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What IT Managers Need to Know About z/VM and the Value of zSeries Virtualization Technology for Linux

Reed A. Mullen

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What IT Managers Need to Know About z/VM and the Value of zSeries Virtualization Technology for Linux

October 2006

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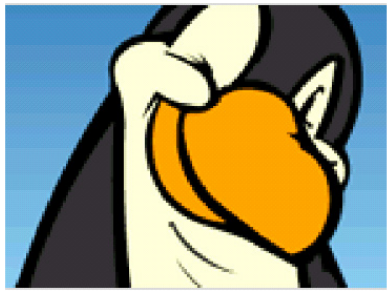
IBM Systems

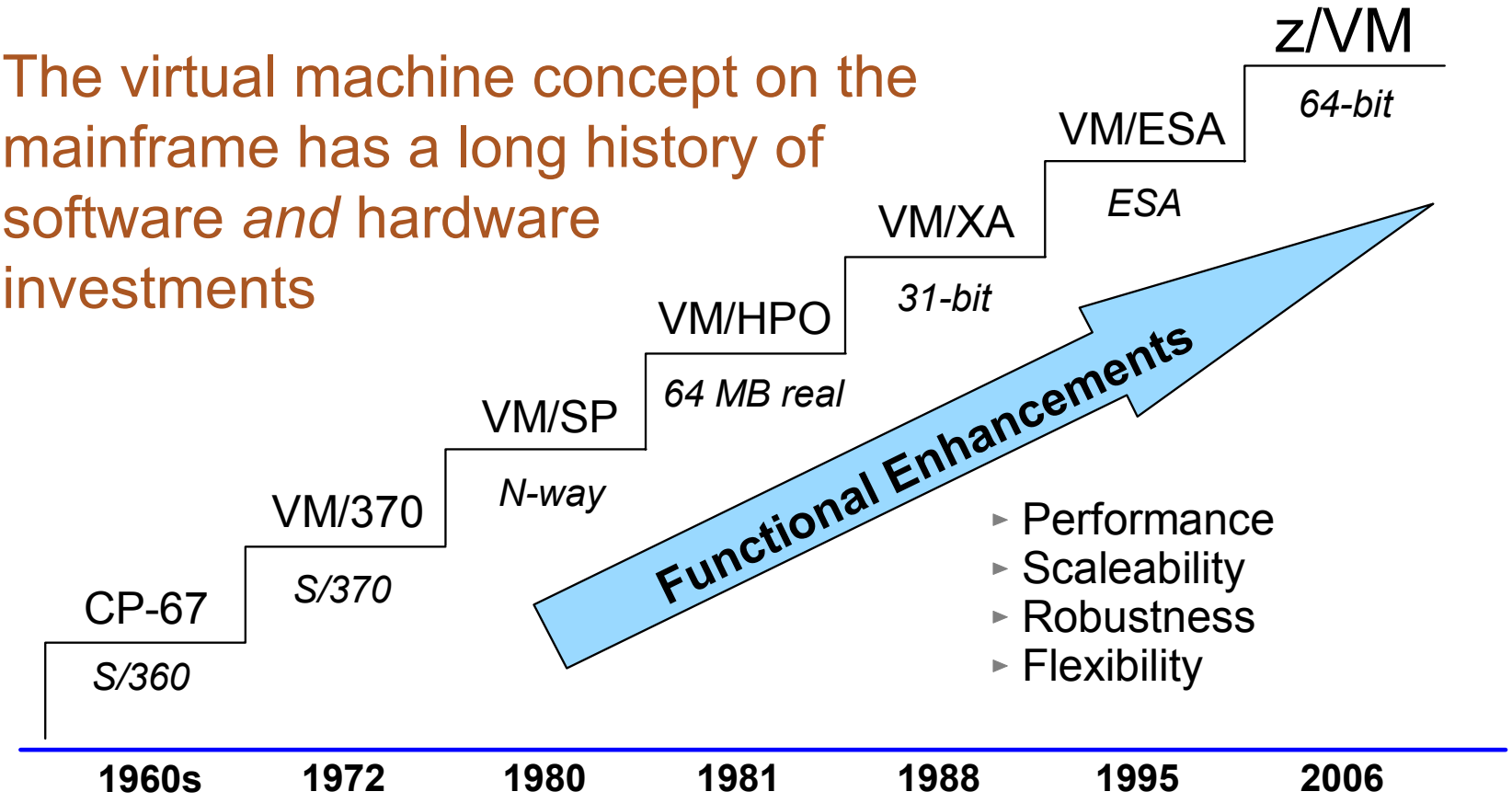
Topics

- **Virtualization Technology and z/VM - the Basics**
- **Integrated Facility for Linux (IFL) and z/VM**
- **The Value of z/VM for Linux**



IBM Mainframe Virtualization Technology Evolution

The virtual machine concept on the mainframe has a long history of software *and* hardware investments



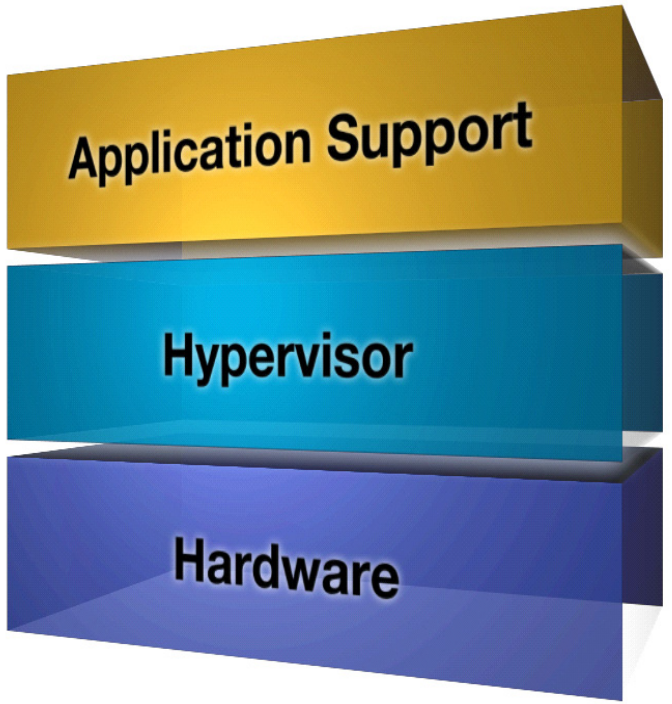
System z virtualization starts on the chip…a combination of architecture, hardware, firmware, and software functionality

zSeries Virtualization: a Multidimensional Solution

Virtualization is built in, not added on

On demand scale out solutions are composed of multiple dimensions of function:

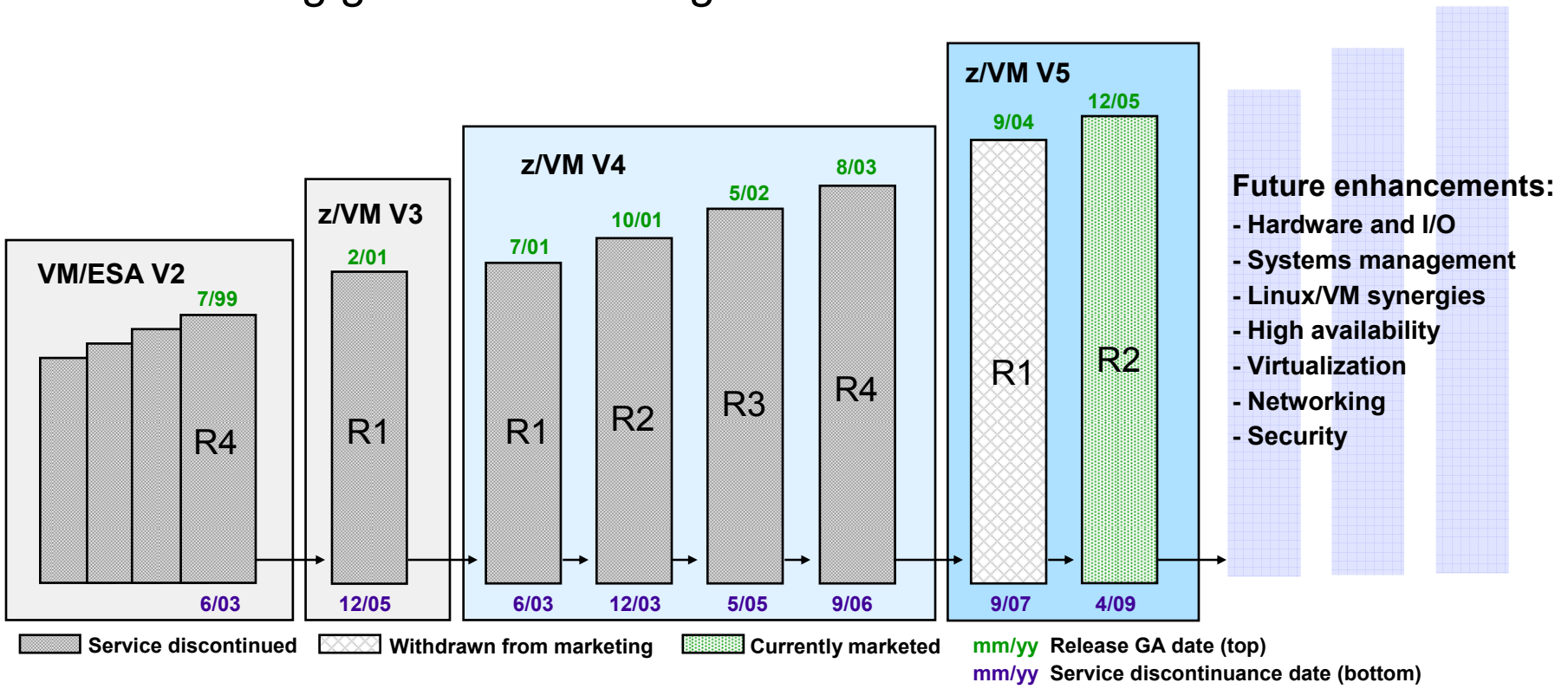
- **Application Support Dimension (open, stable)**
  - Open, stable operating system
  - Virtual server awareness infrastructure
  - Enterprise applications
- **Hypervisor Dimension (poweful, flexible)**
  - Shared-memory based virtualization model
  - Granular resource sharing and simulation
  - Flexible virtual networking
  - Resource control and accounting
  - Server operation continuity (failover)
  - Server maintenance tools and utilities
- **Hardware Dimension (robust, reliable)**
  - Legendary reliability, scalability, availability, security
  - Logical partitioning (LPAR)
  - Processor and peripheral sharing
  - Interpartition communication
  - Virtualization support at the hardware instruction level (e.g., SIE)



Recent z/VM Release History

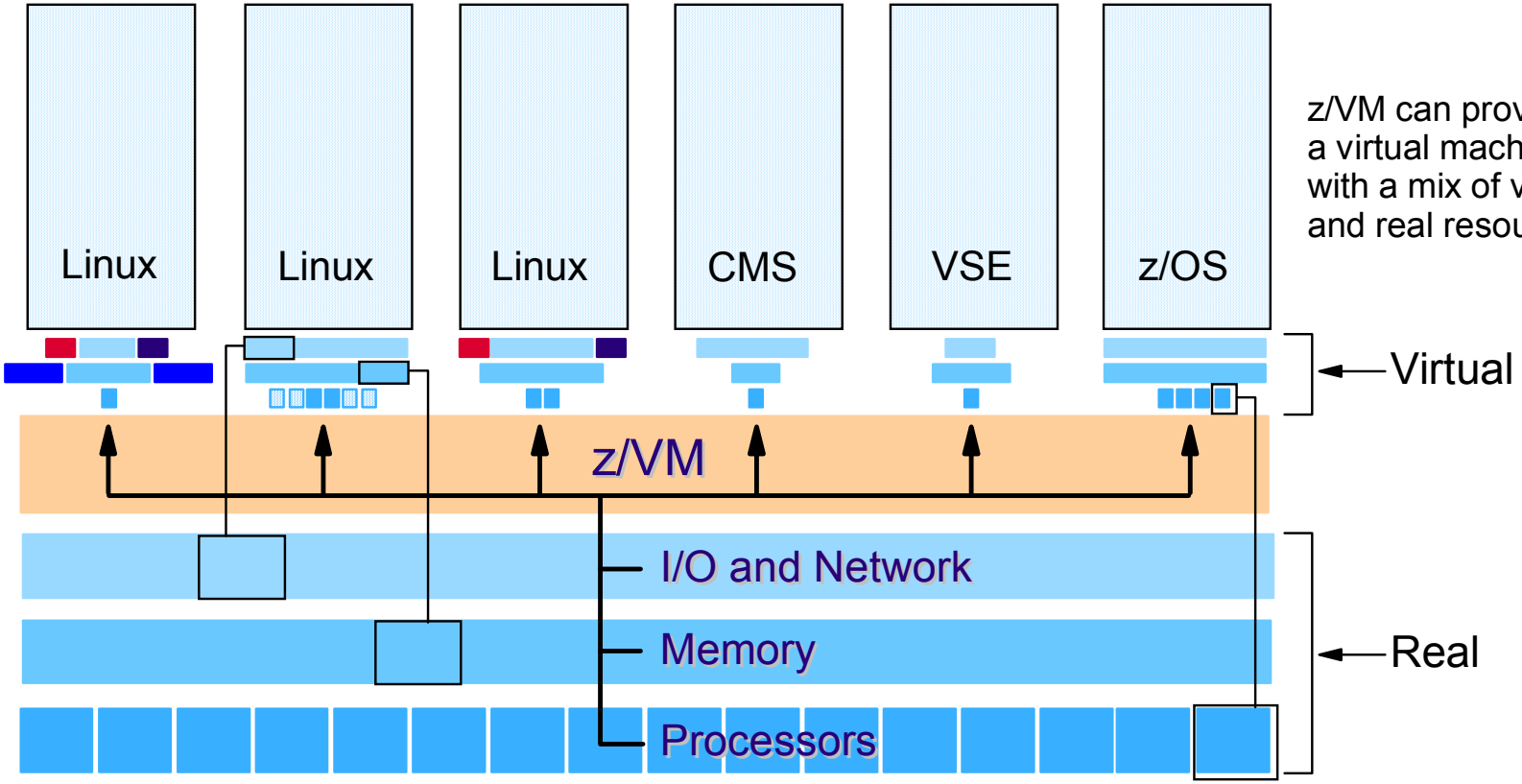
z/VM Version 5: High-Value Virtualization Technology

- ★Generating new business with Linux on System z
- ★Enabling growth for existing VM customers



z/VM Technology: More than Partitioning

A *Virtual Machine* simulates the existence of a dedicated real machine, including processor functions, storage, and input/output resources.

