

The Art of the Possible - Linux Workload Consolidation on System z

Increasing Operational Efficiencies and Driving Cost Savings

February 2011



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Competitive Consolidation Yields Great Business Outcomes!

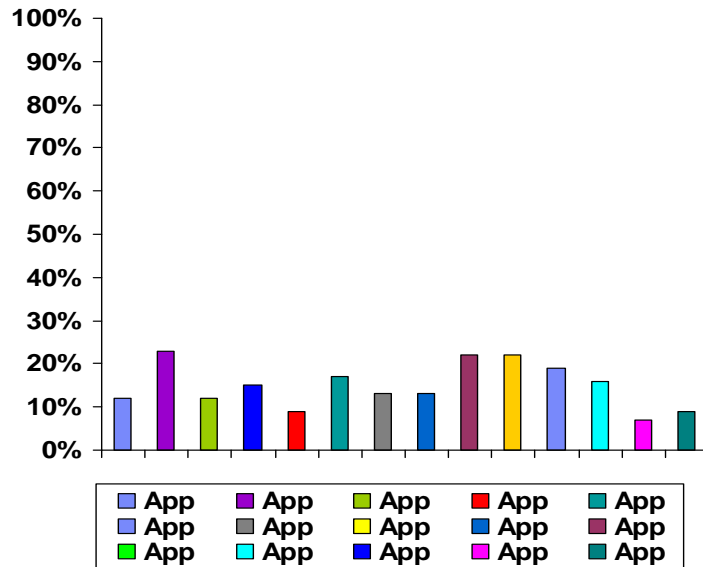
The most efficient platform for large-scale Linux consolidation

Customer	Distributed Cores	Ratio of Distributed to IBM System z [®] cores	Additional Benefits
Insurance Company	60	30 to 1	48 hour migration!
Government Agency	292	58 to 1	70% cost savings!
Large Bank	200	50 to 1	\$9M savings, fast migration w/GTS services
Bank in Russia	200	50 to 1	Reduced payment processing costs by 95%
Trading Company		40 to 1	Scale and availability

**These are all IBM System z10[®] consolidations.
Imagine possibilities with IBM zEnterprise[™]!**

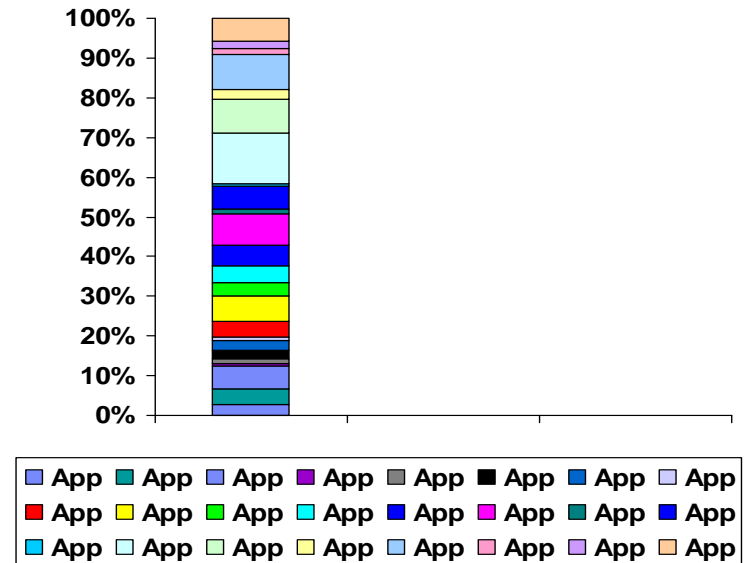
Maximizing Utilization of Resources with IBM System z

Moderate distributed servers



Typically single application per physical server

Up to 100% utilized System z server

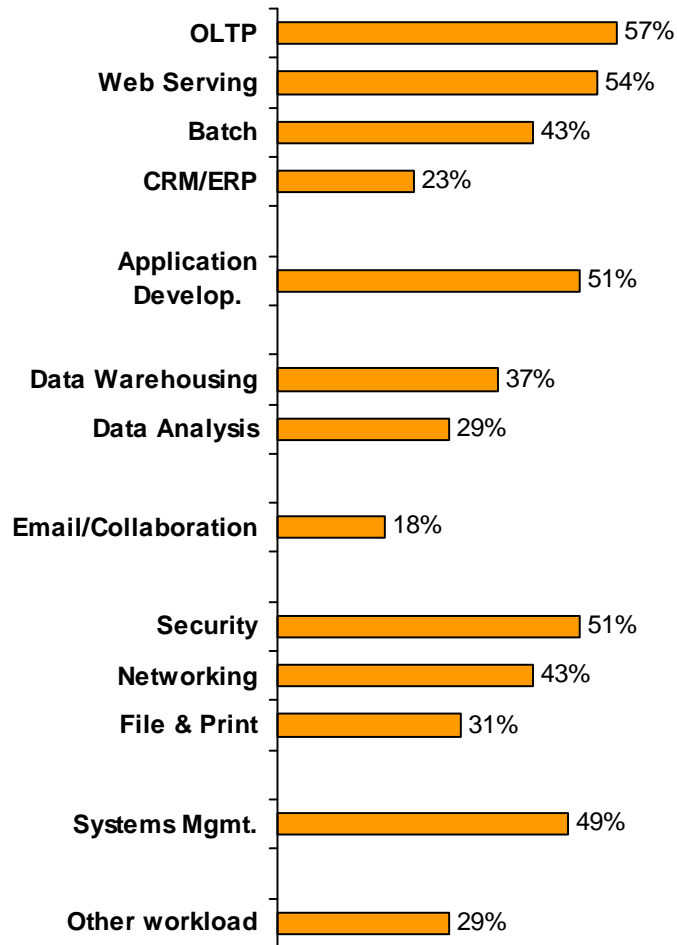


Many applications on one physical System z server

- Up to 100% server utilization compared to 10-20% distributed server utilization*
- Shared everything infrastructure allows for maximum utilization of resources
 - Processors, Memory, Network, Adapters, Cryptography, Devices

* Source: gomainframe.com Joe Clabby

Consolidate what?



Percentage of survey respondents

Source: 4Q2010 IBM Market Intelligence

Customers use Linux® on System z for:

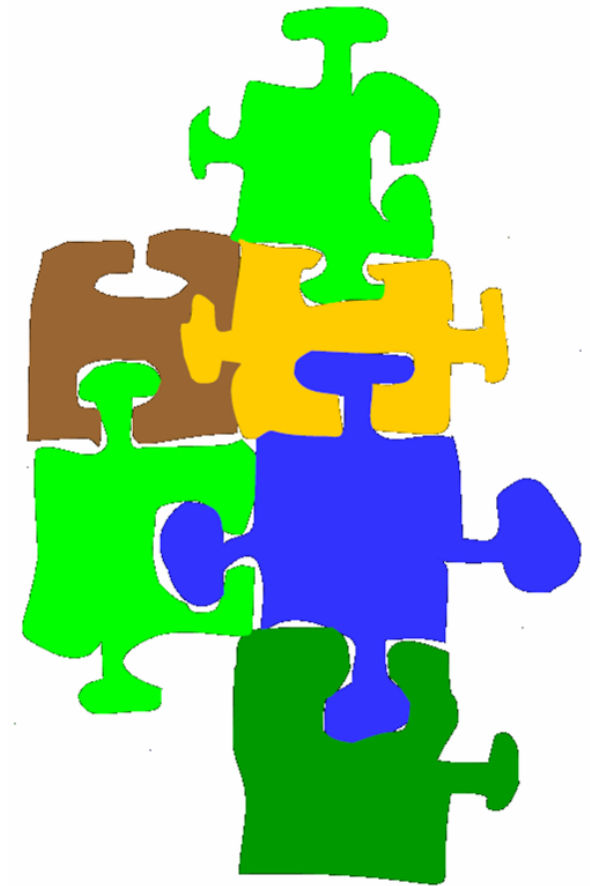
- Application Serving (OLTP, Web, ERP, etc.)
- Application Development
- Data Serving (Warehousing & analytics)
- Infrastructure Serving (Security, file, print, etc.)

Recommended “best fit” workloads:

- **Business critical applications:** WebSphere®, SAP, Oracle E-Business Suite, ...
- **Development & test:** e.g. of WebSphere / Java™ applications
- **Data services:** Cognos®, DB2®, InfoSphere®, Oracle, Informix®, Builders WebFOCUS
- **Email & collaboration:** Lotus Domino®, Lotus® Collaboration products, Web 2.0
- **Network Infrastructure:** FTP, NFS, DNS, etc.,
Business connectors: WebSphere MQSeries®, DB2 Connect™, CICS® Transaction Gateway,
Security Services: Firewall, Proxy, etc.

What Makes A Best Fit Workload for Linux on System z?

