

2012

# IBM System z Technical University

Enabling the infrastructure for smarter computing

## Making the Case for Linux on System z

zLG03

Siegfried Langer



## Abstract

### **zLG03 Making the Case for Linux on System z**

*Siegfried Langer*

*Lecture — Intermediate*

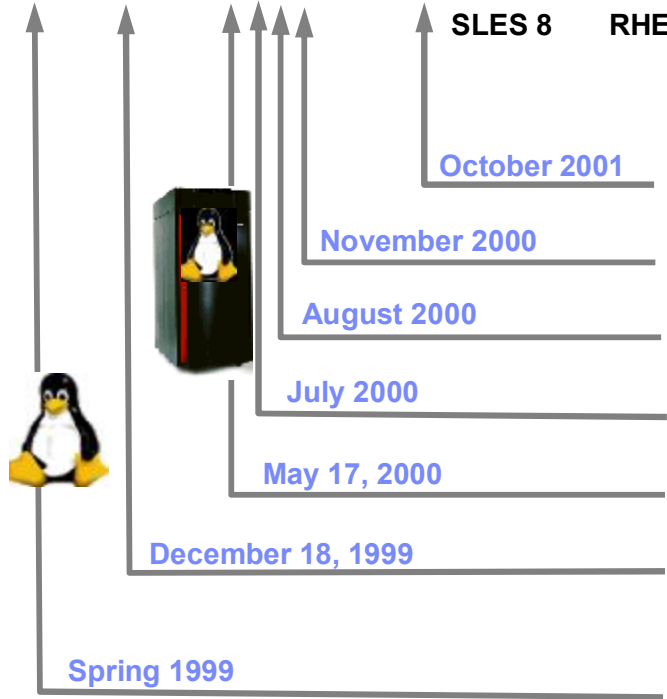
There is a clear trend towards virtualization and hybrid computing. How is Linux on System z positioned against zBX? Where are the advantages compared to VMware? What are the advantages of Linux on System z?

## Discussion Topics

- **12 years of Linux on System z**
- **The Enterprise Linux Server**
- **Strategies to reduce cost and improve value**
- **Fit for purpose**
- **Quality of Service with Linux and zEnterprise**



# How it began



- Red Hat 7.2 available (implemented on Linux 2.4 kernel)
- SuSE Linux 7.0 available
- "S/390 Install Fest" with SuSE pre-release
- IBM announced Integrated Facility for Linux (IFL)
- IBM announced Linux for the enterprise user**
- Kernel patches (version 2.2.13) available on Marist College web site
- Linux running under VM/ESA

## A Simple Idea

12 years ago



- **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**



## A Simple Idea that evolved to an Uniquely Powerful Solution

- **Single-server simplicity**
  - Saving opportunities in software and management costs, power and floor space
  - A cluster with one machine backing up another and an additional failover machine
- **Advanced resource utilization and dynamic allocation**
  - Industry leading virtualization and sharing of system resources such as processors, memory, communication, storage, I/O, networking
- **Massive scalability**
  - Running up to thousands of virtual Linux servers concurrently
  - Supporting a broad range of solutions such as cloud computing, business intelligence, collaboration and Web application serving
- **Rock-solid system security and reliability**
  - Most secure commercial server<sup>1</sup> ensuring isolation of each virtual server environment
  - Cost-attractive business resilience and failover solutions



<sup>1</sup> IBM System z servers are the world's only servers with the highest level of hardware security certification, Common Criteria Evaluation Assurance Level 5 (EAL5).

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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





## Linux versus Mainframe terminology

- Linux

- System administrator
- Network management
- Boot
- 4-processor machine
- Main memory
- Disk
- Scheduler
- NIC

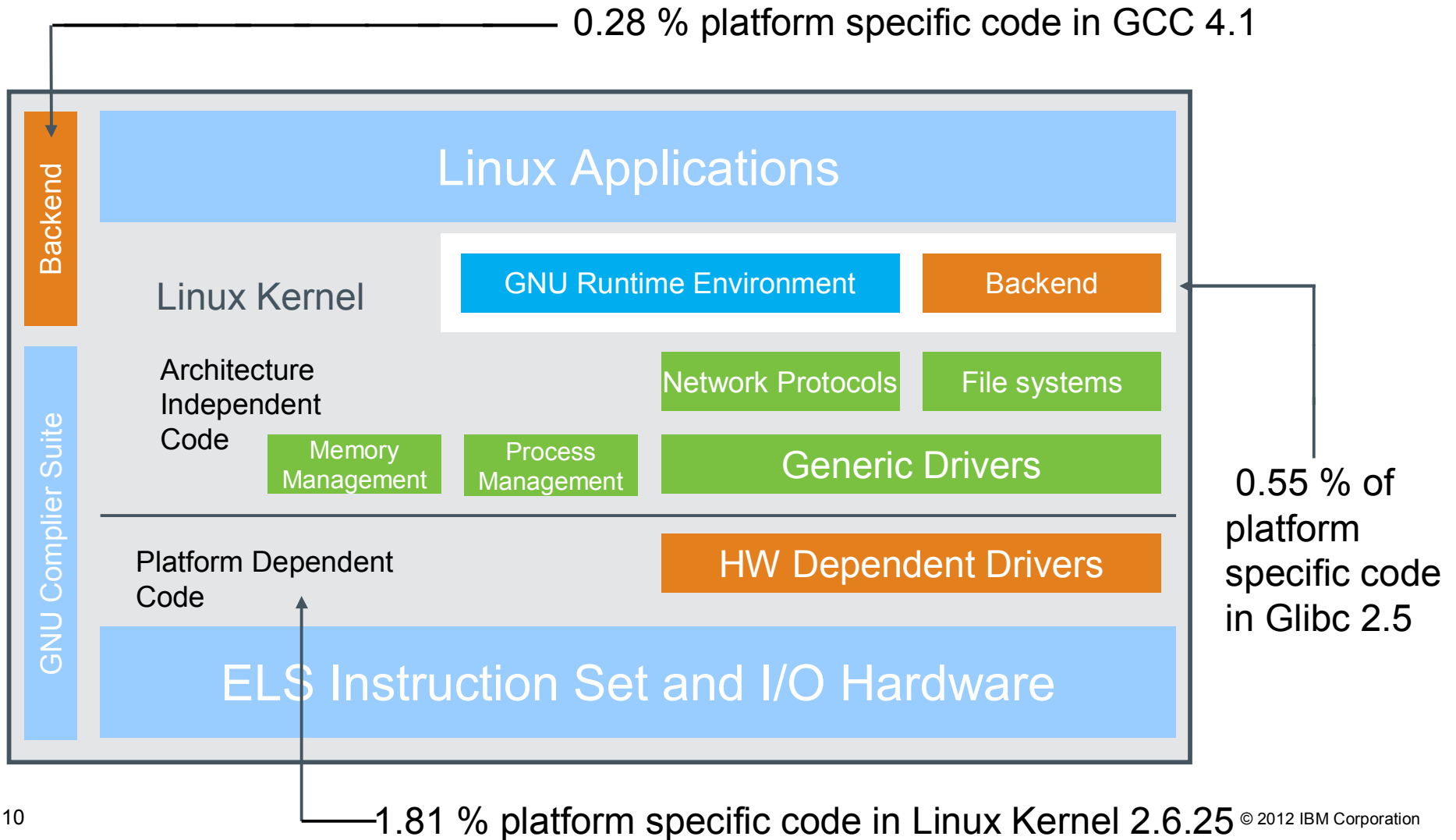
- Mainframe

- System programmer
- Systems management
- IPL
- 4-way
- Main storage
- DASD
- Dispatcher
- OSA

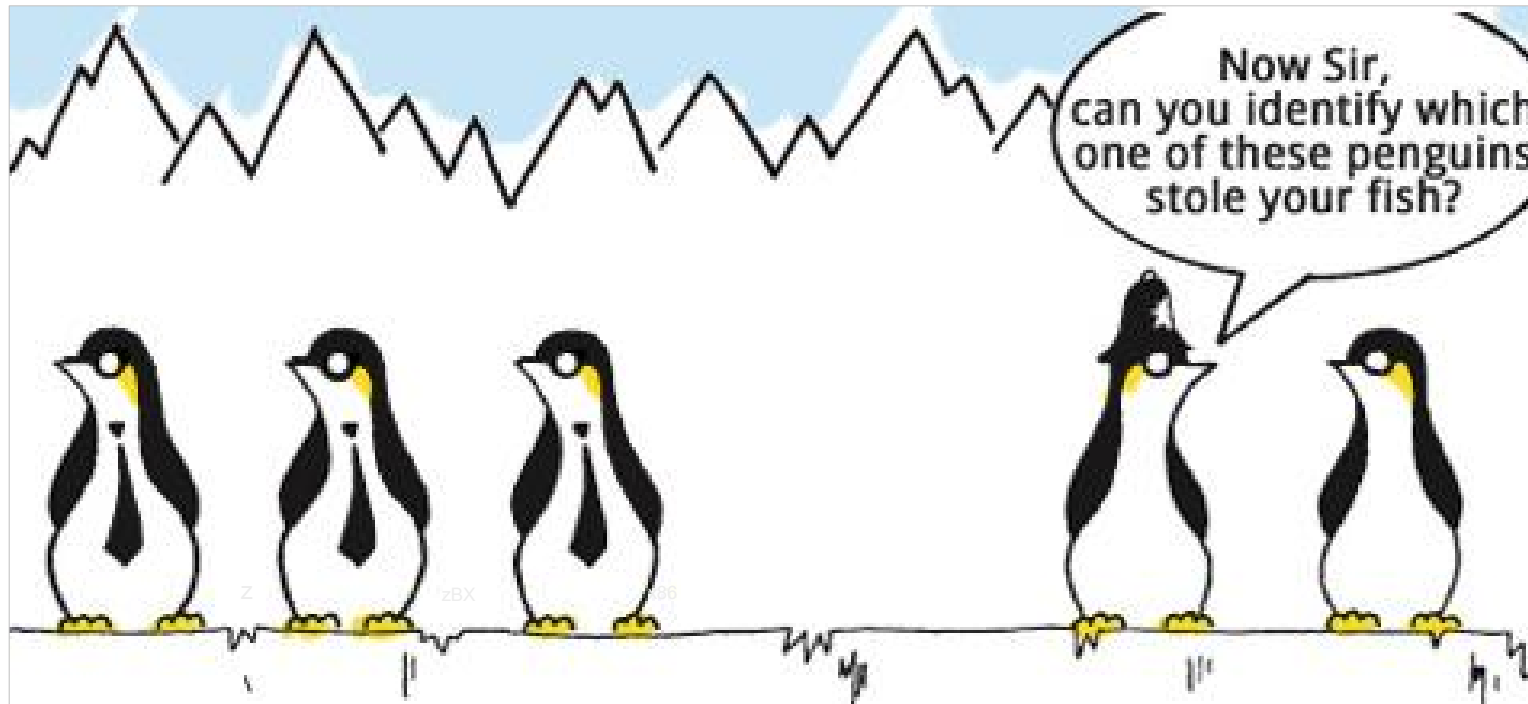


## Structure of Linux on System z

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



## 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).

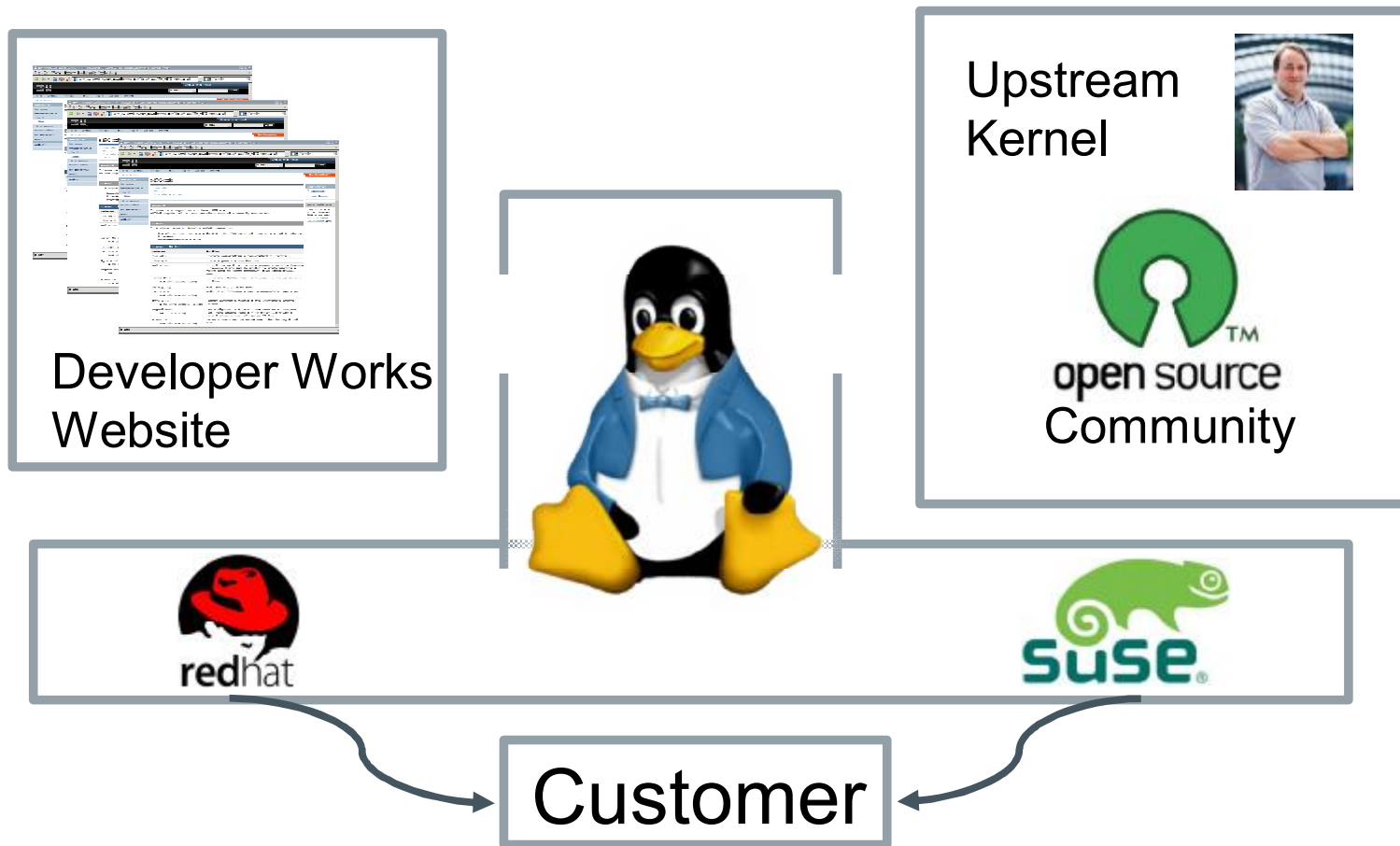
## Linux is Linux...

