Dynamic Infrastructure With System z

SWG Competitive Project Office

Dynamic Infrastructure Requirements

- TCO – Take Costs Out!
- Faster Provisioning
- Secure and Resilient

System z delivers all these capabilities today!
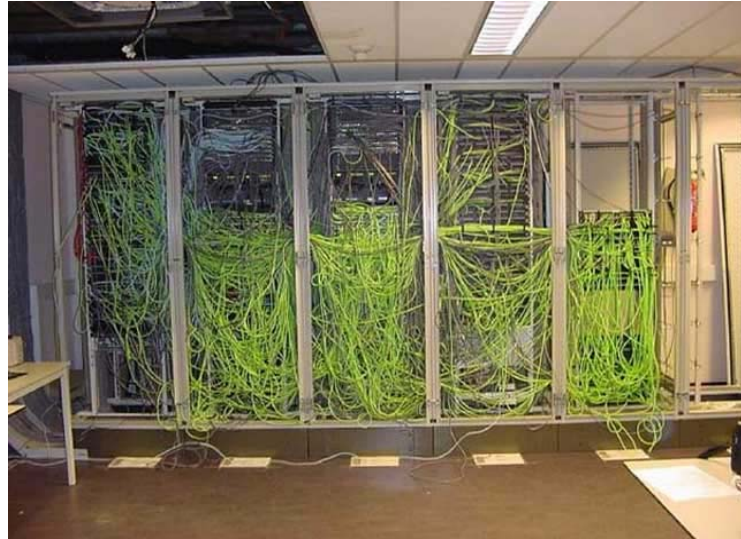
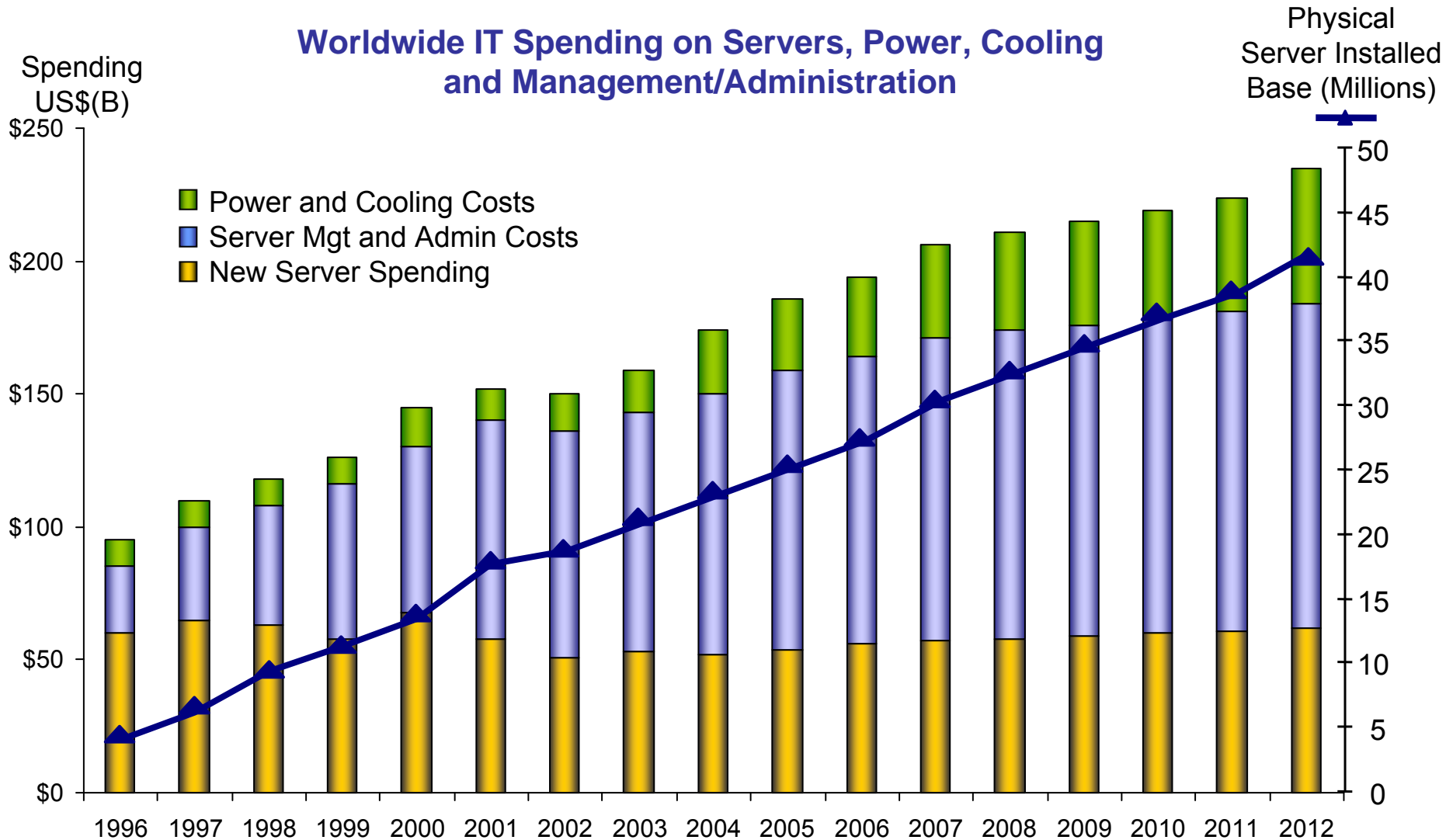**Service Oriented Finance CIO**

IBM

Complexity Is Growing

- Complexity drives cost

- Reduces responsiveness

- Likely to impact security and performance

DO NOT TOUCH ANY OF THESE WIRES

Annual Operating Costs Are Out Of Control

Worldwide IT Spending on Servers, Power, Cooling and Management/Administration

Spending US$(B)

Physical Server Installed Base (Millions)

Legend:
- Power and Cooling Costs
- Server Mgt and Admin Costs
- New Server Spending

