System z Enables Solutions For A Smarter Planet

Dynamic Infrastructure With System z

Dynamic Infrastructure Requirements

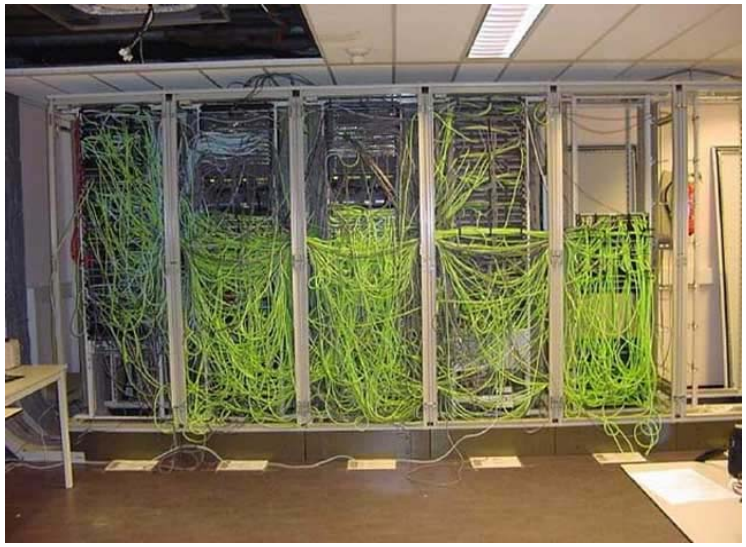
- TCO – Take Costs Out!
- Faster Provisioning
- Secure and Resilient

Service Oriented Finance CIO

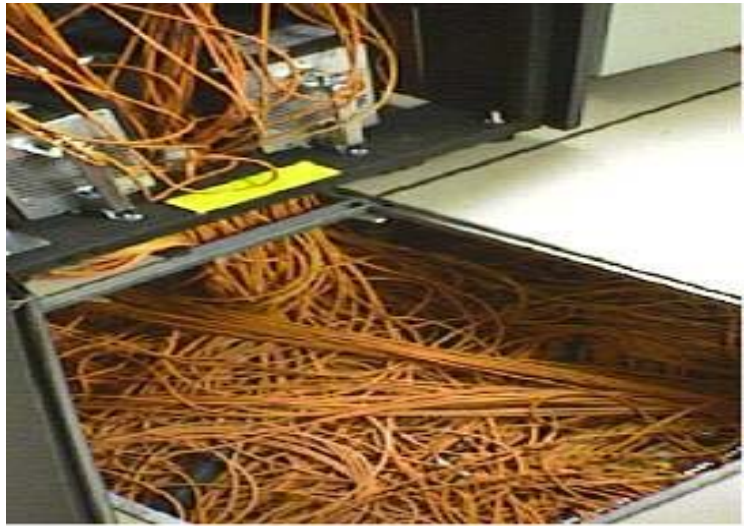
System z delivers all these capabilities today!

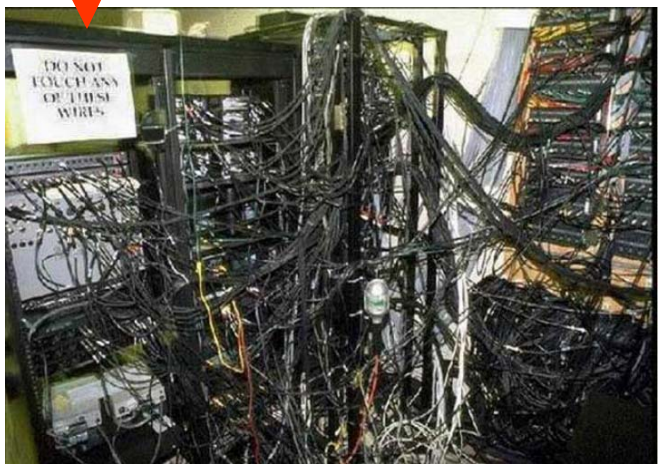
IBM

Complexity Is Growing

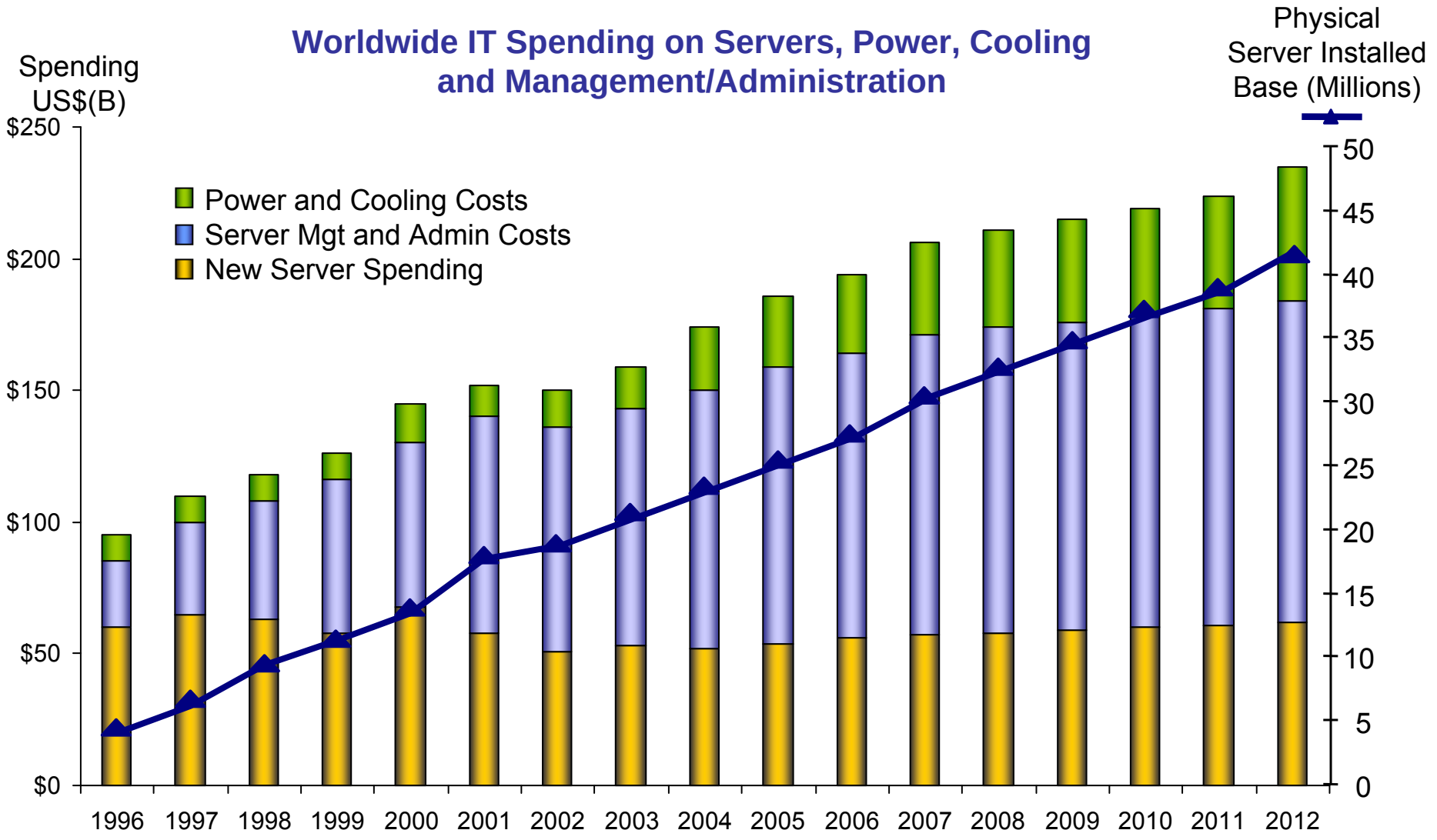


- Complexity drives cost
- Reduces responsiveness
- Likely to impact security and performance





