Andreas Bieswanger

STSM, System z Firmware Development & GreenIT

Energy Management for IBM zEnterprise™ 196

Session 8141

August 5, 2010

SHARE in Boston

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agenda

1	**zEnterprise Energy Efficiency Improvements**
2	**zEnterprise Energy Management Controls**
3	**Unified Resource Manager - Energy Monitoring and Management**
4	**IBM Energy Management Stack Integration**

Goals for energy management

Cost Reduction and Avoidance

- Identify opportunities for energy cost reduction *(Operating Expenses)*
  - *Reduce Over Provisioning*
- Delay facility expansion due to energy or cooling constraints *(Capital Expenses)*

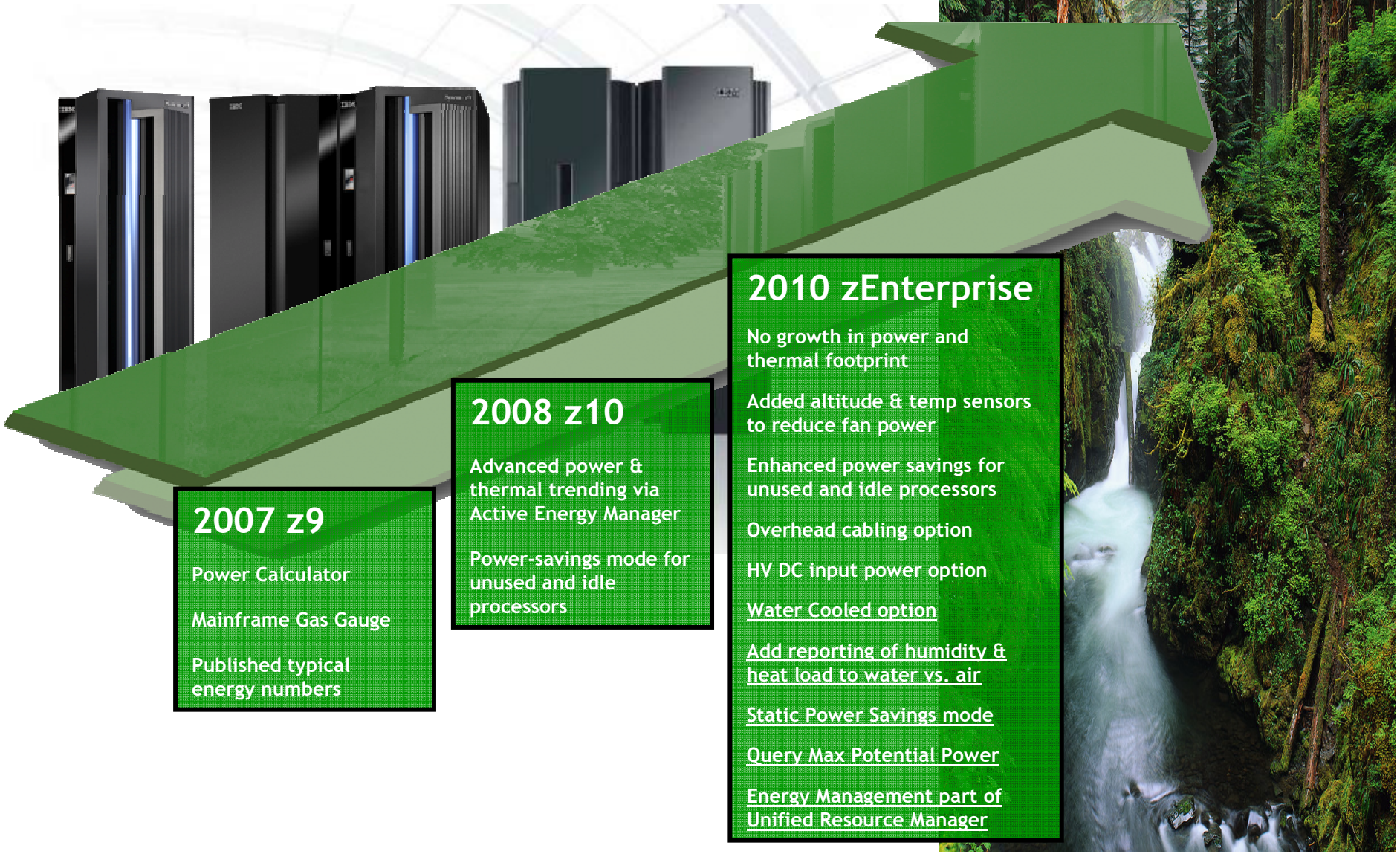
Remove Operational Barriers

- Manage power and cooling capacity to enable growth and flexibility
  - Power Control (Capping, Power Saving)
- Avoid service disruptions caused by energy related outages
  - Identification and reaction to Energy Fault Events

Manage Risk and Streamline Compliance

- Document and validate energy efficiency gains to stakeholders

System z Energy Efficiency Roadmap



2007 z9

Power Calculator

Mainframe Gas Gauge

Published typical energy numbers

2008 z10

Advanced power & thermal trending via Active Energy Manager

Power-savings mode for unused and idle processors

2010 zEnterprise

No growth in power and thermal footprint

Added altitude & temp sensors to reduce fan power

Enhanced power savings for unused and idle processors

Overhead cabling option

HV DC input power option

Water Cooled option

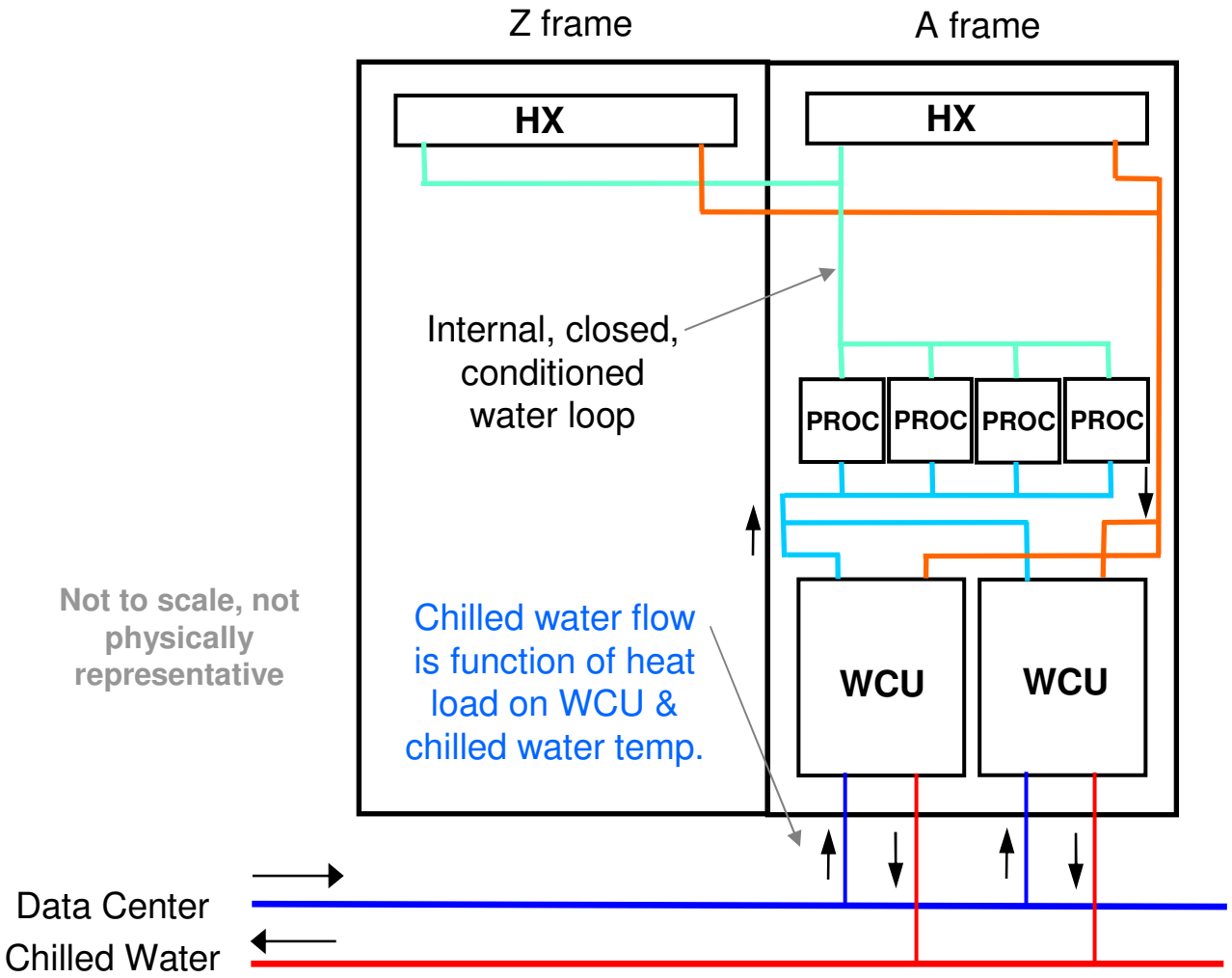
Add reporting of humidity & heat load to water vs. air

