IBM z Systems – More Potential Than Ever

IBM z Systems: Dependable Solutions for a Competitive Edge
Agenda

1. Redefining boundaries for digital and cognitive business
2. **IBM z Systems: Dependable solutions for a competitive edge**
3. Agile integration with the API Economy
4. Transforming data into immediate advantage
5. Cost-effective operations that deliver superior service
Multiple technology choices exist today…

Which one is right?
Public clouds have advantages...

- No infrastructure costs
- Pay as you go
- Fast and agile
- Elastic

Appropriate workloads for public clouds
- Sporadic, variable load
- Less stringent performance, reliability and security requirements
…But not all workloads can or should move off-premises

- Many applications have specific requirements that can only be met with on-premises platforms
  - Specialized hardware
  - Maximum up-time
  - Highest level, end-to-end security
  - Close, stable control and management
  - Higher levels of governance or audit control

- Moving a System of Record off-premises could be disastrous
  - Mission-critical data and applications, corporate ‘crown jewels’
  - Sensitive customer data, regulatory requirements
  - Full control of the environment
Cloud platforms with commodity servers aren’t appropriate for some kinds of workloads

- Commodity servers are “good enough” in some cases, but not all
  - For workloads with exceptionally high cache/memory or I/O requirements
  - For very large databases which would need to be ‘sharded’ (horizontally partitioned) across many servers
  - When availability and reliability are paramount
  - When software priced per core

  Commodity servers not designed to handle this
  Sharding introduces network latency, increased processing times, and addition cost
  Commodity servers not designed for redundancy or reliability
  Low utilization and server proliferation drives up core count
No one platform is right for everything – Hybrid cloud is the answer

As cloud strategies mature and the business benefits* of implementing cloud throughout the organization become clear, hybrid cloud has emerged as the consensus choice to support business growth.

* Business benefits:

- Increased business agility
- Greater responsiveness
- Lower TCO with faster ROI
- Improved customer experiences
- Faster, more accurate decision-making

Of enterprises will be using a hybrid environment this year

Adopt... or be vulnerable to disruption

Source: Under Cloud Cover: How leaders are accelerating competitive differentiation. IBM Center for Applied Insights.
Hybrid clouds are flexible by definition, and flexibility enables disruption

- Flexibility is built in – workloads run on “best-fit” platform
  - Determined by cost, reliability, scalability, elasticity, service requirements.....
  - Minimize data movement, maximize throughout, etc.

**The Line of Business view:**
- Easy to use
- Cost effective
- Available when I need it
- Meet my requirements, deliver my results... FAST!

**The IT view:**
- Easy to manage
- Reduced complexity
- Secured and controlled
- Meets my business process goals
DEMO: On a hybrid cloud, each workload runs on the *optimal*, “best-fit” platform

Line of business users

Easy to use, self-service portal

Best fit deployment using open standards

IBM Cloud OpenStack Services

Off-Premises cloud

IT administrators

Standardized deployments
Enforced business rules
Automated process

z Systems

On-Premises cloud

Traditional IT

Linux KVM

Power Systems

VMware ESX

.86

.86
To support hybrid clouds, on-premises infrastructure must be world-class, extensible, and open

- World-class to support traditional IT
- Highly virtualized, extensible and efficient for private clouds
- Open and secure

IBM z is optimized for performance, throughput, and elasticity
- Leading platform for System of Record workloads and traditional IT
- Highly virtualized and scalable for System of Engagement and on-premises private clouds
Introducing IBM z13s – our most powerful mid-sized mainframe

- Faster clock speeds (4.3 GHz) and radically restructured core micro-architecture
- 1.4x more z/OS processing capacity, and 2.1x more Linux capacity
- 50% more cores, 2x more cache, and up to 8x more memory
- 2x increase in channel speed, and 1.5 -1.8x more bandwidth per I/O domain
- 50% more logical partitions supported (up to 40)
- Adds simultaneous multi-threading (2 threads per core) and Single Instruction Multiple Data (SIMD) instructions

- Real-time decision making with in-transaction scoring
- Hundreds of production capable virtual machines
- Faster data sharing between systems
- More scale for mobile transactions
- Faster fraud detection
- Lower cloud cost
IBM z13 – the flagship enterprise server for core business processing

- **z13 leadership performance**
  - 40% more total capacity
  - 2x performance boost for cryptographic coprocessors
  - 50-80% more bandwidth per I/O domain
  - 2x increase in channel speed
  - 3x increase in memory
  - 2x increase in cache

- **Market momentum since introduction in January, 2015, continues**
  - Strong double-digit revenue growth in every quarter
  - 50 new clients added across 25 countries
  - 40% of z Systems customers have IFLs installed / 81 of top 100 clients

