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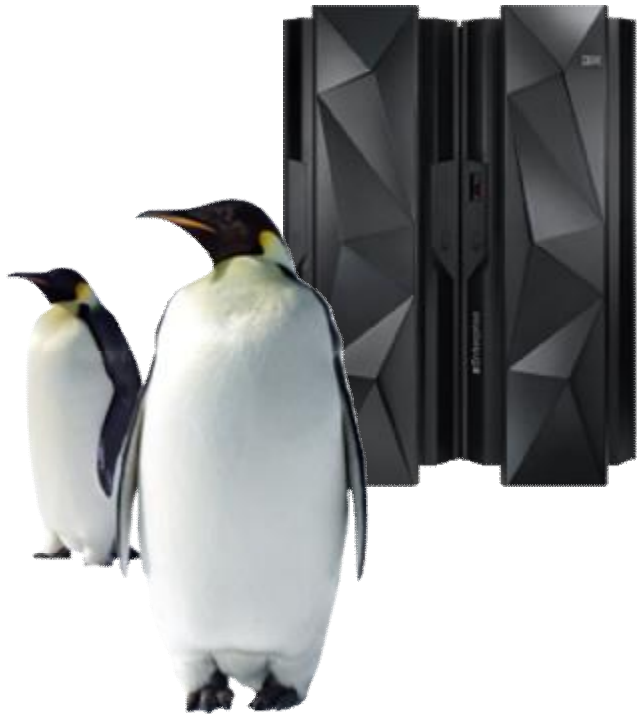
Business Development Manager z/VSE & Linux on System z

Making the Case for Linux on System z

WAVV Conference
Covington, Kentucky
April 7-10, 2013

Discussion Topics

- **Linux on z - from a skunk works to mainstream**
- **The Enterprise Linux Server**
- **Extreme virtualization**
- **Strategies to reduce cost and improve value**
- **Quality of Service with Linux and zEnterprise**



How it began

SLES 8 **RHEL 3**

October 2001 Red Hat 7.2 available (implemented on Linux 2.4 kernel)

November 2000 SuSE Linux 7.0 available

August 2000 “S/390 Install Fest” with SuSE pre-release

July 2000 IBM announced Integrated Facility for Linux (IFL)

May 17, 2000 **IBM announced Linux for the enterprise user**

December 18, 1999 Kernel patches (version 2.2.13) available on Marist College web site

Spring 1999 Linux running under VM/ESA

A Simple Idea

13 years ago

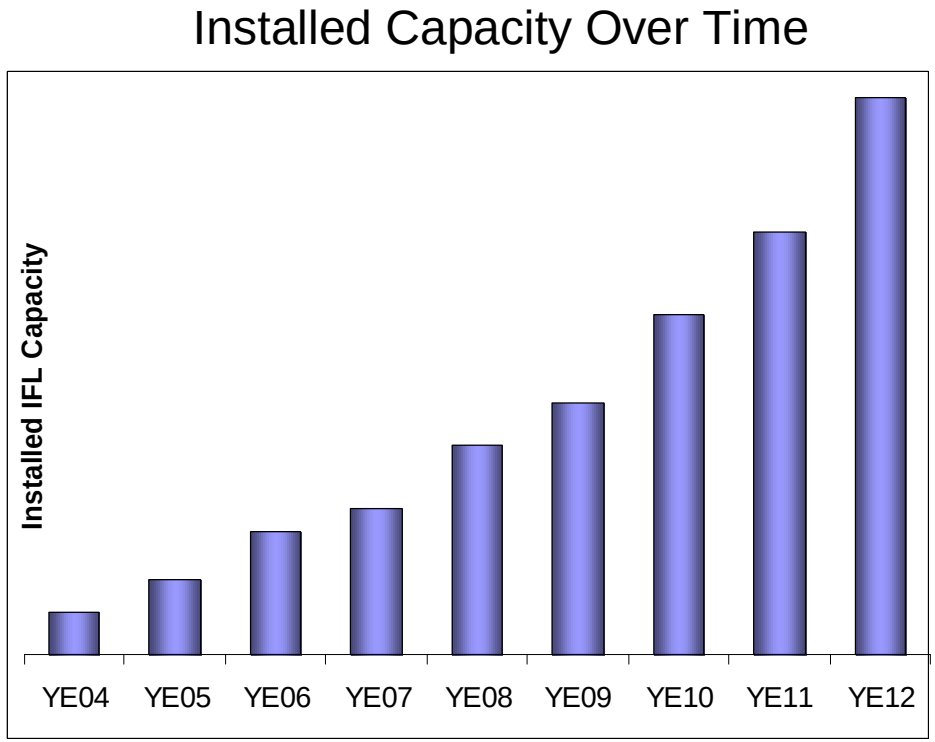
2000

- **Increased solutions** through Linux application portfolio
- Large number of **highly skilled programmers** familiar with Linux
- **Integrated business solutions**
  - Data richness from IBM eServer™ zSeries®
  - Web capability of Linux applications
- **Industrial strength environment**
  - Flexibility and openness of Linux
  - Qualities of service of zSeries and S/390®
- **Unique ability to easily consolidate large number of servers**

Linux on IBM System z in 4Q2012

Installed Linux MIPS at 51% CAGR*

- 22.8% of Total installed MIPS run Linux as of 4Q12
- Installed IFL MIPS increased 32% from 4Q11 to 4Q12
- 36% of System z Customers have IFLs installed as of 4Q12
- 70 of the top 100 System z Customers are running Linux on the mainframe as of 4Q12 **
- 43% of new System z Accounts run Linux (FY10-3Q12)
- 32% of all System z servers have IFLs



*Based on YE 2003 to YE 2012
** Top 100 is based on total installed MIPS

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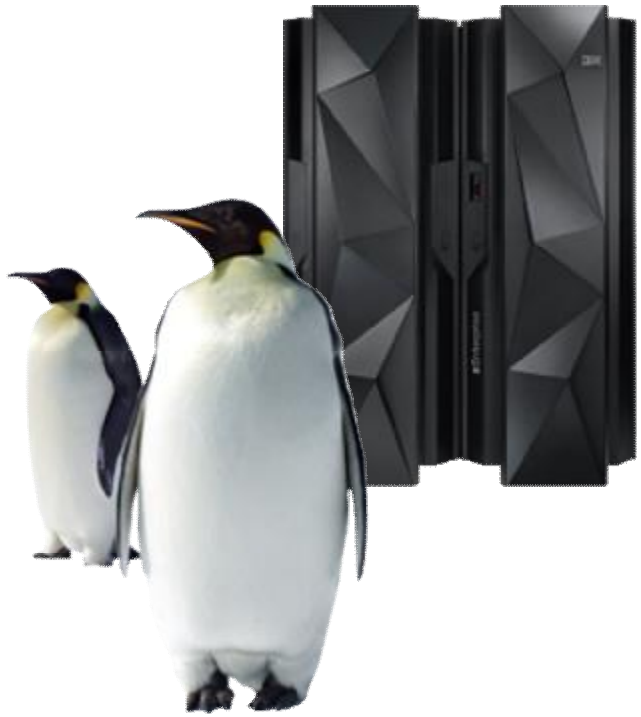


Enterprise Linux Server (ELS)*

alias

- **Large highly-scalable enterprise class server** running Linux
- Linux on System z server
- Solution Edition for Linux on System z
- zEnterprise and Linux on System z
- Linux on a highly virtualized server based on System z architecture
- Linux on the mainframe
-
-

zEnterprise EC12

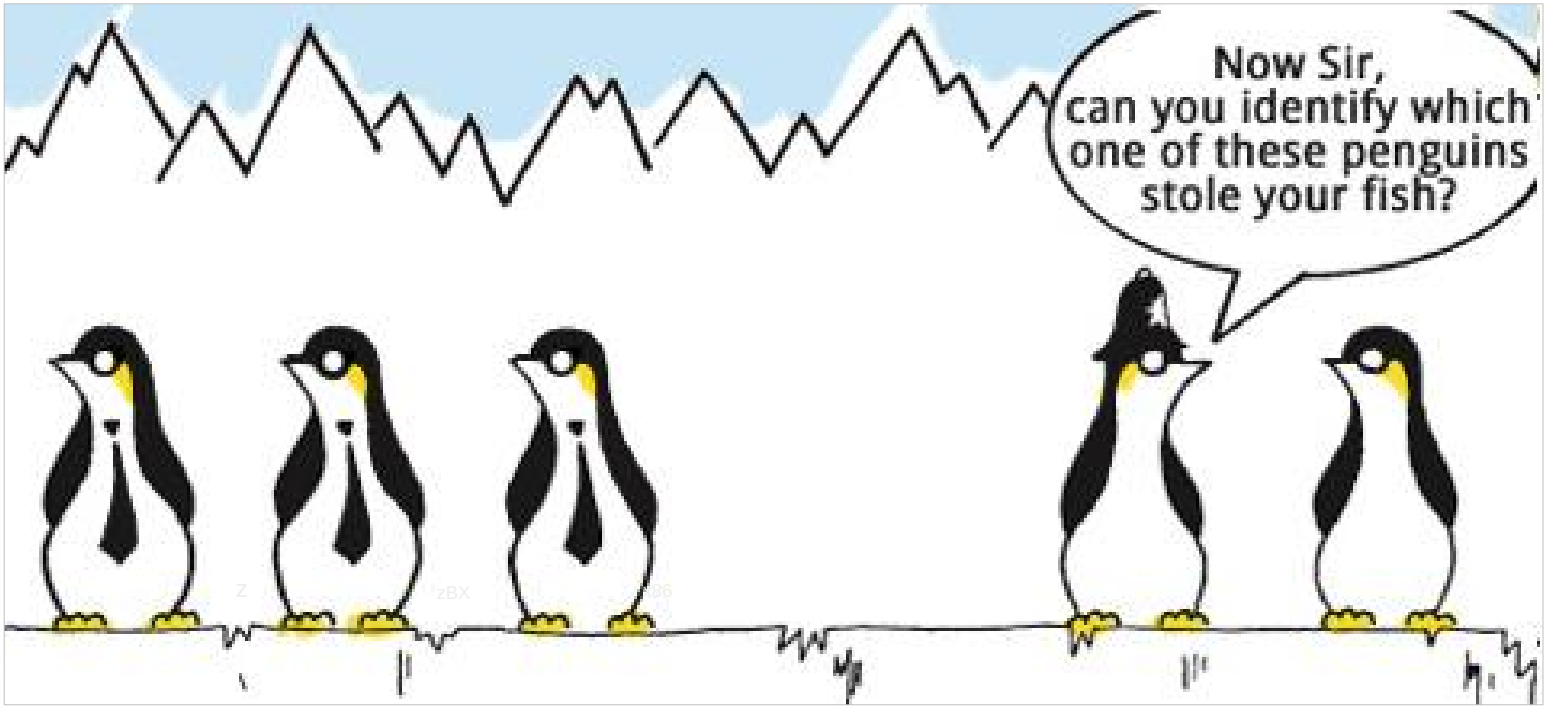
zEnterprise 114

*) Originally ELS was a pre-configured IBM System z10 BC including z/VM

Linux versus Mainframe terminology

- Linux
  - System administrator
  - Network management
  - Boot
  - 4-processor machine
  - Main memory
  - Disk
  - Scheduler
  - NIC
- Mainframe
  - System programmer
  - Systems management
  - IPL
  - 4-way
  - Main storage
  - DASD
  - Dispatcher
  - OSA

Increasing your flexibility



§ **The Linuxes** (on different architectures) **all look the same** (shell, X, tools, etc.) **and have the same roots** (Linux Kernel source)**.**

§ **But they have different ancestors** (architectures)**, hence have different personalities and qualities** (features and options derived from the platform)**.**

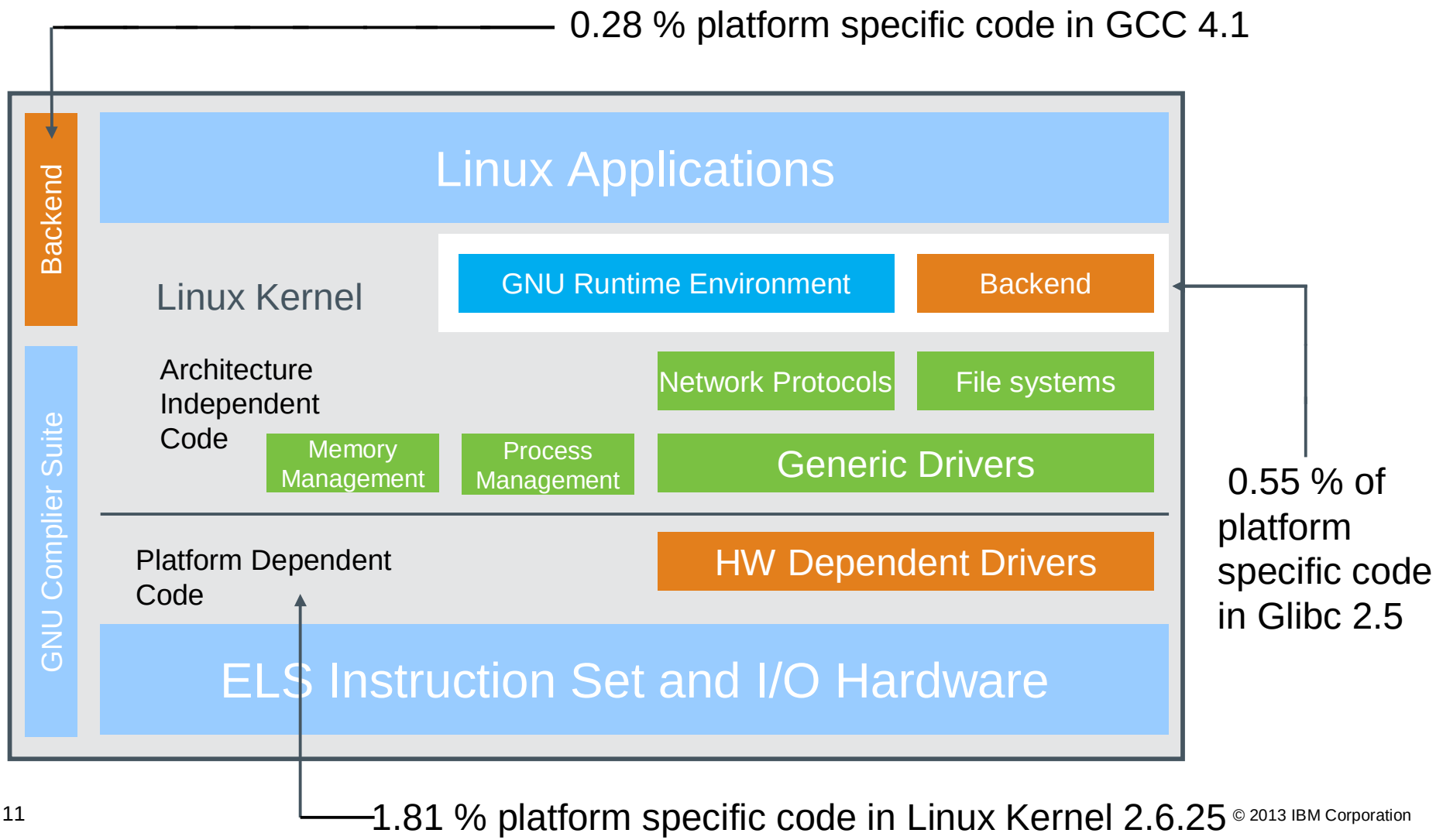
Linux is Linux…

… but features, properties and quality depends on the underlying architecture

- **Quality of Service, Redundancy or RAS features build-in hardware**
  (Redundant Array of Independent Memory (RAIM), outage avoidance using hotplug hardware)
- **Hardware supported large scale virtualization support**
  (highly efficient, granular and isolated virtualization that is part of the architecture by design)
- **System features**
  (Business Continuity using GDPS / xDR, I/O bandwidth, Capacity on Demand (CoD), Capacity Backup (CBU), autonomic Workload Management (WLM), HiperSockets, Power Capping)
- **System's workload characteristics**
  (small/discrete, highly threaded, parallel data structures, shared data and work queues, mixed workload)
- **Hardware requirements / availability**
  (Crypto: CPACF / Crypto Express3, Decimal Floating Point (DFP), …)
- **Operating system or software requirements / availability**
  (for example the IBM Communication Controller is available for Linux on System z, but not for Linux on x)
- **Licensing constraints**
  (Usually per core – consolidation benefits, sub-capacity options)