Dynamic Infrastructure For A Smarter Planet

- Virtualization and Consolidation is a proven way to save money

Let's Focus

Improve Productivity

Respond Quickly

Service Management

Reduce Costs

Request-Driven Provisioning

Virtualize and Consolidate

Understand All The Operational Costs

Annual Operations Cost Per Server
(Averaged over 3917 Distributed Servers)
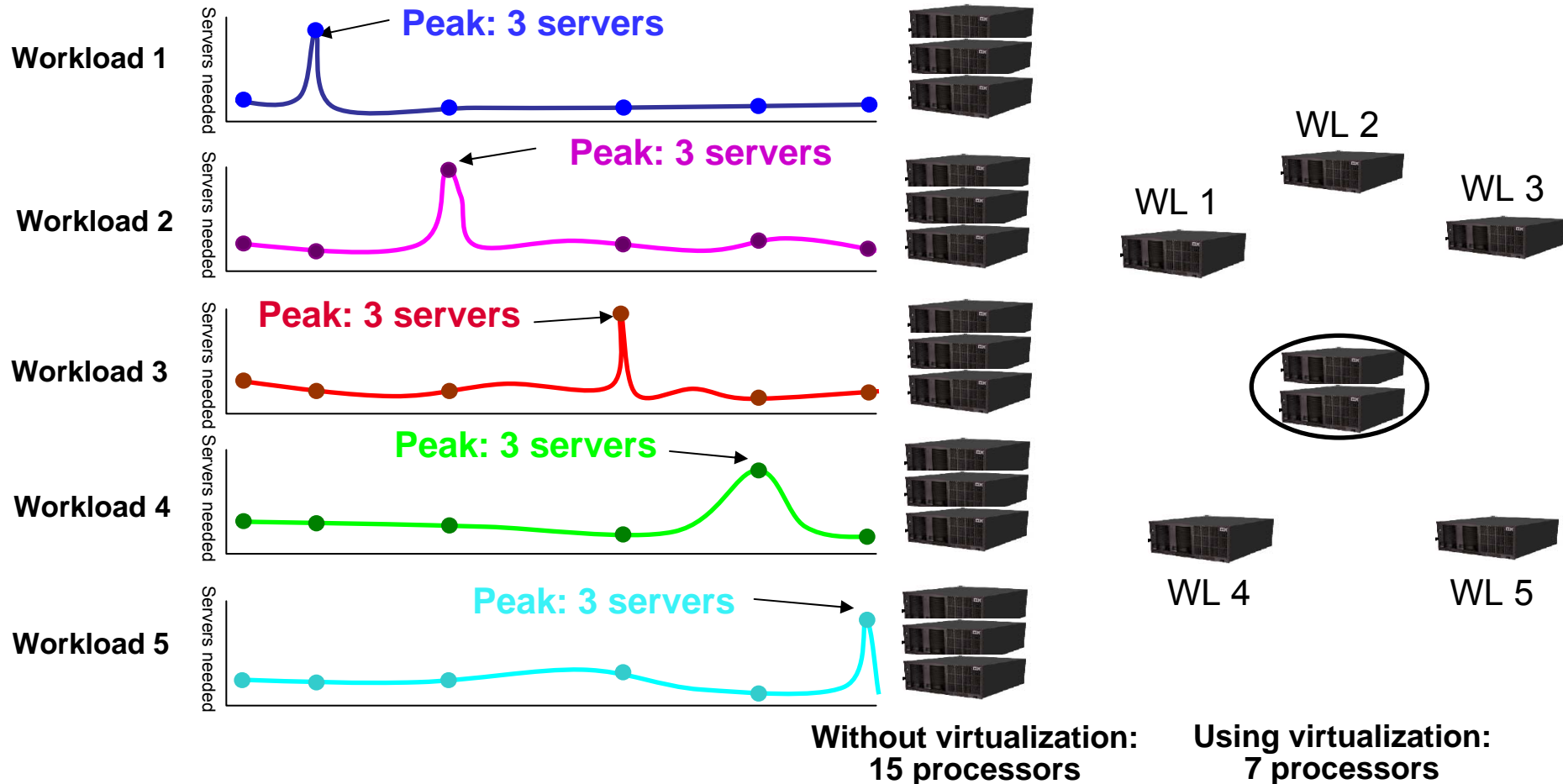
Power	$731
Floor Space	$987
Annual Server Maintenance	$777
Annual connectivity Maintenance	$213
Annual Disk Maintenance	$203
Annual Software support	$10,153
Annual Enterprise Network	$1,024
Annual Sysadmin	$20,359
Total Annual Costs	$34,447

Needed: Something that works on these

The largest cost component was labor for administration
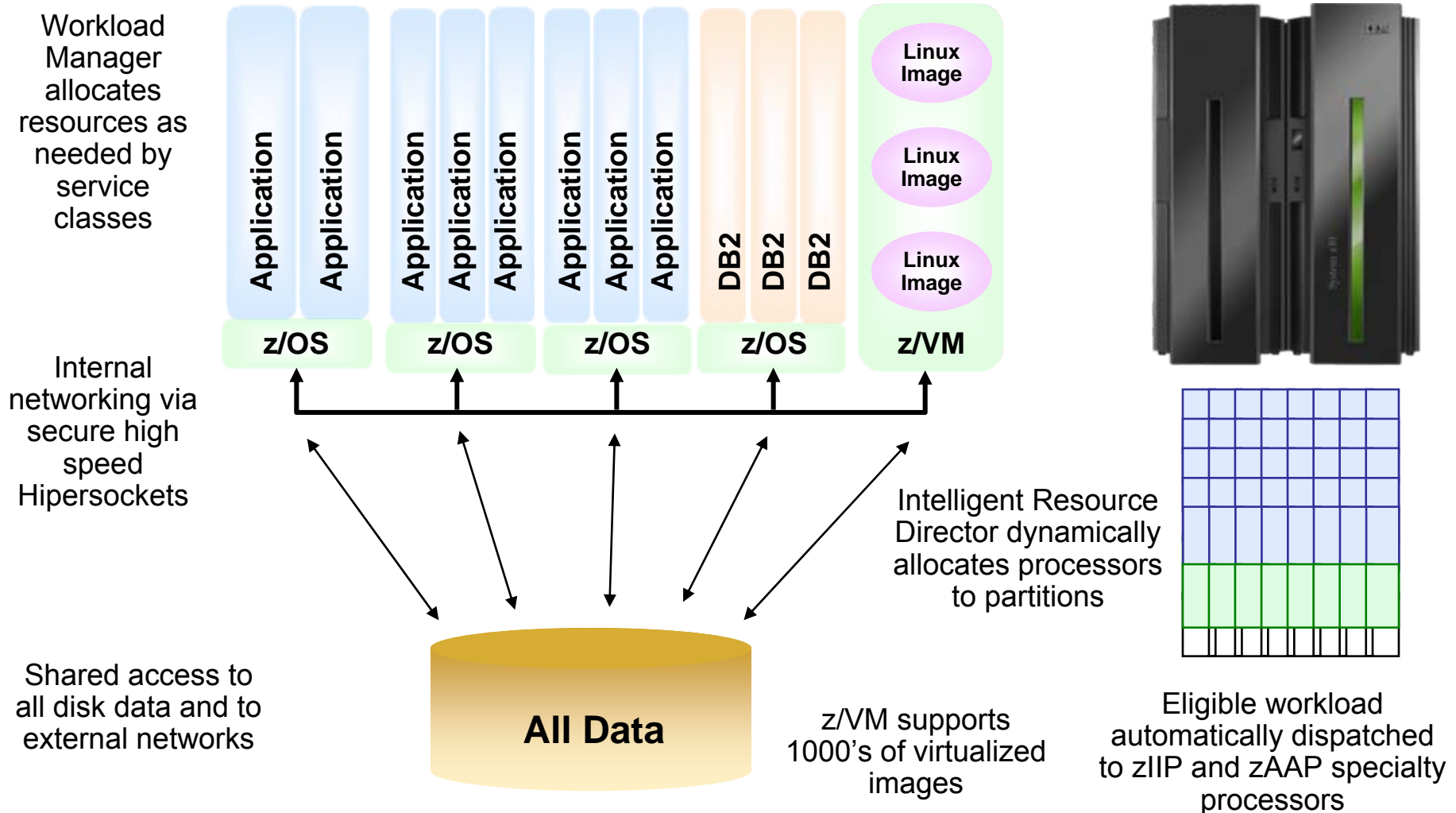7.8 servers per headcount @ $159,800/yr/headcount