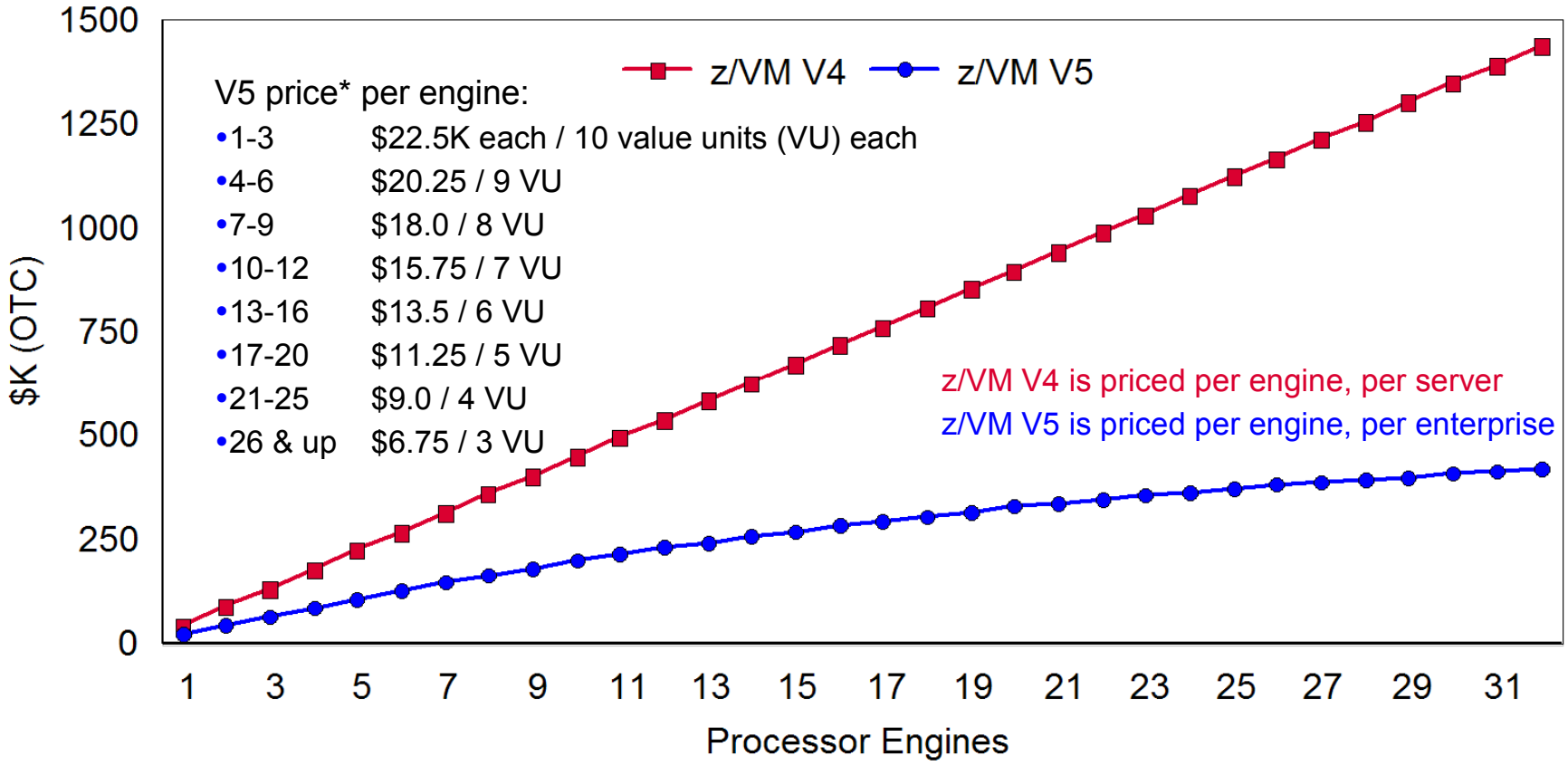


Linux on z/VM is the industry's most advanced virtual blade solution

z/VM Version 5 Product Information

- **Runs on IBM System z9 (z9-109) and IBM eServer zSeries (z800, z900, z890, z990) processors and other equivalent servers**
  - The z/VM V5 Control Program requires 64-bit addressing (z/Architecture)
  - 64-bit and 31-bit (ESA/390) virtual machines are supported
- **Runs on Integrated Facility for Linux (IFL) processor engines as well as standard processor engines**
- **IPLA software product (5741-A05) with new, improved pricing Ts&Cs**
  - One-time charge license fee, priced on a per-engine basis
  - Price/engine decreases (on a tiered basis) as more engines are licensed
  - Engines can be aggregated across an enterprise for licensing purposes
  - Ordered via the System Delivery Option (SDO) (5741-A06)
- **Optional Software Subscription & Support (S&S) product (5741-SNS)**
  - Required to receive IBM support center services
  - Entitles customers to future z/VM releases and versions
  - Annual, renewable license charge
- **Includes priced features**
  - DirMaint, RACF/VM, Performance Toolkit for VM
  - Pre-installed, but disabled (license required; same pricing model as base)

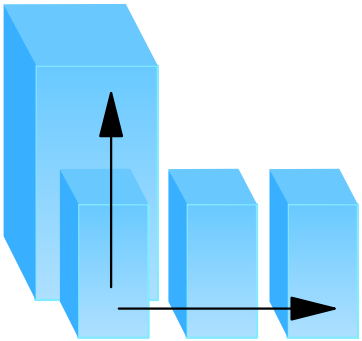
z/VM Version 5 Pricing



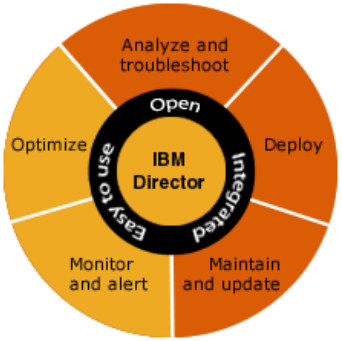
*U.S. prices as of 1 Oct 2006

Key z/VM V5.2 Business Value Propositions

- **Significant "Scale out" and "Scale up" support for hosting virtual server workloads**
  - Improved utilization of large real memory configurations
  - Improved memory management for Linux guests running on a z9-109 server*
  - Improved bandwidth for QDIO operations in a CPU-constrained environment (support for z9-109, z990, z890 servers only)
  - Improved throughput and response time for minidisk I/O in an I/O-constrained environment*
- **Enhanced virtual networking support**
- **Improved FCP/SCSI support**
- **Support staff productivity gains with IBM Director**



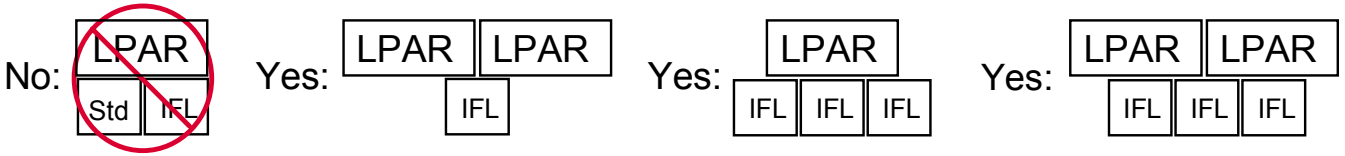
On demand *Scale Up* and *Scale Out*



* References post-GA support previously announced via Statements of Direction on July 25, 2005

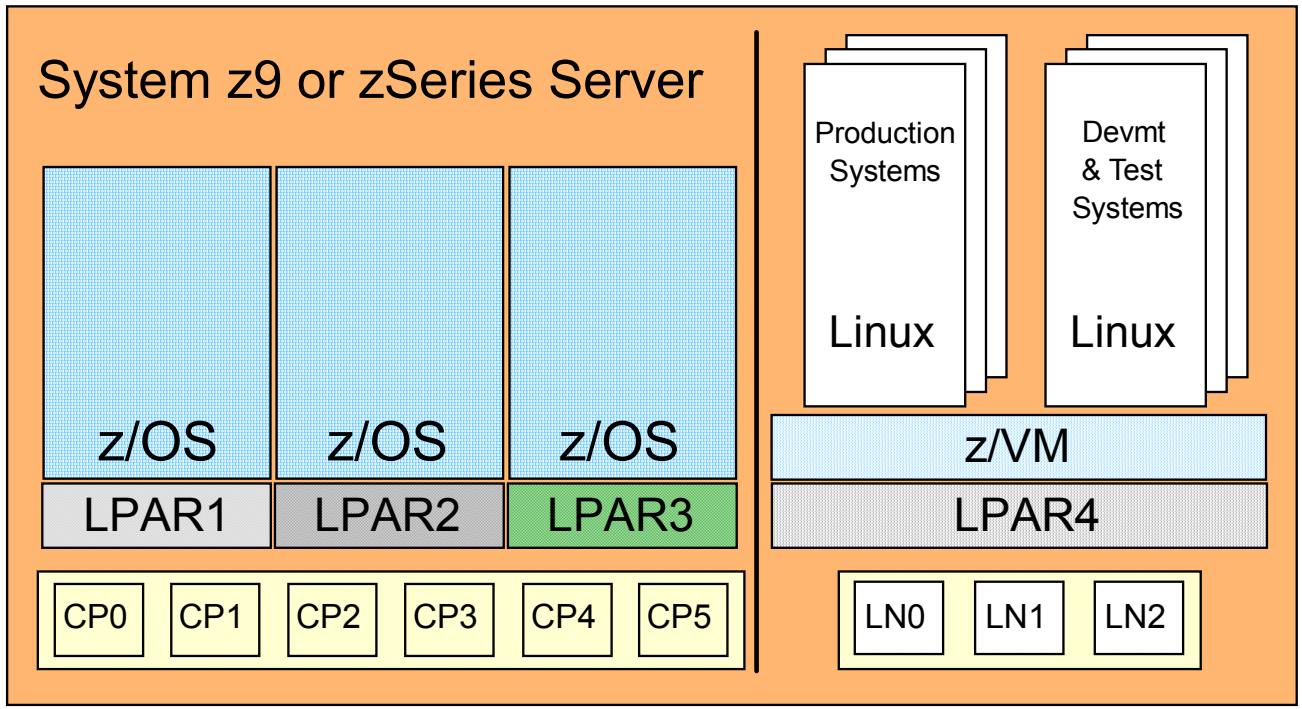
zSeries Integrated Facility for Linux (IFL)

- **IFLs are processors dedicated to Linux-only workloads**
  - Allocated from the set of spare processors on MCM
  - Less expensive than standard processors
  - Will not support traditional mainframe operating systems
  - Only usable in LPAR mode; cannot be mixed with standard processors



- **Available with System z and zSeries servers, G5/G6, Multiprise 3000**
  - Fully configured standard-engine servers do not have spare processors available for IFLs
- **Adding IFLs does not change a server's model designation**
  - No increase in fees for IBM or vendor software installed on standard processors

Sample IFL Configuration



IFL engines have no impact on z/OS licensing and associated software fees

3-engine z/VM V5 charges* (U.S. prices)

Year 1	$84,390	OTC plus S&S
Year 2	$16,890	S&S
Year 3	$16,890	S&S
3-Yr Total	$118,170	

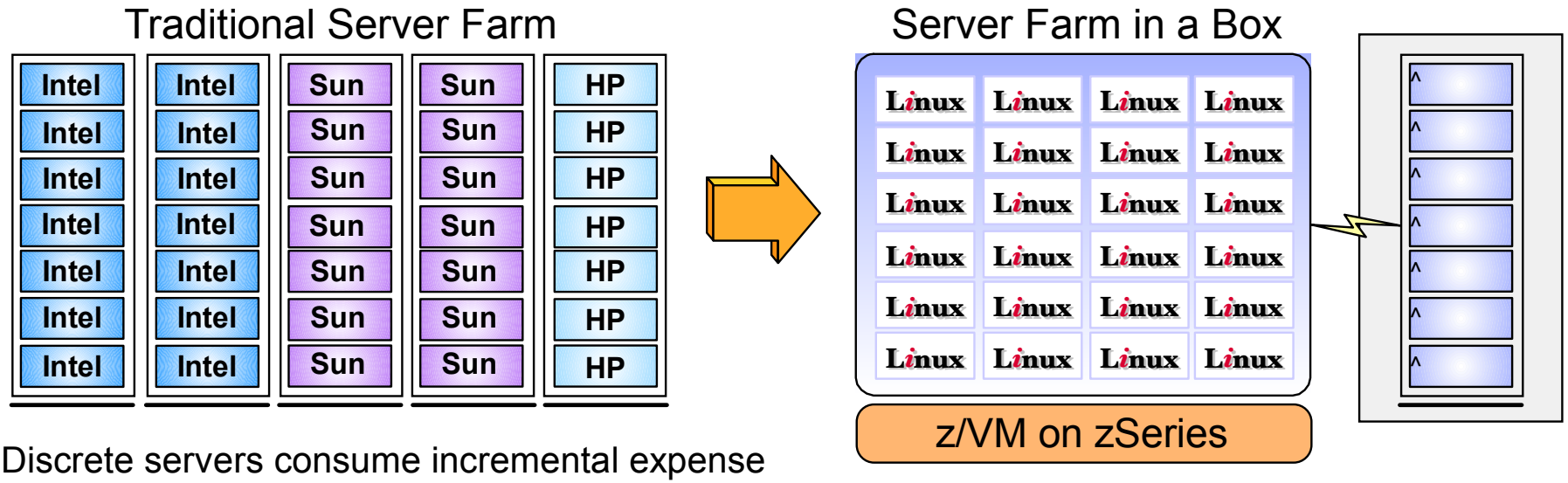
* As of 1 Oct 2006

The Value of z/VM for Linux

Why Run Linux on z/VM?