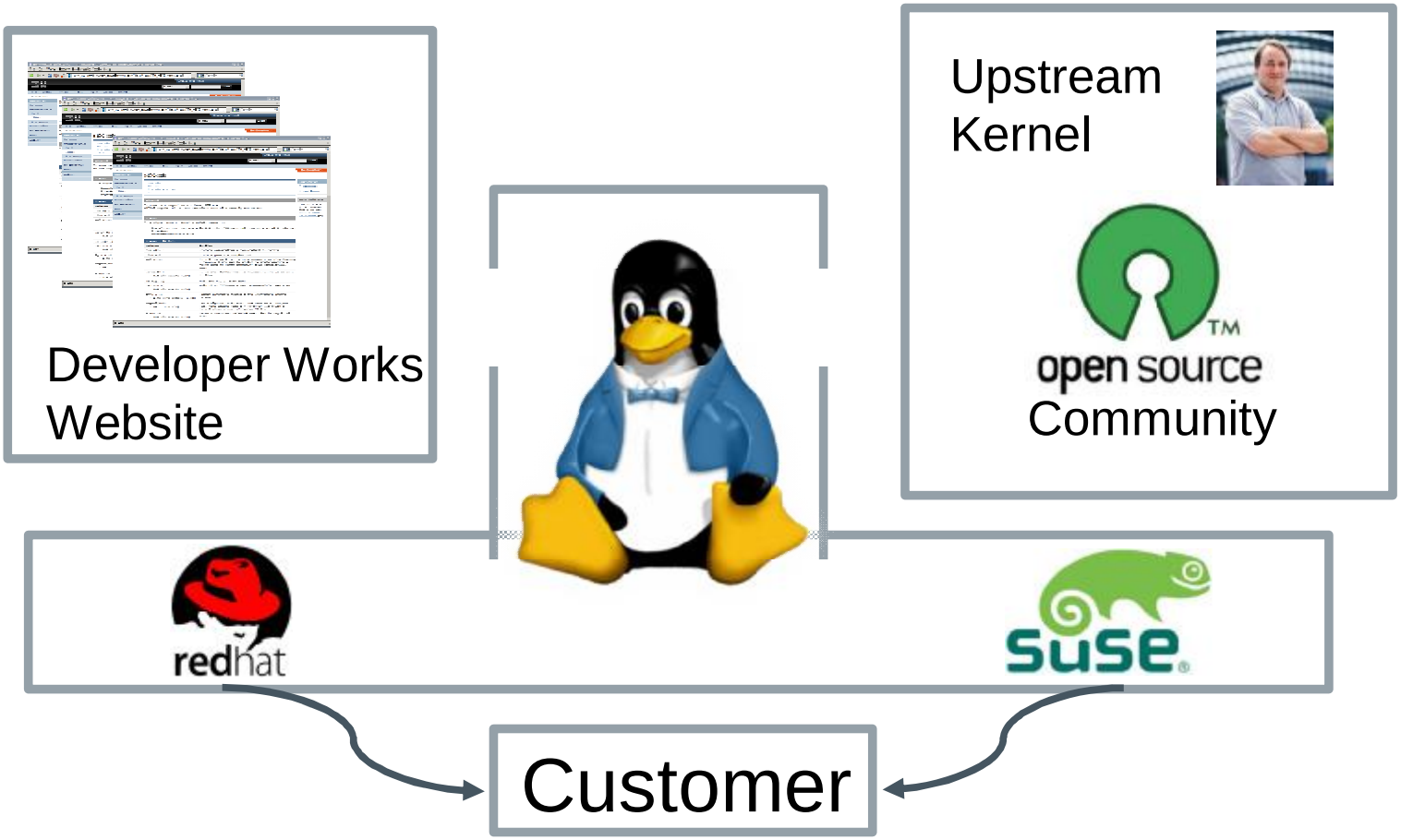
Structure of Linux on System z

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

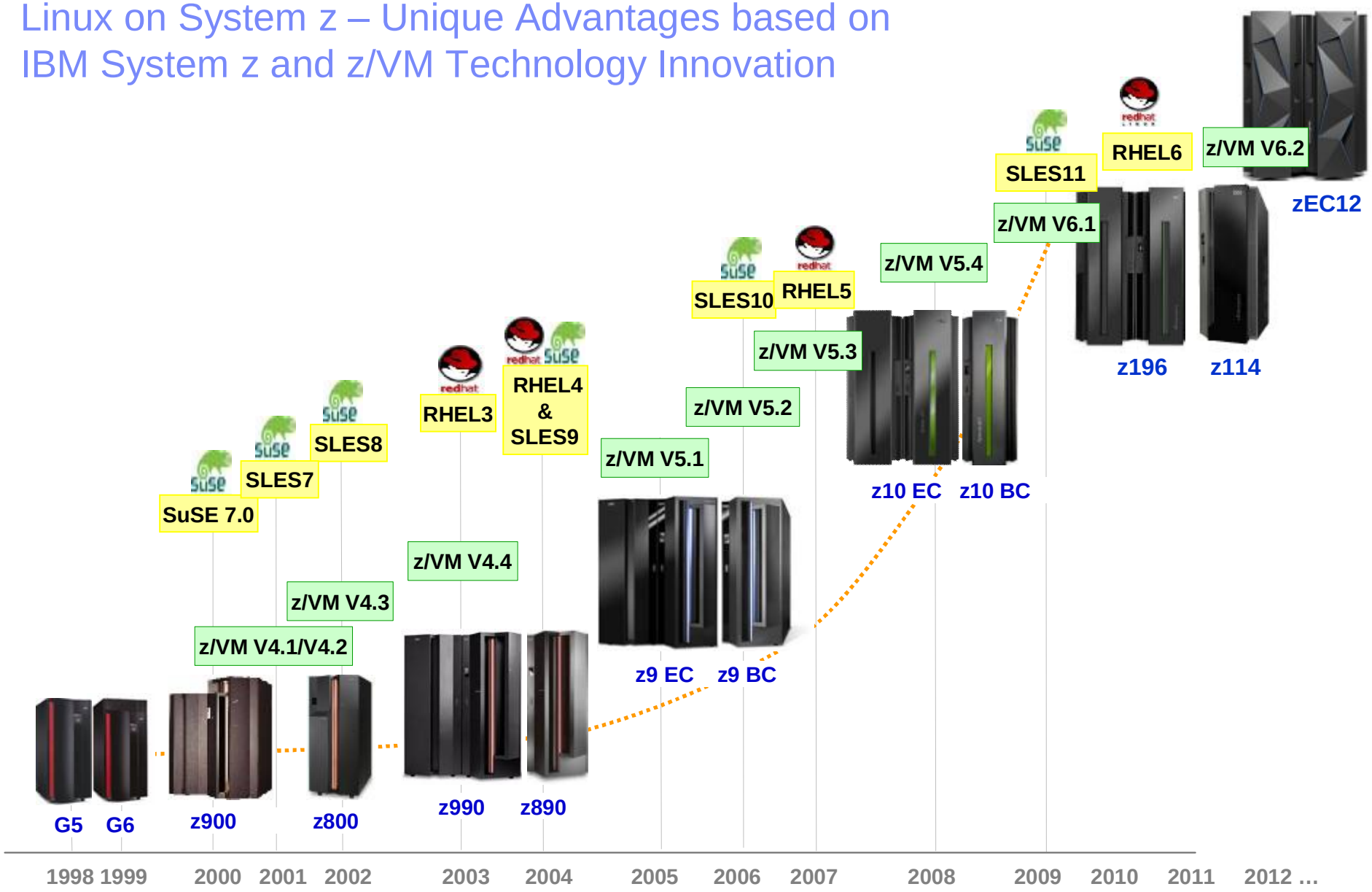


IBM Linux on System z Development

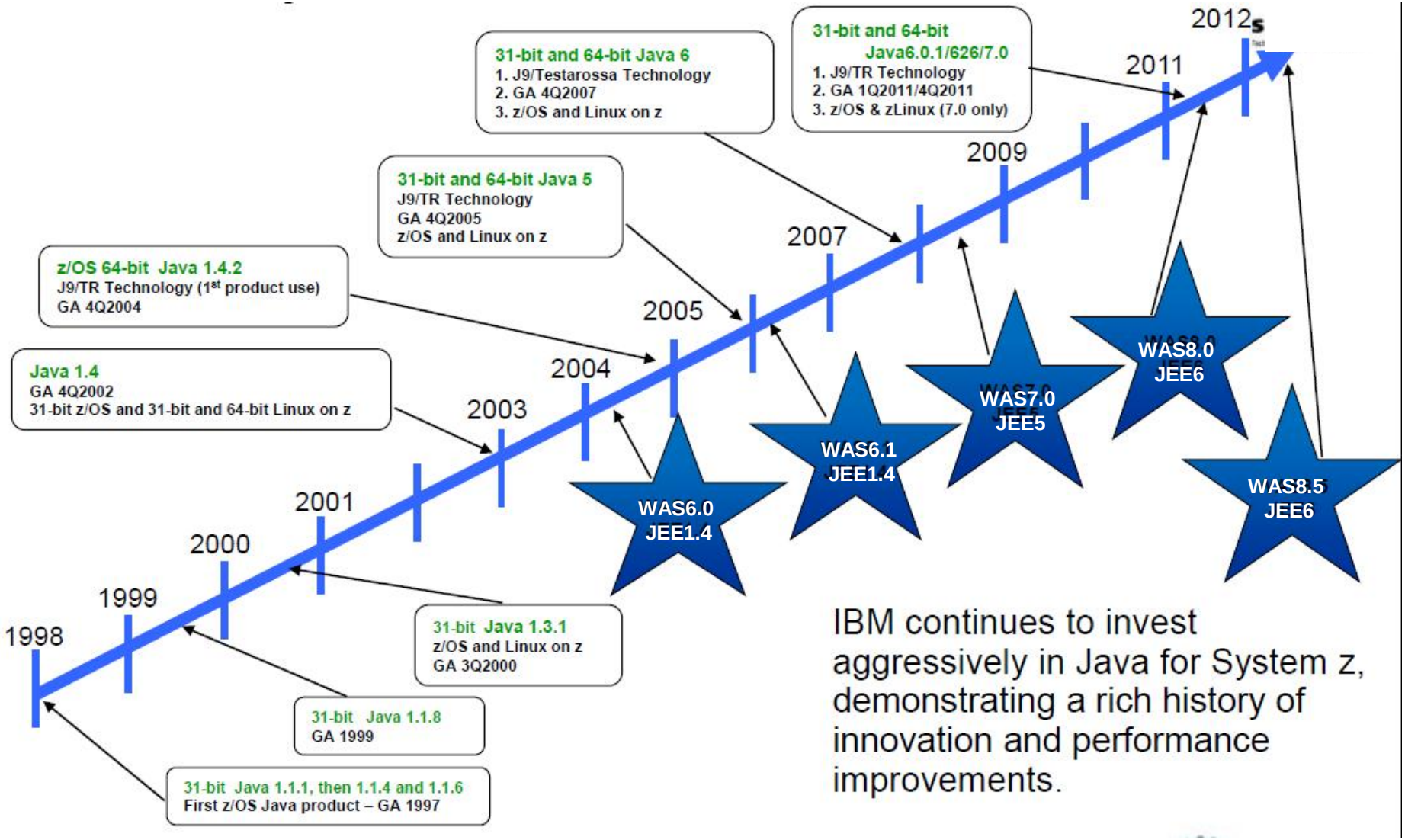
IBM Linux on System z Development contributes in the following areas: Kernel, s390-tools, Open Source Tools (e.g. eclipse, ooprofile), GCC, GLIBC, Binutils



Linux on System z – Unique Advantages based on IBM System z and z/VM Technology Innovation



Java on System z – 15 years of innovation



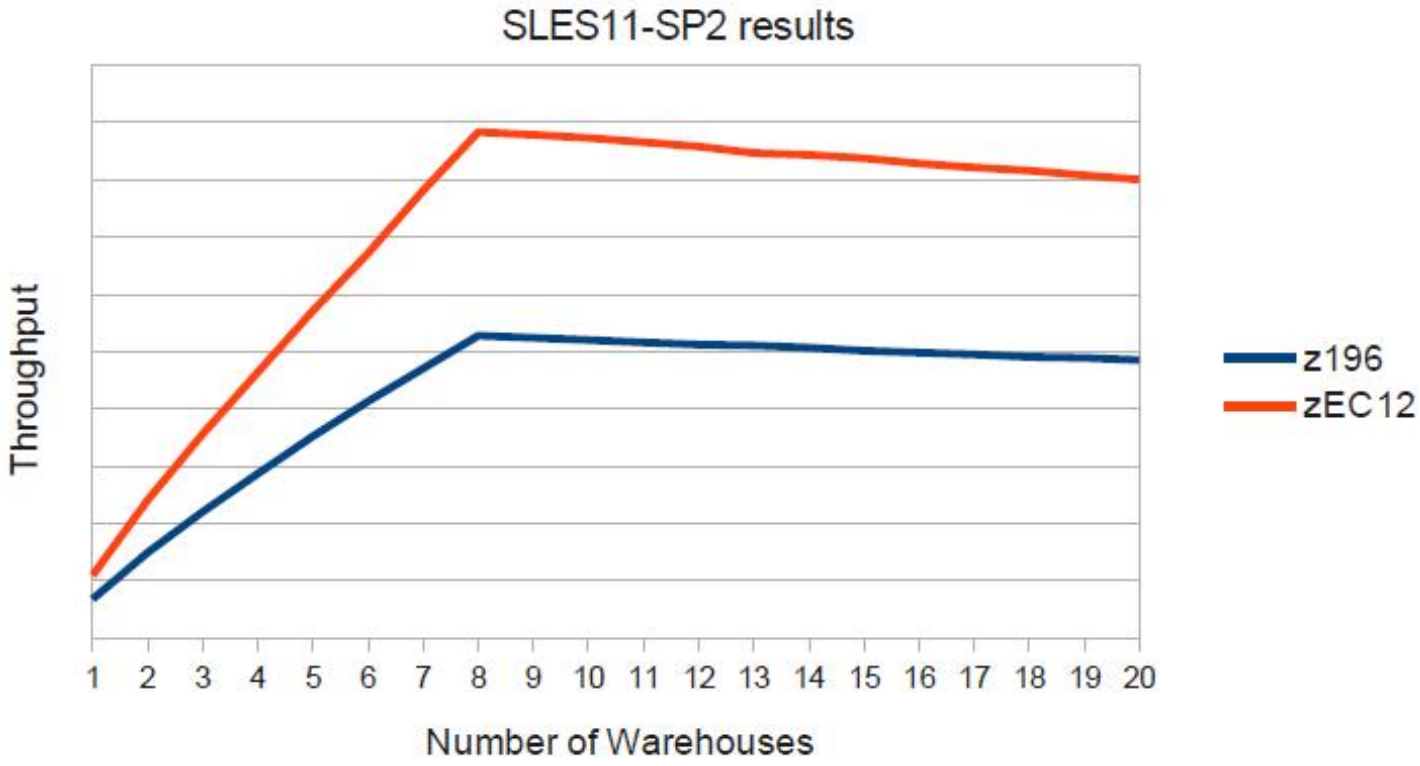
Java benchmark description

- Java server benchmark
  - Evaluates the performance of server side Java
  - Exercises
    - Java Virtual Machine (JVM)
    - Just-In-Time compiler (JIT)
    - Garbage collection
    - Multiple threads
    - Simulates real-world applications including XML processing or floating point operations
  - Can be used to measure performance of processors, memory hierarchy and scalability