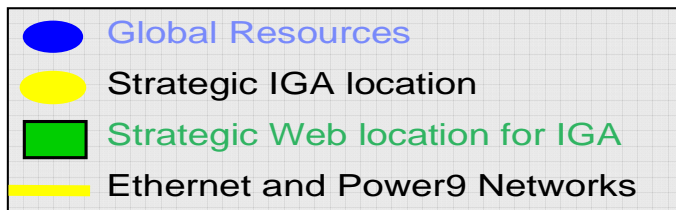
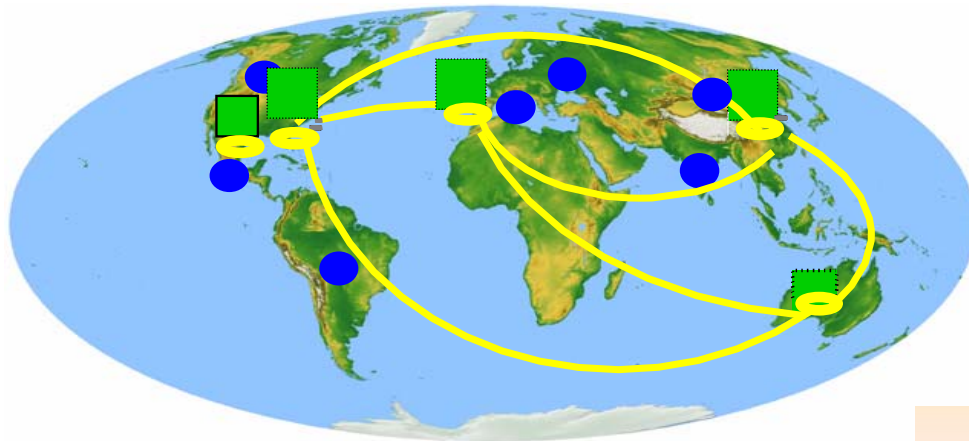
- **Leverage classic strengths of the System z**
 - High availability
 - High i/o bandwidth capabilities
 - Flexibility to run disparate workloads concurrently
 - Requirement for excellent disaster recovery capabilities
 - Security
- **Shortening end to end path length for applications**
 - Co-location of applications
 - Consolidation of applications from distributed servers
 - Reduction in network traffic
 - Simplification of support model
- **Consolidation Effect**
 - **Power requirements**
 - **Software costs**
 - **People Costs**
 - **Real Estate**
 - **Workloads requiring EXTREME Flexibility**



Real Case: IBM's Transformation

We recommend to our customers what we do to improve our business

IBM Strategic Delivery Model



IBM Metrics	1997	Today
CIOs	128	1
Host data centers	155	7
Web hosting centers	80	5
Network	31	1
Applications	15,000	4,700

Tactical and operational efficiencies

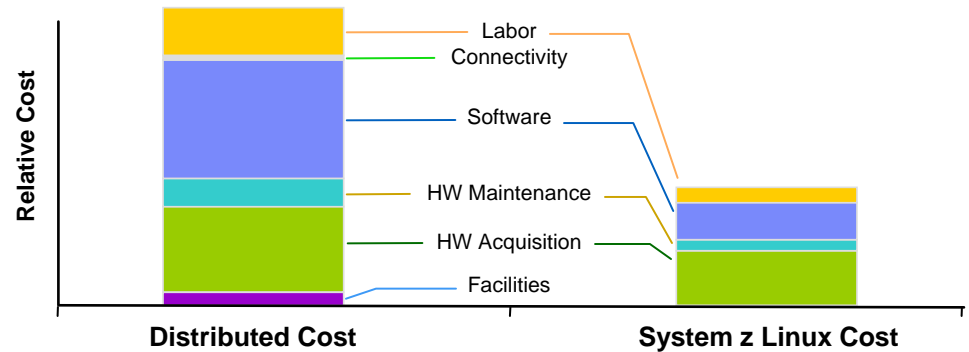
- Consolidation of infrastructure
- Application consolidation/reduction
- Global resource deployment
- Enterprise end-to-end architecture optimization

IBM TCO Comparison Distributed Versus Linux on System z

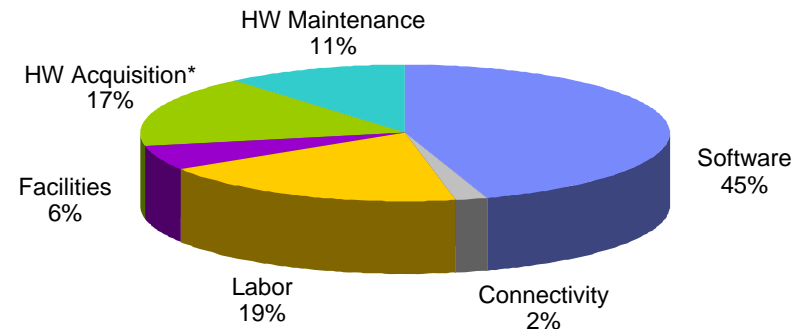
Unit	Distributed	System z Linux	% Reduction
Software Licenses	26,700	1,800	93%
Ports	31,300	960	97%
Cables	19,500	700	96%
Physical Network Connections	15,700	7,000	55%

Results will vary based on several factors including # of servers and work load types

Operating Cost: Distributed vs. Mainframe



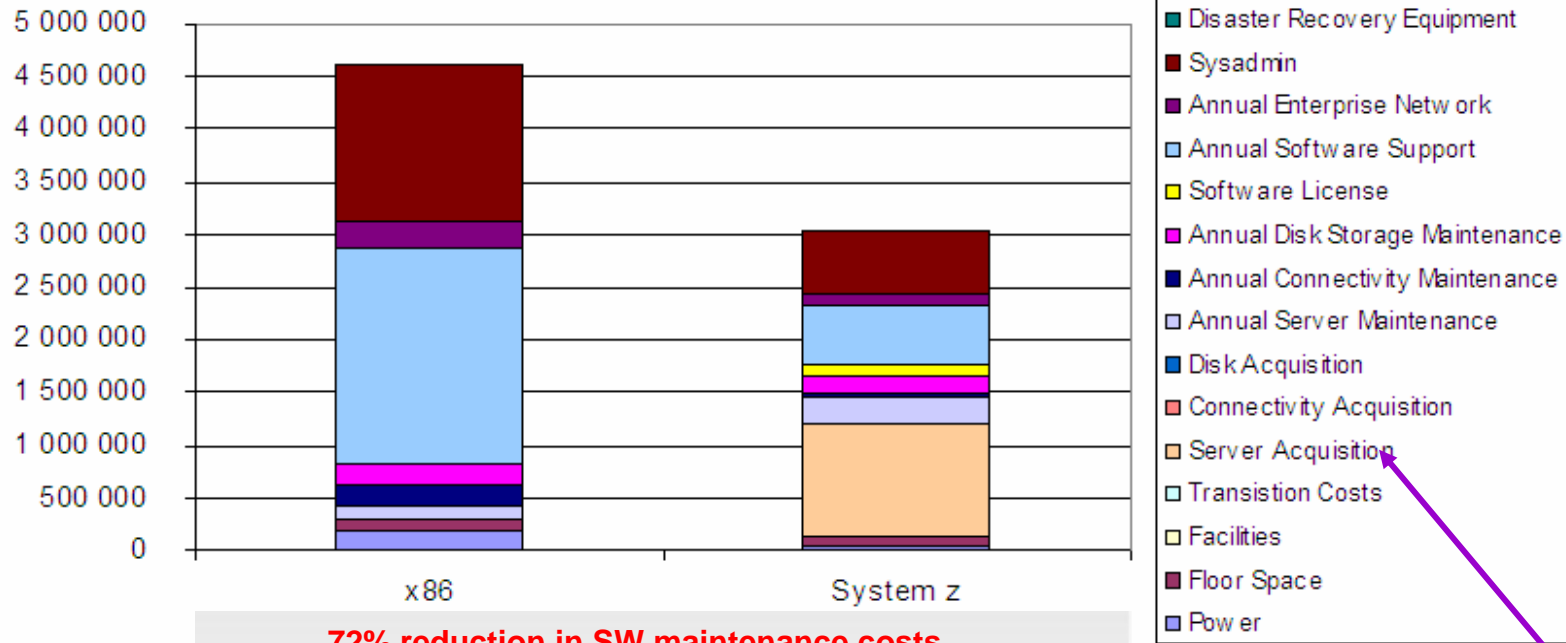
Potential Savings: Categories as a % of Gross Savings



* HW Acquisition compares server/disk refresh of distributed environment to the cost of acquiring new mainframes/storage

Actual Customer Saves \$1.5M with Oracle on 1 System z vs. 45 Oracle x86 Servers!

5-year Costs Distribution



72% reduction in SW maintenance costs
95% reduction in connectivity costs
75% reduction in power/cooling costs
60% reduction in System Admin costs

Note: Upgrade required for mainframe; Dell and HP were existing HW

5-year Cost Comparison	1st Year	2nd Year	3rd Year	4th Year	5th Year
x86	923 625	1 847 250	2 770 874	3 694 499	4 618 124
System z	1 482 559	1 871 822	2 261 085	2 650 348	3 039 611
Delta	558 934	24 572	-509 789	-1 044 151	-1 578 513

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.

Large Bank Reduces Space, Energy Requirements and Saves \$1.5M + (Details for Previous Chart)

	FROM ...	TO ...
Current hardware infrastructure	45x86 (HP + Dell)	IBM System z10 Enterprise Class (z10™ EC)
Footprints	45	1
Cores	111	4 IFLs
Avg utilization	Less than 10%	60%
Peak utilization	35%	85%
# DBs, size of DB	111 Oracle DB	111 Oracle DB
Application	Oracle 10G databases	Oracle 10G databases
OS	Linux	Linux + z/VM®
Energy usage		75% less
Floor Space usage		28% less
TCO: 5 years	\$4.62M	\$3.04M / savings: \$1.58M

Summary of Benefits:

- 111 to 1 core reduction, 27:1 footprint reduction
- Up to 72% software maintenance cost reduction
- Improved application reliability, and efficient Disaster Recovery capabilities

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Banking client solves environment, space and cost issues - an expected 20% cost reduction

	FROM ...	TO ...
Current hardware infrastructure	Sun SPARC	z10 (+ z9 for use as a disaster recovery machine)
Footprints	131 (v440s, v280Rs, E10Ks)	1
Cores		3 IFLs
Application	Customer facing banking systems, including Internet banking and teller platforms (IBM WebSphere application and IBM Process server, along with customised Java applications)	Customer facing banking systems, including Internet banking and teller platforms (IBM WebSphere application and IBM Process server, along with customised Java applications)
OS	Solaris	Linux + z/VM
Energy and Space		
Power (kWhr)	36 kWhr	22 kWhr -> 38% less
Heat (kBTUs/hr)	110 kBTUs/hr	74 kBTUs/hr -> 33% less
Space (Racks)	6,5 racks	4,5 racks -> 31% less
CO2 (Tonnes)	66 tonnes	40 tonnes -> 39% less

Summary of Benefits:

- Maximize space, keep costs down and reduce carbon footprint
- Boost the speed and simplicity of new deployments

