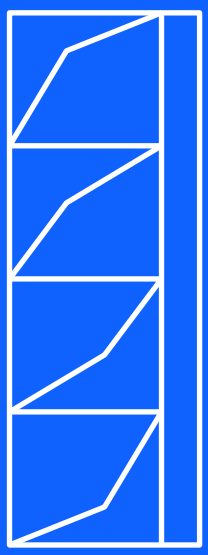


IBM Z® and IBM LinuxONE at a Glance

IBM Z and LinuxONE at a Glance

Hybrid Cloud

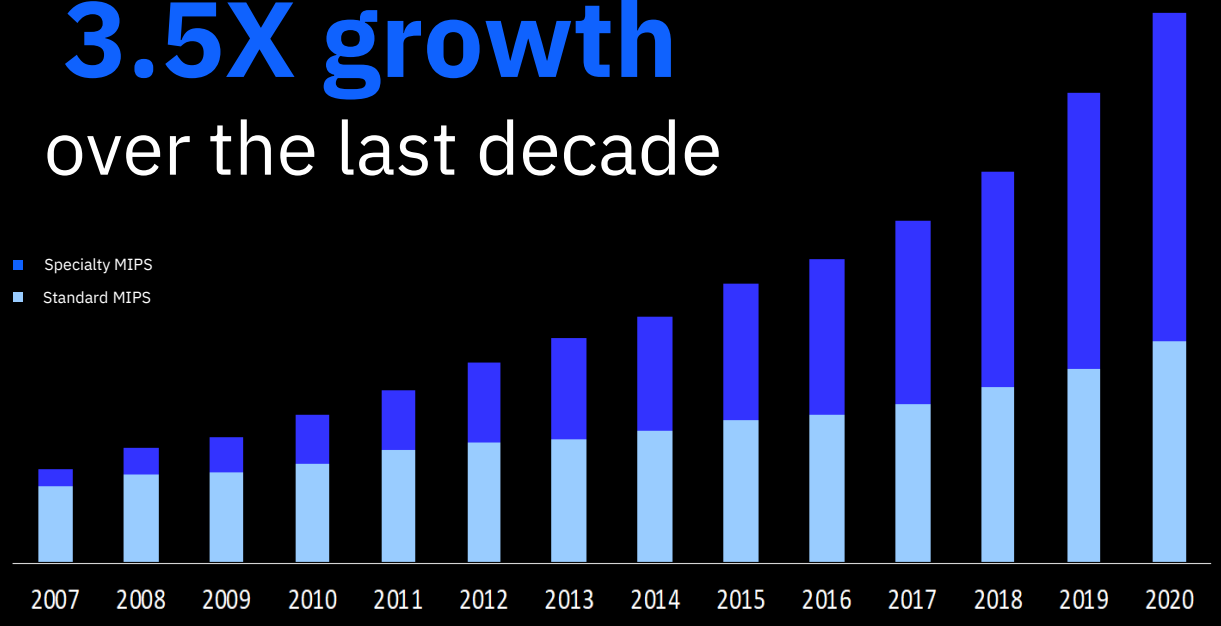
Security & Resiliency

Flexible Compute

next

IBM Z momentum[1]

3.5X growth
over the last decade



- **67 of the Fortune 100**
- **45 of the world's top 50 banks**
- **8 of the top 10 insurers**
- **4 of the top 5 airlines**
- **7 of the top 10 global retailers**
- **8 out of the top 10 telcos**

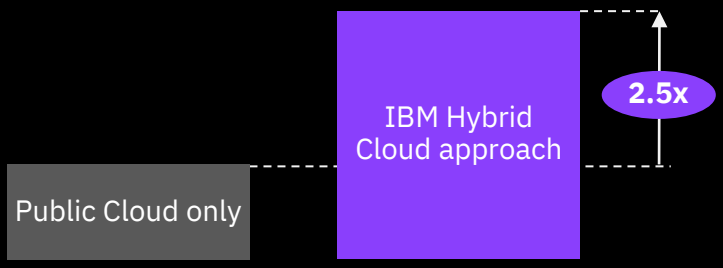
Hybrid Cloud

Combine and unify public cloud, private cloud and on-premises infrastructure to create a single, flexible, cost-optimal IT infrastructure.