Source: IBM internal study

Example:
Improve Efficiency And Reduce Costs

Workload 1 — Servers needed — **Peak: 3 servers**

Workload 2 — Servers needed — **Peak: 3 servers**

Workload 3 — Servers needed — **Peak: 3 servers**

Workload 4 — Servers needed — **Peak: 3 servers**

Workload 5 — Servers needed — **Peak: 3 servers**

WL 1 WL 2 WL 3 WL 4 WL 5

**Without virtualization:
15 processors**

**Using virtualization:
7 processors**

**What's Required: Virtualization and intelligent workload management to accommodate shifting workloads.
But this is automatic on the mainframe!**

System z Is Designed For Extreme Virtualization

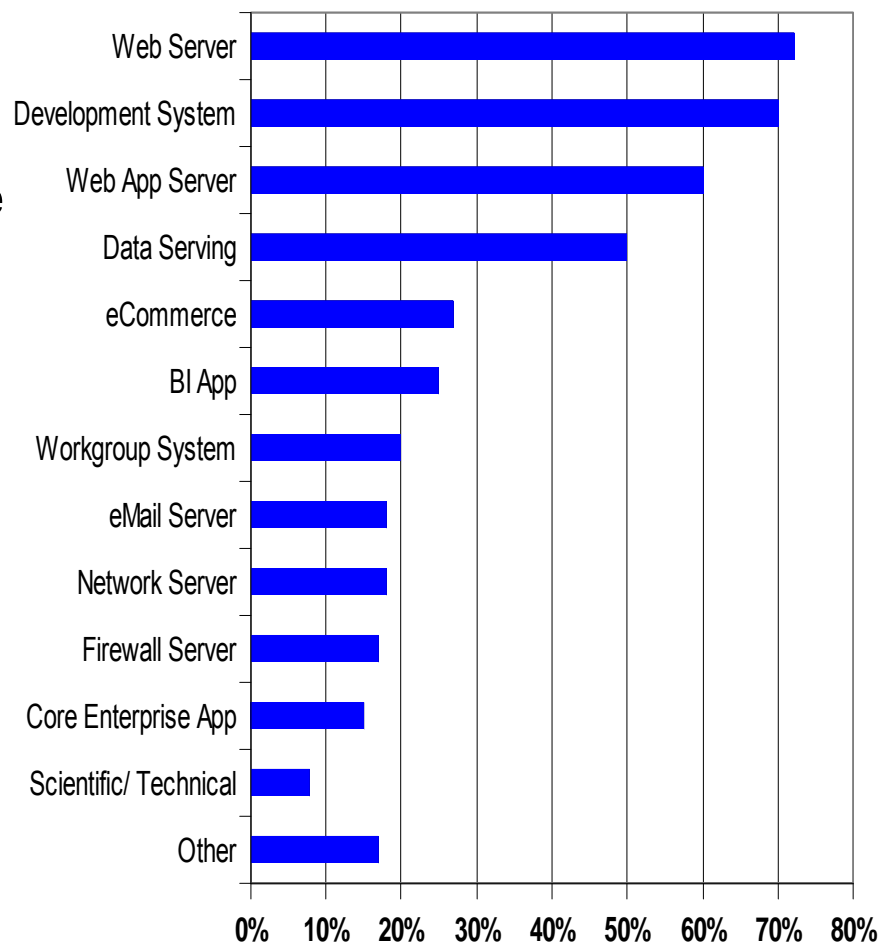**Logical Partitions Share Processors, Common Cache Structures, and I/O**

Workload Manager allocates resources as needed by service classes

Internal networking via secure high speed Hipersockets

Shared access to all disk data and to external networks

Application	Application		Application	Application	Application		Application	Application	Application		DB2	DB2	DB2		Linux Image / Linux Image / Linux Image
z/OS			**z/OS**				**z/OS**				**z/OS**				**z/VM**

All Data

Intelligent Resource Director dynamically allocates processors to partitions

z/VM supports 1000's of virtualized images

Eligible workload automatically dispatched to zIIP and zAAP specialty processors

Workloads That Can Be Consolidated In Linux On A Mainframe

What	Where	Specialty Processor	How
Linux Applications	Linux on z/VM	IFL	Recompile

Linux Middleware
  - IBM Brands (DB2, WebSphere, Lotus, Rational, Tivoli)
  - Oracle Database
  - etc.
	Linux on z/VM	IFL	Rehost

Linux Packaged Applications
  - SAP
  - Oracle
  - etc.
	Linux on z/VM	IFL	Rehost

Linux Workloads On System z

Linux on System z Workloads 2H08

- Clients are deploying Linux on z for a broad set of applications

- Almost 2,500 applications available for Linux on System z

- Leading applications for Linux on System z:
  - ▶ WebSphere
  - ▶ SAP
  - ▶ Domino
  - ▶ Cognos
  - ▶ Oracle

Chart: Linux on System z Workloads 2H08 (percentage by workload type)

Workload	Approx %
Web Server	72%
Development System	70%
Web App Server	60%
Data Serving	50%
eCommerce	27%
BI App	25%
Workgroup System	20%
eMail Server	18%
Network Server	18%
Firewall Server	17%
Core Enterprise App	15%
Scientific/ Technical	8%
Other	17%

x-axis: 0% 10% 20% 30% 40% 50% 60% 70% 80%

How Much Money Can You Save?

- Costs shared by all "N" consolidated images
  - ▶ Hardware
  - ▶ Software
  - ▶ Power
  - ▶ Floor Space
  - ▶ Local Network Connectivity

Cost per Image = 1/N

(graph: Cost Per Image vs N, with points labeled .5, .33, .25, .20, .1 and axis marks 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0 on y-axis; 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 on x-axis)
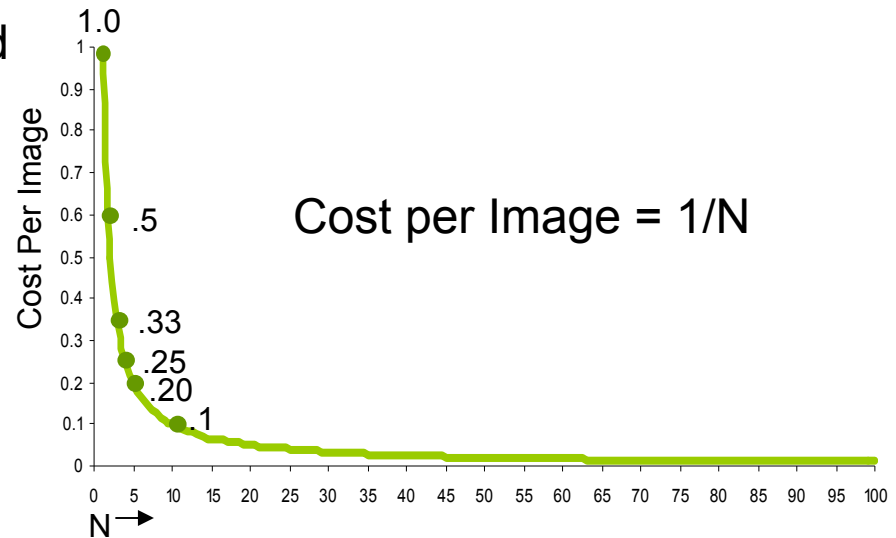
- Costs not shared by consolidated images
  - ▶ Migration cost per image   Fixed cost per image
  - ▶ Off premise network cost

