Why Linux on

IBM System z

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Why Linux on System z - Topics

- **Why Linux**
- **Data Centers**
- **System z Virtualization**
- **System z Engines**
- **System z Security**
- **System z**
  - High Availability (HA)
  - Disaster Recovery (DR)

Why Linux

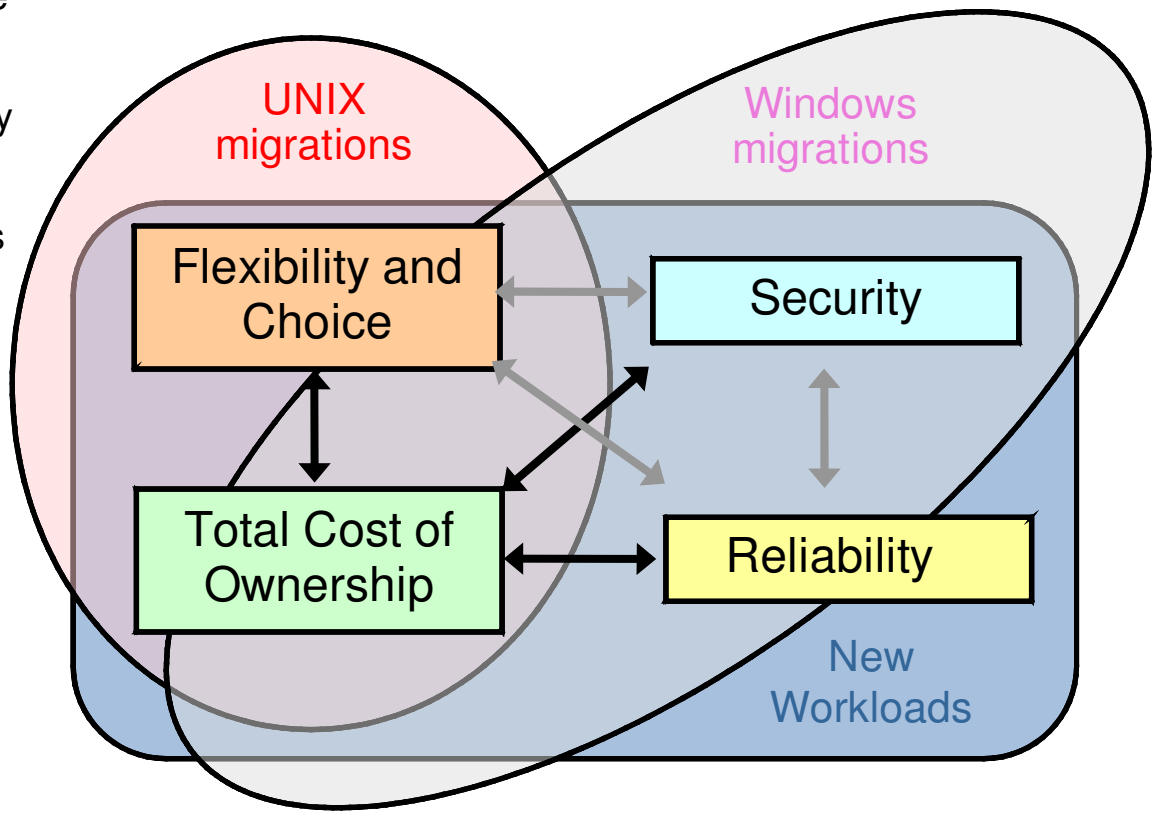
Why Linux?

- **Linux supports multiple hardware platforms**
  - Spanning from embedded devices to supercomputers
  - Speed of support for new platforms
  - Availability of skills, portability of applications
  - Scale-out through clustering as well as scale-up through SMP
- **Linux has an affinity with virtualization**
  - Supported on all major hypervisors, from z/VM to VMware and Hyper-V
  - Inclusion of KVM as part of Linux
- **Linux is flexible**
  - Modular and customizable, with flexible usage licensing
- **Linux is developed by an open community**
  - Sharing skills and resources, leading to faster development

What Makes Linux Special ?

Why Customers adopt Linux today

- Linux offers UNIX customers the flexibility to choose lower cost hardware
- Linux offers Windows customers increased flexibility and enhanced security / reliability
- Linux offers all customers choice for new workloads through open computing, avoiding lock-in to proprietary hardware or software vendors or architectures



New reasons for adopting Linux

- Linux is Modular
  - Faster Development Cycle
  - Customization (e.g. Linux Appliances)
  - Specialization (e.g. Real-time, SELinux)
- Linux is Cross Platform
  - Virtualization, Consolidation, and Cloud
- Linux is Community Developed
  - Sharing resources for a common goal

Linux on System z SWG Strategy

The Cross Brand strategy organization works with the SW brand teams to focus on the following

- Support of core products and solutions (server and client)
- Currency (current distributions, both distributions)
- Functional Parity – equivalent function on System z compared to other platforms
- Virtualization
  - Allow z/VM to "swap out" product when product is idle (e.g. WAS, WAS CE, Domino)
  - Allow sharing of product binaries across Linux images (e.g. MQ, WAS)
  - Run product benchmarks with Linux running on z/VM

Feature Linux on System z in key initiatives

- Industry Solution focus
- Cloud
- Green
- Smarter Planet
- Consolidation/Virtualization (STG)

SWG Platform Strategy

- Platform Support Policy: (18 platforms currently tracked)
  - The current release of a product that is being marketed should support the previous (N-1) and current (N) versions of its priority platforms starting within 90 days of the initial product GA or the platform GA, whichever is later.
- Product types: (approx 65 “core” products)
  - Every product should be classified into the following product types:
    - Standard-platform Product.
    - Nonstandard-platform Product. Products that run only on specific platforms. This may include:
      - Mainframe products
      - Products in maintenance mode
      - Development tools
      - Newly acquired products
- Strategy:
  - Every standard-platform product will support the priority platforms. It may also support any additional platforms selected by the brand.
  - Products or components on which other products or components are dependent will support the priority platforms of the dependent products.
  - Nonstandard-platform products may support any platforms selected by the brand.

General Linux

IBM software for Linux
providing an open, robust and scalable platform for applications

- IBM Linux Home Page (external)
  http://www.ibm.com/linux/
- IBM Software for Linux Home page (external)
  http://www.ibm.com/software/os/linux/software/
- IBM Software Matrix
  http://www.ibm.com/linux/matrix
- Additional Linux Links
  http://www-1.ibm.com/linux/links/index.shtml

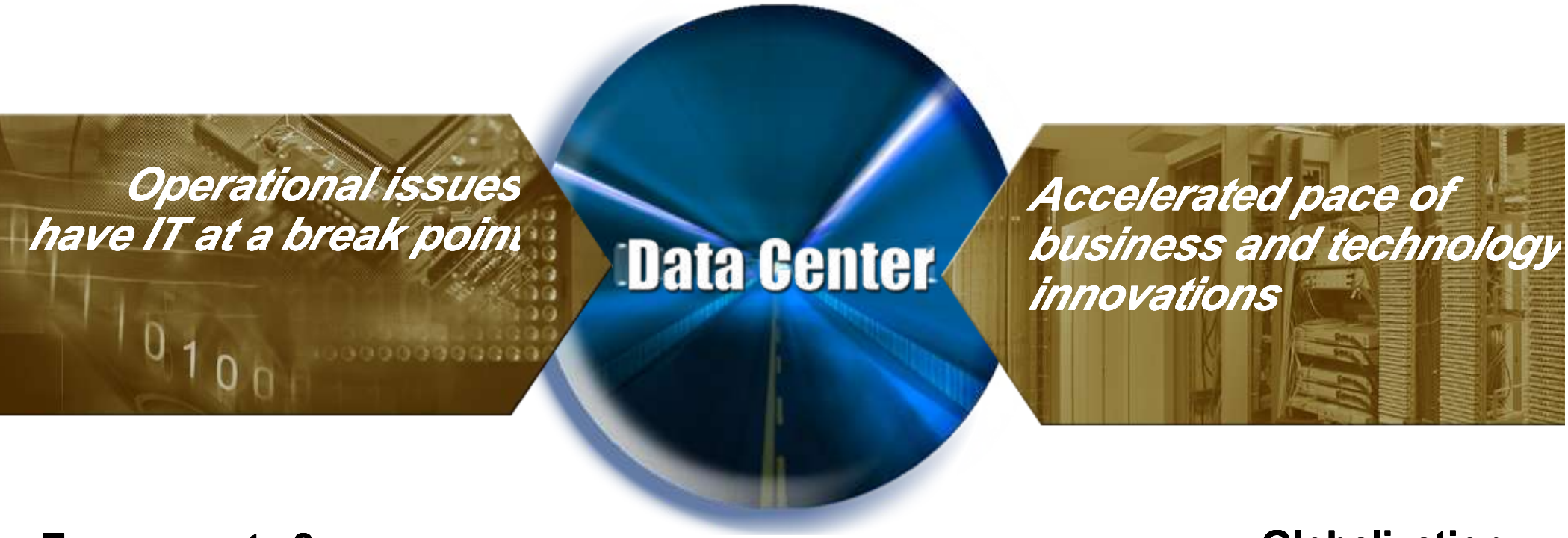
System z

Data Centers

New Enterprise Data Center

- Evolutionary
- Resilient
- Efficient

Multiple forces are driving a transformation of the data center



Energy costs 8x

Management costs 4x

70% of IT budget is operational overhead

Globalization

Acquisitions

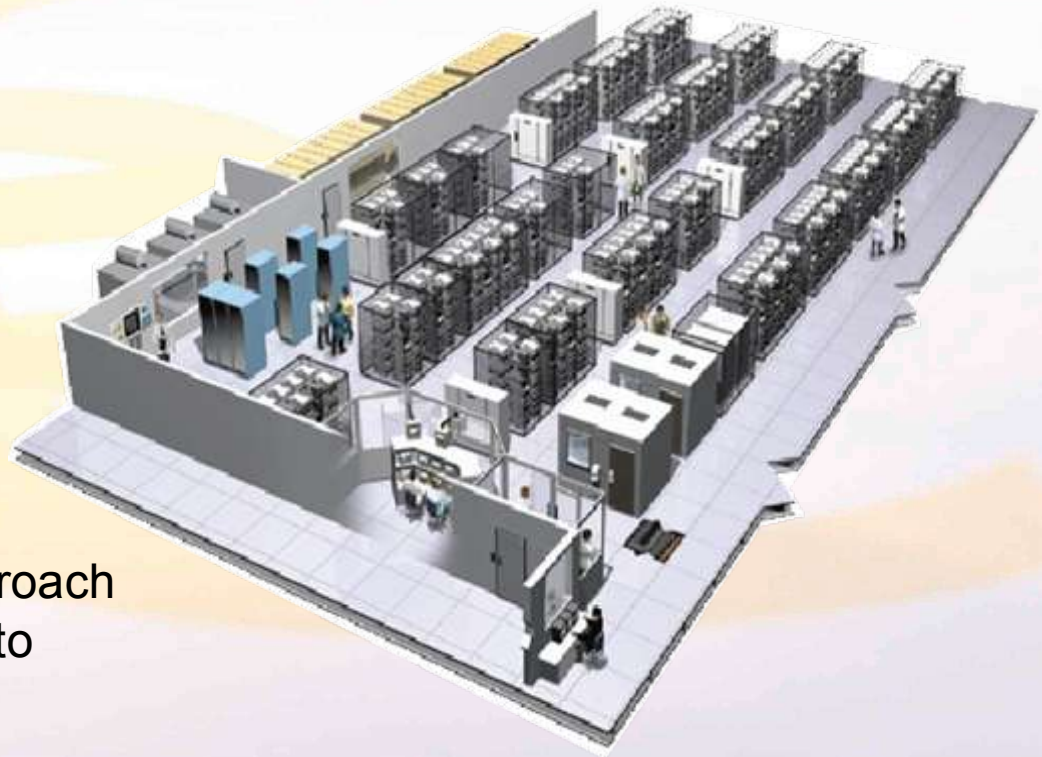
Green

We really examined the growth of distributed servers in Data Centers

A source of complexity and cost, and a Savings Opportunity

Distributed-systems can proliferate IT costs:

- Cost and complexity (e.g., more physical servers, real network gear)
- Excessive energy usage and heating problems
- Inadequate power and cooling infrastructure
- Data silos and data synchronization
- Linear staffing costs
- Linear per processor software costs
- Frequent outages



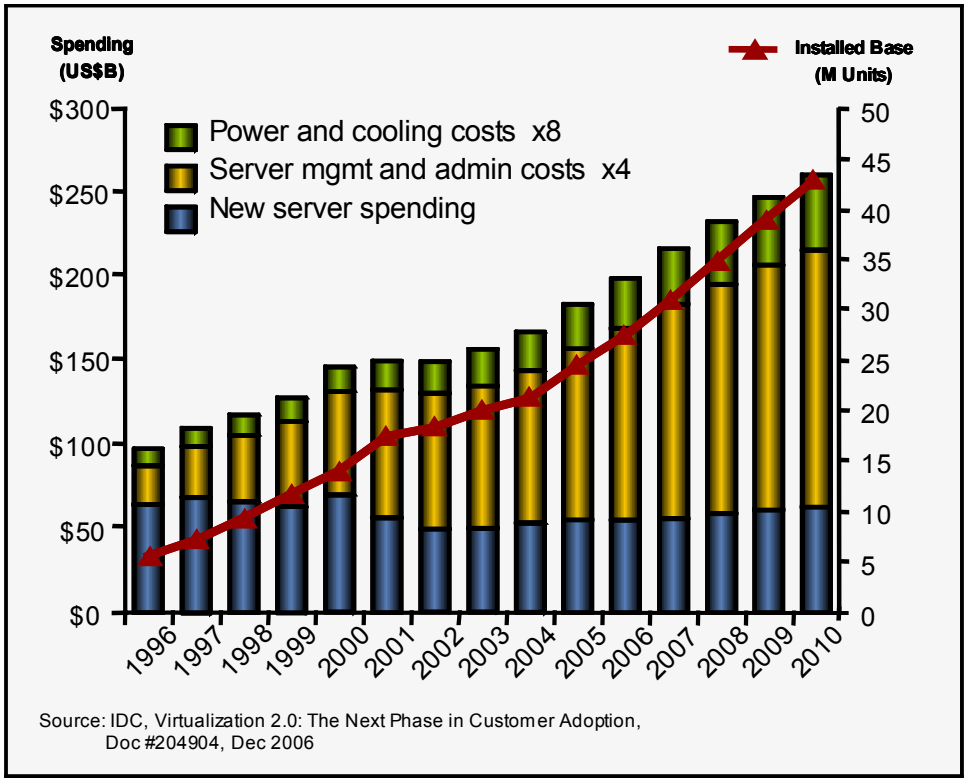
IBM System z10 EC suggests an alternate approach

- Use fewer, more powerful z10 EC servers to unlock the savings in your Data Centers

LESS IS MORE – Focus on highly efficient use of FEWER servers

Cost of Ownership

- **TCO model should include all relevant costs**
  - People costs have doubled as a % of total IT cost since 1996
  - Software costs have grown linearly. Much of it is CPU based.
  - Energy costs could approach total hardware spend in the next several years
  - Hardware spend has been flat



Source: IDC, Virtualization 2.0: The Next Phase in Customer Adoption, Doc #204904, Dec 2006

A TCO model that focuses primarily on hardware spend will ignore many of the most significant costs in the datacenter.

TCO: A Range of IT Cost Factors – Often Not Considered

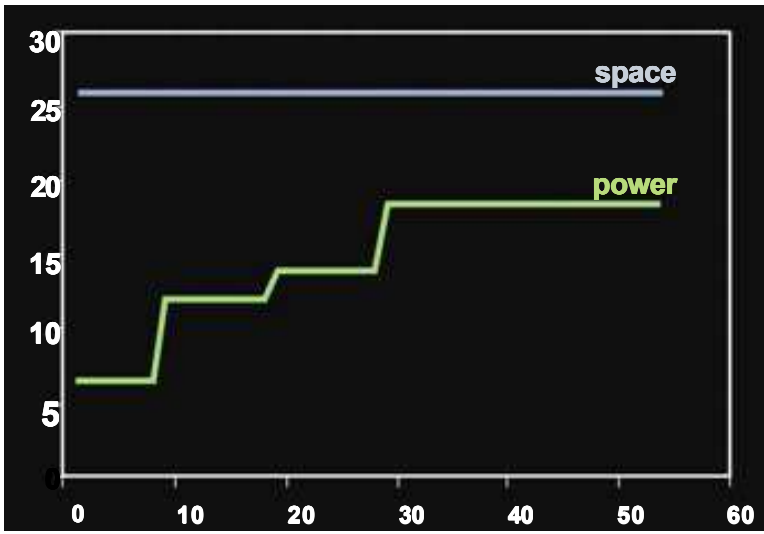
- *Availability*
  - High availability
  - Hours of operation
- *Backup / Restore / Site Recovery*
  - Backup
  - Disaster Scenario
  - Restore
  - Effort for Complete Site Recovery
  - SAN effort
- *Infrastructure Cost*
  - Space
  - Power
  - Network Infrastructure
  - Storage Infrastructure
  - Initial Hardware Costs
  - Software Costs
  - Maintenance Costs
- *Additional development/implementation*
  - Investment for one platform – reproduction for others
- *Controlling and Accounting*
  - Analyzing the systems
  - Cost
- *Operations Effort*
  - Monitoring, Operating
  - Problem Determination
  - Server Management Tools
  - Integrated Server Management – Enterprise Wide
- *Security*
  - Authentication / Authorization
  - User Administration
  - Data Security
  - Server and OS Security
  - RACF vs. other solutions
- *Deployment and Support*
  - System Programming
    - Keeping consistent OS and SW Level
    - Database Effort
  - Middleware
    - SW Maintenance
    - SW Distribution (across firewall)
  - Application
    - Technology Upgrade
    - System Release change without interrupts
- *Operating Concept*
  - Development of an operating procedure
  - Feasibility of the developed procedure
  - Automation
- *Resource Utilization and Performance*
  - Mixed Workload / Batch
  - Resource Sharing
    - shared nothing vs. shared everything
  - Parallel Sysplex vs. Other Concepts
  - Response Time
  - Performance Management
  - Peak handling / scalability
- *Integration*
  - Integrated Functionality vs. Functionality to be implemented (possibly with 3rd party tools)
  - Balanced System
  - Integration of / into Standards
- *Further Availability Aspects*
  - Planned outages
  - Unplanned outages
  - Automated Take Over
  - Uninterrupted Take Over (especially for DB)
  - Workload Management across physical borders
  - Business continuity
  - Availability effects for other applications / projects
  - End User Service
  - End User Productivity
  - Virtualization
- *Skills and Resources*
  - Personnel Education
  - Availability of Resources

Routinely Assessed Cost Factors

When consolidating Linux on low utilization Intel servers, the System z10 Mainframe's ability to provide high utilization may help to reduce both power and facility costs

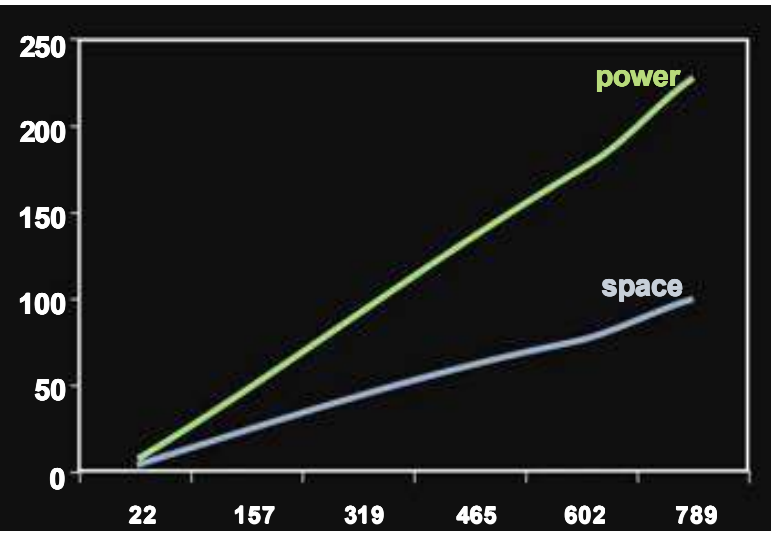
Power and Space Consumption

System z10 EC



Processors

Linux on Intel



Processors

The Linux on Intel servers selected in this example are functionally eligible servers considered for consolidation to a System z running at low utilization such that the composite utilization is approximately 5%. The utilization rate assumed for System z10 EC is 90%. This is for illustration only, actual power and space reductions, if any, will vary according to the actual servers selected for consolidation.

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Linux on System z - Potential Candidates

Medium Peak to Average or Small Workloads (HW / SW Savings)

- Development and test
- Apps with multiple environments that cumulatively have medium peak to average ratios
- Oracle/DB2 databases
- WebSphere
- Tivoli Monitoring
- Sandbox / Training servers

Quality of Service (People / Business Impact)

- System z Hardware RAS
- z/VM - very mature Hypervisor
- Fewer critical Linux patches
- Service bureau virtual hosting
- Lotus Domino
- Infrastructure – LDAP, DNS, TSM, TIM/TAM, FTP
- Critical DR applications

Co-located Applications (with z/OS or other Linux) (Performance / Security / HW)

- CICS / IMS Gateways
- DB2 connect
- Applications with significant z/OS data affinity such as WAS
- SAP Application Servers with z/OS database
- Communication Controller
- MQSeries Queue Manager
- IBI WebFOCUS
- Chatty Linux applications
- Applications that could eliminate security layers between components

Reduce other TCO Factors (People/Other Savings)

- Application environments that can be cloned or replicated (e.g. WebSphere)
- Applications/middleware that can take advantage of shared OS or application binaries
- Speed to market

Linux Strategy (People / Flexibility)

- Significant industry growth in the Linux applications
- IFLs have strong IT industry adoption
- Common OS across platforms reduces administrative costs