Extend the value of your hybrid cloud with IBM Z

2.5X

the value a public cloud-only approach[2]



Driving momentum in IBM Z®

91% of respondents identified expanding their mainframe footprints as a moderate or critical priority in the next 12 months.[3]

74% say they "believe the mainframe has long-term viability as a strategic platform for their organizations."[3]

IDC: The business value of the transformative mainframe[4]

>6:1 benefit to cost ratio for overall efficiencies and revenue

$194 million per year higher/ protected revenue per organization

19% reduction in operating mainframe costs

14% lower hardware / licensing costs

IBM Conclusion:

One size fits all does not work for your customers or your business. Why accept it for your cloud service?

The predictable compute economics of IBM Z in the hybrid cloud



TCO studies indicate that growth on non-IBM public cloud platforms can be **41% to 81% more expensive** than on IBM z15™ using Tailored Fit Pricing.[5]

Flexible pricing options plus pricing predictability	**Usage models: traditional IT, private, public or hybrid cloud**
Tailored Fit Pricing Capacity on Demand Global financing	On-prem and off-prem delivery models Flexible pricing with pay as you go

"When the TCO model came out it was jaw-dropping: we stood to make substantial savings by moving away from a distributed infrastructure."
— Techcombank

IBM Conclusion:

You cannot budget for hidden costs and surprise bills. Make sure that you are in control.

Time to modernize with IBM Z

39%

of IT Decision makers surveyed said modernizing existing applications is a top priority.[6]

"Some say rip and replace – that is feasible, but we believe it's extremely costly, risky and time consuming, that's why we are modernizing on IBM Z."
– M&T Bank, Think 2021

"By implementing lift & shift you conserve the old architecture and have a second environment. You don't have a new modernized environment, you still have the old application."
– Fiducia GAD, Think 2021

Get new services to customers faster

Increase developer velocity by containerizing and modernizing applications with up to **66%** faster application development life cycles with Red Hat® OpenShift®.[7]

Designed to deliver faster service

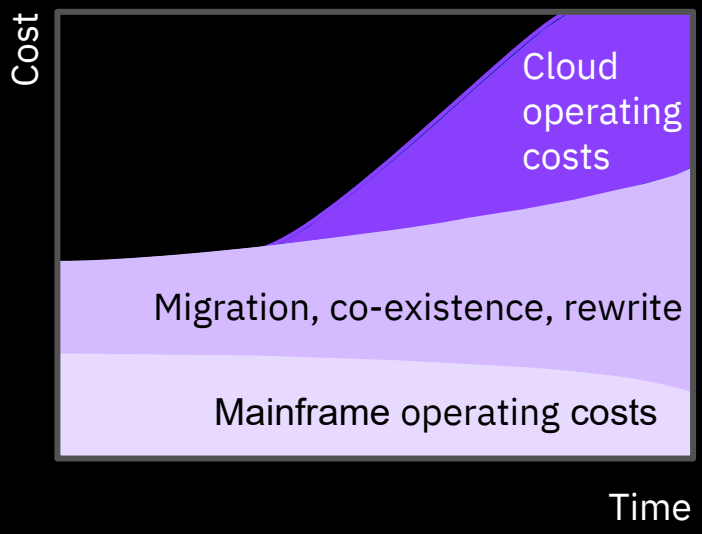
Accelerate service with up to **4.7x** lower latency for co-located OpenShift apps on IBM Z and deliver continuous service with a **3 second** downtime per year design point IBM Z.[8]

IBM Conclusion:

Many mainframe migrations fail due to time and cost overruns. Don't be a lift and shift victim.

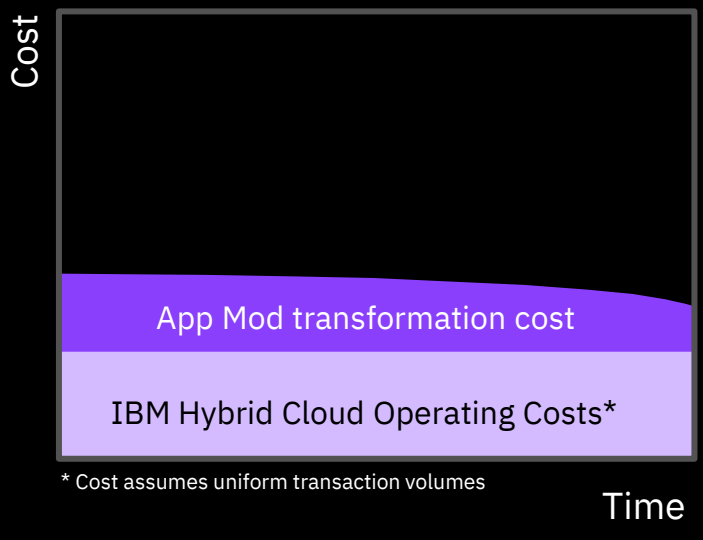
The hidden cost of application migration

Application migration with cloud service providers[9]



or

IBM Application Modernization[9]



3.2X

lower annual TCO with IBM Z App modernization vs. App migration to the cloud only.[9]

In early 2021, approximately **30%** of executives surveyed were underwhelmed by their public and private cloud investments from a functional and financial perspective.[10]

IBM's approach to application modernization leverages **existing investments** and targets only required modernization.

