Linux on System z – A Strategic View

The Future Runs on System z

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IBM Systems

9202 – Linux on System z – A Strategic View

- Datacenters planning to adopt Linux have a key architectural choice to make in designing large-scale implementations
- Is the best approach to running Linux scale-out with rack-optimized servers, to scale up with large SMP servers using virtualization facilities to run many images on a single server?
- For many users, Linux on IBM System z may be the optimal choice
- Jim will describe how Linux on System z, in combination with z/VM, will provide a robust Linux environment which integrates well with z/OS, z/TPF and z/VSE

Agenda

- Linux on System z overview
- Linux on System z deployment criteria
- New products
- IBM Transformation: Major IT Consolidation Initiative
- Additional information about Linux on System z

Linux on System z overview

The Future Runs on System z

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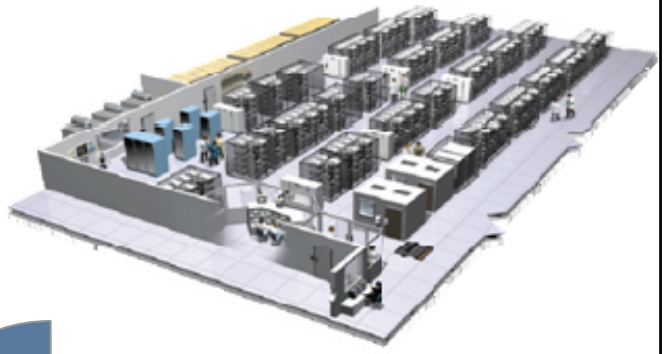
Take back control of your IT infrastructure

A data center in a box – not a server farm

- **Central point of management**
- **Increased resource utilization**
- **Potentially lower cost of operations**
  - Less servers
  - Fewer software licenses
  - Fewer resources to manage
  - Less energy, cooling and space
- **Fewer intrusion points**
  - Tighter security
- **Fewer points of failure**
  - Greater availability



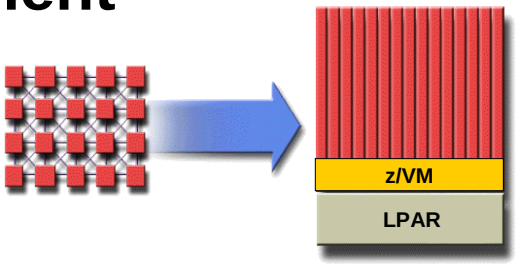
Linux on IBM System z

Linux + Virtualization + System z = SYNERGY

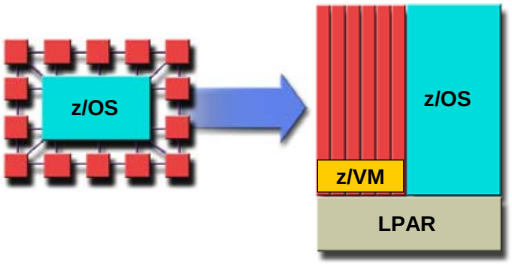
- **The legendary IBM mainframe – IBM System z**
  - Legendary dependability
  - Extremely security-rich, highly scalable
  - Designed for multiple diverse workloads executing concurrently
  - Proven high volume data acquisition and management
- **The IBM mainframe virtualization capabilities – z/VM 5.3**
  - Support for large real memory and 32 processors
  - Enhanced security and LDAP server/client
  - Enhanced memory management for Linux guests
  - Enhanced management functions for Linux
- **Open standards operating system – Linux for System z**
  - Reliable, stable, security-rich
  - Available from multiple distributors
  - Plentiful availability of skills administrators and developers
  - Large selection of applications middleware and tooling from IBM, ISVs and Open Source

What is Linux on System z?

- **A native mainframe operating environment**
  - Exploits IBM System z hardware
  - Not a unique version of Linux



- **Application sourcing strategy**
  - The IBM commitment to z/OS, z/VSE and z/TPF is not affected by this Linux strategy
  - Customers are offered additional opportunities to leverage their investments through Linux
  - New doors are opening for customers to bring Linux-centric workloads to the platform



What System z brings to Linux

- **The most reliable hardware platform available**
  - Redundant processors and memory
  - Error detection and correction
  - Remote Support Facility (RSF)
- **Centralized Linux systems are easier to manage**
- **Designed to support mixed work loads**
  - Allows consolidation while maintaining one server per application
  - Complete work load isolation
  - High speed inter-server connectivity
- **Scalability**
  - System z10 EC scales to 64 application processors
  - System z9 EC scales to 54 application processors
  - System z9 BC scales to 7 application processors
  - Up to 11 (z10 EC), 8 (z9 EC) dedicated I/O processors
  - Hundreds of Linux virtual servers

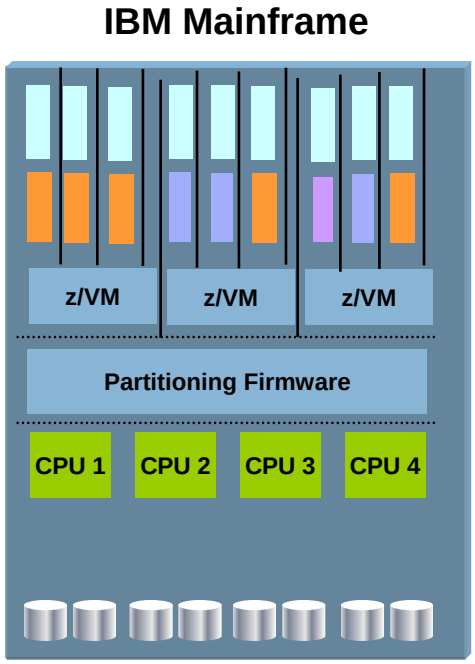
What is different about Linux on System z?

- **Access to System z specific hardware**
  - Crypto support – CPACF, Crypto2
  - Traditional and Open I/O subsystems
    - Disk (ECKD or SCSI) and tape
    - SAN Volume Controller
  - OSA-Express, OSA-Express2 and OSA-Express3 for very high speed communication between z/OS and Linux
  - HiperSockets for ultra-high speed communication between z/OS and Linux on the same machine
- **z/VM aware**
  - Enhanced performance
  - System management tools

Value of Linux on System z

- **Reduced Total Cost of Ownership (TCO)**
  - Environmental savings – single footprint vs. hundreds of servers
  - Consolidation savings – less storage, less servers, less software licenses, less server management/support
- **Improved service level**
  - Systems management (single point of control)
  - Reliability, availability, security of System z
  - High performance integration with z/OS, z/VSE, z/TPF
- **Speed to market**
  - Capacity-on-demand capability on System z
  - Dynamic allocation of on-line users, less than 10 seconds to add a new Linux server image using z/VM and IBM DS8000

System z – The ultimate virtualization resource



- **Utilization often exceeds 90%**
  - Handles peak workload utilization of 100% without service level degradation

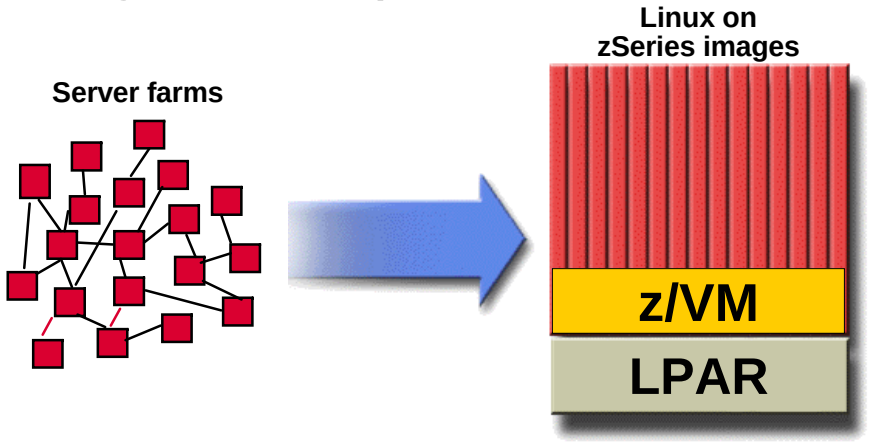
- **Massive consolidation platform**
  - Up to 60 logical partitions, 100s to 1000s of virtual servers under z/VM
  - Virtualization is built-in, not added-on
  - HiperSockets for memory-speed communication
  - Most sophisticated and complete hypervisor function available
- **Intelligent and autonomic management of diverse workloads and system resources based on business policies and workload performance objectives**

z/VM – Unlimited virtualization

- **z/VM provides a highly flexible test and production environment for enterprises deploying the latest e-business solutions**
- **z/VM helps enterprises meet their growing demands for multi-system server solutions with a broad range of support for operating system environments**
- **Mature technology – VM/370 introduced in 1972**
- **Software Hypervisor integrated in hardware**
  - Sharing of CPU, memory and I/O resources
  - Virtual network – virtual switches/routers
  - Virtual I/O (mini-disks, virtual cache, …)
  - Virtual appliances (SNA/NCP, etc.)
- **Easy management**
  - Rapid install of new servers – cloning or IBM Director task z/VM Center
  - Self-optimizing workload management