- Configurations
  - 8 processors, 2 GiB memory, 1 JVM

Java benchmark

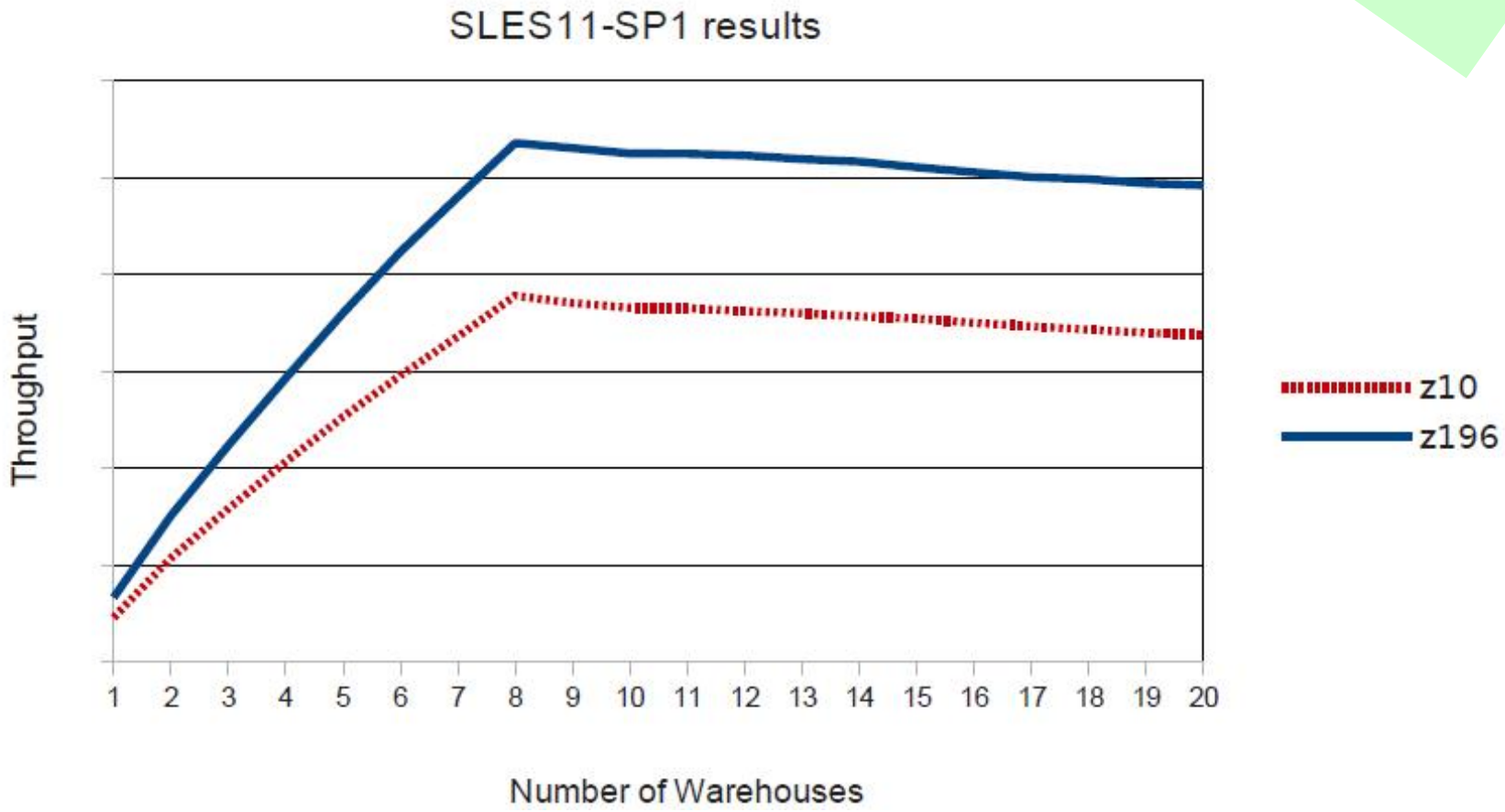
- Business operation throughput improved by approximately 65%
  - IBM J9 JRE 1.6.0 SR9 64-bit
- Results seen with a single LPAR active on the machine
- On a fully utilized machine we expect approximately 30%



Java benchmark

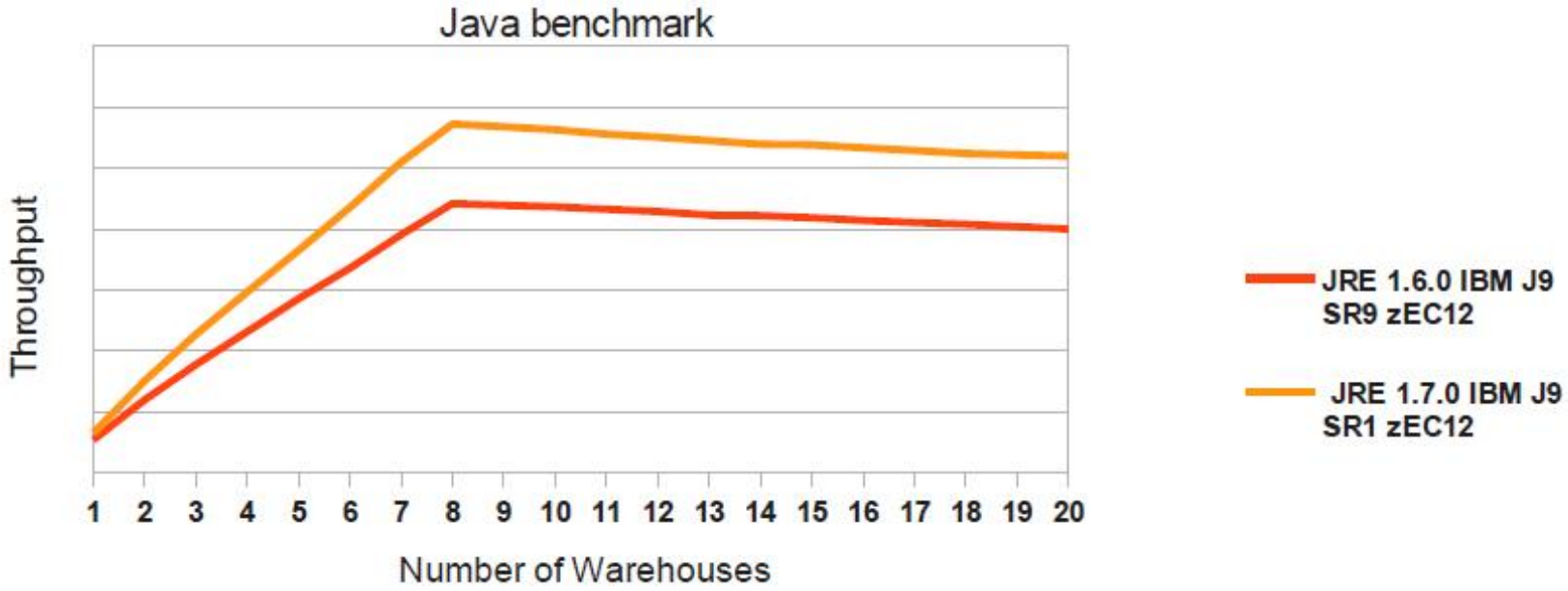
§ Business operations throughput improved by approximately 44%
  – IBM J9 JRE 1.6.0 SR9 64-bit

2010

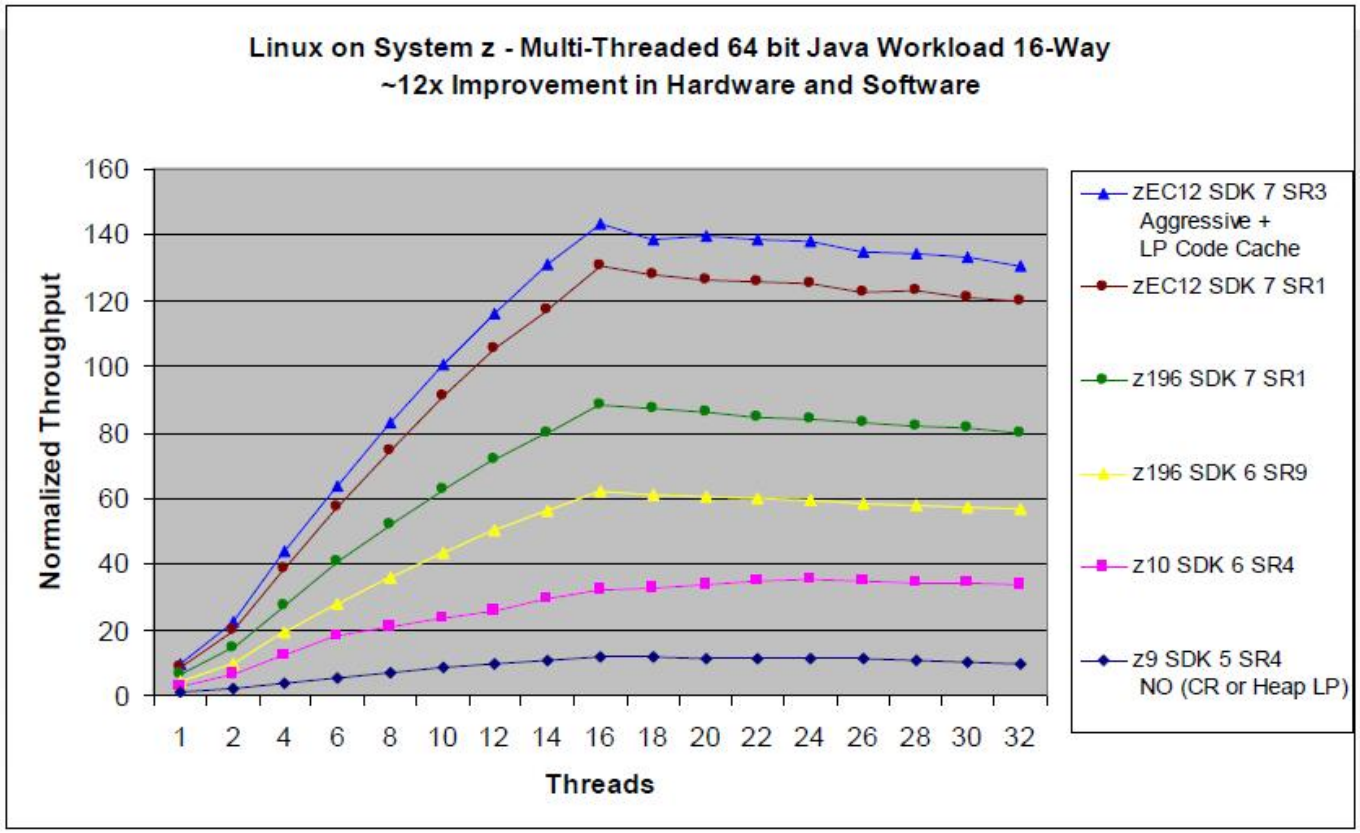


Java – JRE 1.6.0 SR9 vs. JRE 1.7.0 SR1

- Business operations throughput improved by 29%
  - 2 GiB, 8 processors, 1 JVM, only Java versions substituted
- Similar improvements seen over the last years when upgrading to newer Java versions
  - Some software products are bundled with a particular Java version
  - In such case the software needs an upgrade to benefit from the improved performance



Linux on System z and Java7SR3 on zEC12:
64-Bit Java Multi-threaded Benchmark on 16-Way

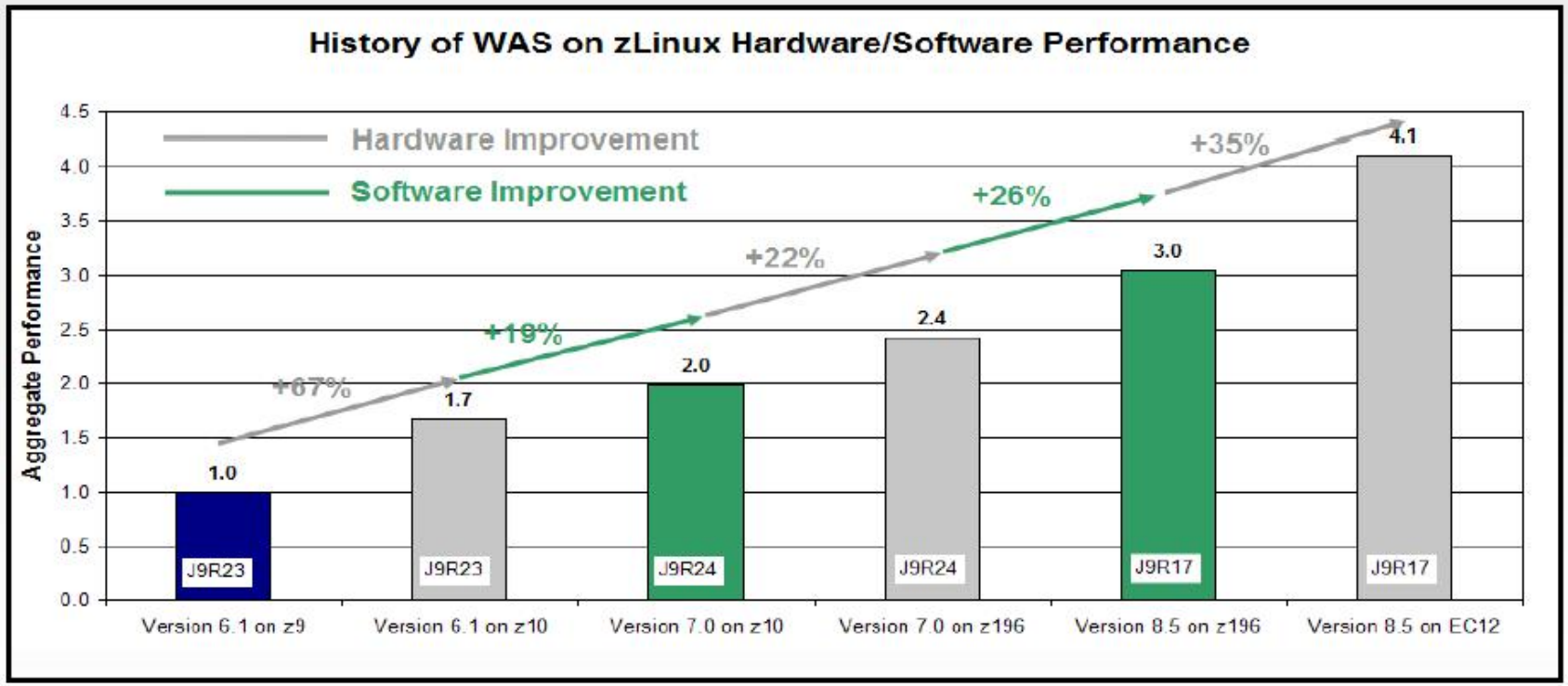


~12x aggregate hardware and software improvement comparing Java5SR4 on z9 to Java7SR3 on zEC12
LP=Large Pages for Java heap CR= Java compressed references
Java7SR3 using -Xaggressive + 1Meg large pages

Controlled measurement environment, actual results may very.