  - ▶ Labor cost per image   Fixed cost per image, but typically less than unconsolidated labor cost

The more workloads you can consolidate, the lower the cost per image

Consolidation Math For Processors

What is the theoretical maximum number of servers that can be consolidated?

Consolidation

N Servers

P_A – Processor Power

U_A – Utilization

C_A – Cores Per Server

One Server

P_B – Processor Power

U_B – Utilization

C_B – Cores Per Server

Ratios

$P_R = P_B / P_A$

$U_R = U_B / U_A$

$C_R = C_B / C_A$

Processor Performance Ratio   Processor Utilization Ratio   Cores per Frame Ratio

$$N \leq (P_R)(U_R)(C_R)$$

Implementation variations from average and practical considerations will constrain this theoretical number
This theoretical maximum assumes a worst-case scenario where all workloads peak at the same time

Identify Consolidation Opportunities

$$N \leq (P_R)(U_R)(C_R)$$

| Servers that are candidates to be consolidated | → | Older servers with slower processors | Servers with low utilization | Servers with a low number of cores |
| Servers that are best consolidation platforms | → | New servers with faster processors | Servers that can achieve sustained high utilization | Servers with a high number of cores |
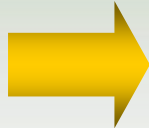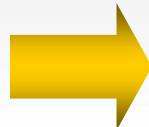
	Performance Ratio	Utilization Ratio	Core Ratio
Typical Ratios	**1.0 - 3.0**	**10 - 20**	**1- 64**

Maximize N!
The more servers you can consolidate, the more money you will save

Consolidation Math Sets Upper Limit But Other Factors Reduce That Upper Bound

$$N \leq (P_R)\,(U_R)\,(C_R)$$

- Efficiency of the platform hypervisor can reduce the consolidation ratios achievable
  - ▶ Different efficiency in each major dimension
    - − CPU utilization
    - − Memory footprint and over-commit overhead
    - − I/O demand

- Service Level Agreements set further thresholds
  - ▶ Random variability of workloads
  - ▶ Response time norms and maximums

Enough theory! We've been doing some consolidation projects on Intel, but IBM keeps suggesting the mainframe would be better. Is that really true? Can you show me?

Consolidating workloads on the mainframe provides the best economy of scale. Let's see why!

Service Oriented Finance CIO

IBM

How Many Workloads Can Be Consolidated? A Benchmark Comparison

We ran a benchmark to compare how many images can be consolidated in practice

**Friendly Bank online banking benchmark
(WebSphere Application Server) + 5MB I/O Load**

**Intel servers x366
4 cores @ 3.66 GHz
12 GB memory**
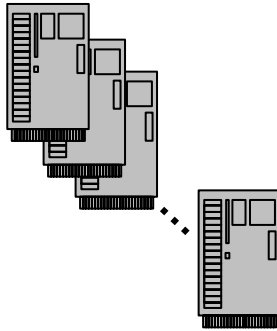
**Case 1:
Consolidate to z/VM**

**zLinux z10-EC
8 IFL cores @ 4.4 GHz
128 GB memory**

**Case 2:
Consolidate to VMware**

**x3650 M2 (Nehalem)
8 cores @ 2.93 GHz
128 GB memory**

**Existing non-virtualized
workload
on older servers**

**Consolidate VM
images on two
different platforms**

**Each VM image run on
4 virtual cores
1 GB virtual memory**

Adjust Benchmark Data For Service Level Agreements

- These benchmark results compare mean measurements when the workload has no variability
  - ▶ Variations in workload demand will exceed the mean

- Service level agreements anticipate variations
  - ▶ Specify that the workload demand will exceed the capacity of the machine in no more than approximately 5% of the measured utilization intervals

- If the variation of each workload is Sigma = 2.5*Mean then the service level agreement is satisfied when
  - ▶ z/VM runs 35 workloads
  - ▶ VMware runs 11 workloads

Consolidated Workloads

- Extreme virtualization with System z
  - ▶ z/VM
  - ▶ IFL specialty processor

- How many physical distributed servers can you consolidate?
  - ▶ Theory (Consolidation math)
  - ▶ Practice (Benchmarks)

- **TCO proof points**

The Enterprise Linux Server

The Enterprise Linux Server is a *new* footprint System z10 machine configured to run Linux-only workloads

- System z10 frame (EC or BC)
- IFL specialty processors
  - ▶ 2 to 10 for z10 BC machine
  - ▶ 6 to 64 for z10 EC machine
- 16 GB of memory per IFL
- Configured with 4-Port FICON cards and 4-Port OSA cards
- z/VM: base operating system and all features
- Hardware and software maintenance for three or five years
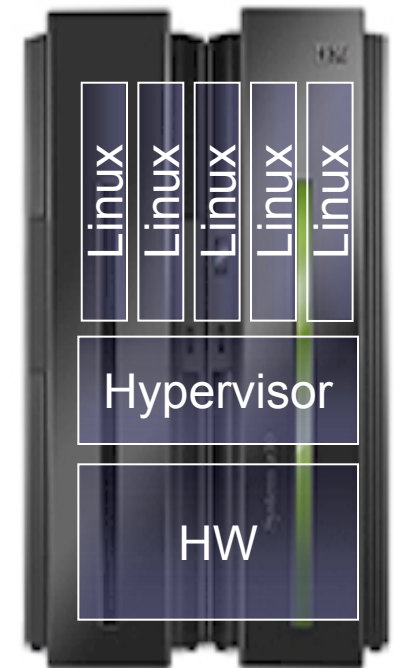
System z10 BC package as low as $50K per IFL

Note: Participation and Pricing may vary by country

System z Solution Edition For Enterprise Linux

The Solution Edition for Enterprise Linux delivers a similar solution stack that users can add to an *existing* z10

- IFL specialty processors
- 16 GB of memory per IFL
- Clients can optionally add more memory or I/O connectivity (OSA and FICON cards)
- z/VM: base operating system and all features
- Hardware and software maintenance for three or five years

Add an incremental LPAR to run Linux on z/VM

Incremental pricing for Solution Edition for Enterprise Linux is similar to the pricing characteristics of the Enterprise Linux Server