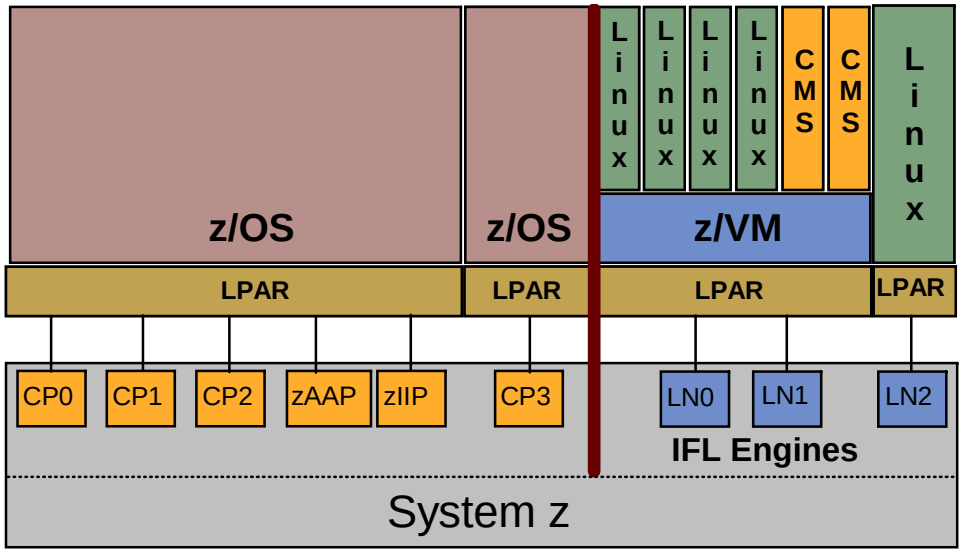
The value of z/VM for Linux

- **Enhanced performance, growth and scalability**
  - Server consolidation enables horizontal growth
  - N-tier architecture on two tiers of hardware
  - Extensive support for sharing resources
  - Virtual networking
  - Effective isolation of Linux images, if required
- **Increased productivity**
  - Development and testing
  - Production support
- **Improved operations**
  - Backup and recovery
  - Command and control

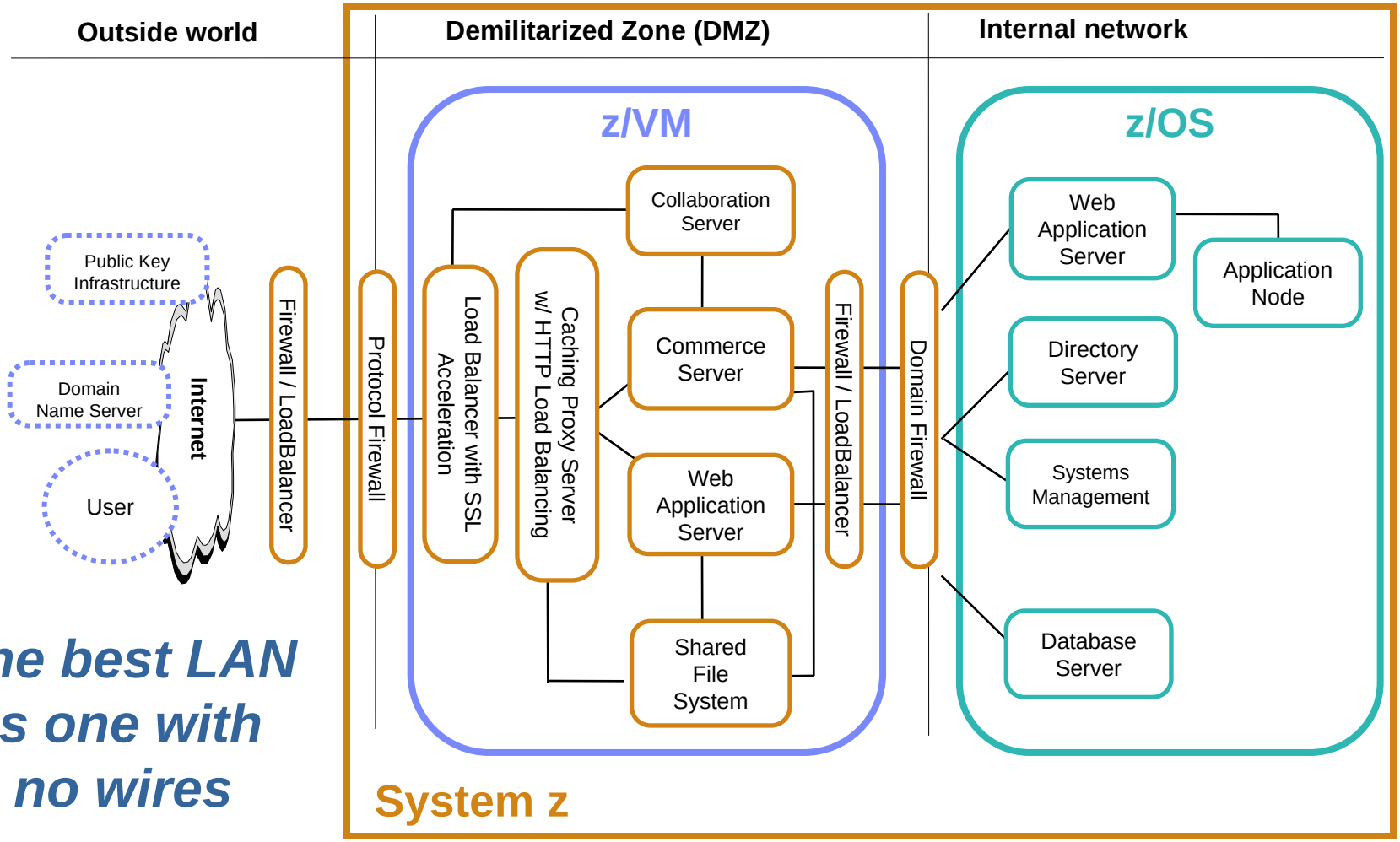


Integrated Facility for Linux

- **Additional engines dedicated to Linux workloads**
  - Supports z/VM and Linux on System z
  - IFLs on “sub-uni” systems run at “full speed”
    - z800, z890, z9 EC, z9 BC, **z10 EC**
- **Traditional mainframe software charges unaffected**
  - IBM mainframe software
  - Independent Software Vendor products
- **Linux and z/VM charged only against the IFLs**