WebSphere Application Server (WAS) on Linux on System z

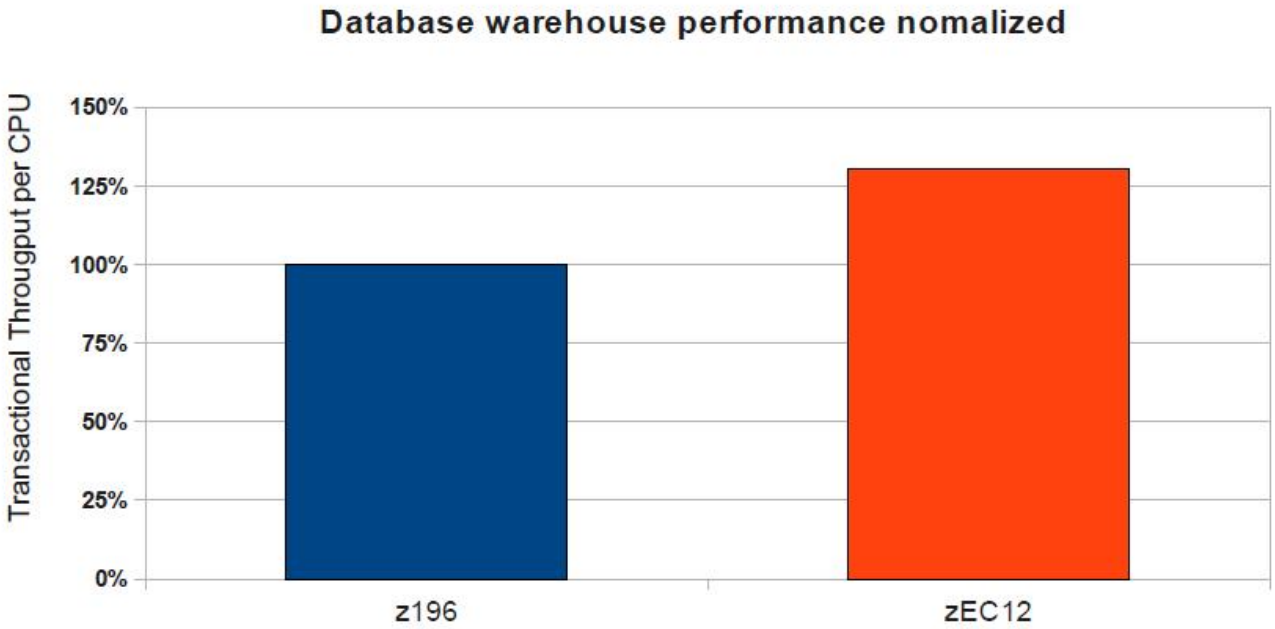
Aggregate HW, SDK and WAS Improvement: WAS 6.1 (Java 5) on z9 to WAS 8.5 (Java 7) on zEC12



~4x aggregate hardware and software improvement comparing WAS 6.1 Java5 on z9 to WAS 8.5 Java7 on zEC12

DB2 database workload

- Benchmark: complex database warehouse application running on DB2 V10.1
- Upgrade to from z196 to zEC12 provides improvement in throughput by 30% at lower processor consumption
- Another 50% performance improvement we saw when comparing z196 to z10



Performance summary

- Tremendous performance gains
  - Performance improvement seen in close to all areas measured
  - Often combined with reduction of processor usage
  - More improvement than just from higher rate to expect
    - Rate is up from 5.2 GHz to 5.5 GHz which means close to 6 percent higher
    - New cache setup with much bigger caches
    - Out-of-order execution of the second generation
    - Better branch prediction

- Some exemplary performance gains with Linux workloads
  - 30% to 65% for Java
  - Up to 30% for complex database
  - Up to 31% for single threaded processor intense
  - 38% to 68% when scaling processors and/or processes

- New zEC12 instructions not yet exploited because no machine optimized GCC is available in a supported distribution

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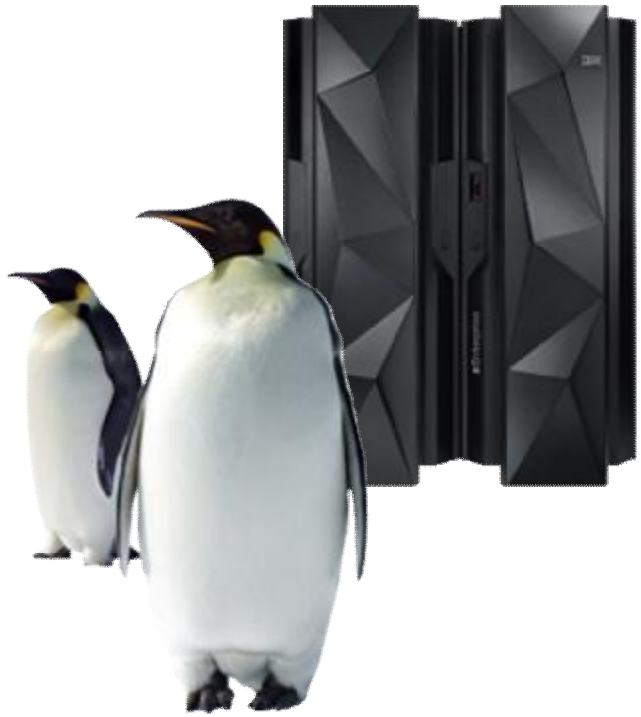


What is Virtualization?

Logical representation of resources not constrained by physical limitations

- Enables user flexibility
- Centrally manage many resources as one
- Dynamically change and adjust across the infrastructure
- Create many virtual resources within single physical device
- Eliminates trapped capacities

IBM Virtualization with System z

A comprehensive platform to help virtualize the infrastructure

Disk Storage: Direct Attached Storage or SAN

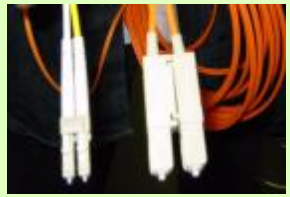
Server

FC HBA or FICON channel card

Laser-SX
Laser-LX

Channel

Transceiver



SC & LC Duplex MM
SC & LC Duplex SW

Connectors & Fiber

Switches
Directors
Routers

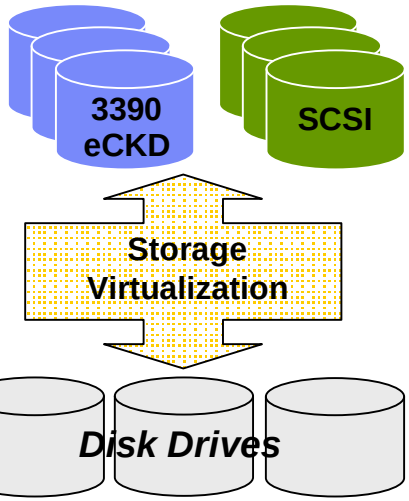
Disk storage devices

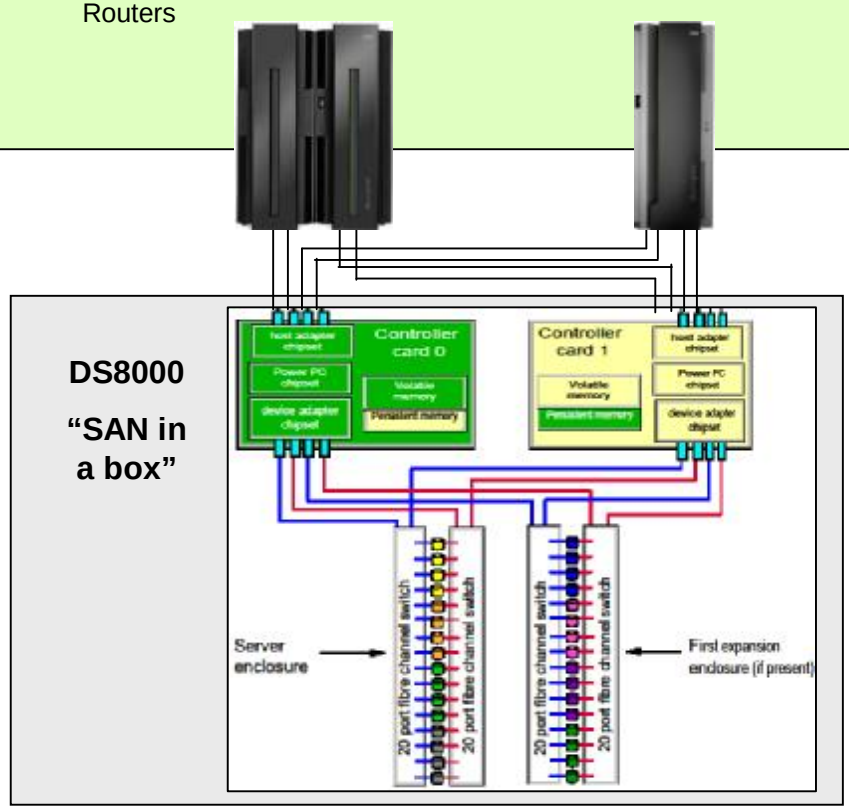
Tape

Backup
Restore

Linux on System z disk options:

- FICON attached CKD:
  - DS8000
- FCP attached SCSI (fixed block):
  - XIV, V7000
  - SAN Volume Controller
  - SAN





Note: FCP attached devices may require connection via a switch

Multidimensional Virtualization

Very large Shared Resource Space

Allows for consolidation and tight integration of Large Server Farms

into

VIRTUAL "BLADES"

VIRTUAL "RACKS"

VITUAL NETWORKS

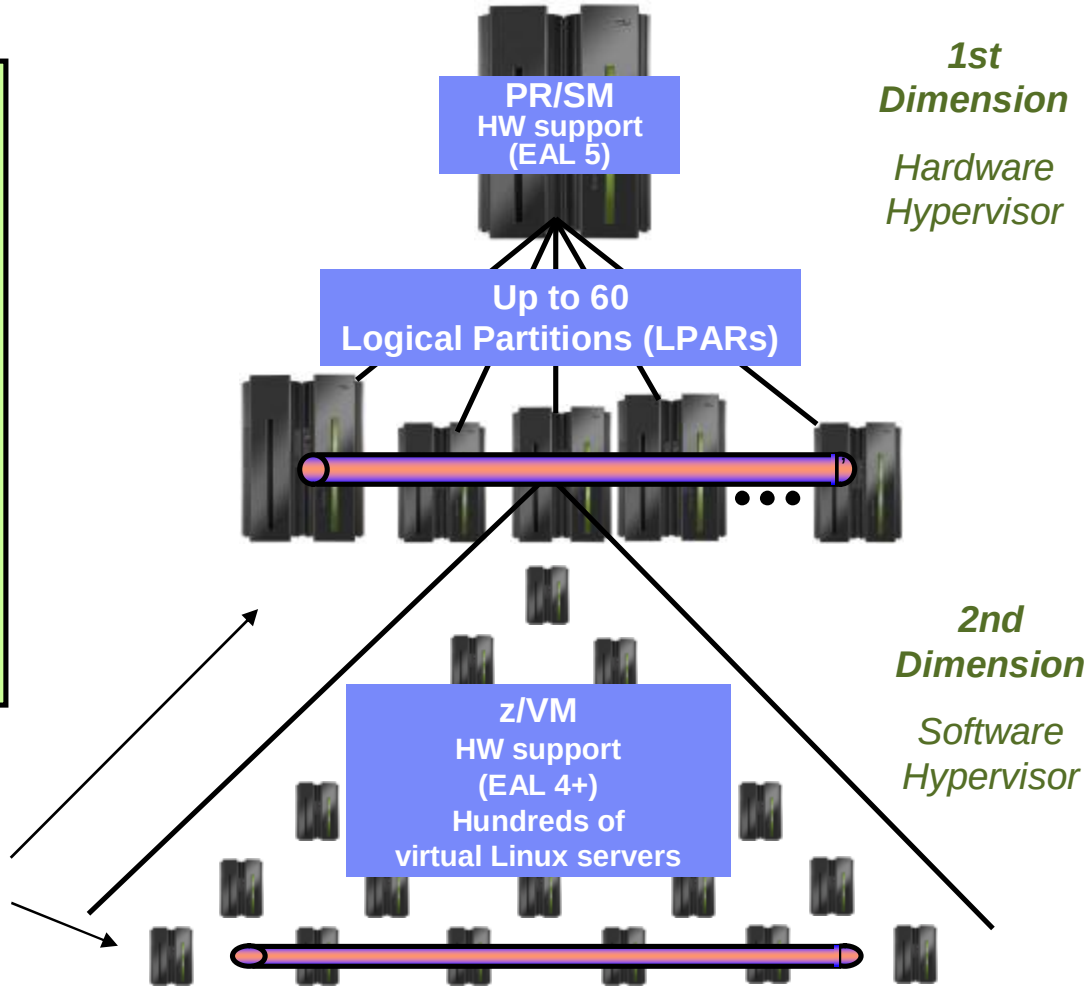
on the same footprint with managed performance, QoS and HW enforced security isolation