Static Power Savings mode

Query Max Potential Power

Energy Management part of Unified Resource Manager

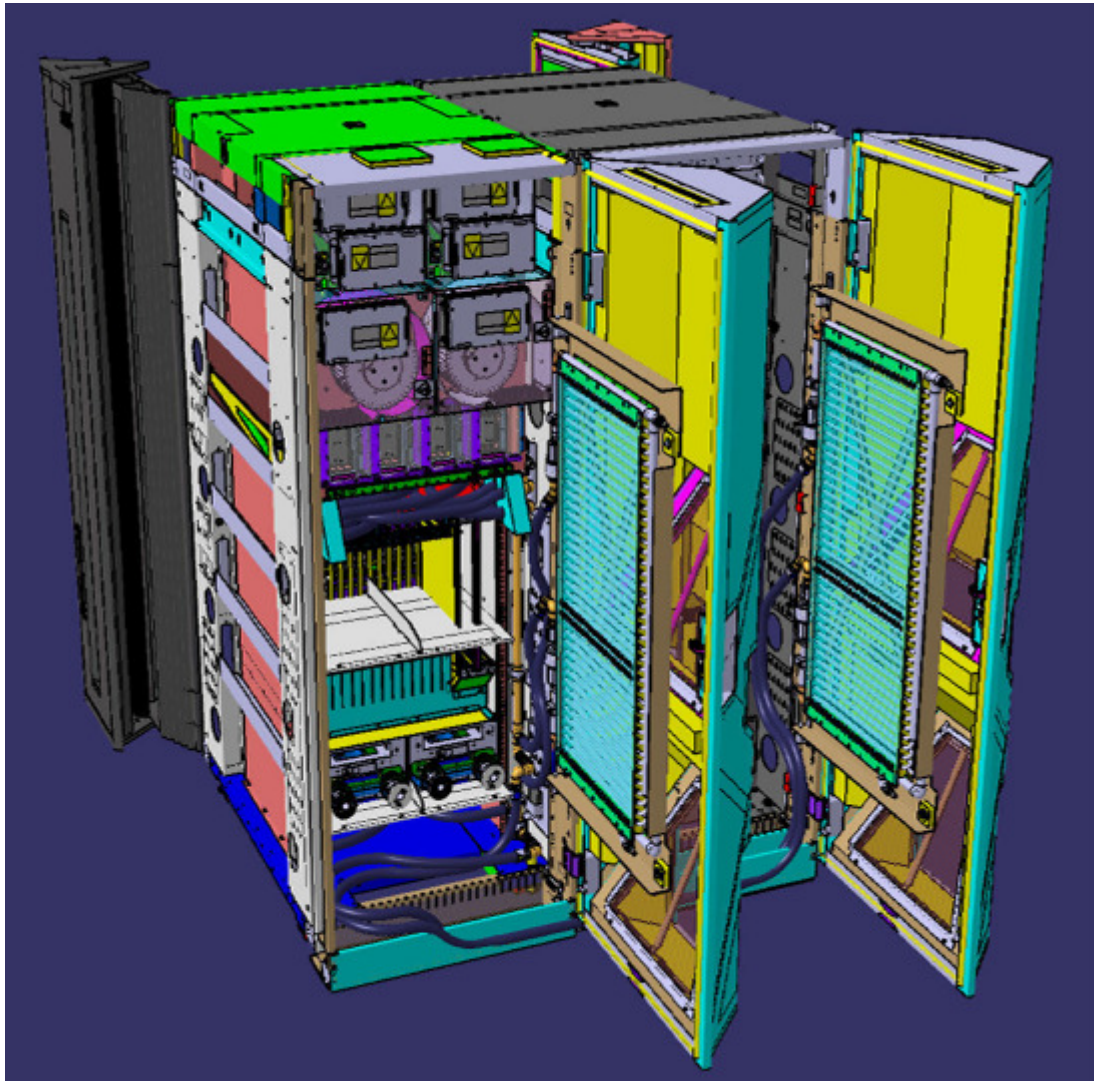
z196 Water Cooling Option



- **Water cooled cold plate on processor MCM in each processor book**
- **2N Water Conditioning Unit (WCU) with independent chilled water connections**
- **One WCU can support system**
- **Heat Exchanger (HX) removes heat from exhaust air at back of both frames**
- **Typically ~70% of system heat load is removed to water.**
- **Air cooling back-up mode for maximum robustness (all heat load to air if lose chilled water in to WCU's)**

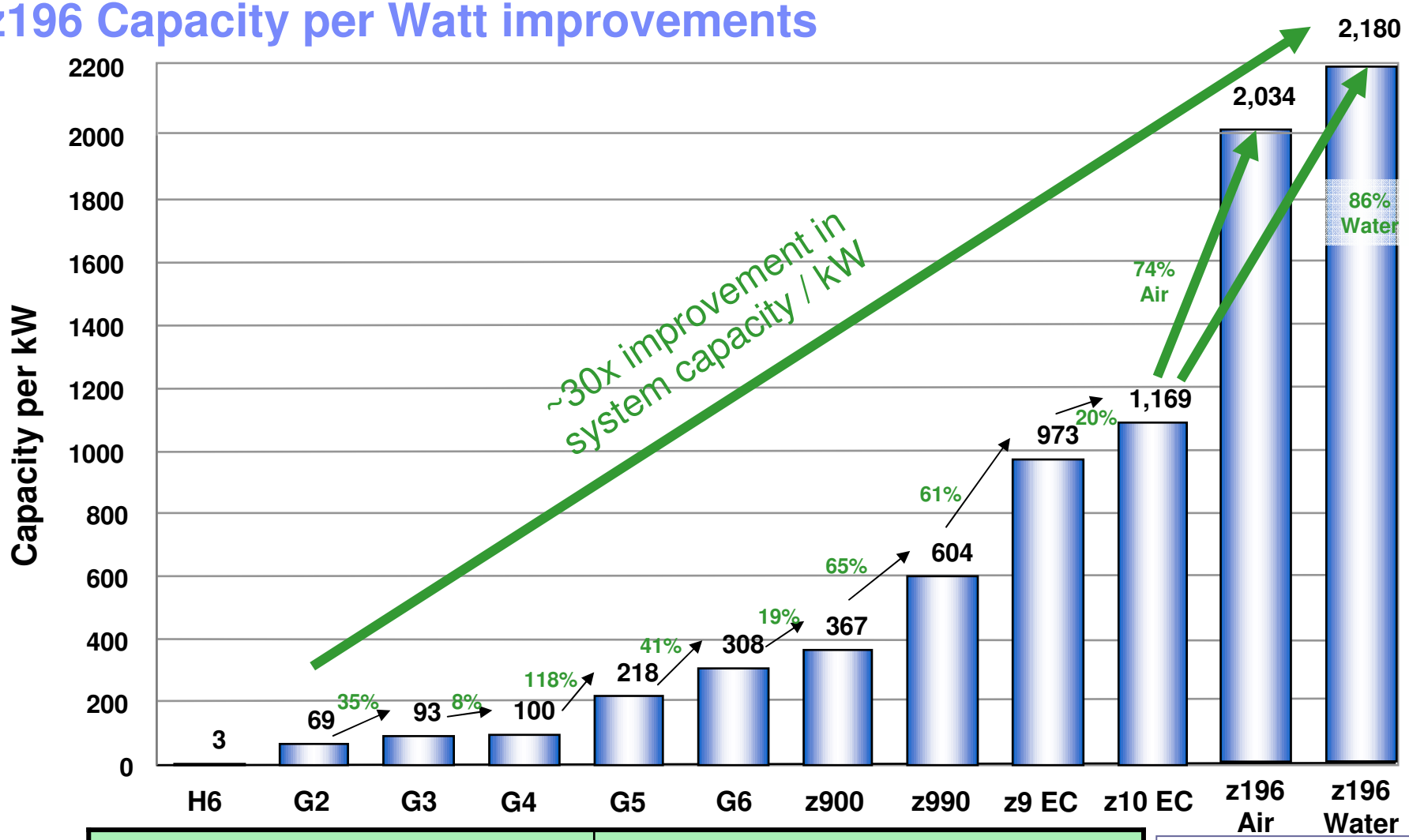
2N building chilled water lines will have better RAS – single facility supply/return shown here.

zEnterprise Water Cooling Option



- Reduce max air heat load to less than 10 kW (about 5 kW typical)
- Input energy saving 2 kW
- Additional power saving in data center typically about 3 kW
  (water cooling efficiency higher than air cooling efficiency)

z196 Capacity per Watt improvements



15 years of CMOS: G2 to z196 *		Net Effect: G2 to z196 *	
Power Increase:	**17%** per year	Performance increased by:	**~300x**
Performance increase:	**46%** per year	**Performance / kWatt increased by:**	**~30x**
Power density increase:	**13%** per year	Performance / sq ft increased by:	**~190x**

Note: Capacity/kWatt assumes hot room, max plugged I/O power, max memory power and all engines turned on. Real world max capacity system is about 3/4 of this.