IBM Conclusion:

Moving applications to public cloud is a short-term decision.
For growth and reduced costs, modernize applications on IBM Z.

Don’t compromise on resiliency or security

A migration only approach can compromise resiliency and security. IBM Z is designed to offer unparalleled availability and security, **designed to protect your customers’ data**.

A major bank and leader in logistics supply chain increased deployment speed and resilience by re-architecting applications across the hybrid cloud[11]

Shifted to agile DevOps approach Standardized development Moved applications where it makes the most sense to run	Relies on IBM Z as a secure and high-performance platform Increases deployment velocity from two releases per year to 24 deployment “go lives” per day

IBM z15 solutions are designed to deliver 99.99999% availability.[12]

90% of respondents see the mainframe platform as a long-term platform for growth.”[13]

Leverage existing security & compliance investments and built-in IBM Z security. Avoid the additional cost of custom-built security and compliance on top of a public or private cloud.

A balanced, business aligned approach to application modernization will optimize costs and improve ROI without sacrificing agility and time to market.

IBM Conclusion:

In today’s environment, security and resiliency shouldn’t have to be compromised. Protect your investments with IBM Z.

Security & Resiliency

Performance, privacy and protection for data at-rest, in-flight, and in-use — and across its lifecycle.

Protect your business data against cyber threats

The Ponemon Institute: 2021 Cost of a Data Breach Report[14]

10%	$4.24 million	287 days	44%
Increase in avg. total cost of a breach, 2020-21	Global average total cost of a data breach	Average time to identify and contain	Of breaches involved customer PII

Process up to **19 Billion** fully encrypted transactions per day within a single system.[15]

Pervasive encryption is a consumable approach to enable extensive encryption of data in-flight and at-rest. It is designed to simplify encryption and reduce costs associated with protecting data and achieving compliance mandates.

IBM Enterprise Key Management Foundation – Web Edition (EKMF Web) provides efficient and security-rich **centralized key management** for IBM z/OS data set encryption on IBM Z servers and public cloud key management systems. It also supports zKey on Linux on Z and in public clouds.

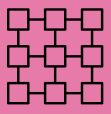
IBM Secure Execution for Linux is designed to provide scalable isolation for individual workloads to help protect them from not only external attacks, but also insider threats. Secure Execution can help **protect and isolate workloads** on-premises, or on IBM LinuxONE and IBM Z hybrid cloud environments.[16]

"With the IBM Z server handling all the encryption, I can rest assured that all of our customer data is safe, without the need for any developer input on the application layer – which makes my life a lot easier."
- Emid

IBM Conclusion:

Security breaches can cost millions.
Are you prepared to take a chance with your data?

Gain a higher level of privacy assurance with confidential computing

Confidential Computing		Confidential computing protects data in use by performing computation in a hardware-based Trusted Execution Environment (TEE). **Confidential computing with IBM** is designed to ensure no one can access your data — not even us.[17]
IBM Cloud® Hyper Protect Virtual Servers		Grants you complete authority over your Linux-based virtual servers for workloads that contain sensitive data and business IP to help developers easily **build secure cloud applications.**[18]
IBM Cloud® Hyper Protect Crypto		Take control of your cloud data encryption keys and cloud hardware security modules (HSM) with **the only service in the industry** that's built on **FIPS 140-2 Level 4-certified hardware.**[19]
IBM Cloud® Hyper Protect Database-as-a-Service		Designed to offer a **secure database environment** for enterprise workloads with sensitive data. Provision, manage, maintain and monitor multiple database types, like MongoDB and PostgreSQL, through standardized APIs.
IBM Hyper Protect Data Controller		Designed to help clients protect their eligible data after it leaves the system of record and travels throughout the enterprise. Maintain appropriate use of data, revoke future access at any time, and keep an audit trail to help **simplify compliance efforts.**[20]

"Our new confidential computing capabilities, enabled by IBM and Ubuntu, help us ensure that data is protected from both external attack and bad actors within an organization. We can provide an exceptionally high level of security at competitive fees for even extremely large data sets."
- Phoenix Systems

"The combination of IBM LinuxONE and IBM Hyper Protect Virtual Servers gives us the most secure foundations possible. IBM CryptoCards are the only HSMs [Hardware Security Modules] that are FIPS 140-2 Level 4 compliant."
- Hex Trust

IBM Conclusion:

Your data is your data.
Why does your cloud vendor need access to it?