High speed (multiple GB/sec) and low latency interconnect

For integration with full integrity/isolation

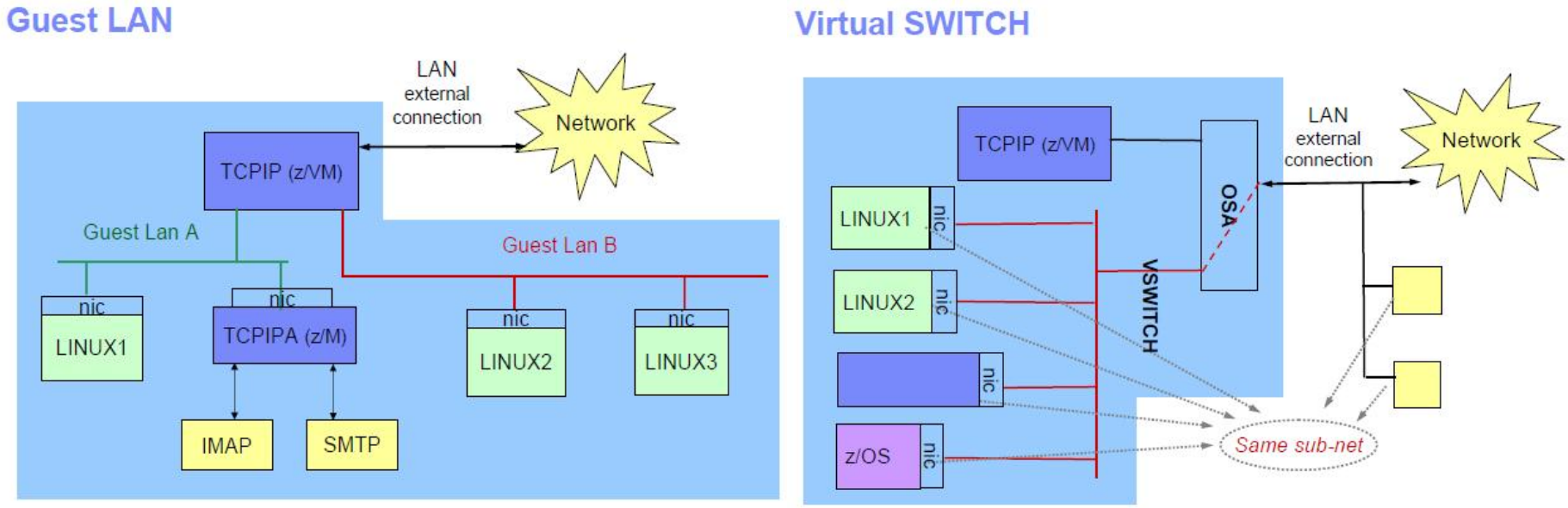
The power of many

The simplicity of one



z/VM Network Virtualization

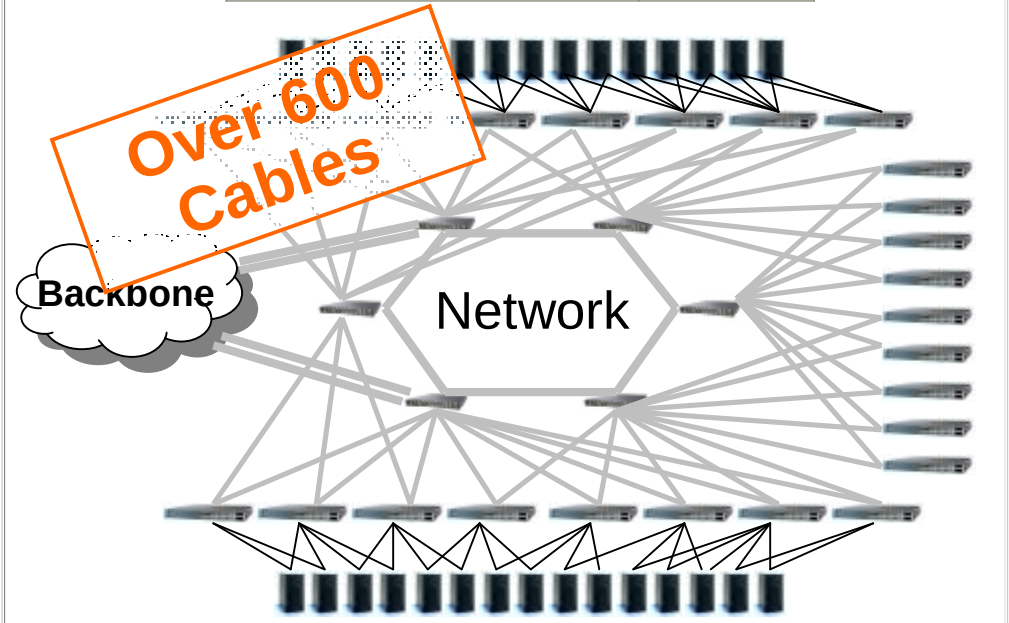
- z/VM virtualizes network connectivity
  - VLAN
  - VSWITCH
- Virtual connectivity uses memory to memory connections controlled by z/VM
  - Very high bandwidth
  - Low latency
  - Internal – no physical devices



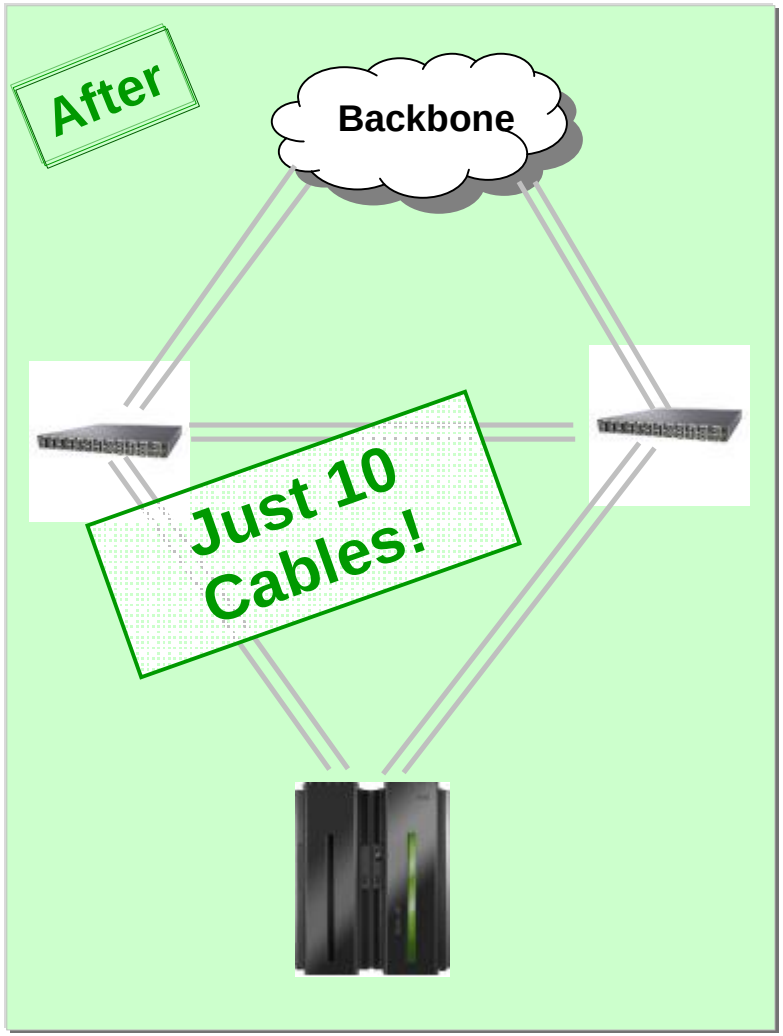
Insurance Company Consolidated 292 Servers to a z10

Before

3560E-24TD	8
3560E-24TD	17
3560E-12D	6
50 Ft UTP Cable	584
10GB Eth Fiber Cable	60



The diagram only shows **30** of **292** servers



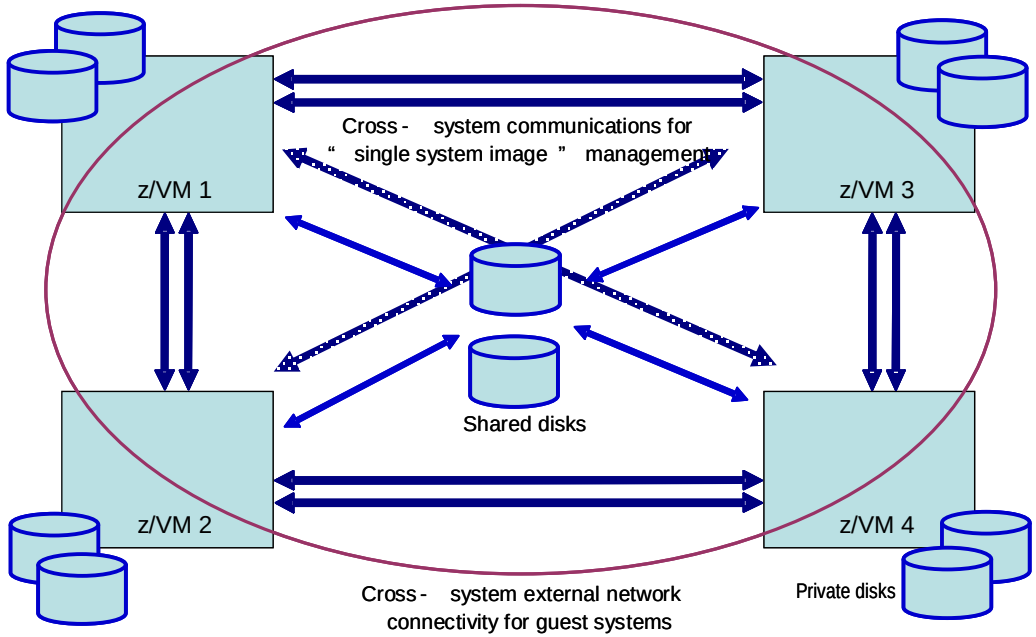
Data is based on real client opportunity and on internal standardized costing tools and methodologies.
Client results will vary by types of workloads, technology level of consolidated servers, utilization factor, and other implementation requirements. Savings will vary by client.

z/VM V6.2 SSI Feature: Clustered Hypervisor with Live Guest Relocation (LGR) Support

- Connect up to four z/VM systems as members of a **Single System Image** (SSI) cluster
- Provides a set of shared resources for member systems and their hosted virtual machines
- Cluster members can be run on the same or different System z servers
- Simplifies systems management of a multi-z/VM environment
  - Single user directory
  - Cluster management from any member

    Apply maintenance to all members in the cluster from one location

    Issue commands from one member to operate on another
  - Built-in cross-member capabilities
  - Resource coordination and protection of network and disks



Advanced virtualization benefits

- Large-scale server hosting - potentially hundreds to thousands of server images
- Clone, patch, and “go live” without outage and with easy rollback
- Hot stand-by without the hardware expense
  - Idle backup images ready to run (or be booted) if primary servers fail
- Potentially faster virtual server creation / provisioning with z/VM
- Hosting multiple z/VM images on a single server (via LPAR) can enhance failover options, I/O sharing, and workload distribution
- Transfer a running virtual machine to another real server (Live Guest Relocation)
- z/VM supports dynamic add of processors, memory and I/O, which immediately become available to guests
- Resource consumption recording / reporting
  - Capture data at hypervisor level (CP Monitor)
  - Useful for charge-back, capacity planning, problem determination, and fix verification
- z/VM sophisticated paging subsystem and shared memory model
  - Large memory over-commit
  - Sharing and dynamic allocation of real memory to virtual server images
  - Share program executables among multiple server images (Linux execute-in-place file system)

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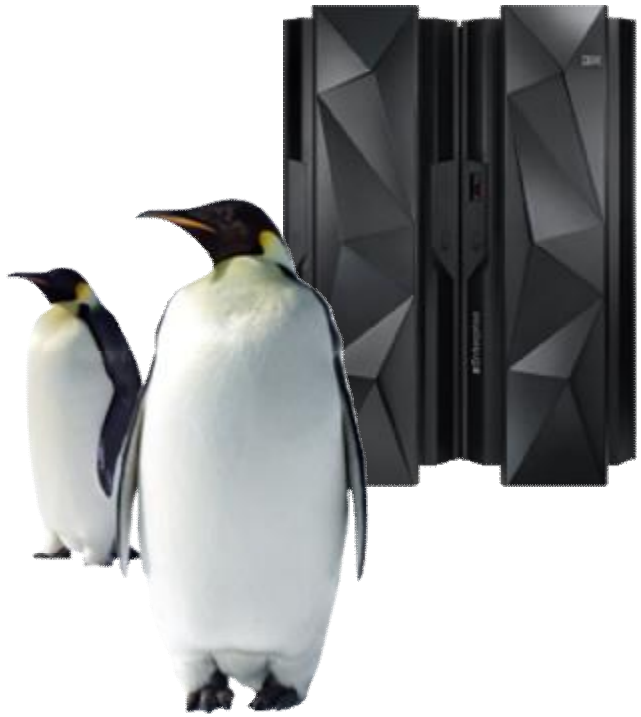
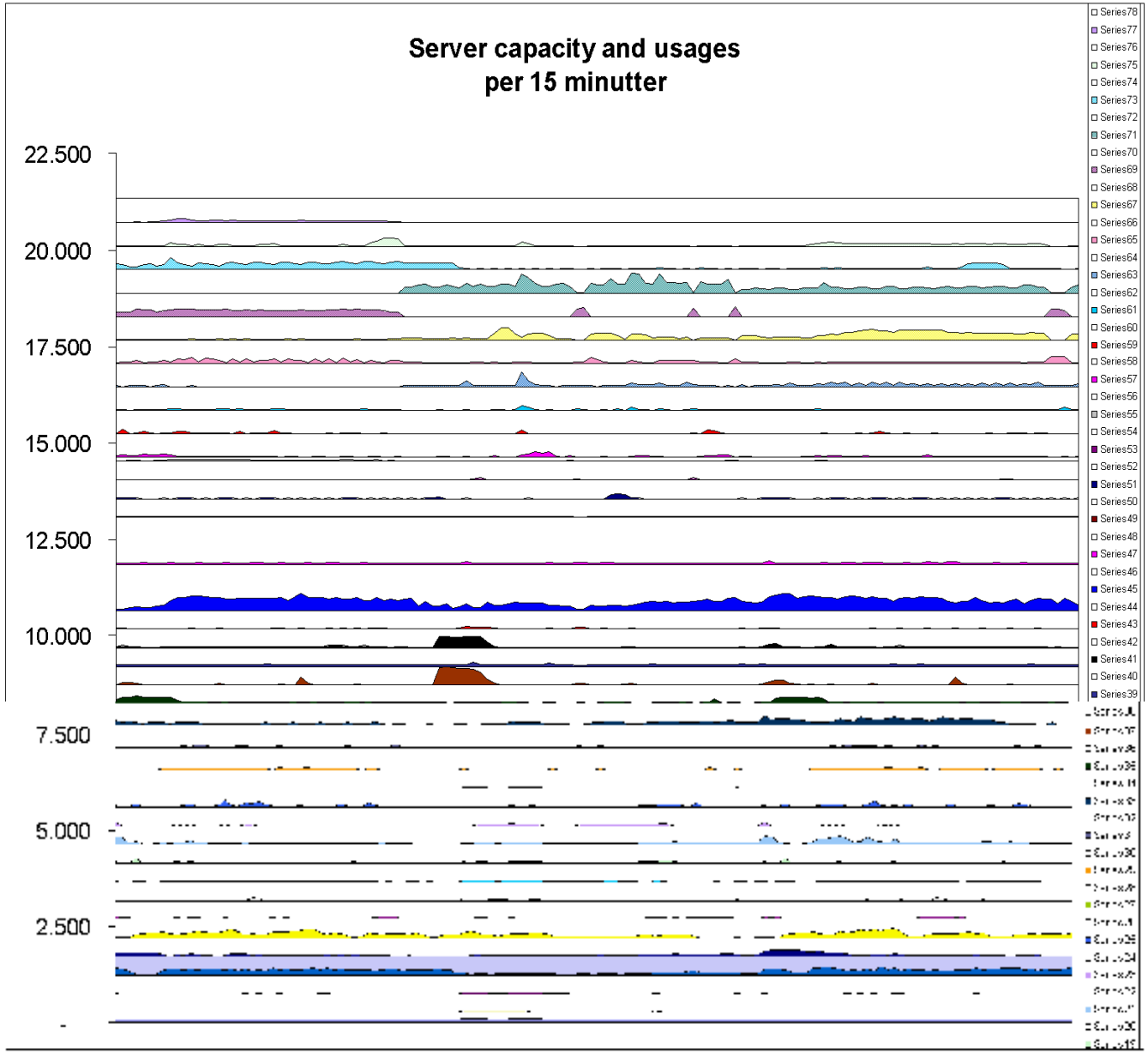