Note: z196 data is not final, numbers are best available as of 7/22/2010

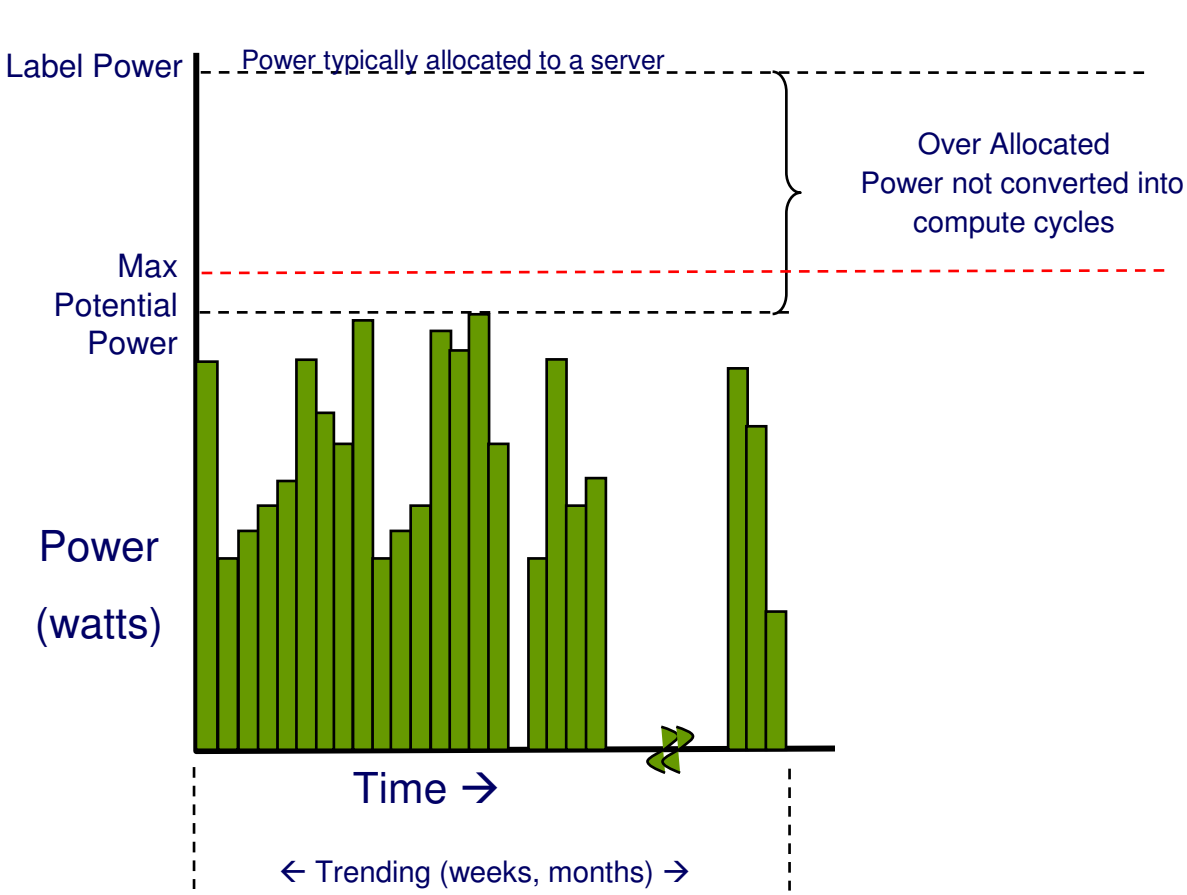
Static Power Saving Mode

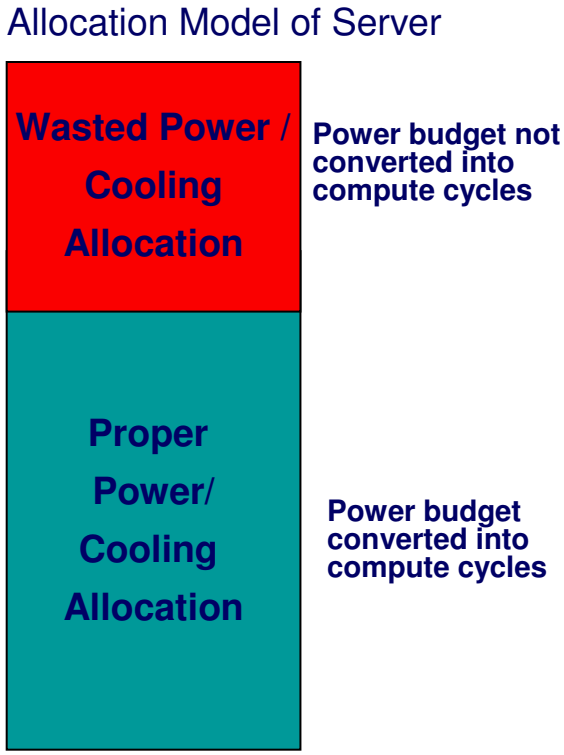
- **Main use cases**
  - Periods of low utilization
  - CBU Systems: Systems used for disaster recovery
- **Base mechanism**
  - Build upon existing RAS functions (frequency/voltage variation) implemented originally for MRU failures (since z900)
  - Use frequency and voltage reduction to reduce energy consumption of CEC
  - Only explicitly triggered by customer. No autonomic changes done “under the cover”
- **Power Savings Mode expectations**
  - Frequency reduction: ~ 17%
  - Processor voltage reduction: ~ 9% voltage reduction
  - Expected system power savings: ~ 10%-20% power savings (configuration dependent)
- For air-cooled systems entering power save is limited to once a day.
- Update to “**STSI: SYSIB 1.2.1 (Basic-Machine CPU) Performance-Reduction Indicator**” to reflect entering and leaving power save mode

Max Potential Power

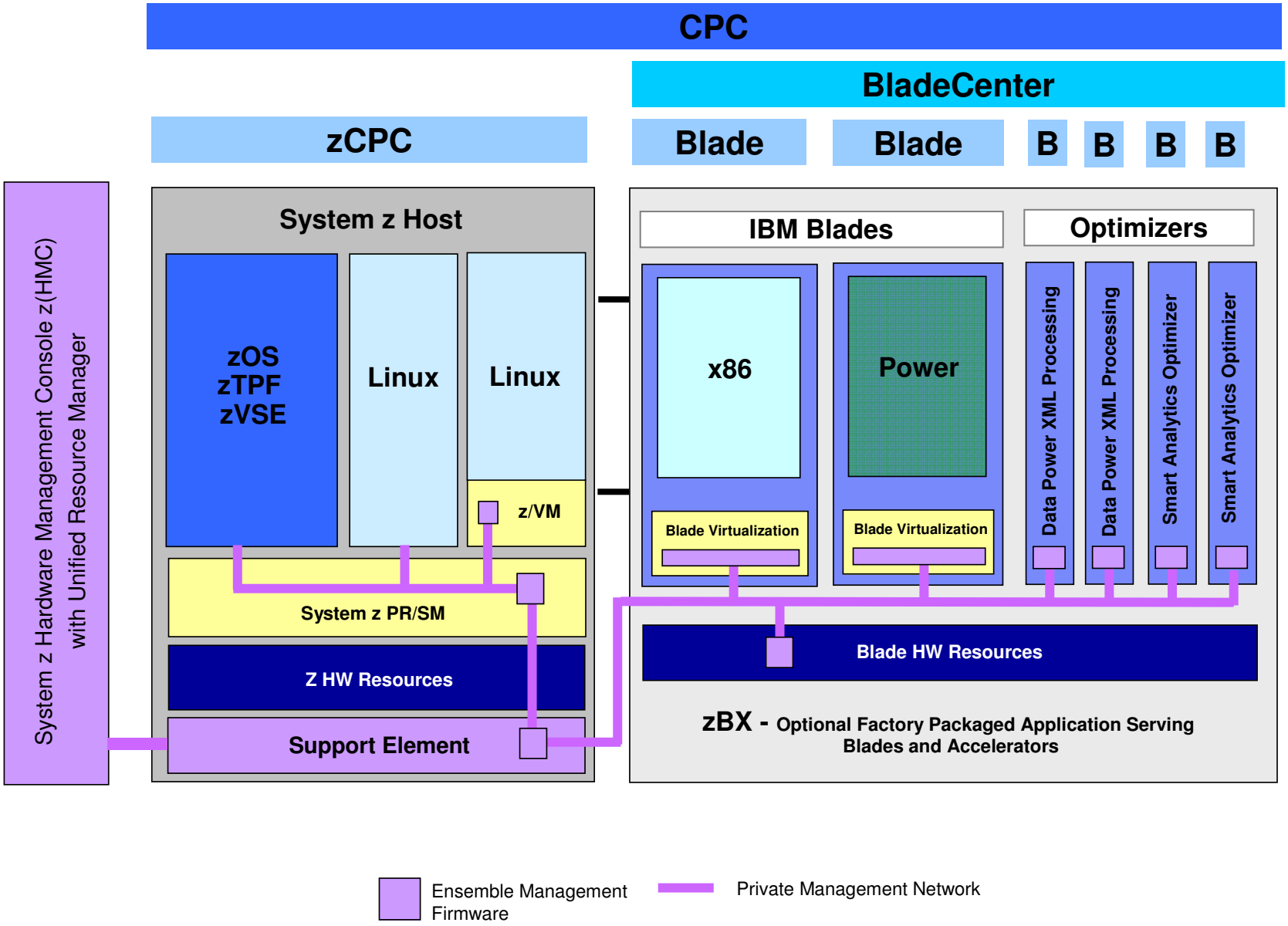
- **Main use cases**
  - Allows reducing power allocation for system since you know the maximum power system can draw even with faults and hot room
  - Allows facility and system people without knowledge of z system configuration and use details to query max possible power of system
  - Looks like power capping to higher level management tools
- **Base mechanism: Calculation of max potential power based on**
  - System configuration
  - Altitude (absolute pressure sensors in bulk power subsystem)
  - Hot room environment
  - Highest single fault service scenario power condition for this configuration
  - Reasonable tolerances
- **Max Potential Power should be used in conjunction with the System z Power Estimation Tool which allows pre-planning for power and cooling needs**

Optimize Power/Cooling Allocation with Max Potential Power





zEnterprise with zBX (z Blade Extension)



Animation

… value made possible by the Unified Resource Manager

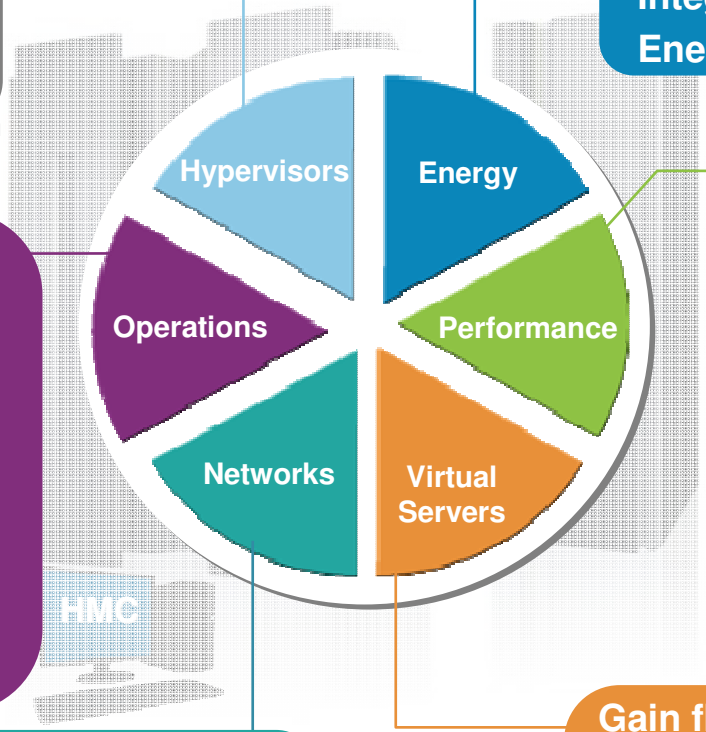
Simplified installation of hypervisors

Gain significant time to market with improved speed of deployment

Insight into energy consumption and environmental data

Integrated energy management

Energy cost savings



Save time, cost and simplify asset management

Decrease problem determination and resolution time for cross-platform resources

Improve and simplify cross-platform availability procedures

Enable broader and more granular view of resource consumption

Allow critical workloads to receive resources and priority based on goal-oriented policies established by business requirements

Smart business adjustments based on workload insight

Provide deep insight into how IT resources are being used

Factory installed and configured network

Improved network security with lower latency, less complexity, no encryption/decryption

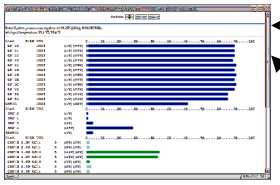
Gain flexibility, consistency and uniformity of virtualization

