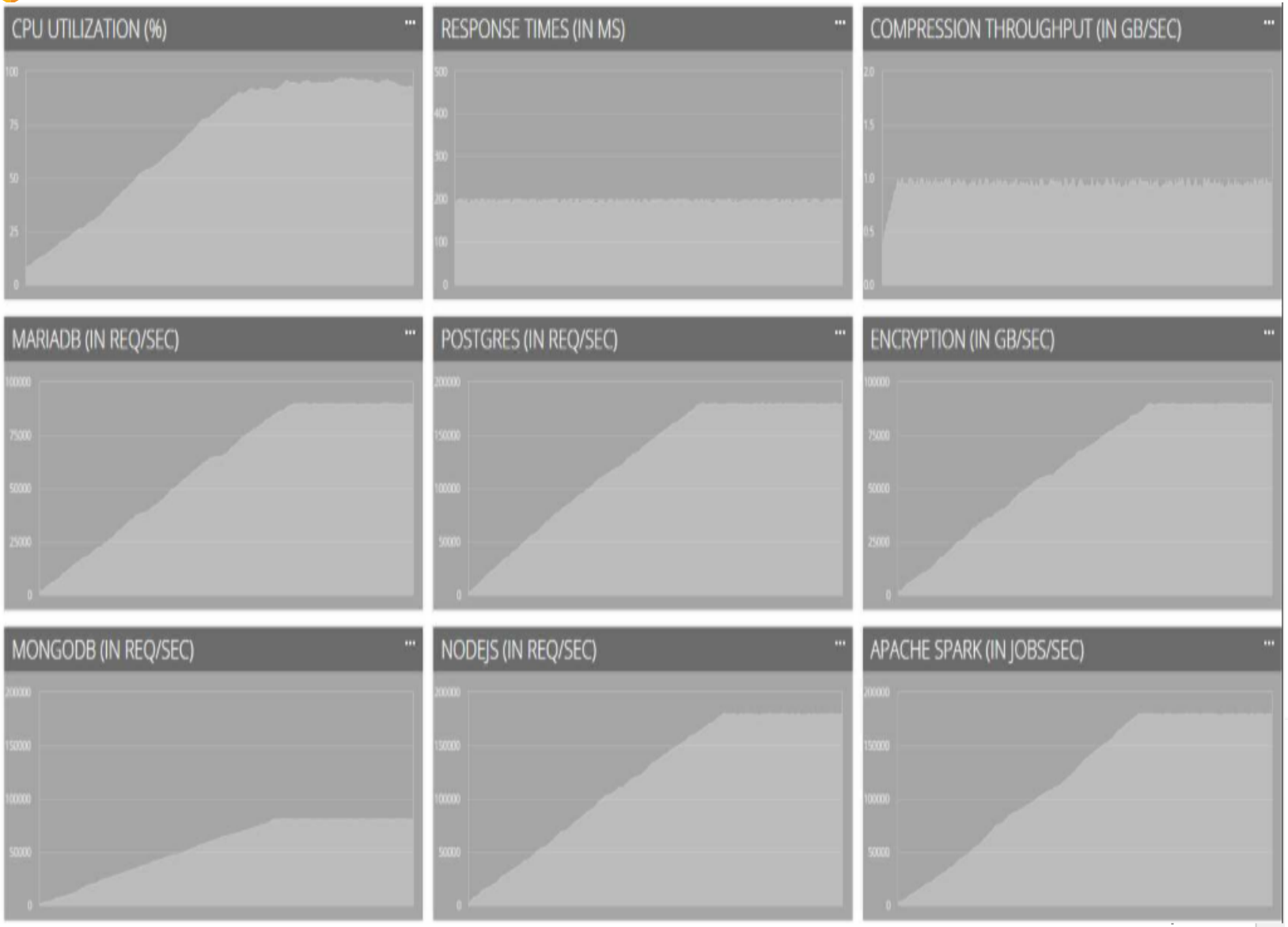


Sentiment Analysis with GeoSpatial input for S&P 500 Financial Data, News Feeds & Tweets