Application serving with Linux on System z



Linux on System z deployment criteria

The Future Runs on System z

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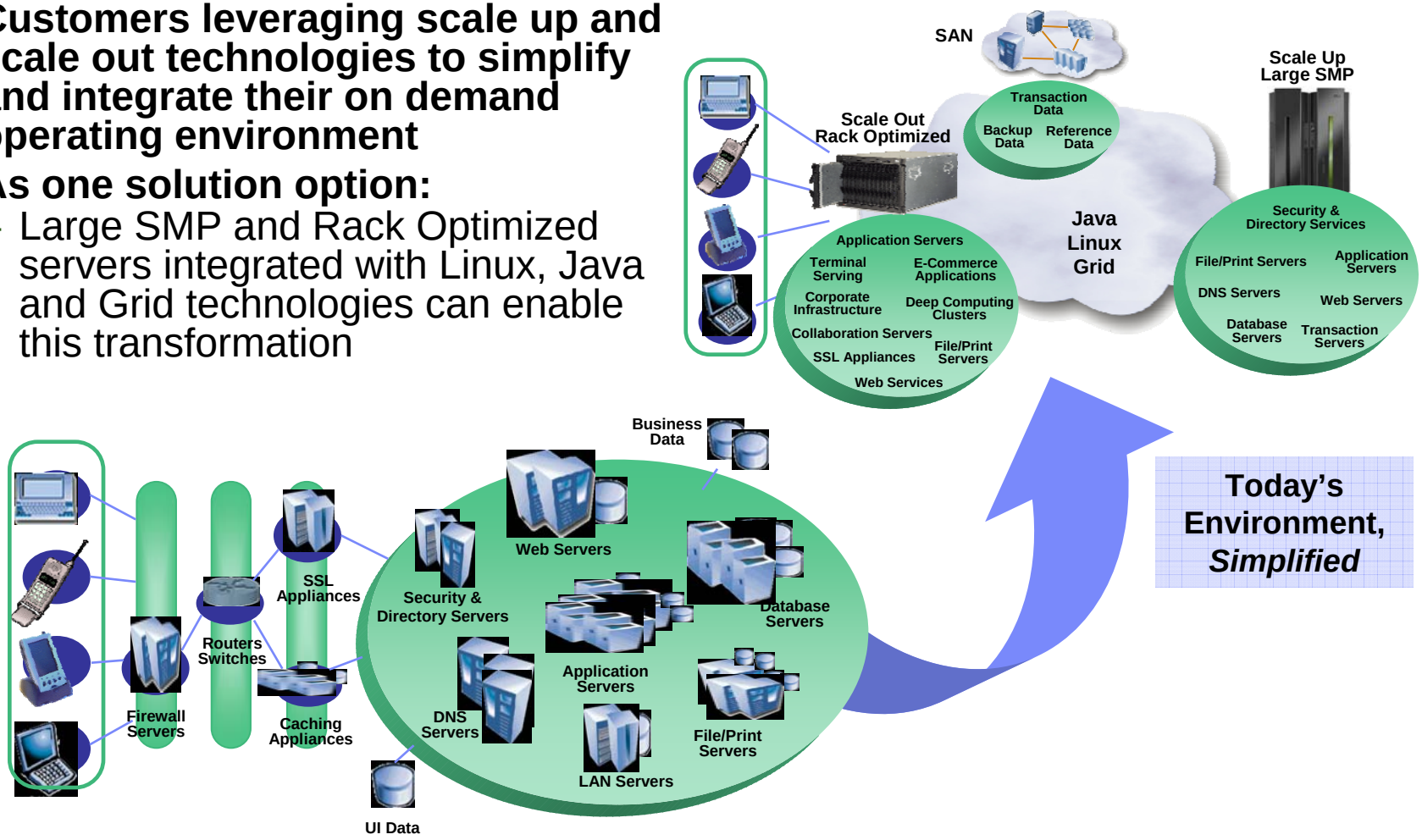
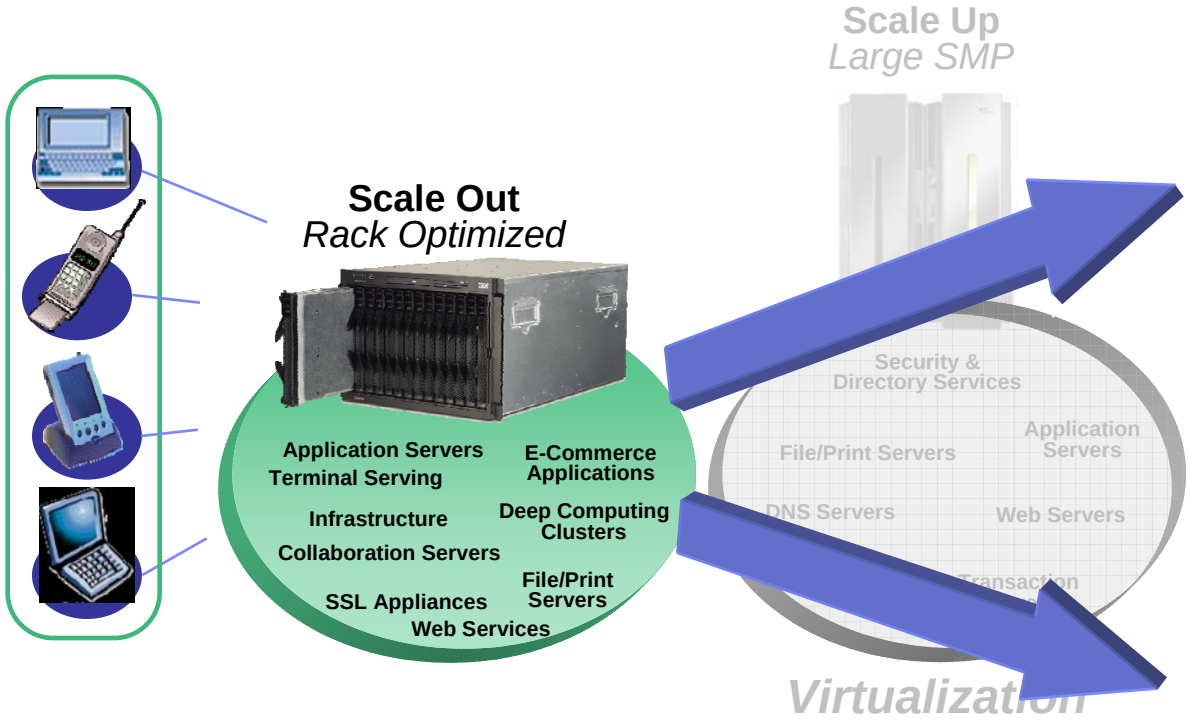
Infrastructure simplification

- **Customers leveraging scale up and scale out technologies to simplify and integrate their on demand operating environment**
- **As one solution option:**
  - Large SMP and Rack Optimized servers integrated with Linux, Java and Grid technologies can enable this transformation

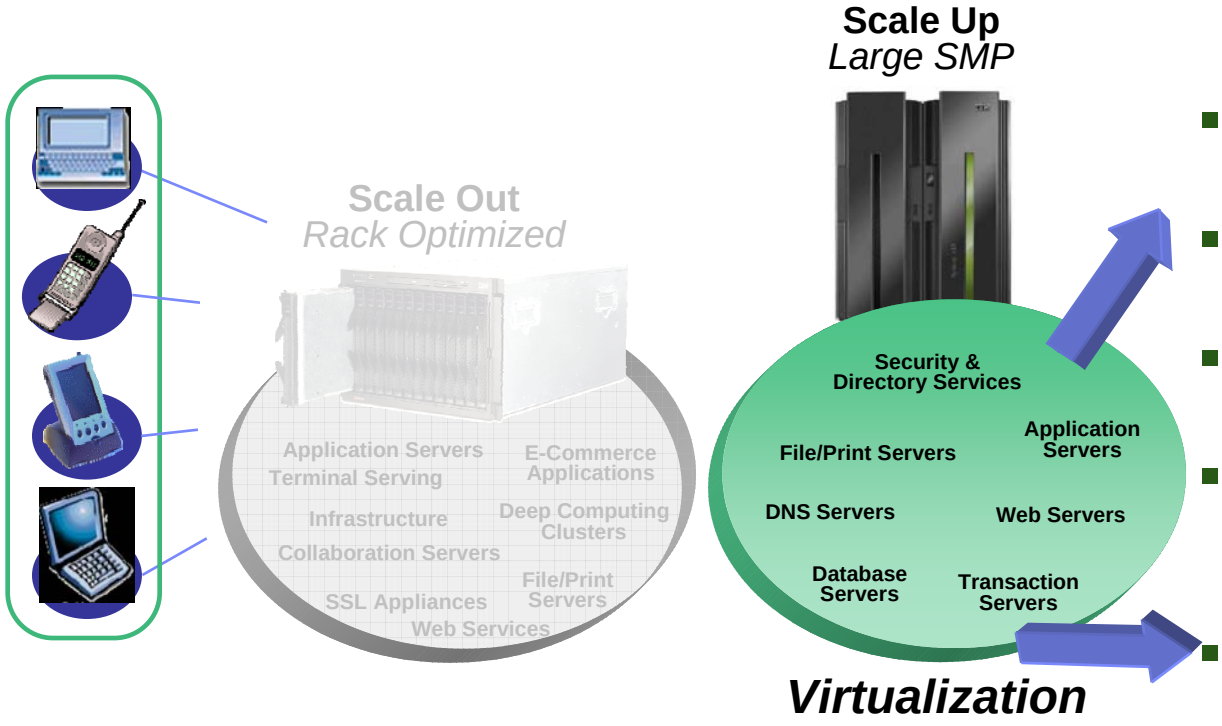


Ideal blade implementations



- Clustered workloads
- Distributed computing applications
- Infrastructure applications
- Small database
- Processor and memory intensive workloads
- Centralized storage solutions

Ideal mainframe implementations



- High performance transaction processing
- I/O intensive workloads
- Large database serving
- High resiliency and security
- Unpredictable and highly variable workload spikes
- Low utilization infrastructure applications
- Rapid provisioning and re-provisioning

Selecting an application

- **Performance on System z CPUs is comparable to CPUs on other platforms of similar speed**
  - CPU speed is not the entire story – it's in the architecture!
  - Architecture designed for multiple or consolidated workloads
  - System z has definite advantage with applications that have mixed CPU and I/O
- **System z and z/VM provide excellent virtualization capabilities**
  - Look for applications that are on lower utilized servers
  - Development and Test are good choices to start
- **Good planning is essential**
- **IBM can**
  - Perform sizing estimates
  - Assist with planning and initial installation needs

Where to deploy on System z – z/OS or Linux?

Technical Considerations

Linux → **z/OS**

Quality of Service

Linux ← **z/OS**

Speed of deployment

Linux ← **z/OS**

Degree of portability

Other Considerations

- Application availability
- Workload Management function and granularity
- File sharing across a Sysplex
- Manageability and scaling characteristics
- Availability of skill

Where to deploy – System z or "distributed"

Technical Considerations

System z	←	"distributed"
Quality of Service		
System z	←	"distributed"
Speed of deployment Instances 2 - n		
System z	←	"distributed"
Data Intensity		
System z	→	"distributed"
Compute Intensity		

Other Considerations

- **Application availability**
  - Certification of solution on hardware/software platform
- **Workload Management**
- **Manageability and scaling characteristics**
  - Especially DB2 and WebSphere on z/OS
  - Proximity of data to application
  - The best network is an internal network!