System z

Virtualization

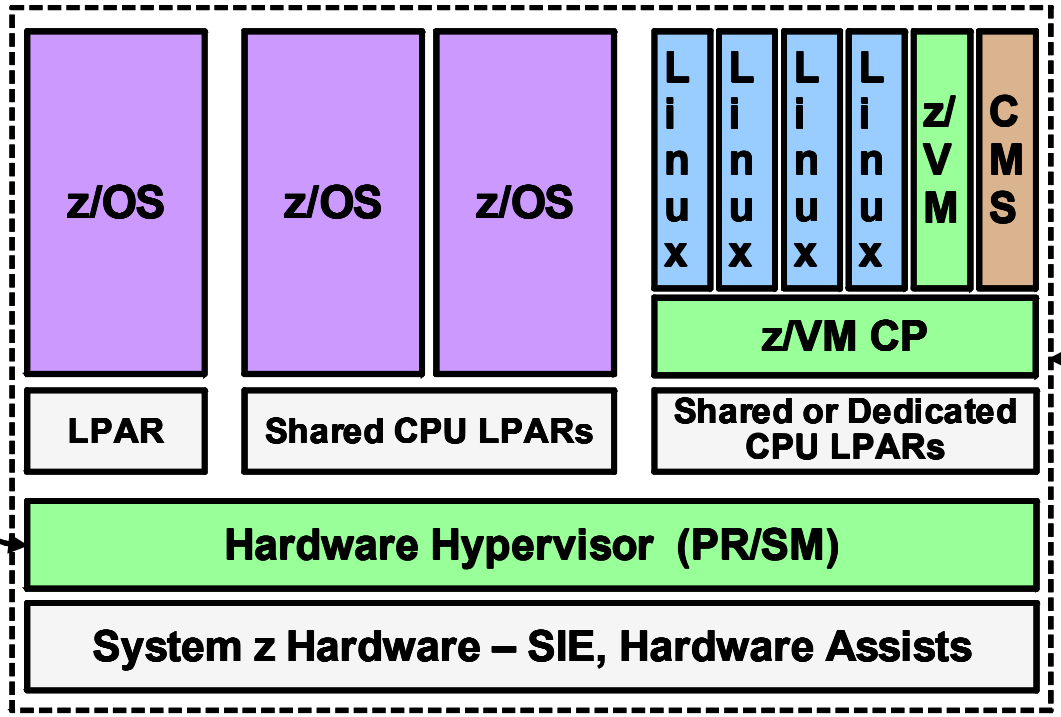
System z Virtualization

Can run z/VM as a guest under z/VM

Isolates and dispatches LPARs

Facilitates virtualized networking between LPARs

Uses virtualization hardware



Isolates and dispatches guests

Provides virtualized CPU, memory and I/O for guests

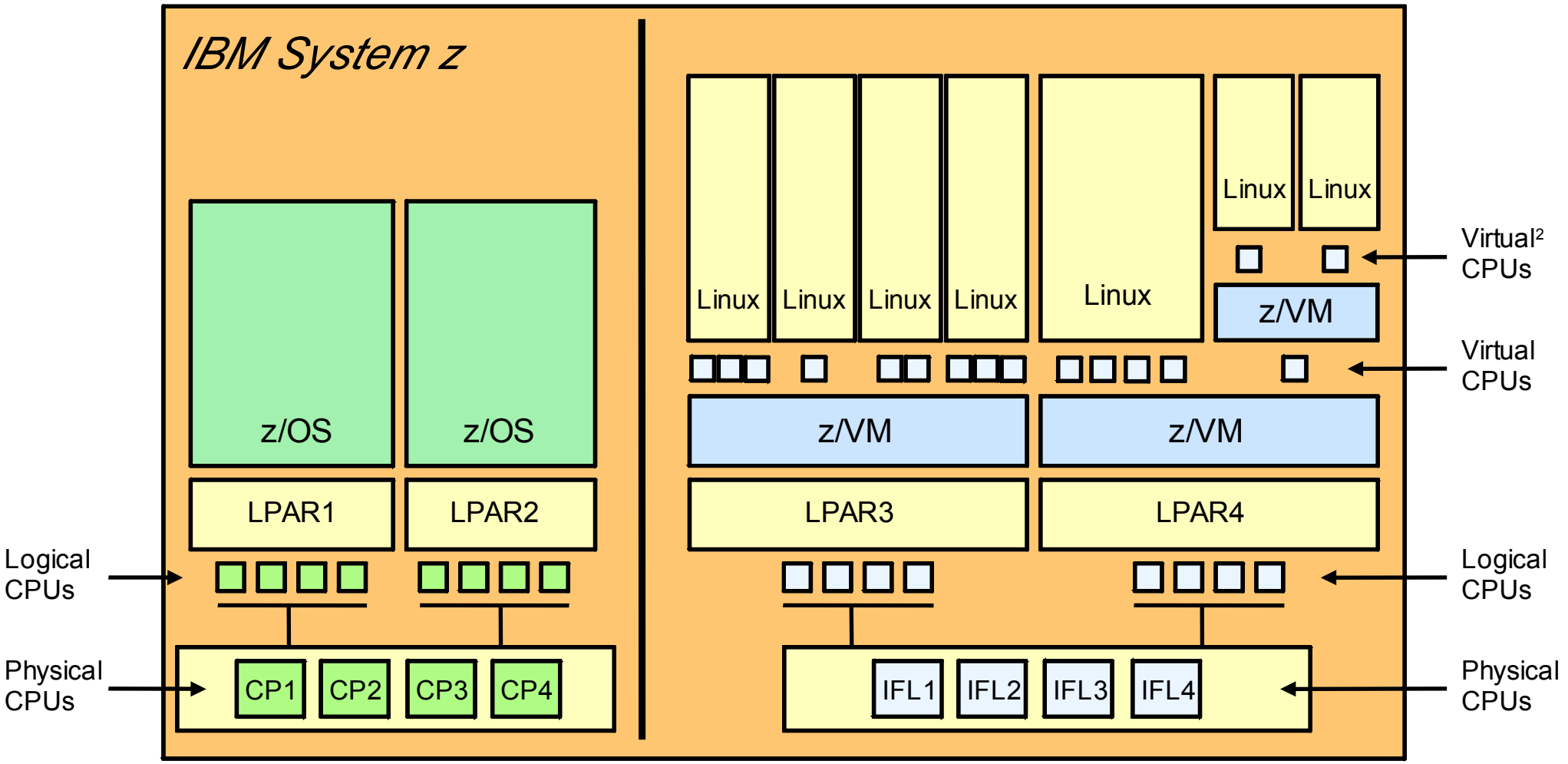
Other guest services

Uses virtualization hardware

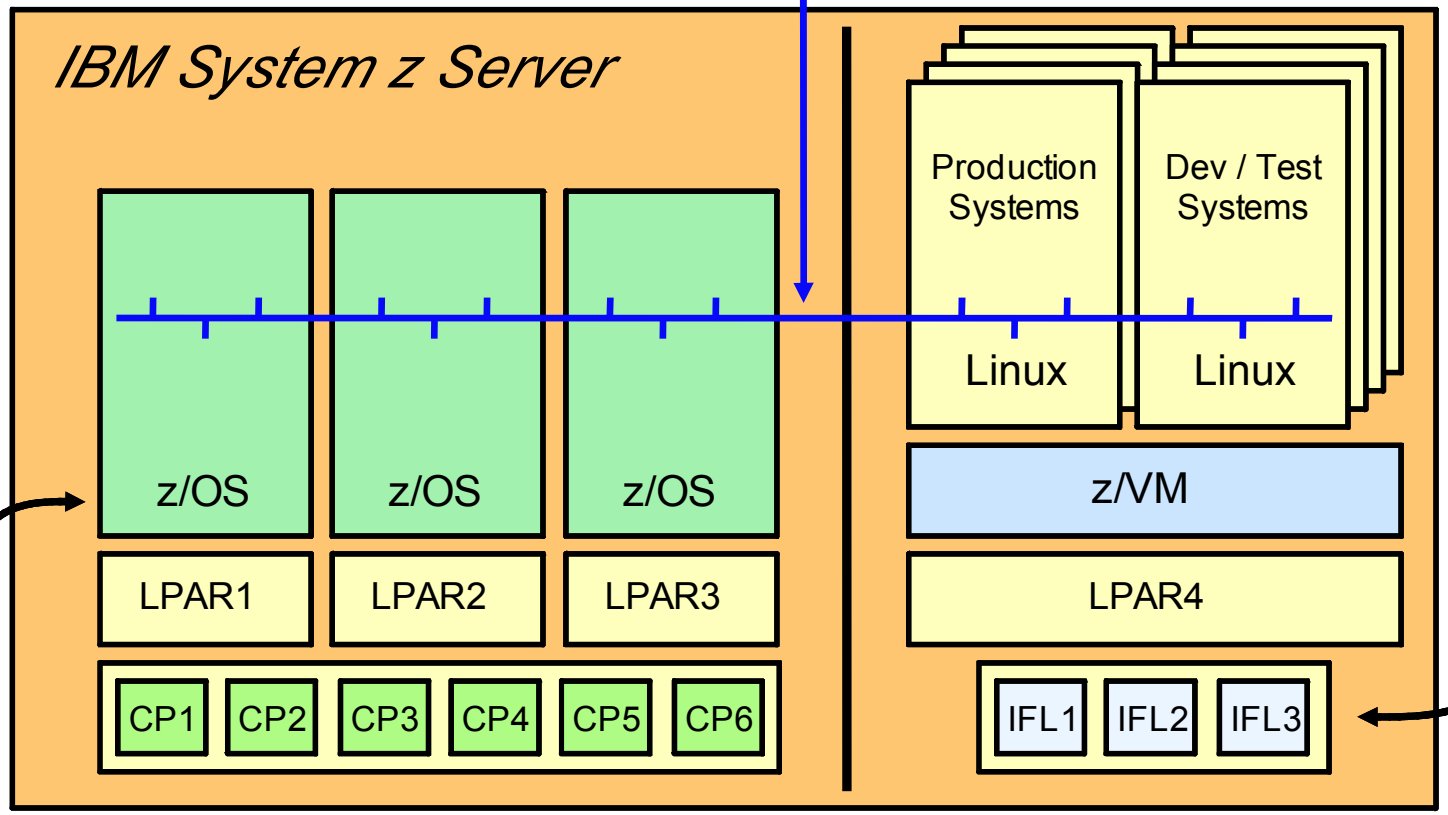
- The majority of virtualization functions are done directly in hardware
- Hardware - saves and loads guests, does address translation, optimizes wait states and spin locks, provides timer facilities, reflects I/O and timer interrupts directly to guests, provides buffer state management for QDIO, allows for second level Hypervisor (z/VM), and other functions
- Results in low latency, low overhead virtualization capabilities

