

SHARE Winter 2013 San Francisco



z/OS Tuning Basics: Exploring the World of zEnterprise Hybrid, Blades, and the zManager

Session 12948

Glenn Anderson, IBM Technical Training



© 2013 IBM Corporation



A “System of Systems” for Predictable Service Delivery

IBM zEnterprise™ 196 (z196) or IBM zEnterprise 114 (z114) or zEC12

- Optimized to host transaction, and mission-critical applications
- The most efficient platform for large-scale Linux® consolidation
- Massive scale-up

zEnterprise Unified Resource Manager

- Unifies management of resources, extending IBM System z® qualities of service end-to-end across workloads
- Provides platform, hardware and workload management

zEnterprise BladeCenter® Extension (zBX)

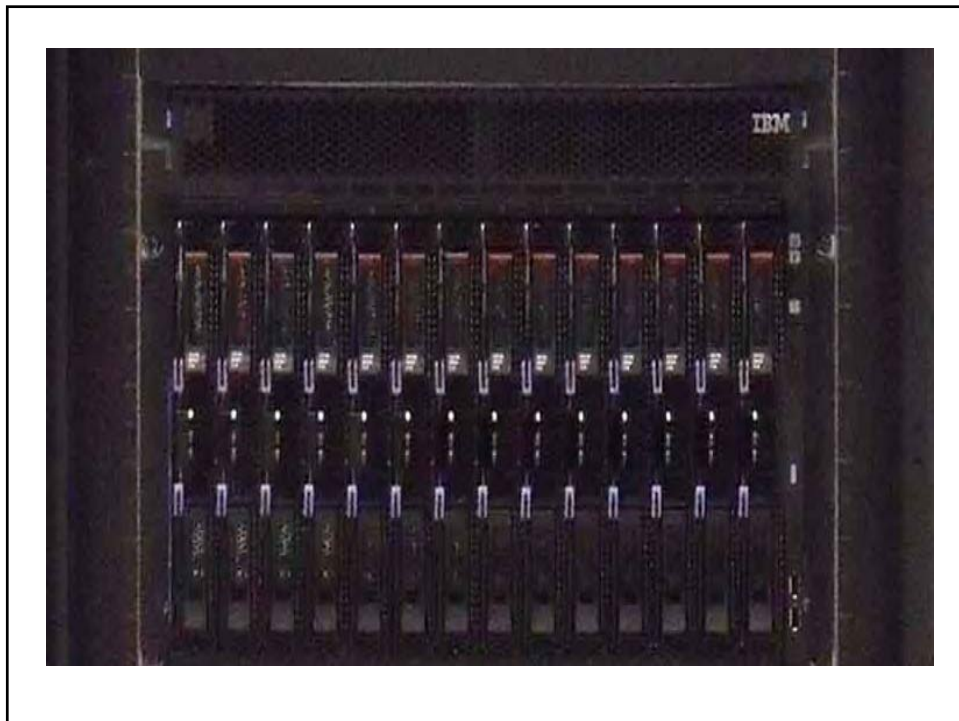
- Selected IBM POWER7® blades and IBM System x® blades for deploying applications in a multi-tier architecture
- High-performance optimizers and appliances to accelerate time to insight and reduce cost
- Dedicated high-performance private network

IBM® zEnterprise System.
Freedom by Design.



2

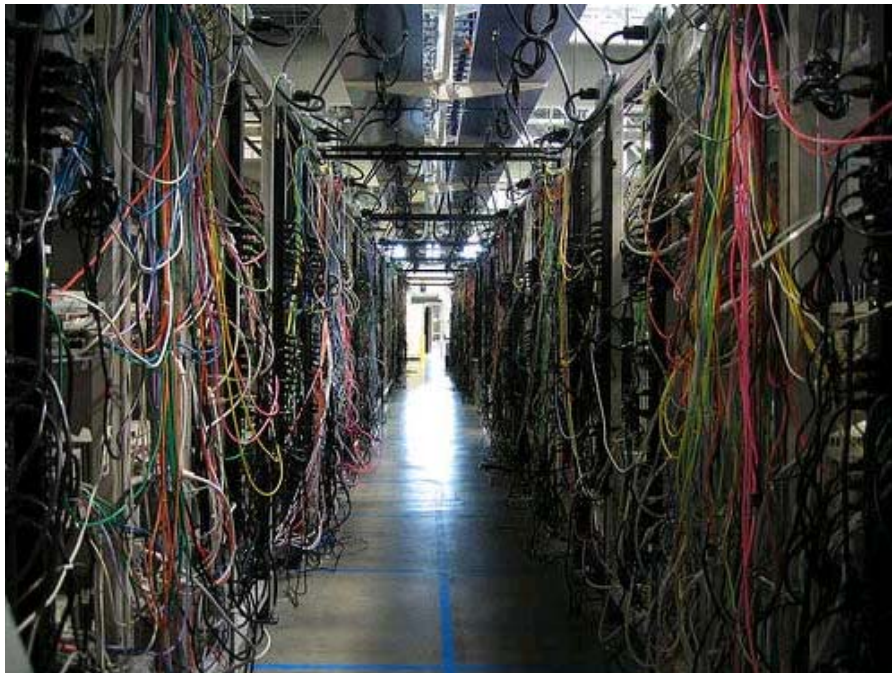


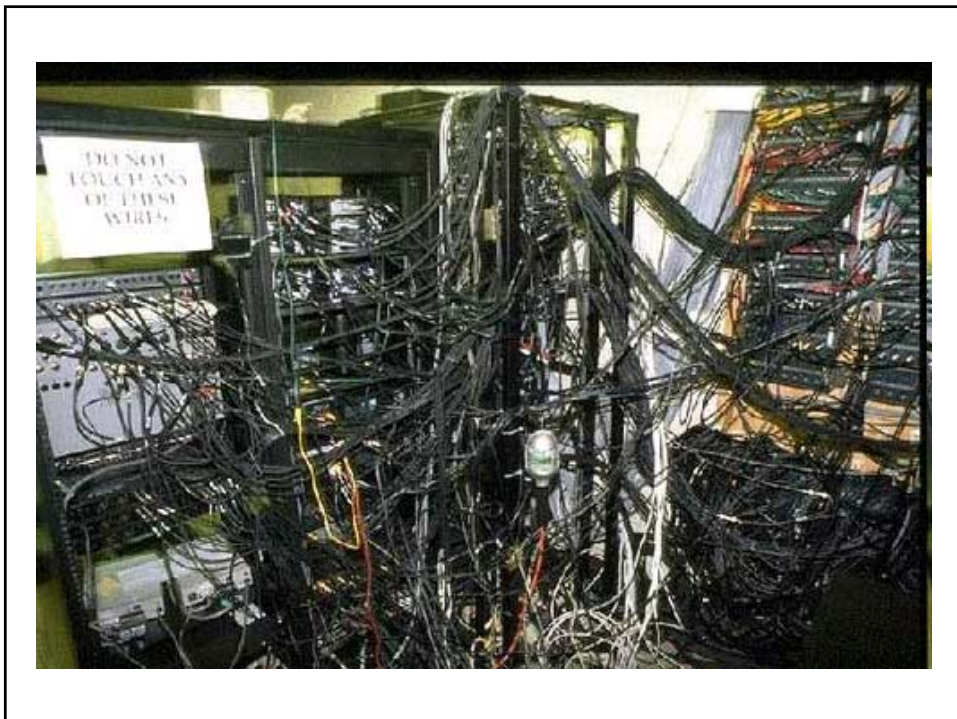
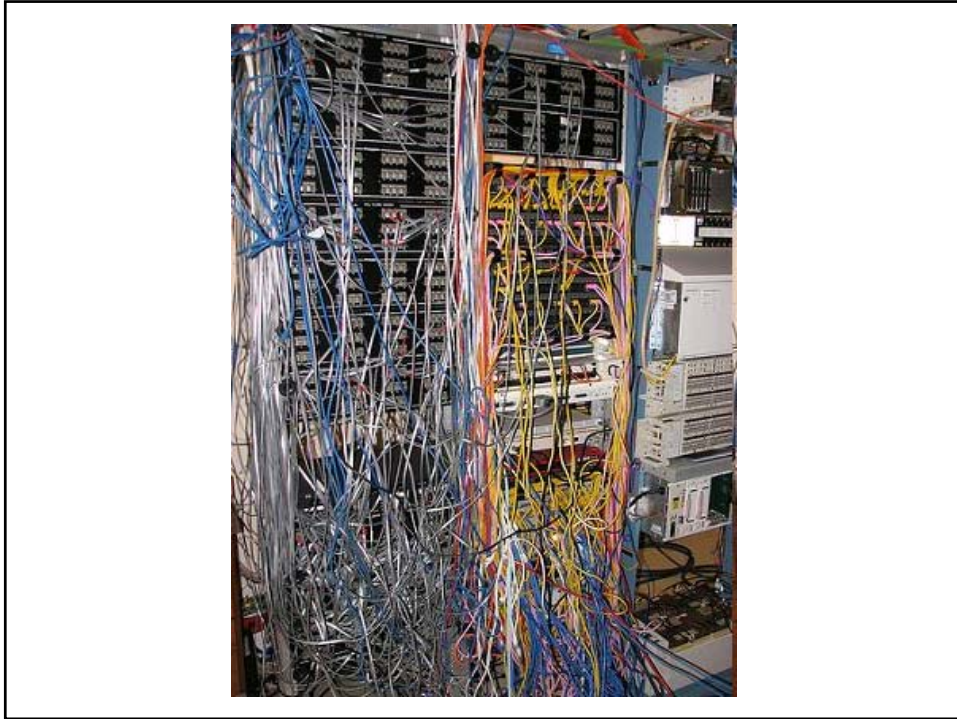


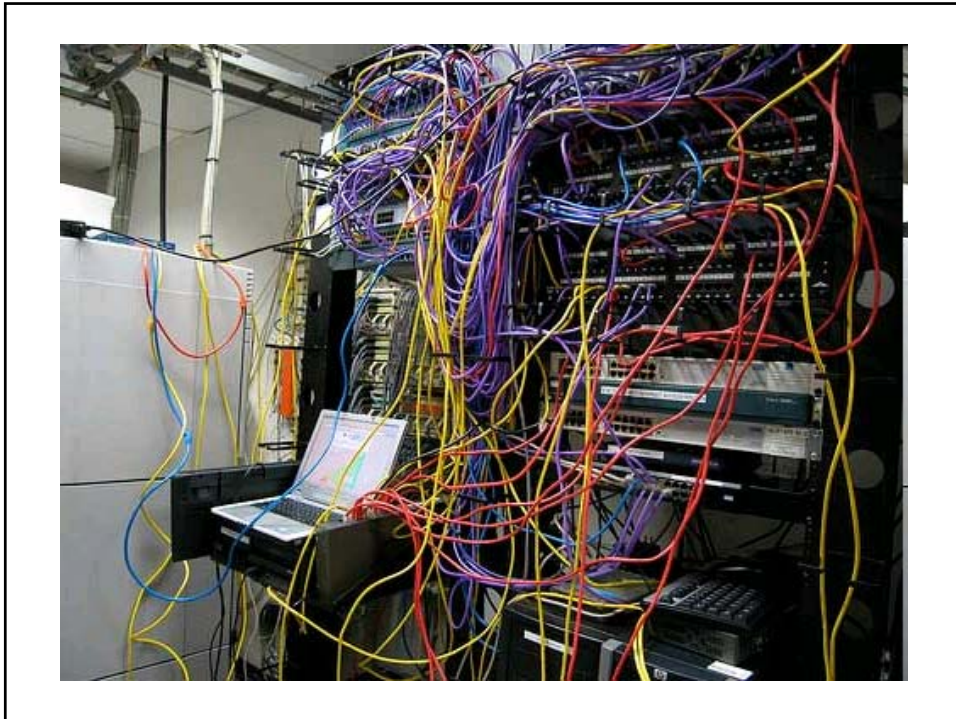


History of Blades.....