RPE2

(from Ideas International)



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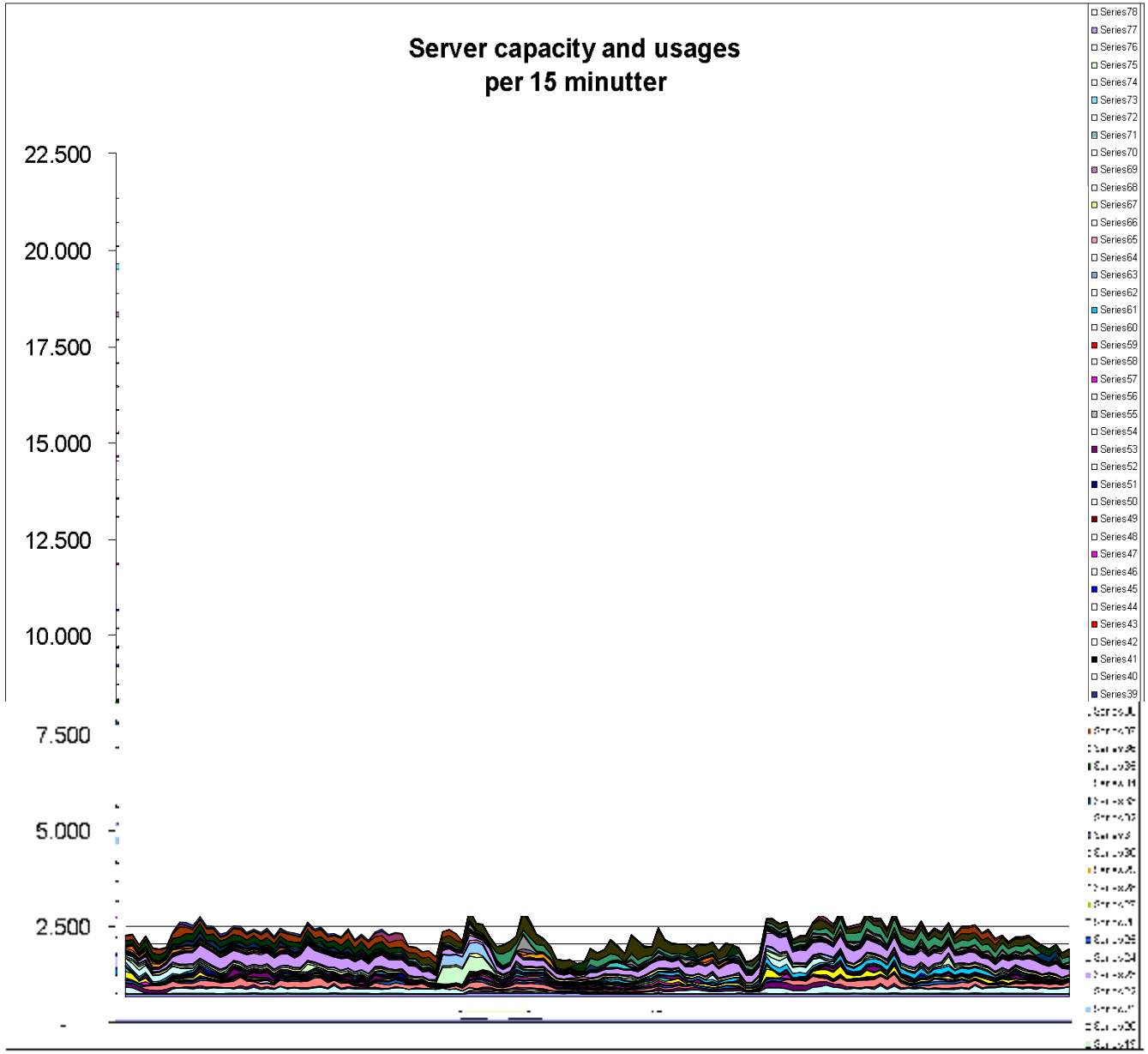


High Core-to-Core Ratios for Consolidations

From Distributed IT-Environments to ELS

Real customer examples with real workloads!

Industry	Distributed Cores	IBM Enterprise Linux Server™ Cores	Core-to-Core Ratio*
Public	292	5	58 to 1
Banking	111	4	27 to 1
Finance	442	16	27 to 1
Banking	131	5	26 to 1
Insurance	350	15	23 to 1
Insurance	500+	22	22 to 1
Banking	63	3	21 to 1
Finance	854	53	16 to 1
Health care	144	14	10 to 1
Transportation	84	9	9 to 1
Insurance	7	1	7 to 1

* Client results will vary based on each specific customer environment including types of workloads, utilization levels, target consolidation hardware, and other implementation requirements.

Optimize and Consolidate for Lower Cost

Linux on System z enables a total cost of acquisition of less than

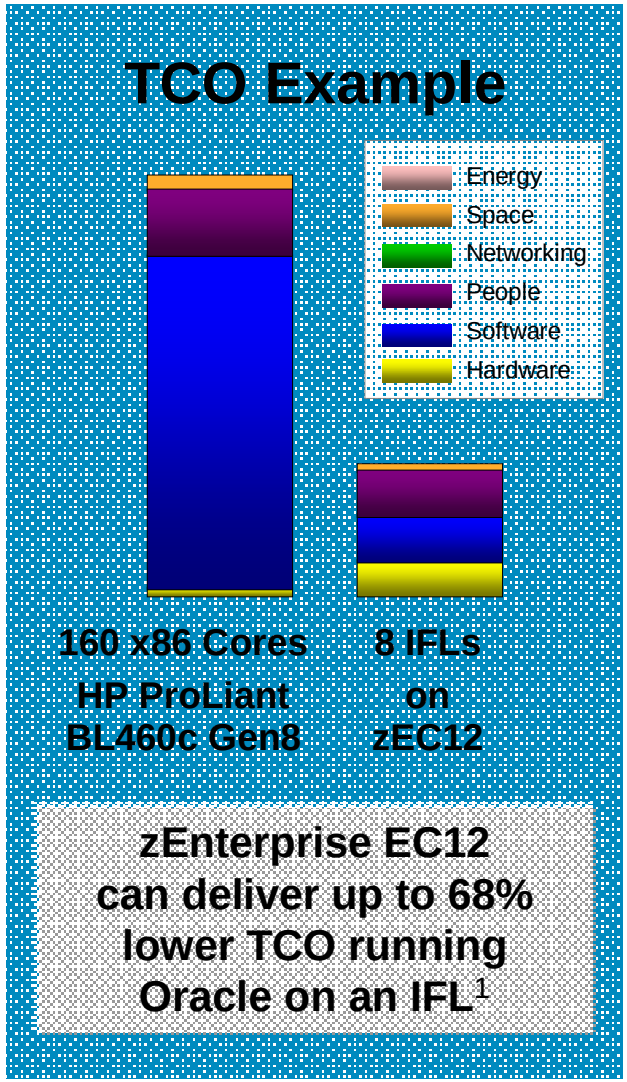
70 cents per day per virtual server[1]

Consolidate up to 60 distributed cores or more on a single System z core, or thousands on a single footprint[1].

System z servers often run consistently at **90%+ utilization**[1]

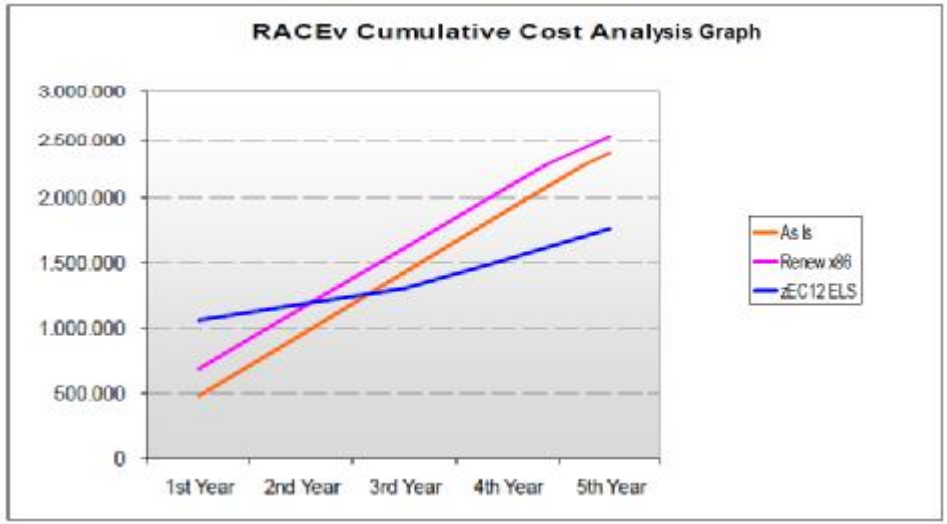
zEC12: 25% increase in processor performance

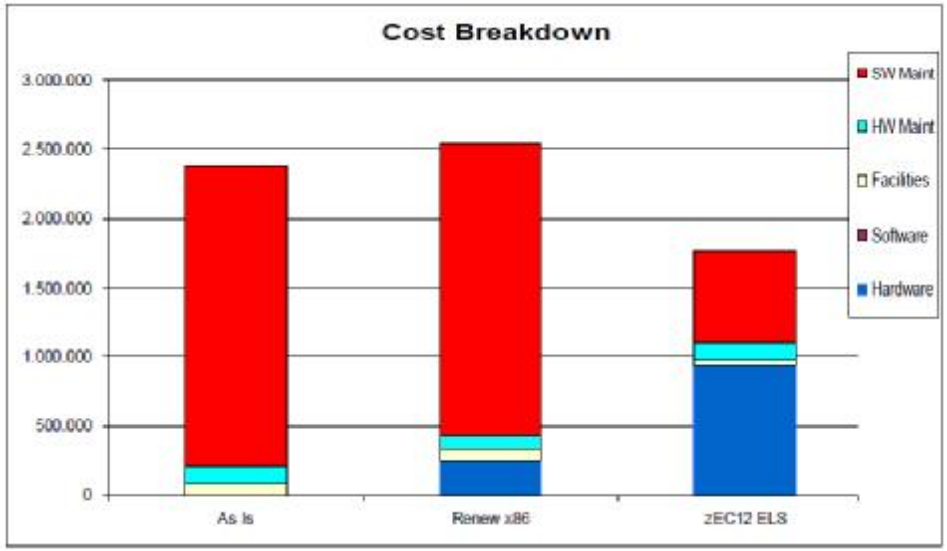
further reduces the cost of **optimizing deployment of new and existing workloads** and **large scale consolidation**



[1] IBM calculations of zEnterprise limits across maximum z196 configuration. Results may vary. 5-Year Total IT Cost

Oracle database consolidation example





Renewal: ProLiant BL280c G6 Xeon X5672 Quad Core 3.2GHz (1ch/4co)

ProLiant BL260c G5 Xeon E5430

Quad Core 2.66GHz (1ch/4co)

- 50 physical Linux servers
  - 10 servers @ 25% utilization
  - 20 servers @ 15% utilization
  - 20 servers @ 10% utilization
- Oracle DB Standard Edition

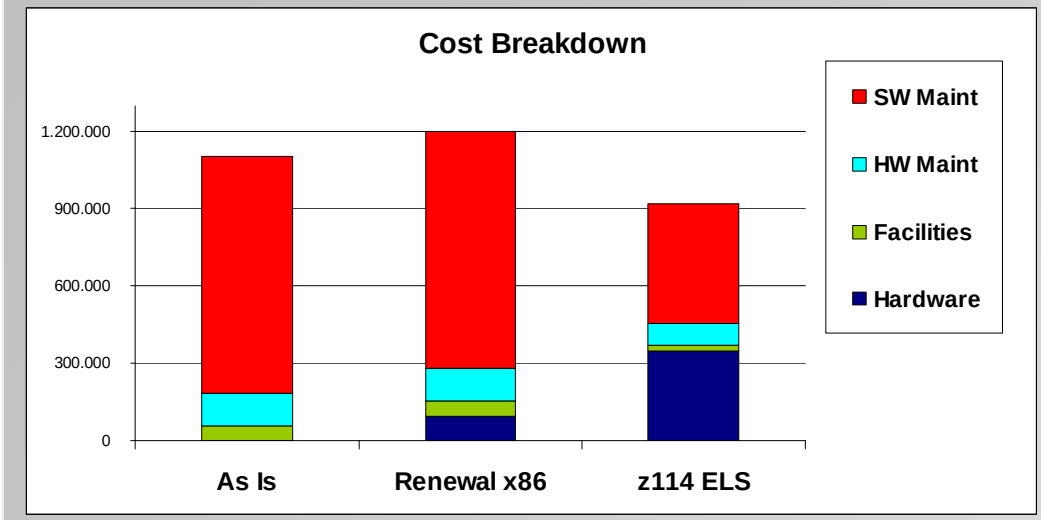
New zEC12 ELS
(Enterprise Linux Server) with

- **6 IFLs**
- **z/VM hypervisor**
- **50 Linux servers**
- **Oracle DB Enterprise Edition**

…plus further savings on system admin, floor space, network, etc.

Sizing information based on IBM internal RACEv tool and US prices. Actual results may vary.