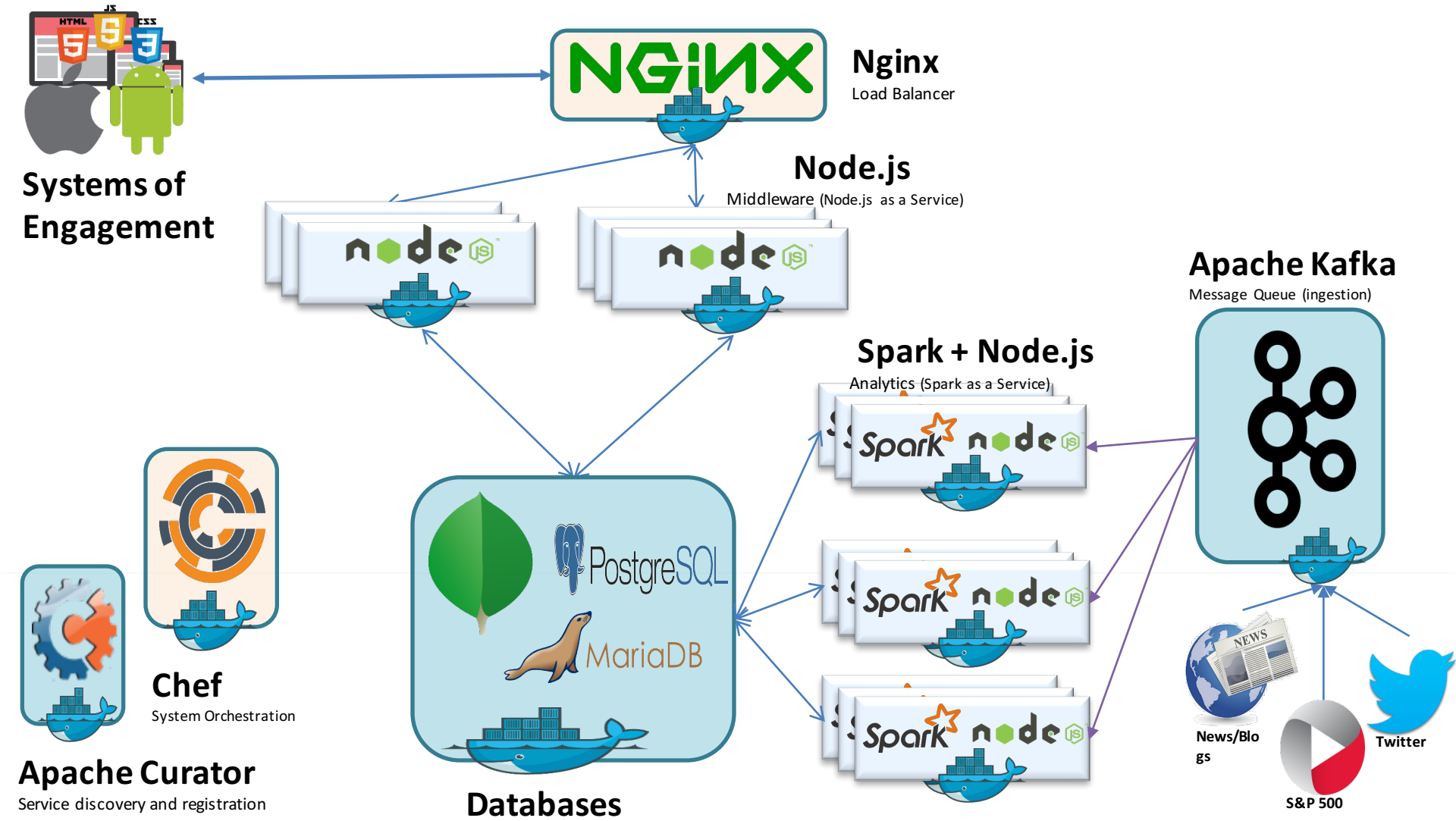
Docker Container Scaling on LinuxONE due to Volume of Financial Trades, News Feeds & Tweets



LinuxONE System Dashboard



Financial Trading Analysis Demo Architecture



Just Awesome Results!

Scalability, Performance, Security, Availability

MongoDB, MariaDB, Postgres up to 2x faster

Compression Spark RDD 4.9x faster
Docker Persistence 4x faster

Heavily Loaded Docker Containers 1.5x

Node.js up to 2x faster

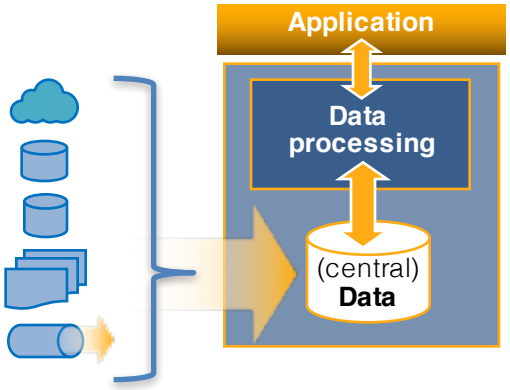
Spark Analytics up to 3x faster

"Single MongoDB *node on LinuxOne scales up to 2TBs with sustained throughput and response time <5ms, while supporting 4Billion+ documents, 460,000 reads/writes/second, with no Sharding required !*

"LinuxOne using Node.js and multiple MongoDB instances handles over *30Billion web events/day*!