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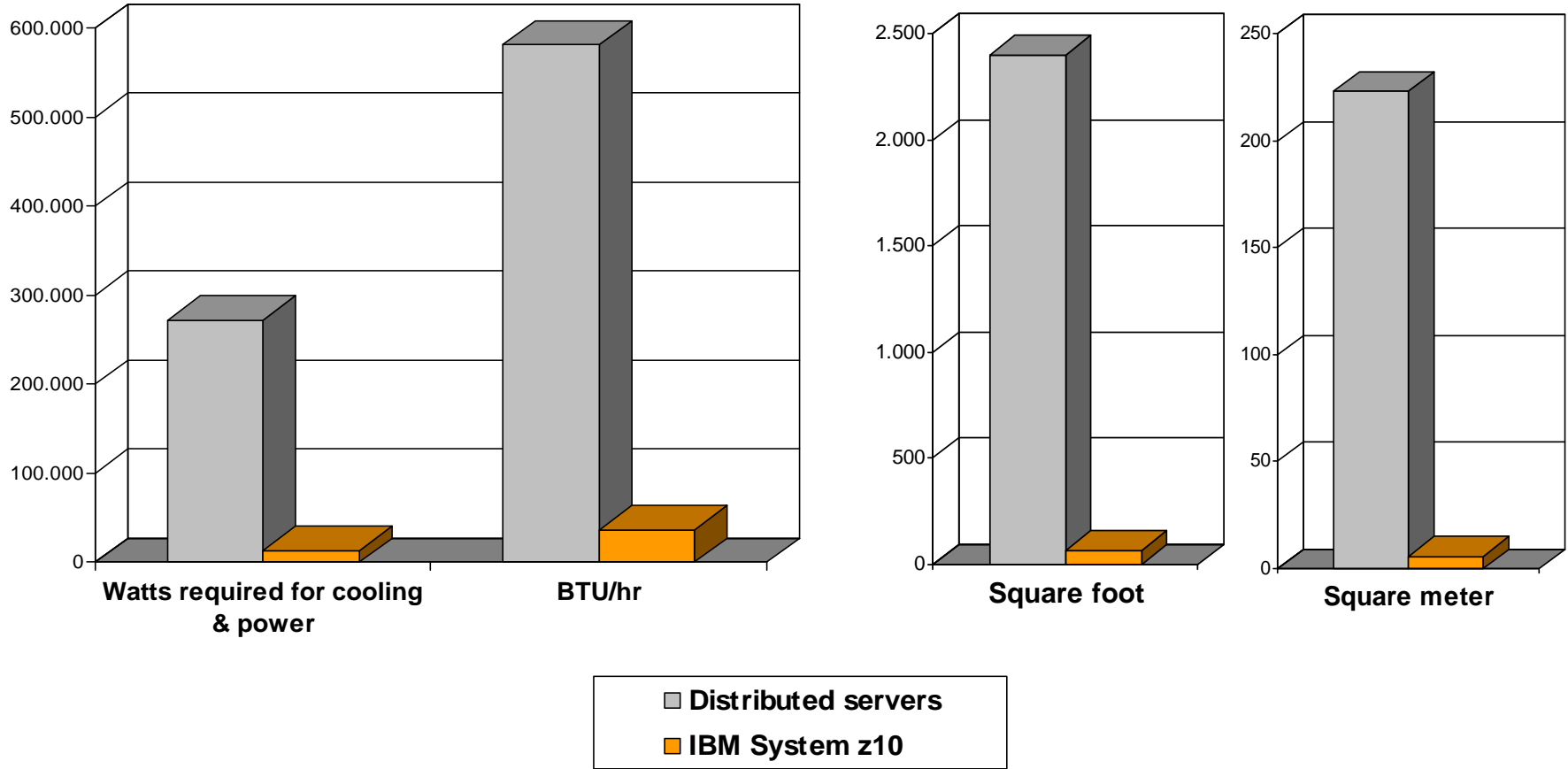
Insurance Company Reduced Energy Requirements 95% by Consolidating 292 Servers to a z10 (1 of 3)

	FROM ...	TO ...
Current hardware infrastructure	Sun (Fire, Netra, Enterprise servers)	z10 EC
Footprints	292	1
Cores/Memory	500+ cores	22 IFLs
Avg Utilization	30 %	90 %
Application	Mainly Web services	Mainly Web services
OS	Solaris	Linux + z/VM
Energy / Space savings		Energy reduction: 95% Heat reduction: 93.6% Floor space reduction: 97%

Summary of Benefits: Improved utilization, reductions in energy, heat
Floor space savings with 292 footprints to 1 reduction

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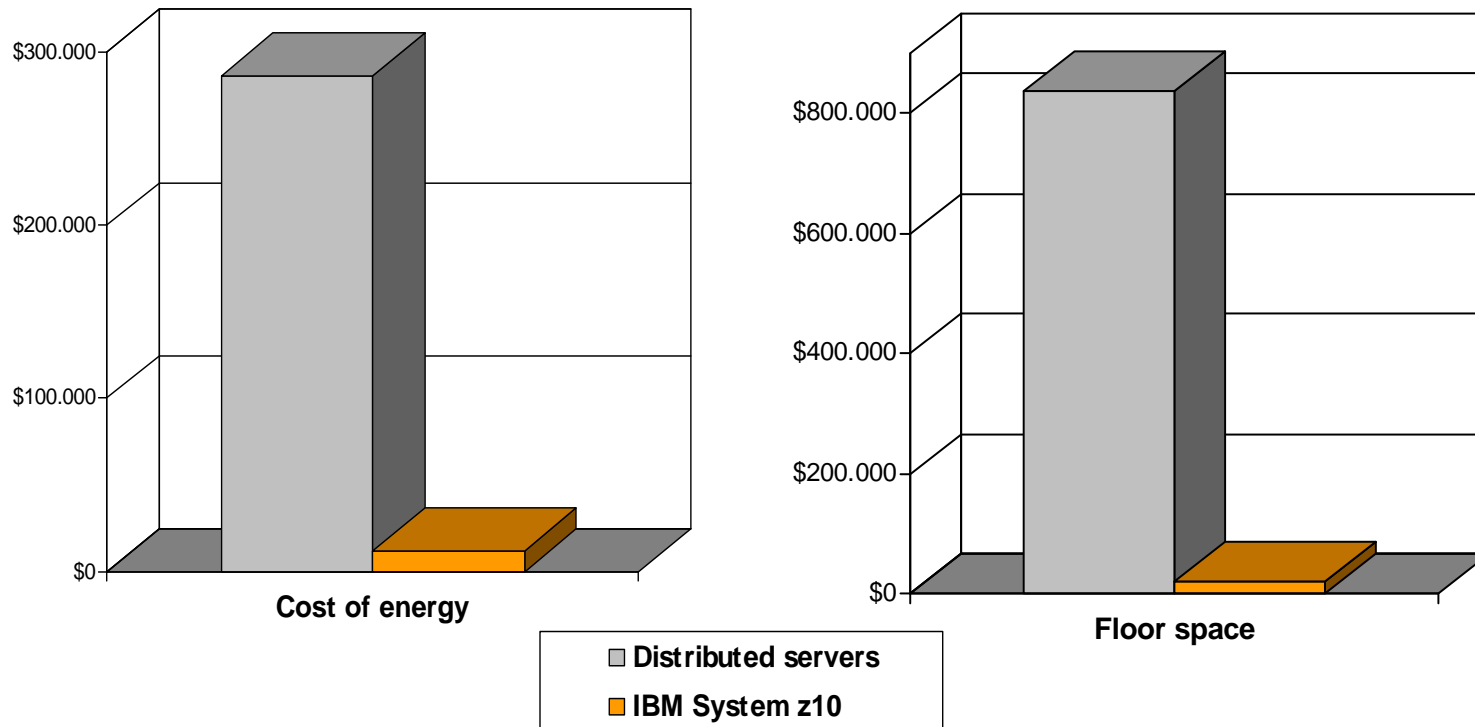
Insurance Company Reduced Energy Requirements 95% by Consolidating 292 Servers to a z10 (2 of 3)



OEM Server environmentals are derived from IDEAS International.

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.

Insurance Company Reduced Energy Requirements 95% by Consolidating 292 Servers to a z10 (3 of 3)



Annual cost calculation

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

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Financial Client Consolidates 61 Sun and HP Servers to a System z10 and Saves 96% on Power and Cooling

	FROM ...	TO ...
Current hardware infrastructure	Sun and HP servers	z10 EC
Footprints	61	1
Cores/Memory	442 cores / 1440 GB	16 IFLs / 82GB
Avg Utilization	13.3%	40%
Peak Utilization	28.7%	92%
# DBs, size of DB	61	61
Application	Oracle databases	Oracle databases
OS	Sun Solaris	Linux + z/VM
Energy usage:		
Power & cooling (Whr)	345,618 Whr	14,766 Whr -> 95% less
Heat (BTUs/hr)	737,030 BTUs/hr	39,648 BTUs/hr -> 94% less

Summary of Benefits: Software savings, energy requirements reduced, better utilization

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.

Insurance Customer Moves From x86 and Uses 60% Less Energy

	FROM ...	TO ...
Current hardware infrastructure	4x86 (IBM)	z10 EC™
Footprints	4	1
Cores	7	1 IFL
Avg utilization	Less than 3%	11 %
Peak utilization	12 %	16 %
# DBs, size of DB	4 Oracle DB	4 Oracle DB
Application	Oracle databases	Oracle databases
OS	Windows®	Linux + z/VM
Energy usage		60 % less

Summary of Benefits:

- Application integration with current System z applications
- Backup and Disaster Recovery capabilities
- Better utilization with smaller footprint and less energy requirements

Legal and Financial Company Saves Energy and Floor Space Doing Data Mining on System z vs. HP

	FROM ...	TO ...
Current hardware infrastructure	HP Proliant ; Sun Fire	z10 EC
Footprints	155 (HP: 45, Sun: 106)	4 (desired separate sites)
Cores/Memory	854 / 676,512 MB	51 IFLs
Peak Utilization	6% to 54% SURF data	90%
Application	Mix of servers used for certification, development, production Oracle DBs and additional workload	Mix of servers used for certification, development, production Oracle DBs and additional workload
OS	HP-UX, Windows	Linux + z/VM

Additional Benefits:

- Avoid HP and Sun server refresh
- Gain disaster recovery in addition to energy savings

Large Bank Consolidates From HP and Sun Saving Power Costs and Gaining Disaster Recovery Protection

	FROM ...	TO ...
Current hardware infrastructure	HP Proliant; Sun Fire, pSeries	z10 EC
Footprints	18	2 (2 separate sites)
Cores/Memory	63	3 IFLs
Peak Utilization	3% to 15% SURF data	74%
# DBs, size of DB	Oracle	Oracle
OS	HP-UX, Windows	Linux + z/VM
Energy and floor space savings		\$28,000 per year