Cost Advantages with IT Optimization on IBM System z



As Is:

ProLiant ML150 G5 Xeon E5430 (2.66GHz, 1ch/4co)

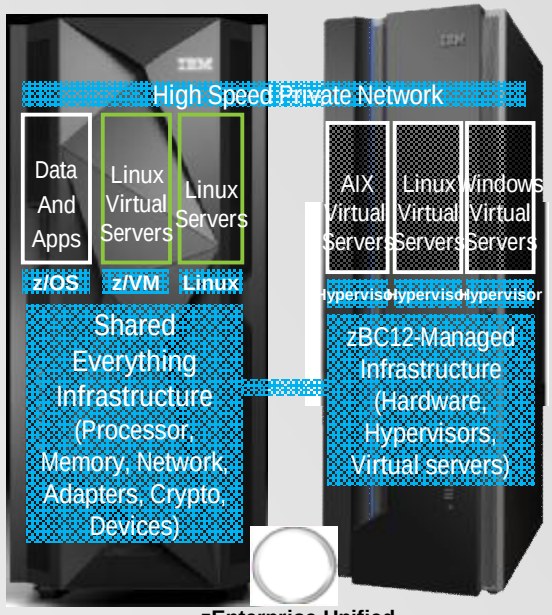
- **20 physical Linux servers**
- **10 servers @ 15% utilization**
- **10 servers @ 10% utilization**
- **Oracle DB Standard Edition**

New z114:

Enterprise Linux Server (ELS) with

- **20 Linux servers**
- **4 IFLs**
- **z/VM virtualization**
- **Oracle DB Standard Edition**

… plus further savings on system admin, network, etc.



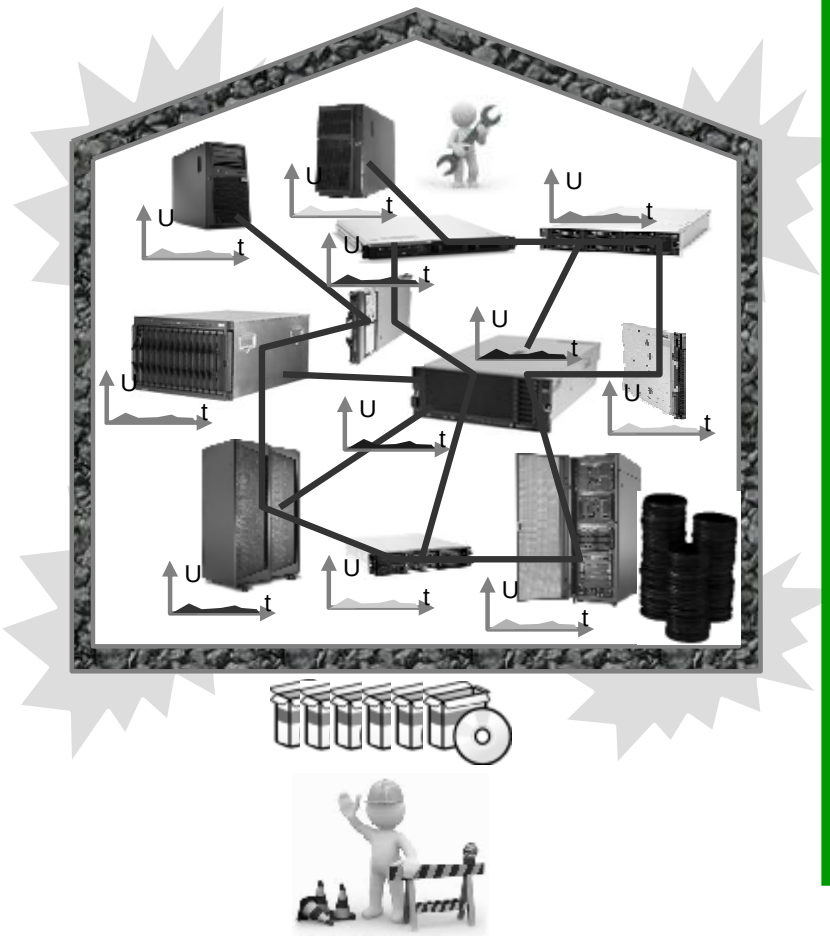
zEnterprise Unified Resource Manager

- **§Virtualization and server management**
- **§Security services for entire enterprise**
- **§Database and warehouse services**
- **§Application development and test**
- **§Mobile application hosting**
- **ð All managed in a Cloud**

Sizing information based on IBM internal RACEv tool and US prices. Actual results may vary.

Why IT Optimization with zEnterprise

Improved IT Efficiency and Reduced Costs



- è Operational and management reduction
- è Software acquisition and licensing cost reduction
- è Maximizing utilization
- è Collocation of data and applications
- è Floor-space and energy reduction
- è Network reduction
- è Hardware acquisition cost reduction
- è Technology refresh effort reduction
- è Growth inside a server
- è Improving security
- è Disaster recovery cost reduction

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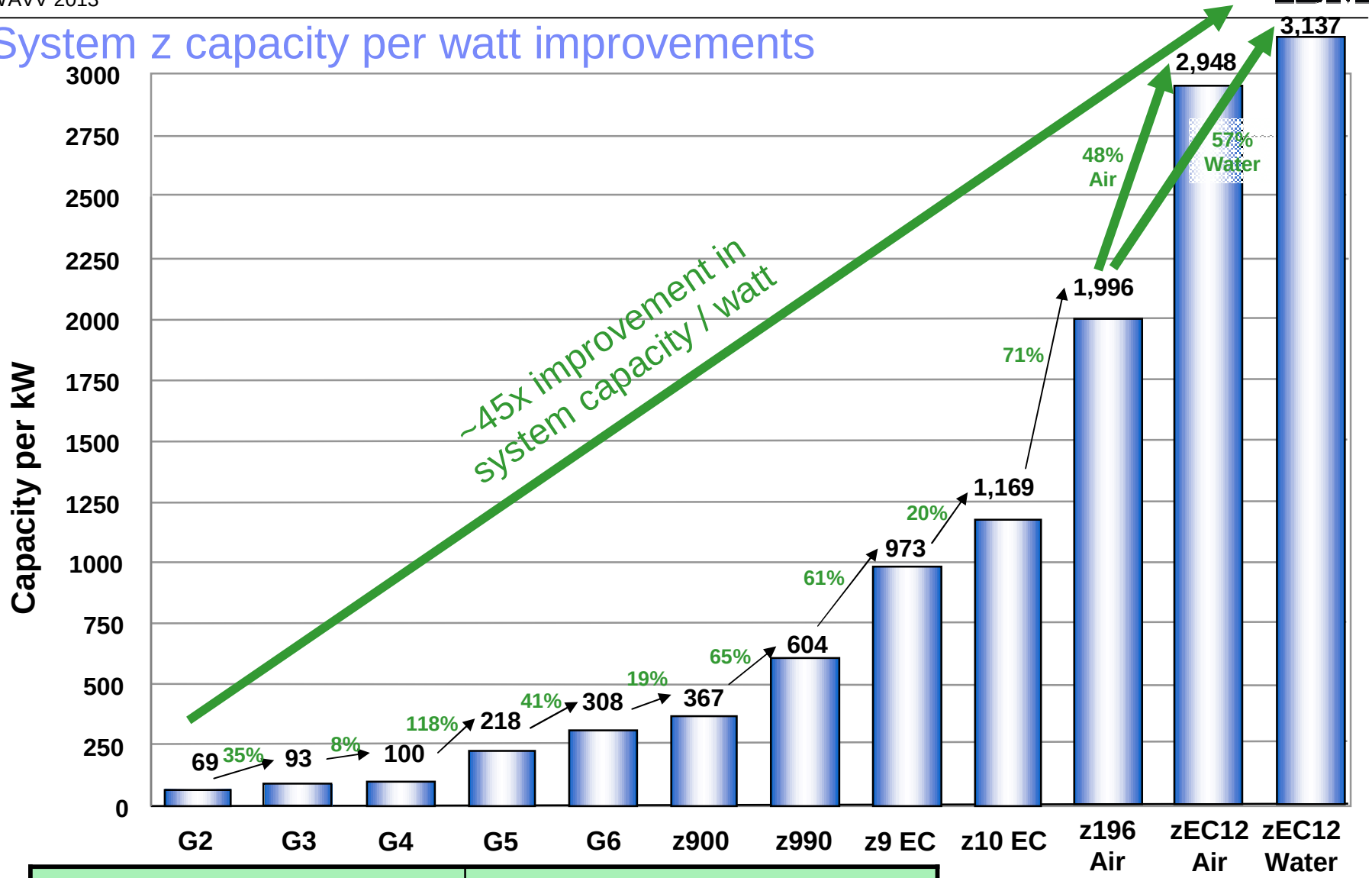
Bank of New Zealand

- Consolidated 200 Sun servers down to 1 IBM System z10 running Red Hat Enterprise Linux
- data center footprint
  eat output by 33%,
  and power consumption by close to 40%
- **Only one administrator needed per 200 virtual servers**
- New environments are deployed in minutes, not days

System z capacity per watt improvements

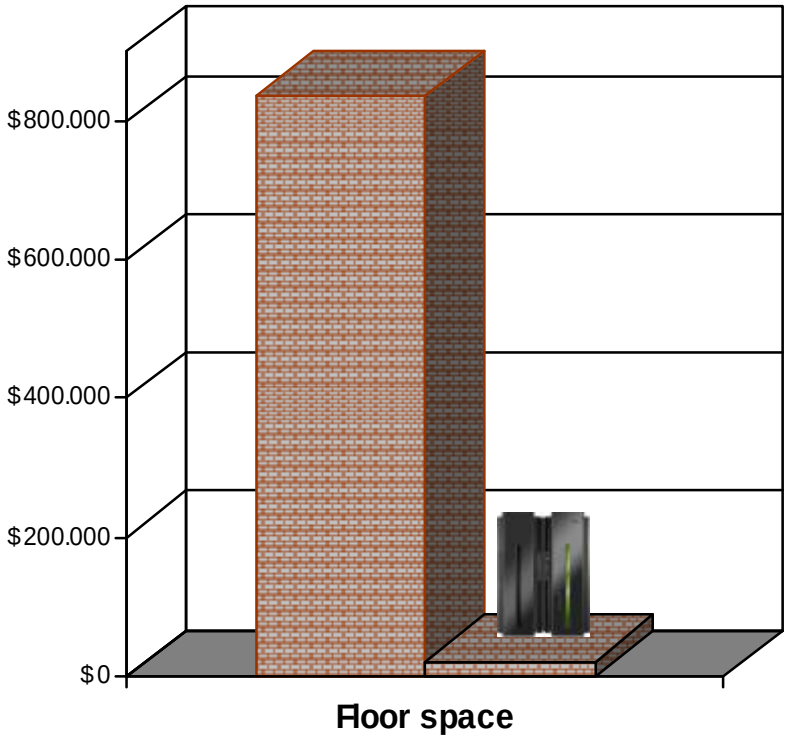


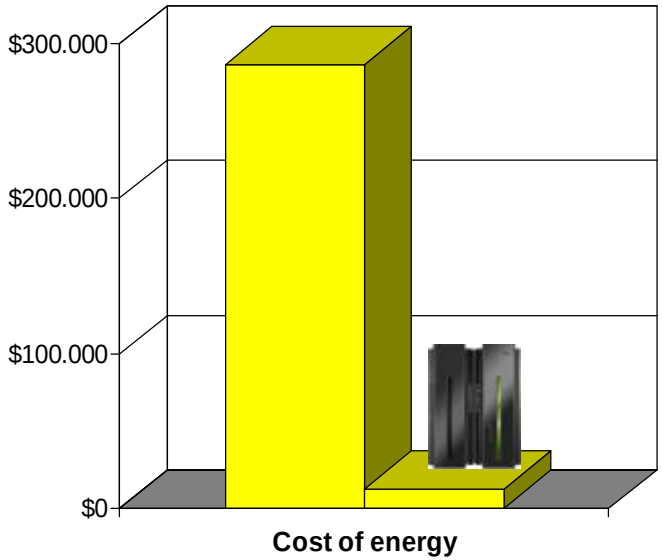
17 years of CMOS: G2 to zEC12		Net Effect: G2 to zEC12	
Power Increase:	**15%** per year	Performance increased by:	**~450x**
Performance increase:	**43%** per year	**Performance / watt increased by:**	**~45x**
Power density increase:	**11%** per year	Performance / floor area increased by:	**~275x**

Note: Latest power data as of 10/1/2012. Max. possible power is used in all calculations: hot room, max plugged I/O power, max. memory power and all engines turned on. Real world max. capacity system is typically about 3/4 of this power.

Insurance Company Reduced Energy Requirements 95% by Consolidating 292 Servers to a z10

OEM Server environmentals are derived from IDEAS International.





Annual cost calculation

- Floor space cost calculated with a rate of $29 per square foot per month
- Energy cost calculated with a rate of $0.12 per Kilowatt

Prices are in USD. Prices may vary in other countries.
Data is based on real client opportunity and on internal standardized costing tools and methodologies.
Client results will vary by types of workloads, technology level of consolidated servers, utilization factor, and other implementation requirements. Savings will vary by client.

Optimized Computing: Nationwide's Linux on System z Virtualization Reduces TCO and Time to Deploy

Nationwide was already experiencing serious technology pain points from the continuous growth of its business. Among these were:

- *Too many distributed physical servers with low utilization*
- *A lengthy provisioning process that delayed the implementation of new applications for headquarters and agencies, and for new customers for Nationwide's human resources outsourcing business*
- *Limitations in data center power and floor space*
- *High Total Cost of Ownership (TCO)*
- *Difficulty allocating processing power for a dynamic environment.*

> *"Our goal was server optimization and our approach was virtualization."*
>
> — Guru Vasudeva, Nationwide Vice President and CTO

TCO results that Nationwide has experienced:

- Monthly Web hosting fees have gone down by 50 percent.
- Hardware and operating system support needs have decremented by 50 percent.
- CPU utilization is up an average of 70 percent, with the elimination of many physical servers with below average utilization.
- Middleware licensing costs for WebSphere, Oracle, and UDB have dramatically fallen.
- There has been an 80 percent reduction in data center floor space needs, and power consumption is down.
- The net of the effort is a $15 million savings for Nationwide IT over the past three years.

www.mainframezone.com/it-management/optimized-computing-nationwides-linux-on-system-z-virtualization-reduces-tco-and-time-to-deploy