*... but features, properties and quality depends on the underlying architecture*

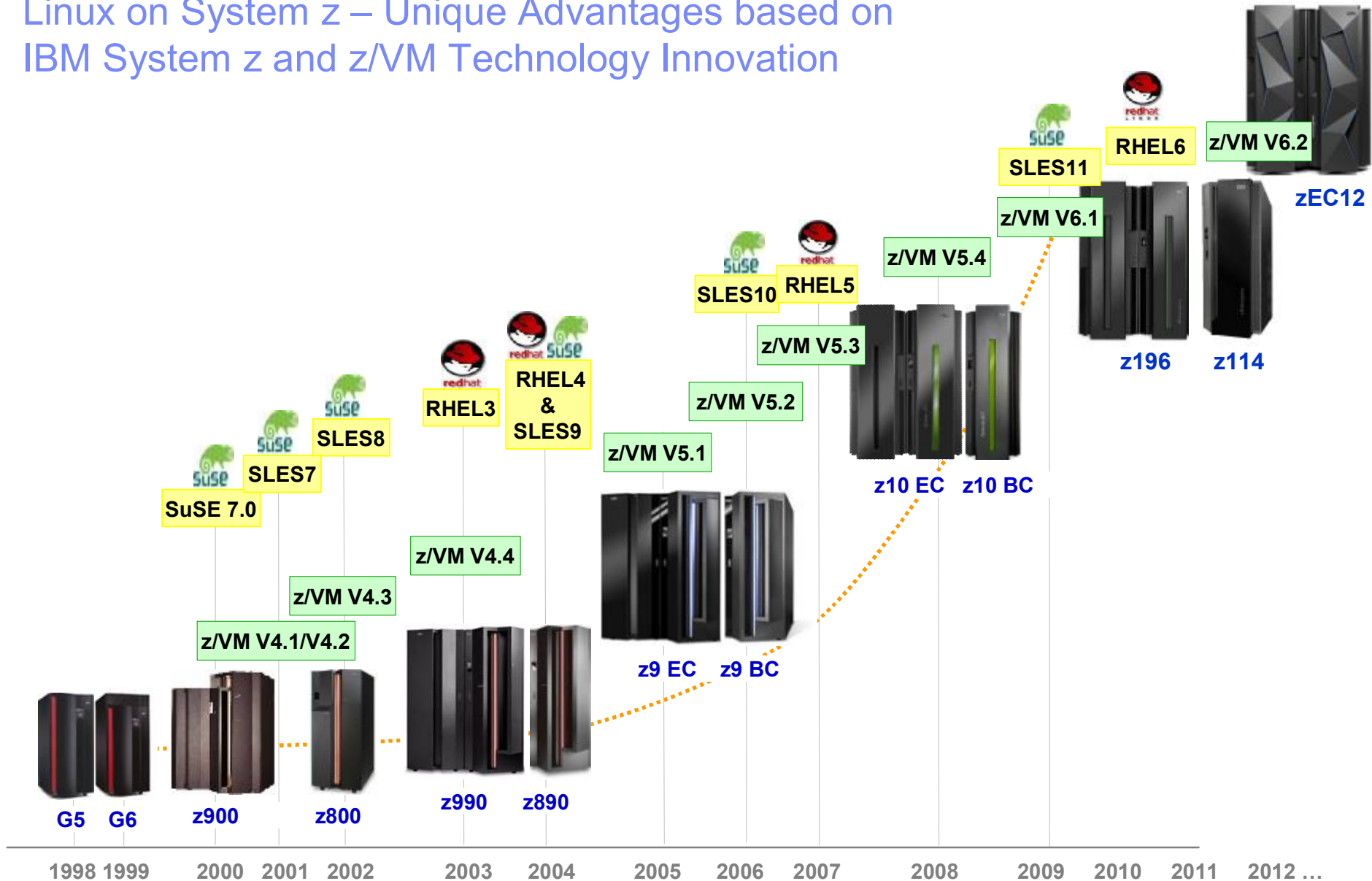
- **Quality of Service, Redundancy or RAS features build-in hardware**  
(Redundant Array of Independent Memory (RAIM), outage avoidance using hotplug hardware)
- **Hardware supported large scale virtualization support**  
(highly efficient, granular and isolated virtualization that is part of the architecture 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)

# 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



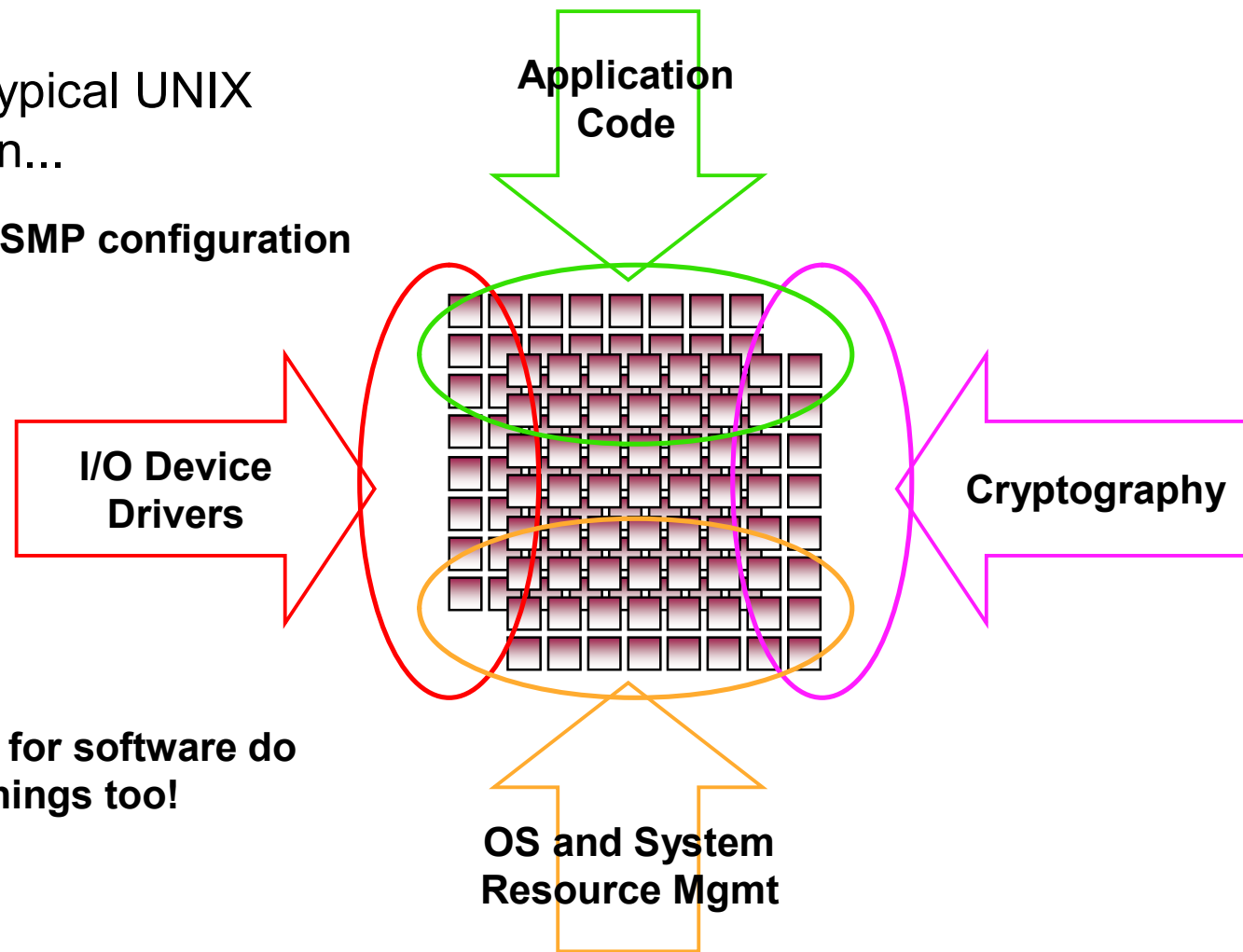
# Linux on System z – Unique Advantages based on IBM System z and z/VM Technology Innovation



# System Design Affects Virtualization Capabilities

Compare to typical UNIX system design...

**Up to 128-way SMP configuration**

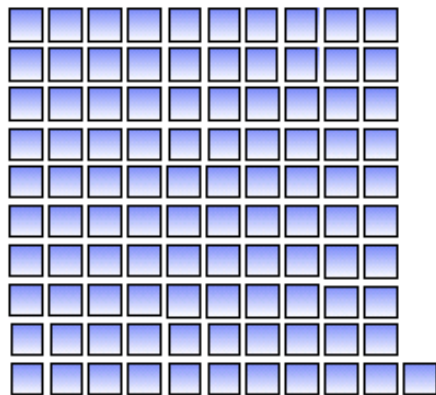


**CPUs licensed for software do a lot of other things too!**

# System Design Affects Virtualization Capabilities

System zEC12 packs a lot of compute power into a single box

### Up to 101-way SMP



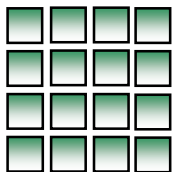
Share up to 101 processors with up to 60 LPARs

Configure these processors as CPs, IFLs, zAAPs\*, zIIPs\*, or ICFs\*

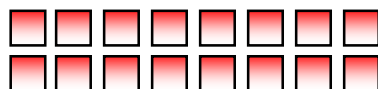
\* No software license fees

- 2 Standard Spare PUs**
- 1 reserved PUs**

### Up to 16 System Assist Processors



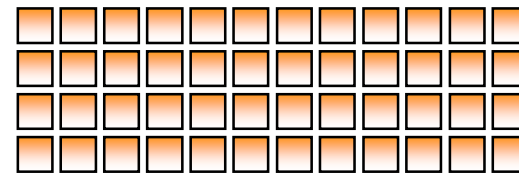
Offload system processing to dedicated CPUs (no impact to software license fees)