Workload share on utilized IFLs

Primary application

60%	**Application serving for "legacy" systems** e.g. WebSphere, SAP, CICS TG, DB2 Connect
30%	**Data serving** e.g. Oracle DB, DB2 UDB, MySQL, Informix, …
5%	**Workplace serving** e.g. Domino, Scalix, …
5%	**Infrastructure serving** e.g. Apache, Samba, NFS, …
<1%	**Linux application development/deployment**

Notes: extrapolation based on analyzing 1/3 of inventory, excludes all IBM. February 2006

Linux on IBM System z

Take back control of your IT infrastructure

- **Unify the infrastructure**
  - IT optimization and server consolidation based on virtualization technology and Linux
  - Linux can help to simplify systems management with today's heterogeneous IT environment
- **Leverage the mainframe data serving strengths**
  - Deploy in less time, accessing core data on z/OS
  - Reduced networking complexity and improved security network “inside the box”
- **A secure and flexible business environment**
  - Linux open standards support for easier application integration
  - Unparalleled scale up / scale out capabilities
  - Virtual growth instead of physical expansion on x86 or RISC servers
- **Leverage strengths across the infrastructure**
  - Superior performance, simplified management, security-rich environment
  - High-performance security-rich processing with Crypto2 cryptographic co-processors
  - Backup and restore processes

New Products

The Future Runs on System z

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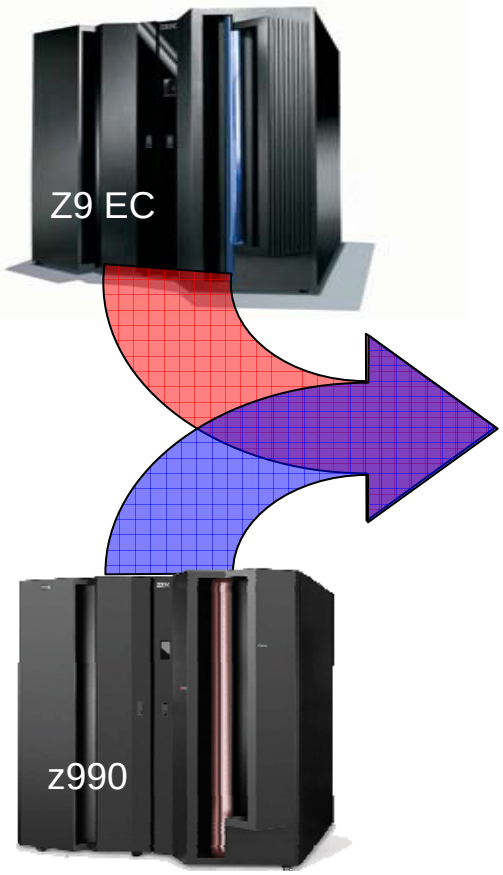
IBM System z10 EC

Increasing capacity, reducing outages and enhancing capabilities

- **Five hardware models**
- **Faster uni-processor 1**
- **Up to 64 customer PUs**
- **36 CP sub-capacity Settings**
- **Star book interconnect**
- **Up to 1.5 TB memory**
- **Separate, fixed 16 GB HSA**
- **Large page support**
- **HiperDispatch**
- **Enhanced CPACF SHA 512, AES 192 and 256-bit keys**
- **Hardware decimal floating point**
- **Just in time deployment for capacity offerings – permanent and temporary**
- **6.0 GBps InfiniBand (IB) HCA to I/O interconnect**
- **SCSI IPL**
- **VM mode LPAR**
- **OSA-Express3 10 Gbps**
- **HiperSockets Layer 2 support**
- **InfiniBand coupling links**
- **Capacity provisioning Support**
- **Scheduled outage reduction**
- **Improved RAS**
- **FICON LX Fiber Quick Connect**
- **Power monitoring**

- Compared to z9 EC **(1)**

z10 EC Overview

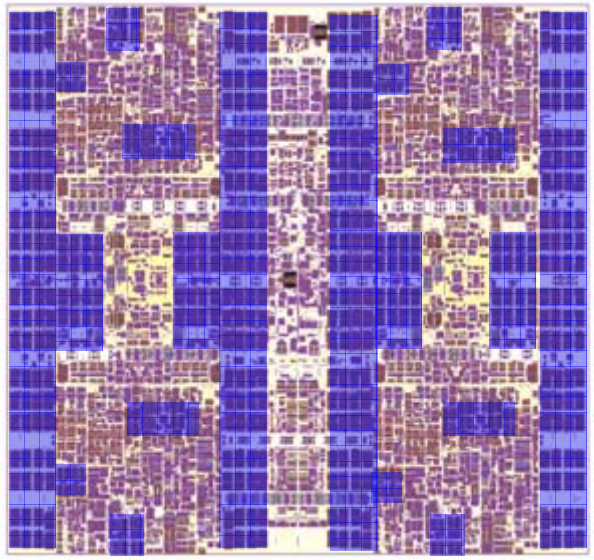


- **New machine type: 2097**
- **Processors**
  - 17 / 20 PUs per book
  - Sub-capacity available up to 12 CPs
  - 3 sub-capacity points
  - 2 spares designated per system
- **Memory**
  - System minimum = 16GB
  - HSA separately managed
  - Maximum 1.5TB / 384GB per book
  - Increments 16/32/48/64 GB
- **I/O**
  - Up to 16 connections per book
  - Each connection 6GB / sec
  - Pairs dedicated to specific function
  - Channels, ICB, PSIB

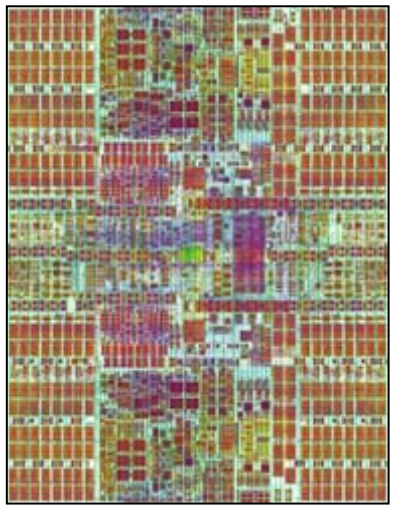
z10 Chip Relationship to Power6

- **Siblings, not identical twins**
- **Share lots of DNA**
  - IBM 65nm Silicon-On-Insulator (SOI) technology
  - Design building blocks:
    - Latches, SRAMs, regfiles, dataflow elements
  - Large portions of Fixed Point Unit (FXU), Binary Floating-point Unit. (BFU), Hardware Decimal Floating-point Unit (HDFU), Memory Controller (MC), I/O Bus Controller (GX)
  - Core pipeline design style
    - High-frequency, low-latency, mostly-in-order
  - Many designers and engineers
- **Different personalities**
  - Very different Instruction Set Architectures (ISAs)
    - Very different cores
  - Cache hierarchy and coherency model
  - SMP topology and protocol
  - Chip organization
  - IBM z10 Chip optimized for Enterprise Data Serving Hub