An Industry Use Case Observation

SINGLE VIEW USE CASE



Data Aggregation

IMPLEMENTATION

- Industry tends to shard across many server farms
- LinuxONE: Vertical scaling within ***one*** server !
  - Co location data-analytics-insights
  - Extreme virtualization
  - Security
  - Network latency
  - Availability & disaster recovery
  - Apps that don't need to worry about clustering, …

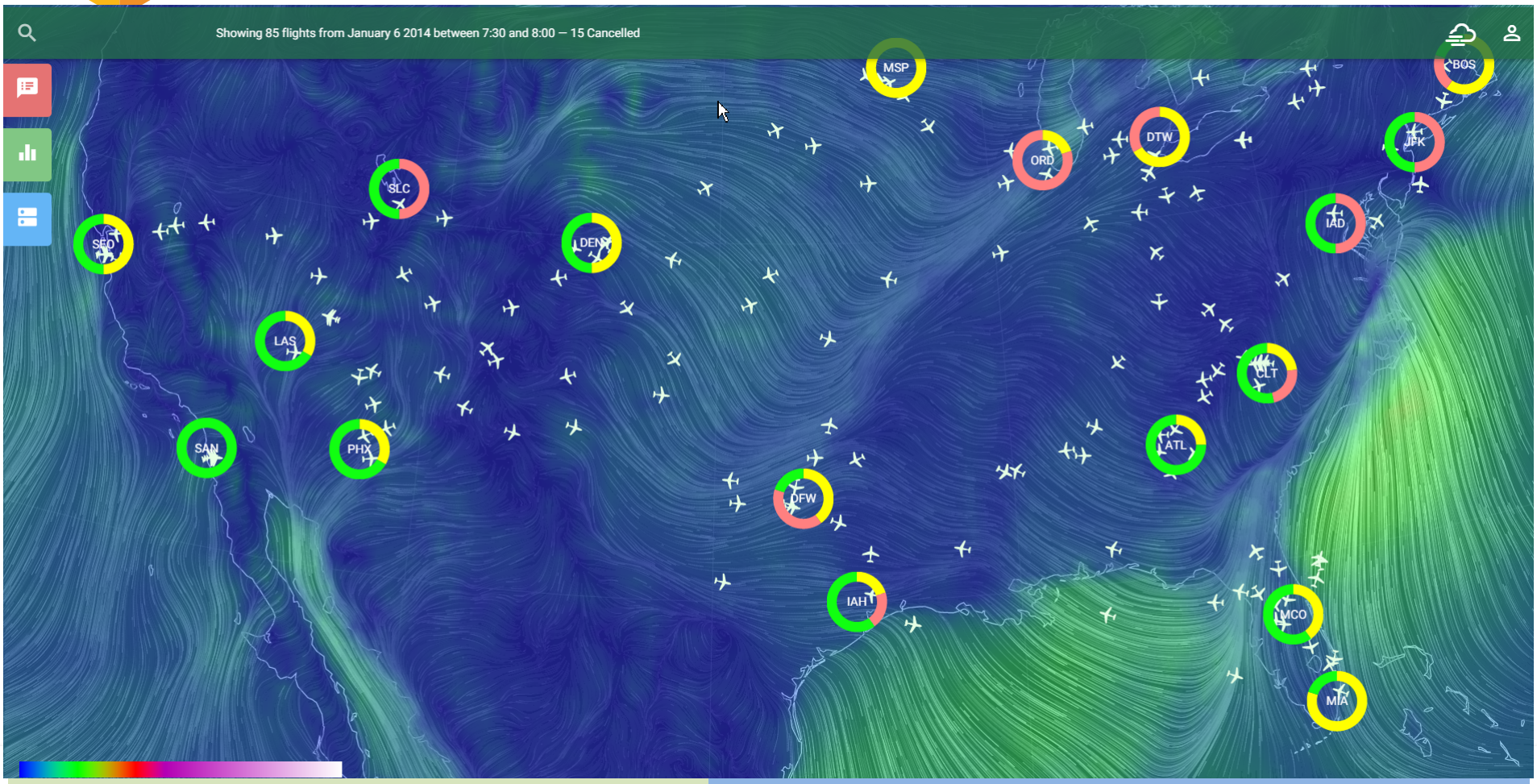
Travel & Transportation Analysis & Insights Demo

Deep analytics providing an enhanced and optimized single view experience for the user

USER CRITERIA	ANALYSIS
Why did my flight got cancelled?	Diagnostic
Geospatial analysis to optimize location paths for airports (in/out), weather, hotel reservations	Geospatial
Predict flight delays based on different data variables (prior flights, airport traffic, weather, etc)	Predictive
Auto-recommendation based on behavior from past data (hotels stay, rent car, etc)	Prescriptive

Have you Ever Been Stranded? Extreme Scaling with LinuxONE to resolve your Travel Nightmares – Jan 2016 Wired.com