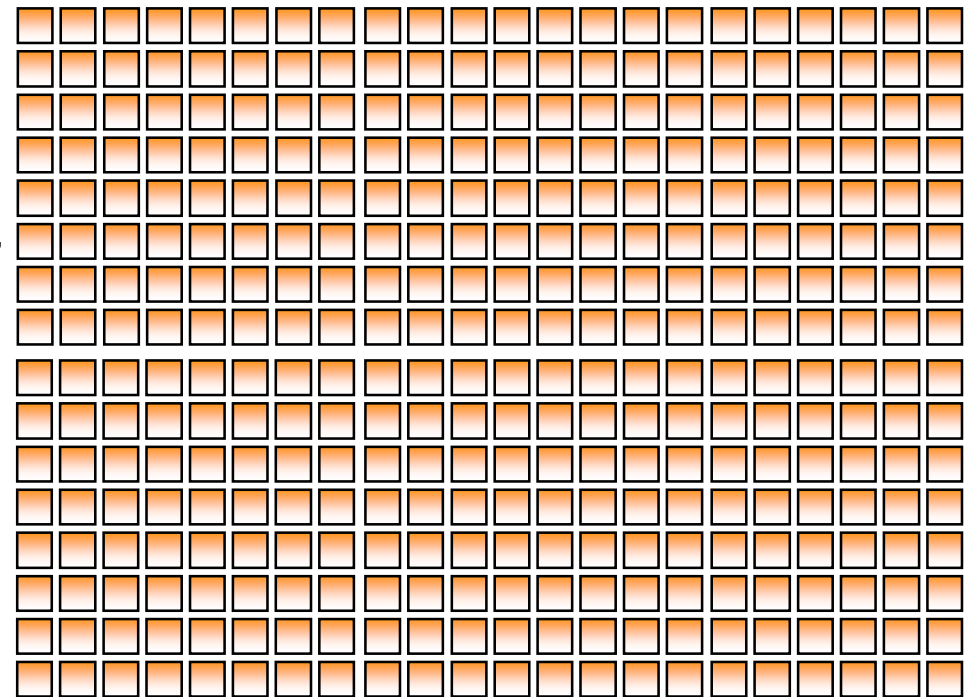
### Up to 16 Crypto Express CPUs

High scale performance for SSL transactions

### Plus up to hundreds of I/O Processors

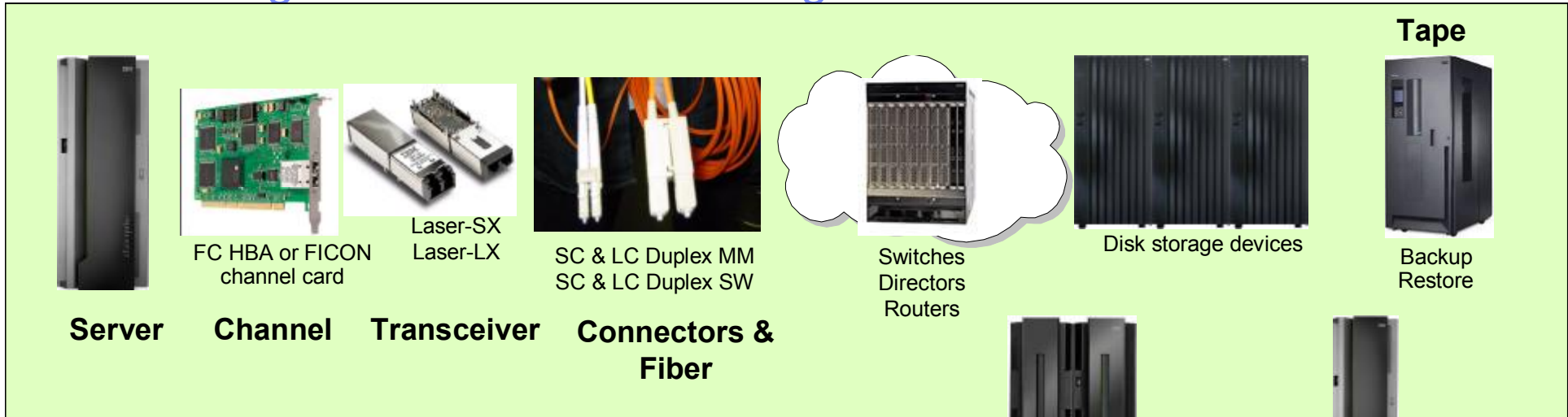


No additional charge for these processors



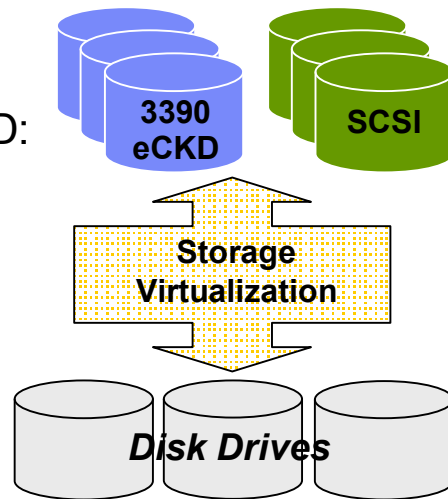


# Disk Storage: Direct Attached Storage or SAN

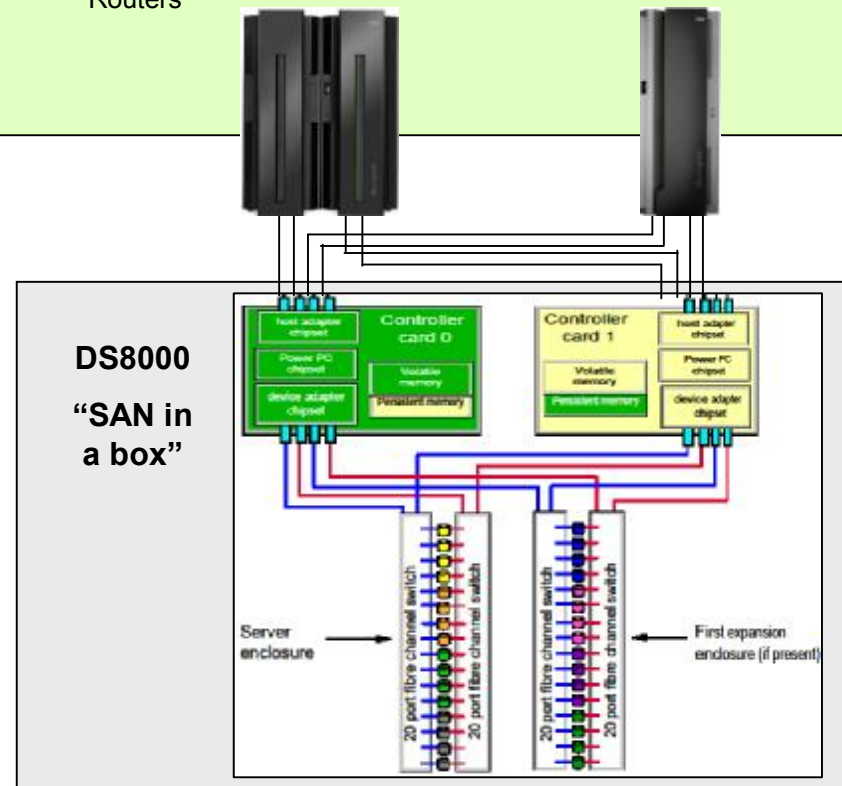


## Linux on System z disk options:

- 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

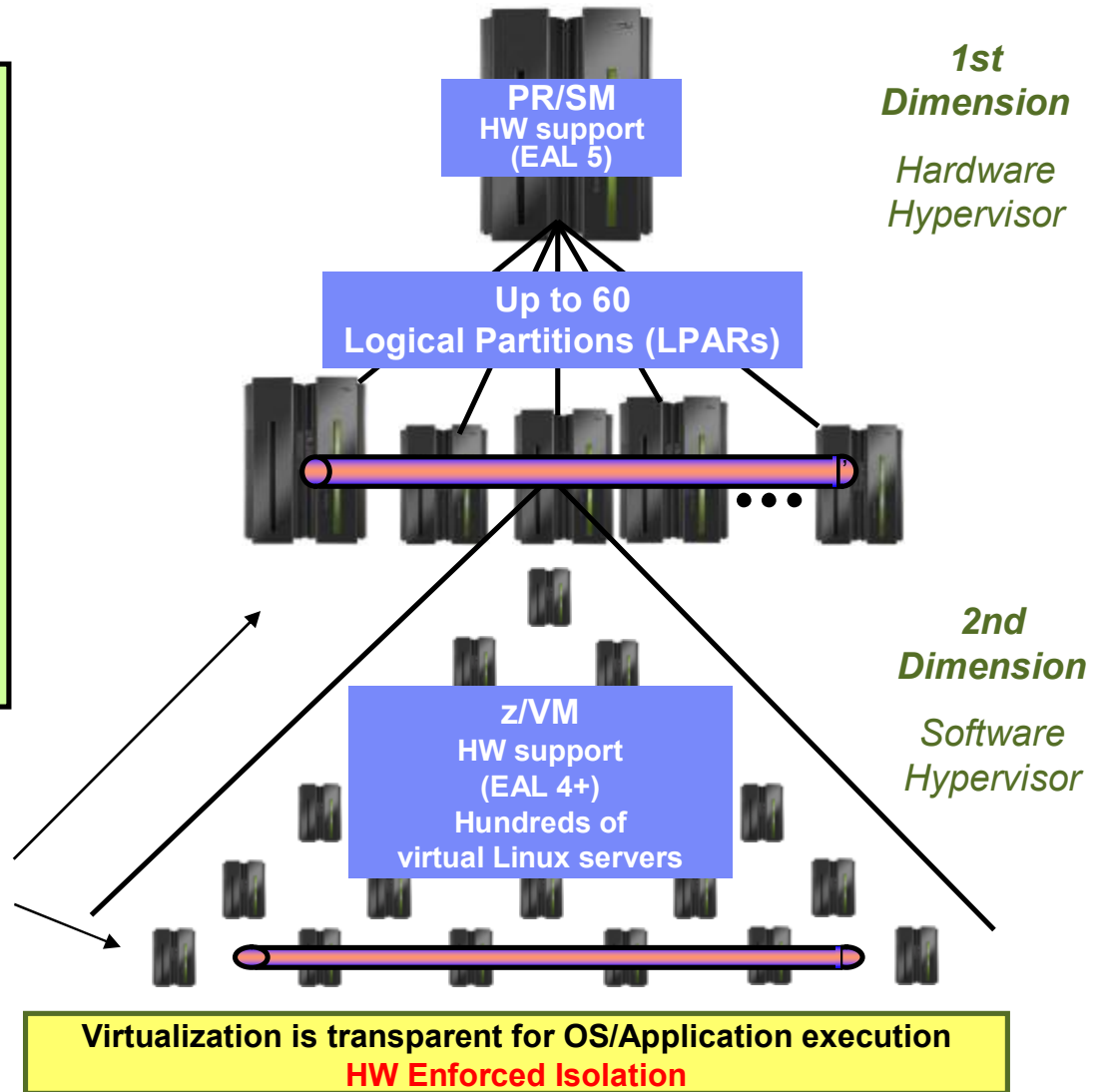


# Multidimensional Virtualization

**Very large Shared Resource Space**  
 Allows for consolidation and tight integration of **Large Server Farms** into  
**VIRTUAL "BLADES"**  
**VIRTUAL "RACKS"**  
**VIRTUAL 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

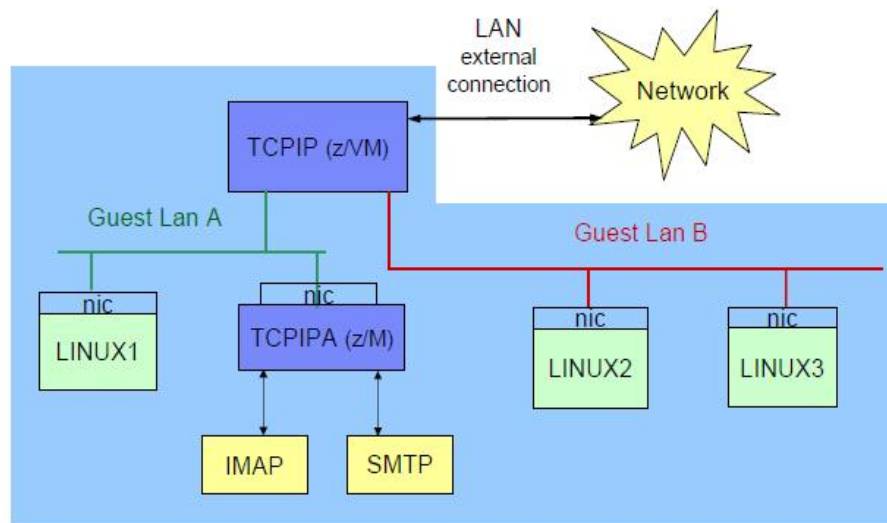
*The power of many*  
*The simplicity of one*