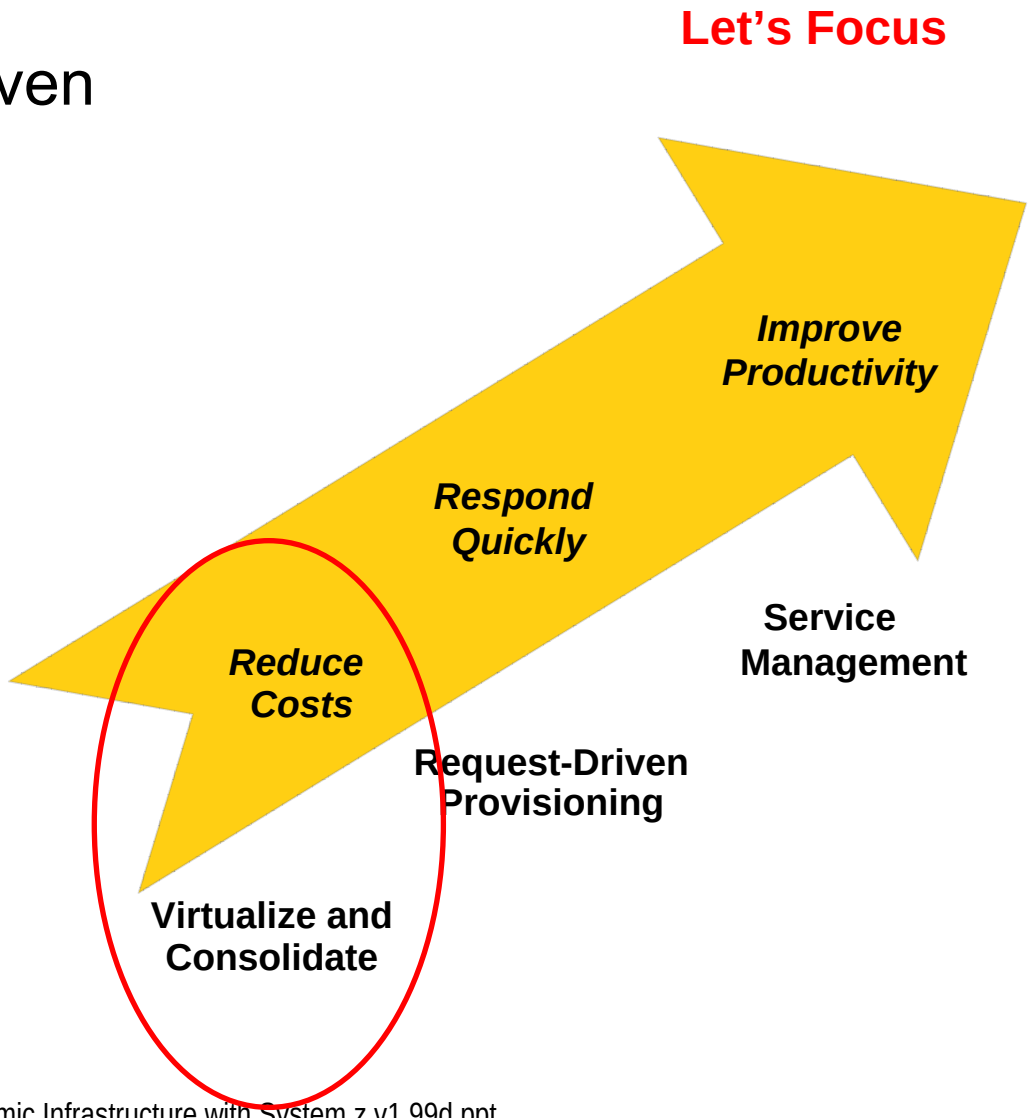
Annual Operating Costs Are Out Of Control



IDC, 2008

Dynamic Infrastructure For A Smarter Planet

- Virtualization and Consolidation is a proven way to save money



Understand All The Operational Costs

Annual Operations Cost Per Server
(Averaged over 3917 Distributed Servers)

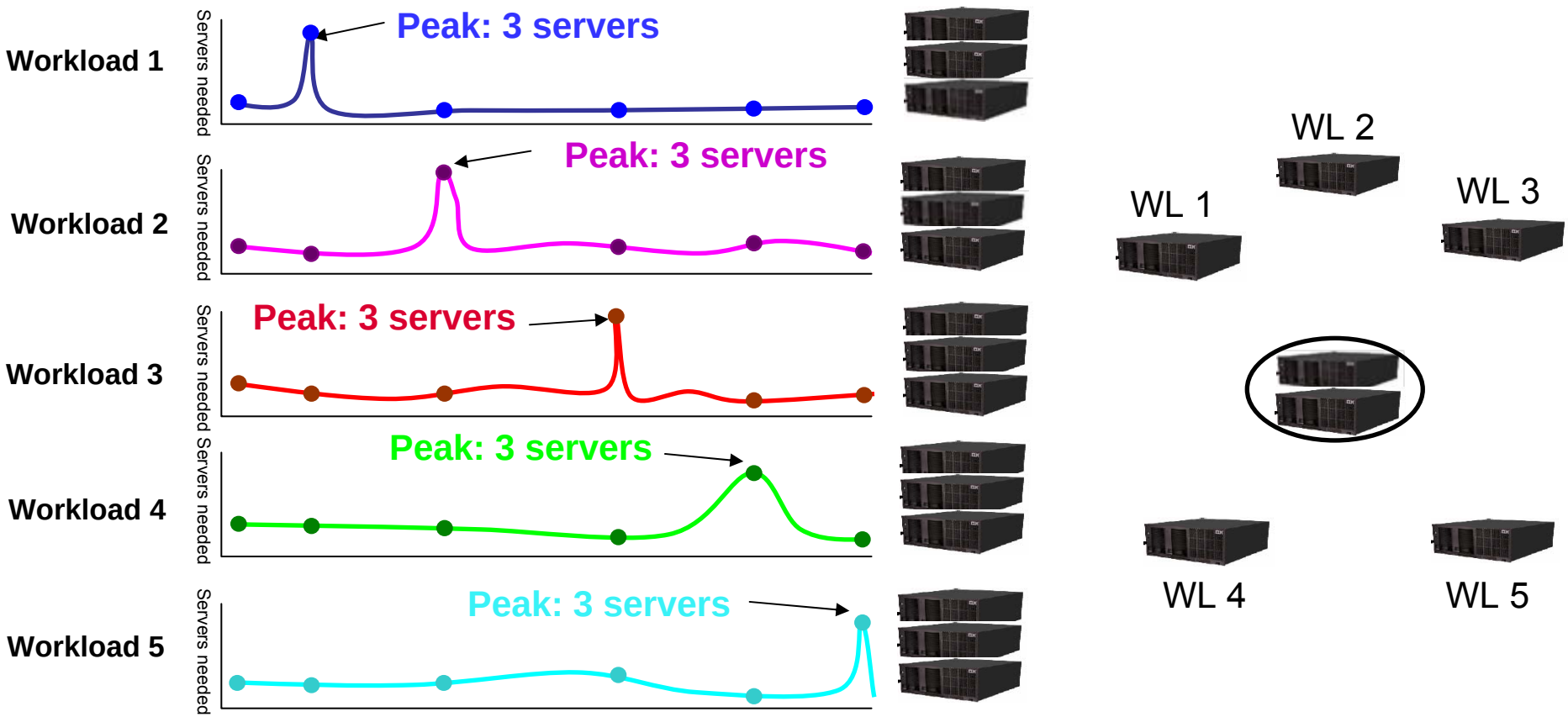
Power	$731
Floor Space	$987
Annual Server Maintenance	$777
Annual connectivity Maintenance	$213
Annual Disk Maintenance	$203
Annual Software support	$10,153
Annual Enterprise Network	$1,024
Annual Sysadmin	$20,359
Total Annual Costs	$34,447