Provide the business with faster time to market

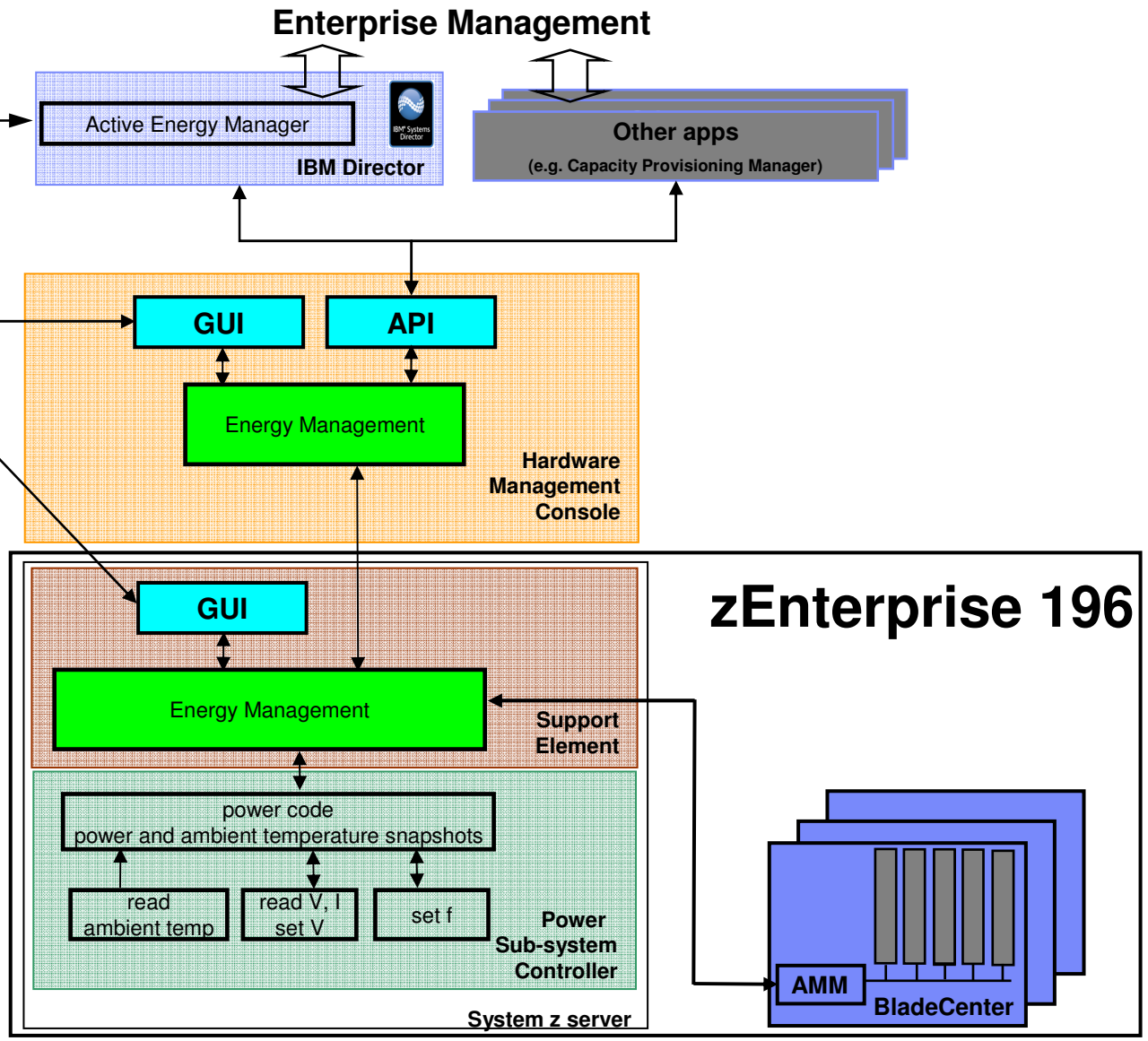
Simplified network management for applications