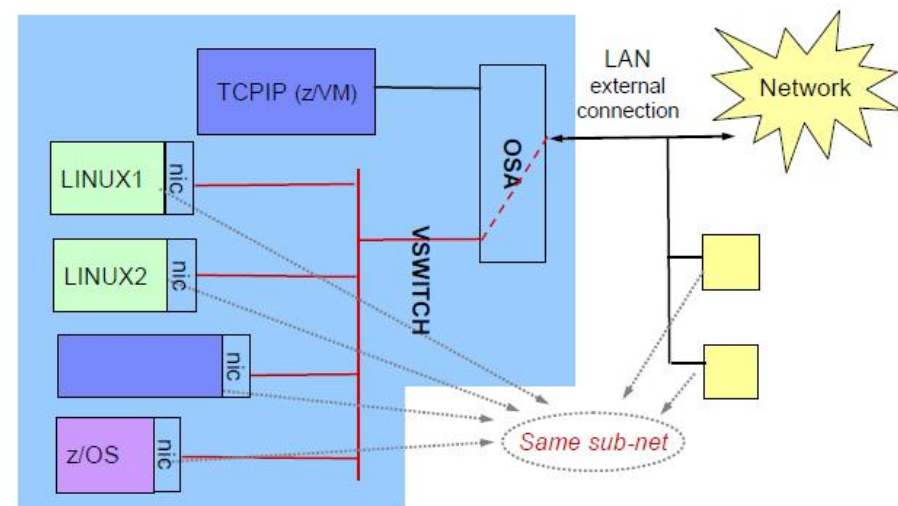
## z/VM Network Virtualization

- 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

### Guest LAN



### Virtual SWITCH



## Advanced virtualization benefits

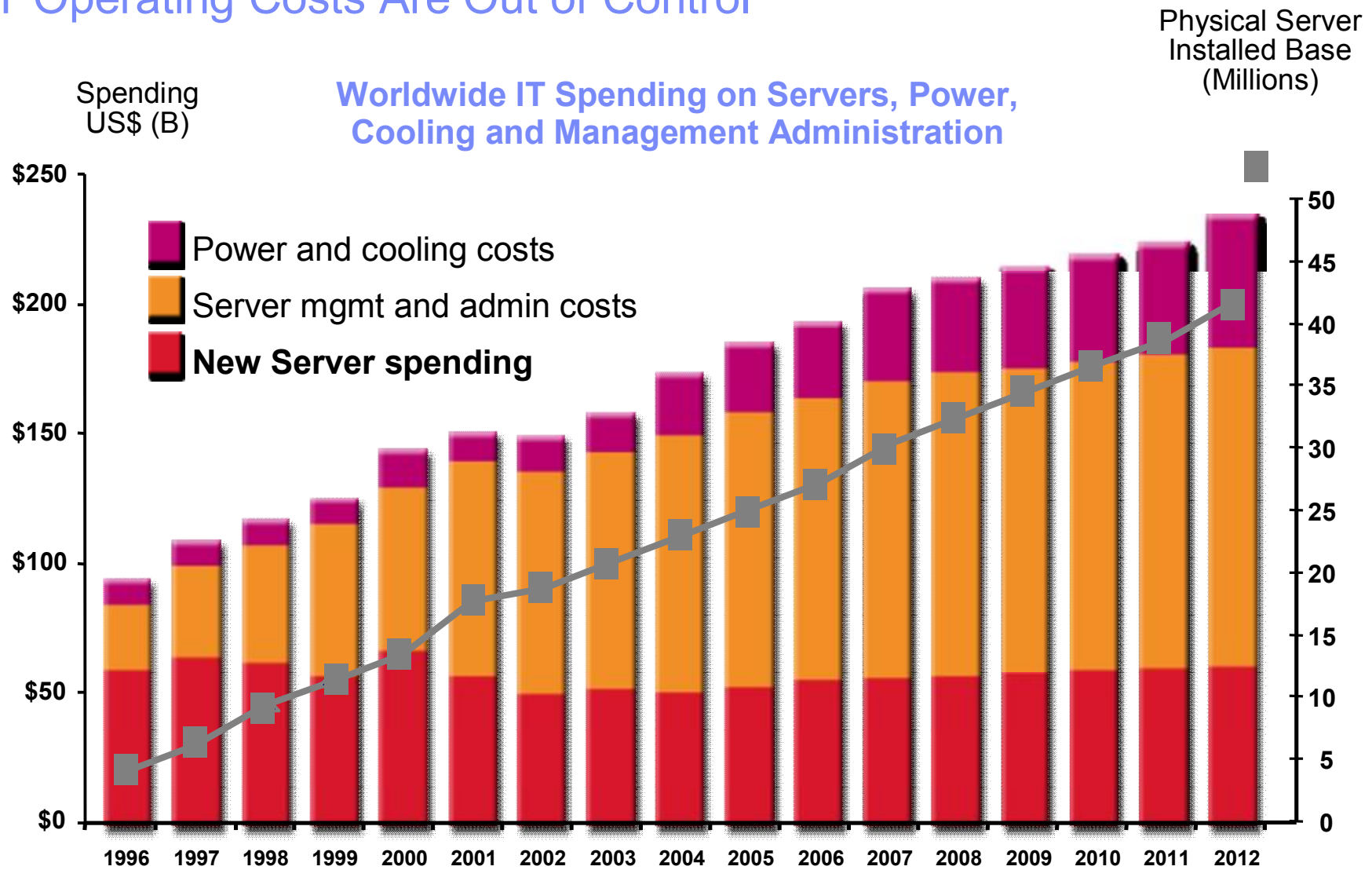
- Large-scale server hosting - potentially hundreds to thousands of server images
- Clone, patch, and “go live” without outage and with easy rollback
- Hot stand-by without the hardware expense
  - Idle backup images ready to run (or be booted) if primary servers fail
- Potentially faster virtual server 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)

## Discussion Topics

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# IT Operating Costs Are Out of Control

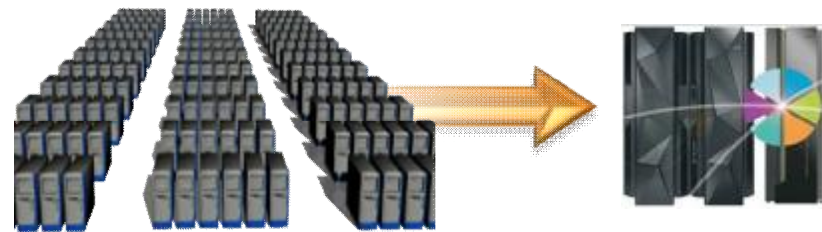


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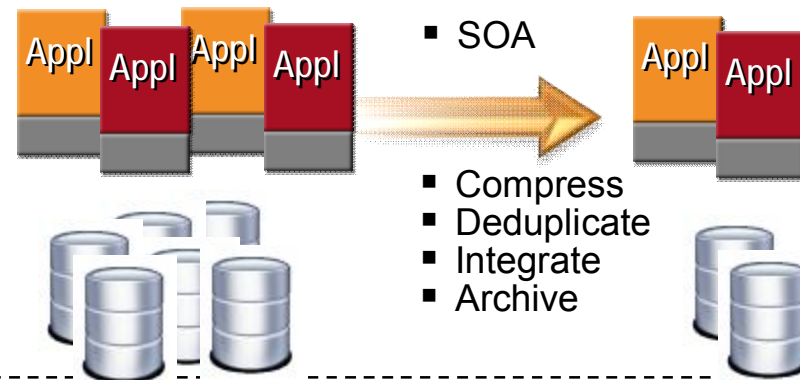
# Strategies to Reduce Costs and Improve Value

## Optimize the Overall IT Environment

**Consolidate Hardware Infrastructure**



**Eliminate Redundant Software and Data**



**Improve Service Delivery**

### Integrated Service Management



Visibility



Control



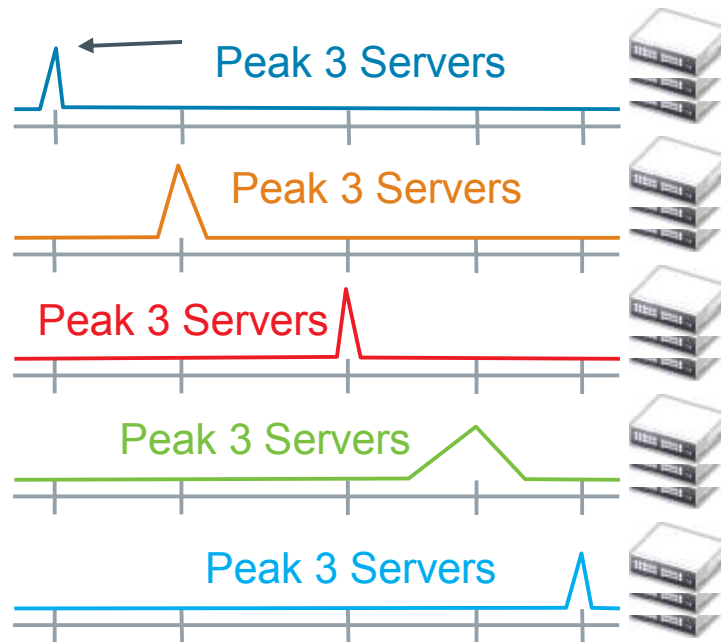
Automation



Cloud Computing

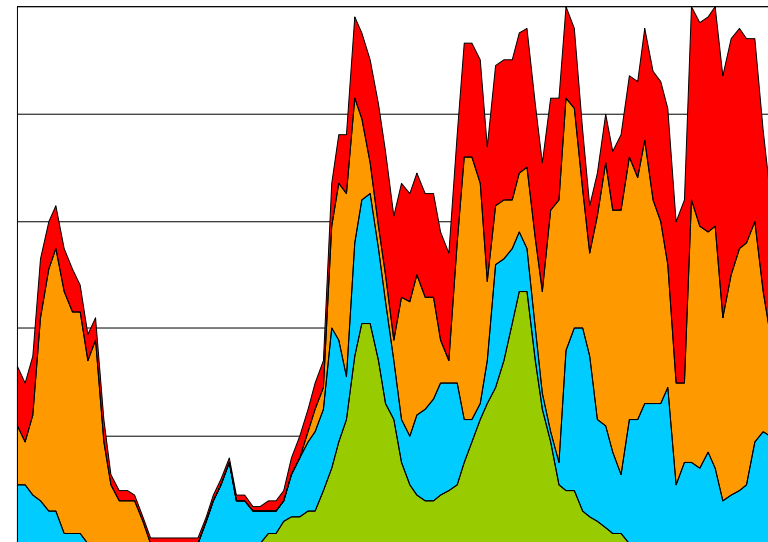
## Why High-End Servers?

### Utilization on x86 systems



According to a study by Gartner, data centers that do not use virtualization have an average server CPU utilization rate of only 15%.