Needed: Something that works on these

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

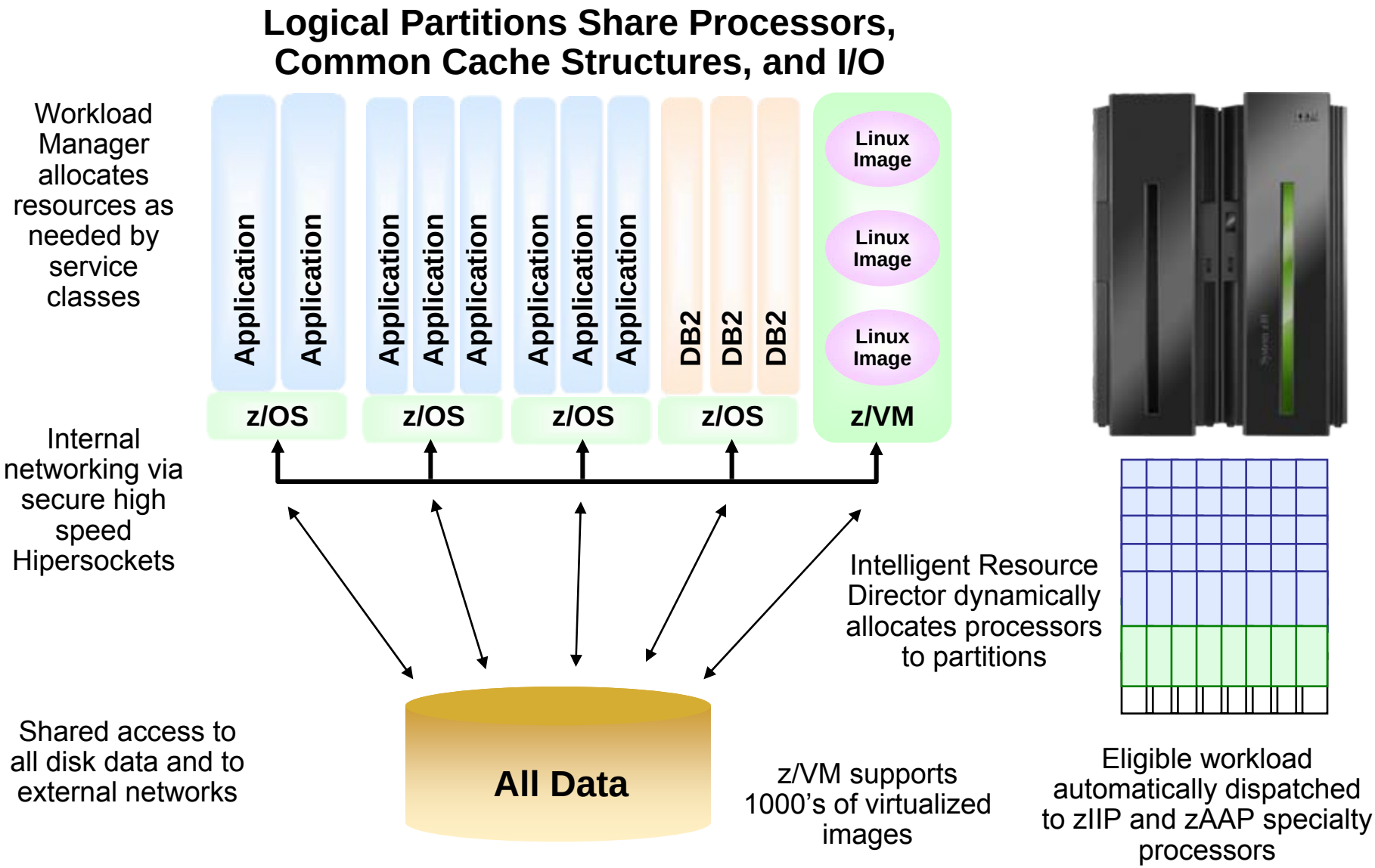
Source: IBM internal study

Example:
Improve Efficiency And Reduce Costs



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



Linux Server Consolidation On System z Takes Cost Out Because…

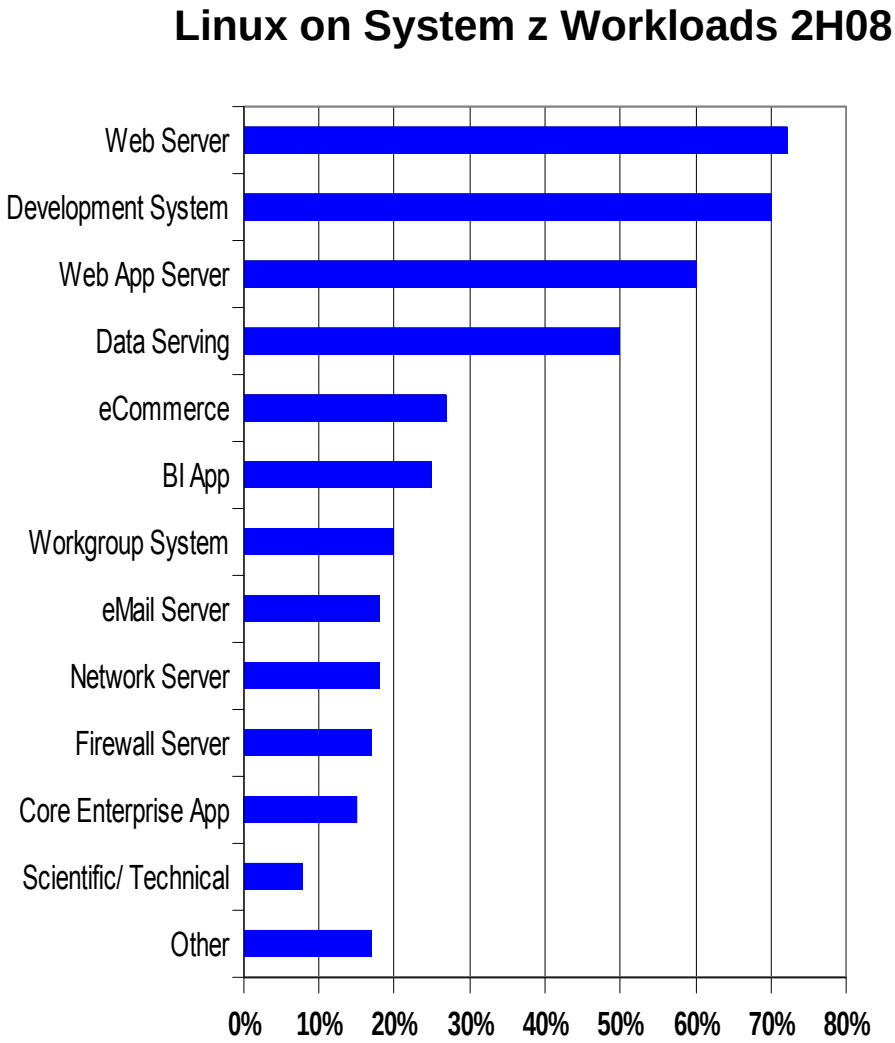
- System z IFL processor is deeply discounted
- IBM (and many other vendors) only charge per IFL processor fees for software, not per image
- Consolidation reduces most other annual operations costs
- Simplify networks by removing physical implementation
- Benefit from System z virtualized storage and hierarchical management
- Leverage mainframe systematic disaster recovery
- Consistently use RACF security
- z/VM can provision new virtual servers quickly
- Disk copy of preconfigured images eliminates software install
- z/VM can handle the consolidation of 1,000's of images