Summary of Benefits:

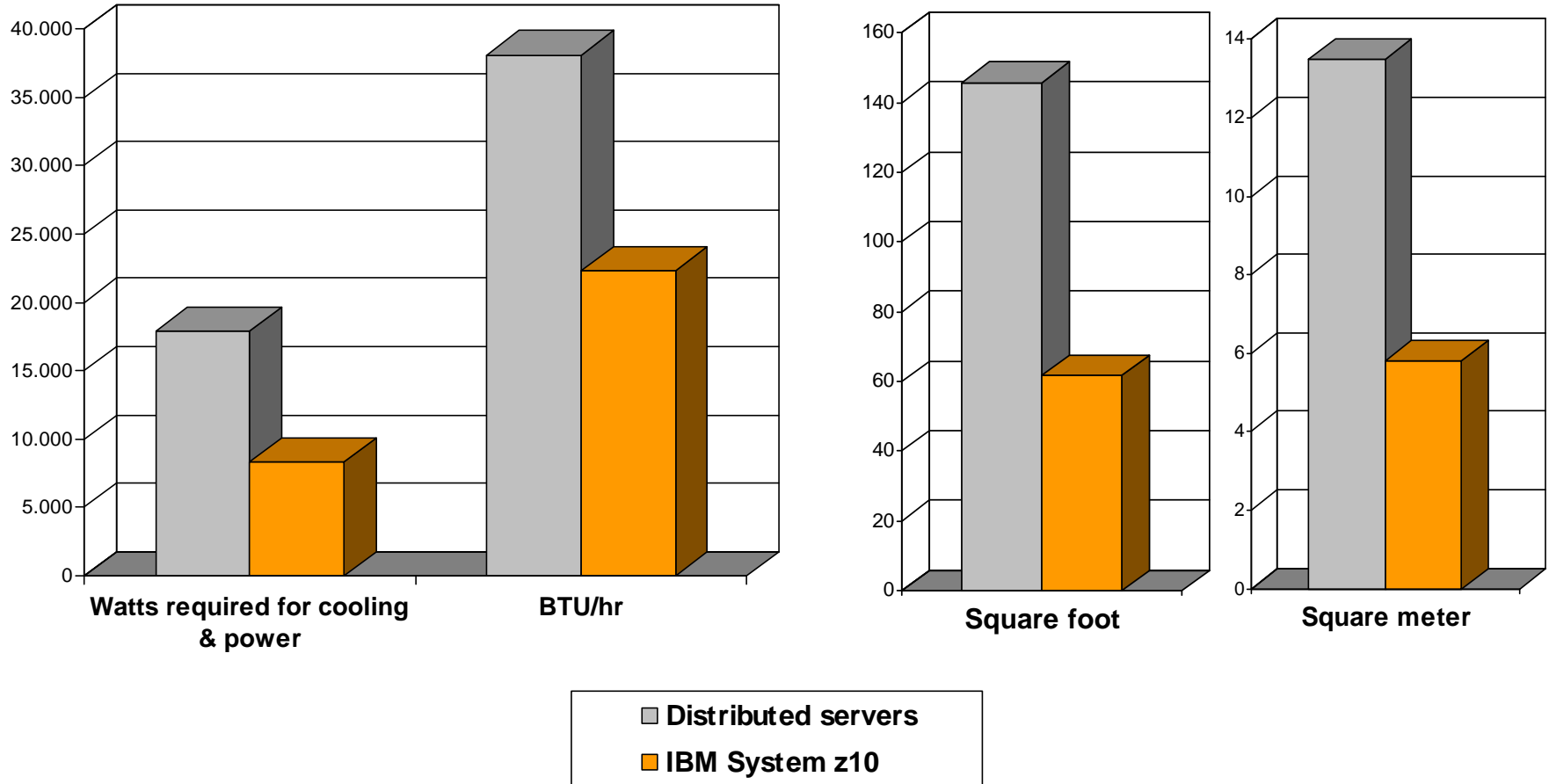
- Energy savings
- Disaster recovery capability
- Better utilization

Prices are in USD. Prices may vary in other countries.

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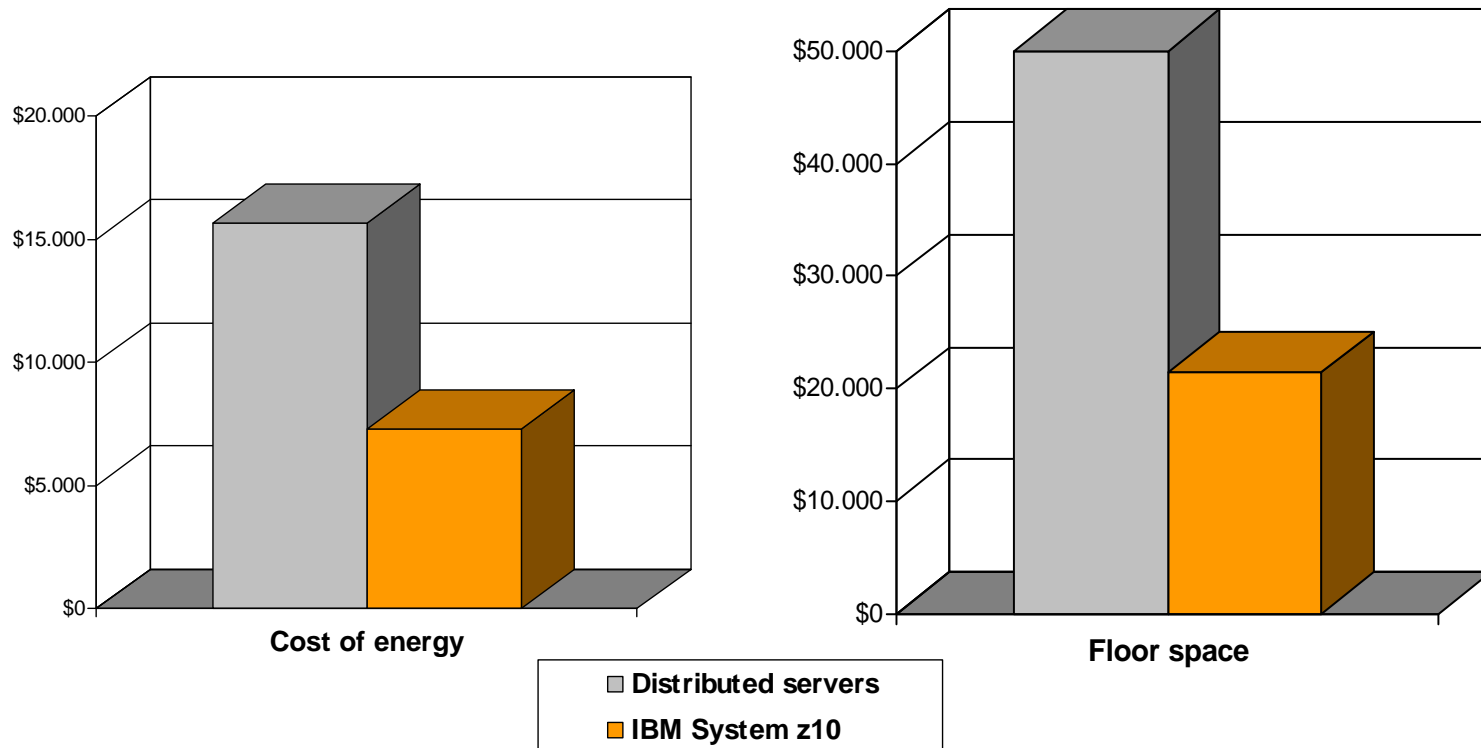
Large Bank Consolidates Eighteen HP and Sun Servers Saving Power Costs and Gaining Disaster Recovery Protection



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Large Bank Consolidates Eighteen HP and Sun Saving Power Costs and Gaining Disaster Recovery Protection



Annual cost calculation

- Energy cost calculated with a rate of \$0.10 per Kilowatt
- Floor space cost calculated with a rate of \$29 per square foot per month

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TCO Comparisons – Real Customer Cases

Scenarios	Cost of Distributed	vs.	System z	Distributed Cost Ratio	Migration Cost
Green Field Cases					
- Banking Benchmark	\$43.3M	vs.	\$18.2M	2.4x	No migration
Migration Examples					
- Asian financial company	\$119.0M	vs.	\$53.0M	2.2x	6.0M
- Asian insurance company	\$25.1M	vs.	\$16.3M	1.5x	2.1M
- NA financial services	\$58.9M	vs.	\$34.0M	1.4x	5.0M
- European financial	\$17.9M	vs.	\$4.9M	3.7x	4.7M
- US County government	\$8.1M	vs.	\$4.7M	1.7x	2.9M
Case Studies					
- European agency	€386.0M	vs.	€204.0M	1.9x	6.3M
- Restaurant chain	\$56.3M	vs.	\$23.3M	2.4x	10.0M
- Asian healthcare	\$15.1M	vs.	\$8.9M	1.7x	4.8M
- Asian bank	\$31.6M	vs.	\$23.5M	1.3x	6.0M
- US utility	\$13.4M	vs.	\$6.2M	2.2x	1.9M
- US manufacturer	\$64.0M	vs.	\$43.3M	1.5x	12.2M
Data Warehouse Offload					
- NA financial company	\$22.4M	vs.	\$14.7M	1.5x	0.9M

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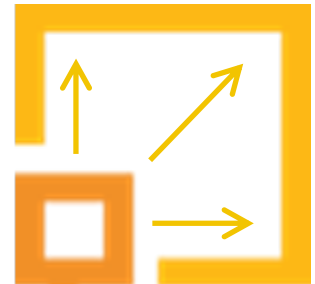
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z196 Delivers Impressive IFL Scalability Enhancements

Consolidate more virtual Linux servers per core - per z/VM LPAR - per z196

- Require even fewer physical servers, fewer network devices, fewer switches, less disk space, less energy, and less floor space
- Spend even less on software license fees with extreme levels of resource sharing and workload consolidation
- Increase the productivity of your IT staff as they manage even more server images on a single IBM zEnterprise 196 (z1960 server)