IBM System z Virtualization Leadership

Extreme Levels of CPU Sharing



Sample Linux-on-z/VM IFL Configuration



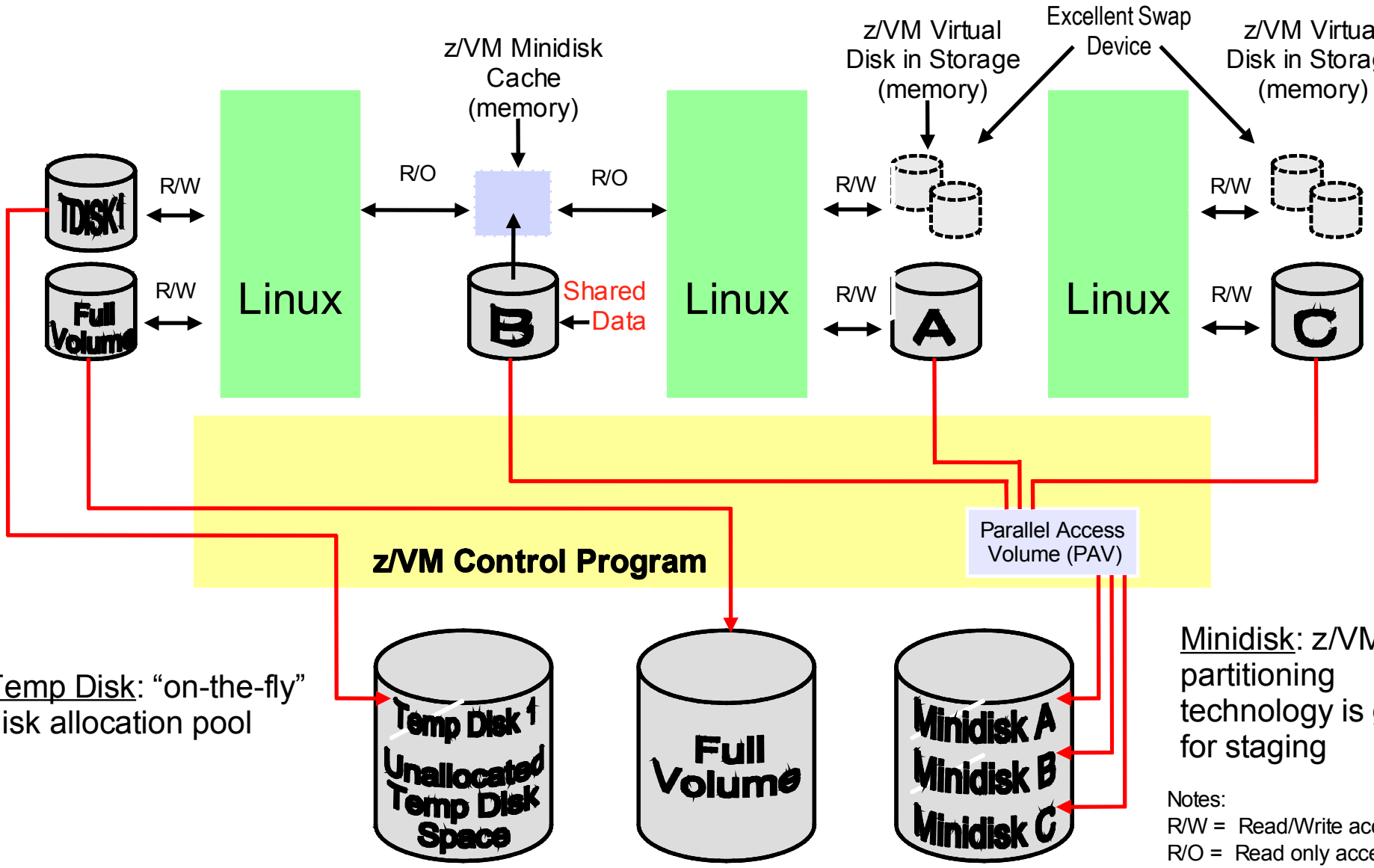
"Inside the box" virtual networking

z/VM and most Linux software fees are priced on real engine capacity...

IFL engines have no impact on z/OS license fees

...a potential source of cost savings given z/VM's ability to overcommit CPU capacity

z/VM Technology: Advanced Disk Support



Temp Disk: "on-the-fly" disk allocation pool

Minidisk: z/VM disk partitioning technology is great for staging

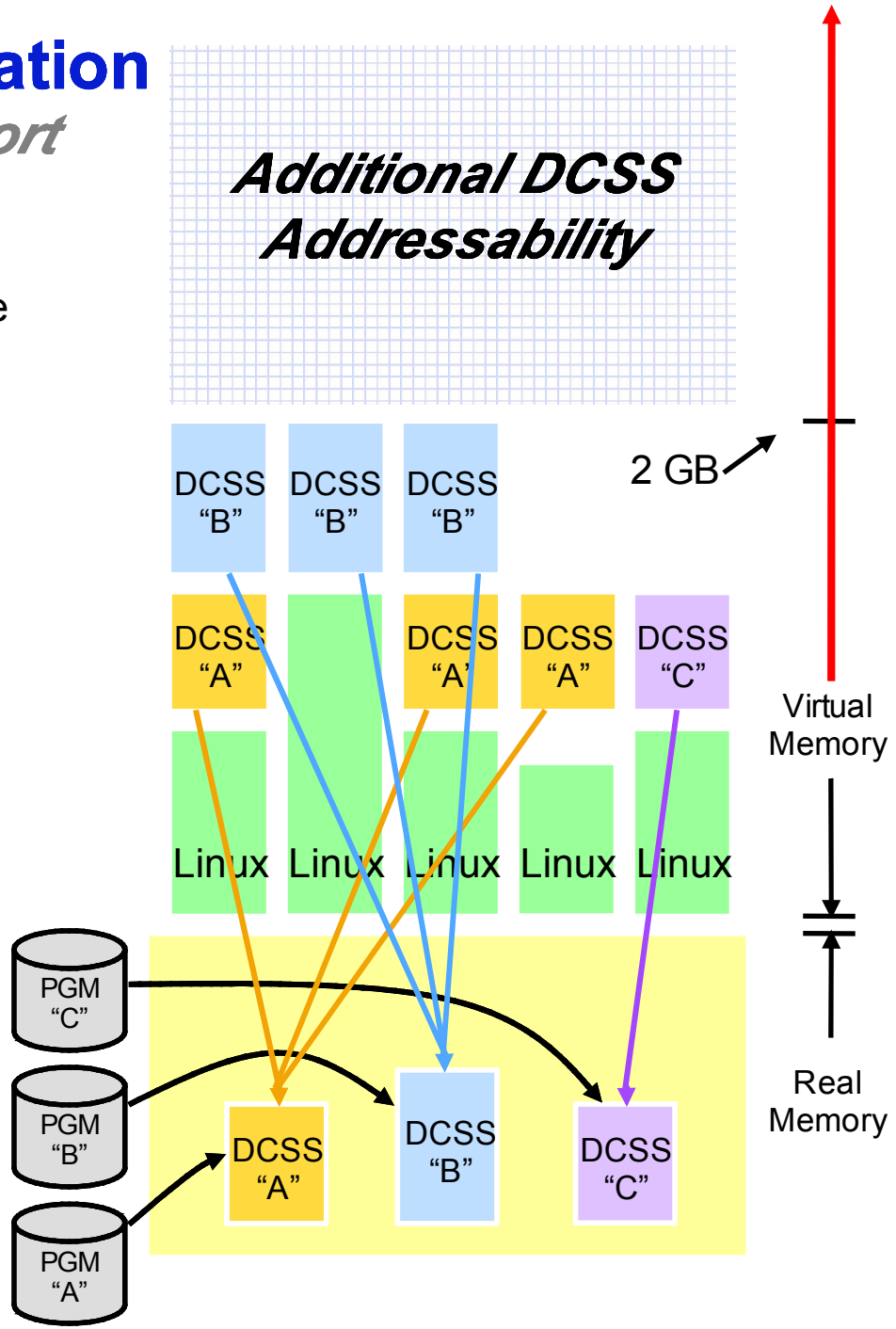
Notes:
R/W = Read/Write access
R/O = Read only access

Extreme Linux-on-z/VM Virtualization

Linux Exploitation of z/VM DCSS Support

- Discontinguous Saved Segments (DCSS)
  - Share a single, real memory location among multiple virtual machines
  - Can reduce real memory utilization
- Linux exploitation: shared program executables
  - Program executables are stored in an execute-in-place file system, then loaded into a DCSS
  - 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
  - Helps enhance overall system performance and scalability
- **z/VM V5.4 support enhancements:**
  - Segments can reside above 2 GB address line
  - Enables even greater system scalability
  - New addressing limit is 512 GB

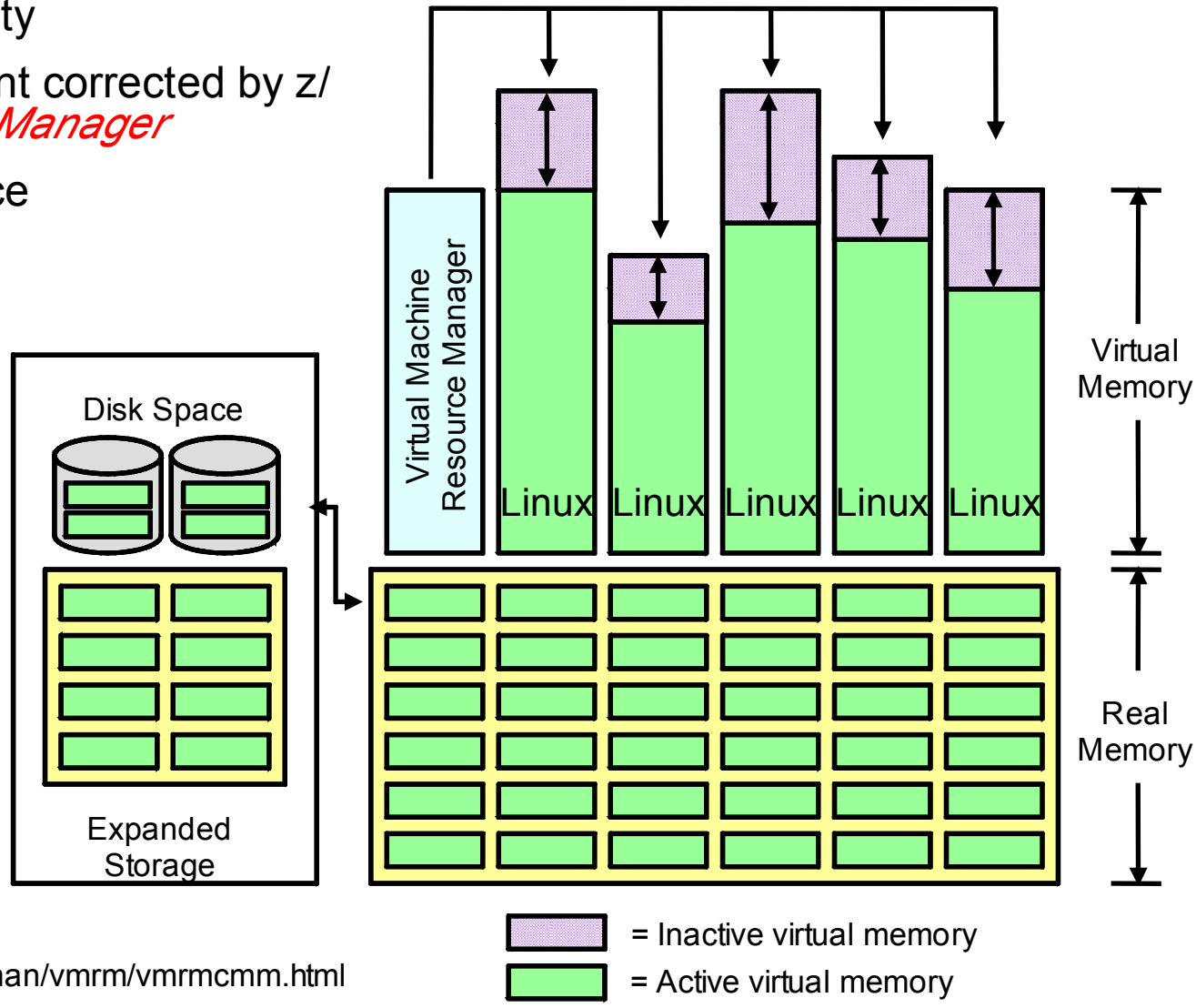
Note: Maximum size of a single DCSS is 2047 MB



Extreme Virtualization with Linux on z/VM

VMRM Cooperative Memory Management (VMRM-CMM)

- Problem scenario: virtual memory utilization far exceeds real memory availability
- Solution: real memory constraint corrected by z/VM *Virtual Machine Resource Manager*
- Linux images signaled to reduce virtual memory consumption
- Demand on real memory and z/VM paging subsystem is reduced
- Helps improve overall system performance and guest image throughput