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

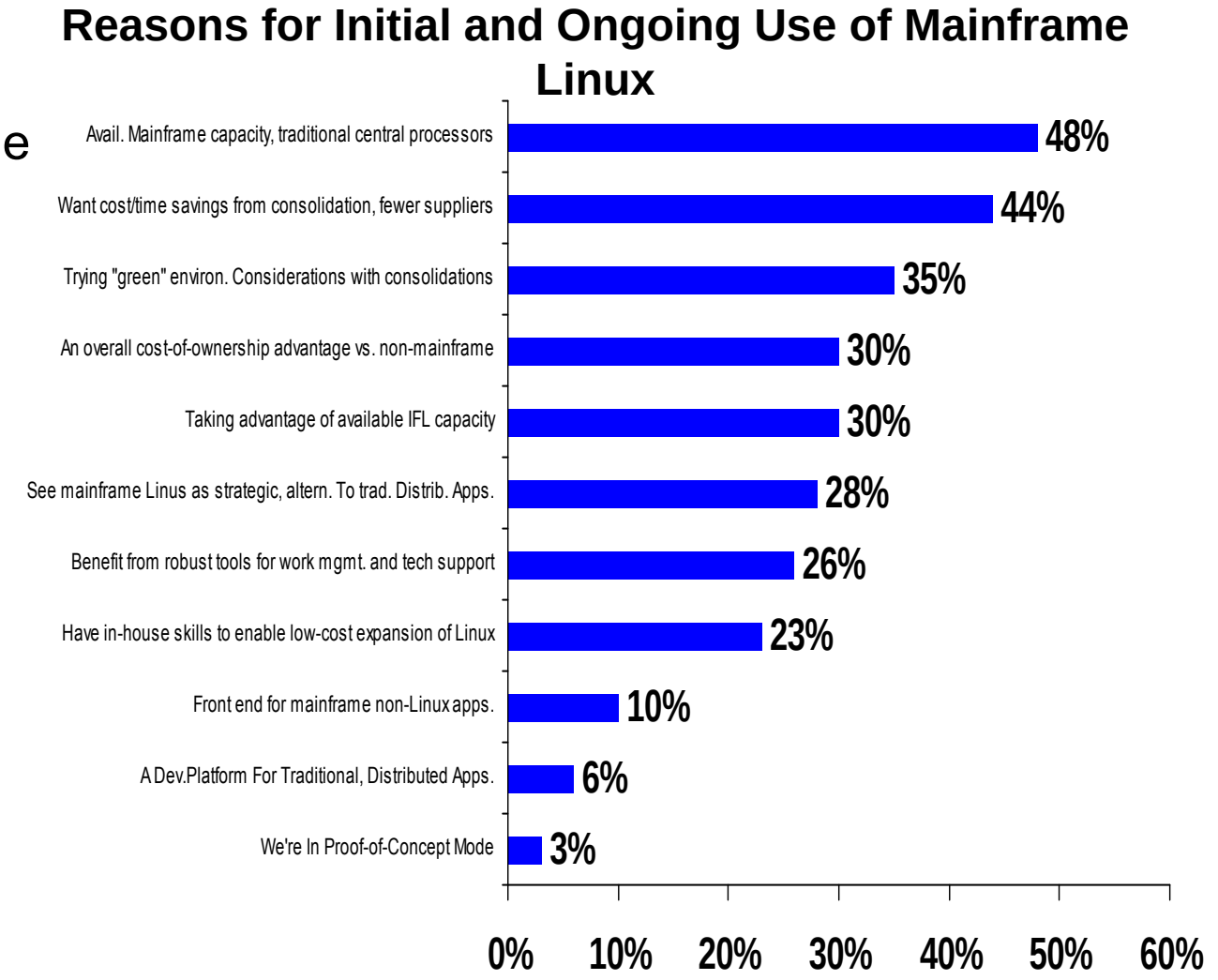
- Clients are deploying Linux on z for a broad set of applications
- Almost 2,500 applications available for Linux on System z
- Leading applications for Linux on System z:
  - WebSphere
  - SAP
  - Domino
  - Cognos
  - Oracle



Customers Have Compelling Reasons For Adopting Linux On System z

Top Reasons

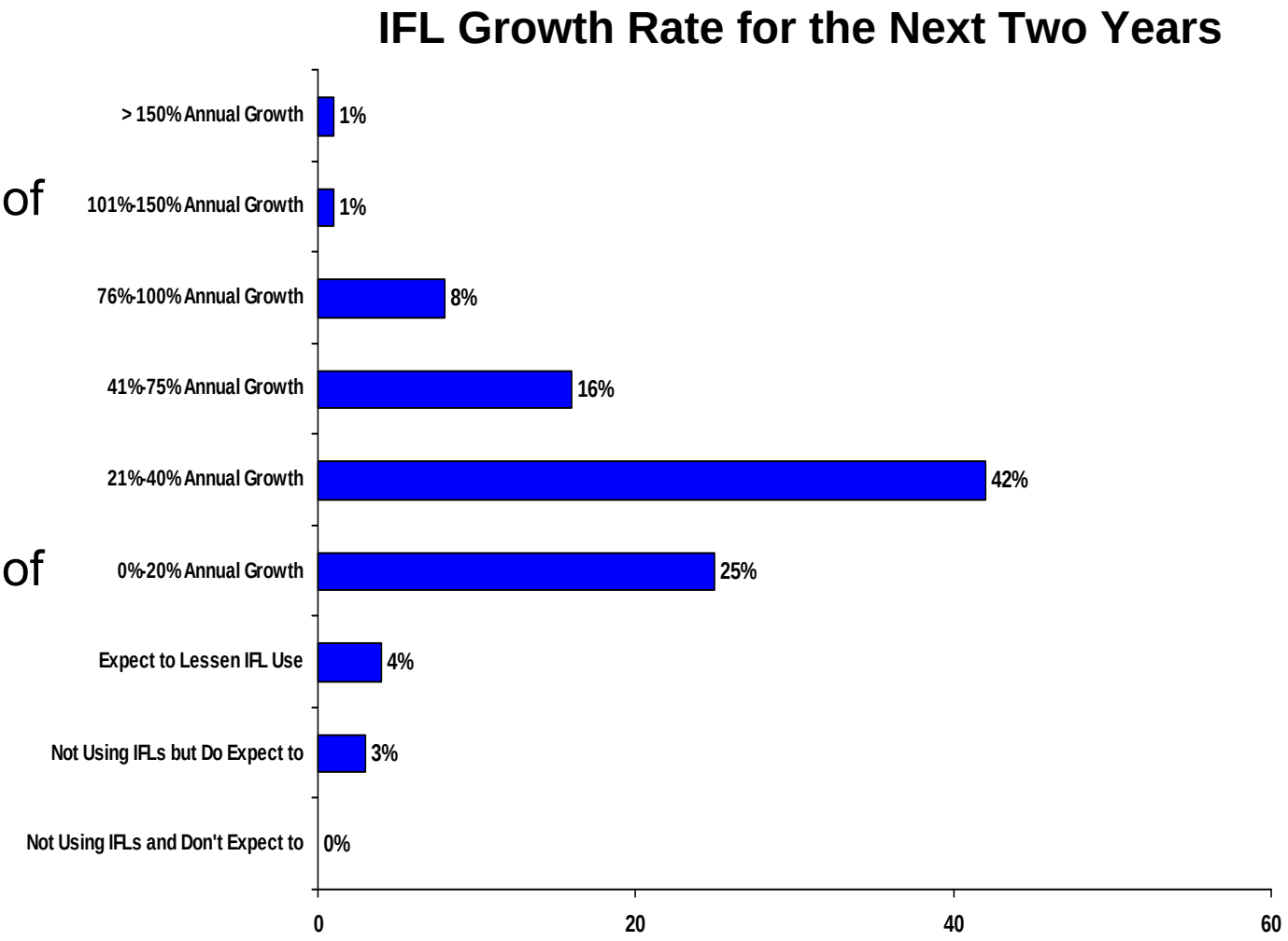
- Available mainframe capacity:
  - Central Processor
  - IFL
- Cost Reduction vs. other platforms:
  - Consolidation savings
  - Overall TCO advantages vs. non-MF
- Going Green