Flexible Compute

Deploy compute resources flexibly and on-demand, regardless of your size and capacity needs. Benefit from flexible consumption models, on-chip compression for defined workloads, and a footprint that fits perfectly into the modern cloud data center.

Ready for cloud data centers

Run up to **1 Trillion**
web transactions per day with z15.[21]

Designed to align with datacenter trends: optimize cost, density and flexibility

Modular and Scalable	Available in one to four **19" frames** depending on capacity needs.
Less Energy Consumption	A single frame z15 saves an estimated **50% in power consumption** per year compared to x86 systems running workloads with the same throughput.[22]
Flexible Footprint	Both raised and non-raised floor options available as well as top and bottom exit I/O and power. An IBM z15™ single frame system requires **75% less floor space** than compared x86 2U servers running the same workloads and throughput.[23]
Sustainable	IBM z13® and IBM z14 customers who have already upgraded to z15 T01 rather than compared x86 servers save an estimated **18.2 million** kWh and reduce greenhouse gas emissions by 12.9 metric tons of CO_2 each year.[24]

"Supported by IBM, we are working to turn greenhouse gas into a resource for good."
- Newlight Technologies

"With IBM technology, we don't have to promise transparency—we can guarantee it. And we can keep looking for ways to do more for the world, confident that we've got the infrastructure and development partner to roll them out quickly and effectively."
- Plastic Bank

IBM Conclusion:

The future is green.
Is your datacenter ready?

Superior data center savings with IBM Z and LinuxONE

Consolidation

Workloads running on **55 x86 servers** could be consolidated onto **one IBM LinuxONE** system, floor space could be reduced by **86%** and annual energy consumption could drop by **62%**.[25]

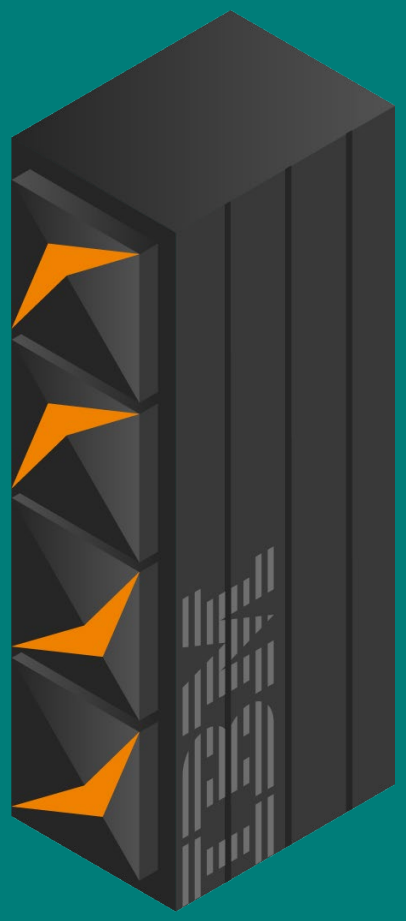
Total Cost of Ownership

IBM internal tests show that same online transaction processing workloads on OpenShift require 17 times fewer cores on LinuxONE III LT2 and deliver a **48% lower TCO** over three years than compared x86 servers.[26]

Workload consolidation analysis requested by financial institutions found that the same Java workloads on LinuxONE or IBM Z provided on average a **60% lower TCO** over five years than on compared x86 servers.[27]

Licenses

IBM LinuxONE III Express uses **75% fewer licenses** for a competitive database versus the compared x86 environment by reducing the number of cores required to run the same transactional workload.[28]



"The more we consolidate onto the LinuxONE platform, the further we will reduce our operational costs. And most importantly, we gain the resilience, robustness and guaranteed performance that comes with an enterprise-class Linux environment."
- The Met Office

IBM Conclusion:

Server sprawl is a real issue.
Don't lose control of your data center.

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Footnotes and disclaimers

1. Sanitized Graphs of MIPS Inventory. Derived from IBM Financial data. From 2007 through 2020, the installed IBM compute capacity of our clients has grown 350%.