- **Infrastructure Simplification**
  - Consolidate distributed, discrete servers and their networks
  - IBM mainframe qualities of service
  - Exploit built-in z/VM systems management
- **Speed to Market**
  - Deploy servers, networks, and solutions ***fast***
  - React quickly to challenges and opportunities
  - Allocate server capacity when needed
- **Technology Exploitation**
  - Linux with z/VM offers more function than Linux alone
  - Linux exploits unique z/VM technology features
  - Build innovative on demand solutions

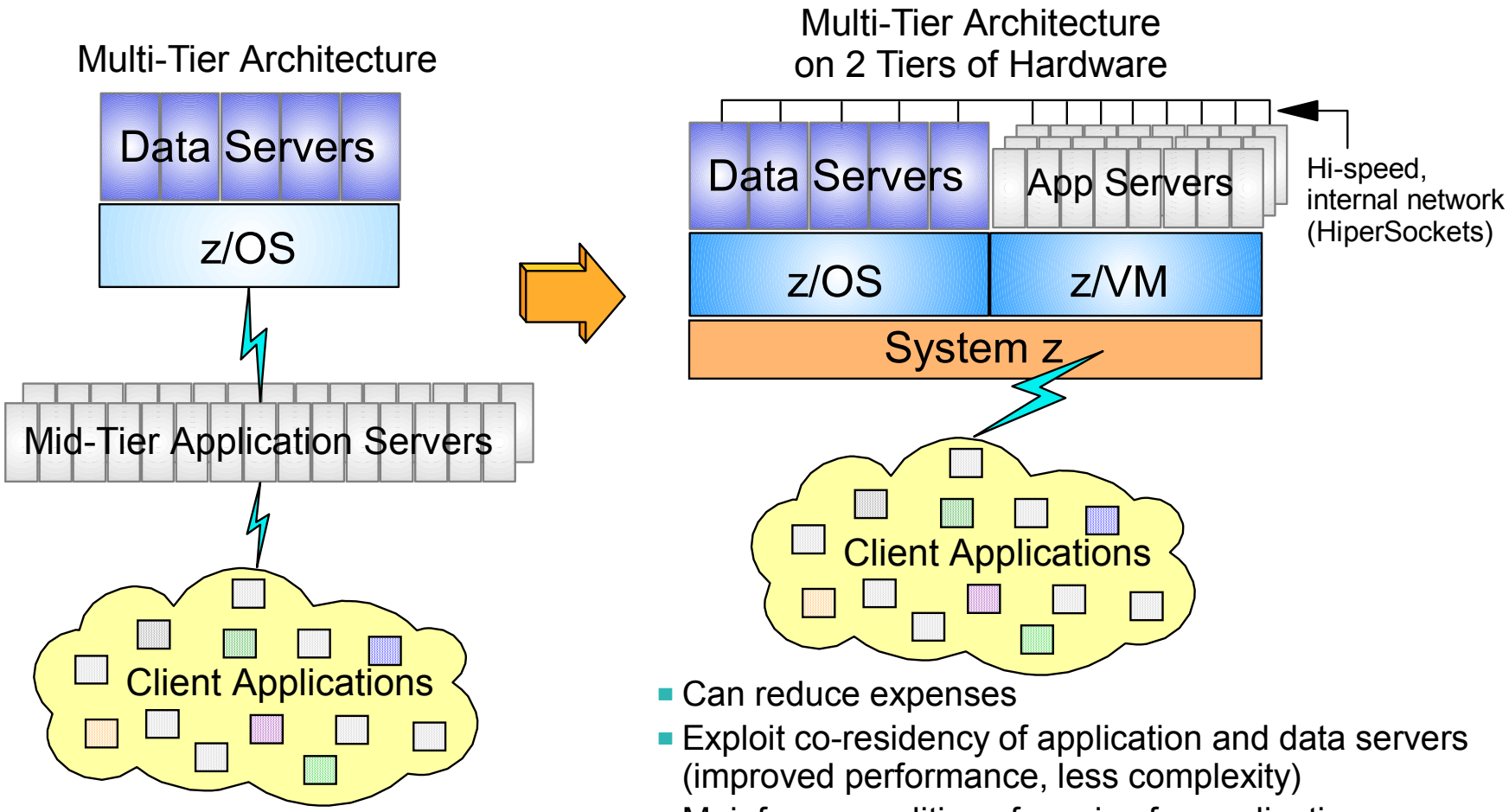
Infrastructure Simplification with Linux on z/VM



- Discrete servers consume incremental expense
  - Hardware price and maintenance
  - Floor space, power, cooling
  - Additional support staff
  - Per server (engine) software fees (ouch!)
- Connectivity requires kilometers of cables
- High availability ensured by spares / re-boots
- Disaster recovery difficult to test

- Can reduce costs without sacrificing server autonomy (one server per application)
- Virtual, high-speed, inter-server connectivity
- Exploit an architecture designed for high availability
- Mainframe qualities of service
- Tested disaster recovery services
- Connect to discrete servers as required

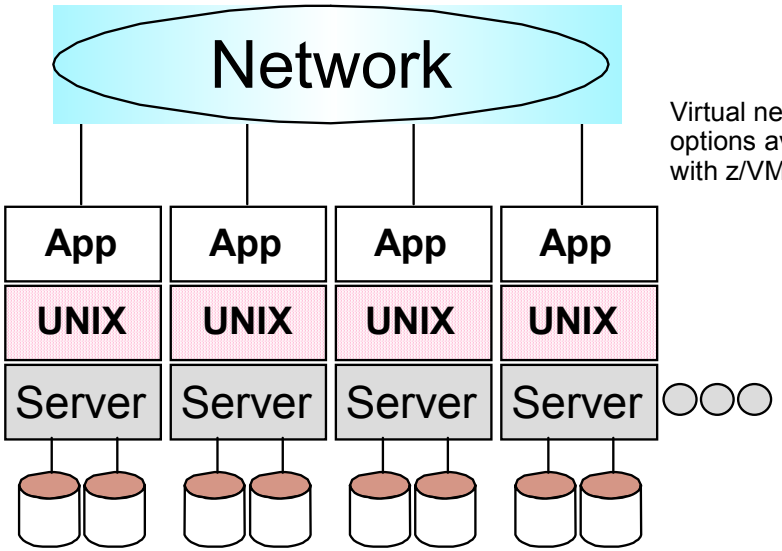
Infrastructure Simplification – Application Integration



- Can reduce expenses
- Exploit co-residency of application and data servers (improved performance, less complexity)
- Mainframe qualities of service for applications
- Little to no change to end-users

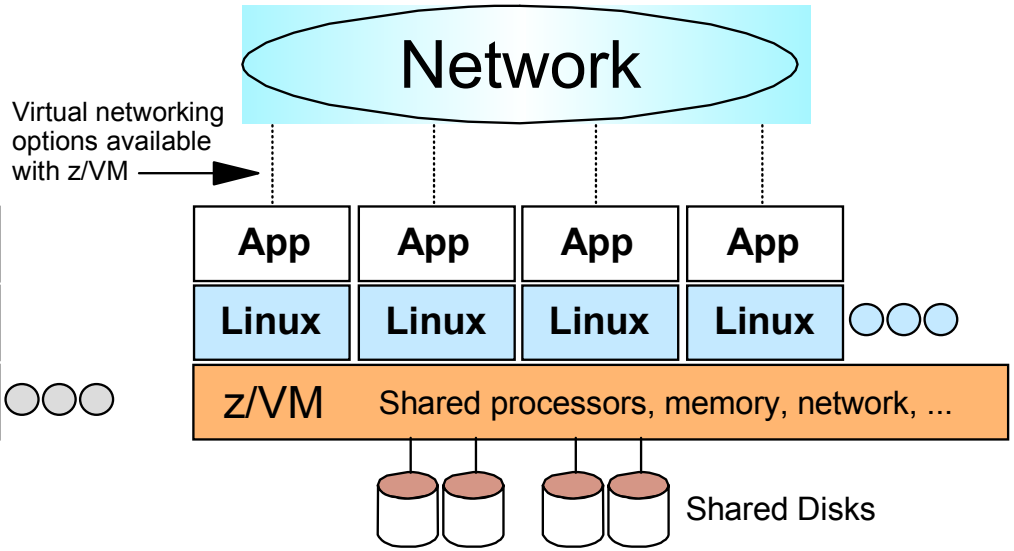
Achieve Rapid Horizontal Growth with Linux on z/VM

Typical UNIX environment



- Dedicated processors, disks, adapters, ...
  - Resources wasted when idle
- Complex system management
  - Networking and software products required for command and control
- New servers available in hours / days

Linux on z/VM



- Shared resources
  - Idle capacity given to servers that need it
- Simplified system management
  - Everything in one box
  - Automation tools included in z/VM
- New servers online in minutes / seconds
- On/Off Capacity on Demand available

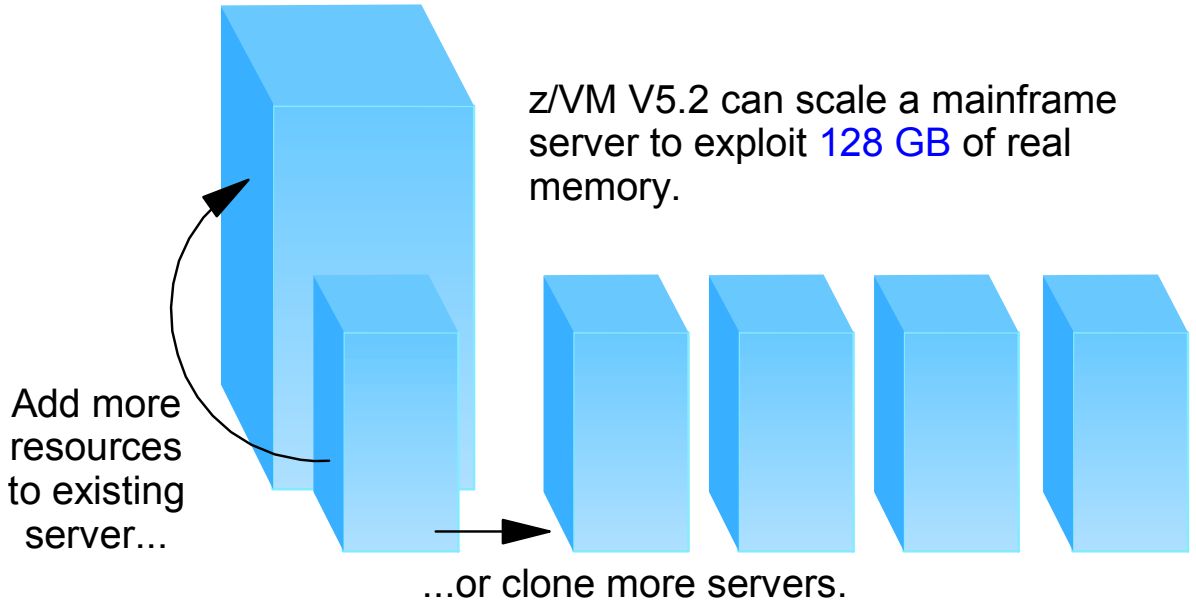
z/VM Technology Exploitation for Linux

- **Resource sharing and scalability**
- **Virtual networking and network consolidation**
- **Advanced disk support**
- **Systems managment, provisioning, command and control**

Resource Sharing and Scalability

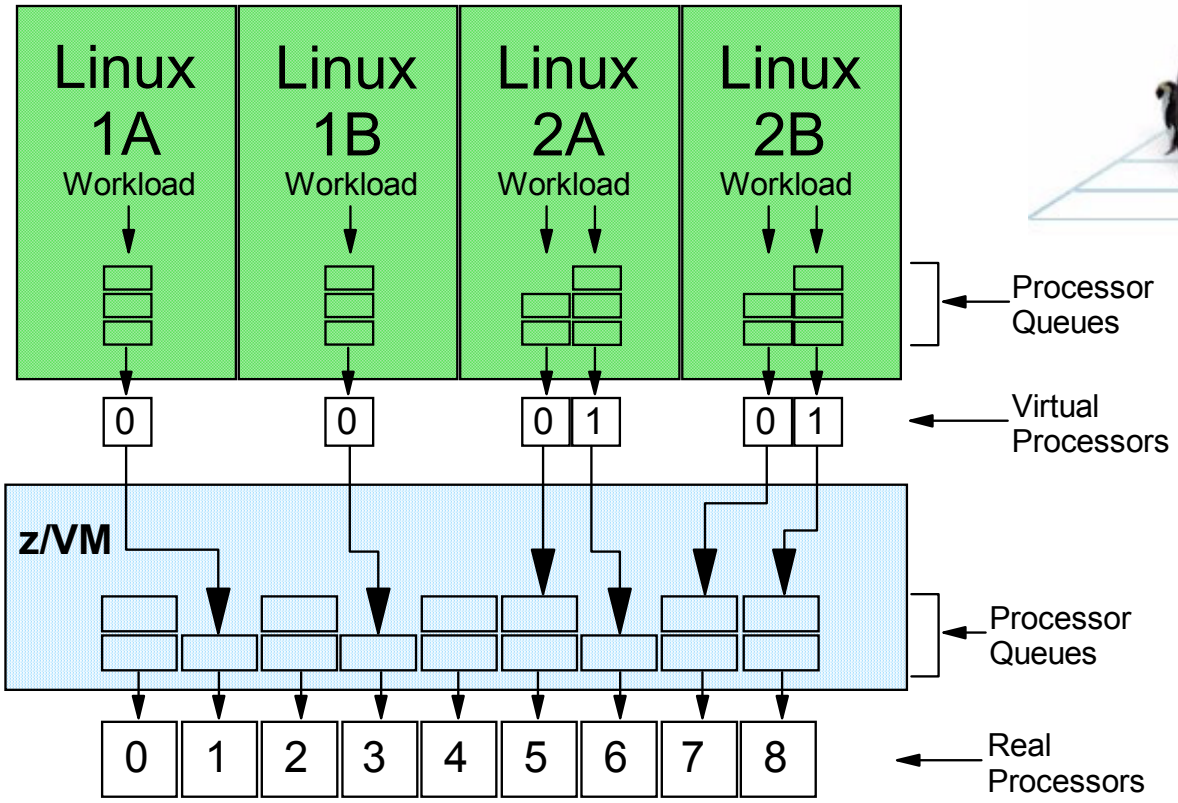
Scale Up and Out with Linux on z/VM

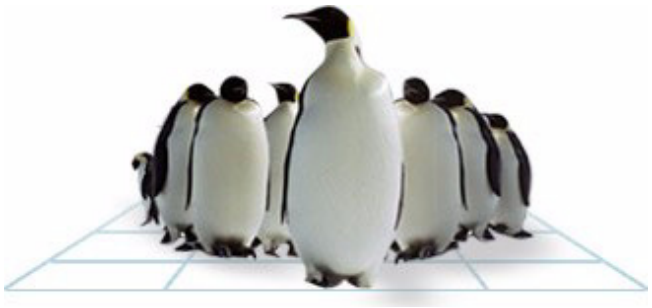
- **With z/VM you can grow horizontally and vertically on the same zSeries server...*dynamically***
- **Provision a virtual machine for peak utilization and allocate its resources to other servers during off-peak hours... *automatically***



Server Sprawl on z/VM is a Good Thing!

Maximize throughput of a multi-image Linux environment by exploiting z/VM support for large n-way (Symmetrical Multiprocessing)





z/VM is very efficient in dispatching workload from multiple virtual processors onto many real processors...

...allocating real processor capacity only to the virtual processors that need it.