### Mixed Utilization on IBM High End Servers

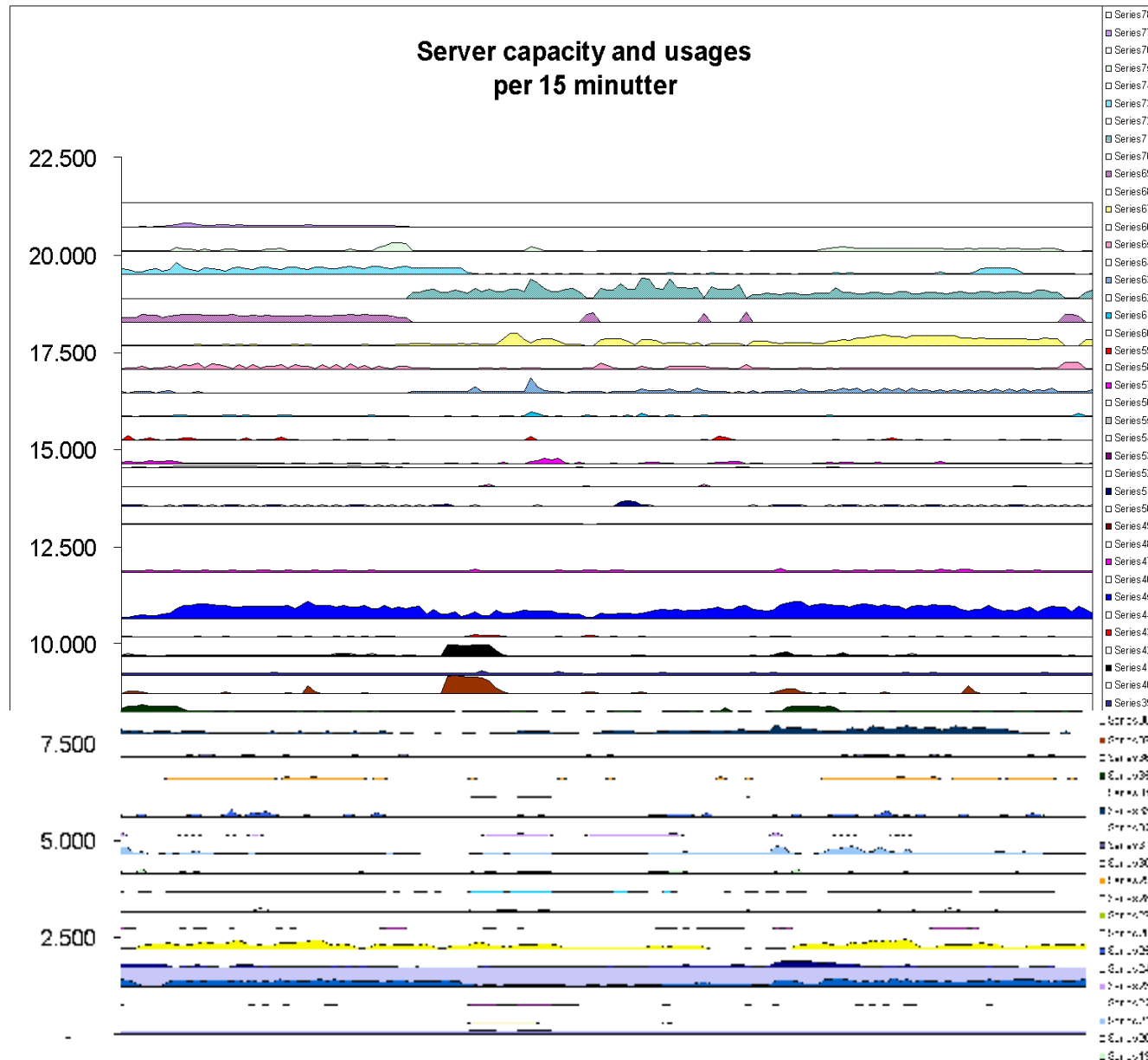


### IBM High End Server: Up to 100% utilization

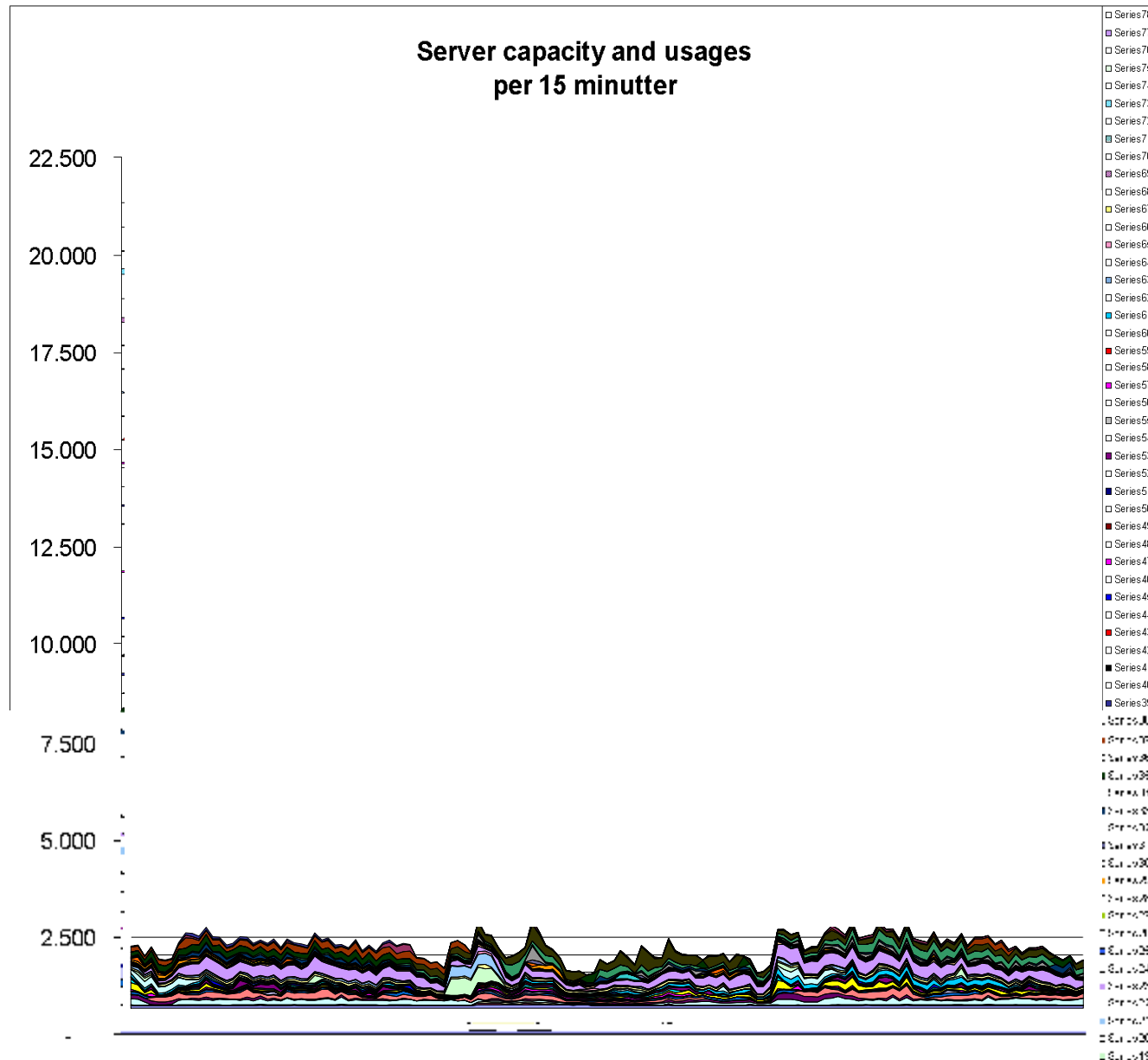
- Highly virtualized and shared resources
- Fewer servers, less power, cooling & admin
- Optimized use of SW assets



**RPE2**  
**(from Ideas International)**



**RPE2**  
**(from Ideas International)**



## 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.

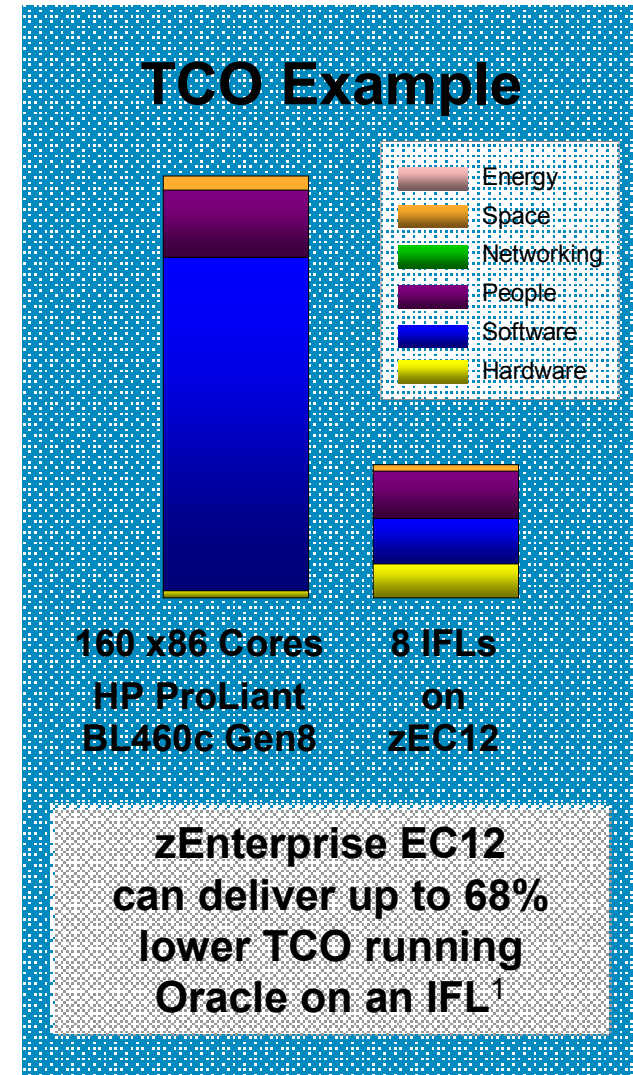
## Optimize and Consolidate for Lower Cost

**Linux on System z** enables a total cost of acquisition of less than **70 cents per day per virtual server<sup>1</sup>**

**Consolidate** up to **60 distributed cores** or more on a single System z core, or thousands on a single footprint<sup>1</sup>.

System z servers often run consistently at **90%+ utilization<sup>1</sup>**

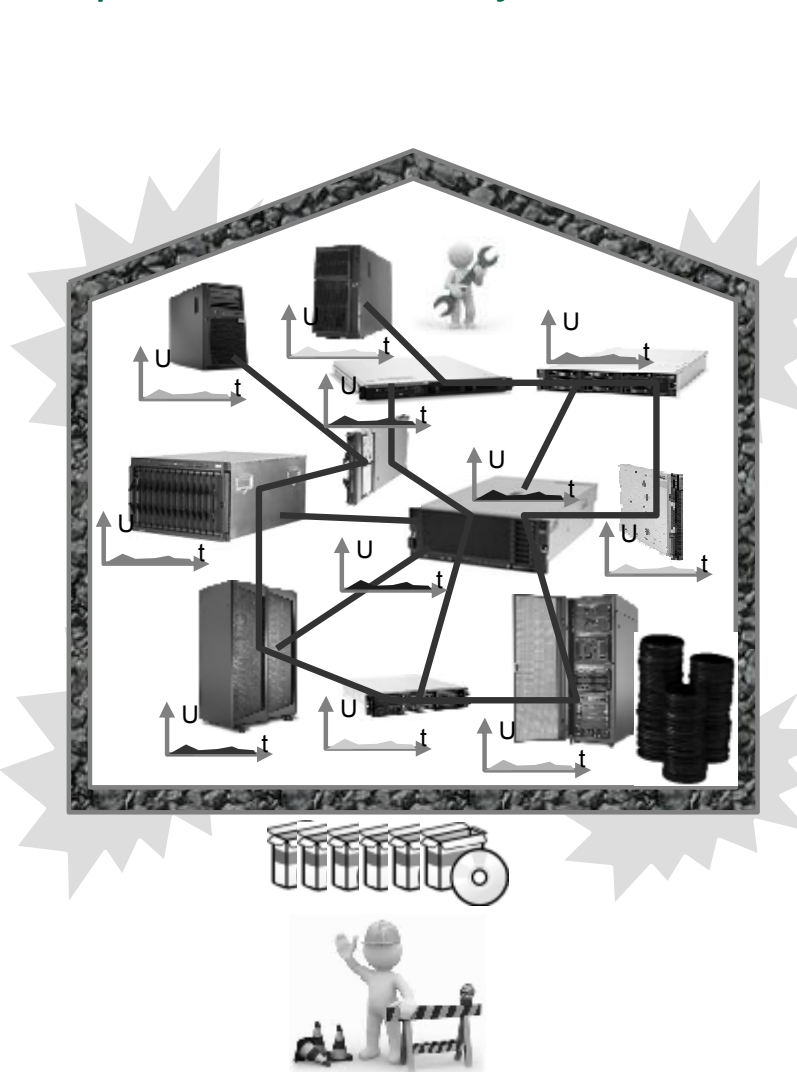
**zEC12:** 25% increase in processor performance further reduces the cost of optimizing deployment of new and existing workloads and large scale consolidation



<sup>1</sup> IBM calculations of zEnterprise limits across maximum z196 configuration. Results may vary. 5-Year Total IT Cost

# Why IT Optimization with zEnterprise

*Improved IT Efficiency and Reduced Costs*



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



## 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.”*

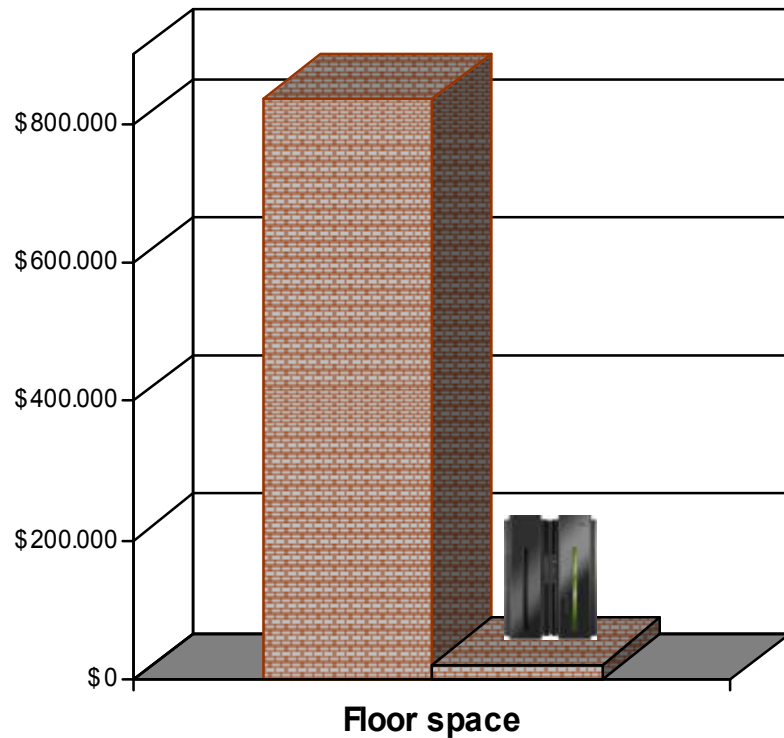
— Guru Vasudeva,  
Nationwide vice president and  
CTO

### **TCO results that Nationwide has experienced:**

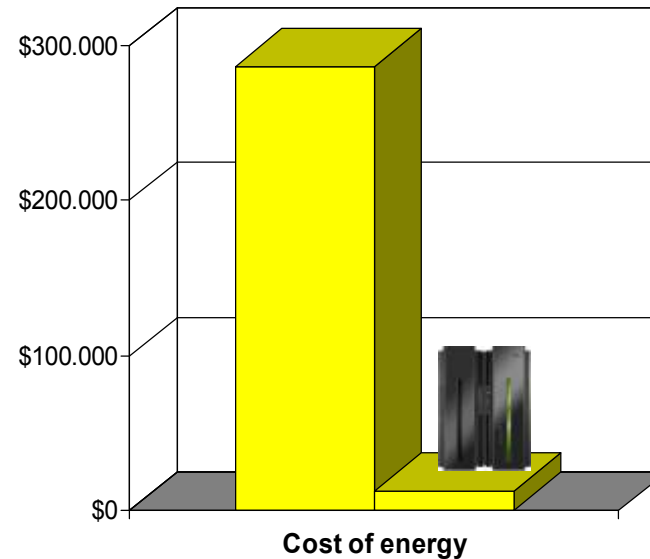
- Monthly Web hosting fees have gone down by 50 percent.
- Hardware and operating system support needs have decremented by 50 percent.
- CPU utilization is up an average of 70 percent, with the elimination of many physical servers with below average utilization.
- Middleware licensing costs for WebSphere, 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](http://www.mainframezone.com/it-management/optimized-computing-nationwides-linux-on-system-z-virtualization-reduces-tco-and-time-to-deploy)