- 1999
 - Data center inefficiency







History of Blades.....

- 1999
 - Data center inefficiency
 - Easier way to deploy large numbers of rack mount web servers in data centers
 - A new server form factor...lower power consumption without sacrificing performance



History of Blades.....

- 1999
 - Data center inefficiency
 - Easier way to deploy large numbers of rack mount web servers in data centers
 - A new server form factor...lower power consumption without sacrificing performance
- 2001
 - RLX Technologies
 - New term... "server blade"
 - First generation target market – large internet data centers



History of Blades.....

- 2002 – 2003
 - As service provider market collapsed, blade manufacturers attempted to take products to broader enterprise data center market
 - HP, Compaq, Dell, IBM, Sun
- 2006 - 2007
 - New blade designs further address needs of data centers....better I/O management and thermal management



What is a Blade Server?

- Blade servers offer a standardized method of deploying multiple processors, memory and I/O resources by placing those resources on plug-in boards that slide into a standard chassis



IBM BladeCenter Family

BladeCenter Chassis by model and type

IBM BladeCenter E

High density, power efficient



- 7U design
- Up to 14 blade bays
- Up to four switch fabrics
- Low cost
- Low power
- Support 10 GB uplinks
- Support 8 Gb FC
- SAS Connectivity Module

IBM BladeCenter T

Highly rugged, Telco, AC/DC, NEBS, air filtration



- 8U design
- Up to 8 blade bays
- Up to 4 switch fabrics
- AC or DC models
- NEBS compliant
- Rugged
- Support 10 GB uplinks
- Support 8 Gb FC
- Telco, military, dirty floor
- SAS Connectivity Module

IBM BladeCenter H

Ultra high performance, and I/O flexibility



- 9U design
- Up to 14 blade bays
- Up to 10 GB midplane
- I/O flexibility up to 8 switch bays
- Support 30 mm blades with up to 8 ports
- Support 10 GB Ethernet
- Support 8 Gb FC
- Support 4x(QDR) InfiniBand
- SAS Connectivity Module

IBM BladeCenter HT

Highly rugged, Telco, AC/DC, NEBS, air filtration



- 12U design
- Up to 12 blade bays
- AC or DC models
- I/O flexibility up to 8 switch bays
- NEBS compliant
- Rugged
- Up to 10 GB midplane
- Support 10 GB Ethernet
- Support 8 Gb FC
- SAS Connectivity Module
- Telco, military, dirty floor

IBM BladeCenter S

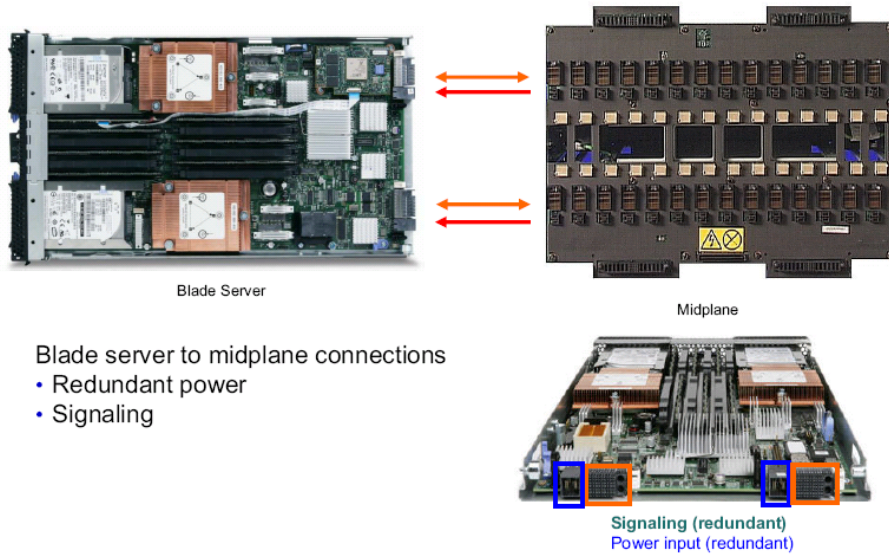
Integrated disk, 110-240v power, BladeCenter outside the datacenter



- 7U design
- Up to 6 blade bays
- Integrated storage
- Up to 3 switch fabrics
- Power (100 - 240v)
- 950 with 1450 AC auto-sensing
- Support 10 GB uplinks
- Support 4 GB FC
- SAS RAID and Connectivity Modules

← Common blades, common switches, common management →

Power and Signal Paths



Advanced Management Module

Center point for IBM BladeCenter infrastructure intelligence

- Hot-swappable module
- Powerful and robust systems management
- Proxy for expansion modules
- Controls all aspects of power, connectivity and communication
- Reliability, availability, and serviceability (RAS)

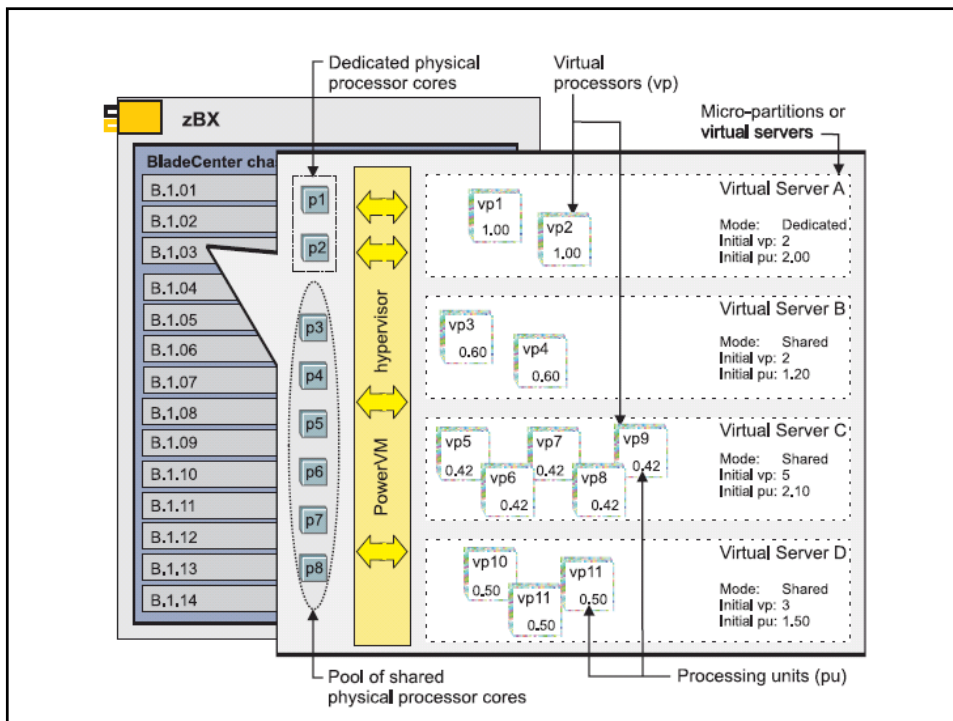


The POWER7 Product Family

<p>Express</p> <p>POWER 750 Express 6,8,12,16,18, 24,32 cores 8-512 GB Memory Up to 8 I/O Drawers</p> <p>POWER 740 Express 4, 6, 8, 12, 16 cores 8-256 GB Memory Up to 8 I/O Drawers</p> <p>POWER 720 Express 4, 6 or 8 cores 8-128 GB Memory Up to 4 I/O Drawers</p> <p>POWER 730 Express 8, 12, or 16 cores 8-128 GB Memory</p> <p>POWER 710 Express 4, 6 or 8 cores 8-64 GB Memory</p>	<p>Scalable Midrange</p> <p>POWER 780 8 or 16 Cores / Node TurboCore Mode 4-64 Cores at 3.8 GHz 4-32 Cores at 4.1 GHz 24x7 Warranty PowerCare Service Up to 2 TB memory Capacity on Demand</p> <p>POWER 770 12 or 16 Cores / Node 4-64 Cores at 3.1 GHz 4-48 Cores at 3.5 GHz Up to 2 TB memory Capacity on Demand</p>	<p>Scalable High End</p> <p>POWER 795 Up to 128 @ 4.25 GHz (4) Up to 192 @ 3.72 GHz (6) Up to 256 @ 4.00 GHz (8)</p> <p>Up to 8 TB memory PowerCare Service Capacity on Demand</p> <p>HPC</p> <p>POWER6 575 32 4.7 GHz / Node Up to 256 GB / Node</p> <p>POWER 755 32 Cores at 3.55 GHz Up to 256 GB Memory</p>
<p>POWER Blades</p> <p>PS700 – 4 core/64 GB max</p> <p>PS701 – 8 cores/128 GB max Selected for zEnterprise zBX</p> <p>PS702 – 16 cores / 256 GB max</p>		

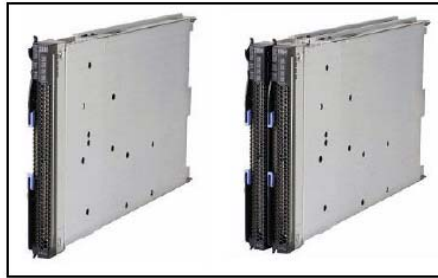
21

© 2013 IBM Corporation

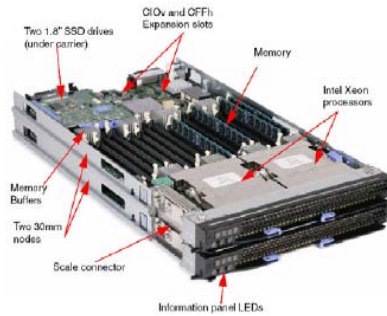


System x – HX5 Blade Server

- The HX5 Blade Server implements the IBM eX5 architecture
- Processor support for up to four Intel Xeon 7500 processors
 - Four-core, six-core or eight-core configurations
 - Hyper-threading
 - Turbo boost
 - Quick path interconnect (QPI)




IBM HX5 two-socket and four-socket configurations



System x Hypervisor

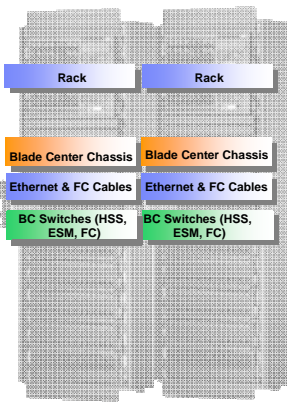
- Integrated KVM based Hypervisor supplied by Unified Resource Manager (xHyp)
- KVM: Kernel-based Virtual Machine
 - Open source virtualization solution for Linux on x86 hardware
- For System x blade on zBX, loaded as firmware
 - Linux Kernel + KVM + zManager components





IBM zEnterprise BladeCenter Extension

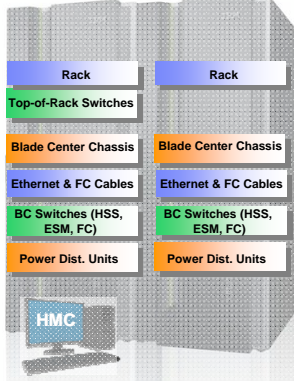
A Uniquely Configured Extension



**Rack infrastructure hosting
IBM BladeCenters**


Looks like a rack with BladeCenters but much more...