z10 – Quad core Chip

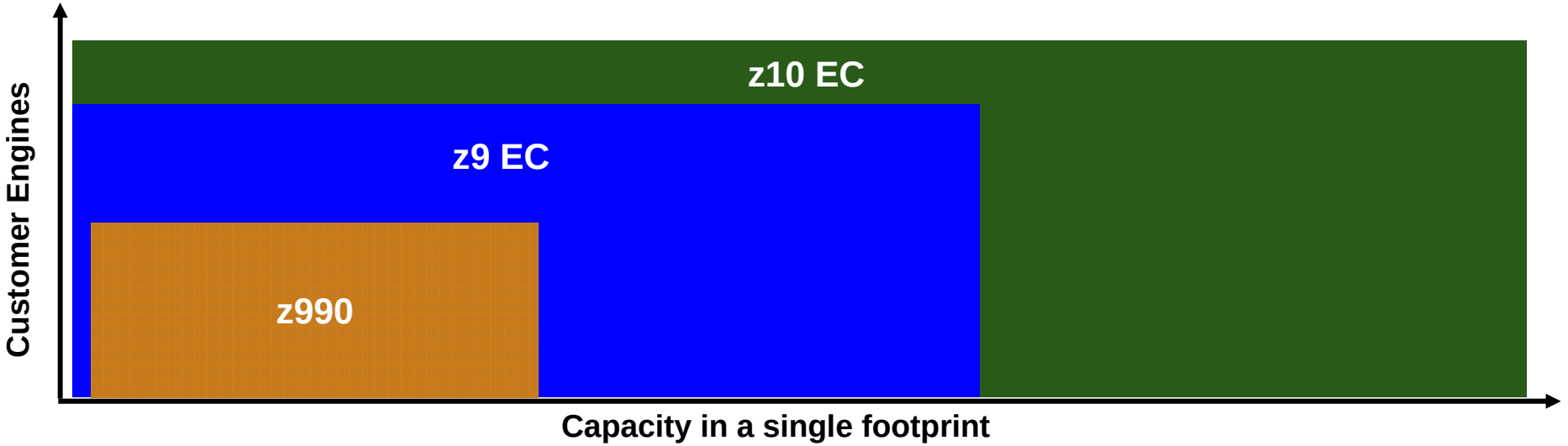


Power6 – Dual core Chip

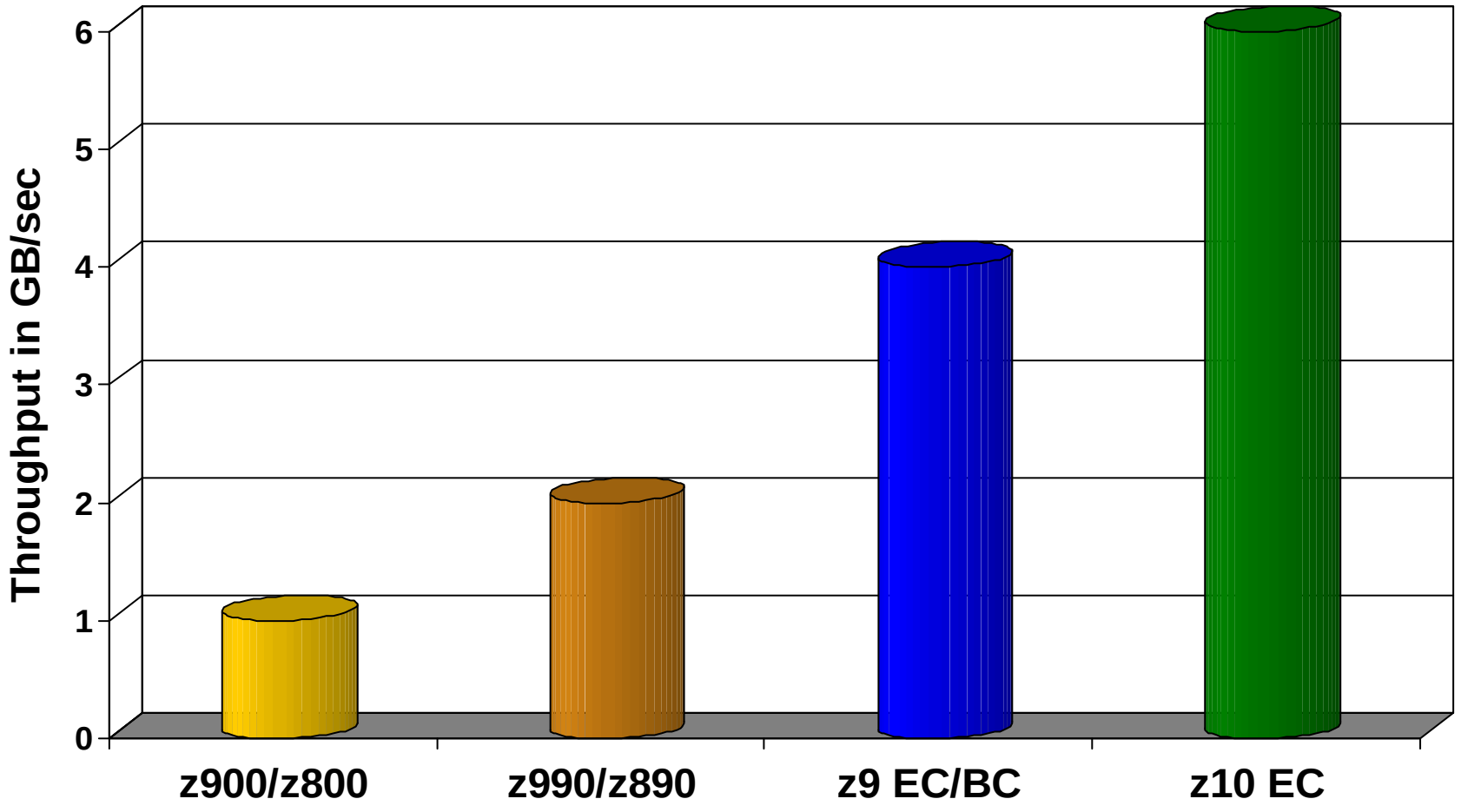


z10 EC Product Positioning

- **z10 EC will provide increased capacity in a single footprint**
  - Faster uni-processor performance
  - Additional available engines for improvement in total system performance
  - Software enhancements to manage hardware configuration more efficiently
- **Significant availability improvements via planned outage reduction**
- **Increased functionality and flexibility in temporary capacity offerings such as CBU, OOCoD**
- **Connectivity improvements include bandwidth, throughput, and distance**