   Fortune 100: https://fortune.com/fortune500/
   Banks: https://www.relbanks.com/worlds-top-banks/assets
   Insurance: https://www.insurancebusinessmag.com/us/guides/these-are-the-top-25-largest-insurance-companies-in-the-world- 123332.aspx
   Airlines: https://en.wikipedia.org/wiki/World%27s_largest_airlines

   Retailers: https://www.investopedia.com/articles/markets/122415/worlds-top-10-retailers-wmt-cost.asp
   Telco: https://www.forbes.com/sites/jonathanponciano/2018/06/06/worlds-largest-telecom-companies-2018/#68b68c857d39

2. Based on an IBM internal cross industry assessment, Institute of Business Value 2020. The Hybrid Cloud Platform Advantage. Read it here: https://www.ibm.com/downloads/cas/QMRQEROB

3. A commissioned study conducted by Forrester Consulting on behalf of Deloitte Consulting LLP, June 2020 | Base: 261 business and IT decision makers with authority or influence over mainframe decisions. https://www2.deloitte.com/us/en/pages/consulting/articles/hello-mainframe-our-old-friend.html

4. IDC Business Value White Paper, co-sponsored by IBM and Broadcom, The Business Value of the Transformative Mainframe, August 2019. IDC interviewed companies with significant mainframe investments - large firms with over $87K employees on average and revenues in the tens of billions.

5. Differences between growing workloads on IBM z15 with Tailored Fit Pricing and public cloud solutions are based on a client use case modeled by the IBM IT Economics team. The model compares hardware, software, labor, networking, floor space, energy, storage, and disaster recovery environment costs for workloads undergoing growth over a five-year period. The model analyzed initial investment costs in year one (2 IBM Z servers with 32,000 MIPS that grow to 38,897 MIPS in the 5th year and 2,460 vCPUs in year one to 2,993 vCPUs in year five for the public cloud scenarios to account for comparable functionality on IBM Z, including HA, development, test, and disaster recovery. Sixty-four vCPU capacity instances were used for the public cloud scenarios in Year 1 (986 database and tools vCPUs and 1,474 WebSphere. Read the Report - Tailored Fit Pricing for IBM Z Offers Cost Effective Workload Growth Compared to Three Public Cloud Examples: https://www.ibm.com/downloads/cas/XAR2QOBD

6. A commissioned study conducted by Forrester Consulting on behalf of IBM, August 2019. The Real Costs of Planned and Unplanned Downtime: https://www.ibm.com/downloads/cas/L57KW7ND

7. “Forrester - Emerging Technology Assessment: The Total Economic Impact Of Using Both IBM And Red Hat Solutions Together,” June 2019. Read the Report: https://www.ibm.com/downloads/cas/7AOR8E06

8. Internal performance tests by Stefan Wirag and team – “Run an OLTP workload on OpenShift Container Platform 4.4 with up to 4.7x lower latency co-located to the used database on z15 T01 using a Hipersocket connection versus on compared x86 platform using a 10 Gb TCP/IP connection to the same database”. DISCLAIMER: This is an IBM internal study designed to replicate banking OLTP workload usage in the marketplace deployed on OpenShift Container Platform (OCP) 4.4.12 on z15 T01 using z/VM versus on compared x86 platform using KVM accessing the same PostgreSQL 12 database running in a z15 T01 LPAR. 3 OLTP workload instances were run in parallel driven remotely from JMeter 5.2.1 with 16 parallel threads. Results may vary. z15 T01 configuration: The PostgreSQL database ran in a LPAR with 12 dedicated IFLs, 256 GB memory, 1TB FlashSystem 900 storage, RHEL 7.7 (SMT mode). The OCP Master and Worker nodes ran on z/VM 7.1 in a LPAR with 30 dedicated IFLs, 448 GB memory, DASD storage, and Hipersocket connection to the PostgreSQL LPAR. x86 configuration: The OCP Master and Worker nodes ran on KVM on RHEL 8.2 on 30 Skylake Intel® Xeon® Gold CPU @ 2.30GHz with Hyperthreading turned on, 448 GB memory, RAID5 local SSD storage, and 10Gbit Ethernet connection to the PostgreSQL LPAR.