- zBX assembled and built at IBM plant
 - ▶ All parts and microcode - tested and shipped as complete package
- zBX hardware redundancy provides improved availability
 - ▶ Redundant switches provide guaranteed connection between z196/z114/zEC12 and zBX
 - ▶ Redundant Power Distribution Units improve availability
 - ▶ Extra blowers manage heat dispersion/removal
- zBX provides isolated and secure network
 - ▶ Four top-of-rack switches for connection to controlling z196/z114/zEC12
 - ▶ Traffic on user networks not affected
 - ▶ Provides foundation for the Unified Resource Manager



**IBM zEnterprise BladeCenter
Extension (zBX)
Model 002 / 003**

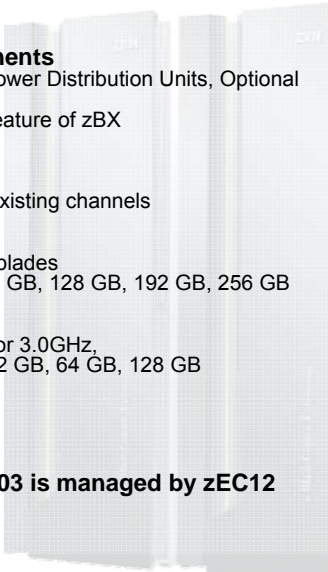
© 2013 IBM Corporation



IBM zEnterprise BladeCenter Extension (zBX)

Machine Type: 2458 Model 003

- **zBX is built with integrated IBM certified components**
 - Standard parts – TOR switch, BladeCenter Chassis, Power Distribution Units, Optional Acoustic Panels
 - Optional optimizer - DataPower (XI50z) ordered as a feature of zBX
- **Up to 112 blades are supported on zBX**
 - System x and POWER7 blades are acquired through existing channels
 - IBM System x Blades – up to 56 entitlements
 - IBM BladeCenter HX5 (7873) dual-socket 16-core blades
 - Four supported memory configurations in zBX – 64 GB, 128 GB, 192 GB, 256 GB
 - IBM POWER7 Blades – up to 112 entitlements
 - IBM BladeCenter PS701 Express - 8-core processor 3.0GHz,
 - Three supported memory configurations in zBX - 32 GB, 64 GB, 128 GB
 - Up to 28 DataPower XI50z blades (double wide)
 - Mix and match blades in the same chassis
- **Model 002 is managed only by z196 and Model 003 is managed by zEC12**




© 2012 IBM Corporation

IBM

Operating System Environments extend application flexibility

- **Support for Linux and Windows environments on System x blades in zBX**
 - 64-bit version support only
 - NEW** – Linux: RHEL 5.5, 5.6, 6.0 & Novell SUSE SLES 10 (SP4) and SLES 11 SP1
 - NEW** – Microsoft® Windows® Server 2008 R2 and Microsoft Windows Server 2008 (SP2) (for either we recommend Datacenter Edition)
 - The zBX web page will host the most current blade ordering information:
http://www.ibm.com/common/ssi/cgi-bin/ssialias?infotype=SA&subtype=WH&appname=STGE_ZS_ZSUSEN&htmlfid=ZSL03128USEN&attachment=ZSL03128USEN.PDF
- **Support of AIX environments on POWER7 blades in zBX**
 - NEW** – AIX®: AIX 5.3 Technology Level 12 or higher, AIX 6.1 Technology Level 5 or higher, AIX 7.1
 - For the most current POWER7 blade ordering information:
http://www.ibm.com/common/ssi/cgi-bin/ssialias?infotype=SA&subtype=WH&appname=STGE_ZS_ZS_USEN&htmlfid=ZSY03019USEN&attachment=ZSY03019USEN.PDF
- **Certifications inherited from blades**
 - NEW** – SAP support for Linux and Windows on x86 blades in the zBX
- **Operating Systems are customer acquired and installed**



© 2012 IBM Corporation


IBM

IBM WebSphere DataPower Integration Appliance XI50 for zEnterprise Helps Extend the Value of zEnterprise

DataPower XI50 is a purpose-built hardware for simplified deployment and hardened security that can help businesses quickly react to change and reduce time to market

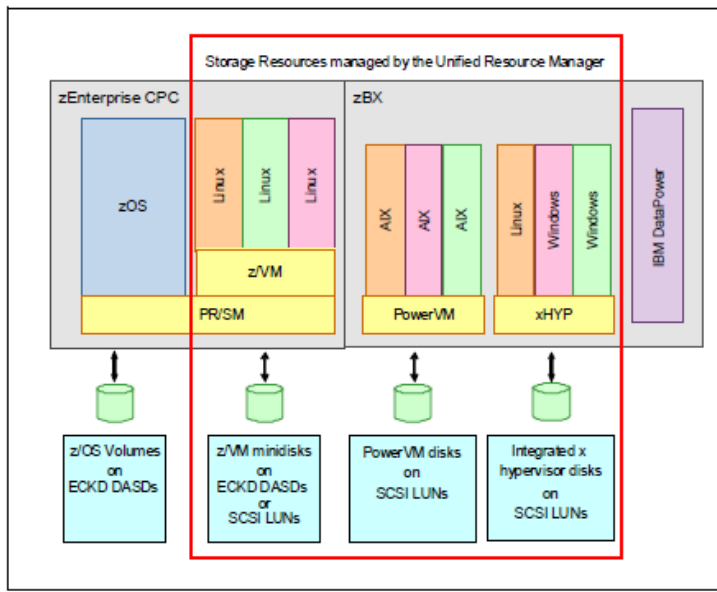
What's different about installing DataPower into the zBX ?

- **Security:** VLAN support provides enforced isolation of network traffic with secure private networks.
- **Improved support:** Monitoring of hardware with "call home" for current/expected problems and support by System z Service Support Representative.
- **System z packaging:** Increased quality with pre-testing of blade and zBX. Upgrade history available to ease growth.
- **Operational controls:** Monitoring rolled into System z environment from single console. Consistent change management with Unified Resource Manager.
- **Cloud:** WebSphere DataPower enhancements can provide a secure, managed connection from the enterprise applications or enterprise users to public cloud applications.

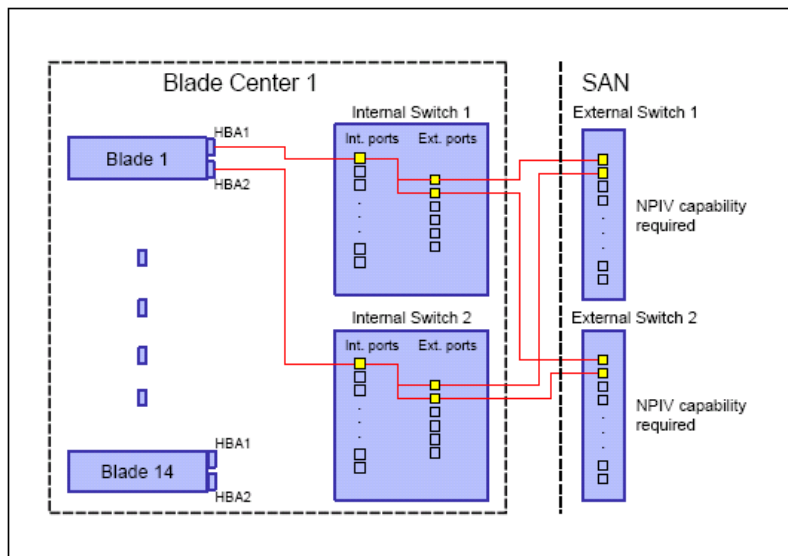



© 2013 IBM Corporation

zEnterprise Storage Resources



zBX Storage Topology





zEnterprise Unified Resource Manager

Transforming the way resources are managed and deployed


What is it?

Unified Resource Manager provides infrastructure awareness to optimize the system resources in accordance with understanding the policies assigned to that particular workload.

Functions are grouped into suites of tiered functionality that enable different levels of capability – Manage, Advanced Management and Automate.

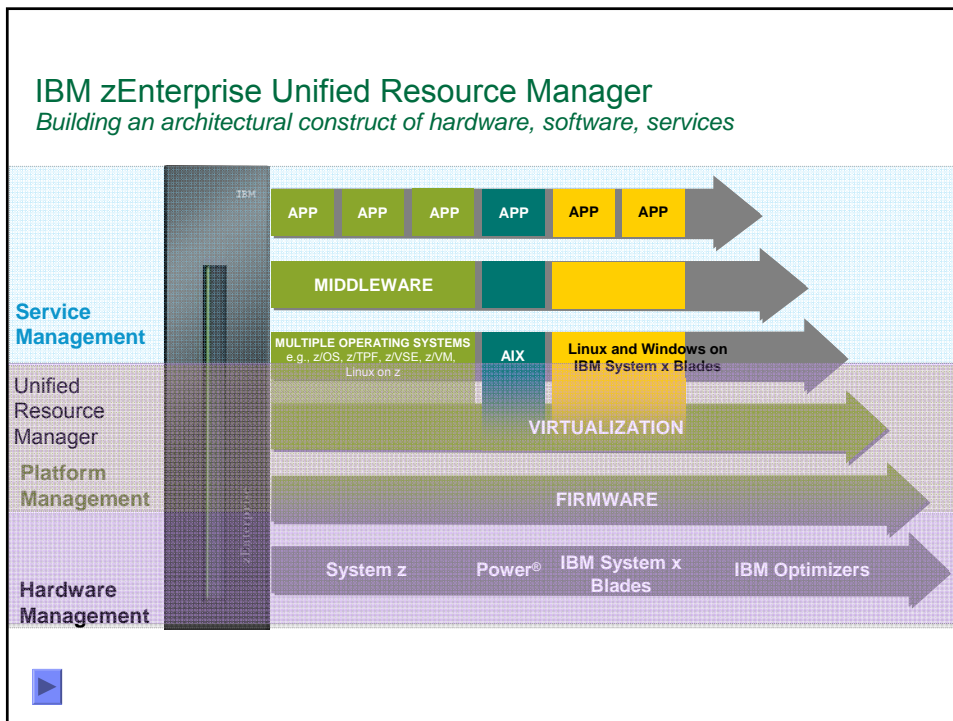
How is it different?