# 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.

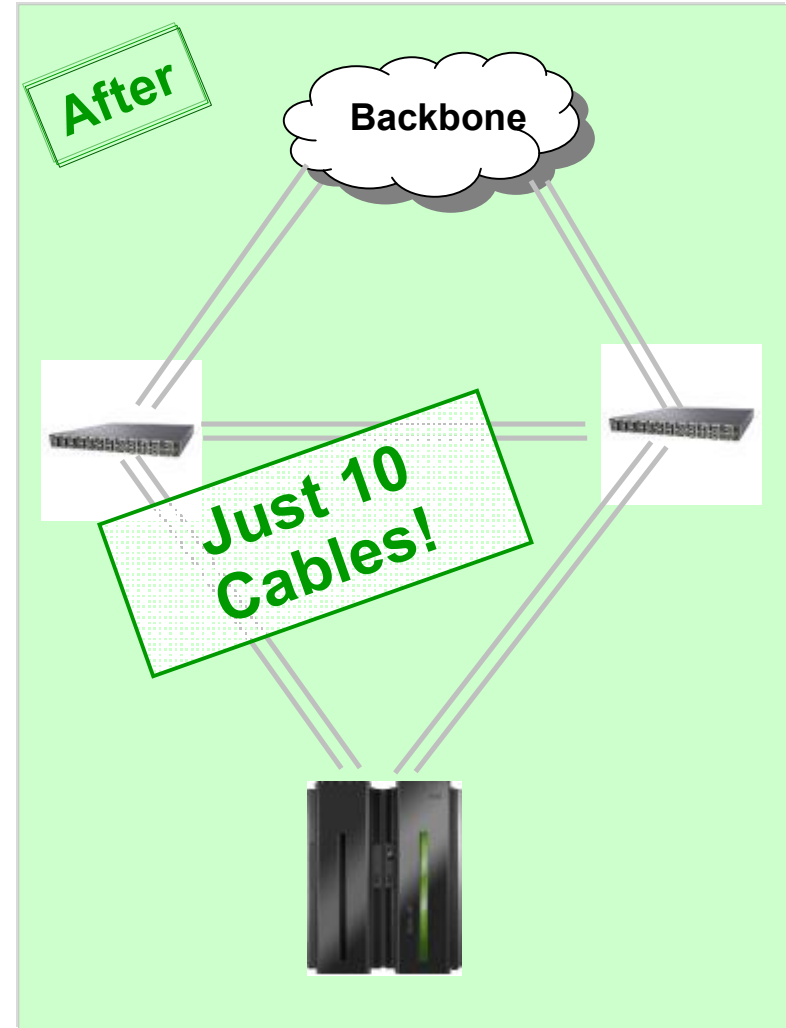
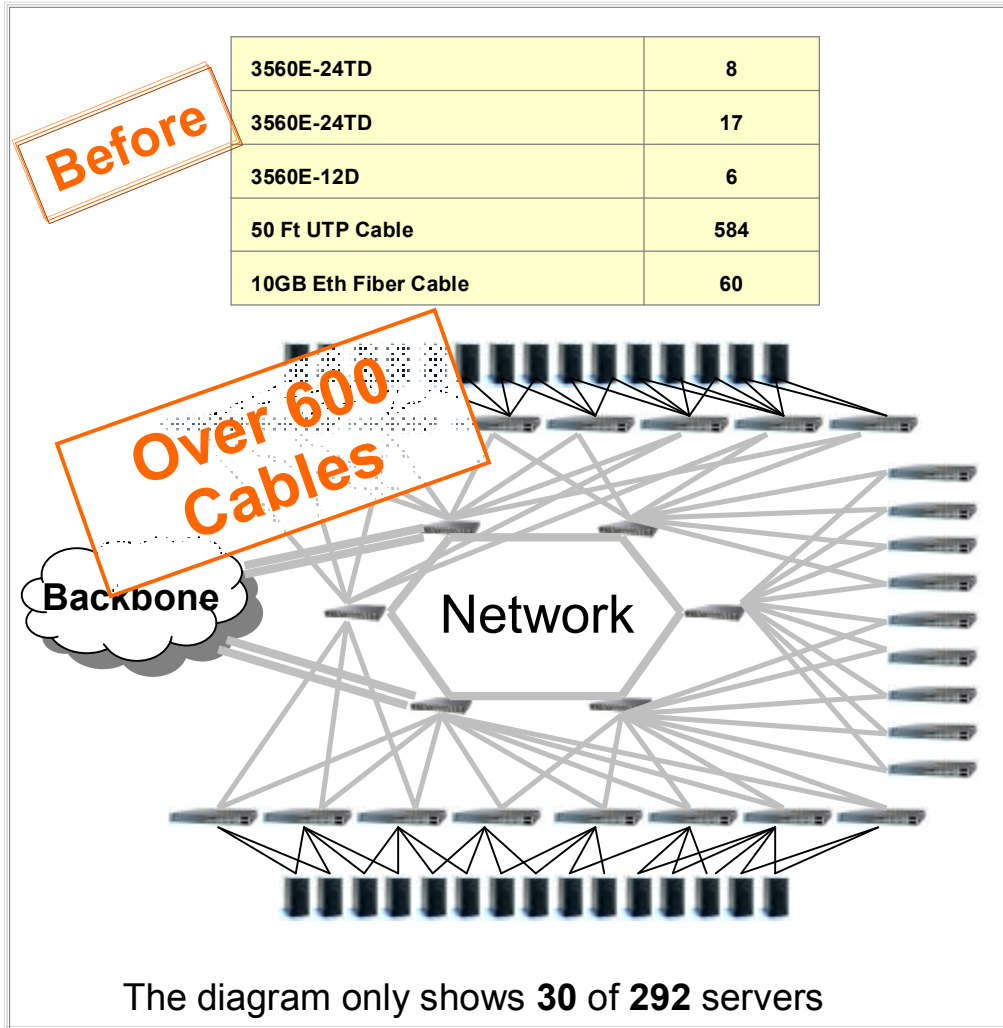


## Bank of New Zealand

- Consolidated 200 Sun servers down to 1 IBM System z10 running Red Hat Enterprise Linux
  - data center footprint
  - heat 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



# Insurance Company Consolidated 292 Servers to a z10



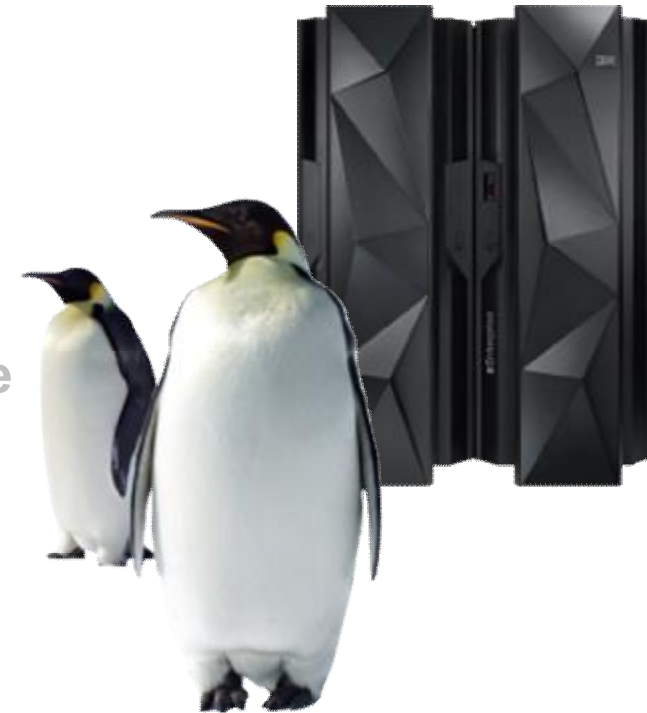
## Summary: Linux on System z advantages

### *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

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- **Fit for purpose**
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## Fit for Purpose



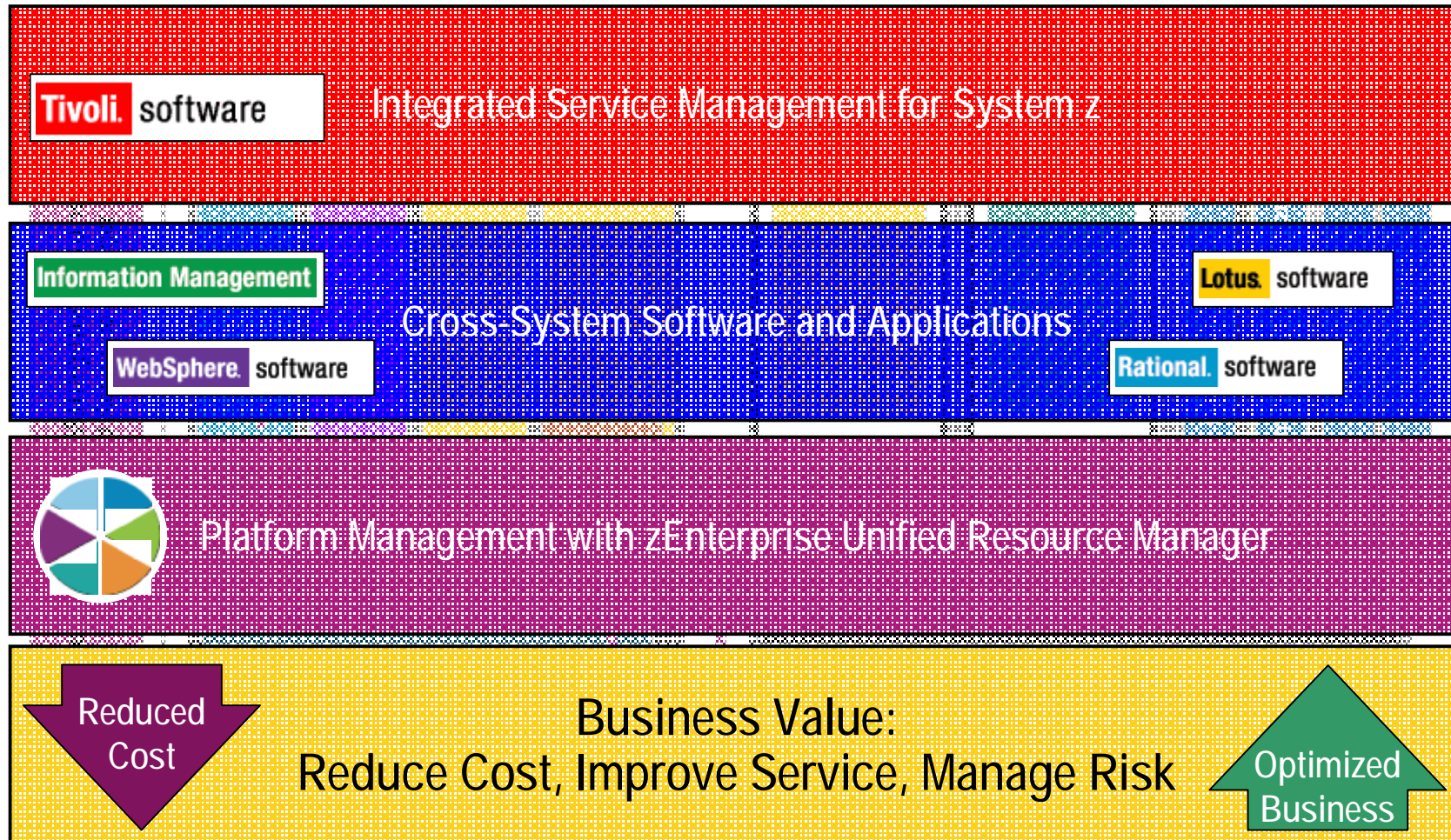
All of these “tools” can very quickly move a person from one place to another.  
But, which one is the right tool to move one person?  
Fifty people? Five hundred people?

*Platform Selection Is All about Using the Right Tool for the Right Job*



**Workload optimized systems**

## Workload Optimization with Operational Certainty and Efficiency Using zEnterprise for “Best Fit” Cloud Computing



## More Choice with Linux on System z and zBX

### Linux on System z

- Highly virtualized with z/VM hypervisor
  - Highest flexibility
  - Supports large number of virtual servers (no architecture limitation)
- Excellent dynamic management of resources
- High level of integration with other System z environments (e.g. z/OS, z/VSE)
  - HiperSockets (data transfer in memory), optionally same disk environment (integration of backup, DR) and more

### zEnterprise BladeCenter Extension (zBX)

- Integration of Linux on System x and AIX on POWER Blades
  - Unified management with zEnterprise Unified Resource Manager
  - Supports integration of heterogeneous application environments
- High-performance optimizers and appliances for fast analysis and reduced cost

*zEnterprise is the beginning of a new generation of System z  
... expect more to come!*



## Value of hybrid computing

– Business Application



**zBX with Power  
and x86 Blades**

– IT Consolidation



**Linux on z  
ELS, SEEL, IFL & z/VM**



– Analytics & BI



**IBM 9700, 9710  
and IDAA**



– Application Innovation



**zBX with DataPower  
XI50z**

- Systems Centers will support customer requests for benchmarks and proof-of-concepts
- Customer success stories

## Workload Optimized Platform Selection

- **Fitness for **functionality**** – Does the code support this and/or that platform
- **Fitness for **non functional requirements**** – How well does it run on each platform
  - ▶ Security / Availability / Disaster Recovery
  - ▶ Scalability / Performance
  - ▶ Maintainability / Serviceability
  - ▶ Future growth
- **Fitness to meet **local needs**** – How well does this or that meet MY needs
  - ▶ Will this platform run my solution?
  - ▶ What will it cost me?
  - ▶ How well will it run?
  - ▶ Can I operate and manage it well enough?
  - ▶ Is this platform effective for the application scope?
  - ▶ Is this solution shared or dedicated to a single business process?
    - Beware the hidden cost of sub-optimization.
    - Be aware of cost dynamics.
    - Large, reliable servers are best for virtualization.
    - Don't trust benchmark results that scale “nearly linearly”.