Footnotes and disclaimers continued

9. IBM clients across different industries and geographies requested TCO analysis of their IBM Z workload offload projects. Mainframe operations ranged in size from 88 to 12,500 MIPS and required some application rewrite effort, varying from 750,000 to 10,000,00 lines of code, to move to an x86 environment. client workloads were comprised of IBM monthly license charges (MLC) and International Program License Agreement (IPLA) licensing and independent software vendor (ISV) licensing. Hardware was comprised of IBM Z servers running z/OS and specialty engines such as IBM z Integrated Information Processors (zIIPs). Each client engaged the IT Economics team to evaluate the workloads, their existing mainframe environment and proposed distributed environment for the offload.
   One third of clients had already initiated IT offload activities while another third had completed the effort, although reported the project as a failure. The remaining third was considering offload and was still in the planning phase of their project.
   For all the TCO assessments, IT Economics consultants met on-site with the client to discuss offload planning and execution, analyzed forecasted project costs, and examined actual cost to date for those in execution mode. IT Economics analysis observed activity omissions and underestimated sizings in the offload projects and quantified offload costs for the clients. The clients concurred that their plans had underestimated the effort, cost and risk of their offload project plans. The average five-year x86 TCO for all clients was 3.2x higher than the IBM Z TCO, with a range of 2.1x to 3.7x

10. From IBV study "Application modernization on the mainframe" IT application development, maintenance, and operations performance survey data. IBM Institute for Business Value Performance Data and Benchmarking Program. 2021.

11. IDC White Paper, sponsored by IBM, Adaptive Application Modernization Strategies — Leveraging Resilient Practices, Platforms, and Hybrid Cloud for Business Innovation, July 2021. Read it here: https://www.ibm.com/downloads/cas/R2MKAQKD

12. IBM internal data based on measurements and projections was used in calculating the expected value. Necessary components include z15s running in a Parallel Sysplex with resiliency technology enabled, such as System Managed CF Structure Duplexing, Sysplex failure management and Capacity Provisioning Manager. Other configurations may provide different availability characteristics. IBM z15 solutions are designed to deliver 99.99999% availability.

13. 2020 BMC Mainframe Survey Results, Driving Digital Success with the Mainframe: Adapt, Automate, and Secure. Read the study here: https://www.bmc.com/forms/mainframe-survey-results.html?productInterest=unknown

14. "2021 Cost of a Data Breach Study: Global Overview." Ponemon Institute, 2021. Read it here: https://www.ibm.com/downloads/cas/OJDVQGRY

15. This transaction rate is based on internal measurements of a z15 configuration consisting of 2 8-way LPARs and a 4-way ICF running with dataset encryption and CF encryption enabled. Using these results, full size z15 transaction rates were projected using standard LSPR MIPS. The performance that any user will experience may vary.

16. Workload isolation uses enhanced hardware and firmware protection provided by the IBM z15 and LinuxONE III model family. Read the Solution Brief: https://www.ibm.com/downloads/cas/O158MBWG

17. FIPS 140-2 Security Level 4 provides the highest level of security defined in this standard. See https://csrc.nist.gov/Projects/cryptographic-module-validation-program/Certificate/3410

18. Redbooks: Securing your Critical Workloads with IBM Hyper Protect Services. Read the Redbook: https://www.redbooks.ibm.com/redbooks/pdfs/sg248469.pdf

19. This collection lists the latest security certifications related to the Linux on IBM Z® environment: https://www.ibm.com/downloads/cas/ZJWELX1M

20. IBM Hyper Protect Data Controller supports data sources that can be accessed through a JDBC connection or REST APIs

21. Performance result is extrapolated from IBM internal tests running in a z15 LPAR with 36 or 39 dedicated IFLs and 256 GB memory, a z/VM 7.1 instance in SMT mode with 4 guests running SLES 12 SP4. With 36 IFLs each guest was configured with 18 vCPU. With 39 IFLs 3 guests were configured with 20 vCPU and 1 guest was configured with 18 vCPU. Each guest was configured with 64 GB memory, had a direct-attached OSA-Express6S adapter, and was running a dockerized NGINX 1.15.9 web server. The guest images were located on a FICON-attached DS8886. Each NGINX server was driven remotely by a separate x86 blade server with 24 Intel Xeon E5-2697 v2 @ 2.7GHz cores and 256 GB memory, running the wrk2 4.0.0.0 benchmarking tool (https://github.com/giltene/wrk2) with 48 parallel threads and 1024 open HTTPS connections. The transferred web pages had a size of 644 bytes.