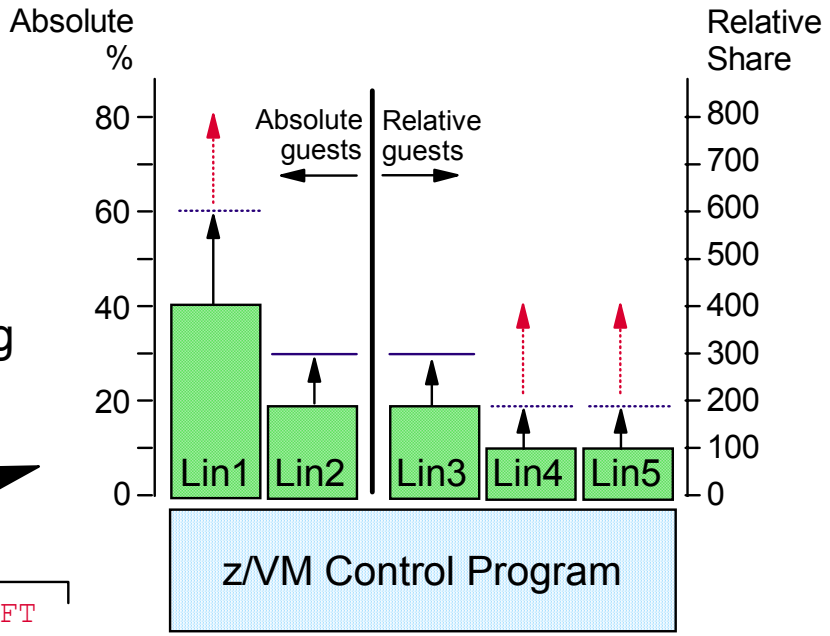
z/VM Technology – CPU Resource Controls

Allocate system resources per Linux image using SET SHARE command

- This is a highly flexible and self-managed function of the z/VM Control Program
- Reserve CPU capacity for peak usage
  - Use it when needed
  - Relinquish the processor cycles for other servers when not needed
- "Absolute guests" receive top priority
- The Virtual Machine Resource Manager can be used to monitor and adjust remaining capacity allocated to "Relative guests"

VM Directory Entries

```
SET SHARE Lin1 ABSOLUTE 40% ABSOLUTE 60% LIMITSOFT
SET SHARE Lin2 ABSOLUTE 20% ABSOLUTE 30% LIMITHARD
SET SHARE Lin3 RELATIVE 200 RELATIVE 300 LIMITHARD
SET SHARE Lin4 RELATIVE 100 RELATIVE 200 LIMITSOFT
SET SHARE Lin5 RELATIVE 100 RELATIVE 200 LIMITSOFT
```

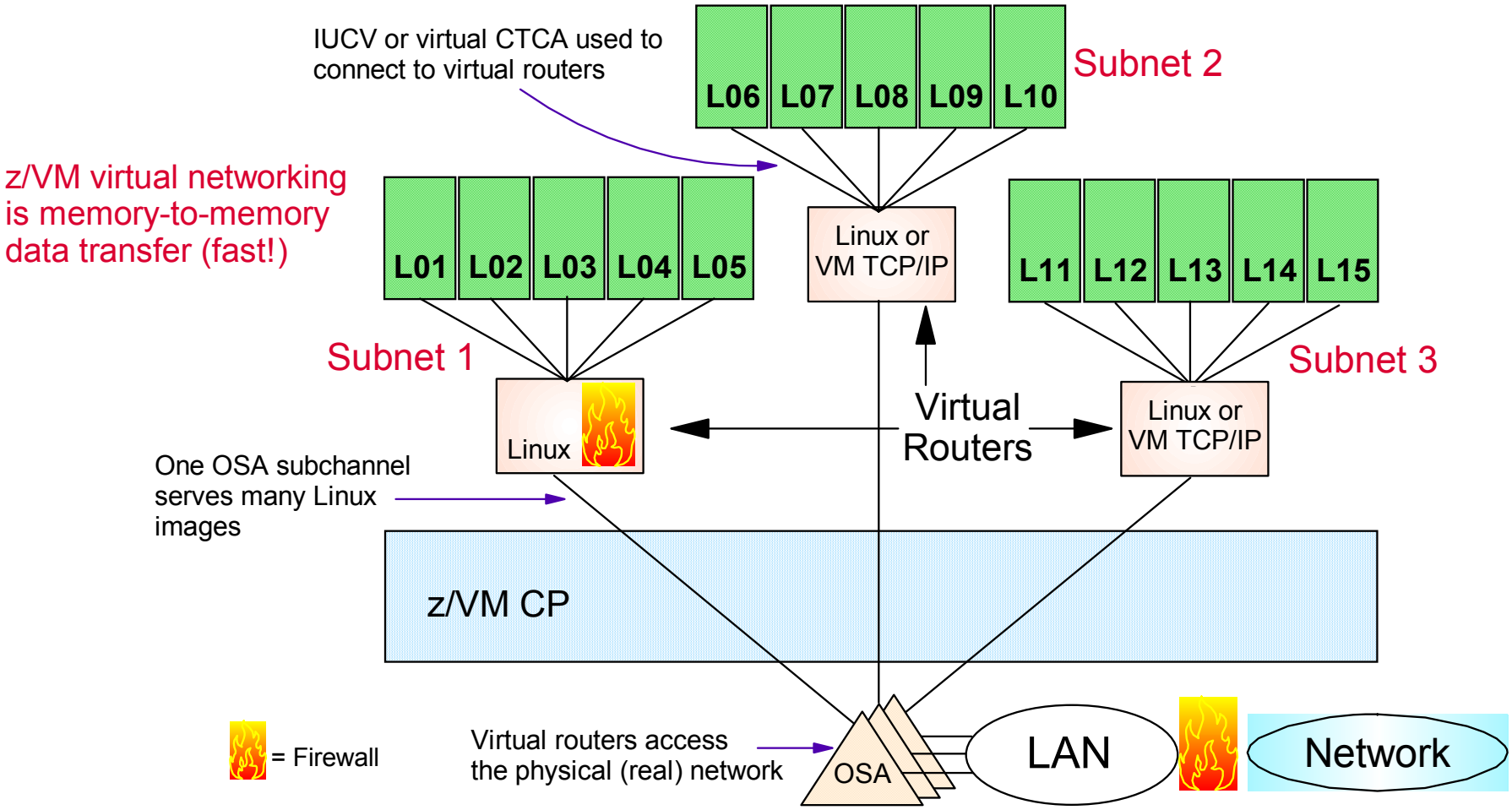


Notes:

..... = limit can be exceeded if unused capacity is available (limitsoft)

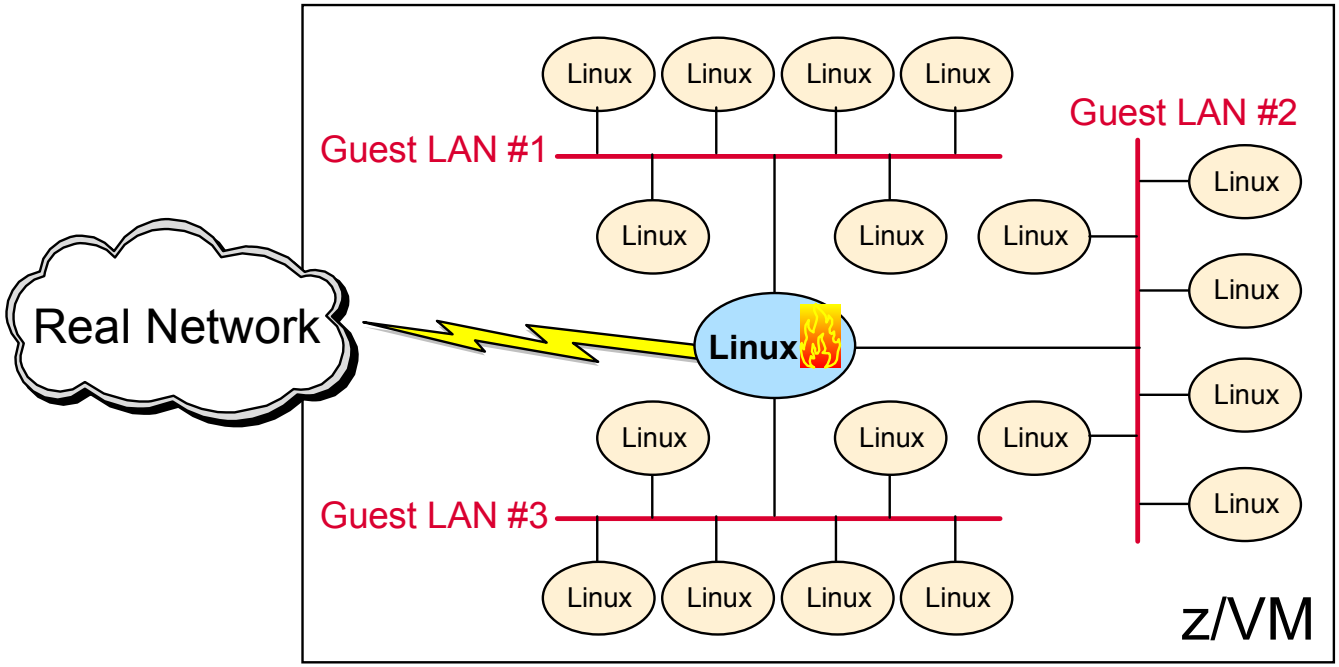
——— = limit will not be exceeded (limithard)

z/VM Virtual Networking – Point-to-Point Connections



z/VM Virtual Networking – Using z/VM Guest LANs

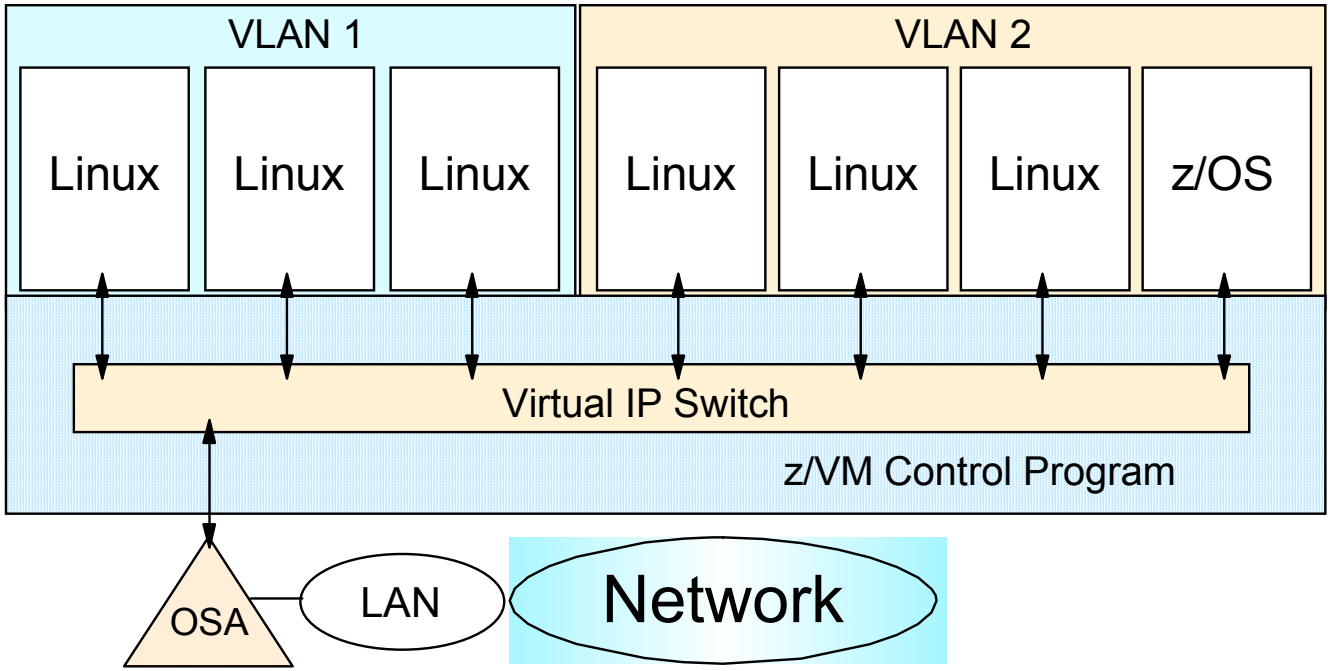
- A Guest LAN is a "virtual" LAN created by the z/VM Control Program
- OSA Express (QDIO) and HiperSockets Guest LANs can be created
  - Point-to-point, Multicast, and Broadcast (QDIO) connections are supported
- Linux images can connect to one or more Guest LANs
  - And connect to real network adapters at the same time
  - This enables a Linux image to provide external routing and firewall services for other Linux images



z/VM Virtual Networking – Using z/VM Virtual IP Switch

- Introduced in z/VM V4.4, enhanced in z/VM V5 - includes support for IEEE VLAN
- Eliminates need for router to connect virtual servers to physical LAN segments
- Provides centralized network configuration and control
  - Easily grant and revoke access to the real network
  - Manage configuration of VLAN segments
  - "On the fly" changes to VLAN topology can be made transparent to virtual servers

z/VM Virtual IP Switch enables even faster access to external networks!