Source: *Usage and Plans for Mainframe Linux – Acceptance and Challenges: TheInfoPro, Inc., 2009*

Customers' Near Term IFL Capacity Growth Expected To Be Strong

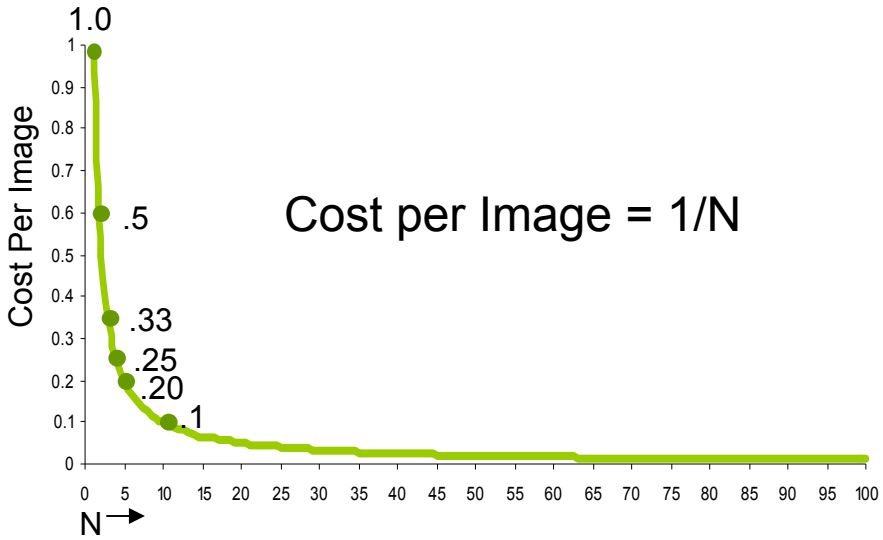
- 24% expect annual growth of 41-100%
- 67% expect annual growth of 0-40%



Source: *Usage and Plans for Mainframe Linux – Acceptance and Challenges: TheInfoPro, Inc., 2009*

How Much Money Can You Save?

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



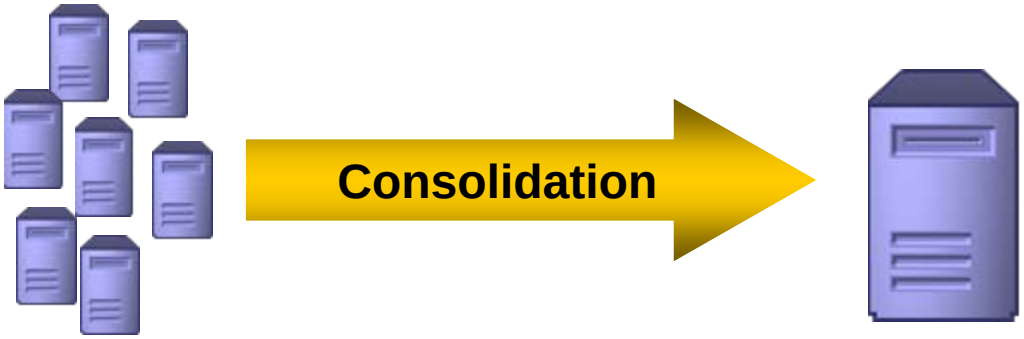
Cost per Image = 1/N

- 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?



Ratios

$P_R = P_B / P_A$

$U_R = U_B / U_A$

$C_R = C_B / C_A$

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

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?

Service Oriented Finance CIO

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

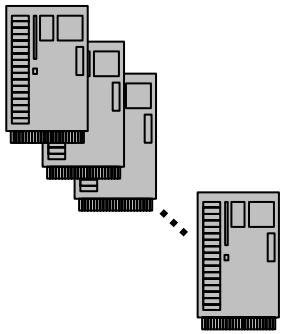
IBM

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)

Intel servers x366
4 cores @ 3.66 GHz
12 GB memory

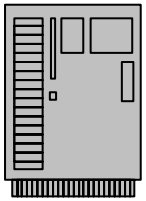


Workload for each server:
5% utilization
40 ms response time
4.5 tps

Case 1: Consolidate to z/VM

Case 2: Consolidate to VMware

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



Intel server x3950
8 cores @ 3.5 GHz
64 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

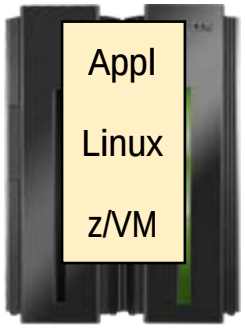
- These benchmark results compare mean measurements when the workload has no variability
  - Variations in workload demand will exceed the mean
- Service level agreements anticipate variations
  - Specify that the workload demand will exceed the capacity of the machine in no more than approximately 5% 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 40 workloads
  - VMware runs 8 workloads

Case Study: Consolidate On Mainframe vs. Keeping Existing Dedicated Servers

Existing Mainframe

Existing processors:
4 general purpose

Add LPARs for Intel Server Consolidation



Add 20 IFL cores

3 year TCO $7.02M

Annual operating cost $1.16M

Payback in Year 1

5 servers to 1 IFL core

Existing 100 Standalone Servers

WAS ND
DB2 ESE
Tivoli Mgmt Agents

Or maintain existing 100 machines in Intel server farm

3 year TCO $14.34M

Annual operating cost $4.78M

Case Study: Consolidate On Mainframe vs. Keeping Existing Dedicated Servers (3 Yrs)

Mainframe Incremental Hardware

OTC		ANNUAL	
20 IFL Processors	$1,500,000	Power/Space	$12,060
		Hardware [1] Maintenance	$350,160
RAM (80GB)	$180,000		
		Systems Admin	$239,679
Disk Acq.	$182,832	Disk Maintenance	$5,712
Migration	$1,685,100		
TOTAL	$3,547,932	TOTAL	$607,611 (yr 2,3)

Mainframe Software

OTC		ANNUAL	
z/VM	$328,500	z/VM	$82,198
		DB2 S&S	$194,400
		WAS S&S	$83,520
		Linux S&S	$180,000
		Mgmt S&S	$15,600
TOTAL	$328,500	TOTAL	$555,718

Dedicated Hardware

OTC		ANNUAL	
Sunk Cost	$0	Power/Space	$171,700
		Hardware Maintenance	Sunk Cost
		Systems Admin	$2,032,300
		Disk Maintenance	Sunk Cost
TOTAL	$0	TOTAL	$2,204,000

Dedicated Software

OTC		ANNUAL	
Sunk Cost	$0	WAS S&S	$696,000
		Linux S&S	$129,900
		DB2 S&S	$1,620,000
		Mgmt S&S	$130,000
TOTAL	$0	TOTAL	$2,575,900

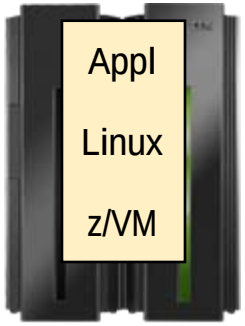
[1] First year maintenance free

Case Study: Consolidate On Mainframe vs. Consolidate On VMware (5 Years)

Existing Mainframe

Existing processors:
4 general purpose

Add LPARs for Intel Server Consolidation



Add 20 IFL cores

5 year TCO $9.34M

Annual operating cost $1.16M

5 servers to 1 IFL core

Existing 100 Standalone Servers

Or consolidate existing 100 machines onto 13 large Intel servers

WAS ND
DB2 ESE
Tivoli Mgmt Agents

8 servers to 1
(1 server to 1 core)

5 year TCO $12.15M

Annual operating cost $1.63M

Case Study: Consolidate On Mainframe vs. Consolidate On VMware (5 Years)

Mainframe Incremental Hardware

OTC		ANNUAL	
20 IFL Processors	$1,500,000	Power/Space	$12,060
		Hardware [1] Maintenance	$350,160
RAM (80GB)	$180,000		
		Systems Admin	$239,679
Disk Acq.	$182,832	Disk Maintenance	$5,712
Migration	$1,685,100		
TOTAL	$3,547,932	TOTAL	$607,611 (yr 2-5)