- **Heterogeneous management:** Total systems management across heterogeneous resources. APIs facilitate enterprise wide management.
- **Integration:** Single point of control, common skills for resources, reduced complexity of day to day operations..
- **Monitoring.** New dashboard for CPU resources and energy management.
- **Simplified installation:** Auto discovery and configuration of resources and workloads with single interface
- **Secure:** Improved network security with lower latency, less hops and less complexity. Improved control of access due to management of hypervisors as firmware.
- **Service and support management:** Virtual machines and blades able to perform hardware problem detection, reporting and call home



31


© 2011 IBM Corporation







Unified Resource Manager

Manage Firmware Suite




- **Manage (DataPower XI50z, select POWER7 and System x blades)**
 - ▶ Monitor and trend reporting of CPU energy efficiency.
 - ▶ New dashboard interface enabling a broader view of system resource consumption.
 - ▶ Integrated hardware / asset management across all elements of the system.
 - ▶ Private and physically isolated connections for secure support and data sharing.
 - ▶ Management of network resources to assist with problem determination.
 - ▶ Administrative simplification (wizard) for virtual server provisioning and enablement of integrated storage and network across hypervisors.
 - ▶ Sharing of resource information and metrics via APIs.







Unified Resource Manager

Advanced Management / Automate Firmware Suites



- **Advanced Management (Select System x blades)**
 - ▶ Additional wizard function to set up resources associated with a workload and the capability to associate those resources with a named business process.
 - ▶ Ability to monitor and report performance.
 - ▶ Load balancing to ensure that network traffic flows correctly.
 - ▶ Energy management capabilities.
- **Automate (Select POWER7 blades and DataPower XI50z)**
 - ▶ Energy management capabilities.
- **Automate (Select POWER7 blades only)**
 - ▶ Additional wizard function to set up resources associated with a workload and the capability to associate those resources with a named business process.
 - ▶ Ability to manage to a user defined performance service level policy and enable performance monitoring, reporting and resource optimization.
 - ▶ Load balancing to ensure that network traffic flows correctly.
 - ▶ Static power savings.

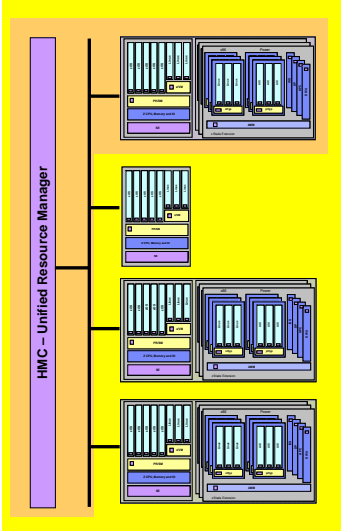




Defining an Ensemble Enables Improved Management and Scale

- An ensemble is a collection of up to eight zEnterprise nodes that are managed collectively by the Unified Resource Manager as a single logical virtualized system
- A zEnterprise node is a z196, z114 or zEC12 with 0 or 1 zBX.
The zBX may contain from 1 to 4 racks each containing up to two BladeCenters. zEnterprise nodes are deployed within a single site
- Automated failover to ensemble back up HMC

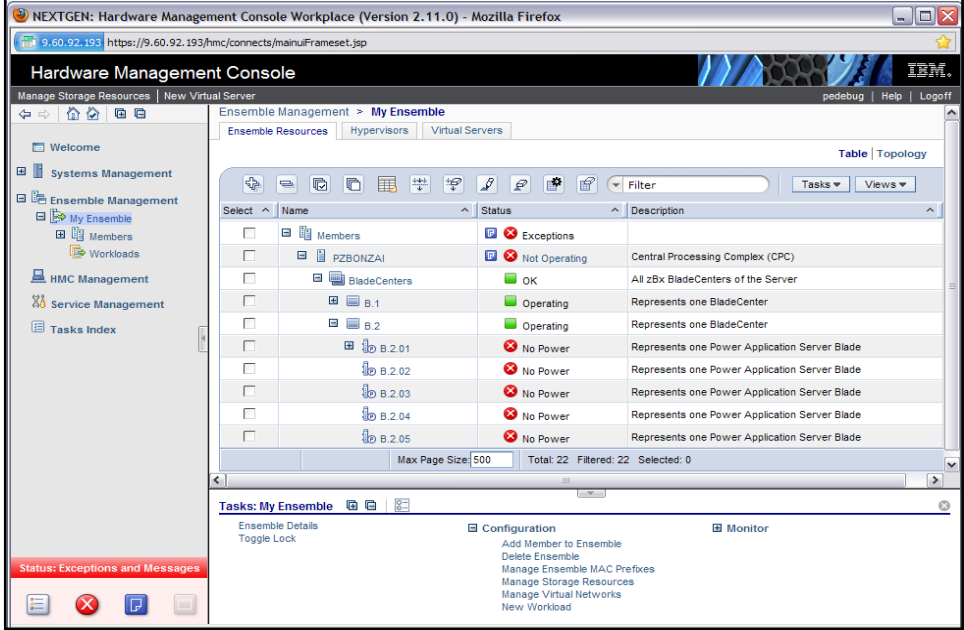
An ensemble allows you to have a single pool of resources –integrating system and workload management across the multi-system, multi-tier, multi-architecture environment.



zEnterprise Node
 zEnterprise Ensemble

© 2013 IBM Corporation

Ensemble Management



Hardware Management Console

Ensemble Management > My Ensemble

Select	Name	Status	Description
<input type="checkbox"/>	Members		Exceptions
<input type="checkbox"/>	PZBONZAI		Not Operating Central Processing Complex (CPC)
<input type="checkbox"/>	BladeCenters		OK All zBx BladeCenters of the Server
<input type="checkbox"/>	B.1		Operating Represents one BladeCenter
<input type="checkbox"/>	B.2		Operating Represents one BladeCenter
<input type="checkbox"/>	B.2.01		No Power Represents one Power Application Server Blade
<input type="checkbox"/>	B.2.02		No Power Represents one Power Application Server Blade
<input type="checkbox"/>	B.2.03		No Power Represents one Power Application Server Blade
<input type="checkbox"/>	B.2.04		No Power Represents one Power Application Server Blade
<input type="checkbox"/>	B.2.05		No Power Represents one Power Application Server Blade

Max Page Size: 500 Total: 22 Filtered: 22 Selected: 0

Tasks: My Ensemble

- Ensemble Details
- Configuration
 - Add Member to Ensemble
 - Delete Ensemble
 - Manage Ensemble MAC Prefixes
 - Manage Storage Resources
 - Manage Virtual Networks
 - New Workload
- Monitor

Hypervisor Report

R90HMC1: Workloads Report - Mozilla Firefox: IBM Edition

9.12.16.241 https://9.12.16.241/hmc/content?taskId=18&refresh=37

Hypervisor Report - r901b206v1

Report Interval: Starting 2/10/11 10:15:53 AM for 15 minutes (2/10/11 10:36:53 AM) [Modify](#)

Start: 15 minutes

Starting from: Date: 2/10/11 Time: 10:15:53 AM Duration: 15 minutes

OK [Apply](#) [Cancel](#)

Hypervisor Details:
 Hypervisor: 8.2.05 Processor count: 8 Total memory allocated for virtual servers: 40,960 MB
 Hypervisor type: PowerVM Total CPU consumption: 96.6% Total memory: 66,536 MB
 Total allocated processing units: 7.50


Virtual Servers:

Virtual Server	Processor Management Status	Processor Management Reason	Virtual Processors	Min Virtual Processors	Max Virtual Processors	Consumed Processors	Hypervisor Processing Unit Delay (%)	Allocated Memory (MB)	Dedicated	Capped	Processing Units	Initial Processing Units	Min Processing Units	Max Processing Units	Min Memory (MB)	Max Memory (MB)
r901b206v1	Active	None	2	1	7	1.02	37.4	4,096	--	--	1.08	0.50	0.10	7.00	4,096	4,096
r901b206v2	Active	None	2	1	7	1.67	11.0	4,096	--	--	1.90	0.95	0.10	7.00	4,096	4,096
r901b206v3	Active	None	2	1	7	0.99	37.9	4,096	--	--	0.71	1.20	0.10	7.00	4,096	4,096
r901b206v4	Active	None	2	1	7	1.00	37.7	4,096	--	--	0.90	0.90	0.10	7.00	4,096	4,096
r901b206v5	Active	None	2	1	7	0.99	50.7	4,096	--	--	0.35	0.90	0.10	7.00	4,096	4,096
r901b206v6	Active	None	2	1	7	0.02	29.0	4,096	--	--	1.08	0.90	0.10	7.00	4,096	4,096
r901b206v7	Active	None	2	1	7	0.99	49.2	4,096	--	--	0.34	0.50	0.10	7.00	4,096	4,096
r901b206v8	Active	None	2	1	7	0.97	51.4	4,096	--	--	0.34	0.80	0.10	7.00	4,096	4,096

Page 1 of 1 Total: 8 Filtered: 0 Deployed: 0

Resource Adjustments

[Close](#) [Help](#)



zEnterprise Unified Resource Manager

Hardware Management

Hypervisor Management

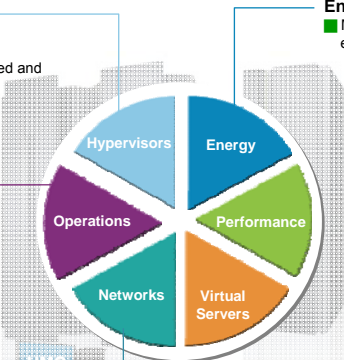
- Integrated deployment and configuration of hypervisor
- Hypervisors (except z/VM) shipped and serviced as firmware
- Management of ISO images
- Creation of virtual networks

Operational Controls

- Auto-discovery and configuration support for new resources (including storage)
- Cross platform hardware problem detection, reporting and call home
- Physical hardware configuration, backup and restore
- Delivery of system activity using new user interface