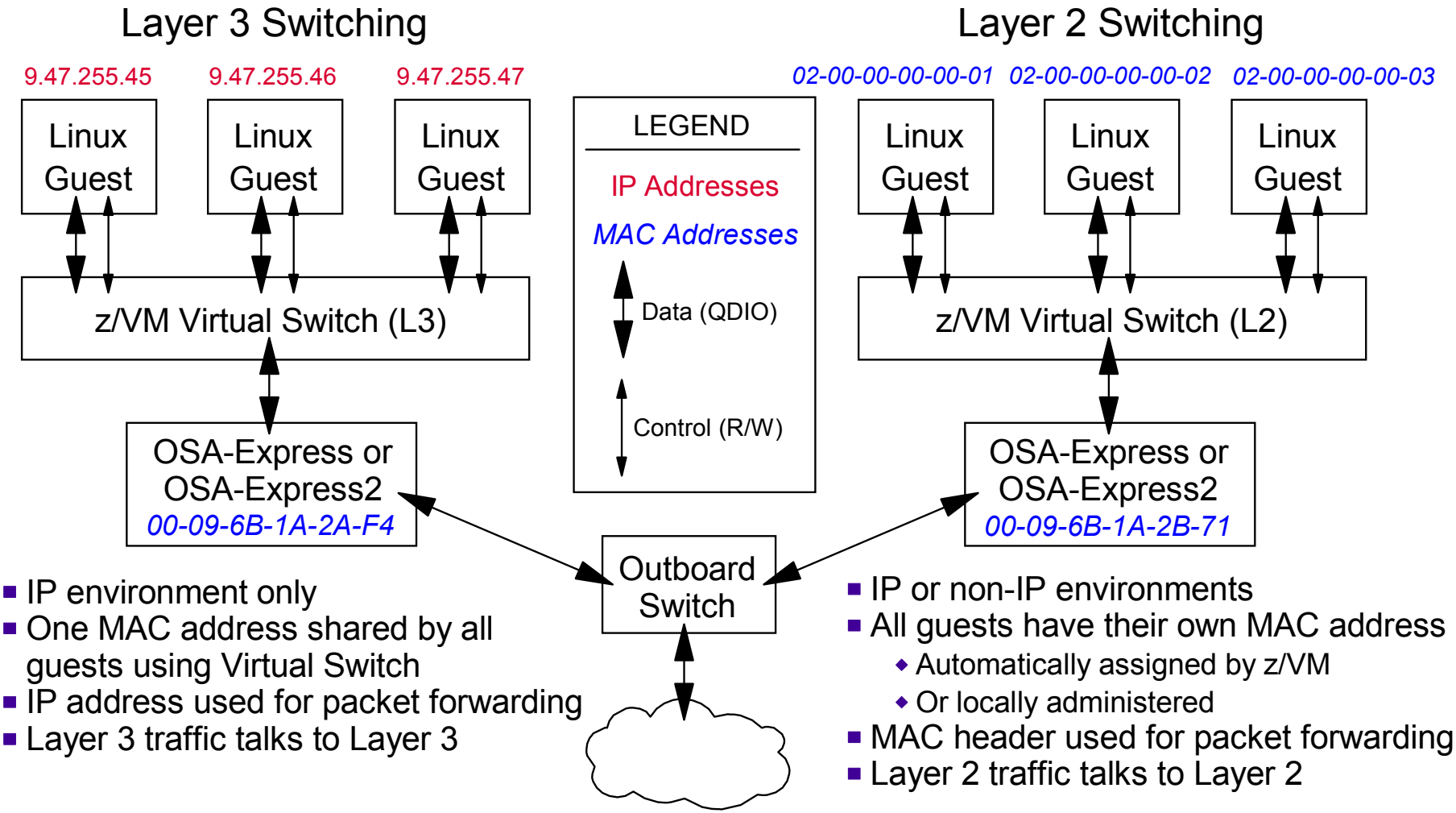
z/VM Virtual Networking

Virtual Switch Support for Layer 2 Mode

- **z/VM Virtual Switch support can operate in Layer 2 mode**
  - Works in conjunction with OSA-Express and OSA-Express2 support for Link Layer (Layer 2) transport mode on z9-109, z890 & z990 servers only
- **Allows destination and target nodes to be referenced by Media Access Control (MAC) addresses rather than IP addresses**
  - Supports IP and non-IP protocols (e.g., IPv4, IPv6, IPX, NetBIOS, SNA, AppleTalk, DECnet)
  - Linux images deployed as guests of z/VM can operate more efficiently
- **z/VM Virtual Switch support will...**
  - Provide flexible and automatic MAC address generation and assignment ensuring uniqueness within and across z/VM images, LPARs, and Servers
  - Perform protocol-independent Ethernet switching
  - Authorize/manage guest connections and IEEE 802.1q VLAN assignments
- **Support details**
  - z/VM V5.2 support is available in the base product
  - z/VM V5.1 support requires PTFs for APARs VM63538 and PQ97436

z/VM Virtual Switch Support

Layer 3 Compared to Layer 2 Switching



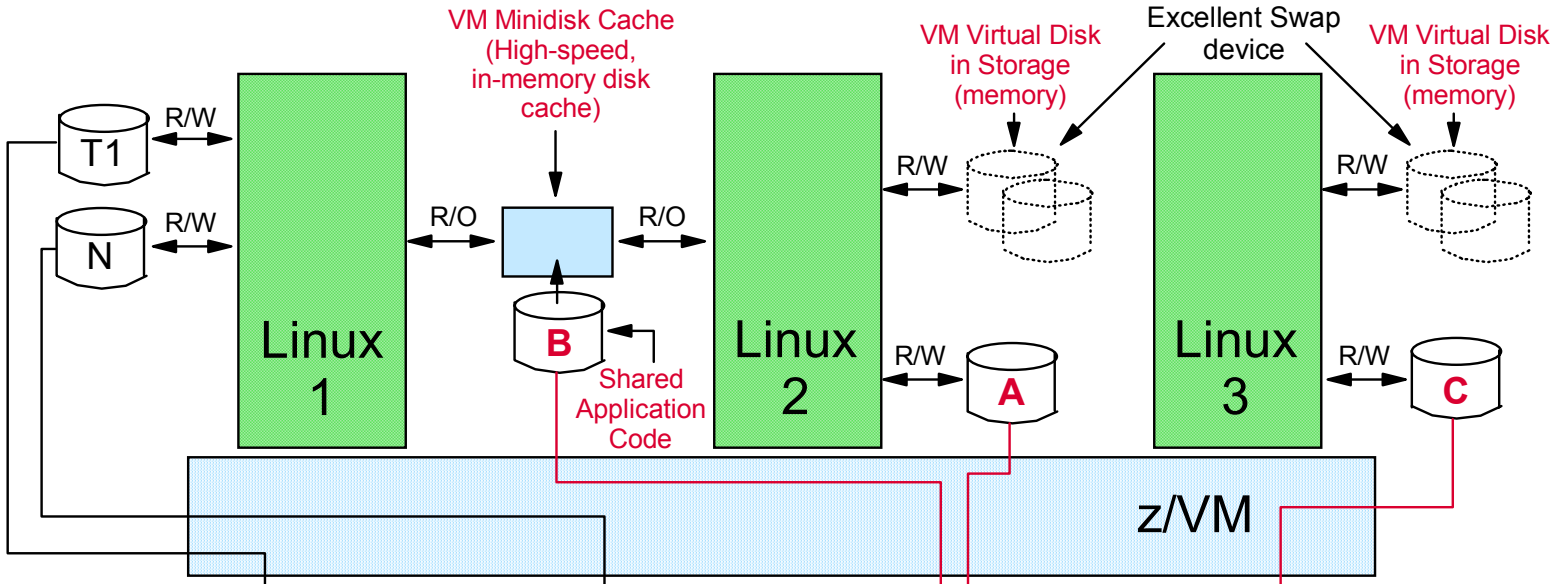
- IP environment only
- One MAC address shared by all guests using Virtual Switch
- IP address used for packet forwarding
- Layer 3 traffic talks to Layer 3

- IP or non-IP environments
- All guests have their own MAC address
  - Automatically assigned by z/VM
  - Or locally administered
- MAC header used for packet forwarding
- Layer 2 traffic talks to Layer 2

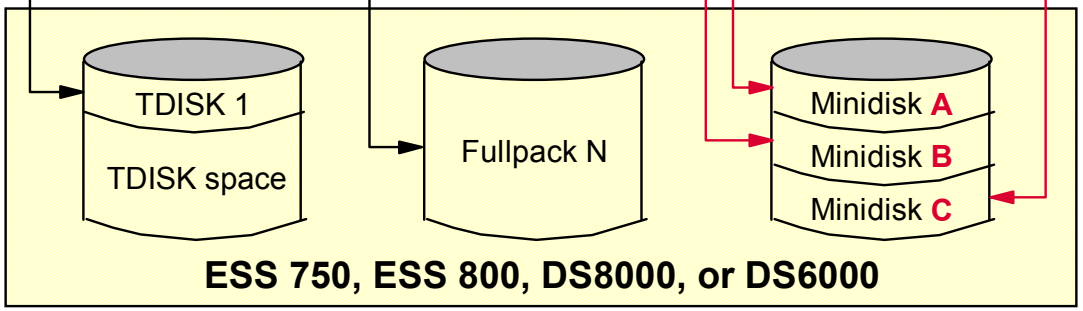
z/VM Technology – Disk

- **Use z/VM Minidisks to partition and share disk storage among Linux virtual servers**
- **Exploit Minidisk Cache for high-speed access to read-only data**
- **z/VM Virtual Disks in Storage (VDISKs) provide memory-to-memory data transfer speeds for read and write operations**
- **Temporary Disks (TDISKs) can be dynamically attached to Linux servers when additional disk space is needed for adhoc operations**
- **With z/VM V5, customers can configure a Linux-on-z/VM server with SCSI-only disk drives**
  - SCSI disks can be directly attached to Linux guests
  - z/VM V5.1 and V5.2 can use SCSI disks for system disk operations (e.g., install, paging, spooling)...this includes CMS and its tools and utilities
  - SCSI disks supported by z/VM V5.2 include: ESS 750, ESS 800, DS8000, and DS6000
  - Connectivity to a fibre-channel fabric is via System z9 or zSeries FCP channels

z/VM Technology – Disk



<u>TDISK</u>: on-the-fly disk allocation pool



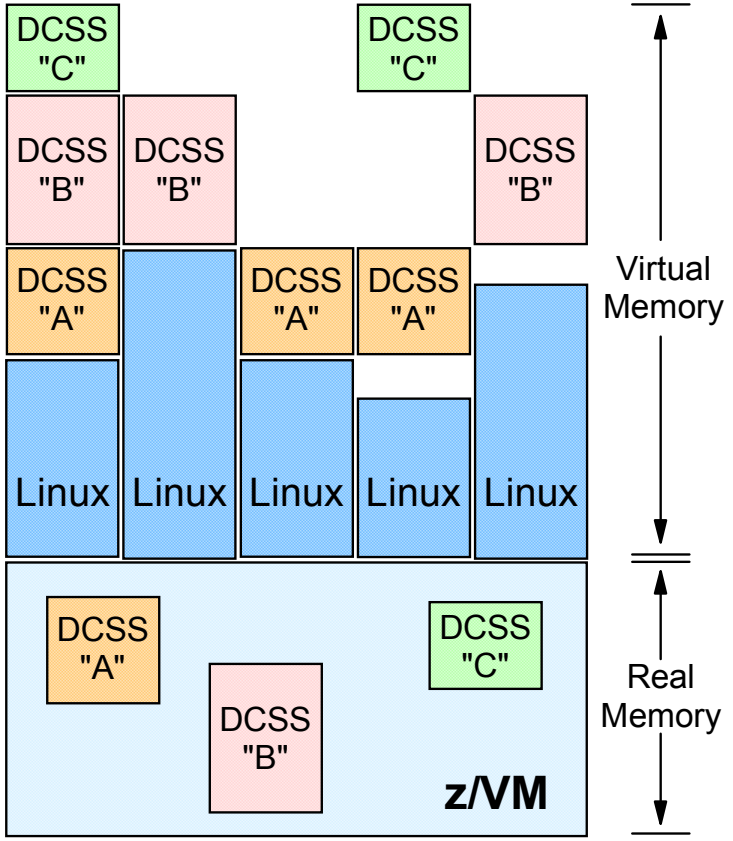
<u>Minidisk</u>: z/VM disk partitioning technology is great for Staging!

Notes:
R/W = Read/Write
R/O = Read Only

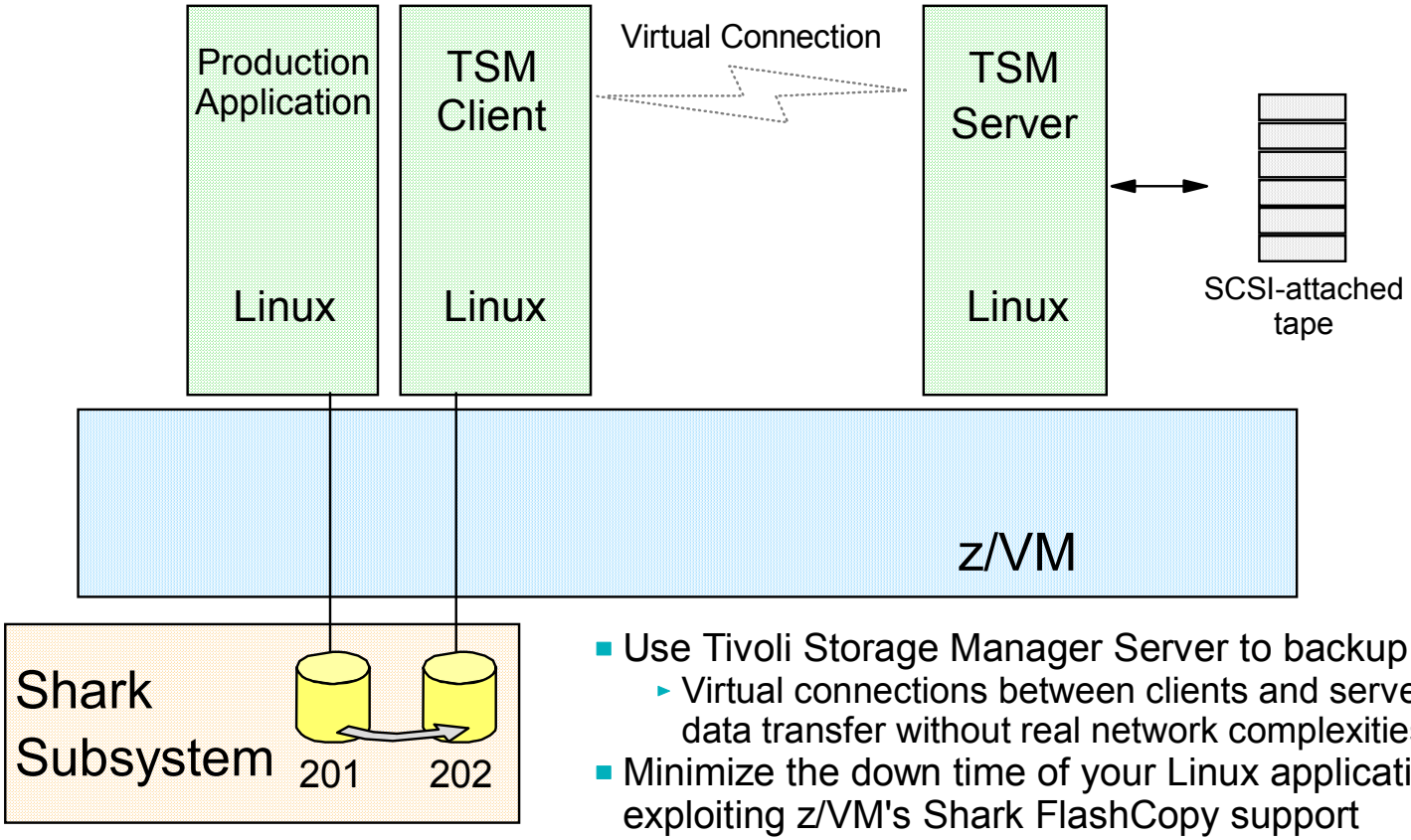
Linux and z/VM Technology Exploitation

Linux Exploitation of z/VM Discontiguous Saved Segments (DCSS)

- **DCSS support is a z/VM exclusive**
  - Share a single, real memory location among multiple virtual machines
  - High-performance data access
  - Can reduce real memory utilization
- **Linux exploitation support available today**
  - Execute-in-place (xip2) file system
  - DCSS memory locations can reside outside the defined virtual machine configuration
  - Access to file system is at memory speeds; executables are invoked directly out of the file system (no data movement required)
  - Avoids duplication of virtual memory and data stored on disks
  - Enables throughput benefits for Linux guest images and enhances overall system performance and scalability