Mainframe Software

OTC		ANNUAL	
z/VM	$328,500	z/VM	$82,198
		DB2 S&S	$194,400
		WAS S&S	$83,520
		Linux S&S	$180,000
		Mgmt S&S	$15,600
TOTAL	$328,500	TOTAL	$555,718

VMware Hardware

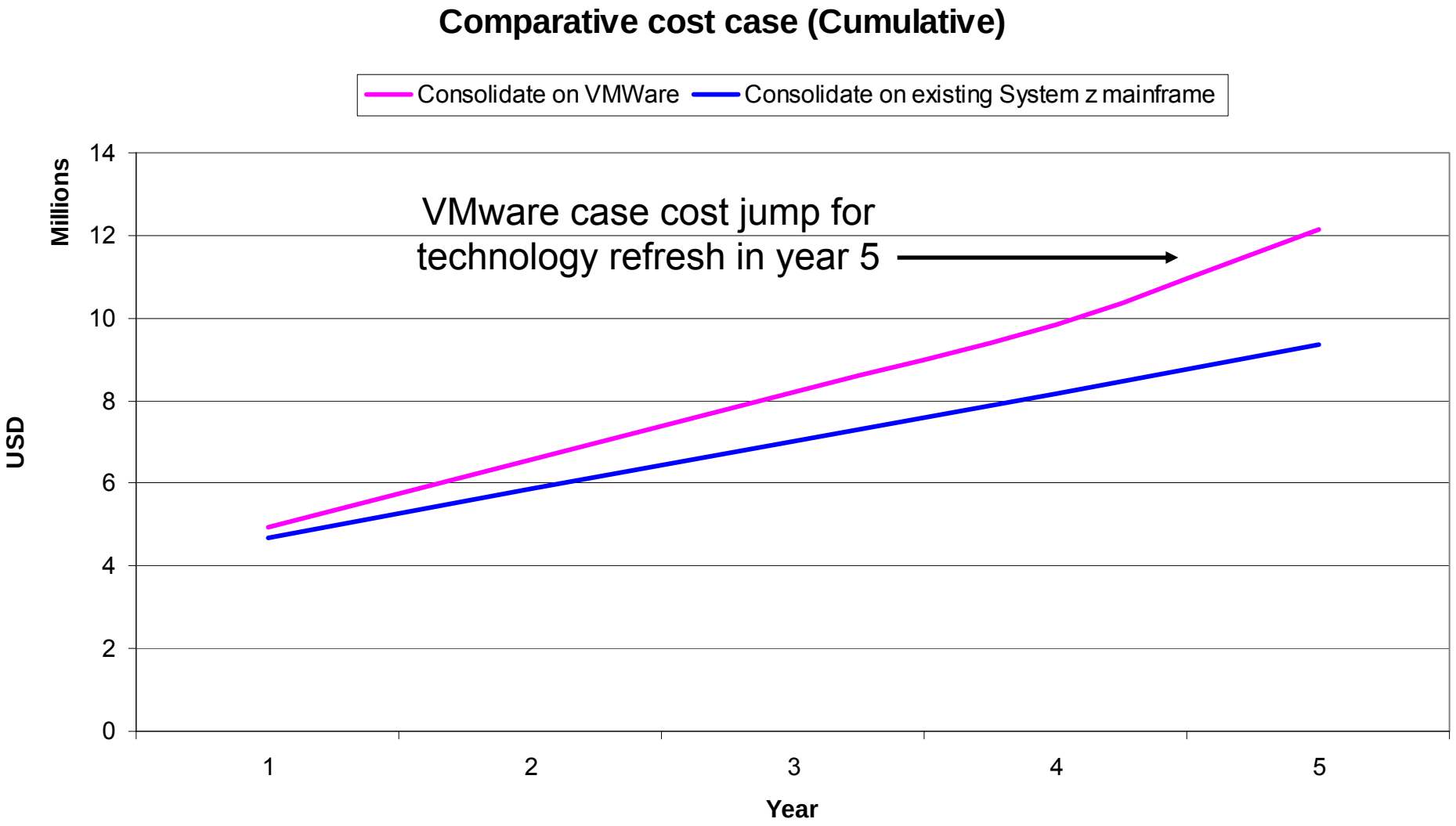
OTC		ANNUAL	
New Servers	$673,205	Power/Space	$27,313
Tech Refresh (yr 5)	$673,205	Hardware Maintenance	Paid in acq.
Disk Acq.	$561,600	Systems Admin	$836,860
Migration	$1,853,610	Disk Maintenance	$26,160
TOTAL	$3,761,620	TOTAL	$890,333

VMware Software

OTC		ANNUAL	
VMware	$299,000	VMware S&S [1]	$74,750
		WAS S&S	$180,960
		Linux S&S	$32,487
		DB2 S&S	$421,200
		Mgmt S&S	$33,800
TOTAL	$299,000	TOTAL	$743,197 (yr 2-5)

[1] First year maintenance free

VMware TCO Result



What Happens If We Add Disaster Recovery?

Existing Mainframe

Existing processors:
4 general purpose

Add LPARs for Intel Server Consolidation

Add 20 IFL cores
Add 20 CBU cores to DR system

5 year TCO $9.93M

Annual operating cost $1.22M

5 servers to 1 IFL core

Existing 100 Standalone Servers

WAS ND
DB2 ESE
Tivoli Mgmt, Automation

Or consolidate existing 100 machines onto 13 large Intel servers + 13 DR servers

8 servers to 1
(1 server to 1 core)

5 year TCO $18.57M

Annual operating cost $2.49M

Case Study: Consolidate On Mainframe vs. Consolidate On VMware (5 Years, with DR)

Mainframe Incremental Hardware

OTC		ANNUAL	
20 IFL Processors	$1,500,000	Power/Space	$12,060
		Hardware [1] Maintenance	$390,160
RAM (144GB)	$324,000		
		Systems Admin	$239,679
Disk Acq.	$365,663	Disk Maintenance	$11,424
Migration	$1,685,100		
TOTAL	$3,874,763	TOTAL	$653,323 (yr 2-5)

Mainframe Software

OTC		ANNUAL	
z/VM	$328,500	z/VM	$82,198
		DB2 S&S	$194,400
		WAS S&S	$83,520
		Linux S&S	$180,000
		Mgmt S&S	$29,424
TOTAL	$328,500	TOTAL	$569,542