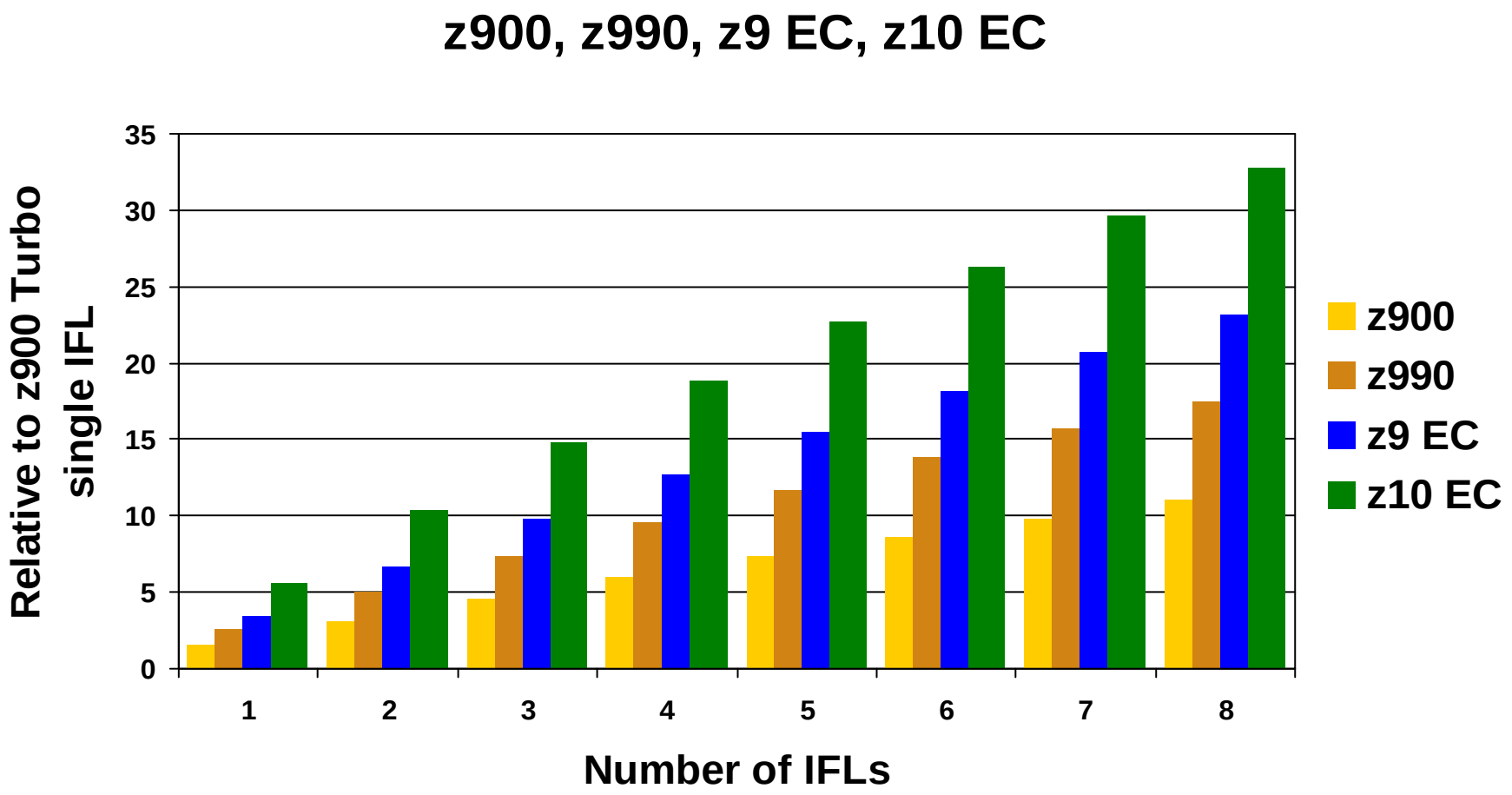


HiperSockets performance



WebSphere Application Server

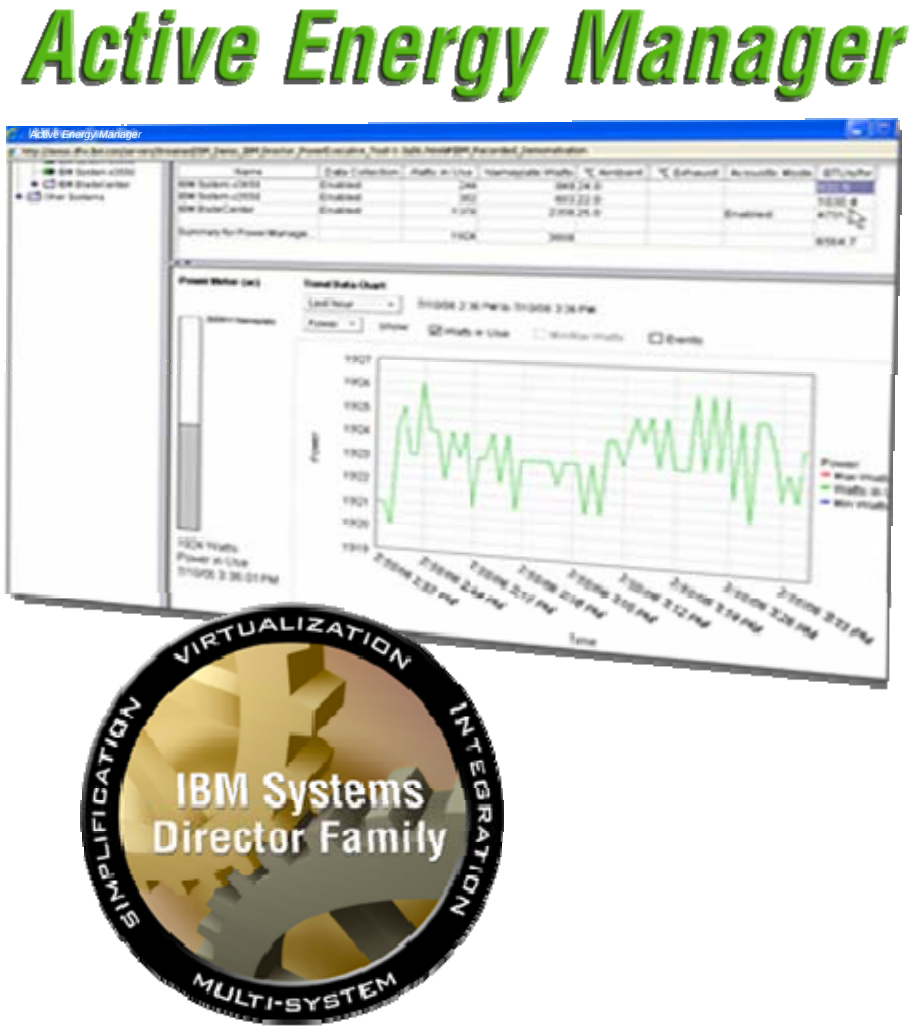
Relative performance on Linux under z/VM



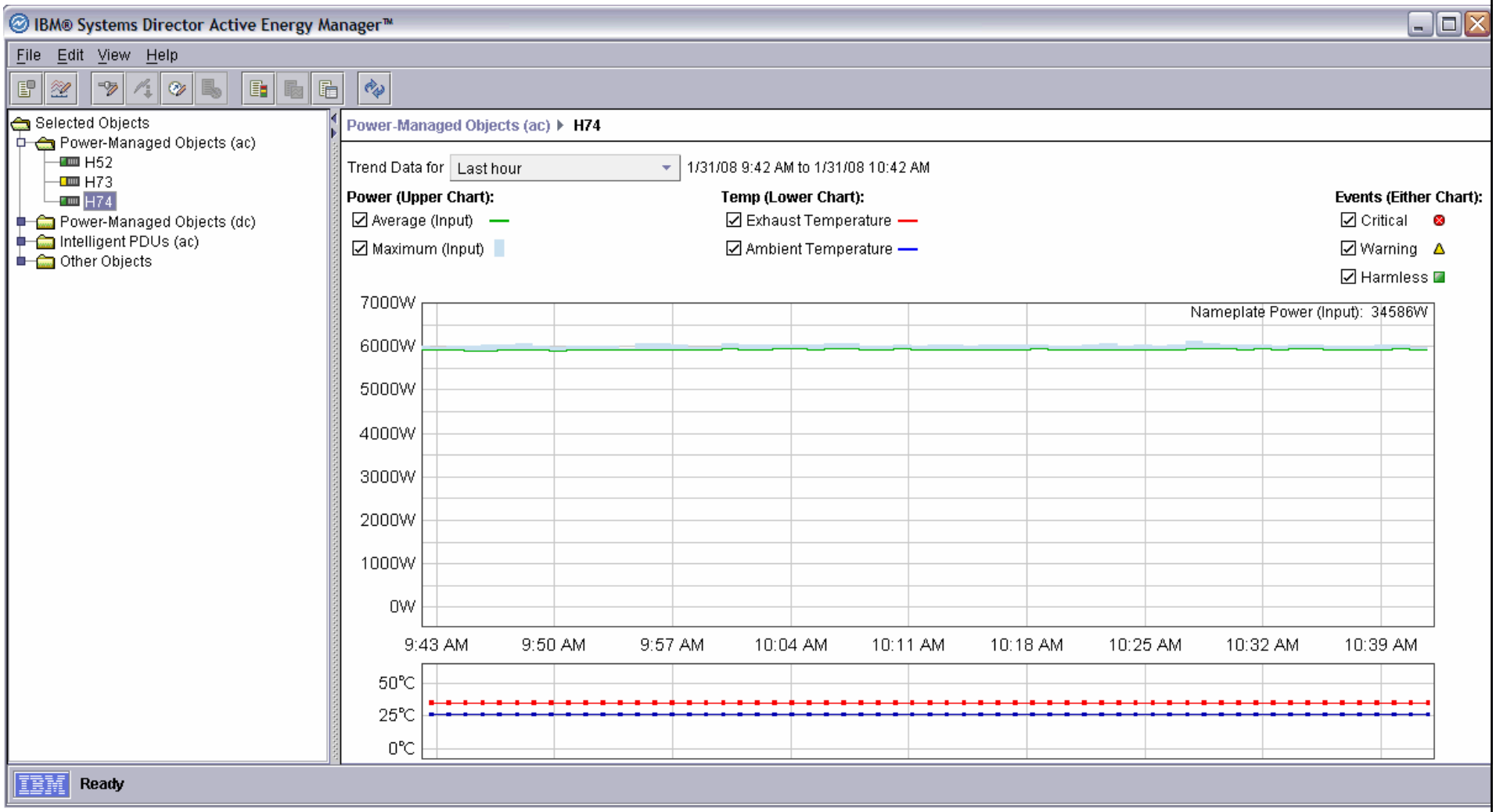
Single WebSphere Application Server image running on Linux under z/VM

IBM Systems Director Active Energy Manager V3.1 (AEM)

- AEM helps companies monitor, measure and control their energy usage
- AEM is a unique energy management solution building block that returns true control of energy costs to the customer
- AEM is an industry leading cornerstone of the IBM energy management framework
- AEM is an energy management software tool that can provide clients with a single view of the actual power usage across multiple platforms in their infrastructure as opposed to researching benchmarked power consumption for each platform
- In tandem with chip vendors like Intel and AMD, and consortiums like Green Grid, AEM advances the IBM initiative to deliver price performance per square foot
- AEM initial focus is on IT load