Network Management

- Monitoring and collecting metrics of networking resources
- Management of virtual networks including access control



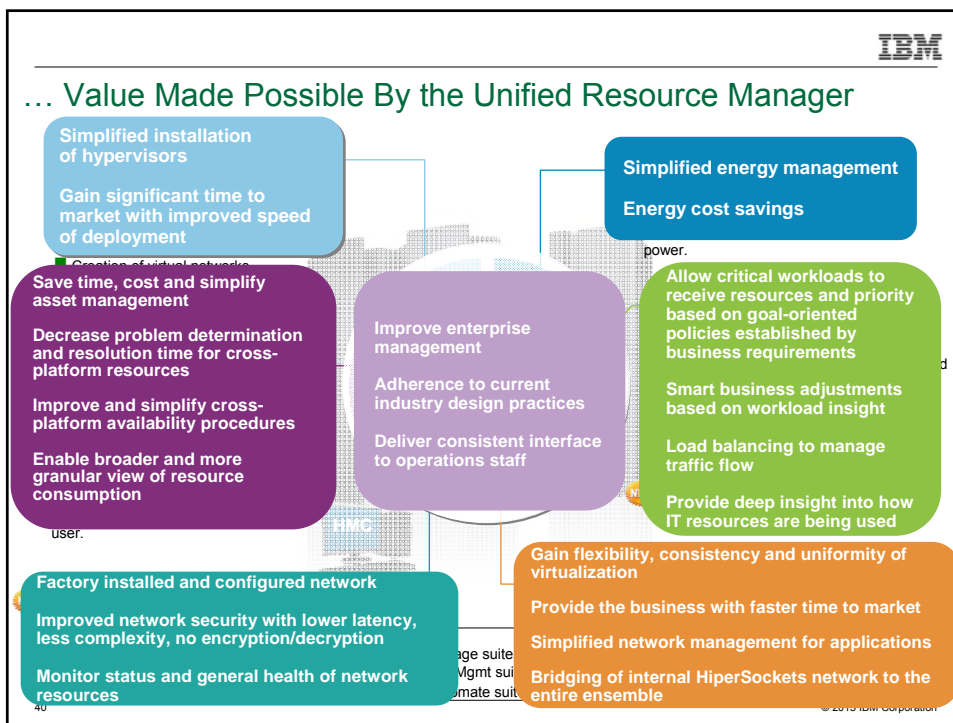
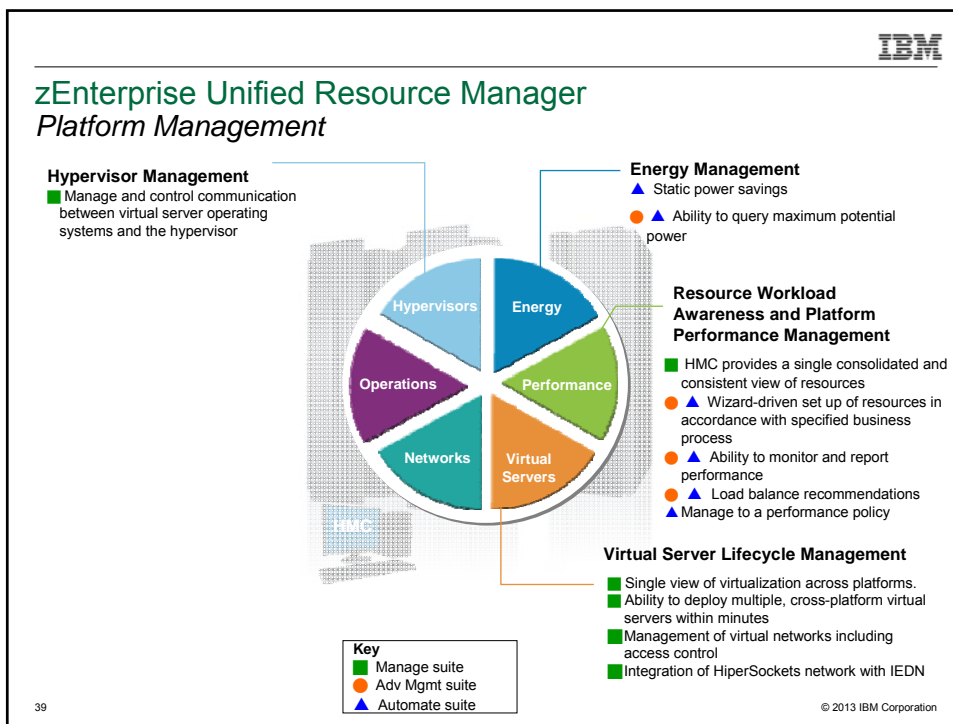
Energy Management

- Monitoring and trend reporting of CPU energy efficiency

Key

- Manage suite
- Adv Mgmt suite
- Automate suite

38 © 2013 IBM Corporation



IBM

Extending zEnterprise Unified Resource Manager

Continuing to add function and management

- **Operational Controls enhanced with auto-discovery and configuration support for new resources**
 - ▶ Dynamic discovery and configuration of storage resources by Unified Resource Manager
- **Extending management functions of Unified Resource Manager with programmatic access**
 - ▶ New Unified Resource Manager APIs enable discovery, monitoring and management of ensemble resources using external tools
 - Open documented interface available for clients
 - Access using common scripting languages like Perl and Python
 - IBM Tivoli® will be taking advantage of the APIs:
 - CA Technologies, Dovetailed Technologies, CSL International and other ISVs are interested in taking advantage of the APIs




41

© 2013 IBM Corporation

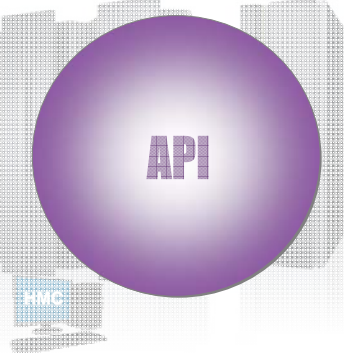
IBM

zEnterprise Unified Resource Manager

Management of zEnterprise from external tools

Application Programming Interface (API) is a new implementation in the HMC

- Build on existing SNMP/CIM function plus new Unified Resource manager capabilities
- TCP/IP Sockets/HTTP is underlying network support with SSL for connection security
- Supports modern scripting languages (e.g., Perl, Python) that have HTTP supporting libraries
- Fully documented and supported for customer and third-party use
- HMC UI remains in place, supported and will continue to be extended as Unified Resource Manager evolves
- APIs are governed by the functions they involve such as 'Manage' or 'Automate'

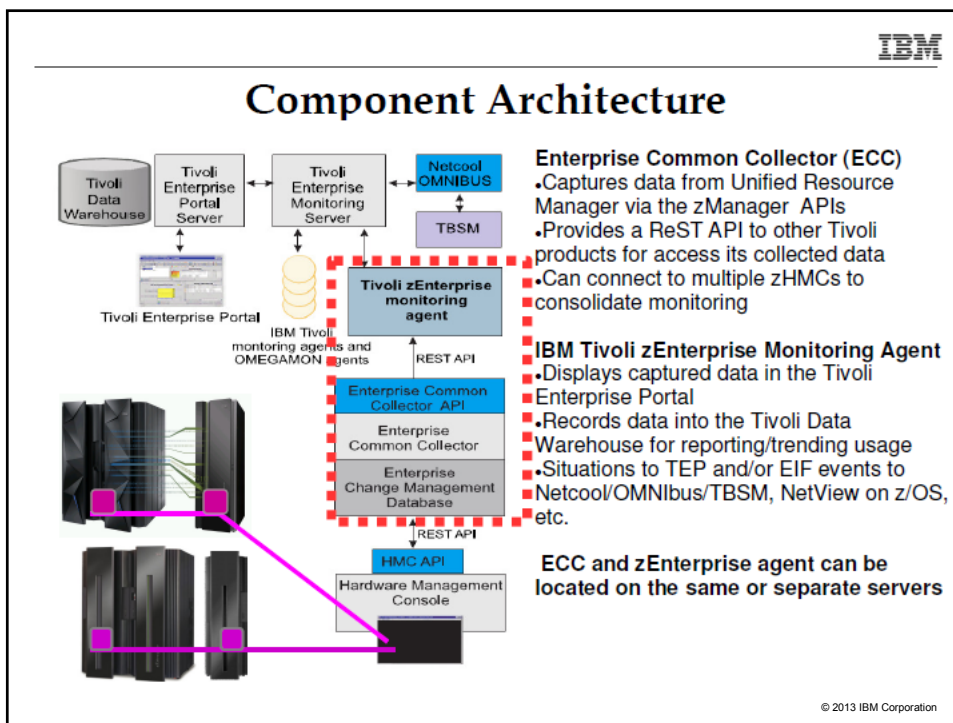
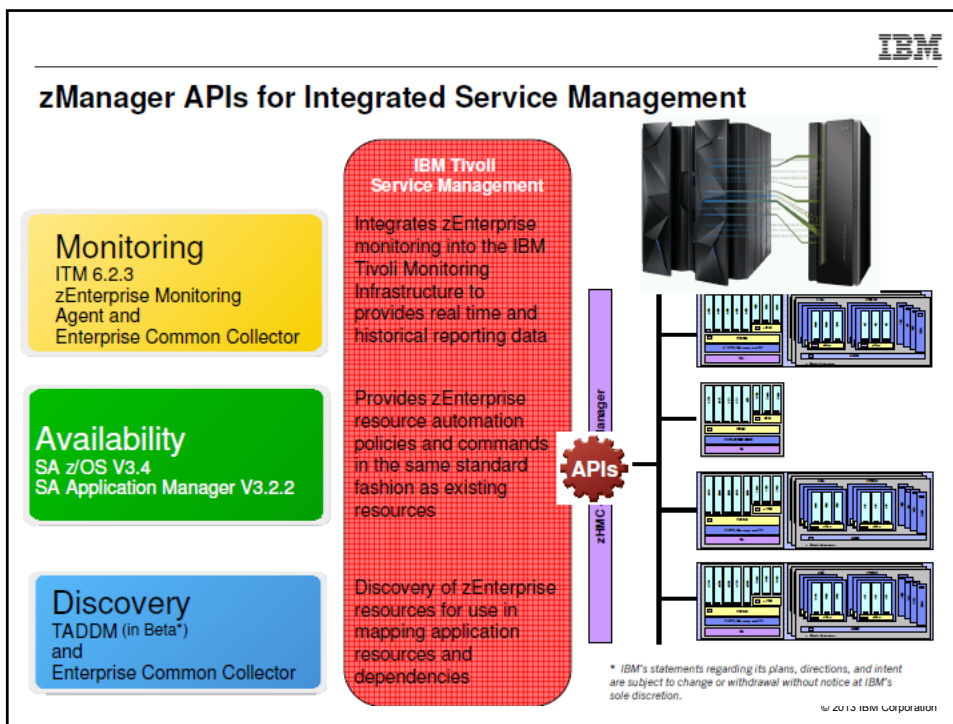


API allows programmatic access to the same functions exploited by the HMC UI. Corresponding to views and tasks in the UI such as:


- List and get properties for core (traditional) entities, ensemble, workloads, virtual networks, virtual hosts, virtual servers, storage, zBX infrastructure (as well as provide start/stop/restart for many of these also)
- Can provide service oriented functions like metrics retrieval and inventory
- Manage energy management modes
- Help on recover actions of virtual actions
- And more ...