zEnterprise Energy Management Structure

Active Energy Manager



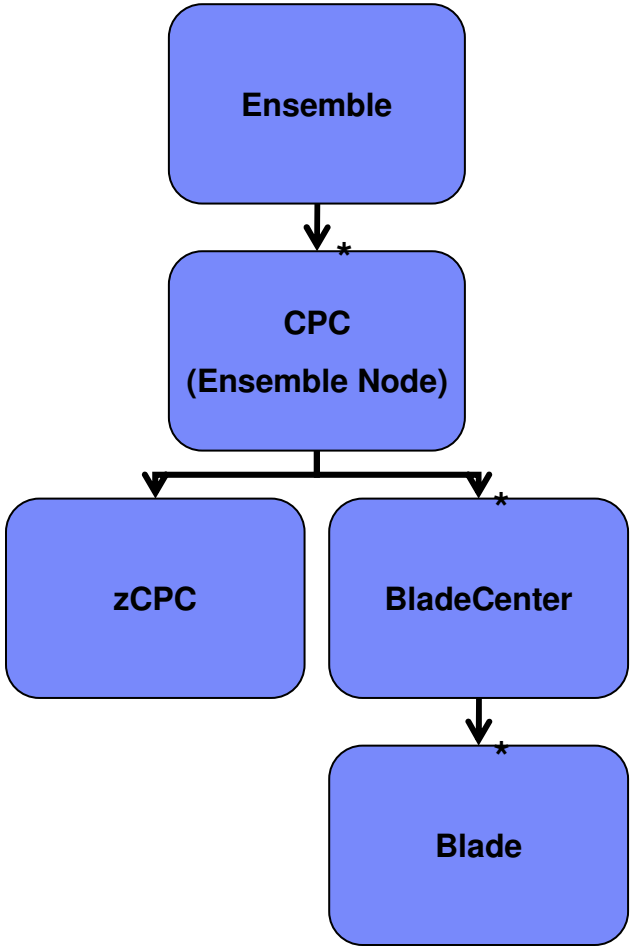
HMC/SE Energy Monitoring Dashboard



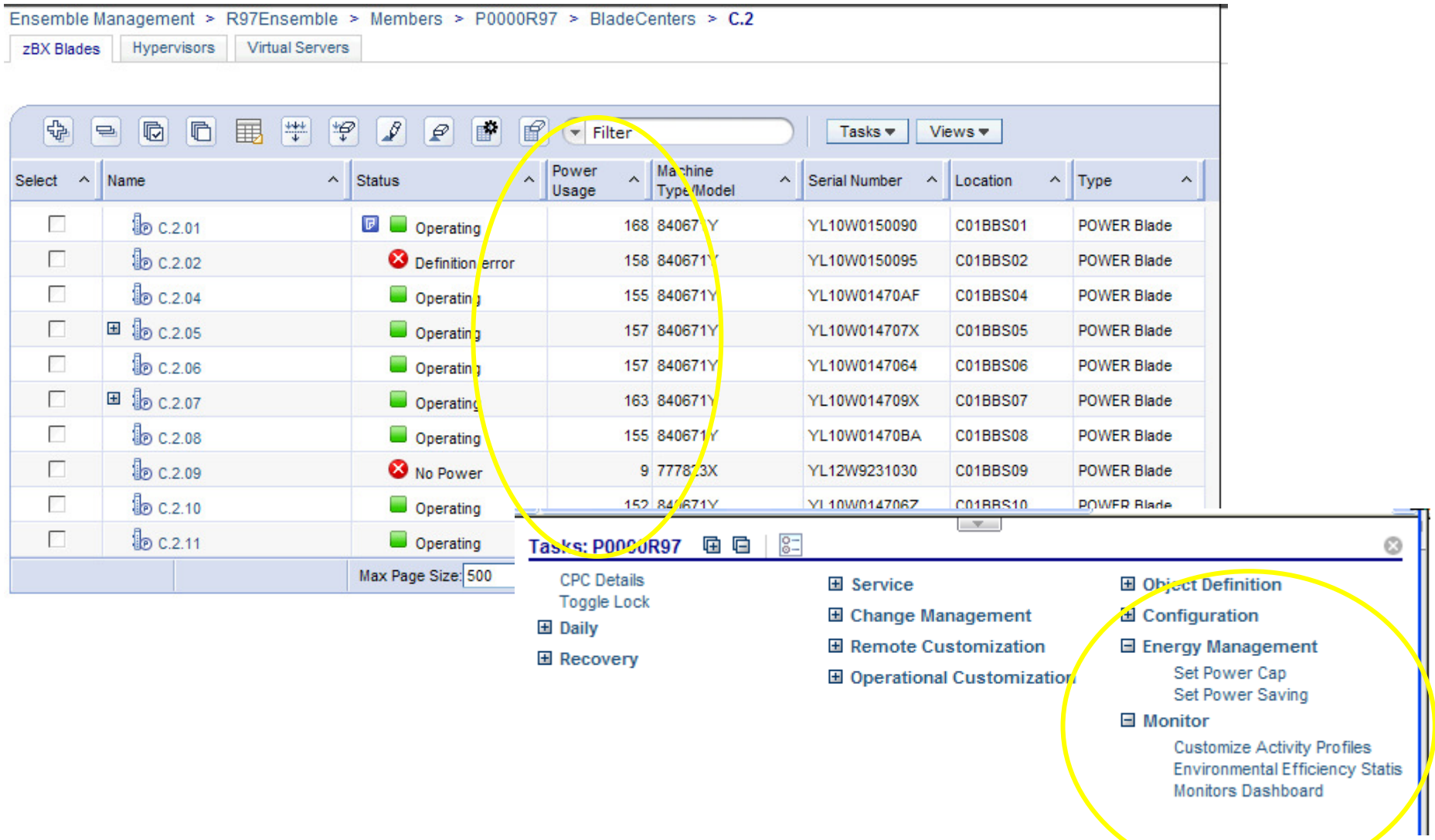
Energy Monitoring Overview

Monitoring data available at

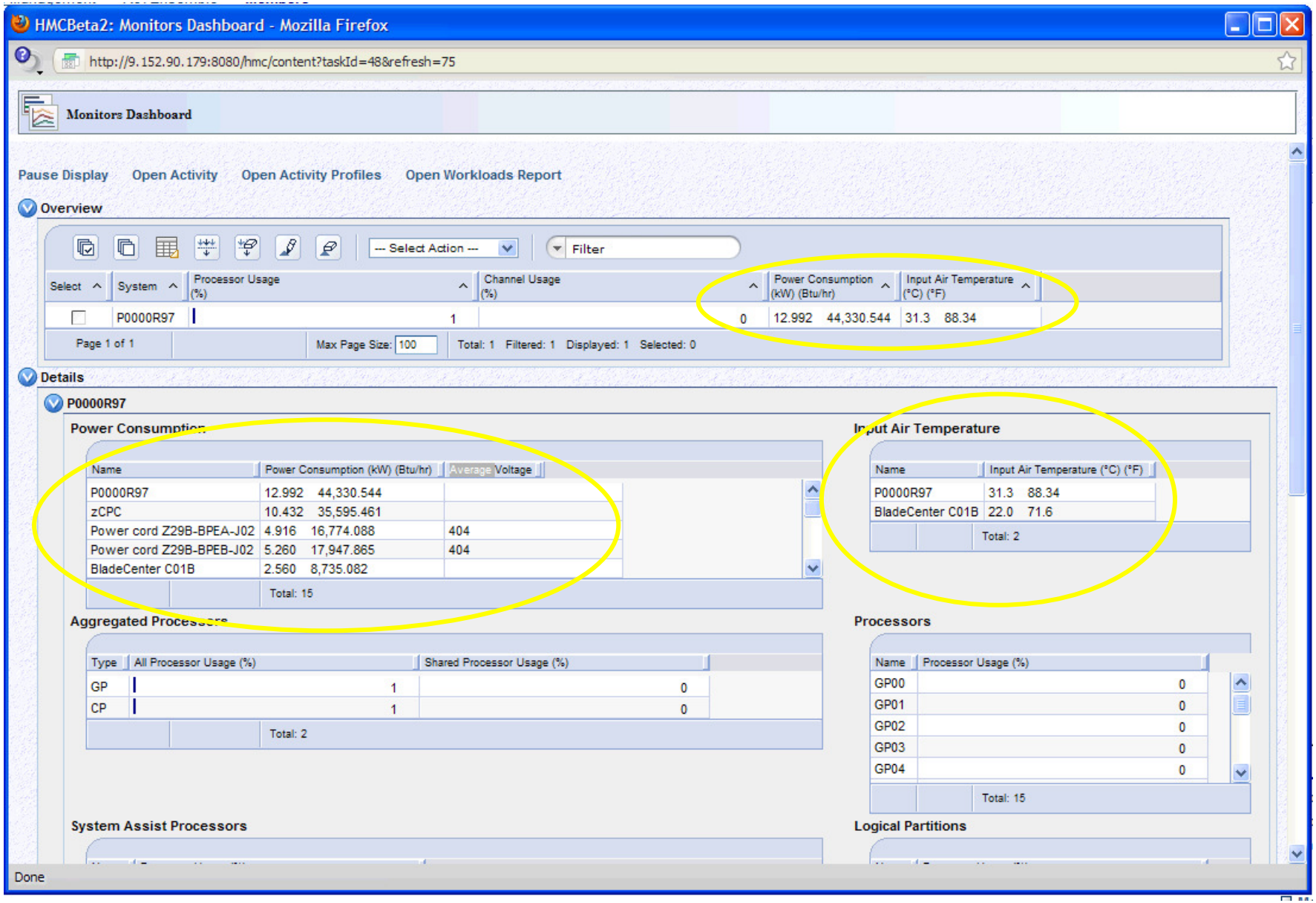
- Main HMC UI
- Monitors Dashboard
- Environmental Efficiency Statistics
- More detailed data for shown for
  - **Blade,**
    - Energy and environmental data
    - Active energy controls
  - **BladeCenter**
    - Aggregated energy and environmental data
    - Active energy controls
  - **zCPC**
    - Energy and environmental data
    - Active energy controls
    - Max potential power
  - **CPC**
    - Aggregated energy and environmental data
    - Active energy controls
  - **Ensemble**
    - Aggregated energy data