**Machine Type: 2964**
**Models: N30, N63, N96, NC9, NE1**

- 10% Single thread capacity improvement over zEC12
- Up to 60% Increase in throughput with SMT on an IFL
- Up to 10 TB 3X more available memory to help z/OS or Linux workloads
- Up to 141 Configurable cores – CP, zIIP, IFLs, ICFs, SAP
IBM z’s strength is providing a highly secure, multi-layered virtualization infrastructure

- Firmware virtualization layer rated at EAL5+ – *highest commercially available!*
  - Better guarantee of workload isolation than x86 platforms
  - Enables multiple z/VM instances per server

- Software virtualization layer (z/VM or KVM) provides support for large numbers of Linux virtual servers
IBM z supports large-scale resource over-commitment for increased flexibility

Over-commitment of resources:
Hosted environment can support considerably more virtual CPU and more virtual memory, in aggregate, than what is physically allocated for the hypervisor instance

Increases flexibility, making it easier to change/modify VMs more quickly and as business requirements change

Significantly improves cost per unit of work (or return on investment)
Allocate or share resources across all workloads to best support multiple types of workloads

- “Shared everything” hardware design means resources can be shared or dedicated to different LPARs
  - Dynamically add cores, memory, I/O adapters, devices and network cards
  - Grow horizontally and vertically without disruption to running environment
  - Provision for peak utilization, unused resources automatically reallocated after peak

... or clone more guests with a high degree of resource sharing
IBM continues to improve the performance of Java workloads on IBM z

New software adds significant new functionality (Liberty profile, SMT exploitation, mobile, cloud...) AND boosts performance by 64%.

~30% annualized improvement

Results may vary.
Cost of running Java workloads on IBM z continues to be reduced

Which platform provides the lowest TCA over 3 years?

Online Banking workload

- New Java function added on top of existing CICS/DB2 Cobol Application
- 50 concurrent users and 20 account reads added per transaction

Baseline: z13 - 704
Add: 1,351 MIPS + 1 zIIP

1,480 tps
$2,502 per tps
(3 yr. TCA)

WAS ND
REST App
x86 VM

Competitor x86 System
Intel E5-2697v2 2.7GHz
3 core (prorated), 6 vCPU

Baseline: z13-704
Add: 1,351 MIPS + 1 zIIP

1,612 tps
$2,105 per tps
using zCAP
(3 yr. TCA)

Liberty
REST App
JavaCICS

Rest App
CICS/DB2
COBOL Application

16% Lower cost per tps

*For systems compared

This is based on an IBM internal study designed to replicate a typical IBM customer workload usage in the marketplace. Test involved measuring throughput in transactions per second for executing a materially identical online banking workload in a controlled laboratory environment with comparable tuning and sizing. Prices, where applicable, are based on US prices as of 06/30/2015 for both IBM and competitor. Price comparison based on 3 Year Total Cost of Acquisition (TCA) includes all HW, SW and 3 years of service & support. Used IBM Collocated Application Pricing (ICAP) for Java on z13.
Faster I/O improves business process speed and customer response times

PCIe Gen3 in z13 supports faster FICON cards

- Increased bandwidth reduces number of I/O slots used
- Enables greater exploitation of Flash Express, zEDC Express and 10GbE RoCE Express

IBM Internal test: I/O driver benchmark, Megabytes per second, full-duplex, large sequential, read/write mix. The actual throughput or performance that any user will experience will vary depending upon considerations such as the amount of multi-programming in the user’s job stream, the I/O configuration, the storage configuration, and the workload processed.
Enhanced cryptographic features insure that data and processing is absolutely secure

- Cryptographic co-processors have been optimized to provide up to **2x faster** encryption functions
- Co-processors hashing functions are up to **3.5x faster**

**50% reduction in cost of ubiquitous encryption**

- Crypto Express5S PCIe feature has up to **2x better** performance than 4S
- New crypto algorithms (i.e. Elliptic Curve, SHA3, Visa FPE) hardcoded in feature
- Meets FIPS, ANSI, PKI, and DK standards
z Systems are exceptional platforms for new compute- or memory-intensive workloads

- Enable totally new types of applications
- Accommodate growing workloads without changes to applications to gain benefits
- Support modern memory-heavy computing languages and architectures
- Reduce need to fine tune memory and leverage the tuning capabilities in DB2, IMS and CICS
- With Linux on z:
  - Run new databases like DB2 BLU
  - Configure up to 1TB of memory for z/VM LPARs
  - Use fewer larger data passes for a faster result set
Vector processing improves compute-intensive analytical workloads, yielding faster results

Single Instruction Single Data (SISD) - previous

Single Instruction Multiple Data (SIMD) - new

With the amount of data increasing exponentially, math and data-intensive analytics computing can lead to high MIPS usage.