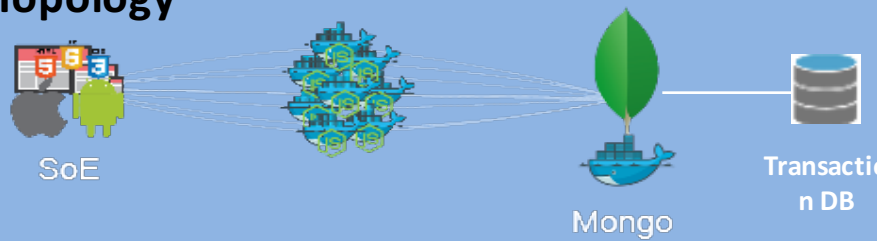
https://youtu.be/1G-Gbv5SsqA



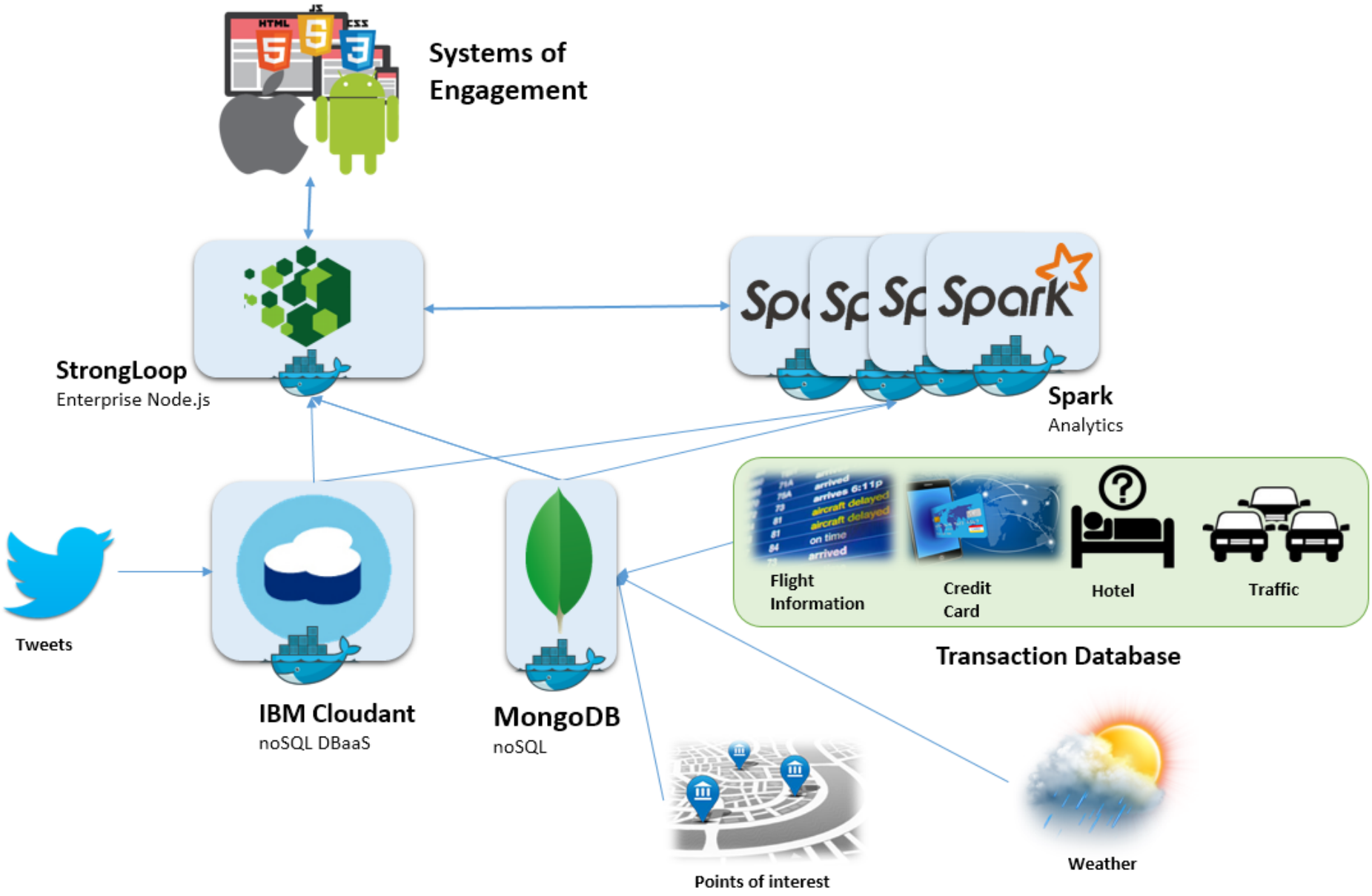
Why LinuxONE

- In 2014, there were nearly 850 Million US Airline passengers or ~ 2.3 millions passengers per day.
- On a bad travel day, an average user could generate ~20 page loads with each page load generating ~100 web events.
- This drives a server volume of ~ 4.6 billion web events per day!