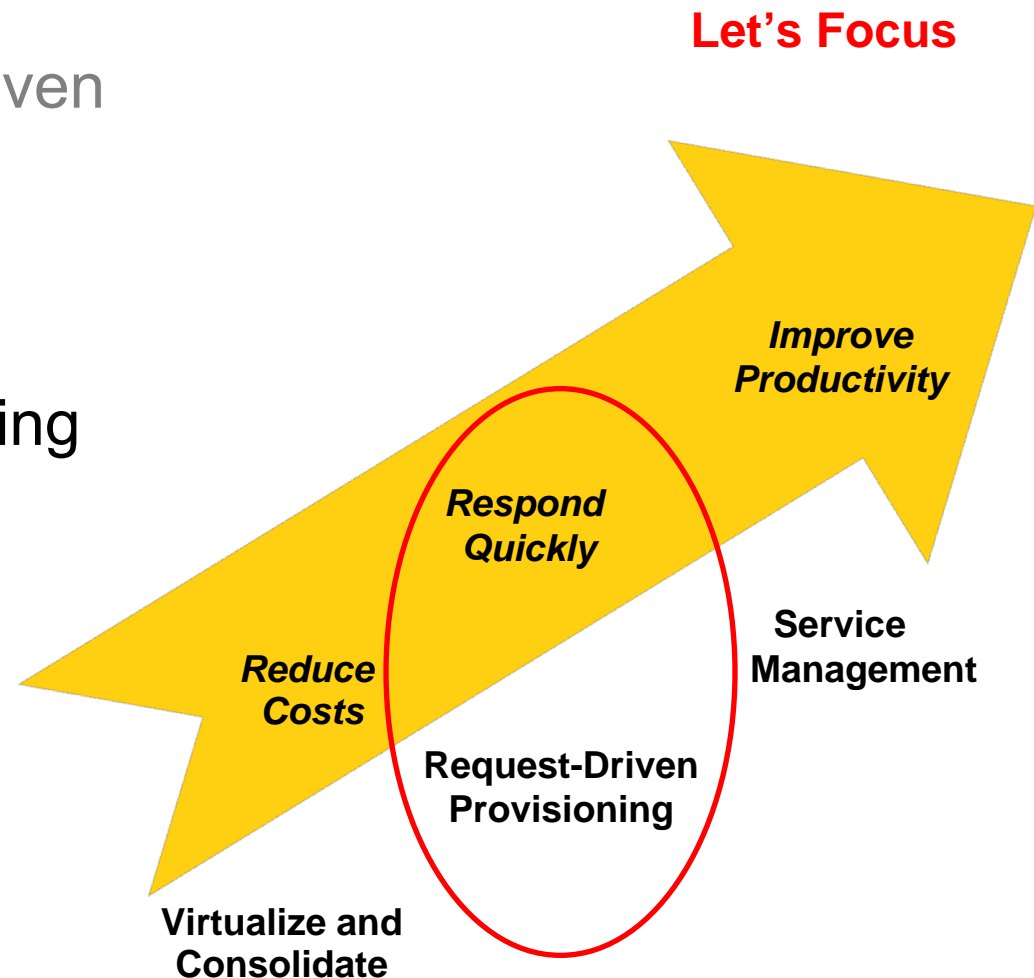# Case Study: Consolidate On Mainframe vs. Consolidate On VMware+Nehalem

Consolidate on new z10EC
Enterprise Linux Server

Appl

Linux

z/VM

28 IFL cores

Existing 120
4-way
Standalone
Servers

**17.5 cores to
1 IFL core**

**WAS ND
DB2 ESE
Tivoli Mgmt Agents**

**5.5 cores to
1 core**

Or consolidate onto 11
8-core Nehalem servers

*3 year TCO
$4.33M*

*Annual operating
cost $854K*

*A brand NEW z10EC
mainframe is cheaper than
VMware!*

*3 year TCO
$5.22M*

*Annual operating
cost $1.63M*

Why Did zLinux Cost Less Than VMware?

- Software per core pricing and fewer IFL cores mean lower software cost

- Lower labor cost of set up

- Enterprise Linux Server pricing for HW, SW, Maintenance

- DR cost much lower on mainframe than distributed

- IFLs are upgraded for free when upgrading

Dynamic Infrastructure For A Smarter Planet

- Virtualization and Consolidation is a proven way to save money

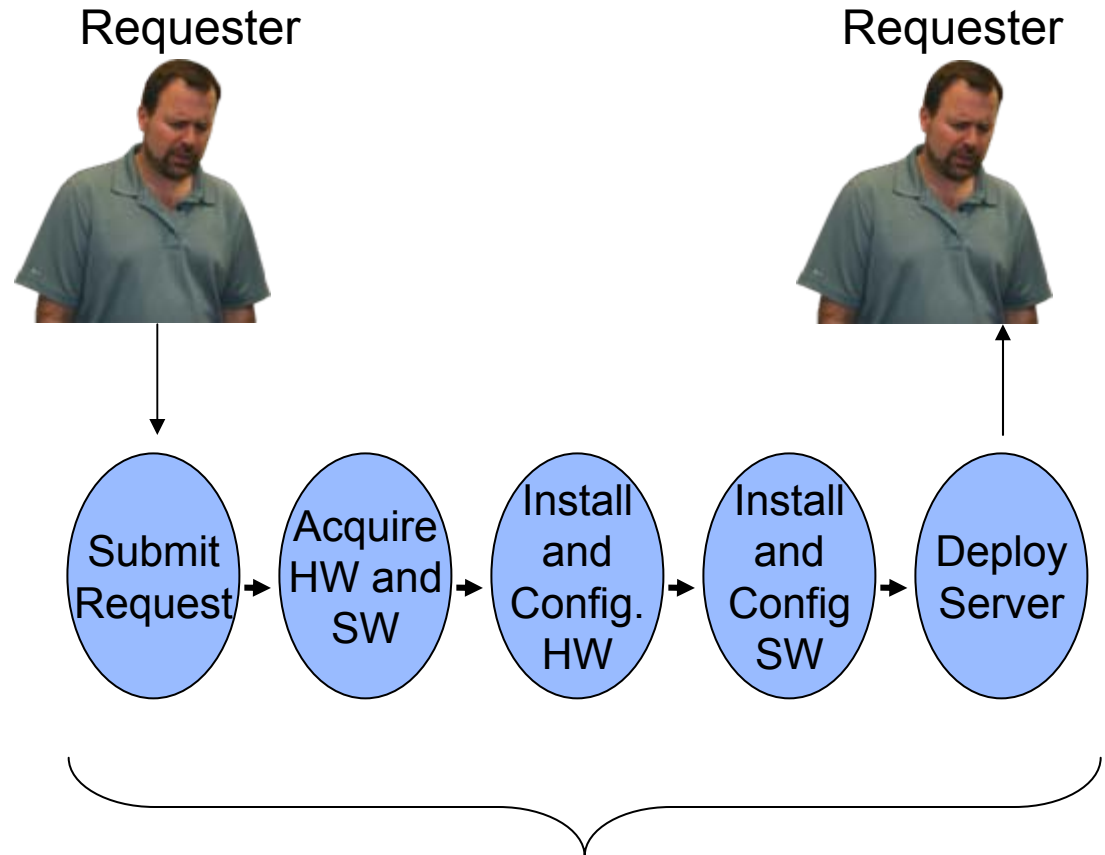- Request Driven, or Automated, Provisioning increases agility and lowers labor costs