Run **50** or more virtual servers per core¹

Potentially host **1000s** of Linux server images using z/VM¹

Increasing Customer Value

- **Up to 80% reduction in energy cost²**
- **Up to 70% reduction in labor cost²**
- **Up to 90% reduction in software costs³**

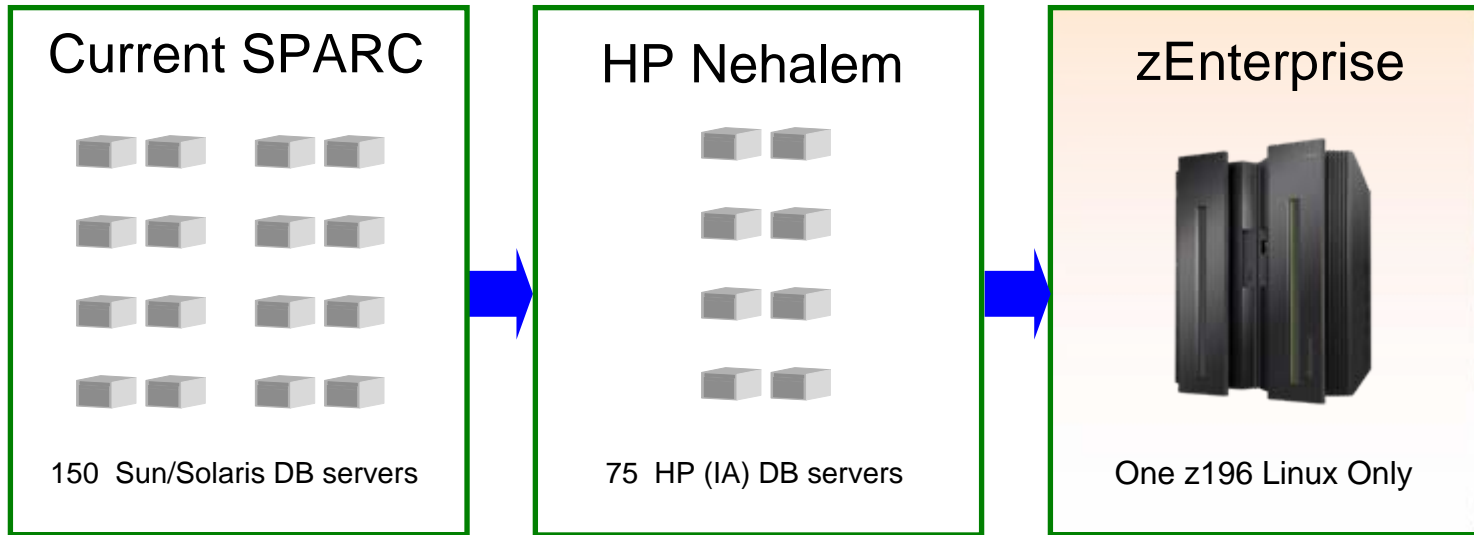
¹ Client results will vary by types of workloads, technology level of consolidated servers, utilization factor, and other implementation requirements. Savings will vary by client.

² When consolidating distributed environments on to Linux on System z. IBM Internal Study based on Oracle SW with Nehalem 4 core running 25% utilization. Results may vary.

³ When consolidating distributed Oracle licenses on to Linux on System z. IBM Internal Study based on Oracle SW with Nehalem 4 core running 25% utilization. Results may vary.

“One Box is Enough” - zEnterprise

System Overview



Tangible Benefits (5 Year TCO Comparison)

	Existing SPARC (4800 Cores)	Proliant BL 460c (600 Cores)	Purchase z196 (80 Cores)
Hardware (Purchase)	17,441,235	1,101,315	2,280,000
Hardware Maintenance	6,976,494	440,526	1,414,950
Software Licenses		14,774,250	3,429,698
Software (S&S)	127,761,150	17,645,625	5,702,486
Total	152,178,879	33,961,716	12,827,133

Prices based on US market prices, local pricing and conditions will vary.

- Intangible benefits:
- Improved security – no information leak during data copy between servers
 - End to End disaster recovery – simplified, single switchover
 - Improved availability – no network routers or switches

Summary of Benefits



Companies, from all sizes across the industries, identify costs savings as a top benefit of IT optimization through server virtualization and consolidation to Linux on System z

But there are even more benefits:

- **Availability** – mean-time between system failures is measured in decades
- **Scalability** – superior architecture and processing power to boost distributed workload performance
- **Security** – unsurpassed robustness, including data and virtual server protection
- **Simplification of system resource management** – single point of control achieves new levels of operational efficiency and service quality

Linux on System z provides a great opportunity for server consolidation and IT simplification

Backup

IBM System z Offerings for Large Scale Consolidation

The Enterprise Linux Server

A dedicated IBM zEnterprise or System z10 server for large-scale Linux workloads

▪ Offerings include

- System z IFL specialty processors, memory, and I/O connectivity
- Hardware maintenance for three to five years
- z/VM virtualization software package with three to five years of subscription and support

▪ Supported with promotions from Linux Development partners Novell and Red Hat

▪ Very competitive pricing

- Competitive TCA with scalable Linux and UNIX[®] alternatives
- Total Cost of Ownership and Qualities of Service that blow away the competition
- Price / performance improves as you grow your environment
- Able to host thousands of servers in a single system
- Pricing starting at under \$1,000 per virtual server for 3 years for very large consolidations⁽¹⁾

System z Solution Edition for Enterprise Linux

Additional capacity on an installed IBM zEnterprise or System z10 server for large Linux workloads

More Solution Editions include: **Cloud**, Data Warehousing, Business Resiliency, Security, WebSphere, SAP, Application Development, Chordiant, ACI

(1) Calculations based on specific solution offering components using IBM and client experiences. Results can vary.

TCA: hardware, virtualization software, memory, maintenance

Designed for Greater Savings, Operational Simplification and System Reliability

Extended capabilities for server consolidation and IT optimization

- Improved total system capacity
 - Up to 80 user-configurable cores
- Up to 3 TB of real memory per server
- Increased internal networks (HiperSockets™)
- Quad-core 5.2 GHz processor
 - New instructions to accelerate Java code
 - Designed to improve processor-intensive workloads
- Ability to extend amount of addressable storage capacity
- Improved power efficiency

Extended qualities of service

- Concurrent add/delete of I/O
- Redundant array of independent memory (RAIM)
- HiperSockets network traffic analyzer
- Crypto Express3 cryptographic enhancements

Linux on zEnterprise196



Dramatic improvement:

Up to **60%**

Improvement in performance

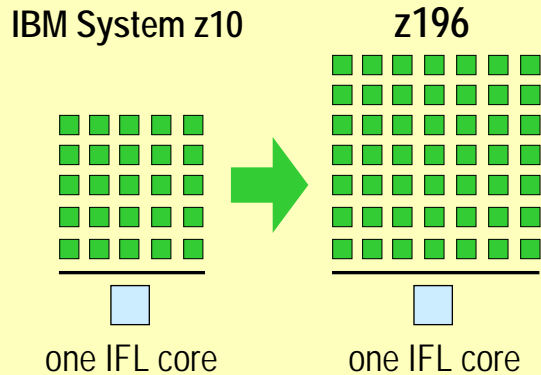
for **35%**

Less cost

- **With no increase in energy consumption**
- **And even better performance with new software**

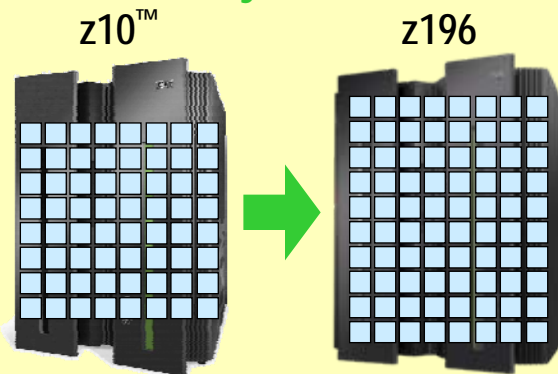
Consolidate More and Spend Less with Linux on z196

Run more *virtual Linux servers* per core

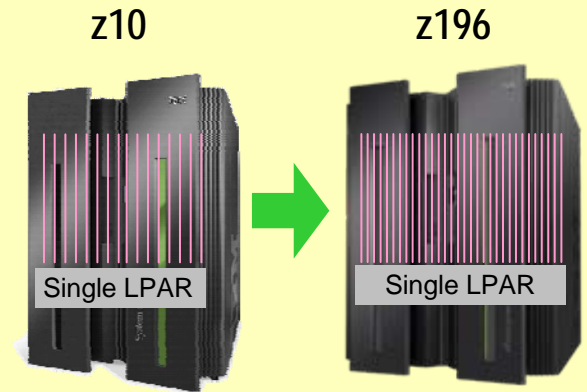


*z196 delivers greater levels of server consolidation **density** and **scalability** with Linux and z/VM that sets a new standard for TCO and service management.*