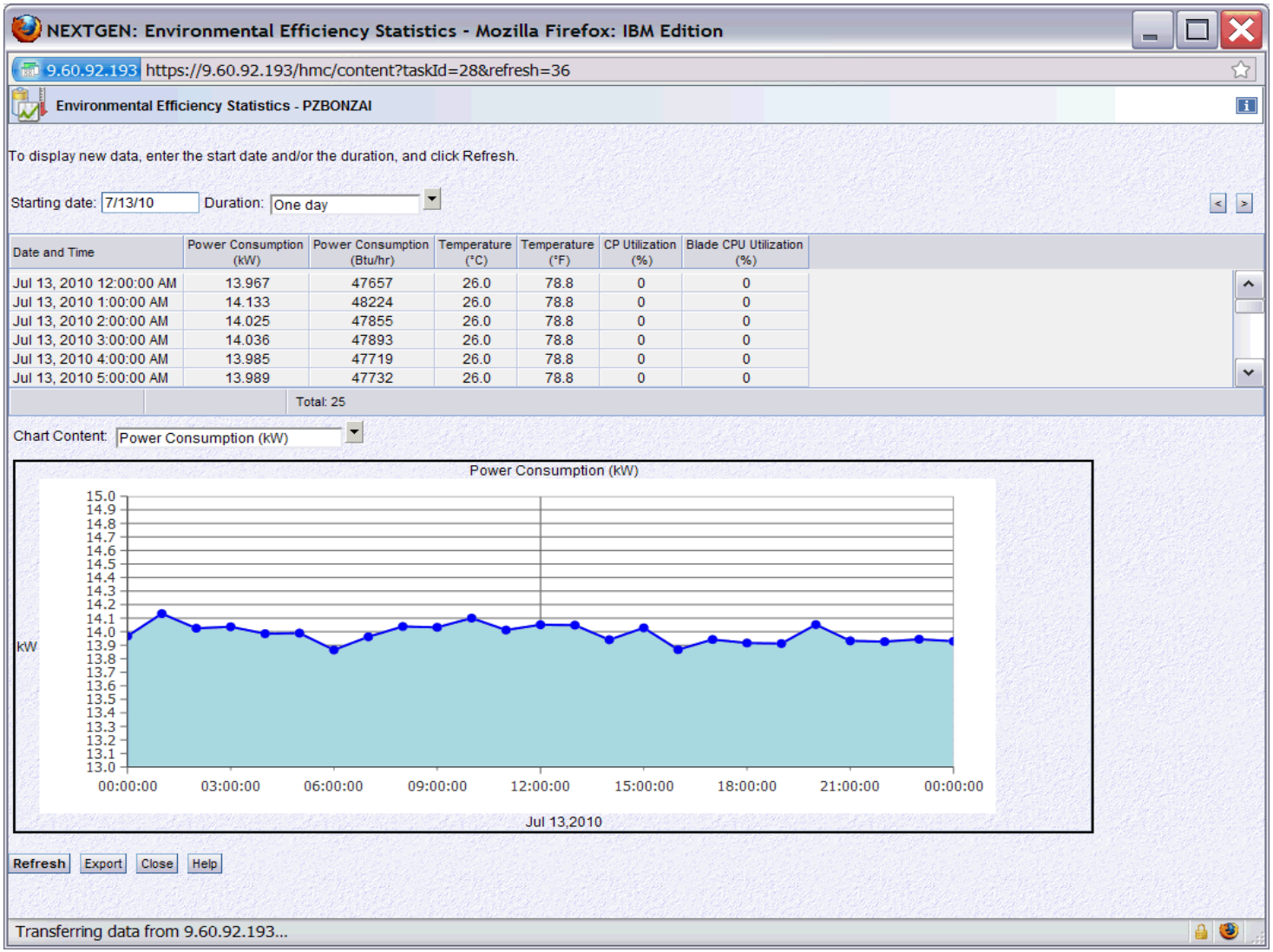
Energy Information at the Main HMC UI



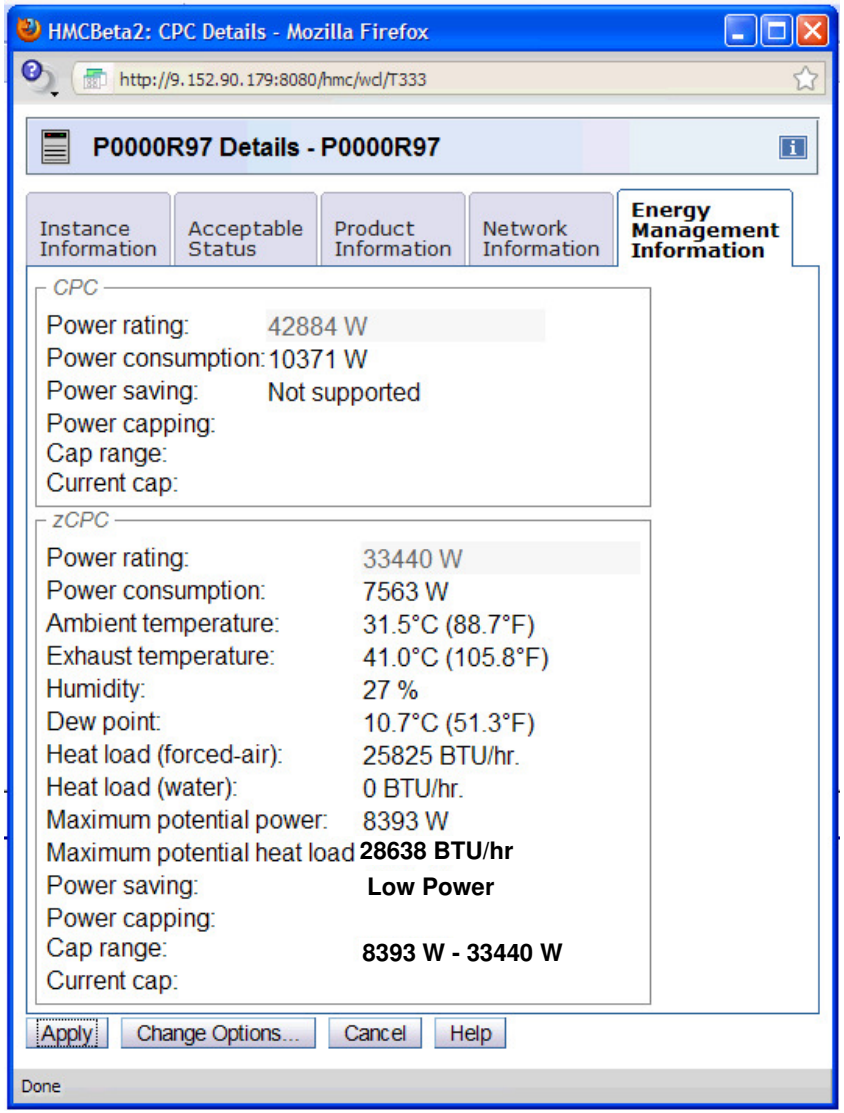
zEnterprise Monitors Dashboard



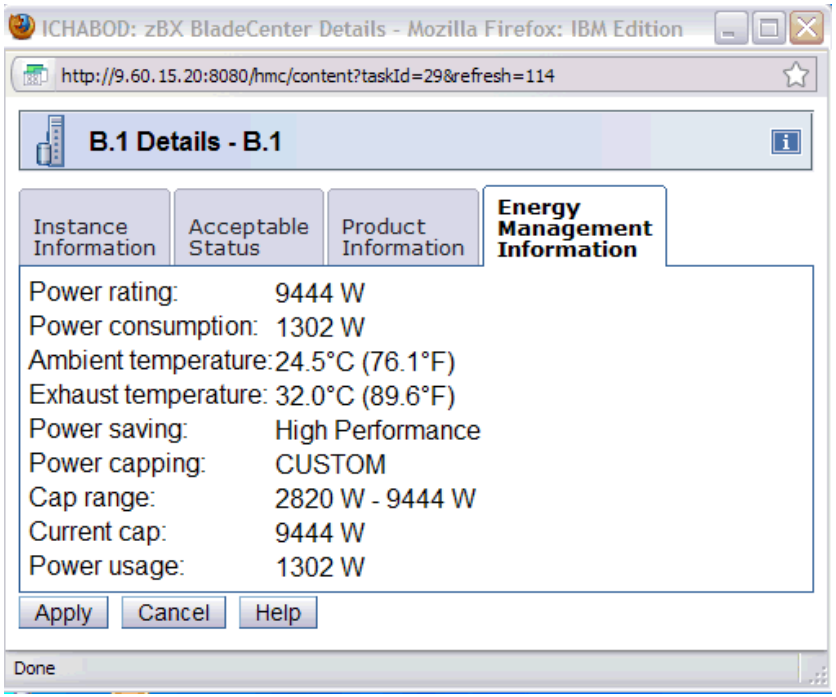
Environmental Efficiency Statistics

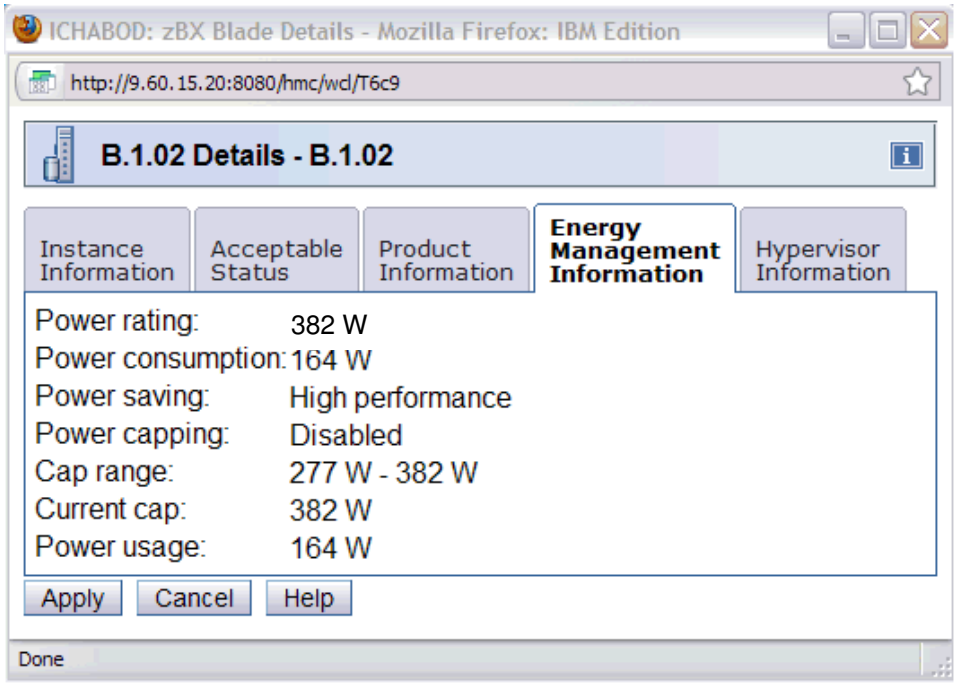


Energy Management Information - CPC and zCPC

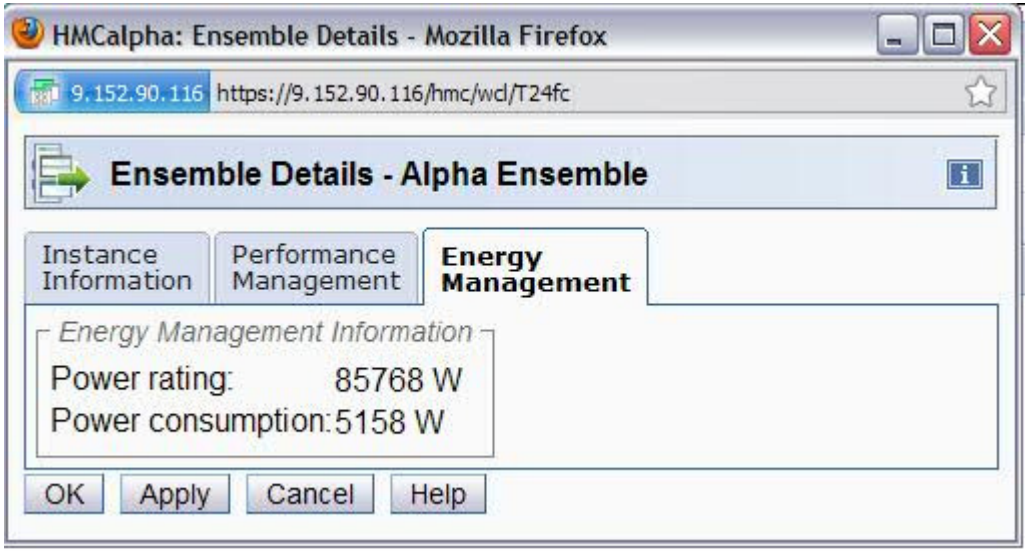


Energy Management Information - BladeCenter and Blade



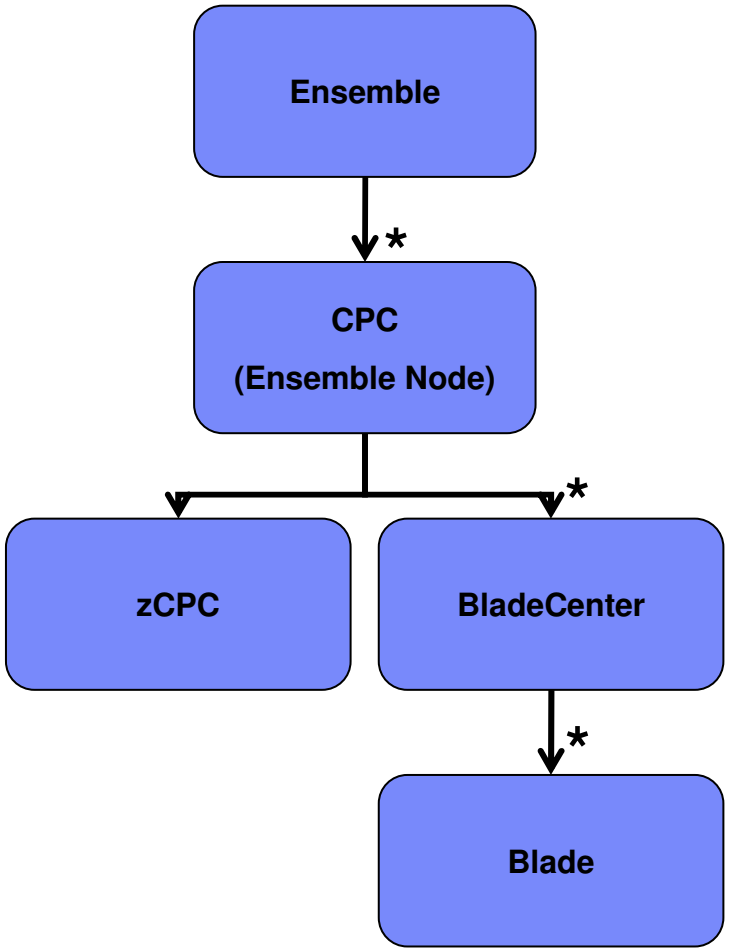


Energy Management Information - Ensemble

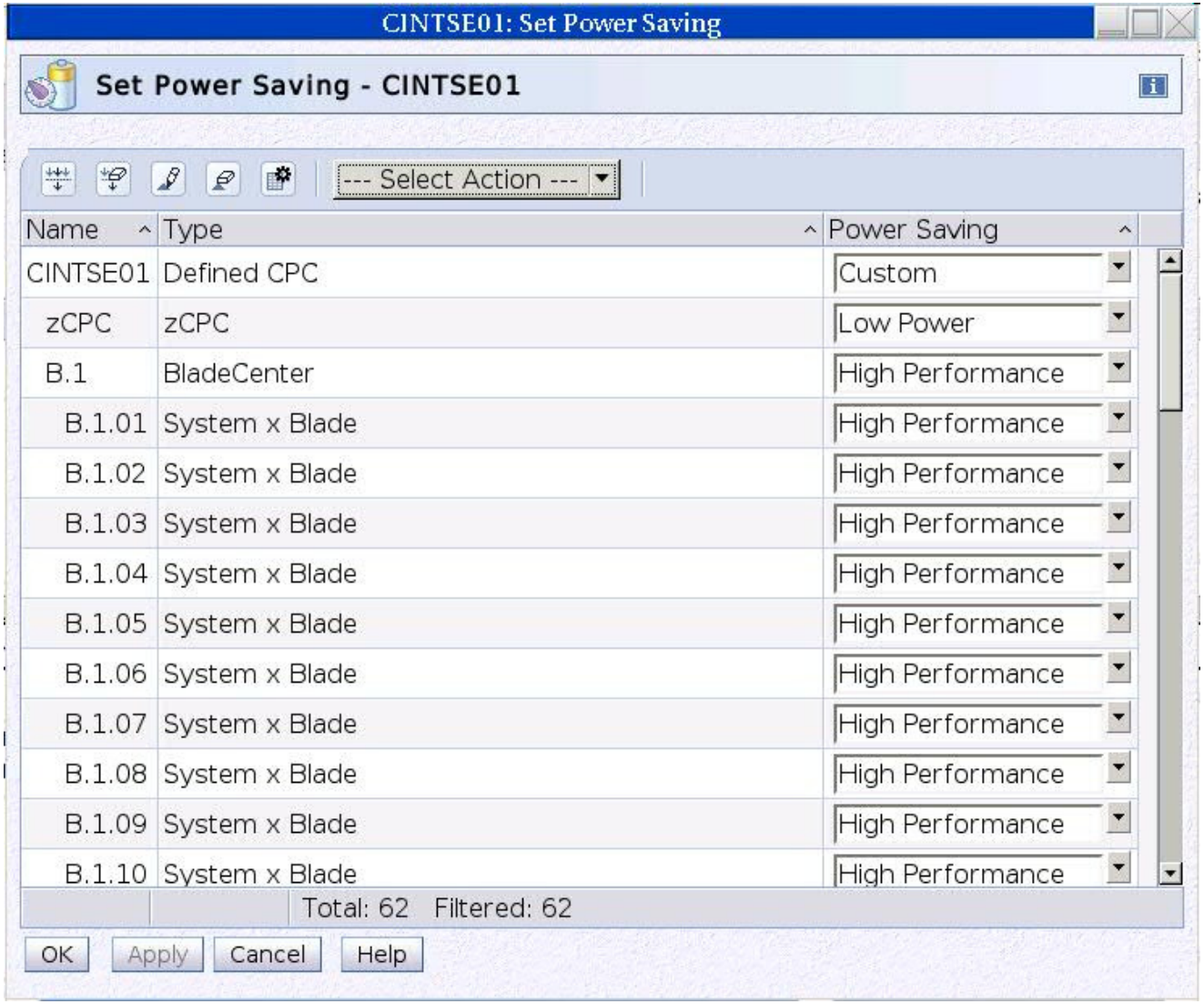