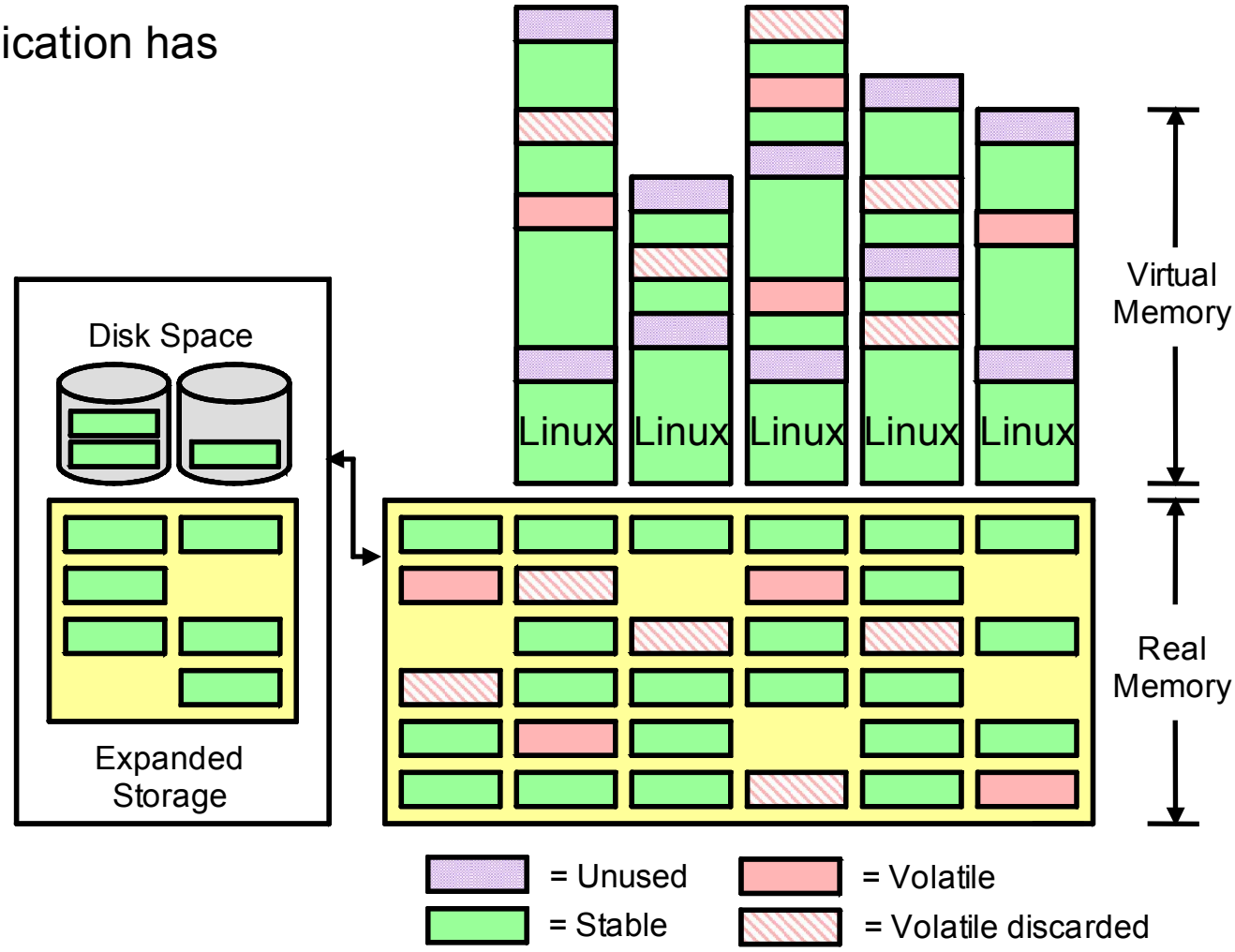


Learn more at:
ibm.com/servers/eserver/zseries/zvm/sysman/vmrm/vmrmcmm.html

Linux and z/VM Technology Exploitation

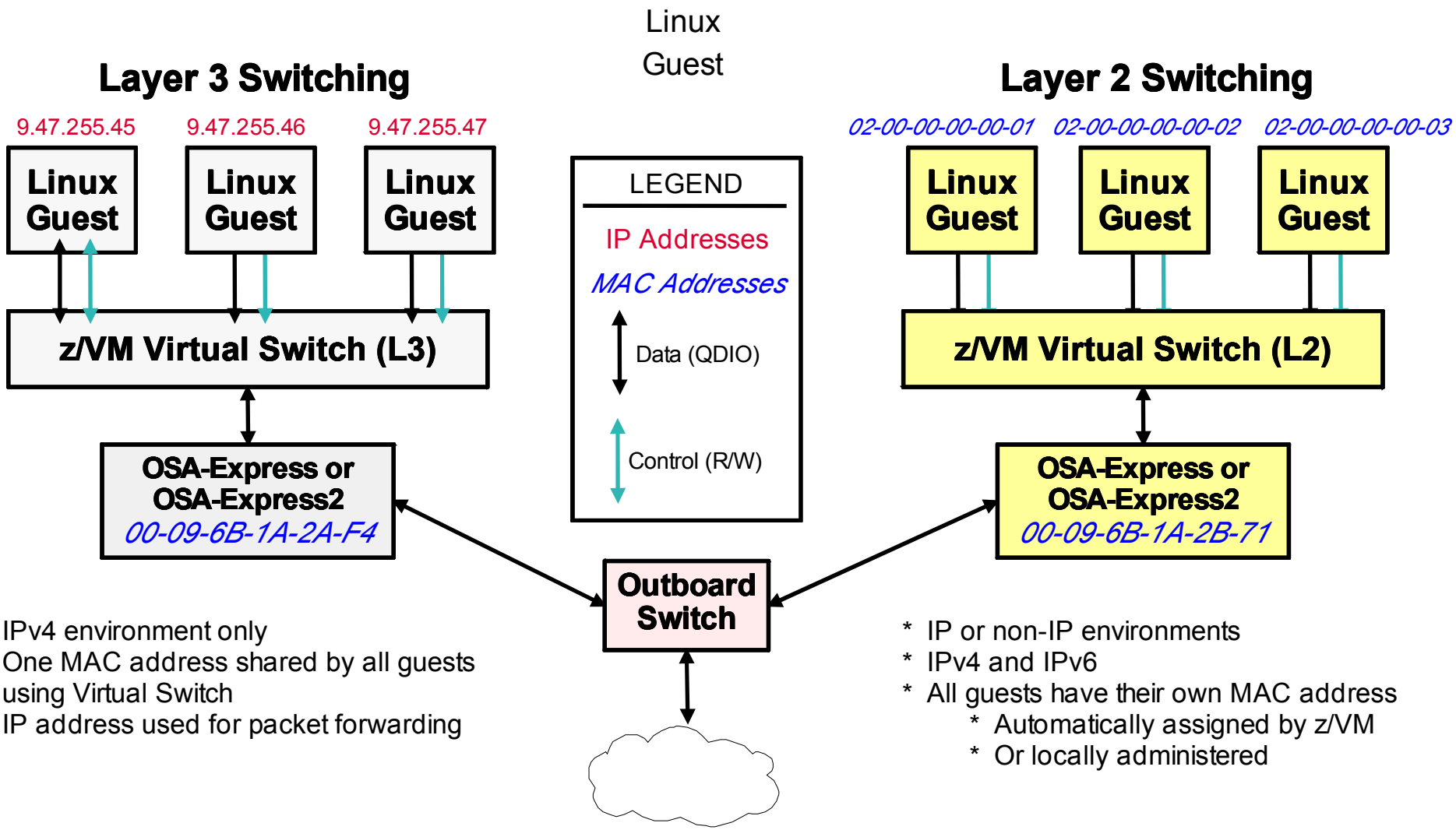
Collaborative Memory Management Assist (CMMA)

- Extends coordination of memory and paging between Linux and z/VM to the level of individual pages using a new hardware assist (*CMMA*)
- z/VM knows when a Linux application has released a page of memory
- Host Page-Management Assist (*HPMA*), in conjunction with CMMA, further reduces z/VM processing needed to resolve page faults
- Can help z/VM host more virtual servers in the same amount of memory
- Supported by System z9 and z/VM V5.3
- Linux support available with Novell SLES 10 SP1



z/VM Virtual Switch Support

Layer 3 Compared to Layer 2 Switching

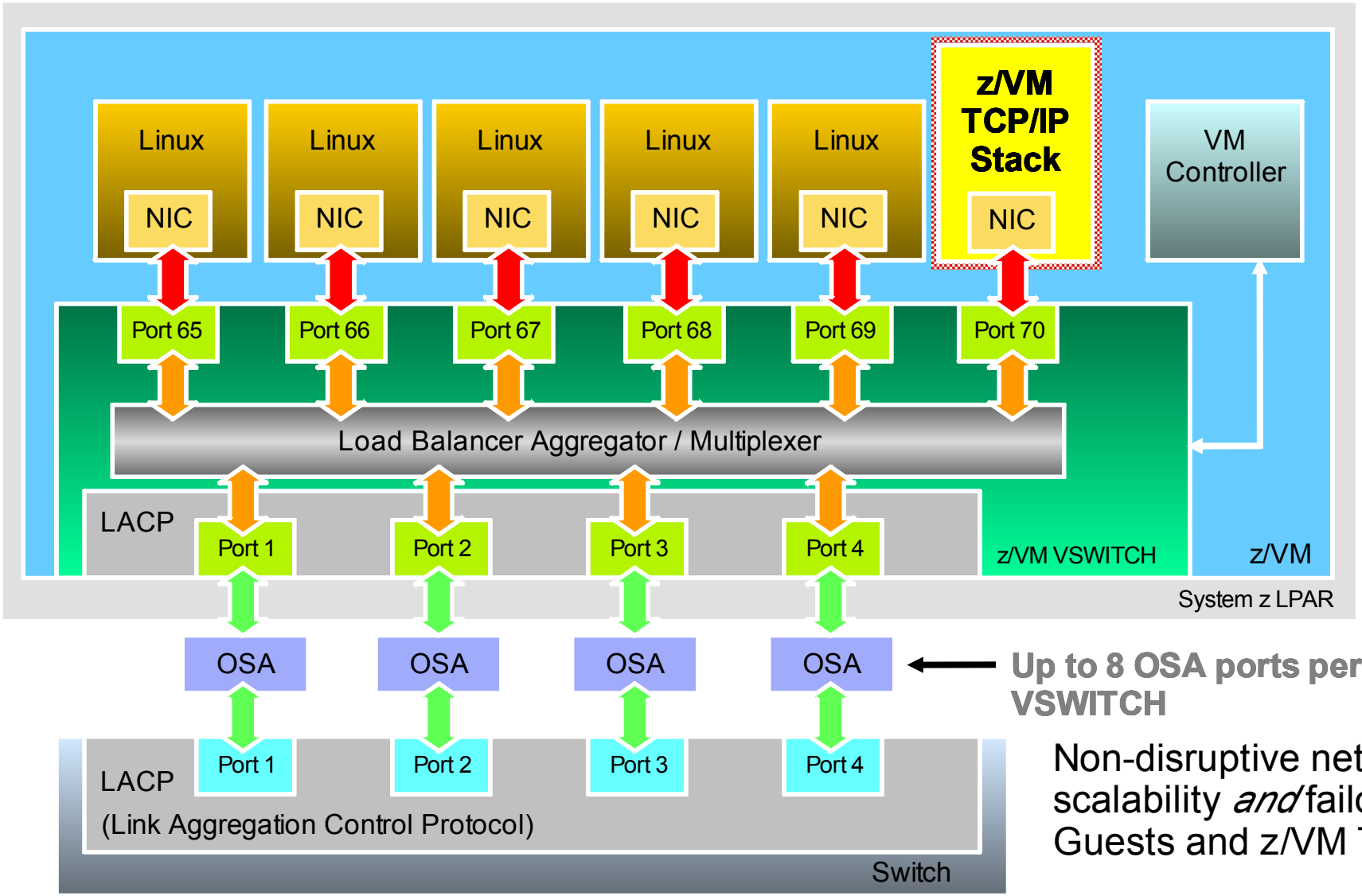


* IPv4 environment only
* One MAC address shared by all guests using Virtual Switch
* IP address used for packet forwarding