Let's Focus

Improve Productivity

Respond Quickly

Service Management

Reduce Costs

Request-Driven Provisioning

Virtualize and Consolidate

Deploying New Applications And Services Is Difficult And Time-Consuming

Example – User Requests New Virtual Image On System z To Test Loan Application

User browses through the service catalog, adds service to his shopping cart, submits request

Request Approved

Request Fulfilled (implemented with Systems Director VMControl)

User gets notification of his requested service being ready

IBM Tivoli Service Request Manager (Service Catalog)

Self Service Portal

Catalog

Auto Manage

Service

IBM Systems Director VMControl

Capture

Deploy

Linux

Linux

z/OS

z/OS

z/VM

Hypervisor

Tivoli Service Request Manager (Service Catalog)

User browses through the service catalog, adds service to his shopping cart, submits request

Request Approved

Request Fulfilled

User gets notification of his requested service being ready

Service Catalog

Self service portal and catalog

- Structured, searchable, database of services available to end users
- Add orders to shopping cart and checkout

Auto manage order approval

- Order authorization and approval

Auto manage order fulfillment

- Automated provisioning of services
- Workflow management of manual process steps

Auto manage user notification

- Automatic notification to users of service being ready

Out-Of-Box Service Catalog Content

Service Line	Service Line Component	Service Definition
Server Systems Management	Server Management	Build New Standard Server Image
		Build New Standard Server Image with Middleware
		Deploy Server to Floor
		Perform Initial Build Activities
		Server Lock Down
	DB Subsystem Support	DBMS Install and Configure
		Add Database to Server
		Remove Database from Server
	Middleware Support	Middleware Install and Configure
Distributed Client Services	IMAC	Office Move
		Minor Facility Request
Enterprise Security Management	Identity and Access	Lotus Notes ID - Change Password
		Lotus Notes ID - Change User Name or Certifier
		Lotus Notes ID – Create/Delete Account
		ID Request
Data Network Services	Operations	Firewall Service Request
Fixed Cost Service Requests		Minor Site Enhancement
		I&S Network Consulting
		Bandwidth Analysis Assessment
Composite Service Examples		Build New Server
		Build New Server with Middleware

DEMO: Tivoli Service Request Manager

- User browses through Service Catalog
- Adds services to shopping cart
- Submits request

Value Of Automated Provisioning

- Automation reduces the labor (time and effort) required

- Time to initial deployment is reduced

- Better image control yields improved stability of systems

- Consistent configurations between test and production minimizes differences across environment

- Critical updates (security, stability, performance) can be automated and scheduled across all systems

- Changes to systems can be automated and scheduled by the support team

Techniques For Automated Provisioning

- Clone pre-configured image templates using disk copy
  - ▶ Systems Director VMControl
  - ▶ Very fast

- Install and configure environments based on pre-built workflows
  - ▶ Tivoli Provisioning Manager (TPM)

DEMO: Provisioning Using Disk Copy

Create a new Virtual Server quickly from existing template using disk cloning
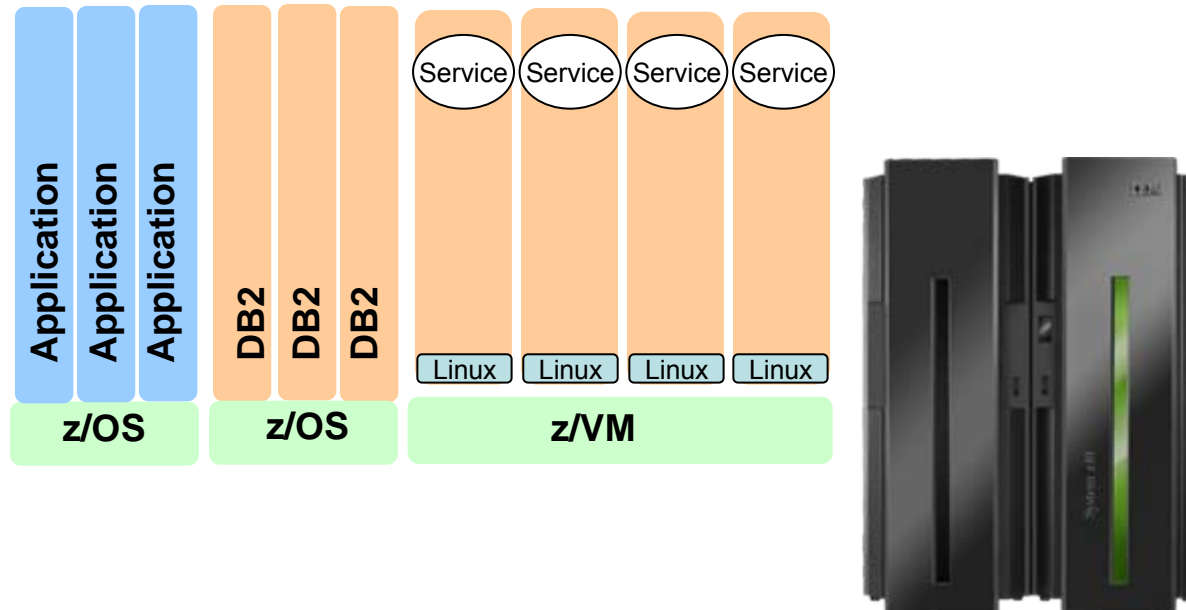
Systems Director VMControl

- IBM Systems Director provides base platform management
  - ▶ Included with purchase of IBM Systems
  - ▶ Provides common management tools for System z, Power Systems, System x, and BladeCenter
  - ▶ Discovery and inventory of physical and virtual resources
  - ▶ Status, health, and monitoring of resources

- IBM Systems Director VMControl extends base platform management
  - ▶ Capture Linux virtual image
    - − complete with guest operating systems, applications and virtual server definitions
  - ▶ Store virtual images in repository
  - ▶ Deploy using virtual image from repository as a template
    - − specify processors, memory, minidisk, virtual disk, temporary disk, linked disk, dedicated disk, network ports, server related settings
  - ▶ Delete Virtual Server
    - − Deleted server is removed from the z/VM user directory
    - − Minidisks are recovered
  - ▶ Edit Virtual Server
    - − z/VM user directory changes, changes to resources

Tivoli Provisioning Manager

- Automates manual tasks of installing and configuring environments
  - ▶ Operating systems
  - ▶ Patches
  - ▶ Middleware
  - ▶ Applications
  - ▶ Storage and network devices
  - ▶ Virtual environments