Topology

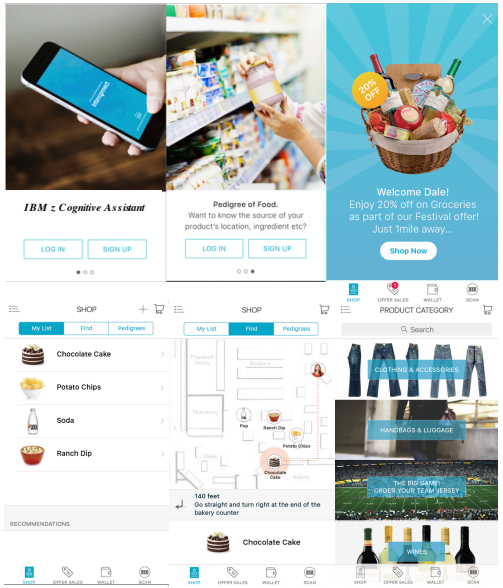


Travel Demo Architecture

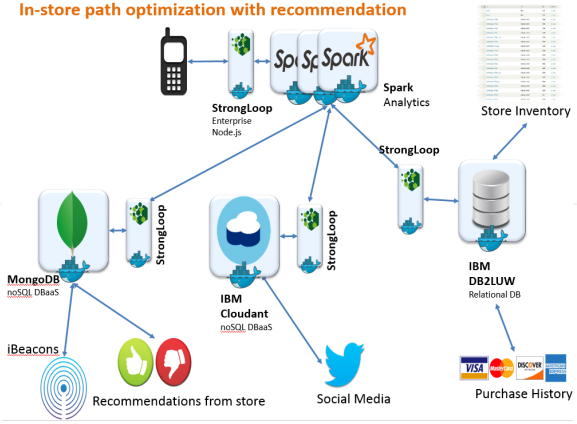


Cognitive Shopping with Blockchain, Deep Analytics, Internet of Things Devices – February 2016 IBM InterConnect

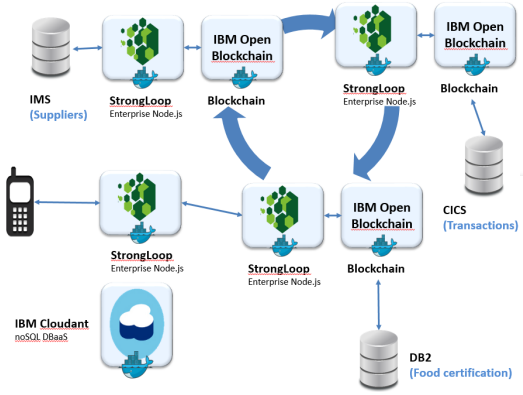
https://www.youtube.com/playlist?list=PLejzQzuteSaraRKTh7Saq9t21ZpKjpE5U