42

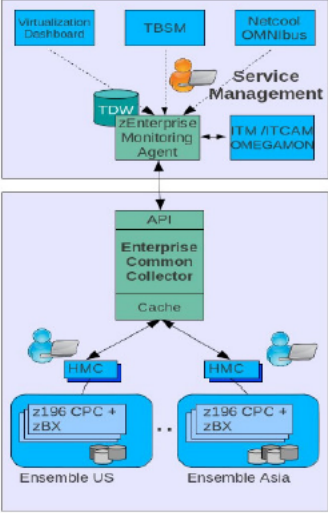
© 2013 IBM Corporation



zEnterprise Monitoring Agent




- Provides visibility into the IBM zEnterprise hybrid infrastructure, including hardware resources, hypervisors, virtual servers, and workload resource groups
- Automated discovery of resources within the monitoring environment
- Integrates the information into IBM Tivoli Monitoring infrastructure to provide:
 - ✓ Information highlighting and alerting capabilities
 - ✓ Integration with data from other agents in the ITM infrastructure
 - ✓ Optional long term history collection and reporting/trending with the Tivoli Data Warehouse and Tivoli Common Reporting
 - ✓ Optional event integration and Business Service Management with Netcool/OMNIBus and Tivoli Business Service Manager (TBSM)



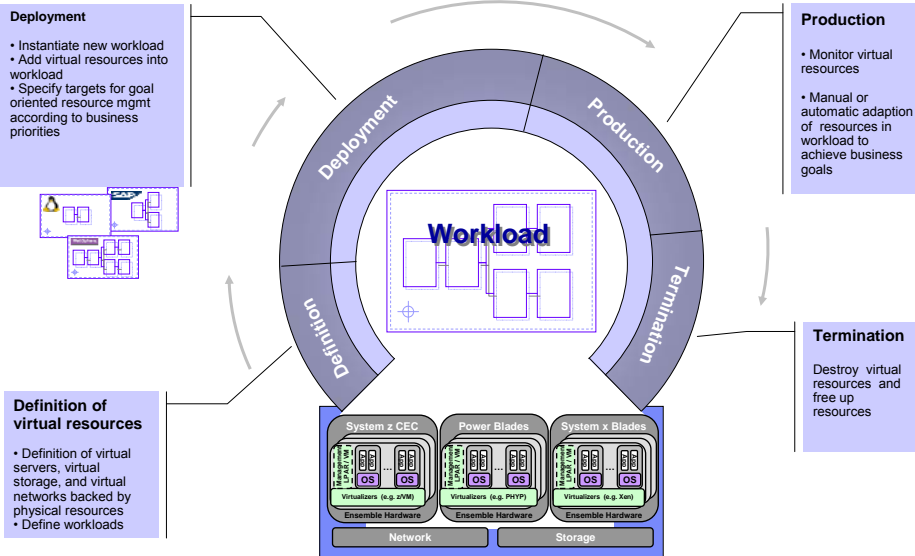
© 2013 IBM Corporation

zEnterprise Lifecycle Management of Virtual Resources



Deployment

- Instantiate new workload
- Add virtual resources into workload
- Specify targets for goal oriented resource mgmt according to business priorities



Production

- Monitor virtual resources
- Manual or automatic adaption of resources in workload to achieve business goals

Definition of virtual resources

- Definition of virtual servers, virtual storage, and virtual networks backed by physical resources
- Define workloads

Termination

- Destroy virtual resources and free up resources

zEnterprise ensemble resource pools

© 2011 IBM Corporation



Putting zEnterprise System to the Task
Operational Controls – POWER7



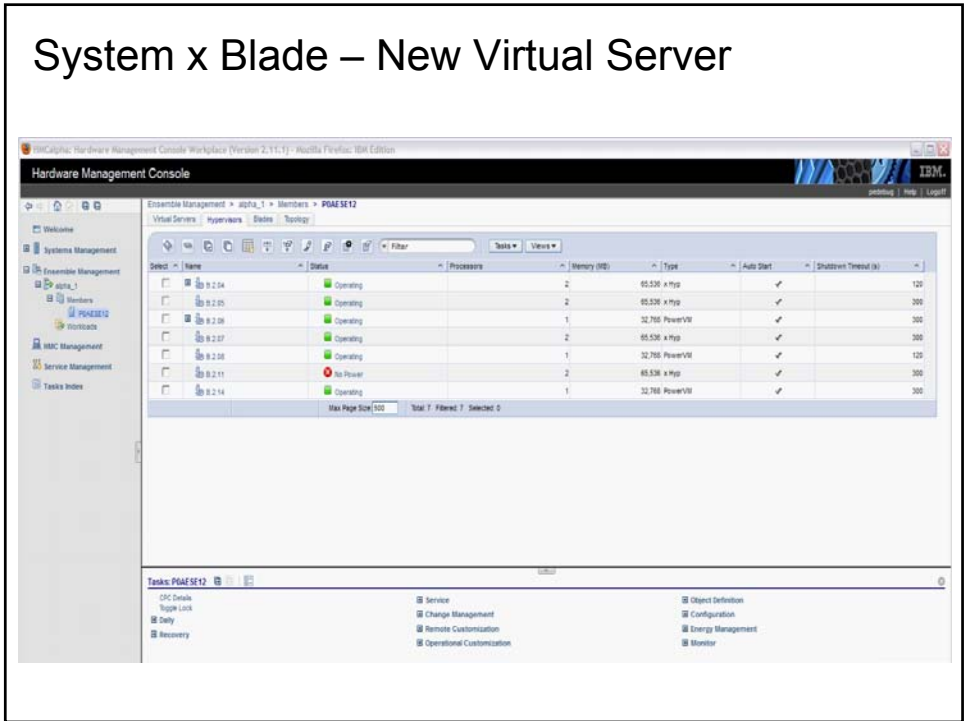
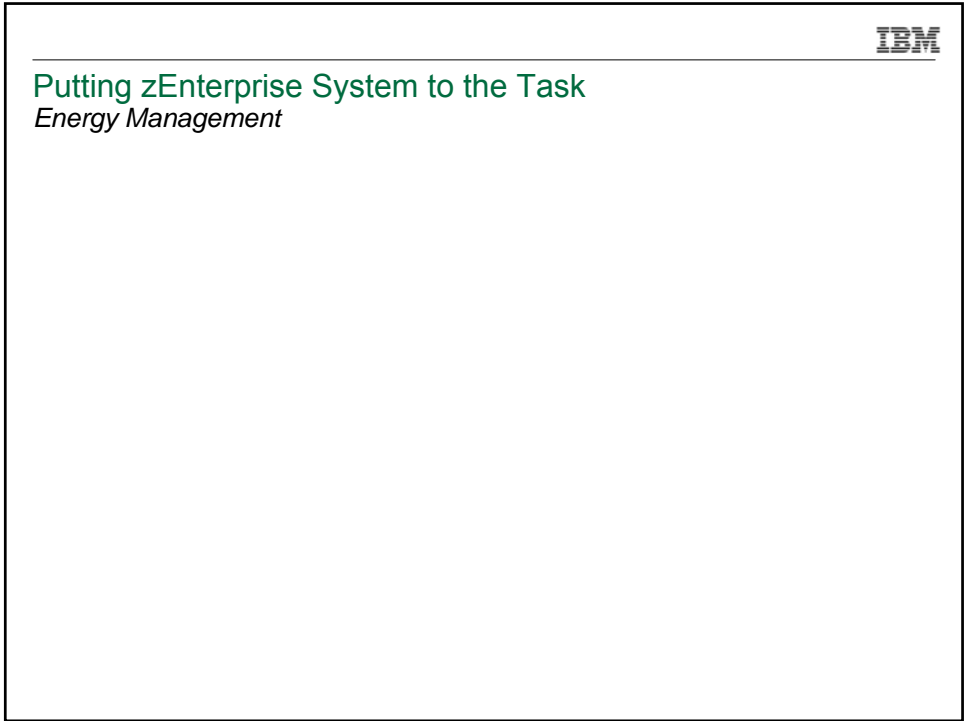
Putting zEnterprise System to the Task
Hypervisor Management and Virtual Server Management – POWER7



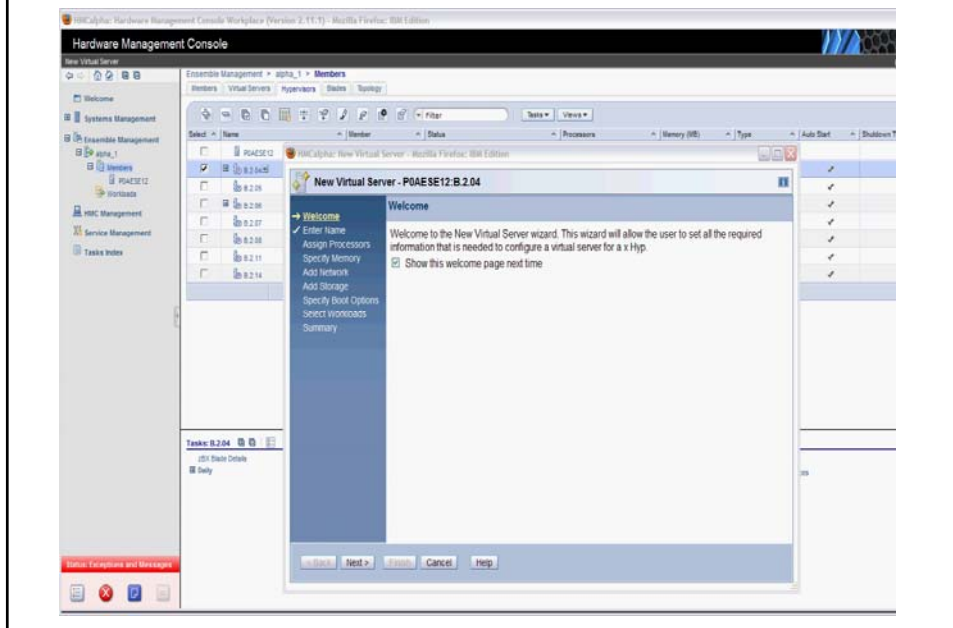
Putting zEnterprise System to the Task
Network Management