- Tasks automated through best practice automation workflows
  - ▶ Pre-built workflows describe provisioning steps
  - ▶ Automation package developer environment to customize for data center best practices and procedures
  - ▶ Automatic workflow execution with verification at each step

Public Cloud Providers Are A New Challenge To Enterprise Data Centers

- Line-of-business units can now go to public cloud providers for IT infrastructure services
  - ▶ Amazon Web Services (AWS)
  - ▶ Microsoft Azure

- Low cost, pay-per-use model seen as more cost-effective
  - ▶ Amazon EC2[1]: $0.10/hour (small Linux/UNIX instance)

- Near-immediate provisioning enables clients to respond at market speed
  - ▶ Pharmaceutical company: 64-node Linux cluster available in 5 minutes on AWS vs. 3 months internally[2]

- Threatens disintermediation of the internal IT team

[1] Virtual server equivalent to 1.2GHz single core Opteron processor
[2] http://www.informationweek.com/cloud-computing/blog/archives/2009/01/whats_next_in_t.html

Competition From Public Clouds Will Drive Adoption of Private Cloud Services By IT

Traditional
Outsourcing

**Users Rent a
Virtual Server**

Public Cloud
Services

**Users Rent a Virtual
Server From The Data
Center**

**Buy
Another
Server**
Traditional IT

Private Cloud
Services
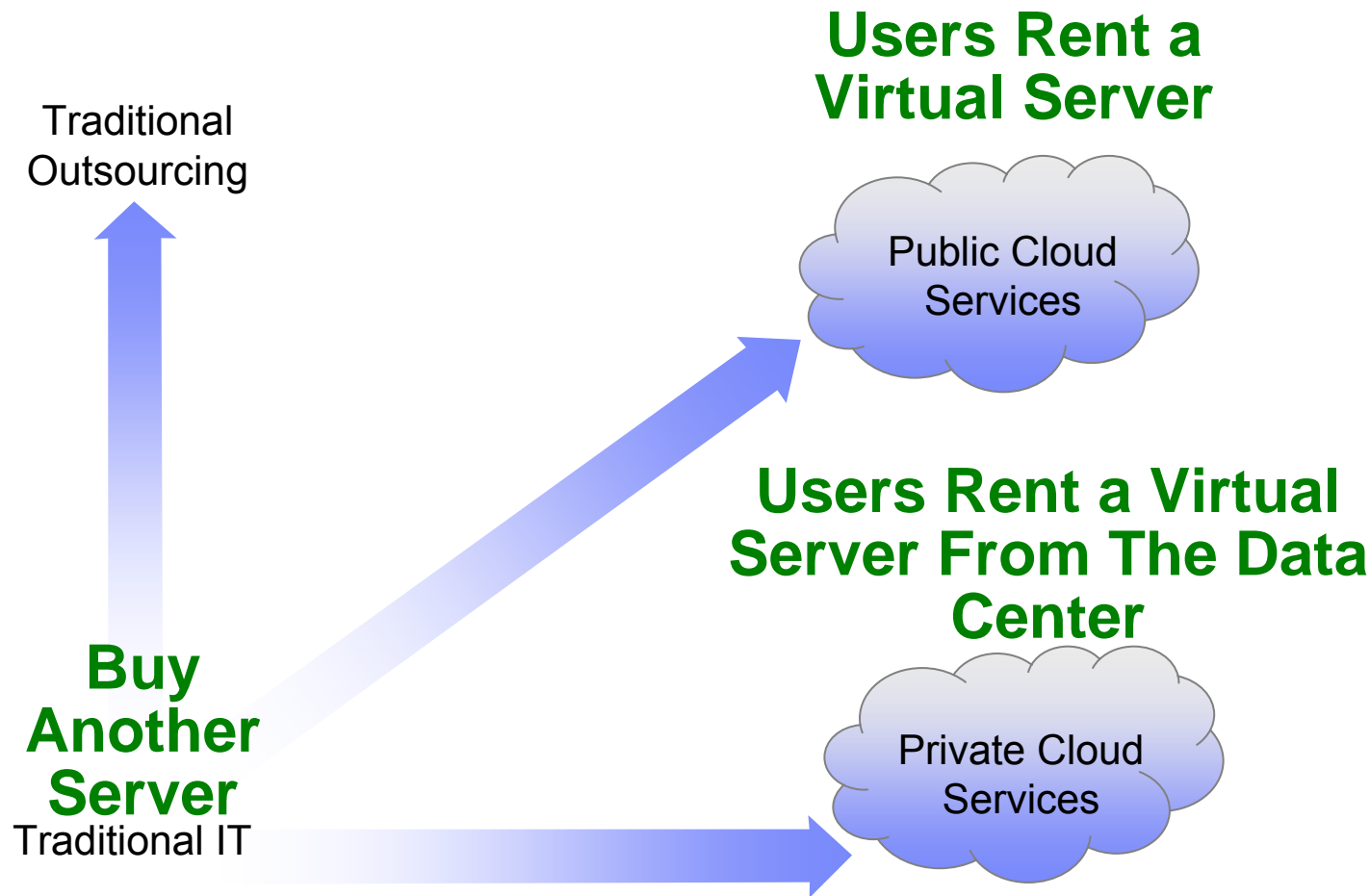
Three Things Are Needed To Build A Private Cloud Service

- Virtualization platform (1000's of images)
  - ▶ zLinux is ideal

- Self-service portal with automated provisioning and monitoring
  - ▶ System z Solution Edition for Cloud Computing (runs on zLinux)

- Meter and billing system
  - ▶ Tivoli Usage and Accounting Manager (runs on zLinux)

IBM System z Solution Edition For Cloud Computing

Builds on the IBM System z Solution Editions For Linux

Adds package of software and services to automate cloud provisioning

- IBM Tivoli software (runs on zLinux)
  - ▶ Tivoli Service Automation Manager (TSAM) V7.2
  - ▶ TSAM WAS component
  - ▶ Tivoli OMEGAMON XE on z/VM and Linux
  - ▶ Tivoli Monitoring for Virtual Servers

- IBM Lab Services
 - ▶ Planning , installation, configuring, testing services

- Significant package discounts
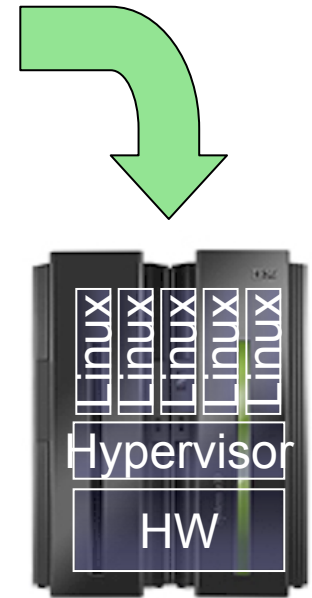
IBM System z Solution Editions For Linux

Solution Edition For Cloud Computing – Services

- Services offered through Lab Service are designed to plan, implement and optimize:

  - ▶ Planning workshop for cloud environment (pre-install)

  - ▶ Configure the system for the customer (LPAR creation, security configuration, etc.)