In-store path optimization with recommendation



Block Chain: Pedigree of food



In-store path optimization with recommendation

Store Inventory

StrongLoop
Enterprise
Node.js

Spark
Analytics

StrongLoop

StrongLoop

StrongLoop

MongoDB
noSQL DBaaS

IBM
Cloudant
noSQL DBaaS

IBM
DB2LUW
Relational DB

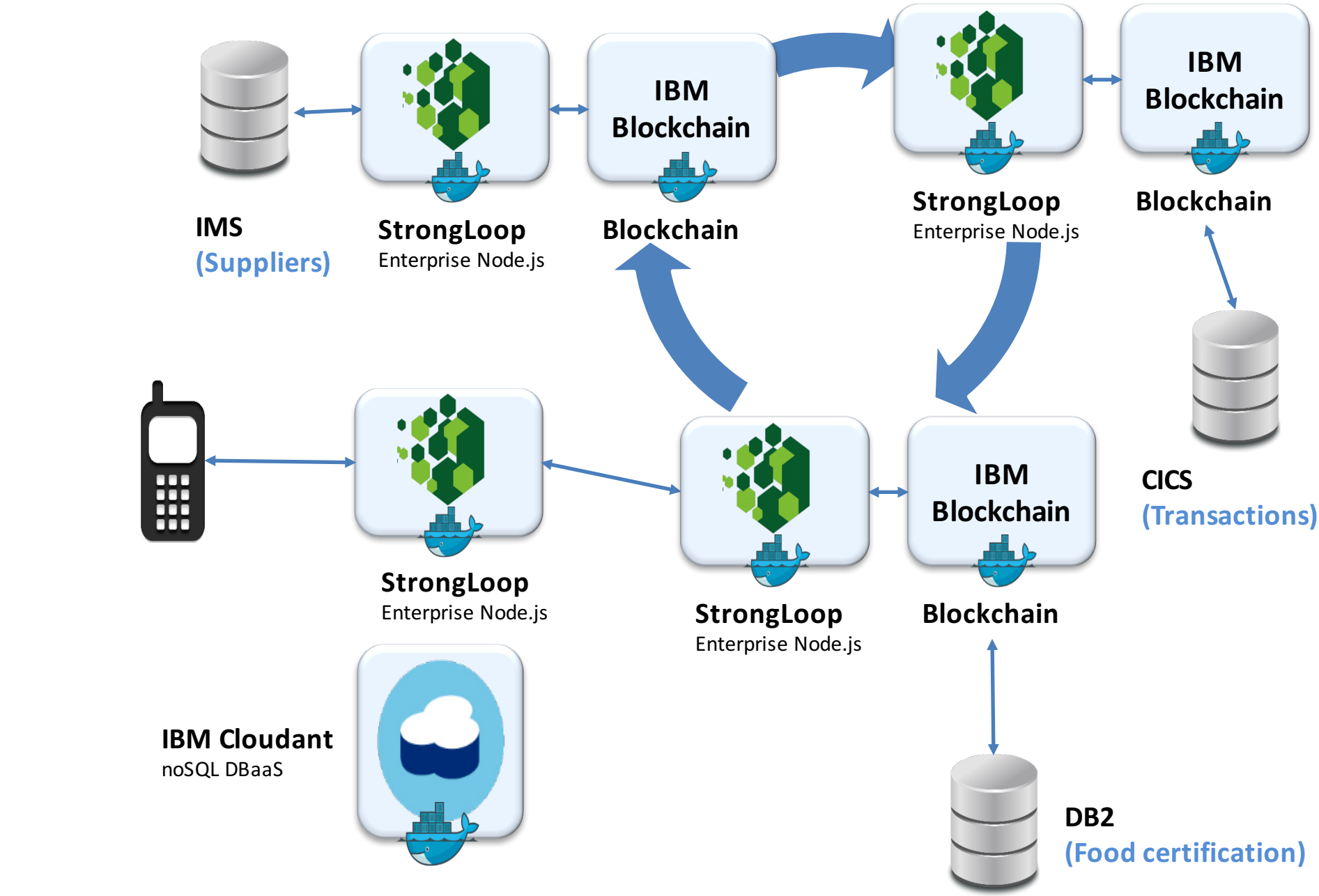
iBeacons

Recommendations from store

Social Media

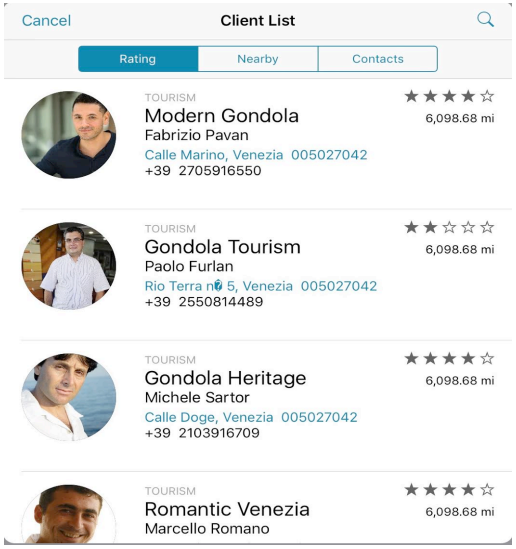
Purchase History

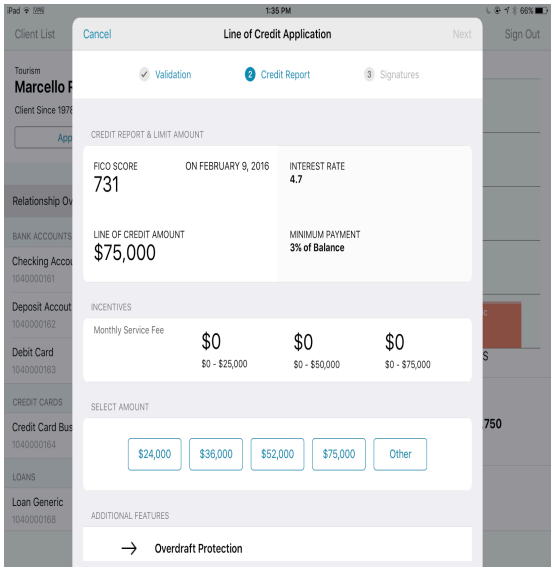
Block Chain: Pedigree of food

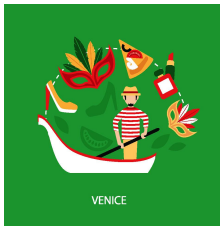


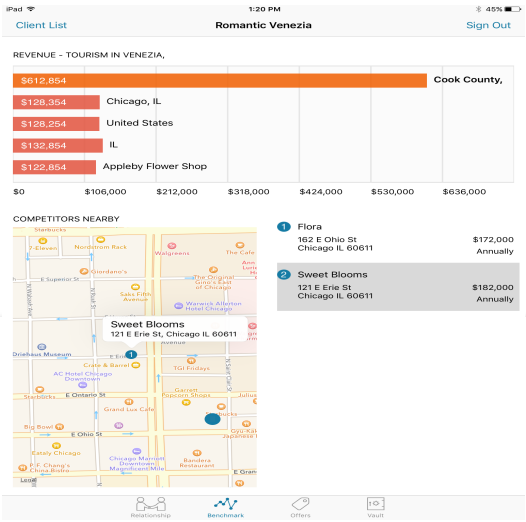
How Fast and Secure Are your Mobile Transactions? – February 2016 IBM InterConnect