* IP or non-IP environments
* IPv4 and IPv6
* All guests have their own MAC address
  * Automatically assigned by z/VM
  * Or locally administered

z/VM Virtual Switch Link Aggregation

With z/VM TCP/IP Stack Connectivity Support in z/VM V5.4

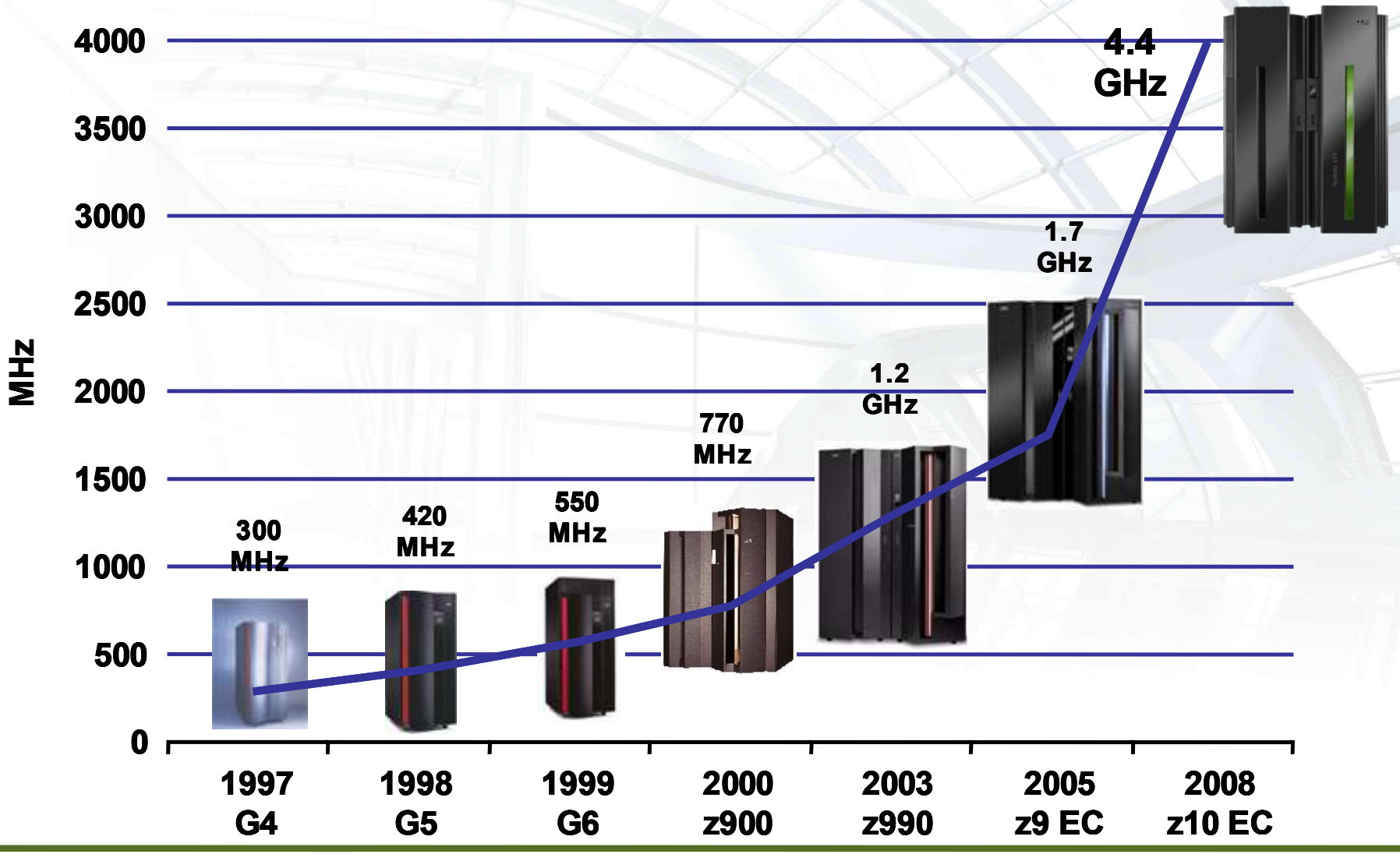


Non-disruptive networking scalability *and* failover for Guests and z/VM TCP/IP.

System z

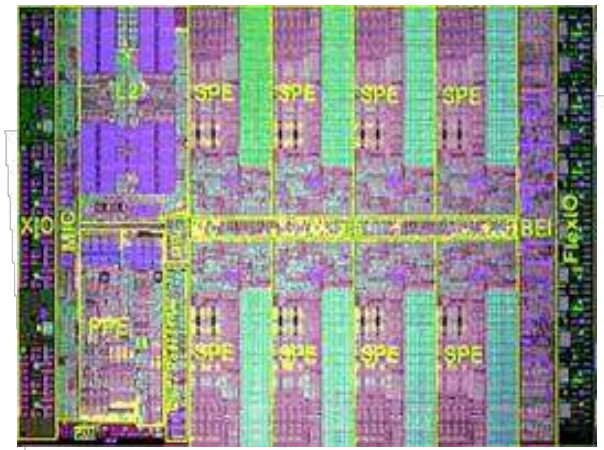
Engines

IBM z10 EC Continues the CMOS Mainframe Heritage



- G4 - 1st full-custom CMOS S/390
- G5 - IEEE-standard BFP; branch target prediction
- G6 - Cu BEOL
- z900 - Full 64-bit z/Architecture
- z990 - Superscalar CISC pipeline
- z9 EC - System level scaling
- z10 EC – Architectural extensions

Evolution of System z Specialty Engines



Cell Broadband Engine™

Building on a strong track record of technology innovation with specialty engines – DB Compression, SORT, Encryption, Vector Facility

Integrated Facility for Linux (IFL) 2000

System z Application Assist Processor (zAAP) 2004

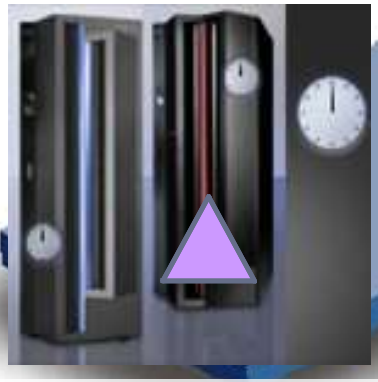
Eligible for zAAP:

- Java™ execution environment
- z/OS XML

IBM System z9 Integrated Information Processor (IBM zIIP) 2006

Eligible for zIIP:

- DB2 remote access and BI/ DW
- ISVs
- New! IPSec encryption
- z/OS XML
- z/OS Global Mirror*

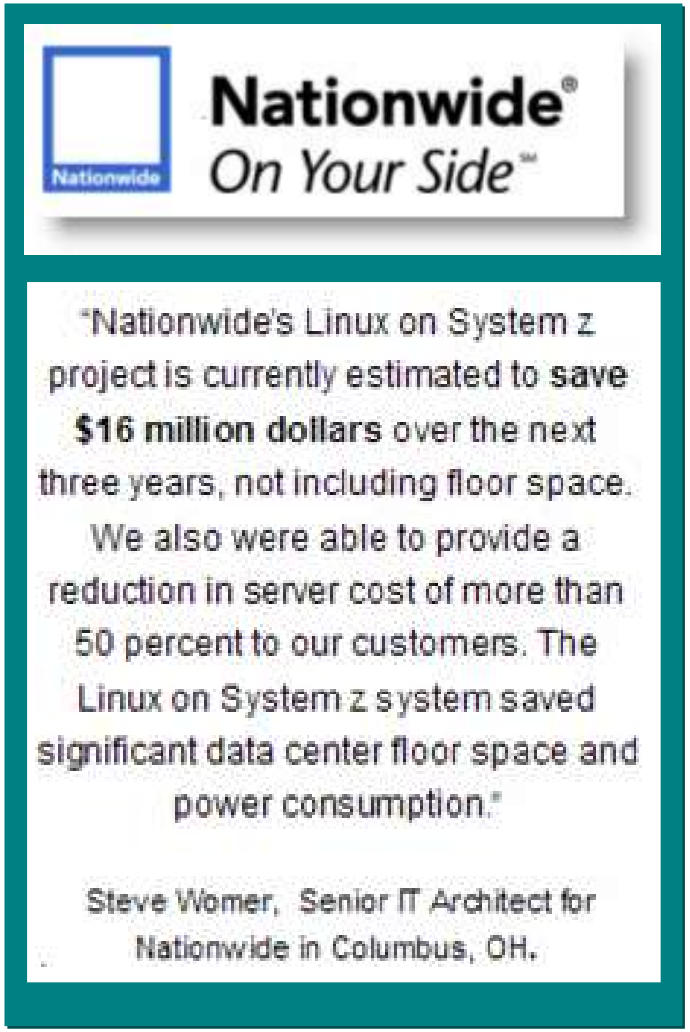


Internal Coupling Facility (ICF) 1997

z/VM 5.4 with the new System z10 EC now allows for any combination of CP, zIIP, zAAP, IFL, and ICF processor-types to reside in the same z/VM LPAR

Nationwide partners with IBM to improve financial squeeze

- **Business Challenge**
  - Pressure on IT growth was forcing them to prioritize IT investments. What started as consolidation project, created unexpected energy savings bonus
- **Solution**
  - Use z/VM virtualization to significantly consolidate servers
- **Benefits**
  - Expect to save $16M over the next 3 years
  - Initial phase: 250 Prod / Test / Dev ➔ 6 IFLs
  - Lower power and floor space by 80% over alternatives
  - Lower middleware costs (DB2, WebSphere, Oracle)
  - 50% reduction in monthly charges for Web infrastructure
  - Dramatically improved server provisioning speed
  - Able to add workloads with out additional FTEs



IBM Consolidation Announcement Highlights

- **IBM Consolidation Effort**
  - 3900 servers to 15 - z10 mainframes
  - 80% savings in annual energy usage
  - 85% savings in total floor space
  - Labor: 54% reduction
  - Software: 36% reduction
  - Improved availability and DR

IBM'S PROJECT BIG GREEN SPURS GLOBAL SHIFT TO LINUX ON MAINFRAME

Plan to shrink 3,900 computer servers to about 30 mainframes targets 80 percent energy reduction over five years

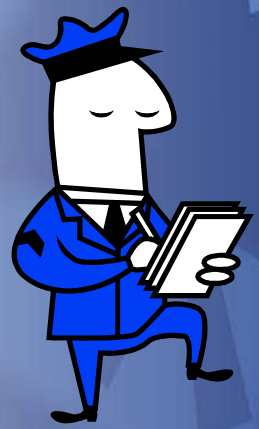
Optimized environment to increase business flexibility

ARMONK, NY, August 1, 2007 – In one of the most significant transformations of its worldwide data centers in a generation, IBM (NYSE: IBM) today announced that it will consolidate about 3,900 computer servers onto about 30 System z mainframes running the Linux operating system. The company anticipates that the new server environment will consume approximately 80 percent less energy than the current set up and expects significant savings over five years in energy, software and system support costs.