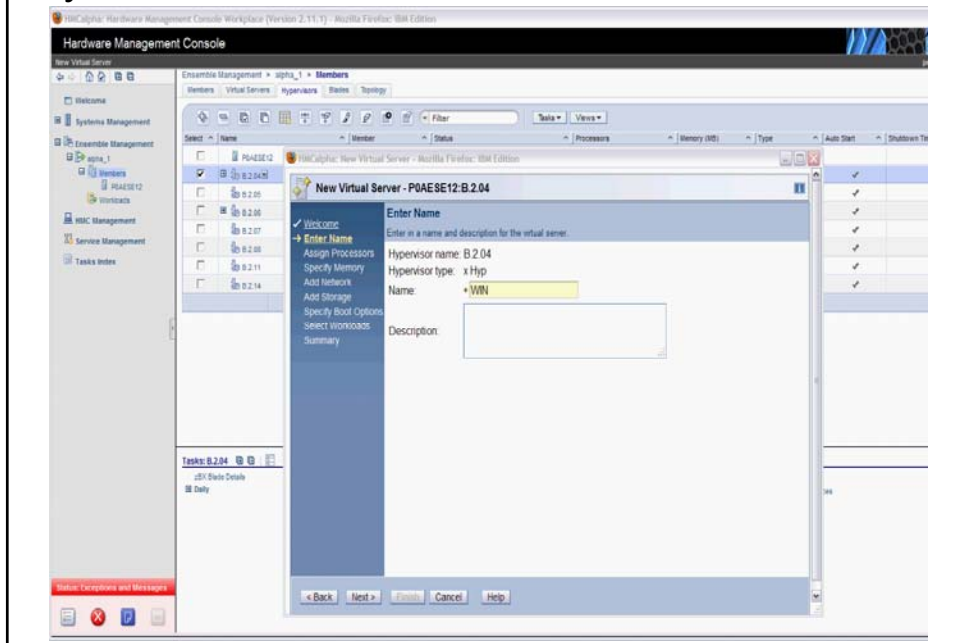
Putting zEnterprise System to the Task
Performance Management



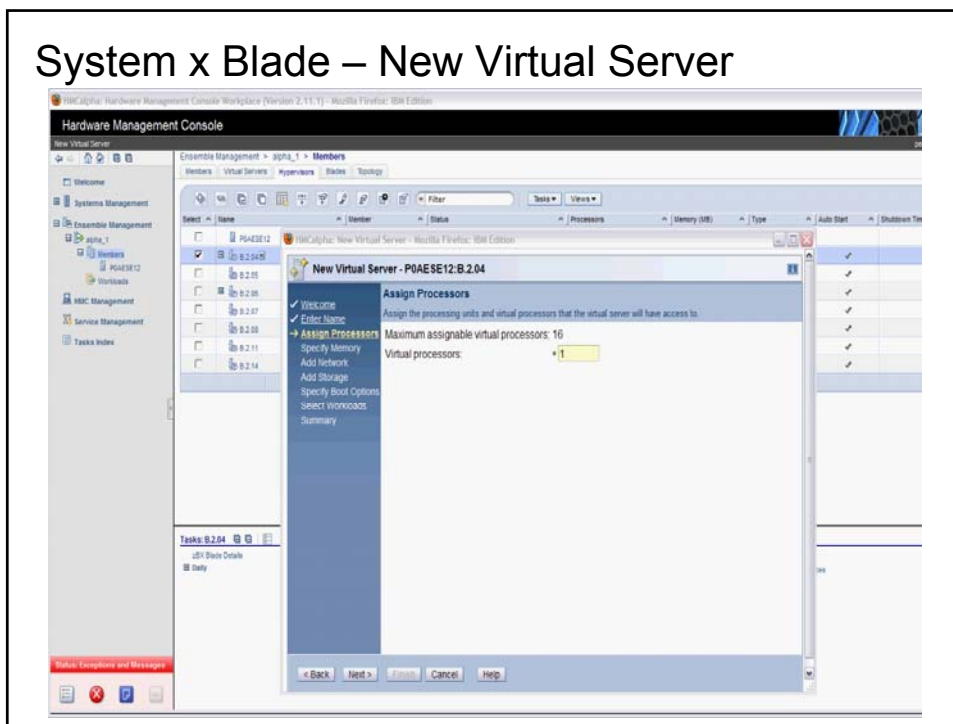
System x Blade – New Virtual Server



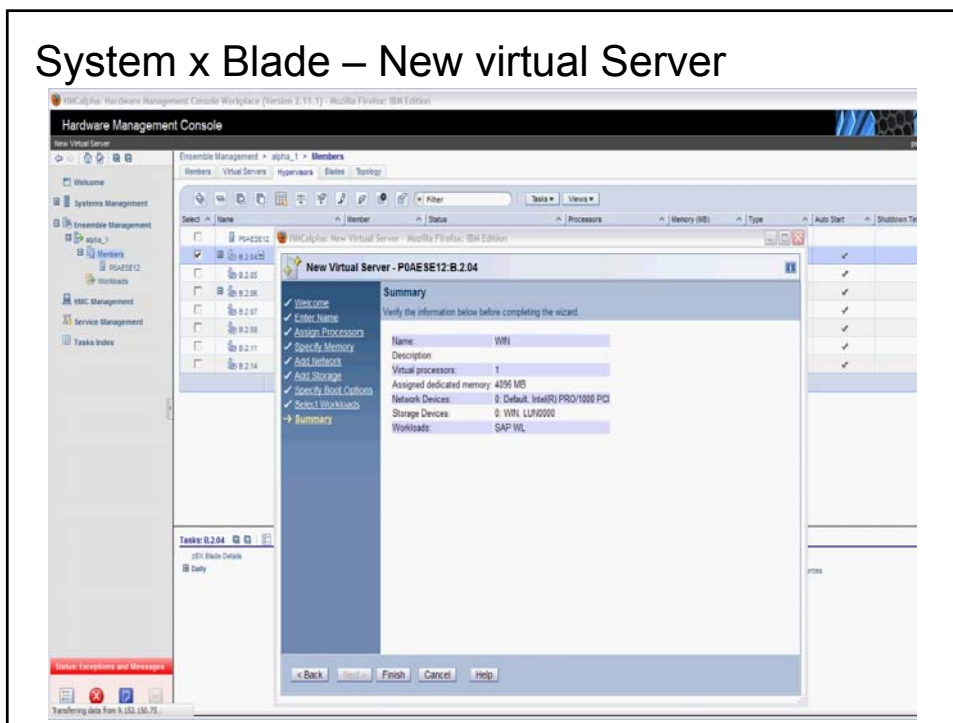
System x Blade – New Virtual Server



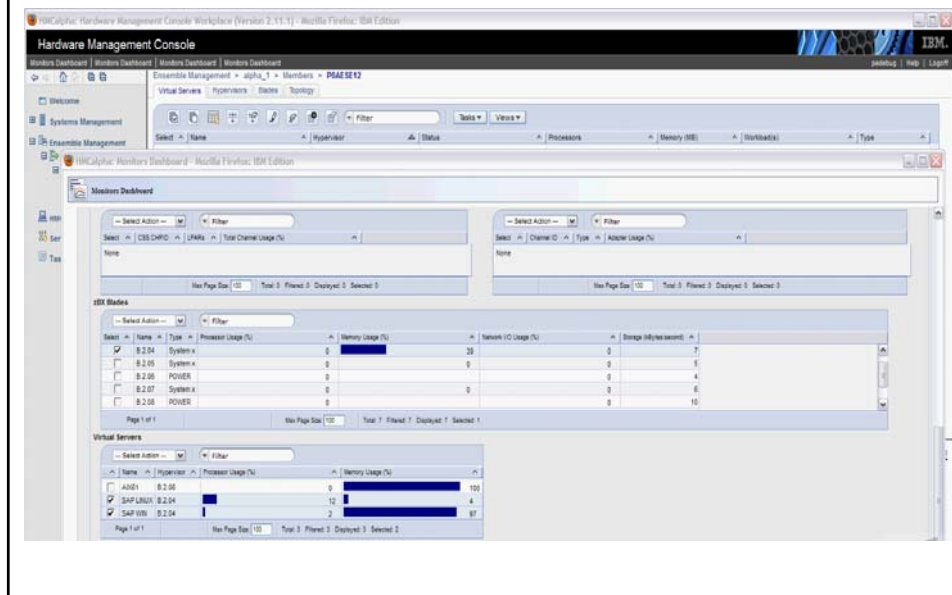
System x Blade – New Virtual Server



System x Blade – New virtual Server

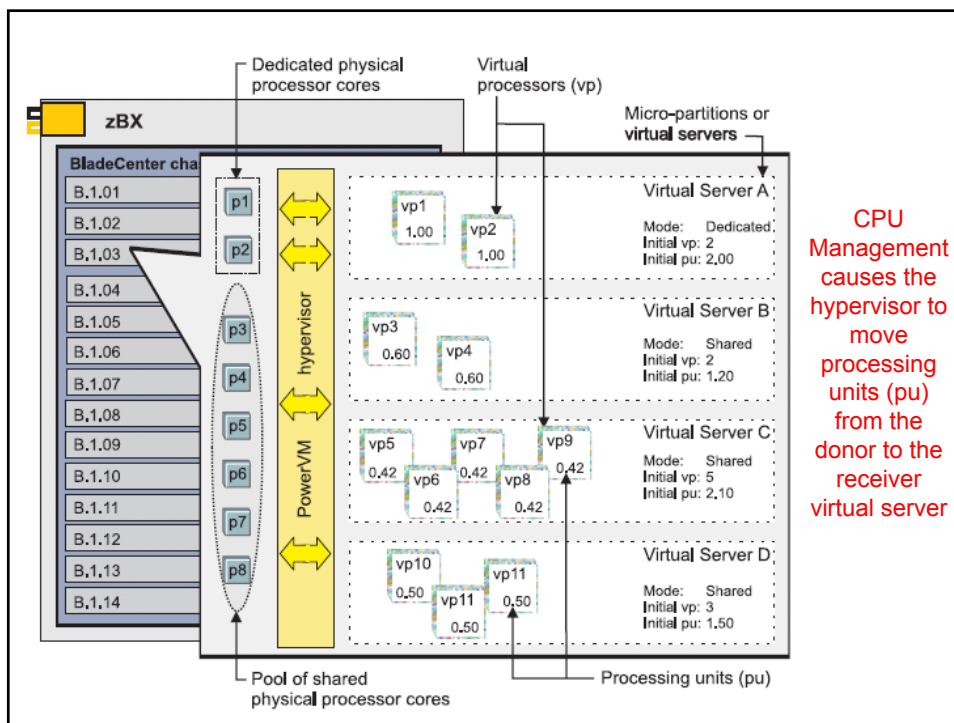
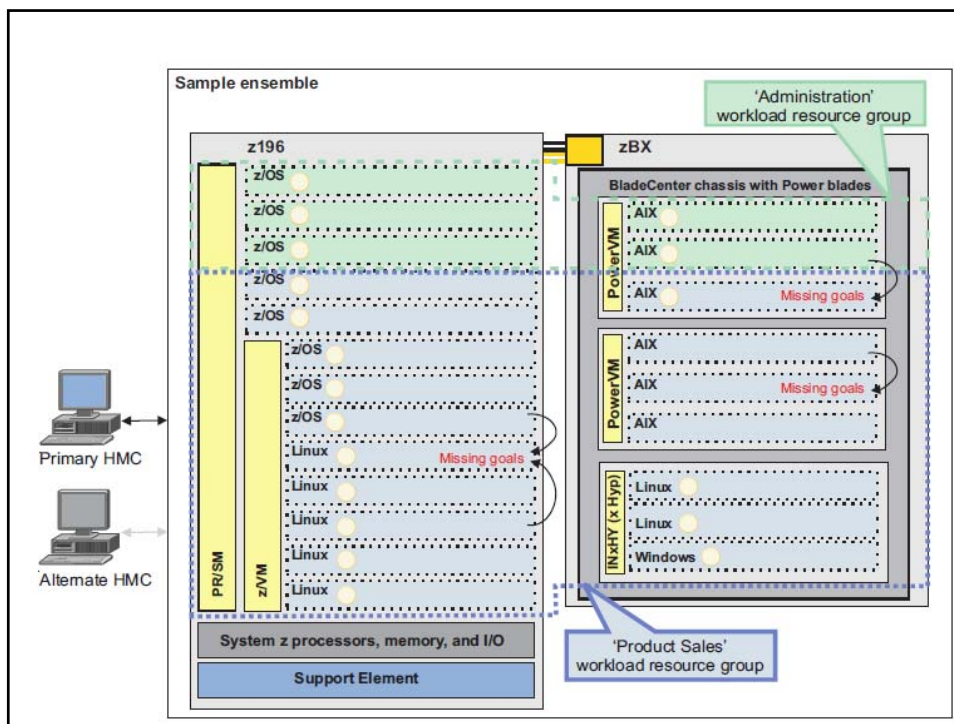