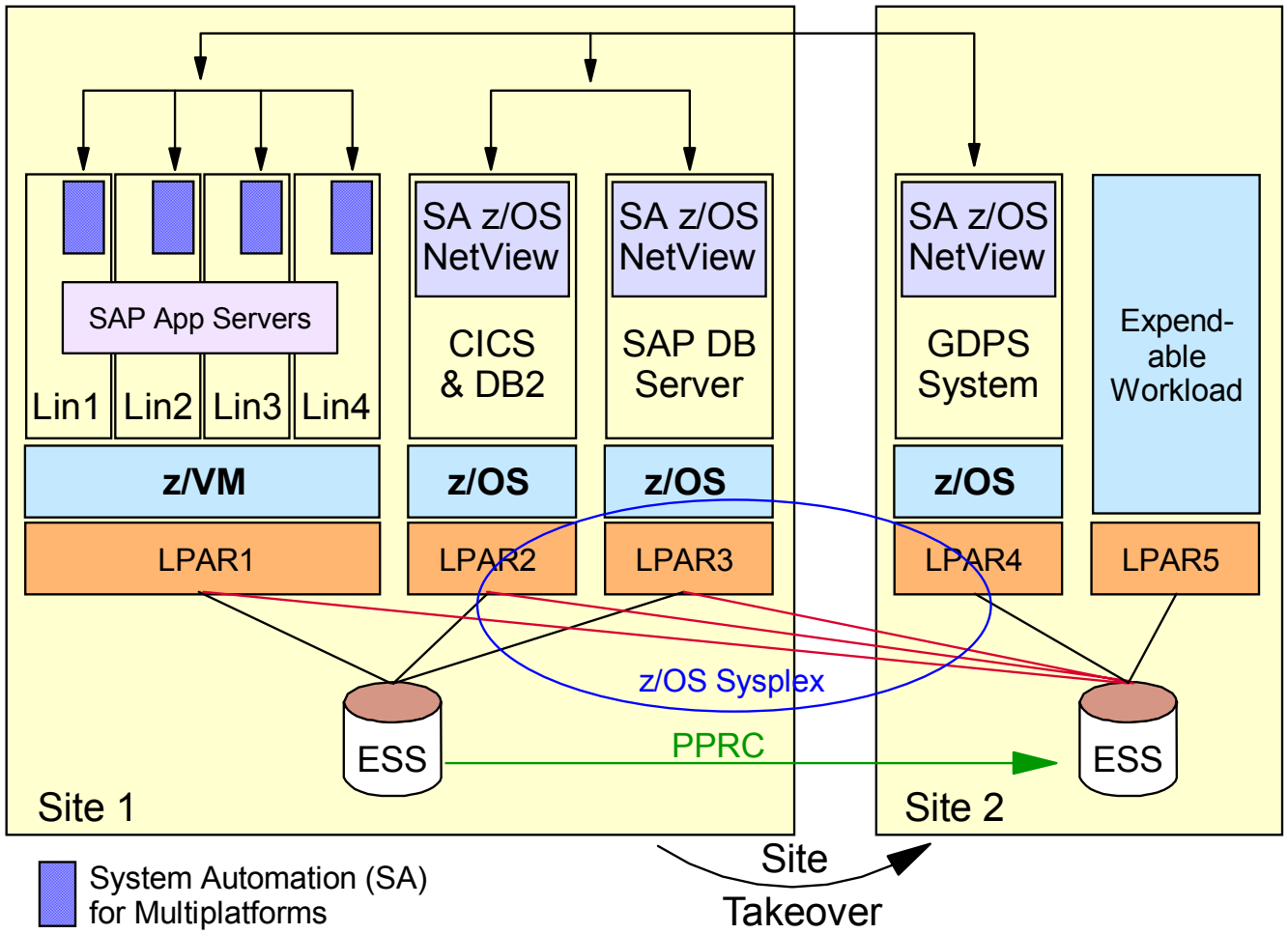


z/VM Technology – Data Backup



- Use Tivoli Storage Manager Server to backup Linux data
  - Virtual connections between clients and server means fast data transfer without real network complexities
- Minimize the down time of your Linux application by exploiting z/VM's Shark FlashCopy support
  - FlashCopy your data using z/VM
  - Run the TSM client code in a separate Linux server image
  - Your production application is back online in seconds

GDPS/PPRC Multiplatform Resiliency for zSeries

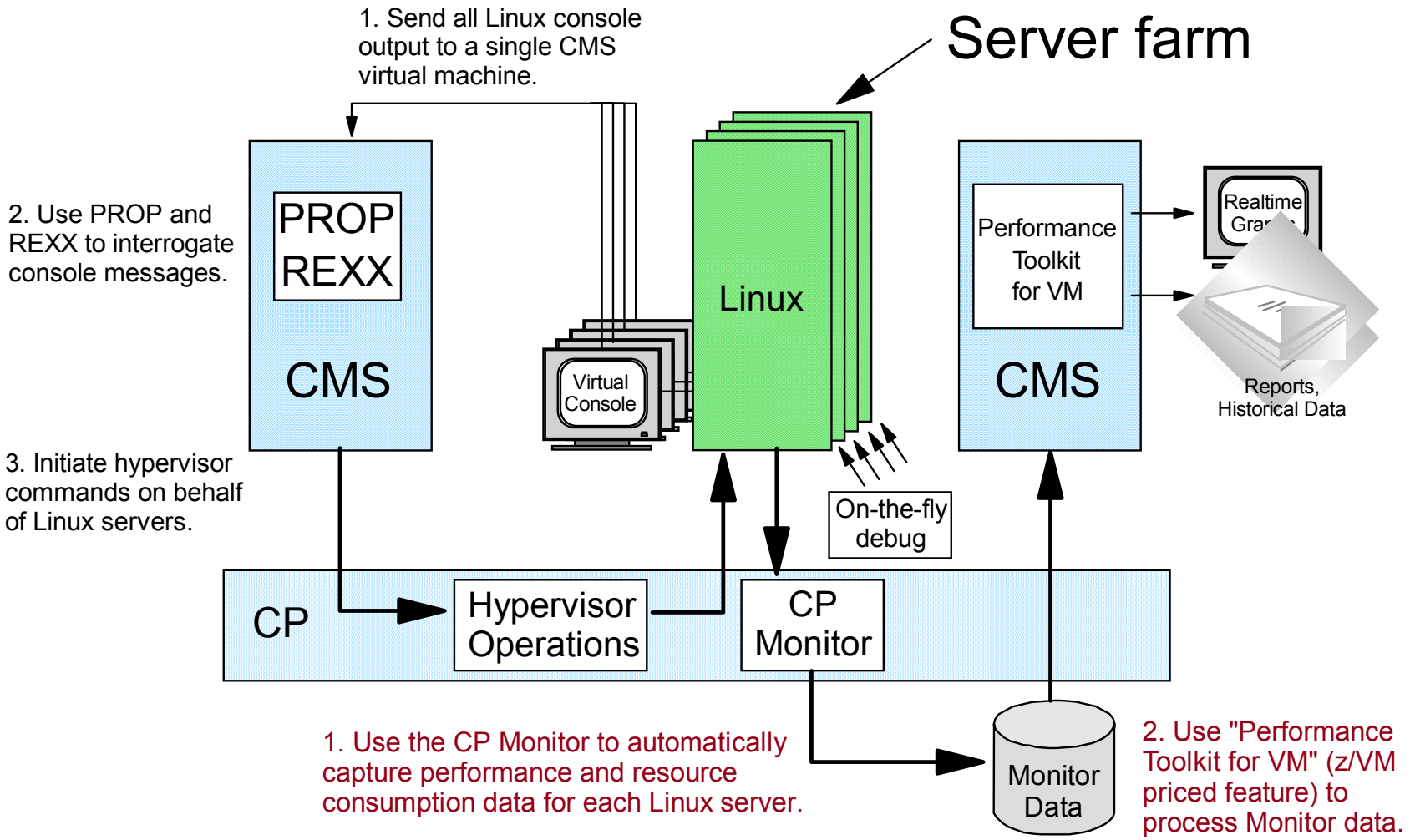


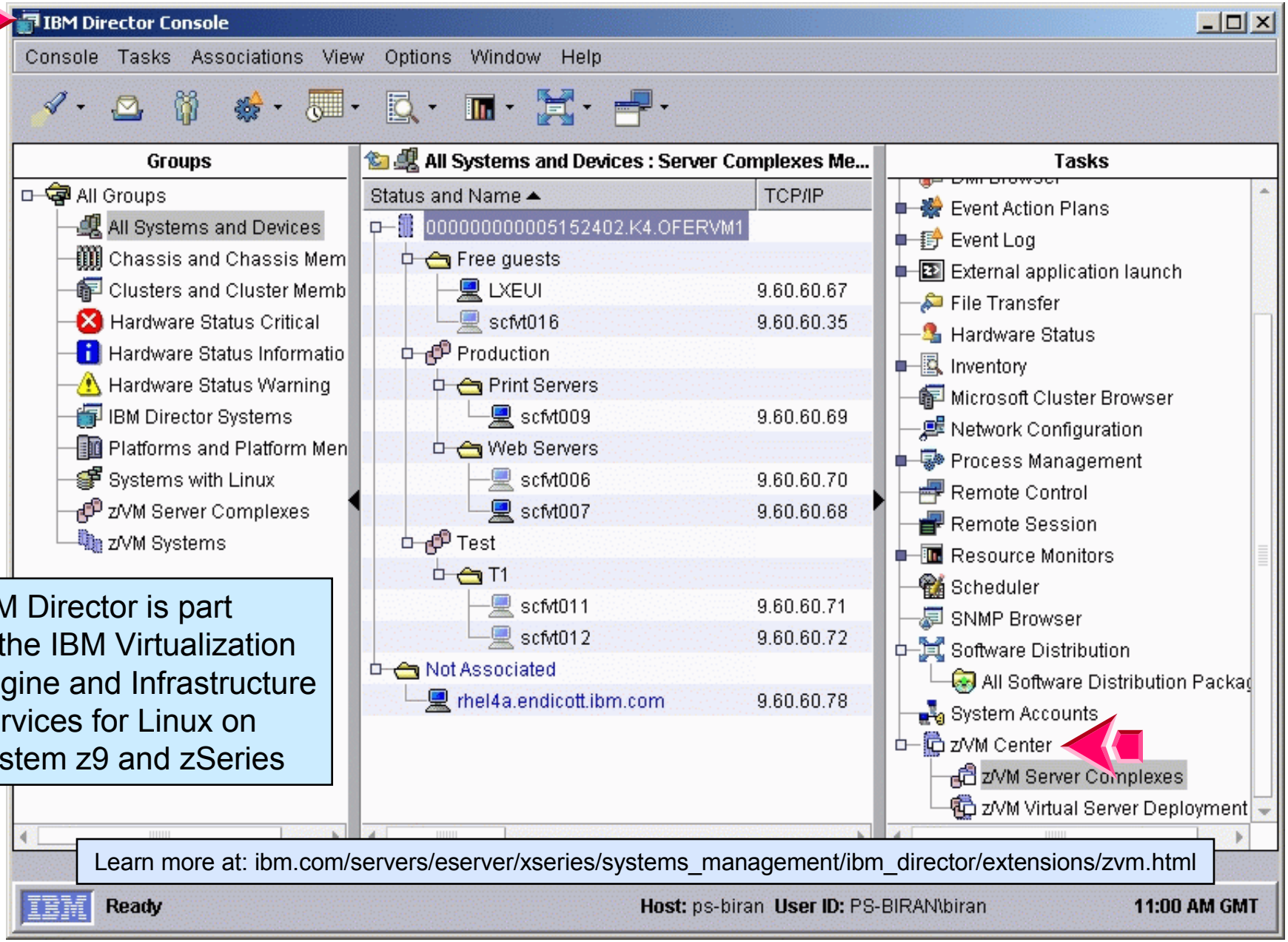
- Designed for customers with distributed applications
- SAP application server running on Linux for zSeries
- SAP DB server running on z/OS
- Coordinated near-continuous availability and DR solution for z/OS, Linux guests, and z/VM
- Uses z/VM HyperSwap function to switch to secondary disks
- Sysplex support allows for site recovery

z/VM Provisioning and Command & Control

- **Built-in z/VM facilities enable cost-effective command and control**
  - Performance data collection and reporting for every Linux image
  - Log accounting records for charge-back
  - Automate system operations with CMS, REXX, Pipelines, virtual console interrogation using PROP (VM programmable operator)
  - Dynamic I/O reconfiguration (e.g., dynamically add more disks)
  - Run EREP on z/VM for system-level hardware error reporting
  - Priced z/VM features:
    - DirMaint - simplifies task of adding/modifying/deleting users
    - Performance Toolkit for VM - performance recording and reporting
    - RACF/VM - security services
- **Samples, examples, downloads available**
  - IBM Redbooks
  - VM web site (**ibm.com**/eserver/zseries/zvm)
- **Extensive suite of solutions available from ISVs**
  - Visit **ibm.com**/servers/eserver/zseries/os/linux/apps/all.html

z/VM Technology – Command and Control Infrastructure

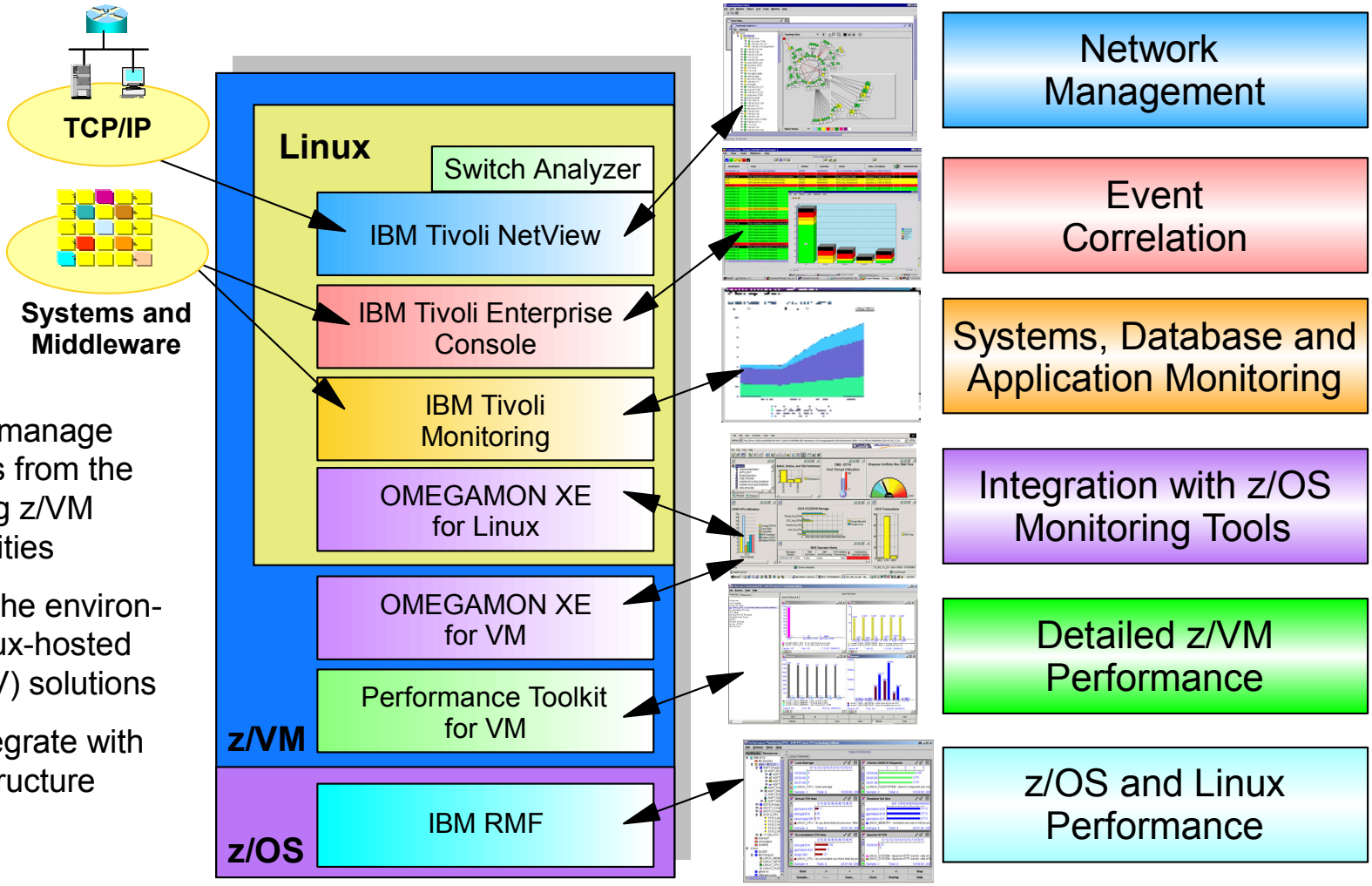




IBM Director is part of the IBM Virtualization Engine and Infrastructure Services for Linux on System z9 and zSeries