At the same time, the transformation will make IBM's IT infrastructure more flexible to evolving business needs. The initiative is part of Project Big Green, a broad commitment that IBM announced in May to sharply reduce data center energy consumption for IBM and its clients.

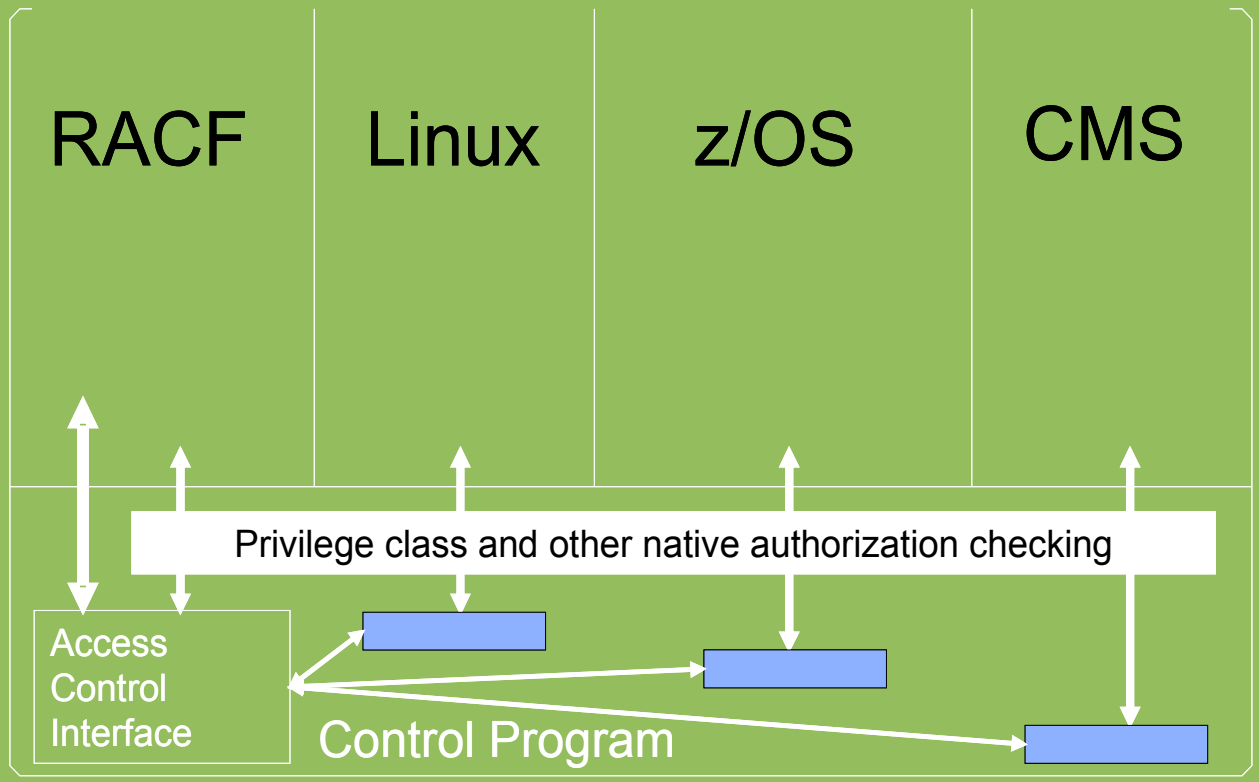
System z

Security



What is z/VM System Security?

- Knowing who is accessing the system or its resources
- Ensuring a user only has access to system resources specifically permitted
- Knowing who is accessing (or failing to access) what resources
- Security is only meaningful in the presence of system integrity
  - Integrity prevents bypass of security controls
  - Audit trail confirms conformance



Learn more: "z/VM Security and Integrity" – ibm.com/servers/eserver/zseries/library/techpapers/pdf/gm130145.pdf

The Mainframe Delivers Great Security at Every Level

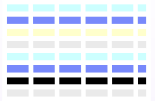
Crypto Cards

Tape encryption

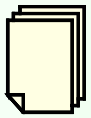
TS1120

Key management

Multilevel security



System z SMF



Consul Insight

Consul System z Tools

DB2 Audit Management Expert

Data Privacy

Compliance and Audit

Extended Enterprise

Tivoli Identity Manager

Tivoli Federated Identity Mgr

Platform Infrastructure

Common Criteria Ratings

Common Criteria

Support for standards

PKI services

Supports VPns etc

RACF

Provides audit, authorization, authentication and access

Communications Server

Network intrusion detection

Built in Secured System z Processing Reduces Risk

- **Workload Isolation**
  - Each user runs in a separate address space
  - Supervisor state & system programs separated
  - LPAR separation ensures processing integrity
  - Storage Protection controls access to protected areas of storage
  - HiperSockets communication secures network communications at memory speed
- **Encryption**
  - Support for encryption in middleware
  - Tape Encryption
  - Key serving
  - System z cryptographic capabilities
- **System Integrity Statement**
  - For both z/OS and z/VM
  - Common Criteria
- **Scalability**
  - Encryption offload enabled by zIIP
  - High performance solution

Allows customers to place multiple workloads on single z/OS & Linux Images.

Helps prevent malware, viruses and worms from disrupting systems operations.

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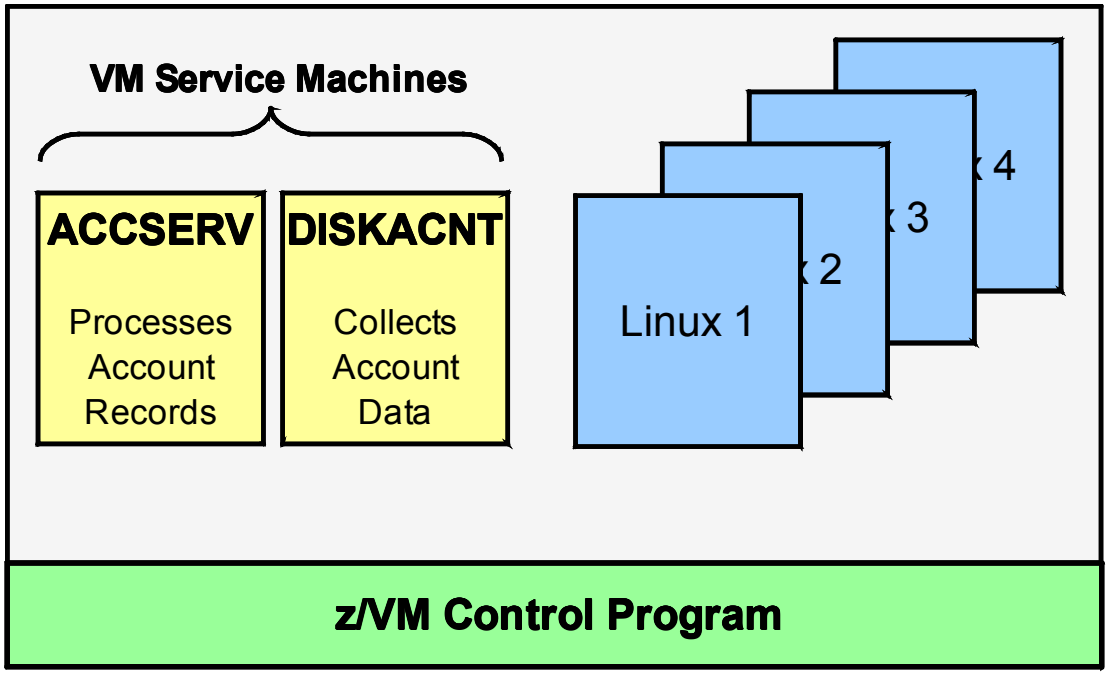
z/VM Security Examples

- **Privilege Class**
  - A - System operator
  - B - Real device management
  - C - System programmer
  - D - Spooling operator
  - E - Systems analyst
  - F - Service representative (CE)
  - G - General user
  - H - Reserved for IBM
  - Customer can use I-Z and 1-6
- **I/O Protection**
  - Access to real devices is controlled by the system administrator
  - I/O commands which affect device or subsystem require additional authorization
  - Virtual Switch – restricted use
  - Minidisks can be shared or non-shared
- **External Security Manager (RACF)**
  - Can audit all privileged commands and limit use to specific individuals
  - Use Access Control List for minidisks instead of minidisk password
  - Secures “the on/off switch”
- **Intrusion Detection**
  - Incorrect passwords
  - Network – Certain denial of service attacks are detected and reported on TCP/IP console
  - Journaling - Guest logons and linking to other guest minidisks are detected and recorded
- **Cryptography**
  - Supports the use of all installed cryptographic options simultaneously by different guests on a z/VM system
- **z/VM Currently certified at EAL 4+**

Note: This security is in addition to security provided by guest operating systems such as Linux.

z/VM Accounting

- **Collect accounting data**
  - CPU
  - Memory
  - Network devices
  - I/O adapters
  - Disk space
- **Useful for charge back purposes**
- **Use in-house reporting scripts or commercial packages**



Additional Information: "**Accounting and monitoring for z/VM Linux guest machines**"
Source: http://www.redbooks.ibm.com/redpapers/pdfs/redp3818.pdf

Virtualization and Security

Should IT Managers Be Concerned?

Virtualization security risks being overlooked, Gartner warns

Gartner raises warning on virtualization and security.

Companies in a rush to deploy virtualization technologies for server consolidation efforts could wind up overlooking many security issues and exposing themselves to risks, warns research firm Gartner.

"Virtualization, as with any emerging technology, will be the target of new security threats," said Neil MacDonald, a vice president at Gartner, in a published statement.