## Complete Range of IT Cost Factors

Cost factors highlighted in yellow are the only ones that organizations routinely assess.

Full Range of IT Cost Factors			
<b>Availability</b> <ul style="list-style-type: none"> <li>High availability</li> <li>Hours of operation</li> </ul>	<b>Additional development and implementation</b> <ul style="list-style-type: none"> <li>Investment for one platform – reproduction for others</li> </ul>	<b>Security</b> <ul style="list-style-type: none"> <li>Authentication and authorization</li> <li>User administration</li> <li>Data security</li> <li>Server and OS security</li> <li>RACF versus other solutions</li> </ul>	<b>Controlling and accounting</b> <ul style="list-style-type: none"> <li>System analysis</li> <li>Cost</li> </ul>
<b>Backup/restore/site recovery</b> <ul style="list-style-type: none"> <li>Backup</li> <li>Disaster scenario</li> <li>Restore</li> <li>Effort for complete site recovery</li> <li>Storage area network (SAN) effort</li> </ul>	<b>Operations</b> <ul style="list-style-type: none"> <li>Monitoring and operating</li> <li>Problem determination</li> <li>Server management tools</li> <li>Enterprise-wide integrated server management</li> </ul>	<b>Operating concept</b> <ul style="list-style-type: none"> <li>Development of an operating procedure</li> <li>Feasibility of the developed operating procedure</li> <li>Automation</li> </ul>	<b>Integration</b> <ul style="list-style-type: none"> <li>Integrated functionality versus functionality to be implemented (possibly with third-party tools)</li> <li>Balanced system</li> <li>Integration of and into standards</li> </ul>
<b>Infrastructure</b> <ul style="list-style-type: none"> <li>Space</li> <li>Power</li> <li>Network infrastructure</li> <li>Storage infrastructure</li> <li>Initial hardware costs</li> <li>Software costs</li> <li>Maintenance costs</li> </ul>	<b>Resource utilization and performance</b> <ul style="list-style-type: none"> <li>Mixed workload/batch</li> <li>Resource sharing: shared nothing versus shared everything</li> <li>Parallel Sysplex versus other concepts</li> <li>Response time</li> <li>Performance management</li> <li>Peak handling and scalability</li> </ul> <b>Skills and resources</b> <ul style="list-style-type: none"> <li>Personnel education</li> <li>Availability of resources</li> </ul>	<b>Deployment and support</b> <ul style="list-style-type: none"> <li>System programming <ul style="list-style-type: none"> <li>Consistent OS and software levels</li> <li>Database effort</li> </ul> </li> <li>Middleware <ul style="list-style-type: none"> <li>Software maintenance</li> <li>Software distribution across firewalls</li> </ul> </li> <li>Application <ul style="list-style-type: none"> <li>Technology upgrade</li> <li>System release change without interrupts</li> </ul> </li> </ul>	<b>Further availability aspects</b> <ul style="list-style-type: none"> <li>Planned outages</li> <li>Unplanned outages</li> <li>Automated takeover</li> <li>Uninterrupted takeover (especially for databases)</li> <li>Workload management across physical borders</li> <li>Business continuity</li> <li>Availability effects for other applications or projects</li> <li>End user service</li> <li>End user productivity</li> <li>Virtualization</li> </ul>

## “Best Fit” Applications for Linux on System z

- WebSphere MQ
- DB2 Connect™
- CICS® Transaction Gateway
- IMS™ Connect for Java
- Oracle Database
- SAP application server
- WebSphere and Java Application Development Platform
- Rapid Application Deployment (RAD) Platform
- Domino
- Network Infrastructure
- Applications that require easy and rapid failover functionality
- Communications Server
- Communication Controller for Linux (CCL)
- Lightweight Directory Access Protocol (LDAP) Security Services
- Information Builders (IBI) WebFOCUS
- Cognos® Business Intelligence (BI)
- Communigate Pro
- Tivoli Storage Manager (TSM)



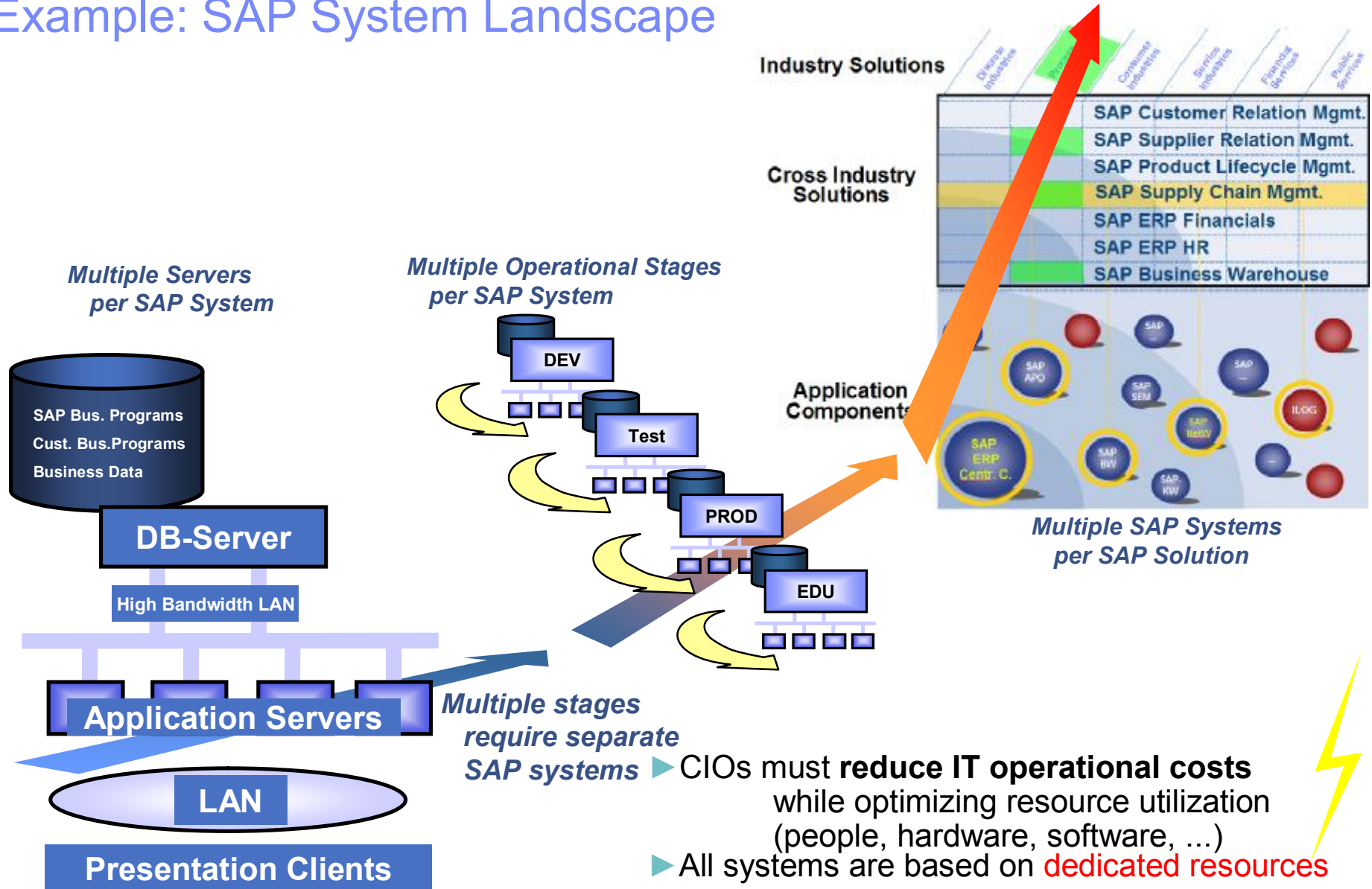
- DB2 Linux, UNIX, and Windows (DB2 LUW)
- Informix Dynamic Server (IDS)
- Apache Web server
- Samba
- LDAP Security Services



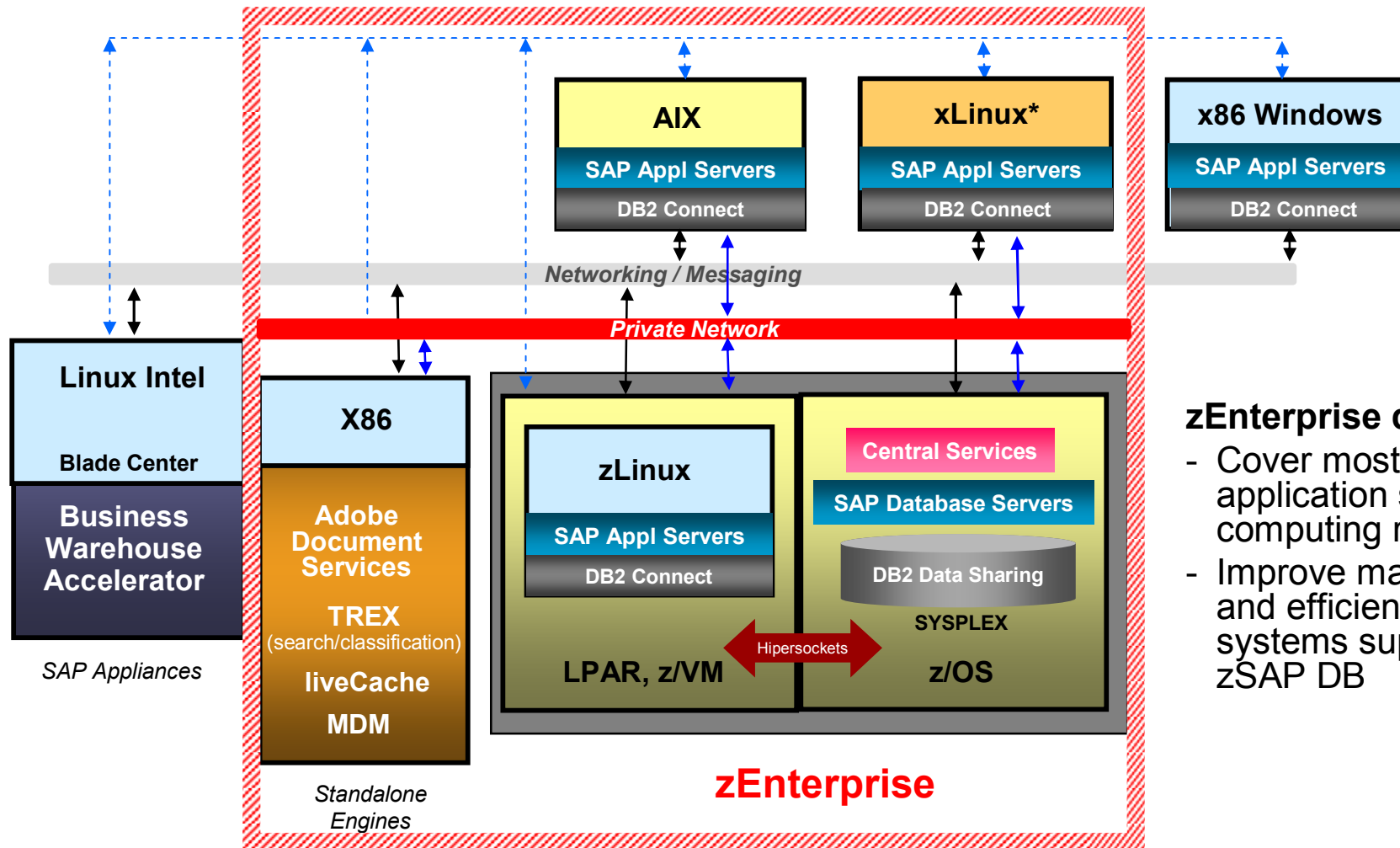
- ISV and IBM applications that are not yet ported to run on Linux on System z
- Applications that by design run at very high sustained utilization, defined here as greater than 98%
- A stand-alone, single application that is the only Linux on System z application, with no plans for further utilization
- Applications that are too internally sensitive to move



# Example: SAP System Landscape



# zEnterprise and SAP



### zEnterprise does:

- Cover most of the SAP application server computing requirements
- Improve management and efficiency of non-z systems supporting a zSAP DB

\*Statement Of Direction

## The Home Depot - SAP on System z

Second largest retailer in the United States with over 1800 stores, 300,000 employees and around 1.2 billion customer transactions a year. Revenue 90 Billion.