SIMD provides yet another chip architecture enhancement - for analytics and compute-intensive competitiveness on z Systems.
Simultaneous multi-threading provides more capacity for the investment

- z13 and z13s support two instruction **threads** per core
  - Threads share all core resources, each thread has its own unique state information
  - One thread can’t lock out the other

- Implemented for IFL and zIIP workloads only
  - Independently implemented for each LPAR – operating system must be explicitly enabled

- Architecturally transparent for middleware and applications
  - Some applications may require modifications to work well

Note: The improvement ratios from one thread to two threads are workload and configuration dependent and can vary widely.

- **38%** performance improvement of zIIPs in z13 over zEC12
- **32%** performance improvement of IFLs in z13 over zEC12
DEMO: SMT gives significant boost to workloads with zIIP offload

With SMT off

With SMT on

Throughput (performance) improved by ~ 50%

Response time improved by ~ 50%

Note: The improvement ratios from one thread to two threads are workload and configuration dependent and can vary widely.
IBM z drives certain business workloads particularly well…

**Business application**

- **Database**
  - Requirements: Low latency, Fast response times

- **Transaction processing**
  - Requirements: Fast throughput

- **Mission-critical**
  - Requirements: Always on, Ultimately secure

**IBM z meets application requirements**

- Fastest clock speed
  - Over 4x more cache per core than typical commodity servers

- Dedicated I/O cores
  - Large virtualized I/O subsystem – unlike typical IT servers

- Purpose-built for reliability, highest availability, and absolute security
IBM z supports a vast ecosystem for both z/OS and Linux

<table>
<thead>
<tr>
<th>Enterprise Big Data and Analytics</th>
<th>Hybrid Cloud</th>
<th>Enterprise Open Source</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Systems of Record</td>
<td>Systems of Insight</td>
<td>Pattern-Enabled Infrastructure as a Service</td>
<td>Linux on z</td>
</tr>
<tr>
<td>Oracle DB2</td>
<td>Spark</td>
<td>docker</td>
<td>redhat</td>
</tr>
<tr>
<td>IBM Cloudant</td>
<td>hadoop</td>
<td>CHEF</td>
<td>spark</td>
</tr>
<tr>
<td>MariaDB</td>
<td>elasticsearch</td>
<td>openstack</td>
<td>perl</td>
</tr>
<tr>
<td>MongoDB</td>
<td>logstash</td>
<td>vmware vRealize</td>
<td>python</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>Kibana</td>
<td>Cloud Manager</td>
<td>ruby</td>
</tr>
<tr>
<td>CouchDB</td>
<td>cassandra</td>
<td>urban(code)</td>
<td>scala</td>
</tr>
<tr>
<td>MySQL</td>
<td>redis</td>
<td>puppet basel</td>
<td>erlang</td>
</tr>
<tr>
<td>WebSphere</td>
<td>software</td>
<td>saltstack</td>
<td>clojure</td>
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<tr>
<td>IBM InfoSphere BigInsights</td>
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<td>javascript</td>
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| Oracle DB2                        | Spark        | docker                 | redhat                 |
| IBM Cloudant                     | hadoop       | CHEF                   | spark                  |
| MariaDB                          | elasticsearch | openstack              | perl                   |
| MongoDB                          | logstash     | vmware vRealize        | python                 |
| PostgreSQL                       | Kibana       | Cloud Manager          | urban(code)            |
| CouchDB                          | cassandra    | puppet basel           | saltstack              |
| MySQL                            | redis        | saltstack              | apache zookeeper       |
| WebSphere                        | software     | saltstack              | apache zookeeper       |
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A private cloud on IBM z can be more cost-effective than other cloud options

For the web application workloads compared, the Linux on z private cloud deployment is estimated to be 45% lower in cost than the compared x86 private cloud and 55% lower in cost than the compared public cloud alternative.

24 General Purpose VMs (2 VMs per workload)

12 Web application workloads each driving 620 transactions per sec; 2 VMs per workload; each VM requiring 2 vCPUs, 8GB memory; 20GB storage

24 m4.large dedicated reserved instances
$3.66M (3yr TCO)

48 cores
$2.95M (3yr TCO)

Private Cloud on x86

Private Cloud on Linux on z

8 cores
$1.63M (3yr TCO)