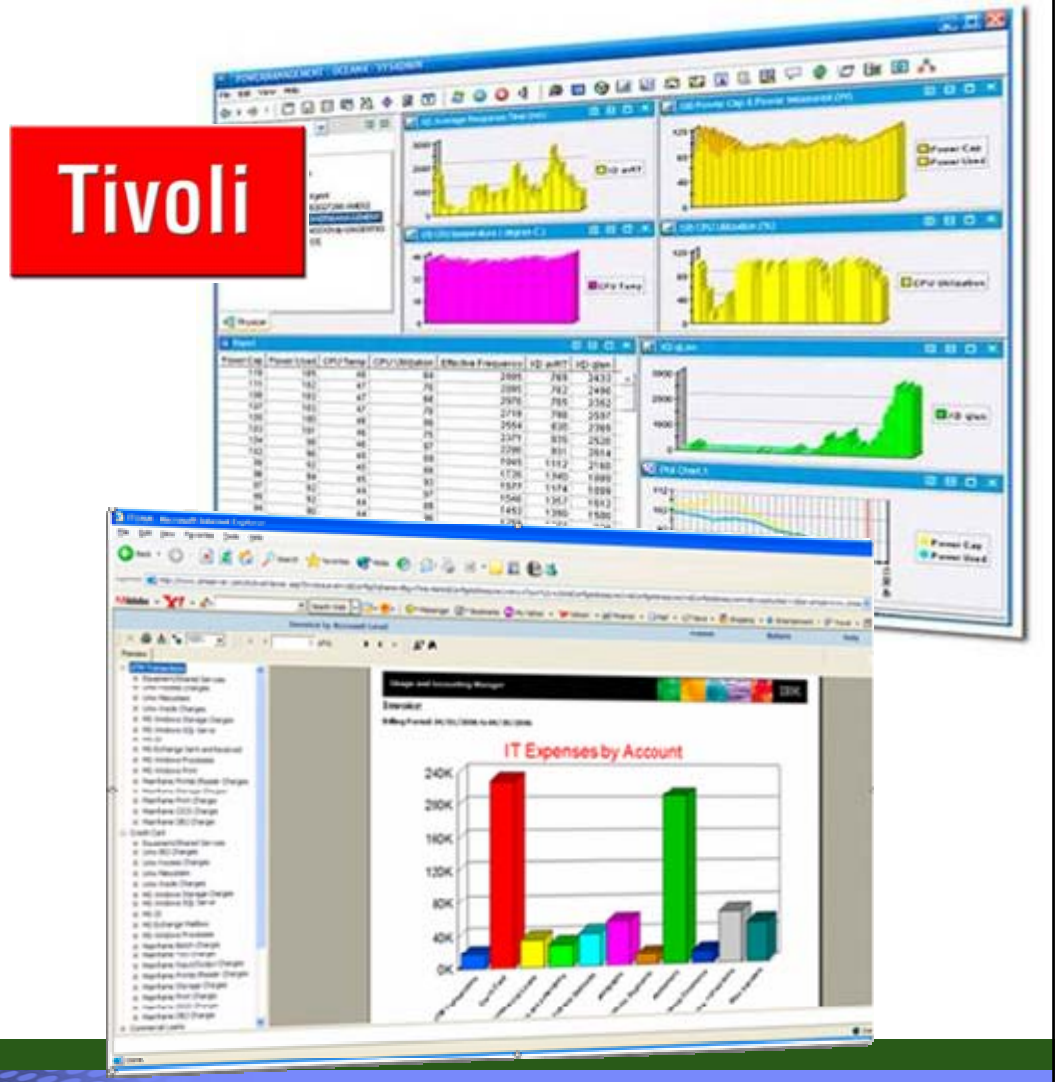


Sample Display from AEM monitoring z10



AEM upward integration with Tivoli to provide energy management solutions

- **IBM Tivoli Usage and Accounting, Monitoring, and Provisioning to help align power use with workload goals**
- **Actively moving workloads and power up/down resources**
  - Who used what?
  - How much did IT cost?



IBM Transformation: Major IT Consolidation Initiative

The Future Runs on System z

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IBM Consolidation Announcement Highlights

- **IBM will consolidate thousands of servers onto approximately 30 IBM System z™ mainframes**
- **We expect substantial savings in multiple dimensions: energy, software and system support costs**
- **Major proof point of IBM's 'Project Big Green' initiative**
- **The consolidated environment will use 80% less energy**
- **This transformation is enabled by the System z sophisticated virtualization capability**

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.

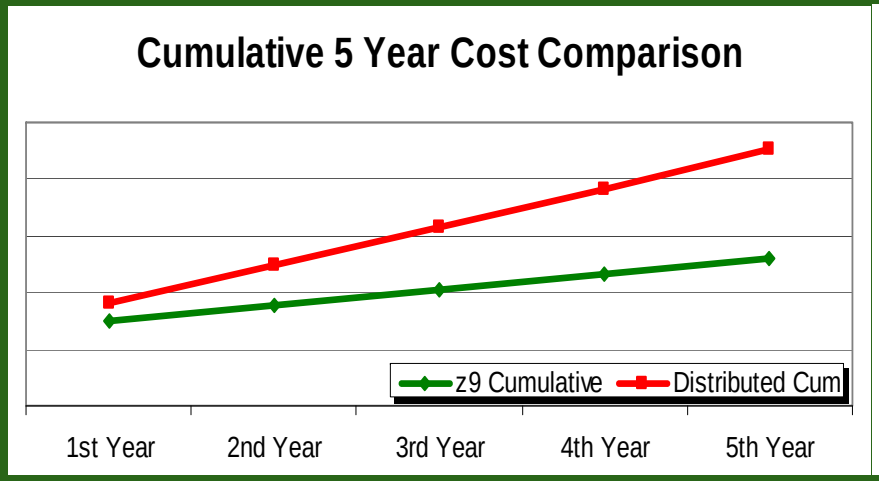
IBM infrastructure

Continued server growth brought physical space challenges

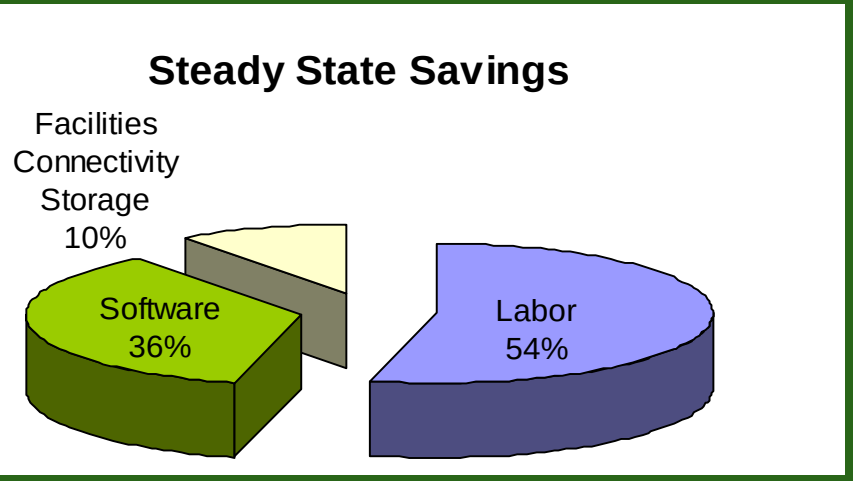
- **Data center efficiencies achieved**
  - Consolidation of infrastructure
  - Application consolidation/reduction
  - Enterprise architecture optimization
  - Global resource deployment
- **Next level of infrastructure challenge**
  - Floor space challenges in key facilities
  - Underutilized assets in outdated Web infrastructure
  - Continued infrastructure cost pressure

Early modeling identified significant potential for savings through virtualization on System z

- **Performed TCO and consolidation assessment on IBM portfolio**
  - Cross-IBM effort: System z, Software Migration Services, TCO Academy, Migration Factory



Analysis models today's steady state operations cost with projected System z operations cost



Savings are net after hardware and migration investments

- **Identified substantial savings opportunity**
  - Annual Energy Usage reduced by 80%
  - Total floor space reduced by 85%

Successful Techniques Preparing for Virtualization

Motivate business units	▪ **Enlist a Senior Executive Sponsor** – Sr. VP Linda Sanford, who manages Transformation for IBM is providing enterprise leadership, working with Business Unit Sr. VPs ▪ **Build an "incentive" rate** – Financial benefit provides good incentive for support and teaming in project execution. Reductions are being phased in during the project with differentiated rates.
Build the business case	▪ **Start with a high level planning estimate** – Initial estimates from zRACE model were validated by the CFO through a detailed analysis of a sample subset of 325 servers
Gather data	▪ **Augment inventories with network tools** – Local and central Configuration Management DB needed augmentation with network scans to gather configurations and application mapping

Successful Techniques
Project Start-up

Start small	▪ **Migrate a small set of servers for a fast start** – An initial Phase to immediately migrate a small number of servers worked well to build early experience
Run operations while transforming	▪ **Use a dedicated team** – IBM's commercial migration practice is implementing most of the management and migration, minimizing the operational team's responsibility to Final Test, Environment Build and Cutover
Manage complexity	▪ **Engage strong project management** – A structured management approach and broad, sustained sponsorship from the business units are critical
Monitor progress and continuously improve	▪ **Use an end-to-end process approach** – A streamlined end-to-end process approach has been established with clear interfaces and handoffs. It will be monitored and improved with process flow metrics, yield metrics and automation

Successful Techniques Business Unit Communication

- **The CIO Office is providing leadership and communication with the Business Units:**
  - Initial CIO communication shared business objectives and commitment
  - Exceptions scrutinized by CIO
  - Regular meetings and communication with business unit application owners during migration
  - Common concerns from business units and application owners being mitigated

Top 5 Concerns	Mitigation
Will my bill go up? How much will it be?	Implementing tiered rates: base cost plus variable usage. Rates will accurately reflect cost to the corporation
Have there been any successful pilots?	Accepting volunteer applications initially. CIO migrating most visible internal application: IBM's Intranet
Will my application run?	Focus on common middleware for initial migrations, communicating results to application teams
Will this impact my business priorities?	Migration process leverages planned changes and takes other business priorities into consideration
What about technical training?	Training to be delivered to application owners and development teams