### Customer Objectives:

- Very high SLA – for managing the stores
- TCO equivalent to Unix/Windows systems
- Disaster Recovery
- Automated Management, Provisioning, Administration & Support
- Growth without adding staff
- Replace and Centralize store systems

### Solution:

- Migrated SAP R/3 to DB2 on z/OS
- Near continuous operations
- Moving application servers to Linux on z for easy provisioning and fast disaster recovery
- Flexible use of resources allows them to add capacity without disruption, and dynamically change priorities based on time of day, or application

### Benefits:

- Scalability to support over 1 Billion transactions/year
- Ability to support SAP and Business warehouse, enables access to P&L, and daily sales targets
- Low TCO
- Low unit cost /work
- Low staffing costs
- Faster time to market for new offerings in stores

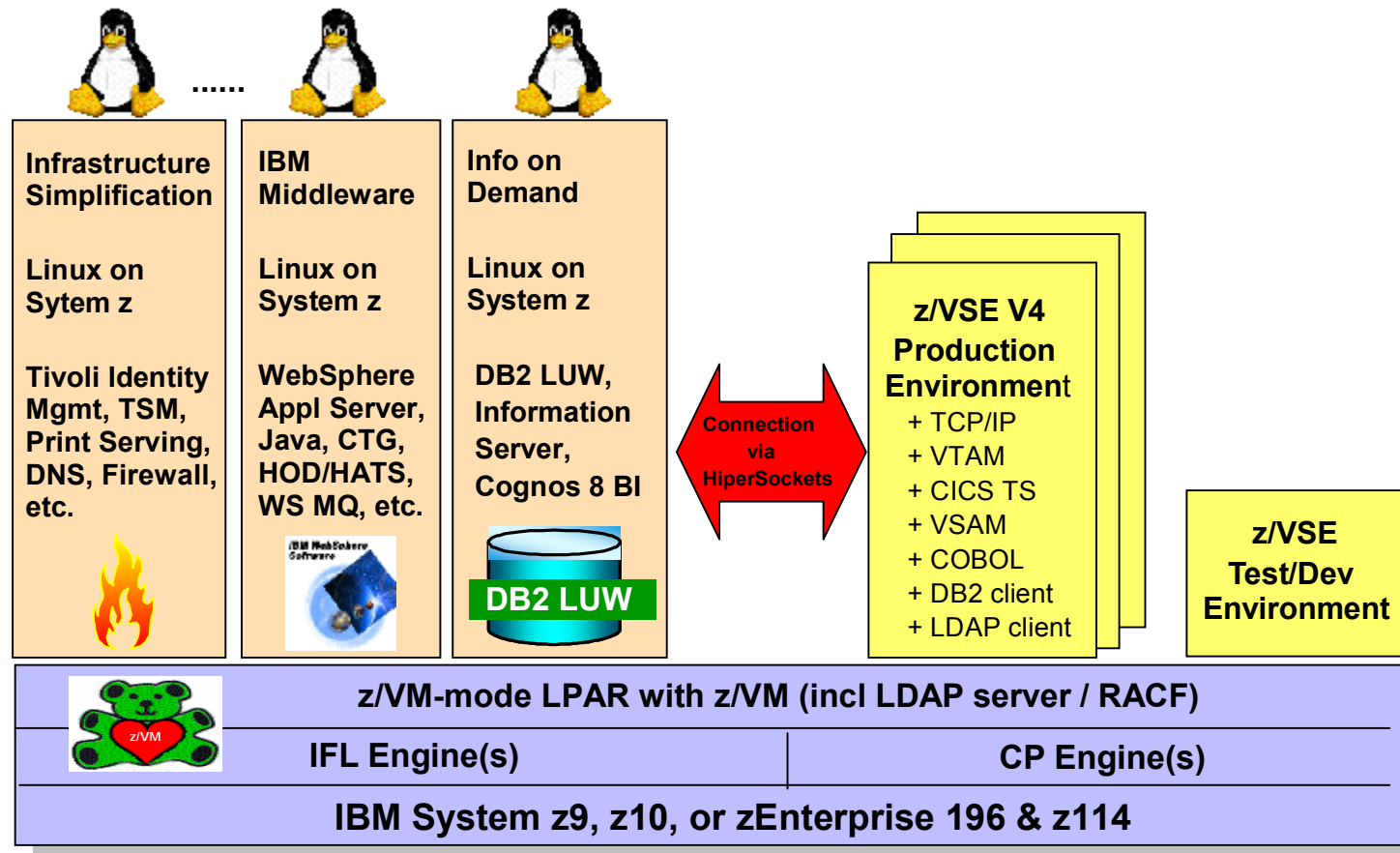


*“Continuous availability and manageability are the design principles of our IT architecture. We’re proud of our ability to fail-over without data loss in a very short period of time. The improved availability and disaster recovery capabilities delivered by running the SAP applications on Linux for System z provide an extra layer of insurance against potentially damaging and expensive outages.”*

**Clifford W. Gum; SAP Technical Architect, The Home Depot**

## z/VSE Strategy: Leveraging z/VSE, z/VM, and Linux on System z

**P**rotect existing VSE investments  
**I**ntegrate using middleware and VSE connectors  
**E**xtend with Linux on IBM System z technology & solutions



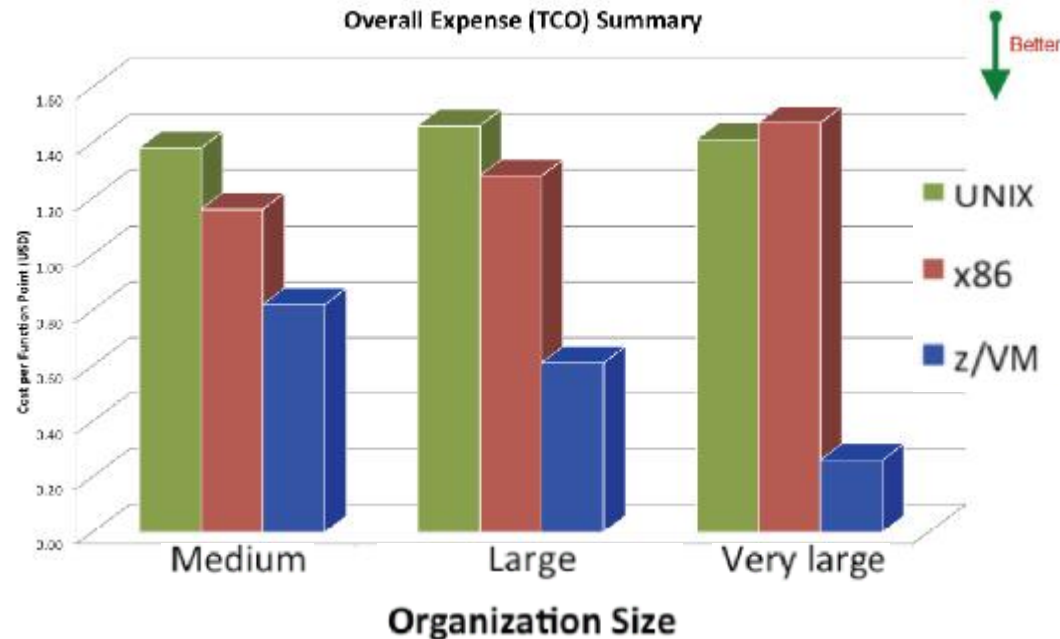
## Discussion Topics

- 12 years of Linux on System z
- The Enterprise Linux Server
- Strategies to reduce cost and improve value
- Fit for purpose
- **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. Virtualizing provides both an isolation and prioritization of resources that allows a single platform to function as if 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. (SIG) 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.

Telephone: 800.821.3800  
Website: www.sig-int.com

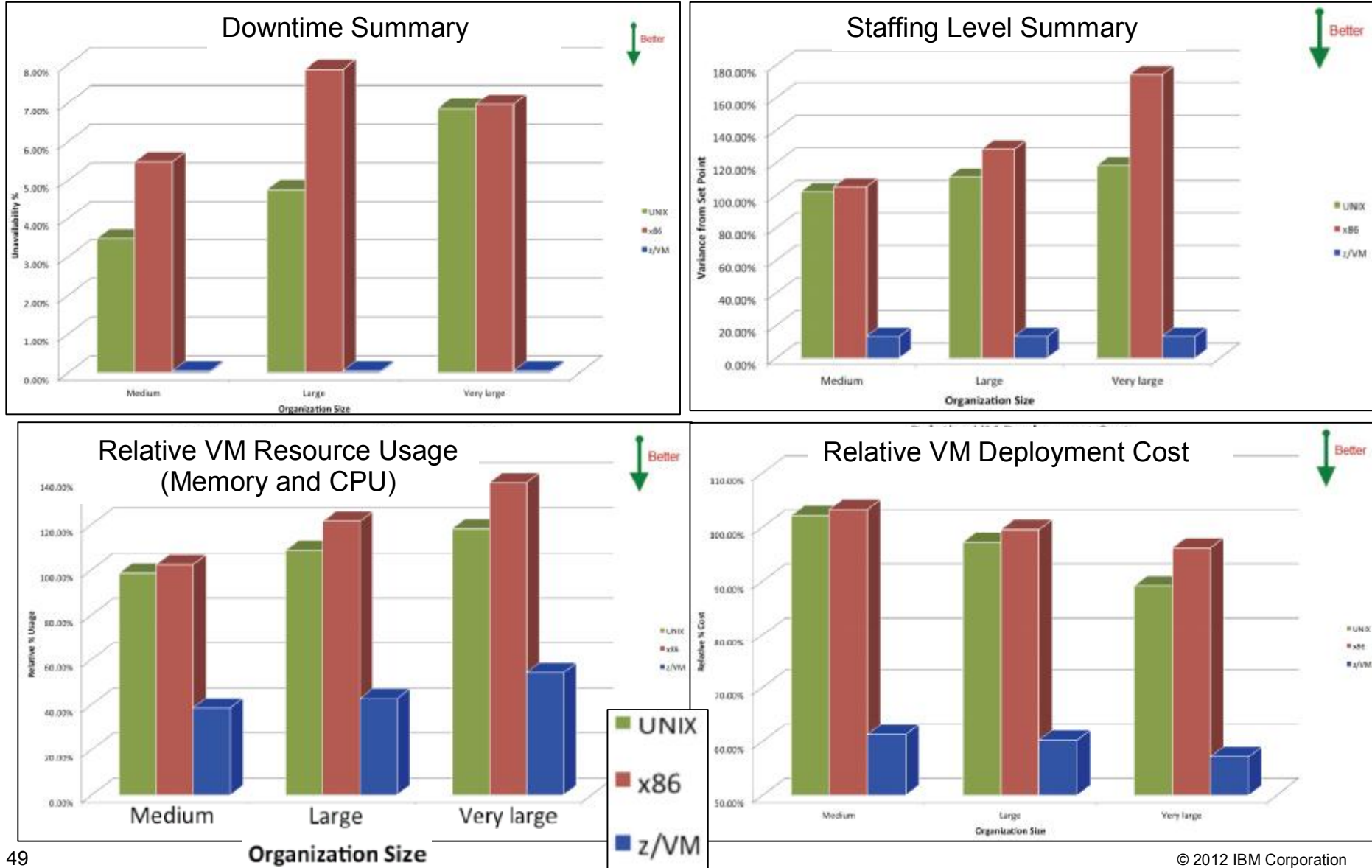
150 South Western Avenue, # 200  
Carpentersville, Illinois 61010

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[http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=WH&infotype=SA&appname=STGE\\_ZS\\_ZS\\_USEN&htmlfid=ZSL03192USEN&attachment=ZSL03192USEN.PDF](http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=WH&infotype=SA&appname=STGE_ZS_ZS_USEN&htmlfid=ZSL03192USEN&attachment=ZSL03192USEN.PDF)

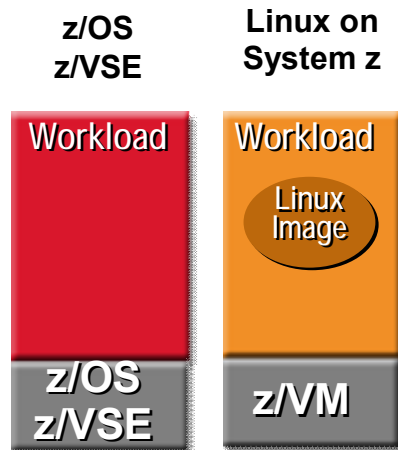


# Solitare Interglobal study

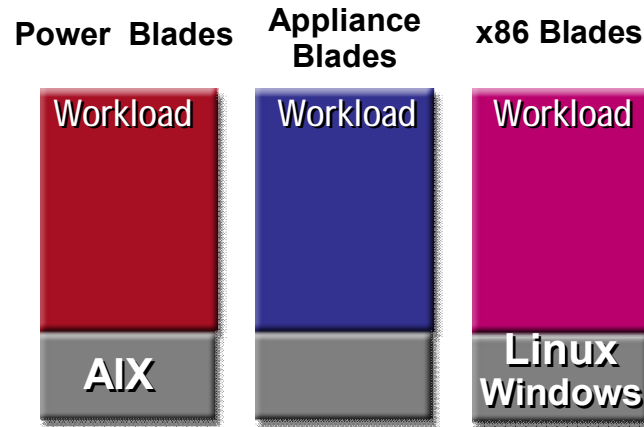


# zEnterprise

## Broadest Architectural Support for Cloud Computing



zEnterprise zEC12, z196 or z114



zEnterprise BladeCenter Extension (zBX)

### Fit-for-Purpose Strategy

- Assign workloads to the environment that best satisfies requirements

### Integrated Service Management

- Visibility
- Control
- Automation

*Achieves overall lowest cost per workload*

# SMARTER COMPUTING

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



**Doing More for Less**

# Questions?



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