Footnotes and disclaimers continued

22. Compared z15 T01 model consists of 3 CPC drawers containing 108 IFLs, and one I/O drawer to support both network and external storage. Power consumption for the z15 T01 is estimated using the Power Estimation Tool for 8561 ht https://www-01.ibm.com/servers/resourcelink/hom03010.nsf assuming a "Normal" workload.
x86 systems ran at various CPU utilizations according to 15 customer surveys, representing Development, Test, Quality Assurance, and Production levels of CPU utilization and throughput. Three workloads were tested, consisting of a mix of leading databases and application servers. Each workload ran at the same throughput and SLA response time on IBM Z and x86. Power consumption on x86 was measured while each system was under load.
z15 T01 performance data and number of IFLs were projected from actual z14 performance data including a performance improvement of 10% on z15 T01. Compared x86 models were 78 2-socket servers containing a mix of 8-core, 12-core and 14-core Xeon x86 processors.
External storage is common to both platforms and is not included in power consumption. Assumes IBM Z and x86 are running 24/7/365.
Power consumption may vary depending on factors including configuration, workloads, etc. Energy cost savings are based on a U.S. national average commercial power rate of $0.10 per kWh based on U.S Energy Information Administration (EIA) data, https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a. Individual rates may vary.
Savings assumes a power usage effectiveness (PUE) ratio of 1.66 to calculate additional power for data center cooling. PUE is based on IBM and the Environment - Climate protection - Data center energy efficiency data, https://www.ibm.com/ibm/environment/climate/datacenter_energy.shtml

23. The actual floor space covered by the systems includes doors and covers. The z15 system includes 3 CPC drawers with 108 configurable processor units and 1 I/O drawer containing 7 FCP and 3 OSA adapters. x86 systems ran at various utilizations according to 15 customer surveys, representing Development, Test, Quality Assurance, and Production levels of utilization and throughput. Workloads tested are a mix of leading databases and application servers. Each consolidated workload ran at the same throughput and SLA response time on Z and x86. All x86 systems are 2U form factor, and 21 x86 systems fully populate a standard 42U rack. External storage floor space is not included. z15 performance data was projected from actual z14 performance data by assuming a 10% performance improvement on z15. Compared x86 models are all 2-socket systems containing a mix of the following x86 processor models: 8-core Xeon E5-2667 v4, 12-core Xeon E7-8857 v2, 12-core Xeon E5-2680 v3, 8-core Xeon E5-4650, 8-core Xeon E5-2650, and 14-core Xeon E5-2690 v4.

24. Total client power savings is based on a summary of upgraded client z15 systems from z13 and z14 with z15 configurations with the minimum number of I/O drawers using the same amount of MIPS, memory and adapters as previous z13 or z14 configurations. Compared IBM z15 T01 model consists of three CPC drawers containing 108 IFLs, and one I/O drawer to support both network and external storage versus 78 x86 systems with a total of 1,672 cores. IBM z15 T01 power consumption was based on the IBM Power Estimation Tool for 8561 https://www-01.ibm.com/servers/resourcelink/hom03010.nsf. x86 power consumption was based on 45 power draw samples for three workload types running from 5% to 20% CPU utilization. x86 CPU utilization rates were based on data from 15 customer surveys representing Development, Test, Quality Assurance, and Production levels of CPU utilization and throughput. Each workload ran at the same throughput and SLA response time on IBM Z and x86. Power consumption on x86 was measured while each system was under load. IBM Z performance data and number of IFLs was projected from actual IBM z14 M04 performance data. To estimate IBM z15 performance, a 10% higher throughput adjustment based on the IBM z15 processor. Compared x86 models were all 2-socket servers containing a mix of 8-core, 12-core and 14-core Xeon x86 processors. External storage is common to both platforms and is not included in power consumption. Assumes IBM Z and x86 are running 24x7x365 with production and non-production (Development, Test, Quality Assurance) workloads. The x86 to z15 workload sizing on the z15 108 IFL configuration was extrapolated for multiple z15 configurations (47 IFLs in a single frame with two I/O drawers, 70 IFLs in two frames with five I/O drawers, 101 IFLs in three frames with seven I/O drawers and 143 IFLs in four frames with ten I/O drawers).

25. Energy savings are based on a workload consolidation assessment conducted by the IBM IT Economics team for an Asia Pacific insurance company running Linux workloads on 55 x86 servers with 3,264 x86 cores versus one LinuxONE Emperor II system with 170 IFLs. Analysis estimates total cost of ownership costs such as hardware, software, labor, floorspace and energy with 38.3 KW for the sized LinuxONE versus 101.6 KW for the x86 environment. The KW numbers are calculated using IBM and vendor published server KW rates, and multiplied by 2 for networking and cooling energy consumption based on the client's data center Power Utilization Efficiency (PUE) of 2, resulting in an estimated reduction from 335K kWh for LinuxONE versus 5.54M kWh for x86. Floor space in use for the 55 x86 servers in the assessment is 42.57 square meters versus an estimated 6.11 square meters for the LinuxONE server. Findings will vary according to individual client environments.