Additional information about Linux on System z

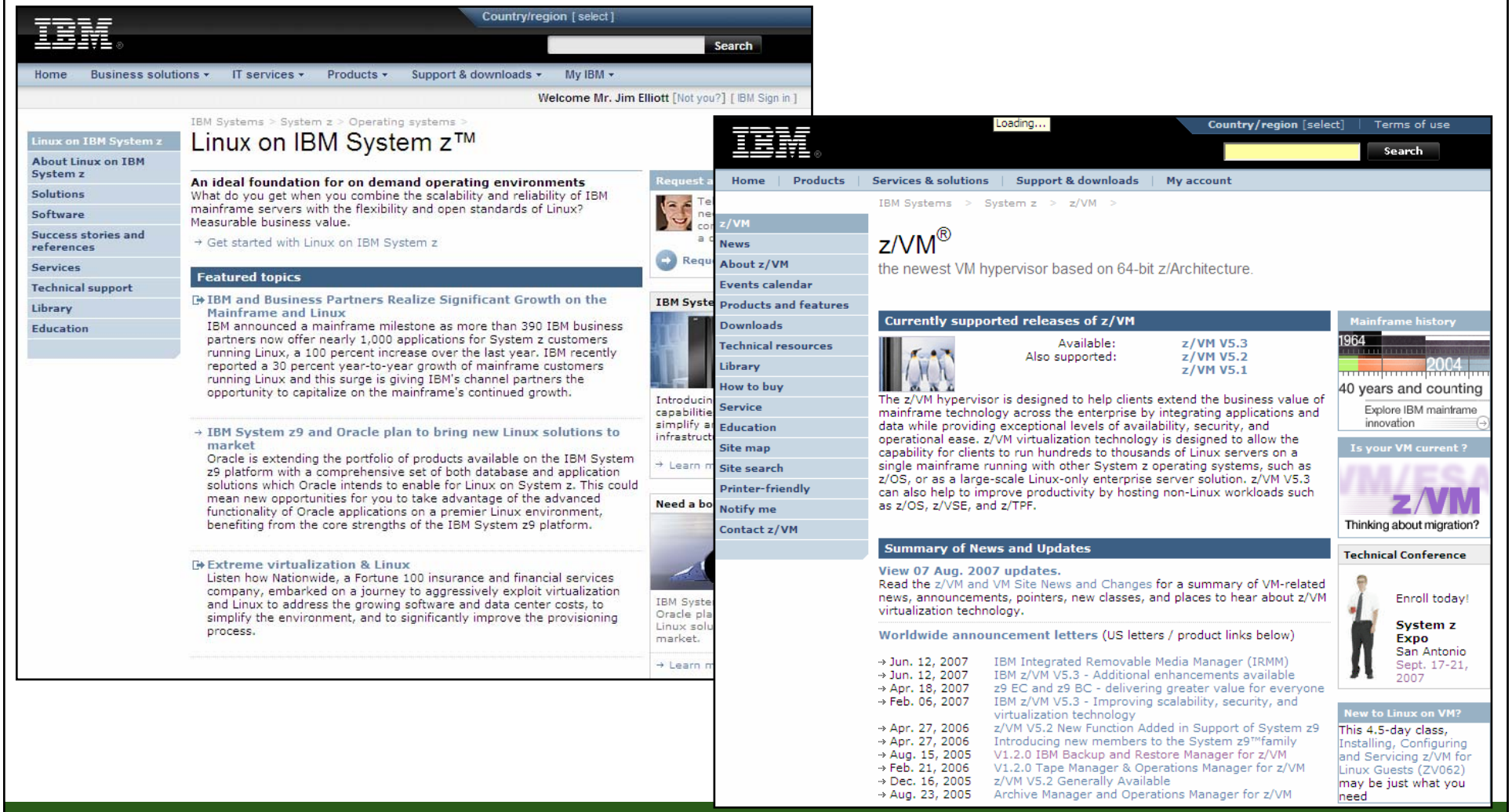
The Future Runs on System z

IBM Systems

Linux on System z and z/VM Web sites

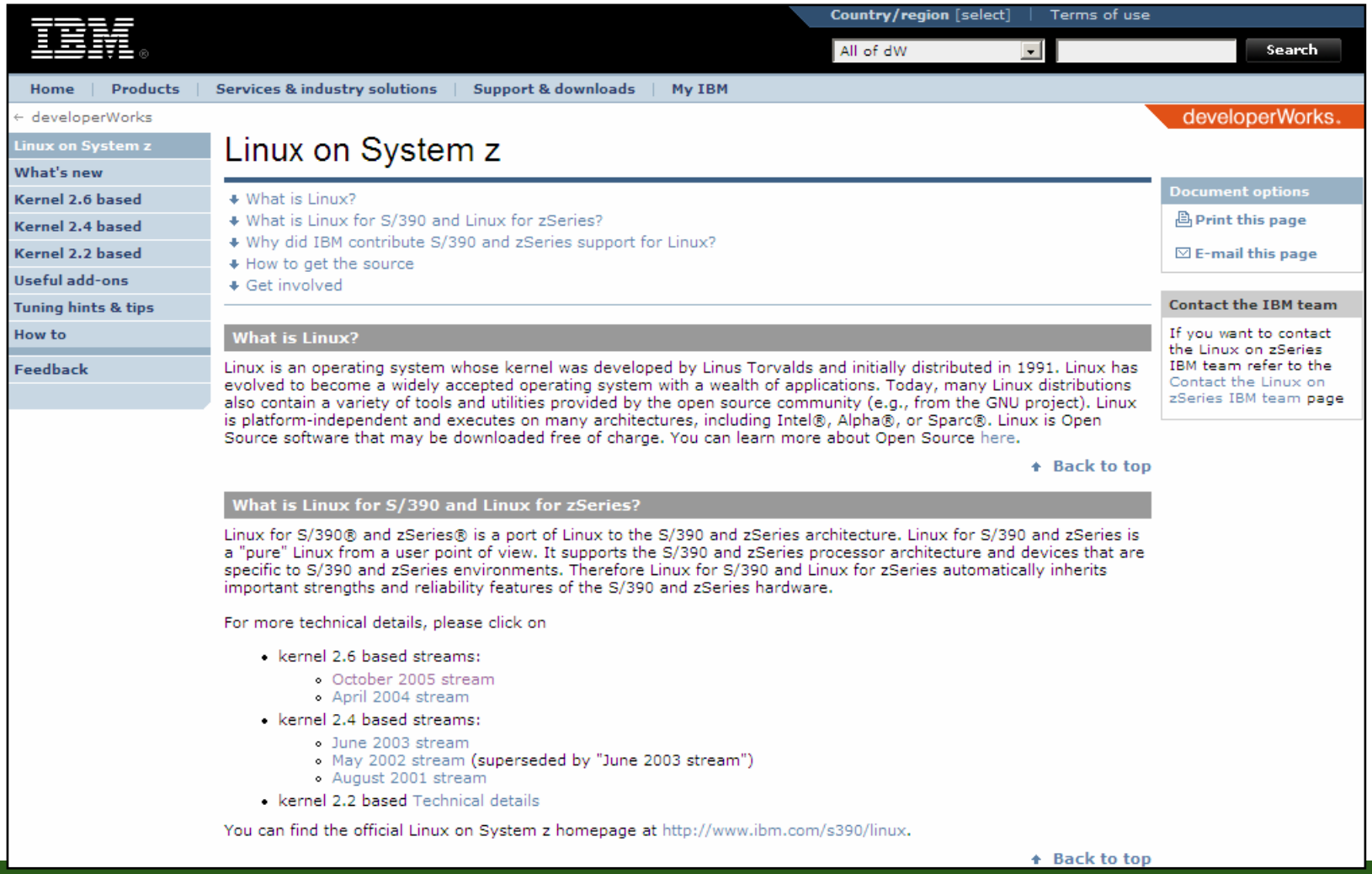
http://ibm.com/systems/z/linux

http://ibm.com/vm



Linux on System z at developerWorks

http://ibm.com/developerworks/linux/linux390



Internet list server discussions

- **IBMVM discusses z/VM**
  - To subscribe, send a note to listserv@listserv.uark.edu. In the body of the note, write only the following line:
    - **SUBSCRIBE IBMVM** *firstname lastname*
  - View and search the current list and archives:
    - http://listserv.uark.edu/archives/ibmvm.html
- **LINUX-390 discusses Linux on System z**
  - To subscribe, send a note to listserv@vm.marist.edu. In the body of the note, write only the following line:
    - **SUBSCRIBE LINUX-390** *firstname lastname*
  - View and search the current list and archives:
    - http://www.marist.edu/htbin/wlvindex?linux-390

Additional web sites

- **z/VM resources for Linux on IBM System z**
  - http://ibm.com/vm/linux
- **Wikipedia**
  - http://wikipedia.org/wiki/Linux_on_zSeries
- **General z/VM tuning tips**
  - http://ibm.com/vm/perf/tips
- **Linux distributions for System z**
  - Novell SUSE Linux Enterprise at http://novell.com/products/server/
  - Red Hat Enterprise Linux at http://redhat.com/rhel/details/servers/

Thank you

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http://ibm.com/linux

http://ibm.com/systems/z

http://ibm.com/vm/devpages/jelliott

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