Energy Controls Overview

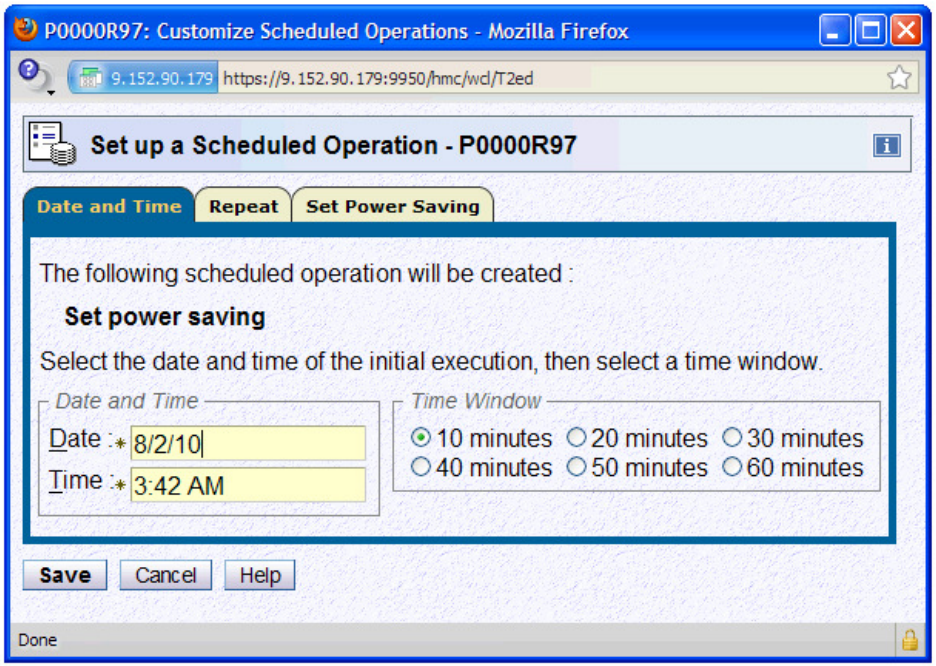
- zCPC
  - Power Save
- Blade
  - Blade power save
    for all blades supporting power savings mode
  - Blade power cap
- BladeCenter
  - BladeCenter group power save
    Ensure that all elements in a group (that support it) are in power save or high performance state.
  - BladeCenter group power cap
    Ensures that the group power consumption stays at or below the maximum value specified in the group cap using automatic power budget distribution.
- CPC
  - CPC group power save
  - CPC group power cap