System x Blade – Monitors Dashboard

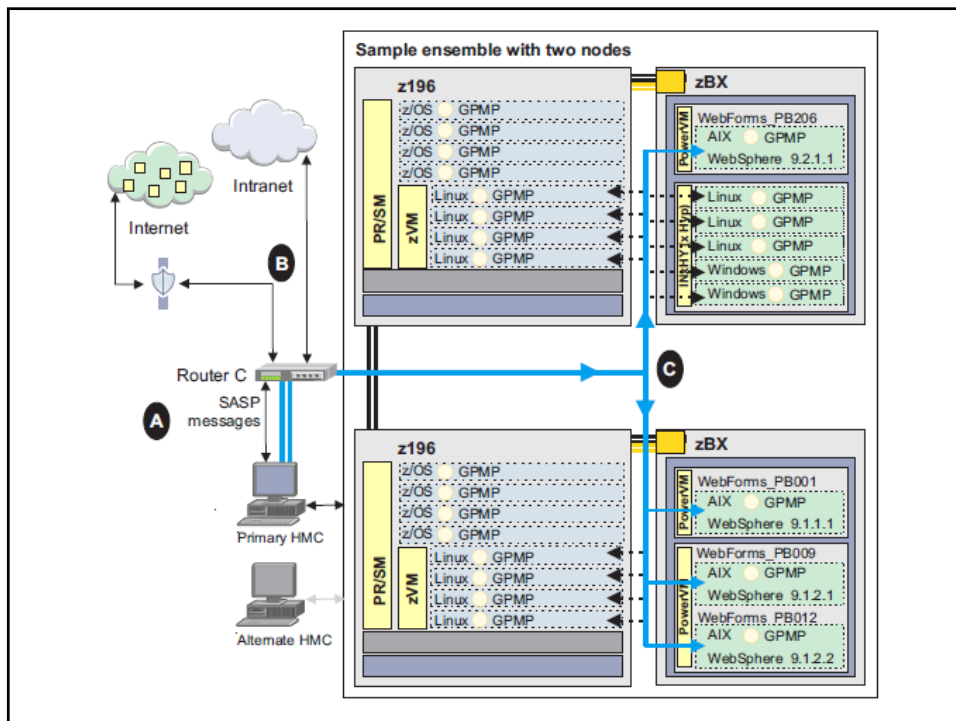
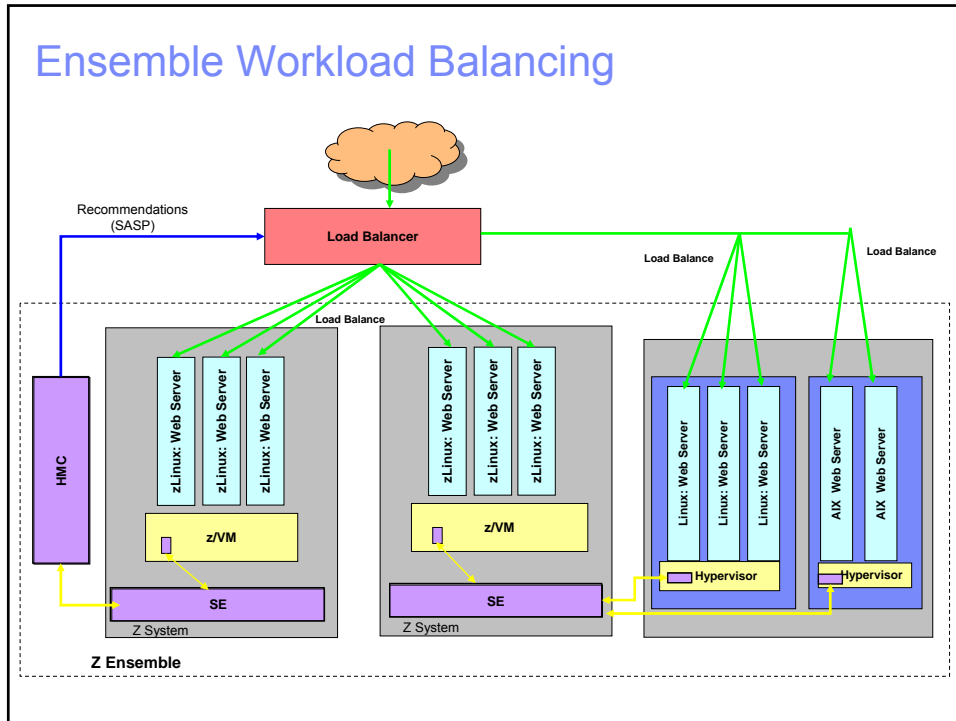


zManager CPU Resource Mgmt Function

- z/VM and PowerVM Hypervisors
 - Virtual Server CPU Management provides the ability to manage CPU resources across virtual servers based on a goal-oriented performance policy.
- System x (KVM based) Hypervisor
 - Does not currently participate in dynamic resource management
 - Statement of Direction (8/28/12): IBM intends to deliver workload-aware optimization for IBM System x blades in the zBX, allowing virtual CPU capacity to be adjusted automatically across virtual servers within a hypervisor
- PR/SM Hypervisor
 - Does not make resource management adjustments based on PPM Policy. Only IRD dynamically influences the PR/SM hipervisor



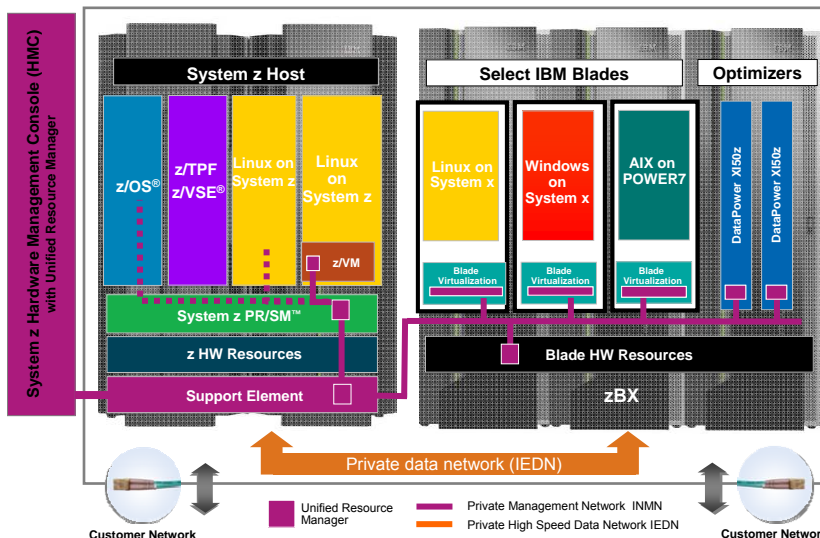
Ensemble Workload Balancing





Putting zEnterprise System to the Task

Use the smarter solution to improve your application design



© 2013 IBM Corporation



Please complete the evaluation for Session # 12948



© 2013 IBM Corporation



Trademarks

The following are trademarks of the International Business Machines Corporation in the United States and/or other countries.

AIX*	IBM (logo)*	System x*	z/OS*
BladeCenter*	Parallel Sysplex*	System z*	z/VM*
DataPower*	Power*	Tivoli*	z/VSE
GDPS*	POWER7*	WebSphere*	
IBM*	PowerVM	zEnterprise	
IBM eServer	PR/SM		

* Registered trademarks of IBM Corporation

The following are trademarks or registered trademarks of other companies.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.
 Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc. in the United States, other countries, or both and is used under license there from.
 Java and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.
 Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
 InfiniBand is a trademark and service mark of the InfiniBand Trade Association.
 Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.
 UNIX is a registered trademark of The Open Group in the United States and other countries.
 Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.
 ITIL is a registered trademark, and a registered community trademark of the Office of Government Commerce, and is registered in the U.S. Patent and Trademark Office.
 IT Infrastructure Library is a registered trademark of the Central Computer and Telecommunications Agency, which is now part of the Office of Government Commerce.

* All other products may be trademarks or registered trademarks of their respective companies.

Notes:

Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.
 IBM hardware products are manufactured from new parts, or new and serviceable used parts. Regardless, our warranty terms apply.
 All customer examples cited or described in this presentation are presented as illustrations of the manner in which some customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics will vary depending on individual customer configurations and conditions.
 This publication was produced in the United States. IBM may not offer the products, services or features discussed in this document in other countries, and the information may be subject to change without notice. Consult your local IBM business contact for information on the product or services available in your area.
 All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.
 Information about non-IBM products is obtained from the manufacturers of those products or their published announcements. IBM has not tested those products and cannot confirm the performance, compatibility, or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.
 Prices subject to change without notice. Contact your IBM representative or Business Partner for the most current pricing in your geography.