Configure *more cores* per System



Configure *more internal networks* per System



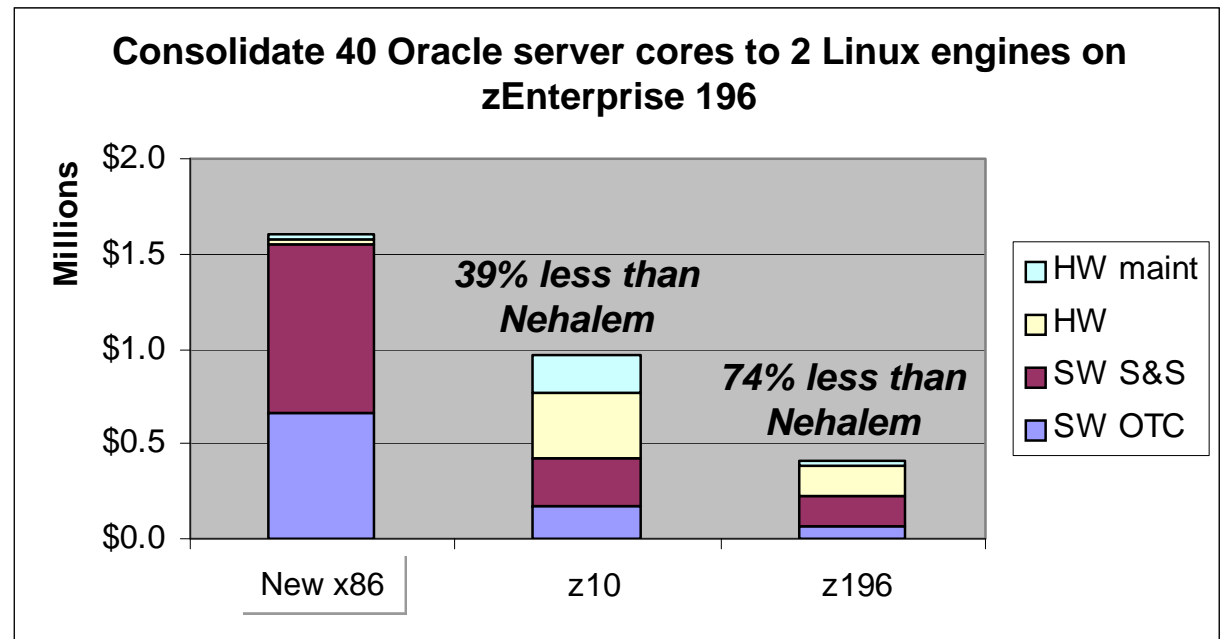
+HiperSockets Network Traffic Analyzer (HS NTA) for Linux

zEnterprise 196 – increasing the economic appeal of server consolidation and IT optimization with Linux and z/VM virtualization

The Most Efficient Platform for Large Scale Consolidation

System z Uses Less Processor Cores and Drives Out Costs

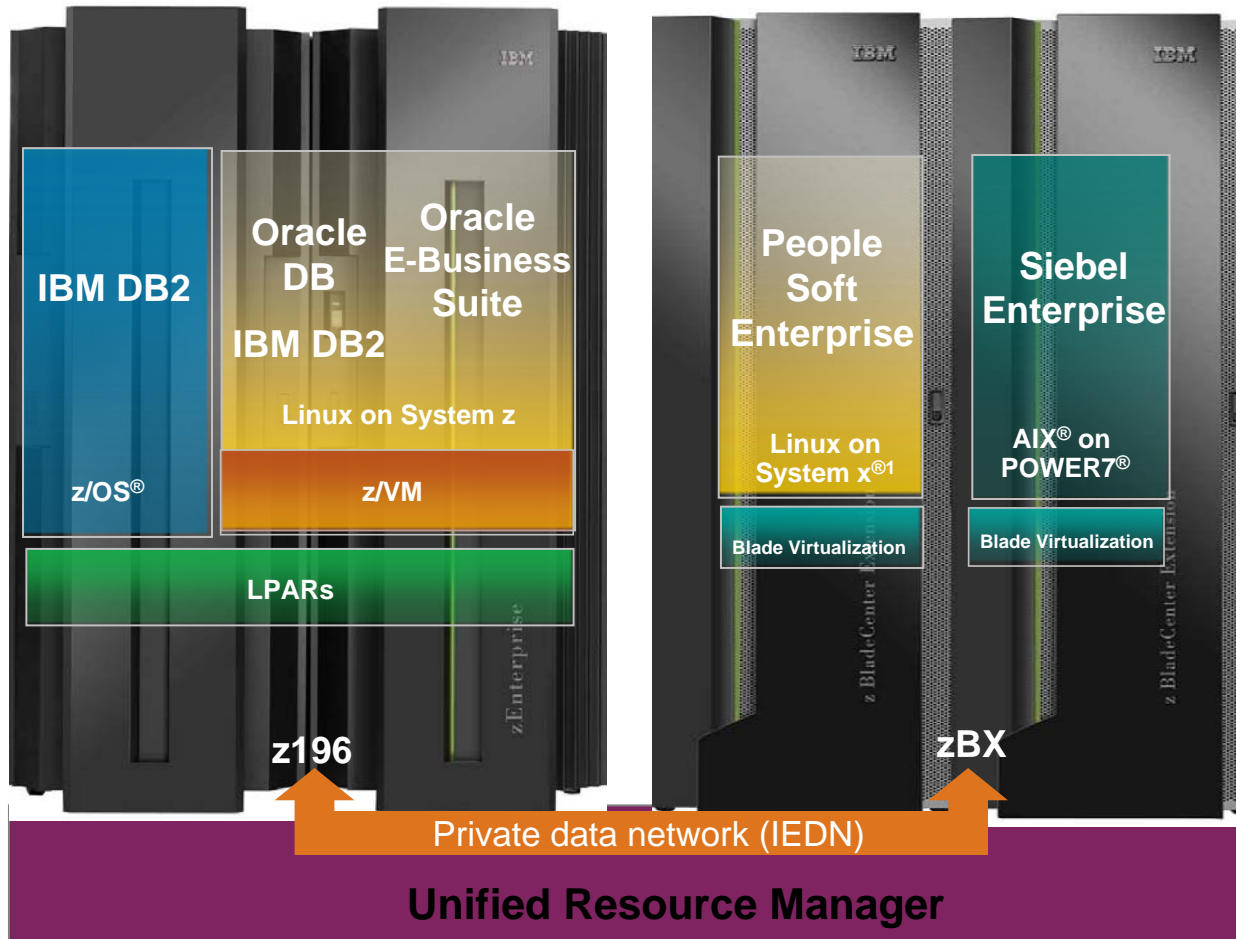
- Lower acquisition cost of hardware and software vs. distributed servers*
- Less than \$1.00/day per virtual server (TCA)*
- Superior Virtualization
 - More virtual servers
 - Less than US\$1000 / virtual server over 3 years
- Fewer processor cores
 - Drives down software acquisition costs
 - Reduces software maintenance costs
- Simplified management
- Ability to scale non disruptively



* Distributed server comparison is based on IBM cost modeling of Linux on zEnterprise vs. alternative distributed servers. Given there are multiple factors in this analysis such as utilization rates, application type and local pricing, etc.; savings may vary by user

Putting Oracle Enterprise Workload to the task

Use zEnterprise solution to improve your Oracle infrastructure design

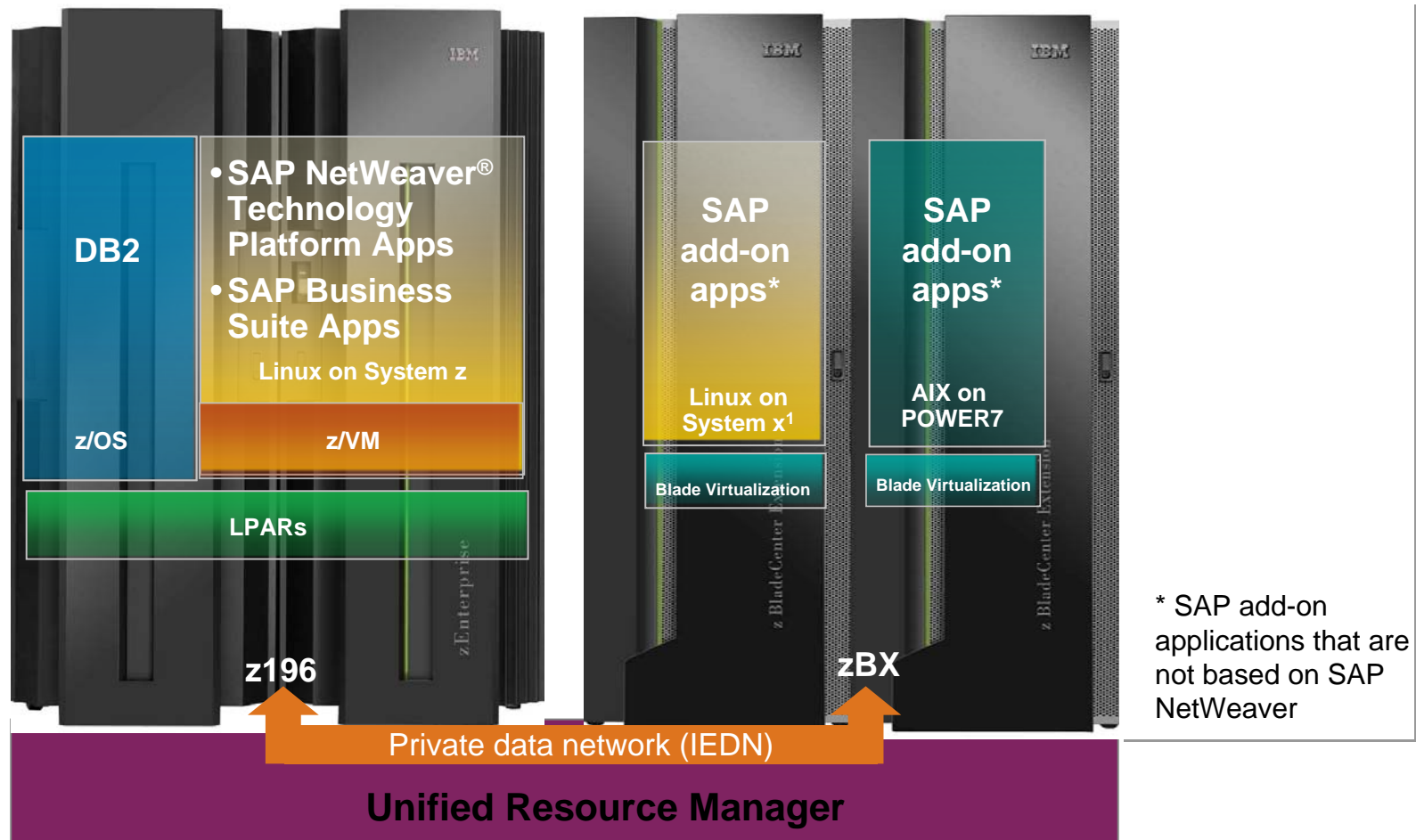


Examples of Oracle applications available on IBM zEnterprise BladeCenter® Extension (zBX) and certified for DBs running on z196:

- Oracle PeopleSoft Enterprise
- Oracle Siebel Enterprise
- Oracle Financial Services
- Oracle Insurance
- Oracle Cross Industry
- Oracle Enterprise Tax Mgmt
- Oracle Siebel CRM for Public Sector
- Oracle Business Intelligence Enterprise Edition

Putting SAP Enterprise Workload to the task

Use the zEnterprise solution to improve your SAP infrastructure design



¹ All statements regarding IBM future direction and intent are subject to change or withdrawal without notice, and represents goals and objectives only.