Learn more at: ibm.com/servers/eserver/xseries/systems_management/ibm_director/extensions/zvm.html

Monitoring Linux on System z



Measure and manage guest systems from the "outside" using z/VM tools and facilities

Complement the environment with Linux-hosted Tivoli (and ISV) solutions

Optionally integrate with a z/OS infrastructure

Linux and z/VM Future Technology Exploitation

Collaborative Memory Management

- Problem scenario: virtual memory utilization far exceeds real memory availability
- z/VM Control Program paging operations become excessive
- Overall system performance and guest throughput suffers

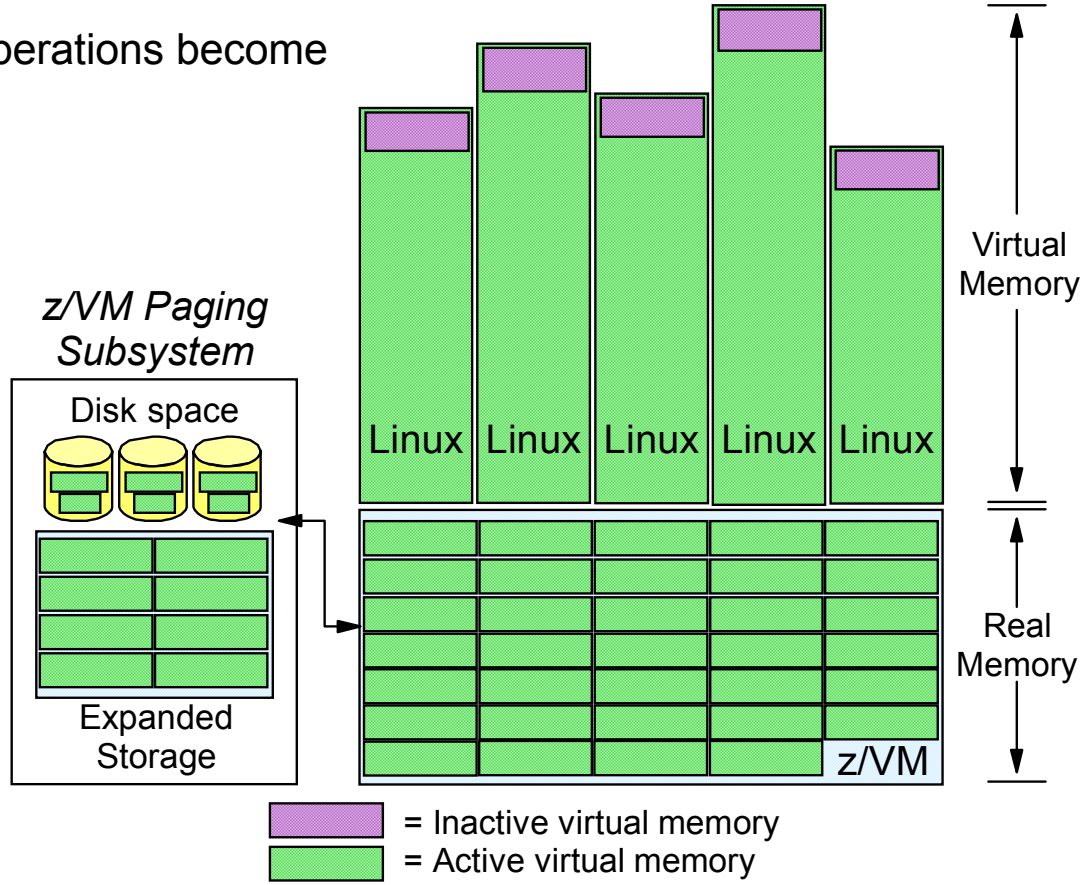


Chart 1 of 2

Linux and z/VM Future Technology Exploitation

Collaborative Memory Management

- Solution: real memory constraint detected and Linux images signaled to reduce virtual memory consumption
- Linux memory pages are released
- Demand on real memory and z/VM paging subsystem is reduced
- Overall system performance and guest image throughput improves
- z/VM V5.2 support available with PTF for APAR VM64085

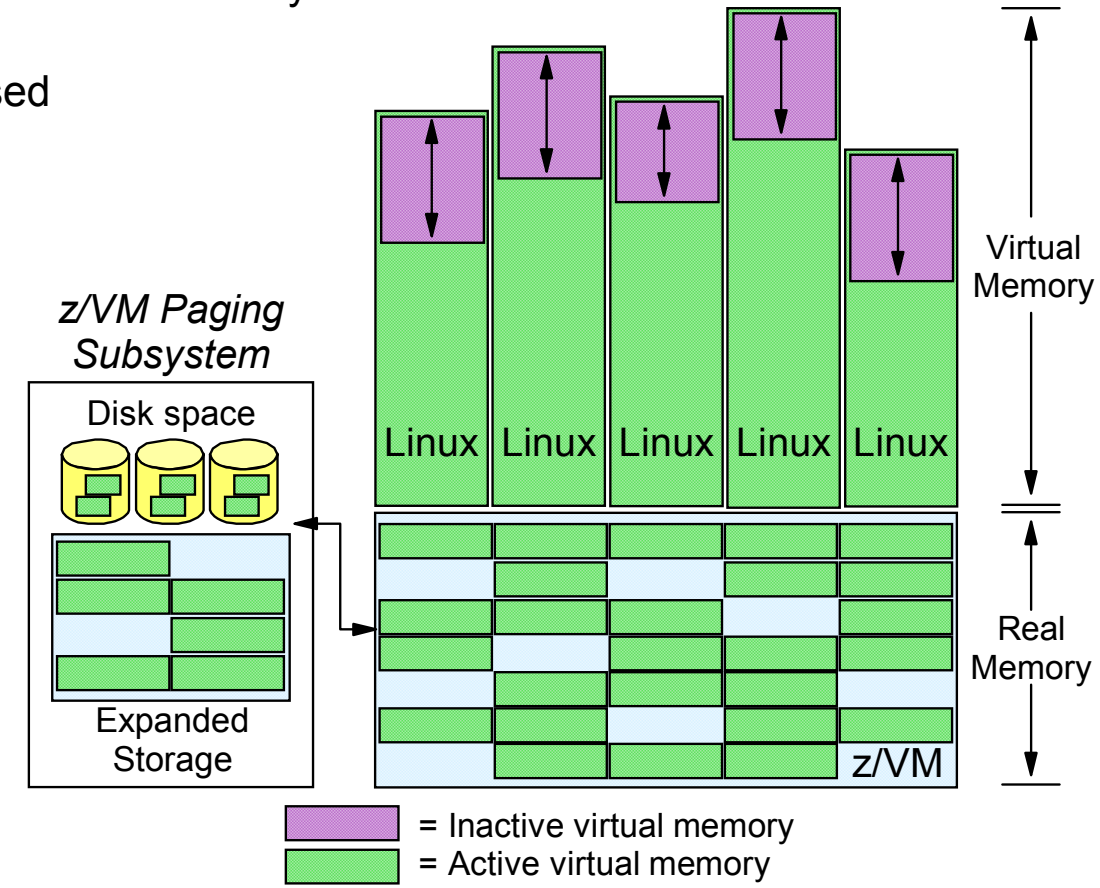
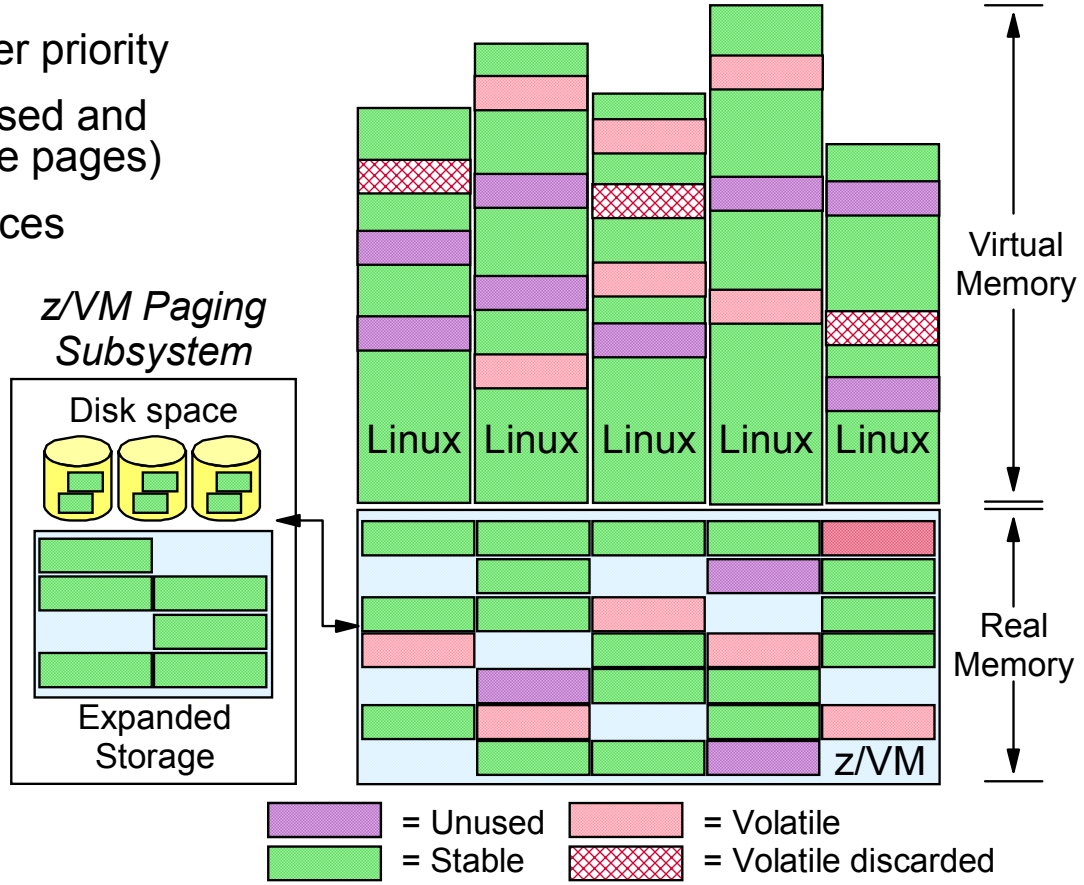


Chart 2 of 2

Linux and z/VM Future Technology Exploitation

Collaborative Memory Management ***Assist***

- Solution: exchange page usage information between Linux guests and z/VM
- Reclaim “unused” pages at higher priority
- Bypass host page writes for unused and “volatile” pages (clean disk cache pages)
- Signal exception if guest references discarded volatile page
- Use host page management assist to re-instantiate pages for next use
- Supported by System z9



Problem: Discrete Servers for Testing are Costly

Another Reason to Deploy Linux on z/VM

- **Development, test, quality assurance, etc. need servers too**
  - These systems represent incremental expense
  - They add to the complexities and inefficiencies of server sprawl
  - Reconfiguring test environments is cumbersome, adds time
  - Innovation is stifled...many ***What if...?*** exercises fail to reach proof-of-concept stage
- **Linux servers on z/VM are ideal for development and support**
  - Give Linux systems to every developer, tester, student, etc.
  - Execute complex test scenarios with minimal duplication of real resources
  - Mirror production environments on separate z/VM test systems
  - Exploit legendary z/VM debugging support
  - Constrain resource consumption of test systems using z/VM built-in allocation controls