45% Less than x86 cloud*
55% Less than public cloud*

*Estimated for systems compared

Performance comparison based on IBM internal tests comparing IBM Linux on z cloud with one comparably configured private x86 cloud and one comparably configured public cloud running general purpose virtual machines designed to replicate typical IBM customer workload usage in the marketplace. System configurations are based on equivalence ratios derived from IBM internal studies and are as follows: Public Cloud configuration: total of 24 general purpose instances; x86 Cloud configuration: total of two x86 systems each with 24 Intel E5-2690 v3 cores, 192GB memory, and 2x400GB SSDs; Linux on z Cloud configuration: total of 8 cores, 384GB memory, and Storwize V7000 with 4x400GB SSDs. Price comparison estimates based on a 3yr Total Cost of Ownership (TCO) using publicly available U.S. street prices (current as of December 10, 2015). Public Cloud TCO estimate includes costs (U.S. East Region) of infrastructure (instances, data out, storage, support, free tier/reserved tier discounts), middleware and labor. Linux on z and x86 TCO estimates include costs of infrastructure (system, memory, storage, virtualization, OS, cloud management), middleware and labor. Results may vary based on actual workloads, system configurations, customer applications, queries and other variables in a production environment and may produce different results. Users of this document should verify the applicable data for their specific environment.
Cost breakdown shows the advantages of Linux on IBM z

Case Study: 24 General Purpose VMs

- Factors contributing to Linux on z advantages:
  - Workloads run on smaller footprint on z13s
    - High performance cores
    - Efficient large cache hierarchy and memory support
    - Fast I/O
    - Shared resources
    - Partitions
    - Capacity on Demand
    - Reliability/redundancy built-in
  - Smaller footprint on z13s results in lower costs
    - Reduced middleware licensing costs
    - Reduced labor costs

Performance comparison based on IBM Internal tests comparing IBM Linux on z cloud with one comparably configured private x86 cloud and one comparably configured public cloud running general purpose virtual machines designed to replicate typical IBM customer workload usage in the marketplace. System configurations are as follows: Public Cloud configuration: total of 24 general purpose instances; x86 Cloud configuration: total of two x86 systems each with 24 Intel E5-2690 v3 cores, 192GB memory, and 2x400GB SSDs; Linux on z Cloud configuration: total of 8 cores, 384GB memory, and Storwize v7000 with 4x400GB SSDs. Cost estimates are 3YR Total Cost of Ownership (TCO) based on U.S. prices (including a 20% discount for middleware and 20% discount for x86 infrastructure) current as of January 1, 2016. Public Cloud TCO estimate includes costs (US East Region) of infrastructure (instances, data out, storage, support), middleware and public cloud labor. Linux on z and x86 TCO estimates include costs of infrastructure (system, memory, storage, virtualization, OS), middleware and labor. Results may vary based on actual workloads, system configurations, customer applications, queries and other variables in a production environment and may produce different results. Users of this document should verify the applicable data for their specific environment.
# IBM z13 key differentiators compared to x86 clouds

<table>
<thead>
<tr>
<th>Capabilities (within system)</th>
<th>IBM z13s</th>
<th>x86 commodity* On-premises</th>
<th>x86 commodity* Public Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Core performance</td>
<td>High</td>
<td>Medium</td>
<td>Low to Medium</td>
</tr>
<tr>
<td>Multi-tier cache performance</td>
<td>High</td>
<td>Medium</td>
<td>Variable</td>
</tr>
<tr>
<td>Memory amount (and overcommit)</td>
<td>High (L1 to L4)</td>
<td>Medium (no L4)</td>
<td>Low</td>
</tr>
<tr>
<td>I/O performance</td>
<td>High</td>
<td>Medium</td>
<td>Variable</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td></td>
<td>Low to Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Spare cores</td>
<td>High</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Reliable memory</td>
<td>High</td>
<td>Low to Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Concurrent upgrades/replacement</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
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<tr>
<td><strong>Scalability (for consolidation within system)</strong></td>
<td></td>
<td>Low to Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Secure partitions</td>
<td>High</td>
<td>Low to Medium</td>
<td>Not available</td>
</tr>
<tr>
<td>Capacity on demand</td>
<td>High</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Multiple workloads/VMs on one system</td>
<td>High</td>
<td>Low to Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Security (for workloads/VMs/data within system)</strong></td>
<td></td>
<td>Medium</td>
<td>Low to Medium</td>
</tr>
</tbody>
</table>

*1- or 2- socket commodity x86 servers compared
Integrating z-based assets with hybrid cloud services drives more value and richer customer experience

IBM z integrates fully with cloud-based API Economy

- Securely connect applications and data across environments to extend valuable business resources
- Combine with data services from business partners to quickly build killer apps
- Publish and socialize internal assets to expand markets
Hybrid cloud is the platform of the future

- IBM z is world-class on-premises infrastructure optimized for hybrid cloud computing
  - High performing System of Record (z/OS)
  - Exceptional System of Engagement (Linux on z)
  - Open, agile and connected, integrating with cloud-based services for value and richer customer experience
  - Supports centralized, standards-based cloud monitoring, provisioning and management

- You’re ready for digital business – with Hybrid Cloud and IBM z