Smarter Optimization and Consolidation with Linux on IBM zEnterprise System

- Linux and z/VM on z196 will continue to deliver unique business value in the areas of virtualization, operational flexibility, scalability, workload management, efficiency, business continuance, reliability and security.
 - These values will continue to exist on the IBM System z architecture only.
 - The virtualization capabilities of the zBX attached hardware will be native to that hardware.



Server and application consolidation on zEnterprise z196 using Linux and z/VM is the industry leader in large-scale, cost-efficient virtual server hosting.

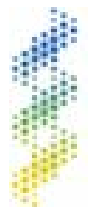
Smarter Virtualization with IBM System z and z/VM

- Do more with less
 - Consolidate more servers, more networks, more applications, and more data in a single machine with Linux and z/VM
 - Achieve nearly 100% utilization of system resources nearly 100% of the time
 - Enjoy the highest levels of resource sharing, I/O bandwidth, system availability, and staff productivity
- Reduce costs on a bigger scale
 - Consume less power and floor space
 - Save on software license fees
 - Minimize hardware needed for business continuance and disaster recovery
- Manage growth and complexity
 - Exploit extensive z/VM facilities for life cycle management: *provisioning, monitoring, workload mgmt, capacity planning, security, charge back, patching, backup, recovery, more...*
 - Add hardware resources to an already-running system without disruption – the epitome of Dynamic Infrastructure
 - Consolidation on a **scale up** machine like System z means fewer cables and fewer components to impede growth

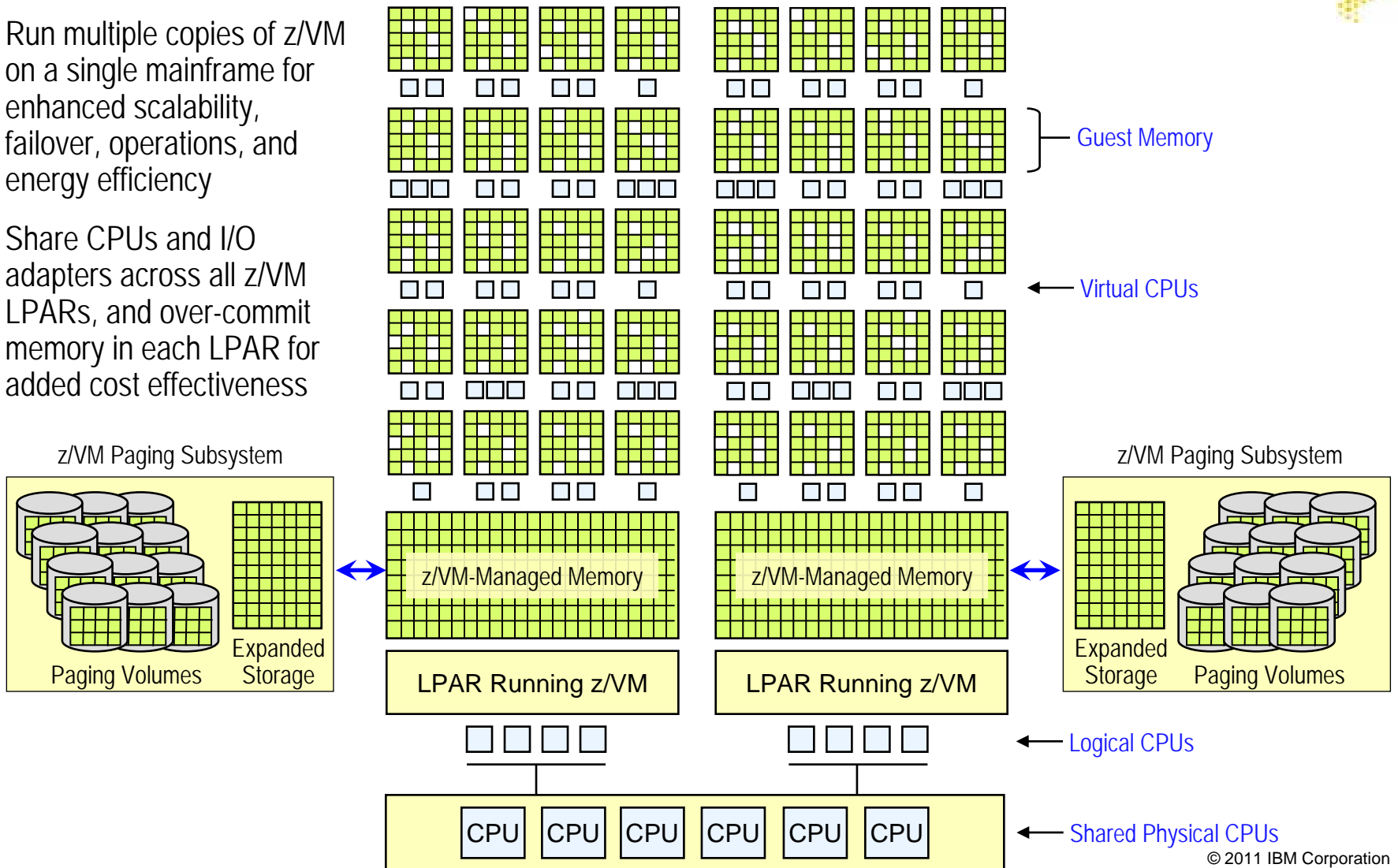


Single-System, Multi-LPAR, Linux-on-z/VM Environment

Maximizing Resource Utilization and System Availability



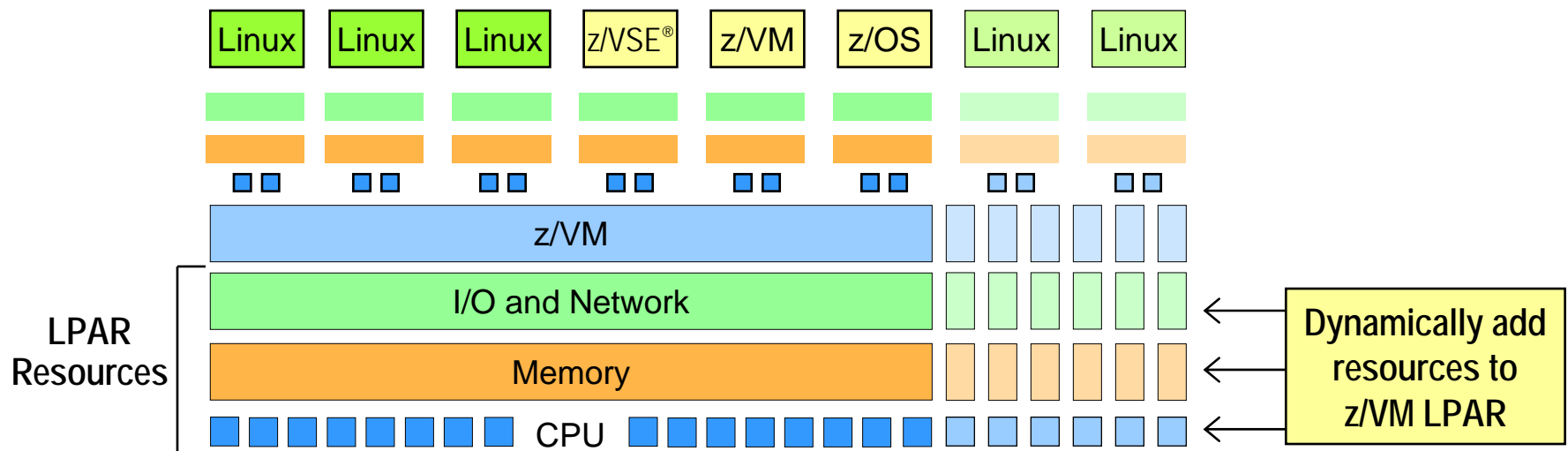
- Run multiple copies of z/VM on a single mainframe for enhanced scalability, failover, operations, and energy efficiency
- Share CPUs and I/O adapters across all z/VM LPARs, and over-commit memory in each LPAR for added cost effectiveness