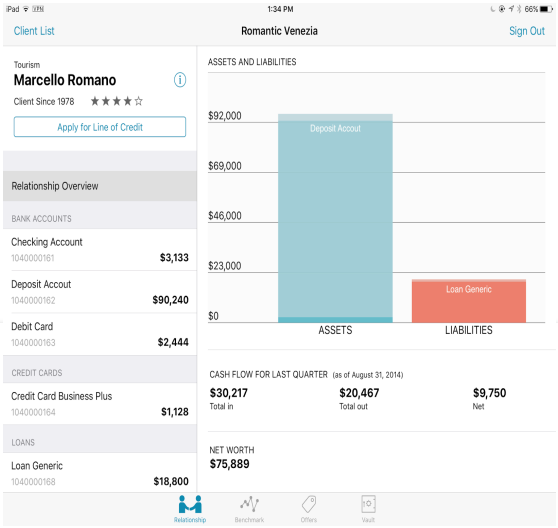
https://ibm.box.com/AdviseAndGrowDemoV1









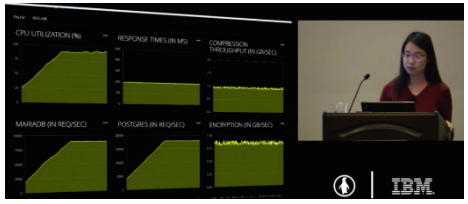


- Apple-IBM App running on iPAD to be used by Bankers selling loans to small businesses
- The Banker can go to the client's office, use analytics to help advise the client how to grow his business and sell banking services on iPAD.
- MobileFirst for iOS with Cloudant running on Linux on z
- Core Banking System running on z/OS
- Restful API's on Banking services

Linux on z is the only Linux deployment that can be co-located with the z/OS System of Record. This unique IBM advantage provides leadership in Security, Response Time and High availability

Market Feedback: LinuxONE Results

Aug 17th Launch Event	**LinuxCon Seattle Keynote:** 1,500+ attendees **Live Video Stream:** 2,100+ live viewers **Other Sessions:** •Mini-summit: Full room capacity – 210+ •Meetup: 114
Upcoming Events	60+ events planned around the globe, including VWWorld, SUSECon, LinuxCon EMEA, Interconnect, and geo events
Videos (9/30)	IBM LinuxONE Linux Without Limits: **569,578** Introducing IBM LinuxONE: **10,637** IBM LinuxONE and Open Source Demo: **132,223** IBM LinuxCon 15: The Penguins are Coming: **5,641**
Media & Analyst Impact	**350+** media articles around the globe, including the Wall Street Journal, Reuters, NY Times, Bloomberg Business, Forbes, Information Week, **50+** analysts briefed representing 3 geos **11 earned** reports published with more expected *"LinuxONE is a full press effort by IBM and likely one of the most significant moves by the company this decade."* – Rob Enderle, Enderle Group, in Pund-IT Weekly Newsletter
Social & Digital	★ **Digital:** 92,000+ views of the LinuxONE page - record high traffic!!! **Reach:** 38.4+k total mentions with 4k from news, 844 forums, 2,600 blogposts and 1,300 Facebook. Twittter accounting for 136M estimated impressions from 31.3k Twitter mentions by 19.1k users **Paid Media:** Custom Banners, Paid search, Social Posts, Gravity, Vine & Sharethrough **Paid Blogs:** Including Forbes & MIT Tech Review **Mainframe Insights:** 2,719 total page views (Aug 24-Sept. 9) **Facebook**: Trended on Aug 17th , 28,777 total reach
Education	**Education**: Attendees from Aug 11-18 includes 1,125+ IBMers & 198 BPs



Solutions:

Designed for the Digital Economy

Solution	Use Cases	LinuxONE Value	Enabling Technologies & Services
Mobile	- Agile Development and Delivery of Mobile Apps - Integration with Core Systems of Record - Secure End-to-End Mobile Transaction - Personalized Mobile Experience Through Analytics	- Secure mobile devices, data and enterprise transactions without sacrificing response time - Deliver mobile services on an open and highly responsive infrastructure that meets the peaks in mobile workloads	- IBM MobileFirst Platform Foundation, MobileFirst Platform Custom Pattern for Linux, MobileFirst Protect, API Management, IBM Integration Bus, Urban Code Deploy, IBM Rational Collaboration Lifecycle Management, IBM Rational Developer for the Enterprise, DataPower, WebSphere Application Server - LinuxONE Mobile Services
Analytics	- High Performance Business Intelligence and Reporting - Big Data Insights and Next Generation Database - IT Operational Analytics for Continuous Business Availability	- Maintain a high-performing business analytics and data warehousing solution without added complexity or cost - Scale up to more users and out to more data while containing costs and reducing complexity - Cost effectively meet the availability expectations of business - Reduce data center complexity and cost with more efficient administration and facilities management	- Cognos, Cognos Custom Pattern for Linux, DB2, DB2 Custom Pattern for Linux, DB2 BLU, BigInsights, IT Operational Analytics, IBM zAware, Spark - LinuxONE Analytics Services
Cloud	- Cloud Platform for Enterprise Systems of Record - Cloud Platform for Any Database Workload - Cross Platform Hybrid Cloud Solution	- Provide agility and time to value with unparalleled qualities of service for business-critical applications - Enable cloud solutions with uncompromised system uptime, airtight data security, and powerful vertical scalability - Deliver high performance and optimize for efficiency	- z/VM and KVM, Wave, Infrastructure Suite for z/VM and Linux, UrbanCode Deploy with Patterns, Custom Patterns for Linux, IBM Cloud Manager with OpenStack, VMware vRealize Automation (*requires ICM for z/VM*), VMSecure, zVPS - LinuxONE Cloud Services
DevOps	- Develop, test, deploy and operate enterprise-level applications - Accelerate software delivery by enabling collaborative development and automation across organizational silos. - Enable developer productivity starting from scratch, open source, or Bluemix, across platform, and languages.	- Complete management and automation of the software development cycle. - Freedom to choose the right development tools for the job and unify development across platforms - Quick feedback and low cost of entry to nimbly incorporate improvements into future iterations	- Rational Collaborative Lifecycle Management (CLM), Urban Code Deploy, IBM Application Performance Manager (APM) - WAS Liberty, Bluemix - LinuxONE DevOps Services

IBM LinuxONE Community Cloud

GOAL: Give developers, ISVs and students remote access to LinuxONE & IBM z

ISVs

- Available for ISV through PartnerWorld
- Hosted by IBM in Dallas, Boeblingen and Beijing
- Port, test, benchmark key applications
- Available Now

Clients

- Remote access environment free of charge for limited time
- Client Sandbox for Proof of Concept work to verify and test new apps and try new technologies
- Available Now

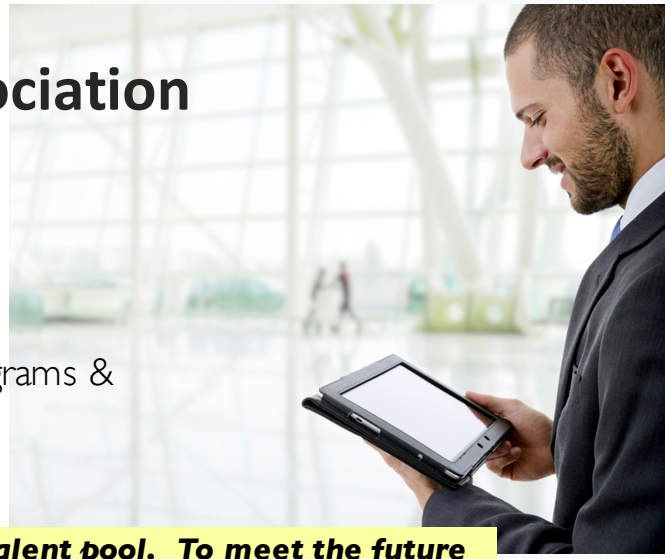
Students & Developers

- Free access to Developers Students, and Entrepreneurs
- Hosted by Partnership Universities: Syracuse, Marist and others
- Get a LinuxONE virtual machine in minutes
- Available November 2015

Open Mainframe Project Mission

- Open source, technical community that industry and community participants easily participate and contribute to the creation of assets that development of Enterprise Grade Linux characteristics
- Leading members of the ecosystem: end users, solution providers, application developers and systems administrators
- Host infrastructure & establish neutral home:community meetings, events, collaborative discussions
- Providing structure around the business and technical governance of the project.

Value Proposition via Linux Foundation Association



- Business decisions through Board and committee representatives
- Technical direction through a TSC representative
- Ensure the financial viability.
- Build a community partnered with academia to increase # academic programs & create robust pipeline of industry relevant skills.

Long term success of Linux on the mainframe requires a vibrant & growing talent pool. To meet the future employment requirements of the industry, training of capable talent must begin within academic institutions.

Current Members

- Project at www.openmainframeproject.org
- Fill in the online form for more info: https://www.openmainframeproject.org/about/join
- Alternatively contact Scott Nicholas at the Linux Foundation: snicholas@linuxfoundation.org