VMware Hardware

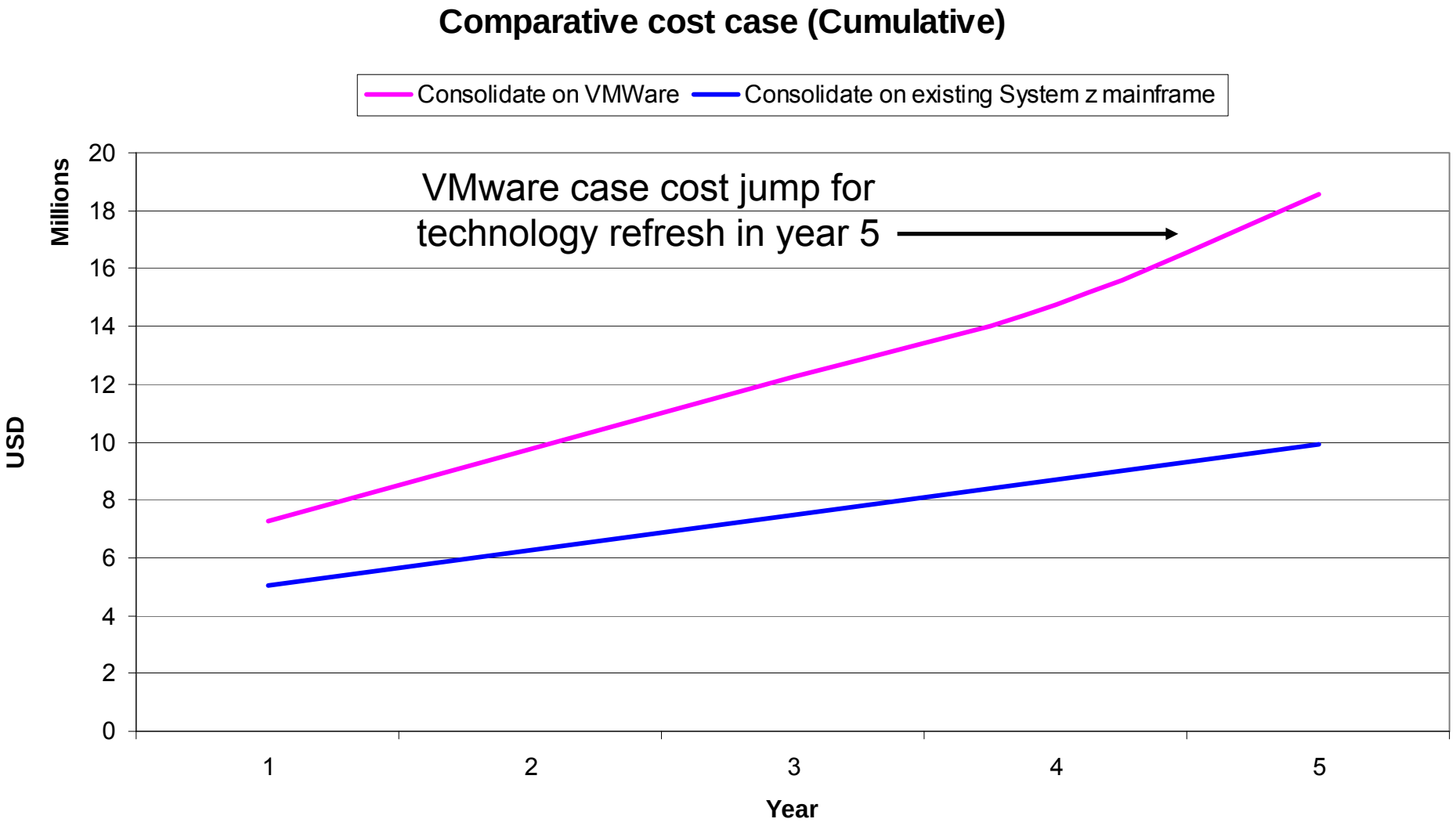
OTC		ANNUAL	
New Servers	$1,346,410	Power/Space	$54,626
Tech Refresh (yr 5)	$1,346,410	Hardware Maintenance	Paid in acq.
Disk Acq.	$1,123,200	Systems Admin	$836,860
Migration	$1,853,610	Disk Maintenance	$52,320
TOTAL	$5,669,630	TOTAL	$943,806

VMware Software

OTC		ANNUAL	
VMware	$598,000	VMware S&S [1]	$149,500
		WAS S&S	$361,920
		Linux S&S	$64,974
		DB2 S&S	$842,400
		Mgmt S&S	$127,504
TOTAL	$598,000	TOTAL	$1,546,298 (yr 2-5)

[1] First year maintenance free

VMware TCO Result With Disaster Recovery



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
- IFL processor discount
- DR cost much lower on mainframe than distributed
- IFL's are upgraded for free when upgrading
- Incremental cost case (not new footprint)

System z Provides Additional Advantages

- System z provides better qualities of service
  - Better platform reliability and serviceability
  - Higher I/O bandwidth
  - Opportunity to use RACF for consistent security
  - Systematic disaster recovery for zLinux workloads

- And there are additional System z cost advantages not yet discussed
  - System z storage virtualization
  - Smooth predictable growth of z capacity as workloads grow
  - Lower cost for systems management hardware and software on System z

Bank Of New Zealand Consolidated Their Front-End Sun Servers To A Single Mainframe

bnz

Combination of z/VM and Red Hat Linux enabled BNZ to virtualize a largely distributed Sun environment, which incorporates all of its front-end systems, down to just one box

- Consolidated workload of 100's of Sun SPARC systems to the new mainframe system
- Reduced front-end systems datacenter footprint by 30%
- Reduced front-end power consumption by nearly 40%
- 39% reduction in carbon dioxide emissions
- 20% annual ROI expected over the life of the platform

Bank Of New Zealand Scenario

	FROM …	TO …
Competing HW infrastructure	Sun SPARC (e10K, v440, 280R)	z10 EC
Footprints	Tens of machines	1 machine
Cores / Memory	131 cores* Thousands of GB	3 IFLs, 160 GB Storage
Application	Front-end IT environment, incl. the internet banking and back teller functions through to backend data	
OS	Solaris (multiple versions)	Linux + z/VM
Energy / Space / Other: Power (kWhr) Heat (kBTUs/hr) Space (racks) CO2 (tonnes)	 36 kWhr 110 kBTUs/hr 6.5 racks 66 tonnes	 22 kWhr -> 38% less 74 kBTUs/hr -> 33% less 4.5 racks -> 31% less 40 tonnes -> 39% less

Summary of Benefits:

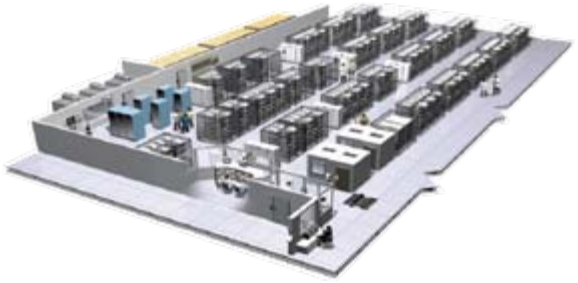
- **Maximize space, keep costs down and reduce carbon footprint**
- **Boost the speed of new deployments**

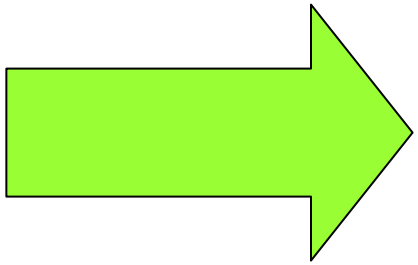
*Customer estimate

Server Consolidation and Migration Services Offering – May 2009 – NEW

Initiative to make it easier for Sun and HP Customers to join the move to IBM System z

- Dramatically reduce the time/effort in migrating applications
- Based on IBM's own server consolidation experience
- z Rewards
  - Customer financial incentives to take advantage of these services