Linux on z/VM: Flexible, Efficient Growth

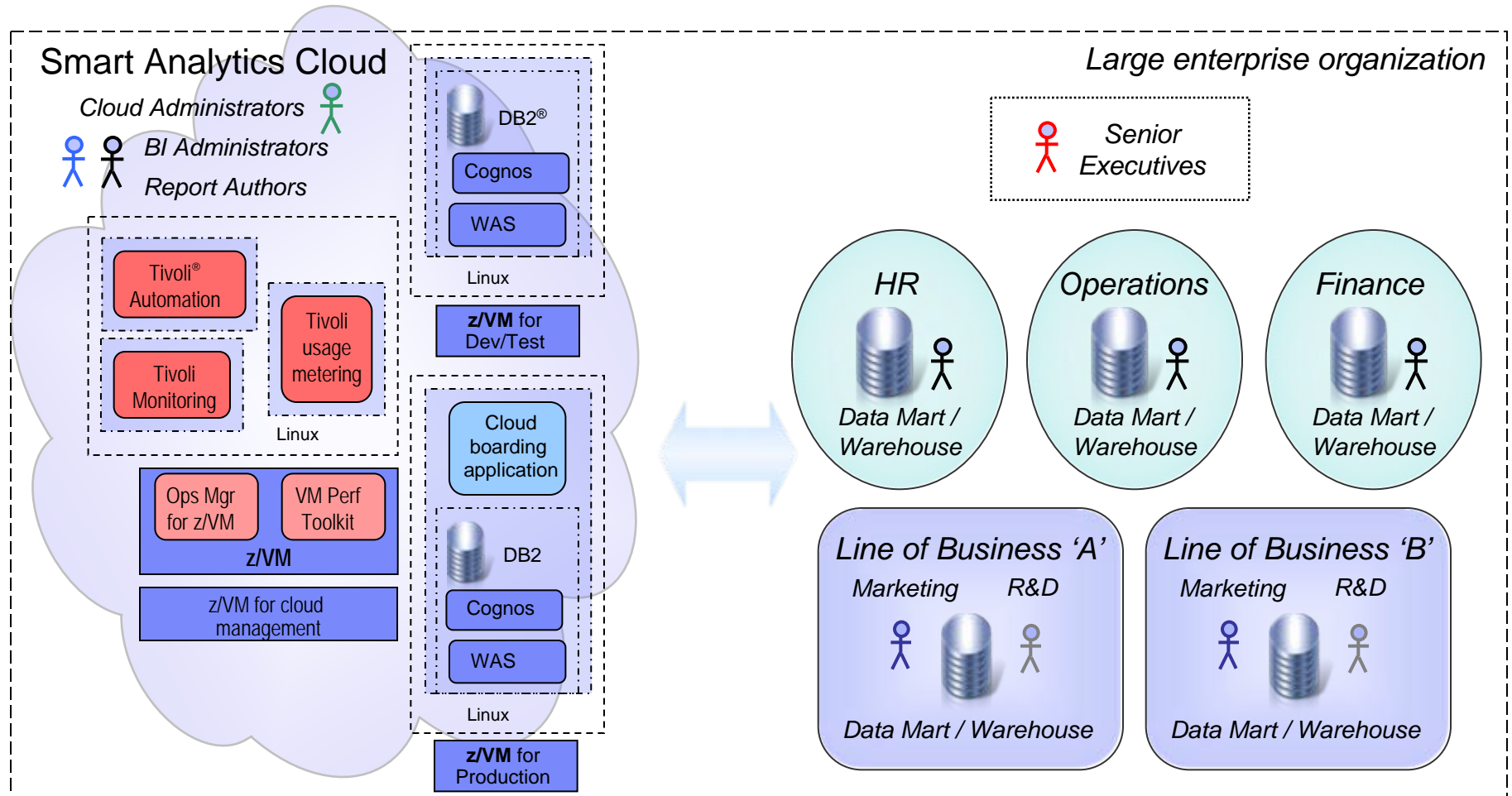


- Clients can start small with Linux on System z and non-disruptively grow their environment as business dictates
- Users can dynamically add CPUs, memory, I/O adapters, devices, and network cards to a running z/VM LPAR
- z/VM virtualizes this capability for guest machines



Smart economics: non-disruptively scale your z/VM environment by adding hardware assets that can be shared with every virtual server

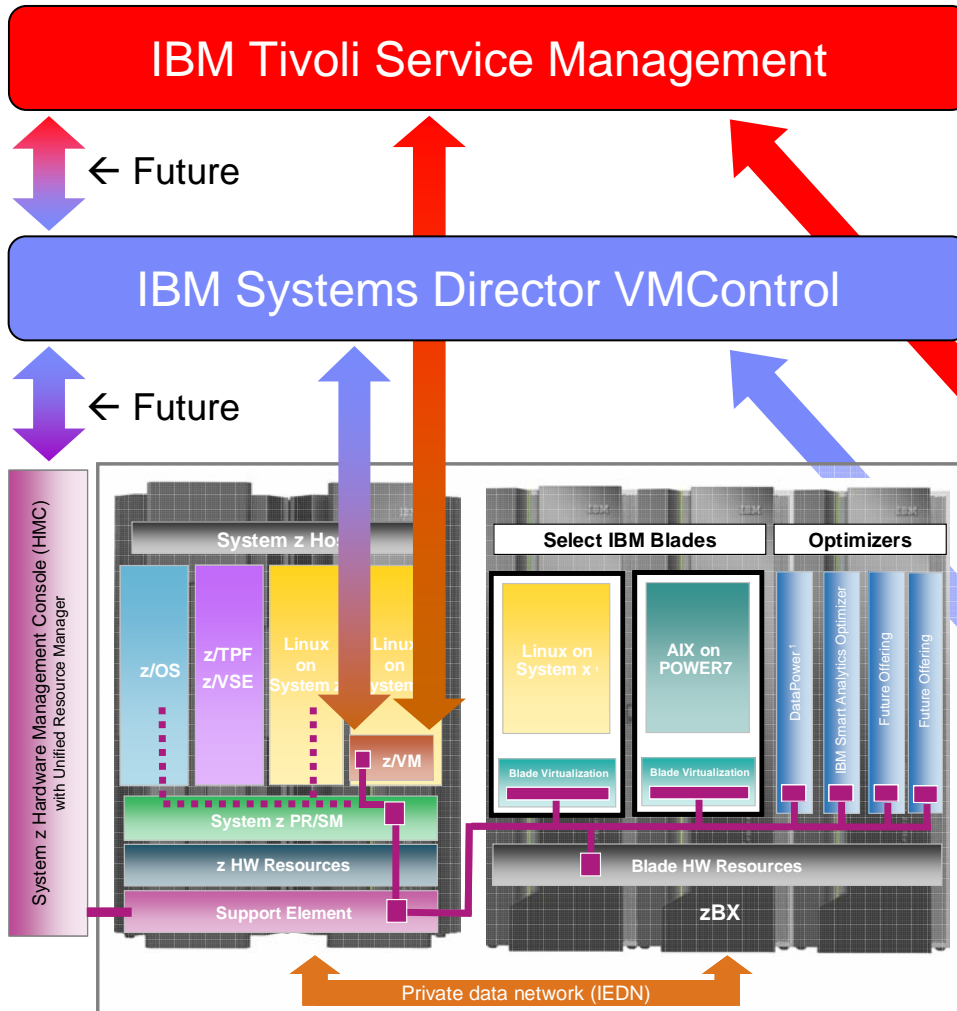
Smart Analytics Cloud for Large Enterprises



This offering transforms the delivery of business intelligence into a service that is readily available and affordable to corporate users across and beyond the enterprise

Multi-System Cloud Management on IBM zEnterprise

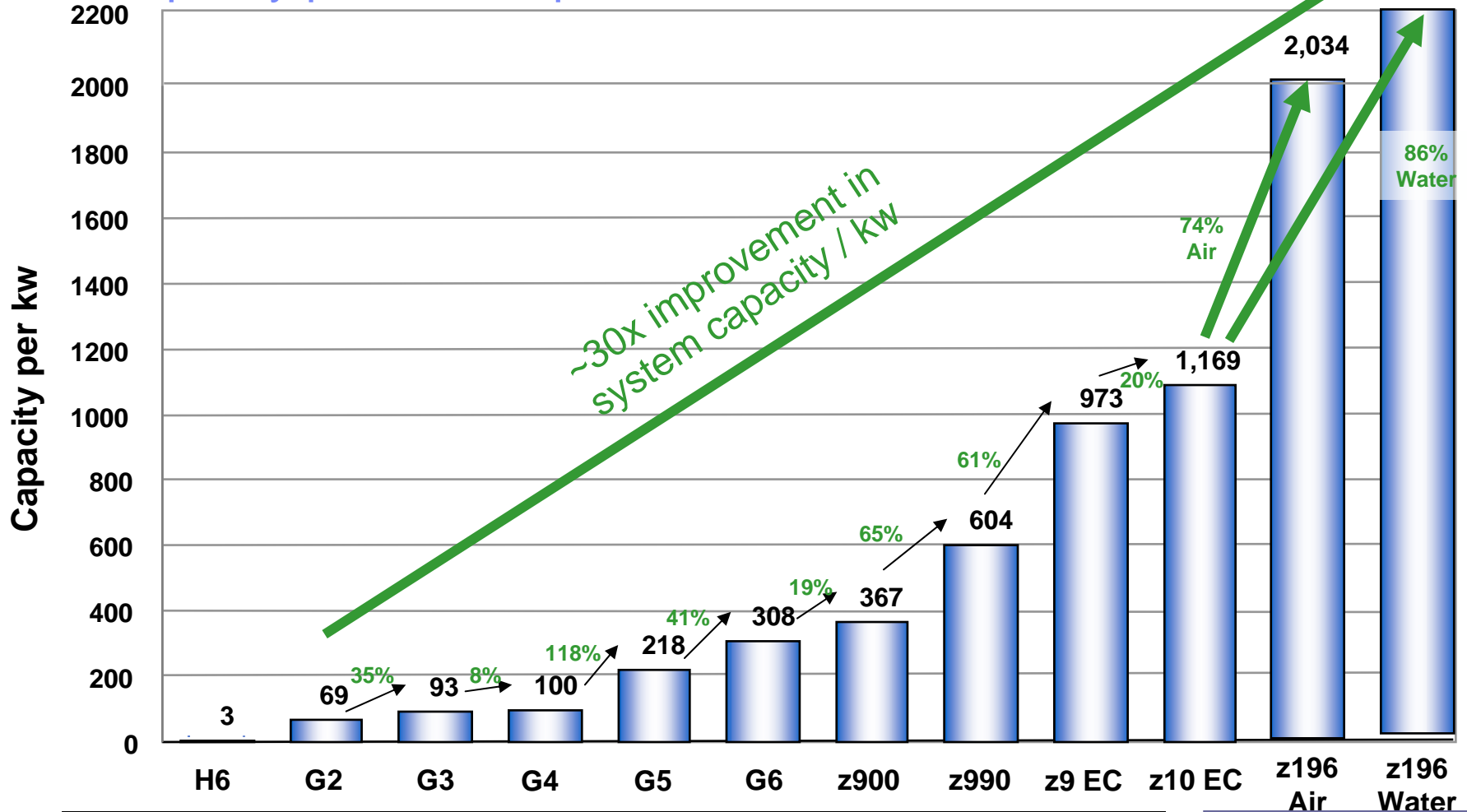
The Big Picture Going Forward



- Enables optimal workload placement in a multi-system cloud infrastructure: spend less *and* deliver higher qualities of service
- Allows clients to manage all the hypervisors in a zEnterprise system with consistency
- Extends same management capabilities to Power and System x servers elsewhere in the enterprise



z196 Capacity per Watt improvements



15 years of CMOS: G2 to z196 *		Net Effect: G2 to z196 *	
Power Increase:	17% per year	Performance increased by:	~300x
Performance increase:	46% per year	Performance / kWatt increased by:	~30x
Power density increase:	13% per year	Performance / sq ft increased by:	~190x

Note: Capacity/kWatt assumes hot room, max plugged I/O power, max memory power and all engines turned on. Real world max capacity system is about 3/4 of this.

Service Levels to Match Your Business Needs

Increased flexibility for your multi-architecture strategy