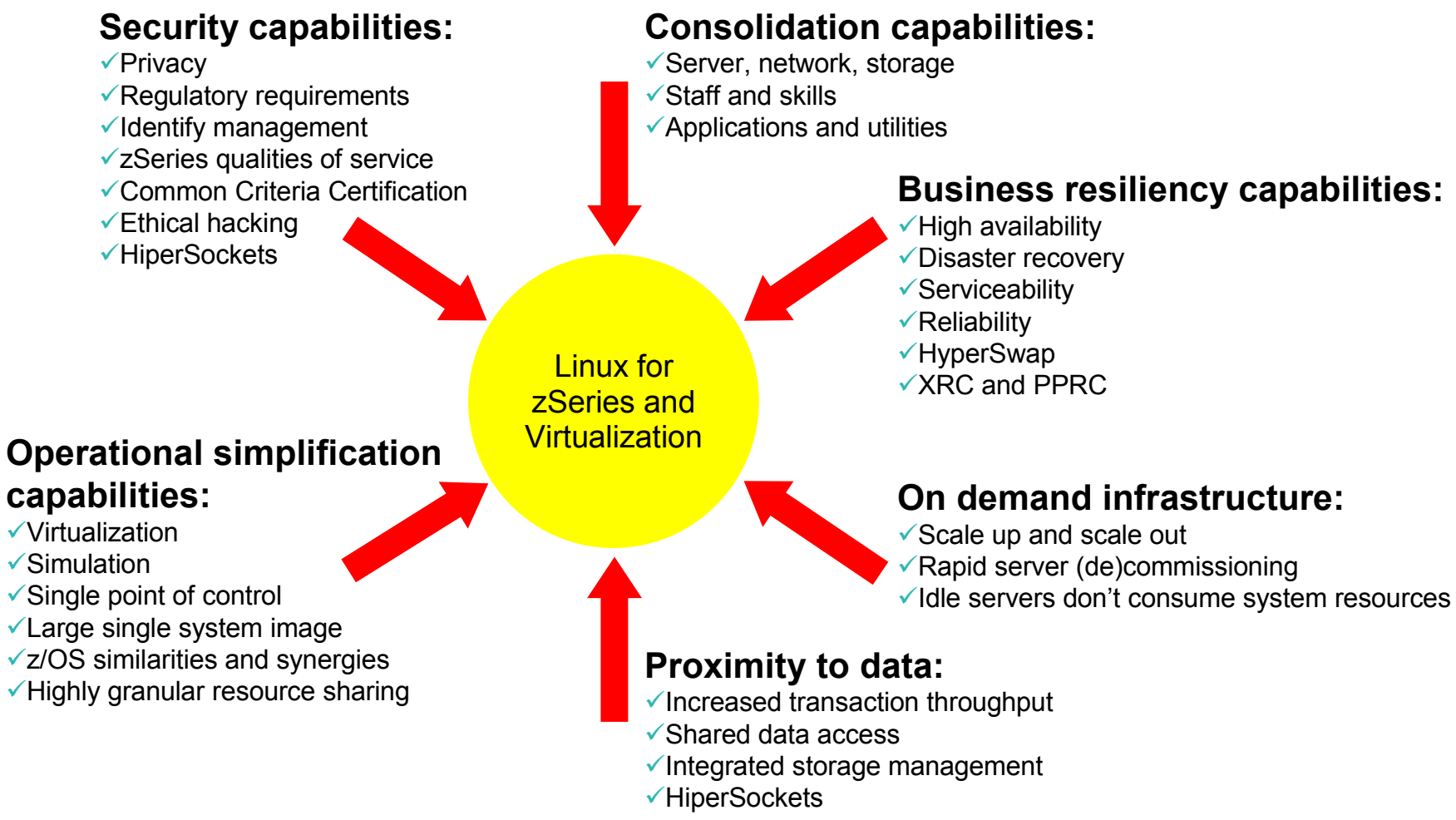
Key Learning Points

Linux and z/VM – Changing the Server Landscape

- **Industry-leading virtualization technology**
  - Host tens to hundreds of virtual Linux servers on a single mainframe
  - Exploit high performance virtual networking among Linux images
  - Take advantage of functionally rich, built-in systems management functions
- **Infrastructure simplification**
  - Exploit z/VM technology on IFL or standard processor engines
  - Reduce hardware expense and complexity with virtual servers and virtual networks
  - Simultaneously test and deploy different levels of Linux kernels on the same z/VM image
  - Host Linux-based on demand solutions side-by-side z/OS environments
- **On demand computing**
  - Provision servers in minutes, not days or weeks
  - Monitor, manage, and reconfigure servers dynamically without interruption
  - Record and report virtual and real resource consumption for chargeback and capacity planning

Linux and z/VM on System z9 and zSeries

Providing Unmatched Value Propositions for Linux Workloads



Key Points – Distributed Costs

- **The cost of running additional workload on distributed servers goes up linearly**
  - Labor is now the highest cost element in distributed environments
  - Administrative staff costs increase in proportion to number of servers
  - New workload requires additional servers
  - Cost of additional servers is linear
  - Cost of software licenses is linear
  - Electrical and air conditioning costs also increasing
- **Net: scale out strategies on distributed systems do not reduce the cost per unit of work as the workload grows**

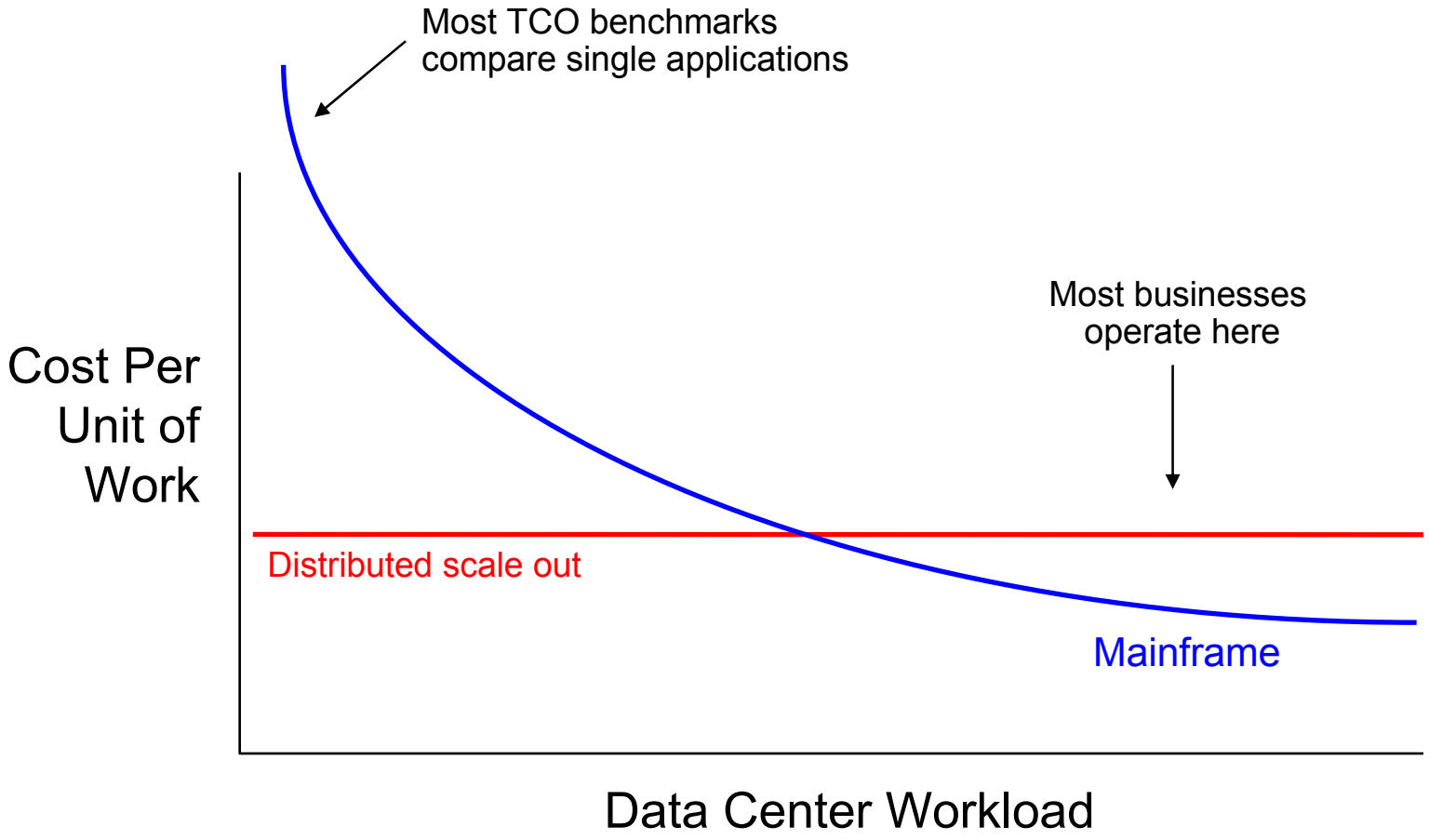
This pricing discussion is based on list prices

Key Points – Mainframe Costs

- **The cost of running incremental workload on the mainframe goes down as the total workload grows**
  - Labor costs hold steady as workload grows
  - IBM pricing policies designed to favor the addition of more workload
  - Special hardware pricing for new workload types
  - Lower software costs per transaction as workload grows
  - Lower electrical and air conditioning consumption than server farms
- **Customers have learned that a mainframe running high-throughput workloads are the most cost efficient platform**

Mainframe Cost per Unit of Work

Decreases as Workload Increases



First National Bank of Omaha

	Servers	*Reliability*	*Utilization*	*Staff*
First move: Implemented distributed computing architecture that became too difficult to monitor, maintain, upgrade and scale	30+ Sun Solaris servers 560+ Intel servers	Unacceptable	12%	24 people growing at 30% per year
Next move: Consolidated back on the mainframe	One z990	Much improved	84% - with additional capacity available on demand	Reduced to 8 people

Seven times better utilization on mainframe hardware

7x better utilization also reduces software licensing, labor, power, and cooling costs accordingly

Hannaford Goes Real Time with Linux on System z9

- **Northeastern United States supermarket chain**
- **Consolidated 300 Linux store servers on to a single mainframe**
  - Running 62 virtual servers instead
  - Orders now received directly from store aisles; just-in-time inventory management
  - Introduced new web portal for business partners
- **Reduced costs while improving customer and partner satisfaction**
  - Significant labor savings across the IT organization
- **Read more at: biz.yahoo.com/iw/051205/0103015.html**

"The only way we'd consider consolidating critical data from hundreds of servers onto one system was by choosing an IBM mainframe for its legendary reliability and availability."

- Bill Homa, Senior Vice President and CIO of Hannaford Brothers Company

Linux and z/VM Resources

- **IBM Learning Services Classes**
  - Installing, Configuring, and Servicing z/VM for Linux Guests (ZV062)
  - z/VM and Linux Connectivity and Management (ZV100)
  - z/VM RACF and DirMaint Implementation (ZV200)
  - Linux Basics - a zSeries Perspective (HLX13)
  - Linux Implementation for zSeries (ZL100)
  - Advanced Solutions for Linux on zSeries (ZL150)
  - Deploying WebSphere and Advanced e-business Applications on Linux for zSeries (LINX5)
  - Deploying WebSphere Centric Products on Linux for zSeries (LINX6)
  - Find more info at: ibm.com/servers/eserver/zseries/os/linux/ed.html
- **z/VM Security and Integrity whitepaper**
  - ibm.com/servers/eserver/zseries/library/techpapers/gm130145.html
- **Linux for zSeries and S/390 listserver**
  - www.marist.edu/htbin/wlvindex?linux-390
- **IBM Global Services**
  - ibm.com/services/us/index.wss/offerfamily_services/igs/a1002810

Linux for System z and zSeries Redbooks

- **System Management**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg246820.html
- **Server Consolidation with Linux for zSeries**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp0222.html
- **High Availability for z/VM and Linux**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp0220.html
- **Cloning Linux Images in z/VM**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp0301.html
- **Performance Measurement and Tuning**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg246926.html
- **Large Scale Linux Deployment**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246824.html
- **Managing a Samba Server from z/VM**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/redp3604.html
- **TCP/IP Broadcast on z/VM Guest LAN**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/redp3596.html
- **Application Development**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246807.html
- **ISP/ASP Solutions**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg246299.html

Linux for System z and zSeries Redbooks (cont'd)

- **Linux Systems Management Using Aduva Director**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/redp3599.html
- **Virtual Router Redundancy Protocol on VM Guest LANs**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp3657.html
- **z/VM Configuration for WebSphere Deployments**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp3661.html
- **VSWITCH and VLAN features of z/VM 4.4**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp3719.html
- **Formatting and Labeling a DASD Volume for Linux Guests Running Under z/VM**
  - www.redbooks.ibm.com/abstracts/tips0275.html
- **Partitioning DASD for Linux Guests Running Under z/VM**
  - www.redbooks.ibm.com/abstracts/tips0277.html
- **Linux with zSeries and ESS: Essentials**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/sg247025.html
- **IBM Lotus Domino 6.5 for Linux on zSeries Implementation**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg247021.html
- **Accounting and Monitoring for z/VM Linux Guest Machines**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp3818.html
- **Best Security Practices**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg247023.html

Linux for System z and zSeries Redbooks (cont'd)

- **Performance Toolkit for VM**
  - www.redbooks.ibm.com/redpieces/abstracts/sg246059.html
- **Advanced LDAP User Authentication: Limiting Access to Linux Systems Using the Host Attribute**
  - www.redbooks.ibm.com/redpieces/abstracts/redp3863.html
- **Printing with Linux on zSeries Using CUPS and Samba**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedbookAbstracts/redp3864.html
- **Running Linux Guest in less than CP Priviledge Class G**
  - publib-b.boulder.ibm.com/Redbooks.nsf/RedpaperAbstracts/redp3870.html
- **Linux on zSeries Fibre Channel Protocol Implementation Guide**
  - www.redbooks.ibm.com/redpieces/abstracts/sg246344.html
- **Implementing IBM Tape in Linux and Windows**
  - www.redbooks.ibm.com/redpieces/abstracts/sg246268.html
- **Networking Overview for Linux on zSeries**
  - www.redbooks.ibm.com/redpapers/abstracts/redp3901.html
- **OSA-Express Quick-Start Table for z/VM**
  - www.redbooks.ibm.com/abstracts/tips0104.html
- **Capacity Test of IFL vs. CP**
  - www.redbooks.ibm.com/abstracts/tips0479.html
- **Experiences with Oracle 10g Database for Linux on zSeries**
  - www.redbooks.ibm.com/redpieces/abstracts/sg246482.html

Linux for System z and zSeries Redbooks (cont'd)

- **A Shared WebSphere Application Server Installation for Linux on zSeries**
  - www.redbooks.ibm.com/redpapers/abstracts/redp3998.html
- **Linux Software Management with Aduva OnStage**
  - www.redbooks.ibm.com/redpapers/abstracts/redp4057.html
- **Mainframes and GIS--A New ESRI Solution on IBM zSeries using Linux**
  - www.redbooks.ibm.com/redpapers/abstracts/redp4112.html
- **Running Linux on IBM System z9 and zSeries under z/VM**
  - www.redbooks.ibm.com/redpieces/abstracts/sg246311.html
- **Linux for IBM System z9 and IBM zSeries**
  - www.redbooks.ibm.com/abstracts/sg246694.html
- **z/VM and Linux on IBM System z: The Virtualization Cookbook for SLES9**
  - www.redbooks.ibm.com/abstracts/sg246695.html
- **IBM Communication Controller for Linux on System z V1.2.1 Implementation Guide**
  - www.redbooks.ibm.com/redpieces/abstracts/sg247223.html
- **Using DCSS/XIP with Oracle 10g on Linux for System z**
  - www.redbooks.ibm.com/redpieces/abstracts/sg247285.html
- **WebSphere Portal Server Cloning on Linux for zSeries and z9**
  - www.redbooks.ibm.com/redpapers/pdfs/redp4175.pdf
- **z/VM and Linux on IBM System z: The Virtualization Cookbook for Red Hat Enterprise Linux 4**
  - www.redbooks.ibm.com/abstracts/sg247272.html

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