Footnotes and disclaimers continued

26. This is an IBM internal study designed to replicate banking OLTP workload usage in the marketplace on an IBM LinuxOne III T02 using eight IFLs across two LPARs. Seven IFLs and a total of 640 GB memory were allocated to one LPAR for three OpenShift masters and four worker nodes. One IFL and a total of 128 GB memory were allocated to the second LPAR for the OpenShift load balancer. IBM Storage DS8886 was used to create eight 250 GB DASD minidisks for each of the eight z/VM guests running in the LPARs. The OpenShift cluster version 4.2.20, using Red Hat Enterprise Linux CoreOS (RHCOS) for IBM Z, was running across seven z/VM guests and the remaining eighth z/VM guest was running the OpenShift load balancer. SMT was enabled across all IFLs. The x86 configuration was comprised of six servers running KVM with 15 guests (three masters and twelve workers) for the OpenShift cluster version 4.3.5 with RHCOS and a seventh server was used for the load balancer on RHEL 7.6. For x86 storage each guest operating system was configured with a 100 GB of virtual disk. Each guest had access to all vCPUs of the KVM server on which it was running. Compared x86 models for the cluster were all 2-socket servers containing a mix of 6-core, 8- core, 12-core and 16-core Haswell, Skylake and Ivy Bridge x86 processors using a total of 136 cores with a total of 2,304 GB memory. The load balancer was a 2-socket 8-core server with a total of 384 GB memory. Both environments used jMeter to drive maximum throughput against two OLTP workload instances and were sized to deliver comparable results (15,487 responses per second (RPS) with IBM Z and 14,325 RPS with x86). The results were obtained under laboratory conditions, not in an actual customer environment. IBM’s internal workload studies are not benchmark applications. Prices, where applicable, are based on U.S. prices as of 02/12/2020 from our website and x86 hardware pricing is based on IBM analysis of U.S. prices as of 03/01/2020 from IDC. Price comparison is based on a three year total cost of ownership including HW, SW, networking, floor space, people, energy/cooling costs and three years of service & support.

27. Financial institutions in different geographies requested analysis of Java x86 workloads for consolidation onto IFLs on IBM Z or LinuxONE. The assessments involved business critical workloads running in production and non-production environments for IBM Java application server middleware running on different types of x86 and distributed servers. TCO costs included migration, hardware, software, networking, energy, floor space and people costs. TCO savings with IFLs or LinuxONE ranged from 43% to 80% over five years with an on average savings of 60%. Each client engaged the IT Economics team to evaluate the distributed workloads and the proposed IFL or LinuxONE environment for the consolidation. For each assessment, IT Economics consultants met with the client to discuss consolidation planning and execution, analyzed the client's current total cost of ownership, and provided a projected total cost of ownership with workload consolidation based on estimated core consolidation ratios for the client's workloads based on workload sizing estimates from IBM internal testing and comparable client workload data. For additional information on x86 workload analysis contact the IBM IT Economics team, IT.Economics@us.ibm.com.

28. This is an IBM internal study designed to replicate a typical IBM customer workload usage in the marketplace using an IBM LinuxONE III Express with 12 cores, 768 GB memory, z/VM, RHEL, and competitive database versus a comparably tuned x86 configuration with a quarter rack x86 systems with 96 x86 Broadwell cores, using 768 GB memory, RHEL Linux, and competitive database. LinuxONE Express and x86 TPS sizing requirements used in the study were extrapolated from a 48,974 TPS use case test on a LinuxONE III LT1 with 50 cores 2,048 GB memory, z/VM, RHEL, and competitive database and a comparably tuned x86 configuration with a total of sixteen x86 systems, each with 28 x86 Broadwell cores for a total of 448 cores, using 768 GB memory, RHEL Linux, and competitive database executing a materially identical order fulfillment database workload in a controlled laboratory environment and not in an actual customer environment. Results will vary. The test for the database workloads, each running as a guest on z/VM in a logical partition, executed an identical SQL query transaction mix for a total throughput of 48,974 transactions per second. For the x86 configuration, the test measured the same number of database workloads, each running on bare metal and executing an identical SQL query transaction mix at a total throughput of 48,974 transactions per second. LinuxONE III Express TPS extrapolation results were adjusted from LinuxONE III LT1 to LinuxONE Express processor speed, resulting in total throughput of 10,197 transactions per second for the 96 x86 core environment.

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