– NetworkWorld.com, April 6, 2007

System z

HA and DR

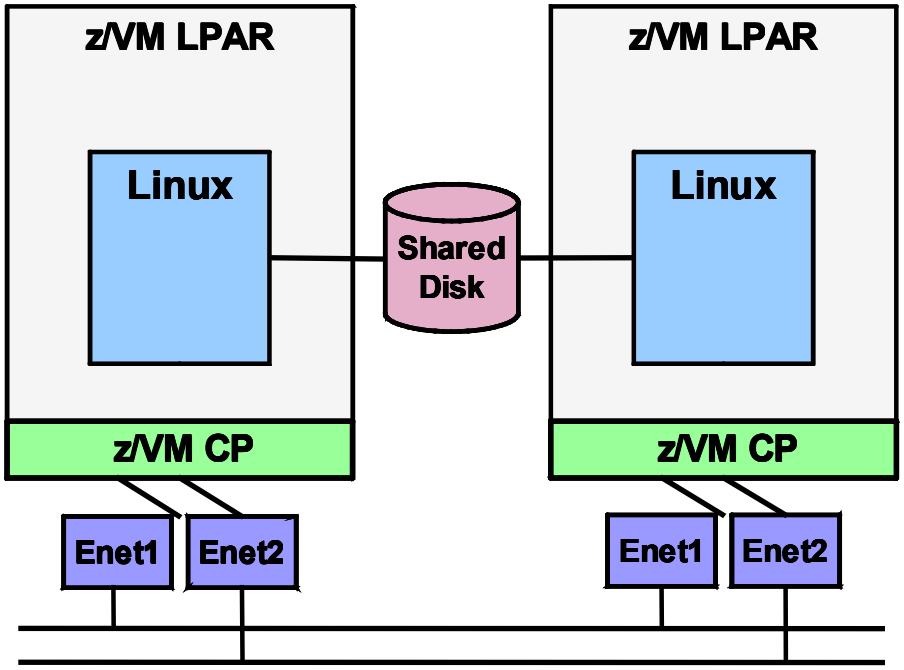
Generic Linux – High Availability

- **Clustering Software (Examples)**
  - Tivoli System Automation for Multiplatforms (IBM)
  - Linux HA (open source)
  - Linux Virtual Server (open source)

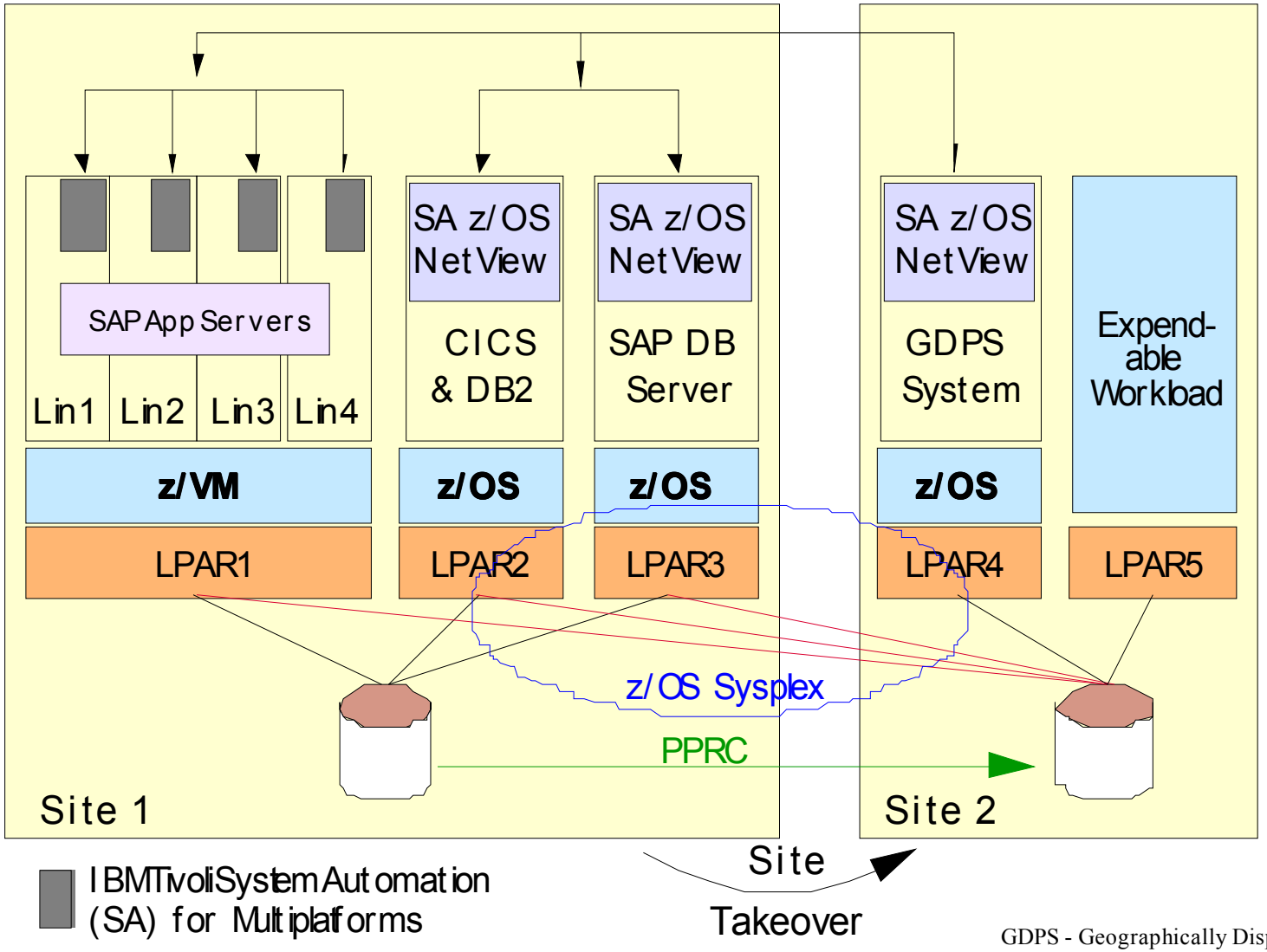
- **Application Clustering (Examples)**
  - Websphere ND
    - Clusters share session data and logs
  - DB2 HADR
    - Provides failover between primary and backup DB2 servers
    - Data is mirrored between servers
    - Fast takeover
  - Oracle RAC
    - Can be run active/active or active/passive
    - Less CPU overhead and faster failover with active/passive configuration

Linux & z/VM High Availability

- **Probably of different scenarios varies greatly**
  - Application is most likely to fail, entire System z box is least likely
  - System z MTBF measured in decades
  - Most hardware and firmware upgrades can be done concurrently
- **Designing HA solution**
  - How much availability is enough?
  - Configure for what you need
  - Can provide multiple Linux and z/VM instances within the same frame



GDPS/PPRC Multiplatform Resiliency for System z



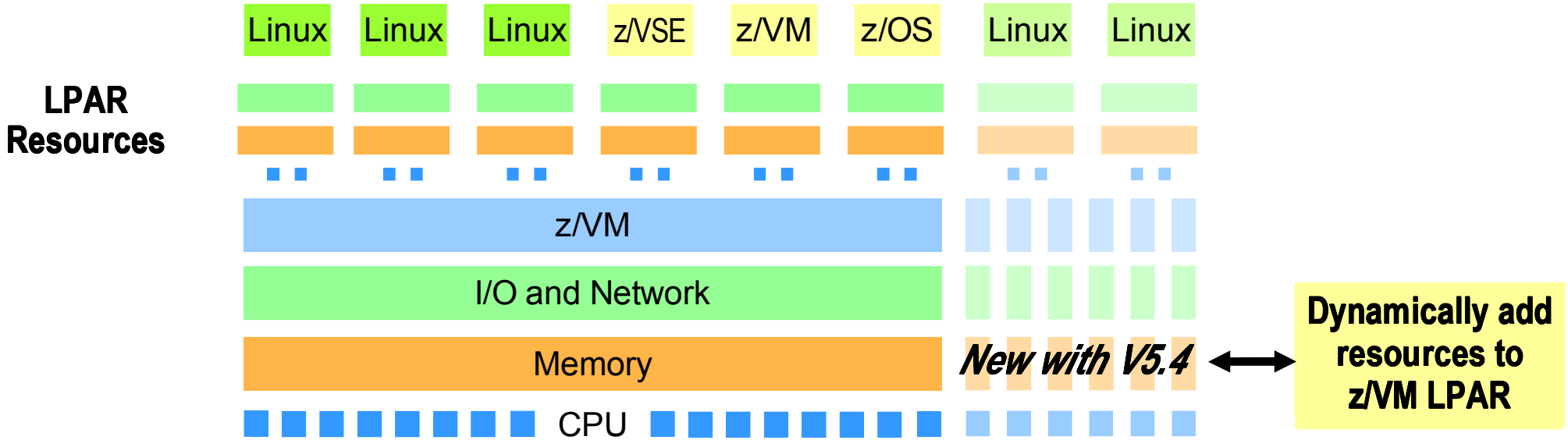
- Designed for customers with distributed applications
- SAP application server running on Linux for System z
- SAP DB server running on z/OS
- Coordinated near-continuous availability and DR solution for z/OS, Linux guests, and z/VM
- Uses z/VM HyperSwap function to switch to secondary disks
- Sysplex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

GDPS - Geographically Dispresed Parallel Sysplex
PPRC – Peer to peer Remote Copy

z/VM Dynamic Memory Upgrade

New z/VM V5.4 Function Enhances System Availability

- Users can non-disruptively add memory to a z/VM *LPAR*
  - Additional memory can come from: *a)* unused available memory, *b)* concurrent memory upgrade, or *c)* an LPAR that can release memory
  - Memory *cannot* be non-disruptively removed from a z/VM LPAR
- z/VM virtualizes this hardware support for *guest machines*
  - Currently, only z/OS and z/VM support this capability in a virtual machine environment
- Complements ability to dynamically add CPU, I/O, and networking resources



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

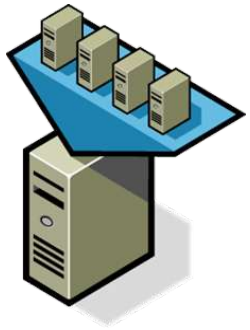
Disaster Recovery – Tape Options

- **Full volume backup**
  - Can be done with z/OS, or z/VM
  - Very fast tape drives
  - May need to quiesce systems (not always)
    - Flashcopy can reduce downtime
  - Most useful for major problems
    - DR
    - Entire volume loss
    - Etc.
  - Easily incorporated into existing z/OS backup strategies
- **File by file backup**
  - Numerous products, e.g. TSM, Veritas
  - Incremental backup – quick
  - Full restore can be slow and network limited
  - Most useful for “oops” scenario
    - Need to retrieve single file
- **Most companies use both for Linux on Z**
  - Different recoveries for different failure scenarios

Evolution of data center energy efficiency

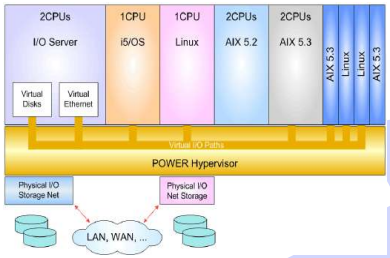
Centralization

- Consolidate many centers into fewer
- Reduce infrastructure complexity
- Improve facilities management
- Reduce staffing requirements
- Improve business resilience (manage fewer things better)
- Improve operational costs



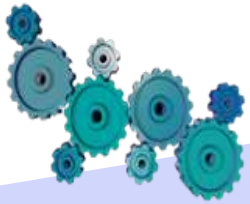
Physical Consolidation

- Consolidate many servers into fewer on physical resource boundaries
- Reduce system management complexity
- Reduce physical footprints



Virtualization

- Remove physical resource boundaries
- Increased hardware utilization
- Allocate less than physical boundary
- Reduce software licensing costs



Application Integration

- Migrate many applications into fewer images
- Simplify IT environment
- Reduction of operations resources
- Improve application specific monitoring and tuning

Myths and Reality

- **Myth**
  - Mainframes are expensive
  - Mainframes are slow
  - Mainframes customers are shrinking
  - IBM milks the Mainframe as a cash-cow
  - Putting Linux on a Mainframe is stupid
  - The development of a specialized micro for the mainframe is not sustainable

- **New Reality**
  - Once you get past the sticker shock, the TCO is actually quite compelling, & value is high
  - The new quad-core z10 processor runs at 4.4GHz and is 50% faster than the z9
  - Actually, >350 large and 1300 midsize clients are growing their MIPS by >30% & their z spend by 11% CAGR, in a -3% market
  - IBM has increased investments by $100's M on z technology and field resources
  - Perhaps, unless you are executing lots of threads, have a lot of servers, or accessing lots of data (sound familiar?)
  - IBM realizes synergy between Power, z, and Software Group, delivering significant shareholder and client value

Time for ?

Always time for follow-up

Thank You

Want help with System z virtualization strategy planning, server consolidation, and complete data center management solutions:

Your local IBM sales rep has new workload sales specialist ready to help create successful project plans with you today.