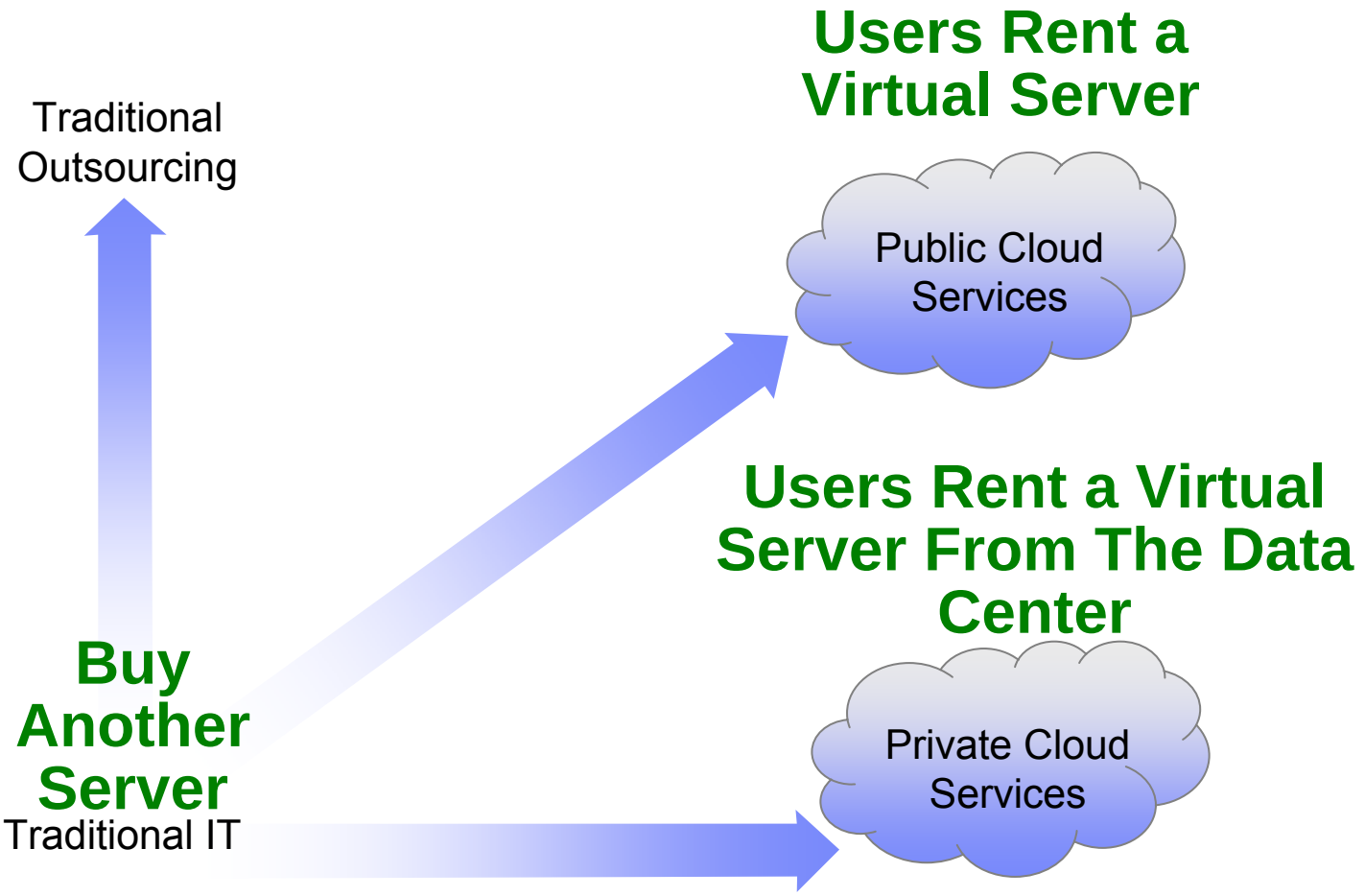


Public Cloud Providers Are A New Challenge To Enterprise Data Centers

- 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

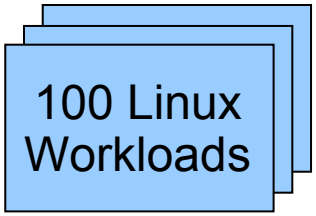
[1] Virtual server equivalent to 1.2GHz single core Opteron processor
[2] http://www.informationweek.com/cloud-computing/blog/archives/2009/01/whats_next_in_t.html

Public Cloud Competition Will Drive The Evolution To Private Cloud Services



Use Case Study To Compare TCO - 100 Linux Workloads (1.7 Oversold)

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



WAS

DB2

ITCAM

Amazon EC2

Private Cloud
x86 hypervisor

Private Cloud
zLinux

Requirements

Buy 100 IBM x3250 4-core servers

100 Amazon EC2 instances

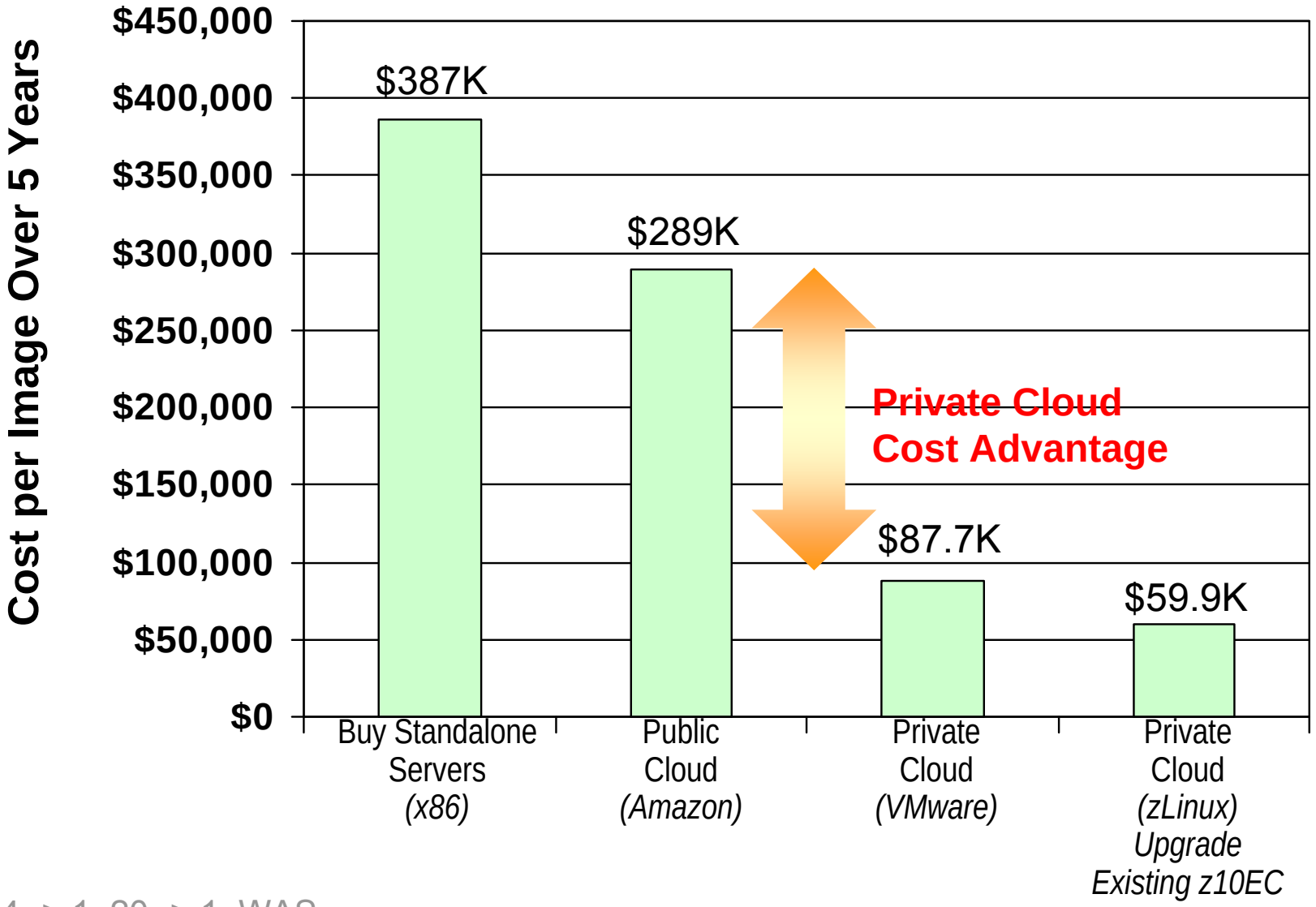
8 IBM x3950 8-core servers

100/(1.7 x 8) = 7.3 -> 8

12 IFLs on existing IBM z10 EC

100/(1.7x5) = 11.8 -> 12

You Can Deliver Workloads At The Lowest Cost With A Private Cloud



4 -> 1, 20 -> 1, WAS

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 large scale consolidation projects, **consider grouping workloads** for consolidations on different platforms
  - By location, function, or workload type
- Be prepared to **compare the cost** of consolidation on zLinux vs. consolidation on VMware/Intel

Summary

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

Start a project now !

IBM