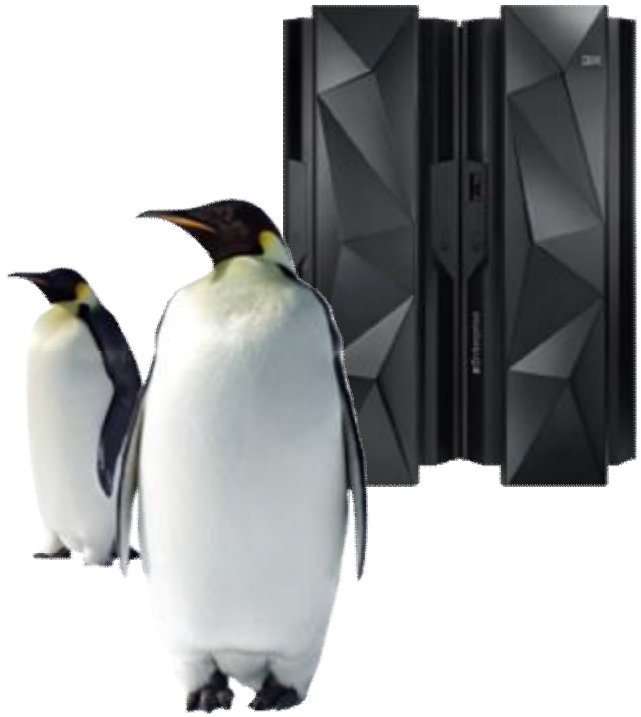
Summary: Linux on System z advantages

As seen by a large financial services company

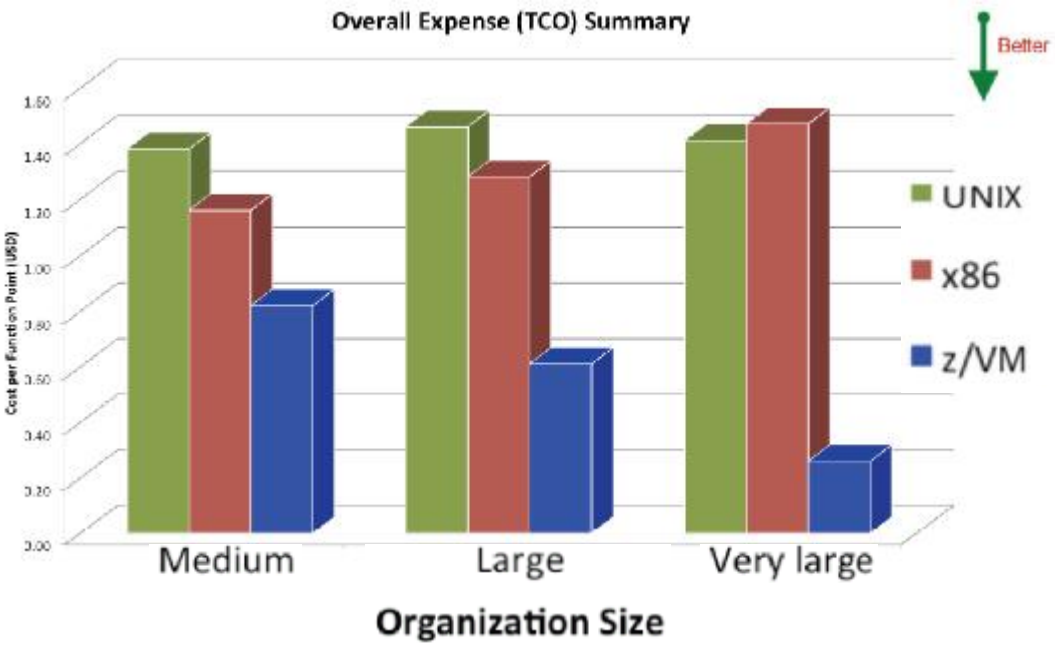
- **Test servers tend to multiply** (one application can require 16 or more servers)
  - Unit testing
  - QA testing
  - Enterprise testing
  - Regression testing
  - Cluster testing
  - Middleware and Operating System version testing
- **Reliable common driver code** for all virtual servers
- Hardware platform **changes / upgrades** are all possible **without major disruption** to Linux
- Every virtual server benefits from hardware upgrades, technology refreshes, and hardware currency – **no waiting for the 3-to-4-year upgrade cycle**
- **No cables!**
- No flaky memory cards, no NIC mismatches, no CPU failures
- Real hardware multi-pathing
- **Significant power / floor space / cooling savings**
- Decommissioned virtual server resources are returned to the shared pool of system resources and reused (vs. spending about $800 to dispose of an old physical server)

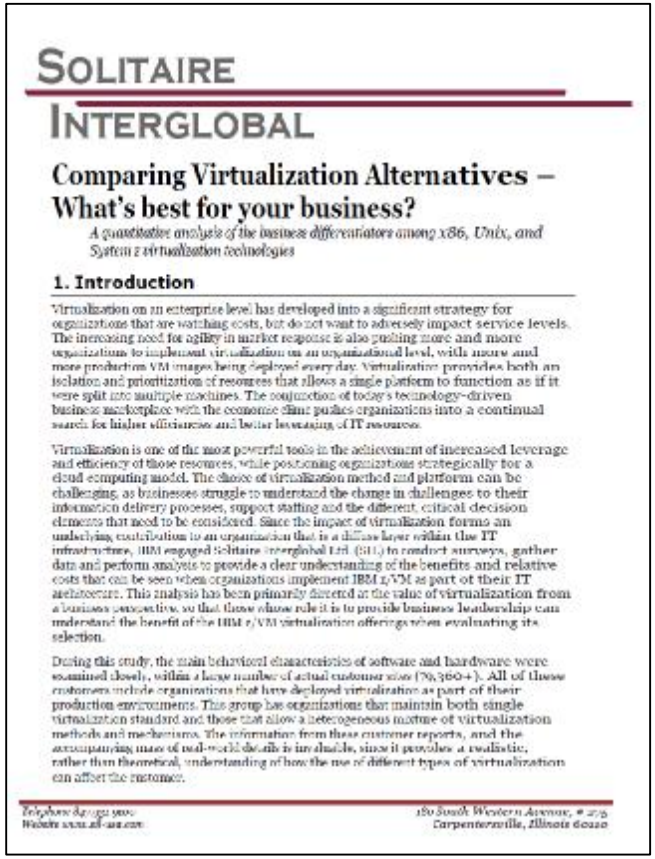
Discussion Topics

- Linux on z - from a skunk works to mainstream
- The Enterprise Linux Server
- Extreme virtualization
- Strategies to reduce cost and improve value
- **Quality of Service with Linux and zEnterprise**



Comparing Virtualization Alternatives
Overall Expense (TCO)





SOLITAIRE
INTERGLOBAL

Comparing Virtualization Alternatives – What's best for your business?

A quantitative analysis of the business differentiators among x86, Unix, and System z virtualization technologies

1. Introduction

Virtualization on an enterprise level has developed into a significant strategy for organizations that are watching costs, but do not want to adversely impact service levels. The increasing need for agility in market response is also pushing more and more organizations to implement virtualization on an organizational level, with more and more production VM images being deployed every day. Virtualization provides both an isolation and prioritization of resources that allows a single platform to function as if it were split into multiple machines. The conjunction of today's technology-driven business marketplace with the economic climate pushes organizations into a continual search for higher efficiencies and better leveraging of IT resources.

Virtualization is one of the most powerful tools in the achievement of increased leverage and efficiency of those resources, while positioning organizations strategically for a cloud computing model. The choice of virtualization method and platform can be challenging, as businesses struggle to understand the change in challenges to their information delivery processes, support staffing and the different, critical decision elements that need to be considered. Since the impact of virtualization forms an underlying contribution to an organization that is a diffuse layer within the IT infrastructure, IBM engaged Solitaire Interglobal Ltd. (SIL) to conduct surveys, gather data and perform analysis to provide a clear understanding of the benefits and relative costs that can be seen when organizations implement IBM z/VM as part of their IT architecture. This analysis has been primarily directed at the value of virtualization from a business perspective, so that those whose role it is to provide business leadership can understand the benefit of the IBM z/VM virtualization offerings when evaluating its selection.

During this study, the main behavioral characteristics of software and hardware were examined closely, within a large number of actual customer sites (79,360+). All of these customers include organizations that have deployed virtualization as part of their production environments. This group has organizations that maintain both single virtualization standard and those that allow a heterogeneous mixture of virtualization methods and mechanisms. The information from these customer reports, and the accompanying mass of real-world details is invaluable, since it provides a realistic, rather than theoretical, understanding of how the use of different types of virtualization can affect the customer.

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Carpentersville, Illinois 60110

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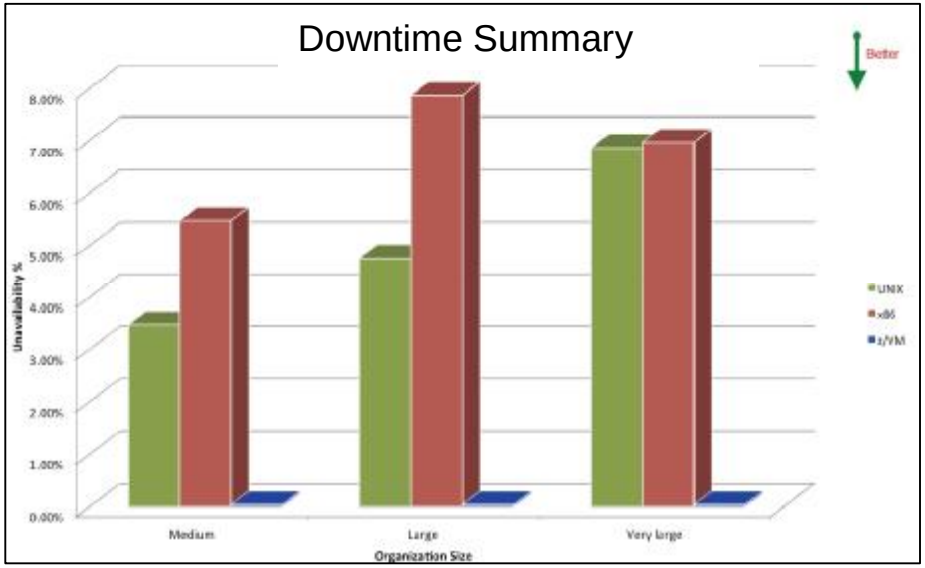
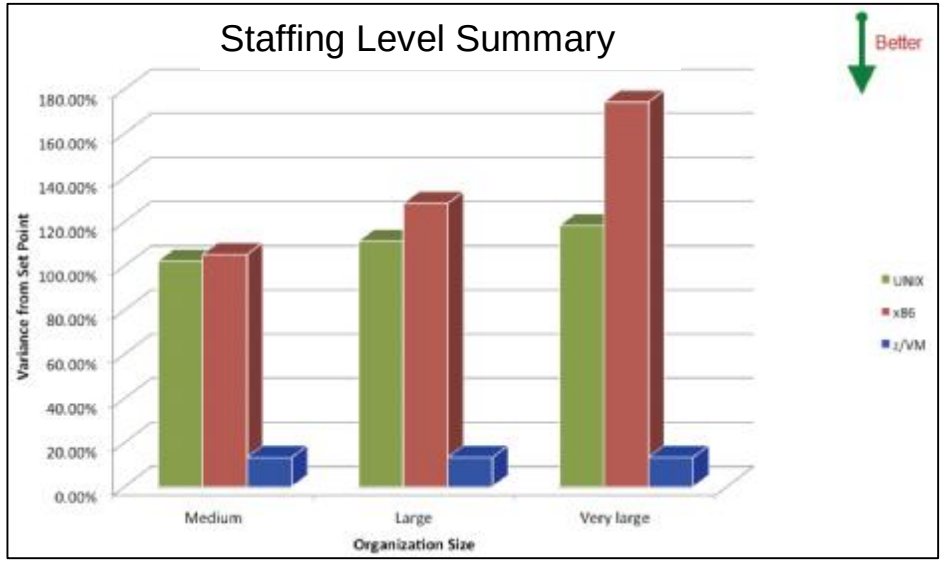
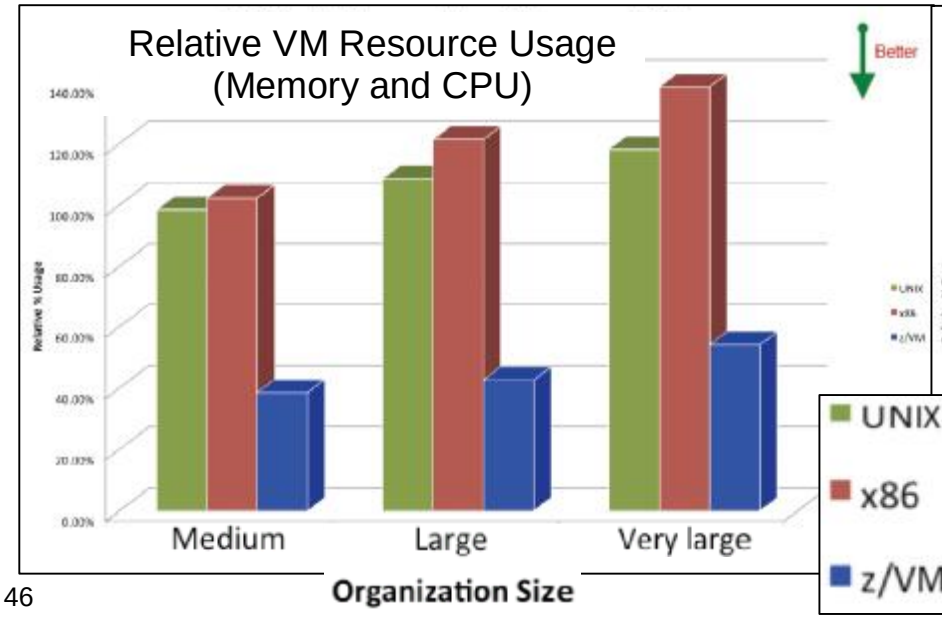
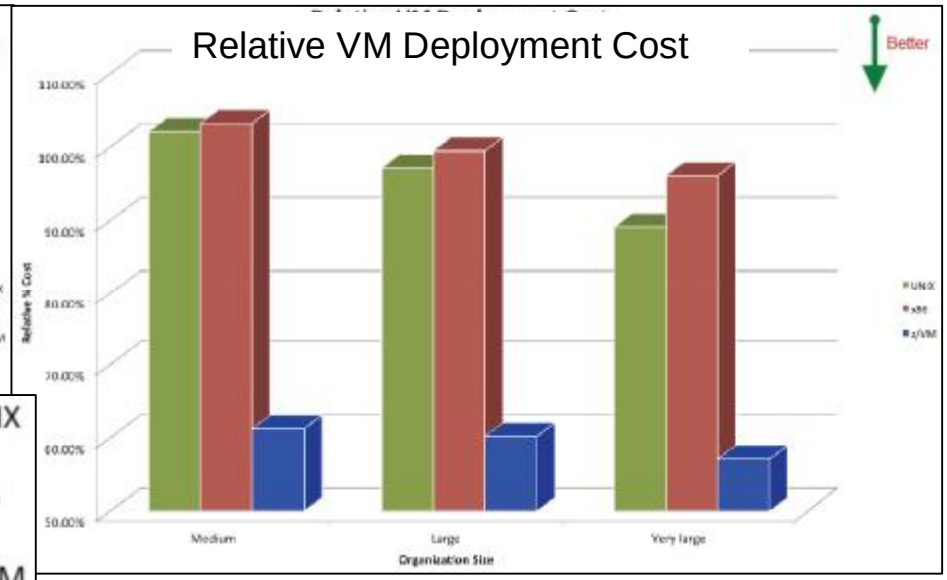
Solitare Interglobal study



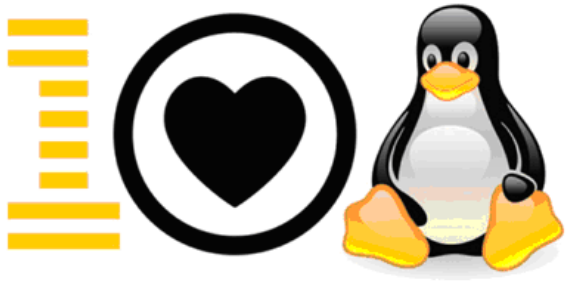






SMARTER COMPUTING

Use of hardware and software technologies to increase operational efficiencies and optimize workload performance
while reducing Total Cost of Ownership



Questions?

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