  - ▶ Install / prepare the base z/VM environment

  - ▶ Install and configure Tivoli products / components

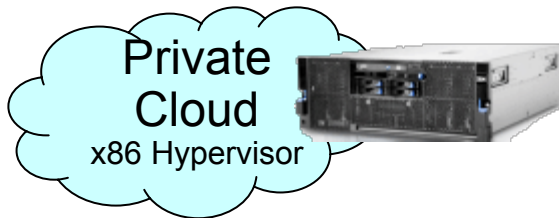 - ▶ Testing scenario development and execution for service automation and management

Example – What Is The Lowest Cost Way To Support 100 Linux Workloads?

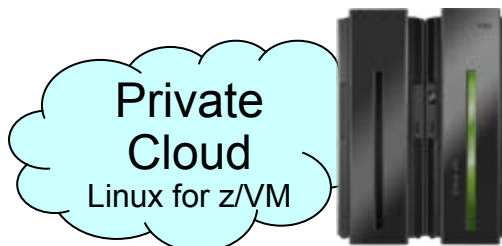*Which platform provides the lowest TCO cost per image over 5 years?*
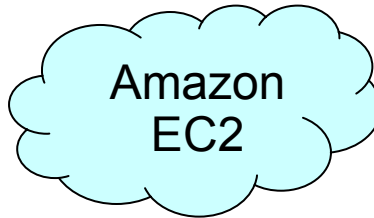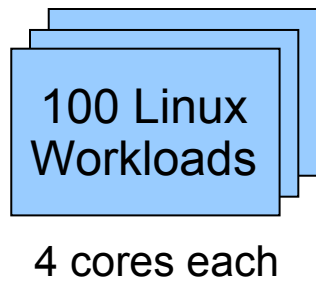
Requirements

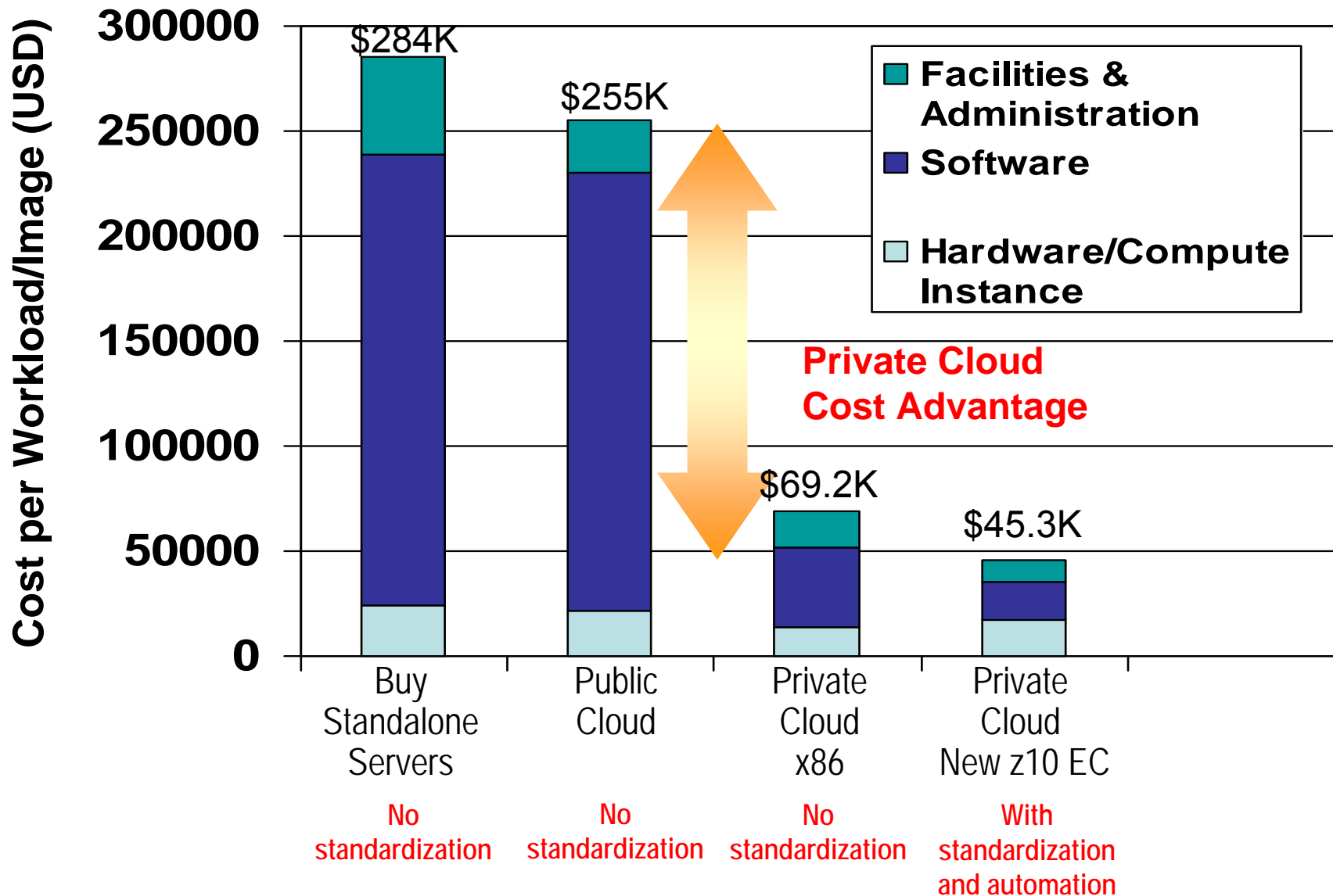Buy 100 IBM x3250 4-core servers

100 Amazon EC2 instances

8 IBM x3950 8-core servers

New IBM z10 EC w/12 IFLs

100 Linux Workloads

4 cores each

Amazon EC2

Private Cloud
x86 Hypervisor

Private Cloud
Linux for z/VM

Note: Assume 1.7 oversold factor

Cost Per Image For Linux Workloads (5 Yr TCO)

Data Centers Can Leverage The Cost Advantage Of Private Clouds

- Eliminate competition from public clouds

- Gather in distributed workloads outside the data center

- Demonstrable cost savings for the business

A Plan For Consolidation

- **Pick Linux workloads that are easy to migrate**
  - ▶ Middleware and packaged applications
  - ▶ Infrastructure
  - ▶ C++ (recompile)
  - ▶ Open source may not yield same cost savings

- Use consolidation math to **identify servers with low utilization, older processors, and few cores per server**

- **Establish expected service levels**
  - ▶ Group workloads to offset expected variability

- For la[   ]ation projects, **consider grouping workloads** for co[   ] platforms

  Use System z Solution Editions

  - ▶ By location, function, or workload type

- Be prepared to **compare the cost** of consolidation on zLinux vs. consolidation on VMware/Intel.

Summary

A Dynamic **I**nfrastructure with System z can **T**ake **C**osts **O**ut.

Start a project now !

IBM