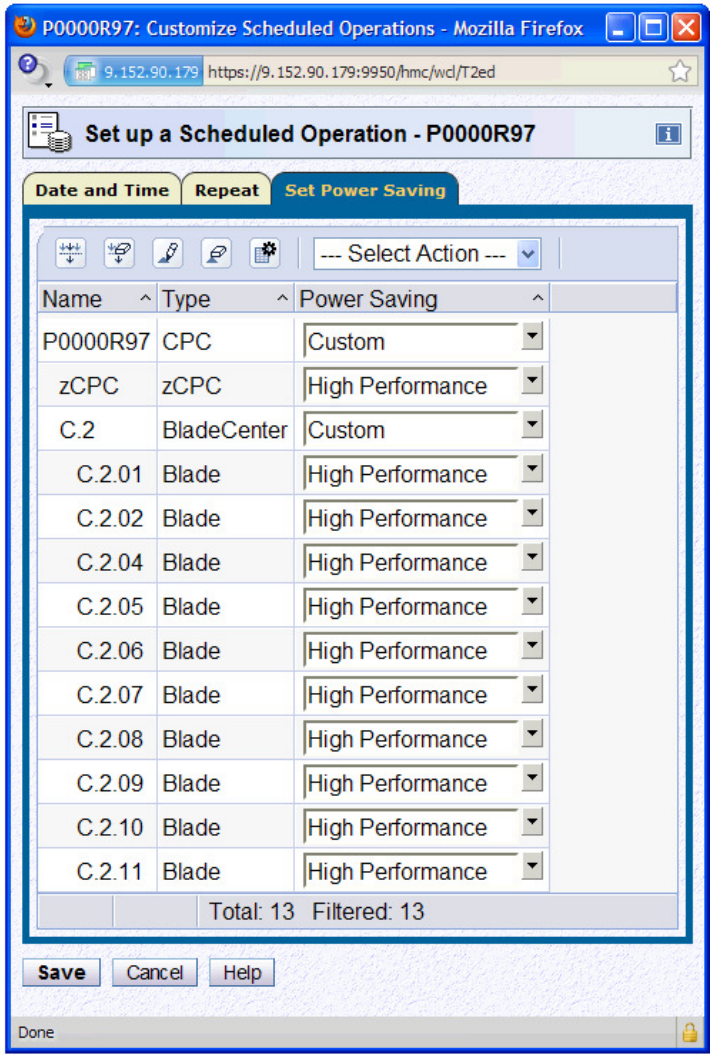


Set Power Saving Task

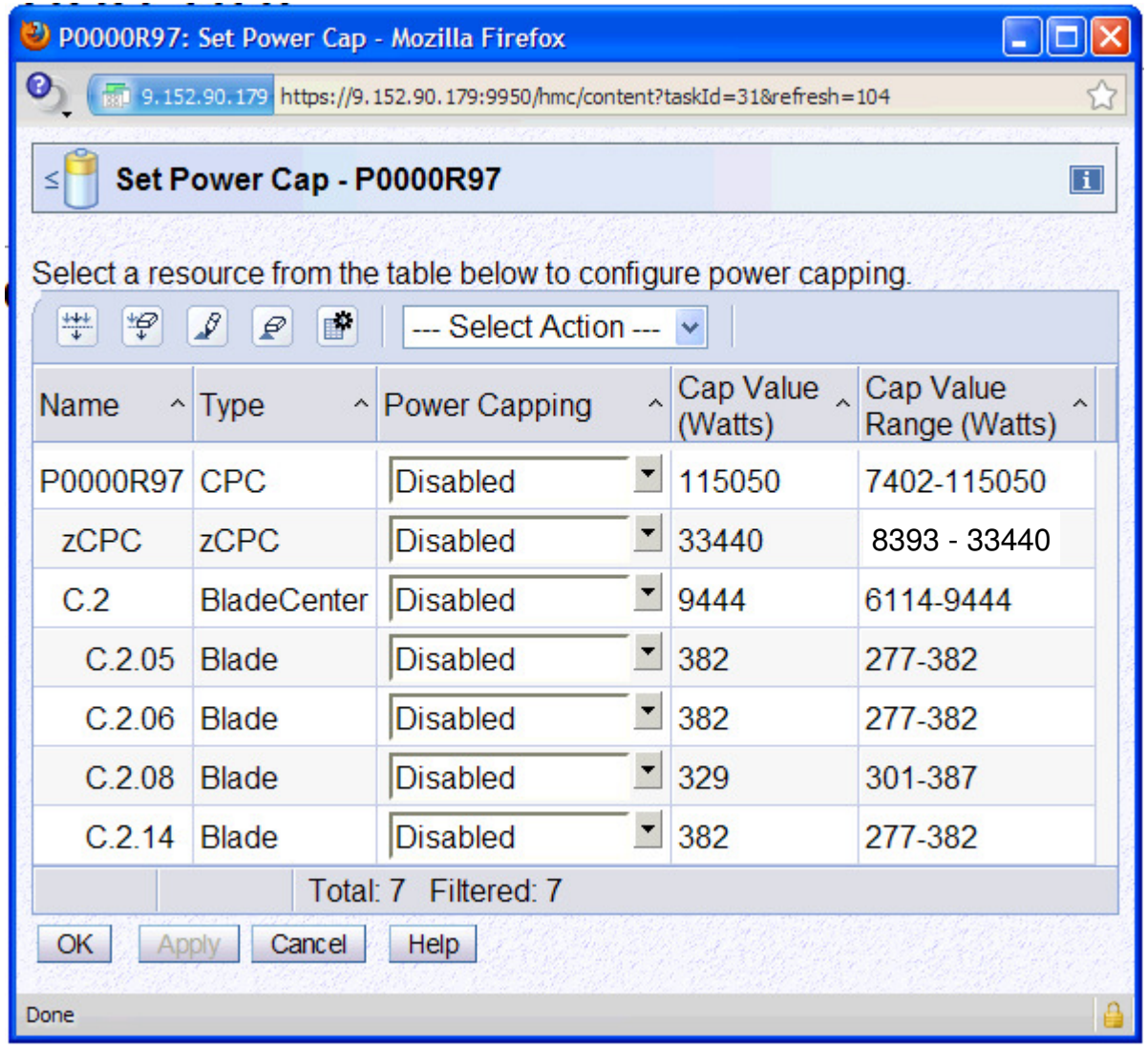


Energy Management Automation



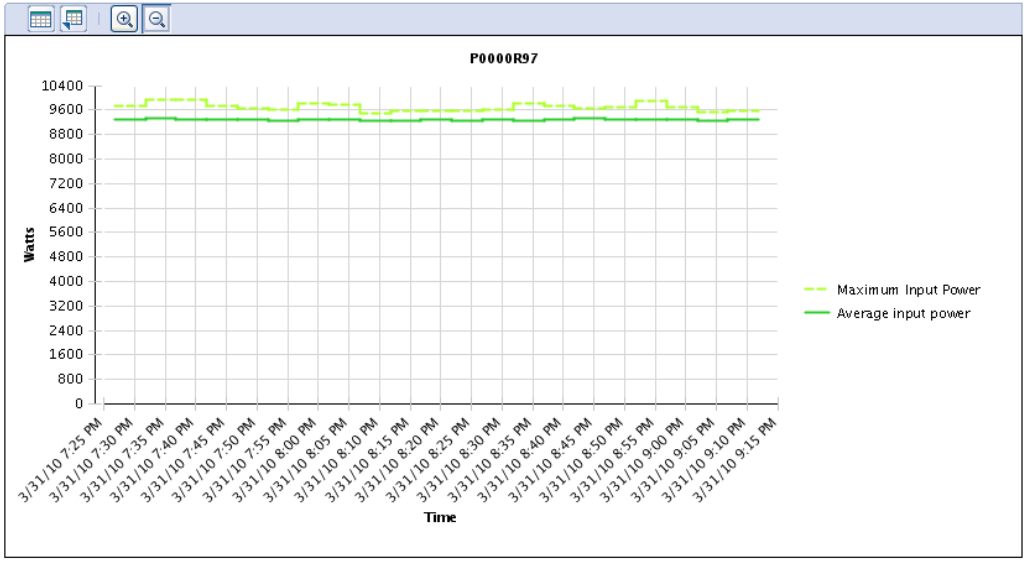


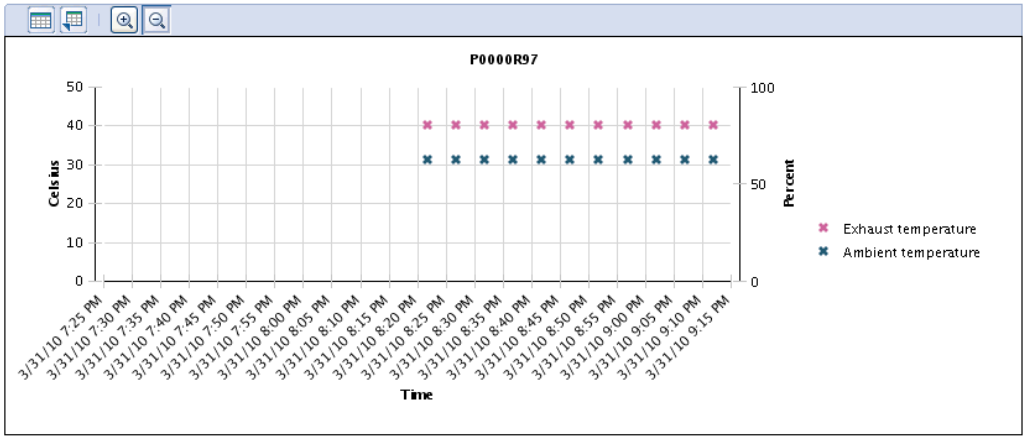
Set Power Cap



Active Energy Manager Integration

- IBM System Director Active Energy Manager is an advanced energy manager provided through IBM Systems Director
- AEM monitors, measures and controls energy usage at the data center level
- Support across a large spectrum of IBM and non-IBM systems. System z support available since z10 GA1.
- Monitoring functions can be used free of charge.
- Enables to monitor System z in context of a heterogeneous data center.





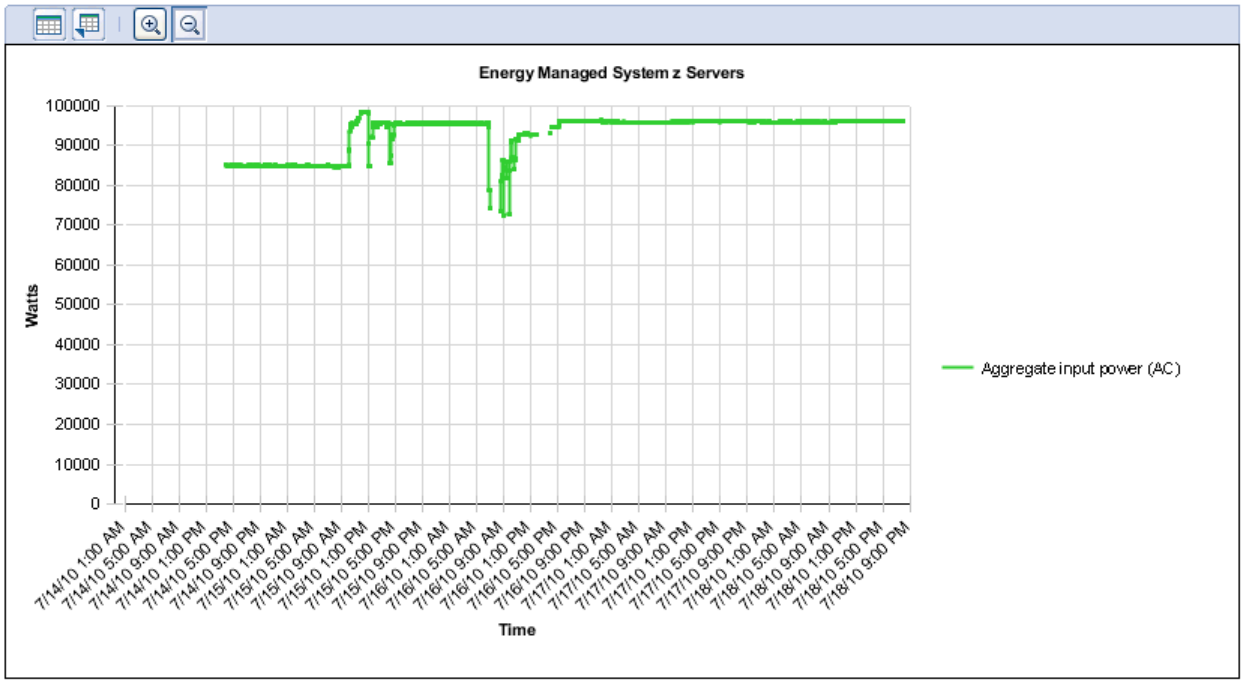
AEM Datacenter Trending of Energy and Environmental Data

Target: Energy Managed System z Servers [Browse...]

Time period: Custom interval [Custom settings]

Chart: [Options]

[Refresh Trend Data]



Navigate Resources

Energy Managed Resour... > Energy Managed System z Servers (View Memb

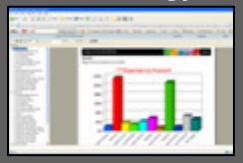
Actions | Search the table... Search

Select	Name	Average I...	..	Ambient Temperature	Exhaust Temperature	Description
☐	ECL2	15,816		25		CEC
☐	H05	17,321		34	45	CEC
☐	M04	2,921		32	36	CEC
☐	P0000H27	23,719		32		CEC
☐	P0000H28	10,612		32	42	CEC
☐	P0000H30	15,078		30	40	CEC
☐	P0000R97	10,517		30	45	CEC

IBM Integrated Energy Management

Tivoli energy management solution

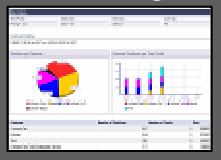
Financial Accounting for Energy



Storage & Data Optimization

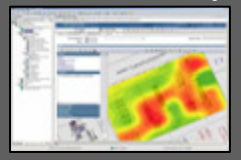
Energy-Aware Provisioning and Scheduling

Energy Dashboard for Business Service Management



Optimize Energy Efficiency of Assets

Data Center Mapping and Thermal Maps

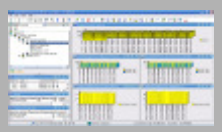


Tivoli Monitoring for Energy Management

Tivoli

Enterprise Data Repository

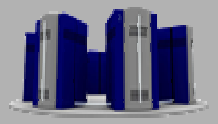
Enterprise Energy Optimization & Reporting



Enterprise Alerting for IT and Facilities

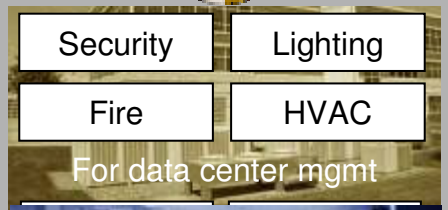
IT Assets

Discover and Manage Non-IBM Systems



Enterprise Assets

Facility Infrastructure Assets



IBM Systems Director Active Energy Manager

IBM® Systems Director

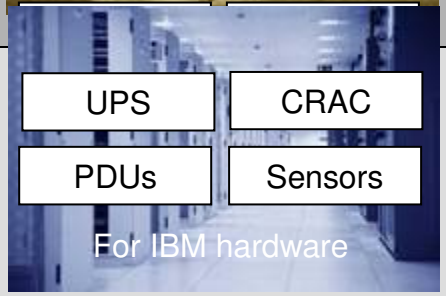
Active Energy Management

Views, Alerting, & Reporting for IBM Systems

IT Assets

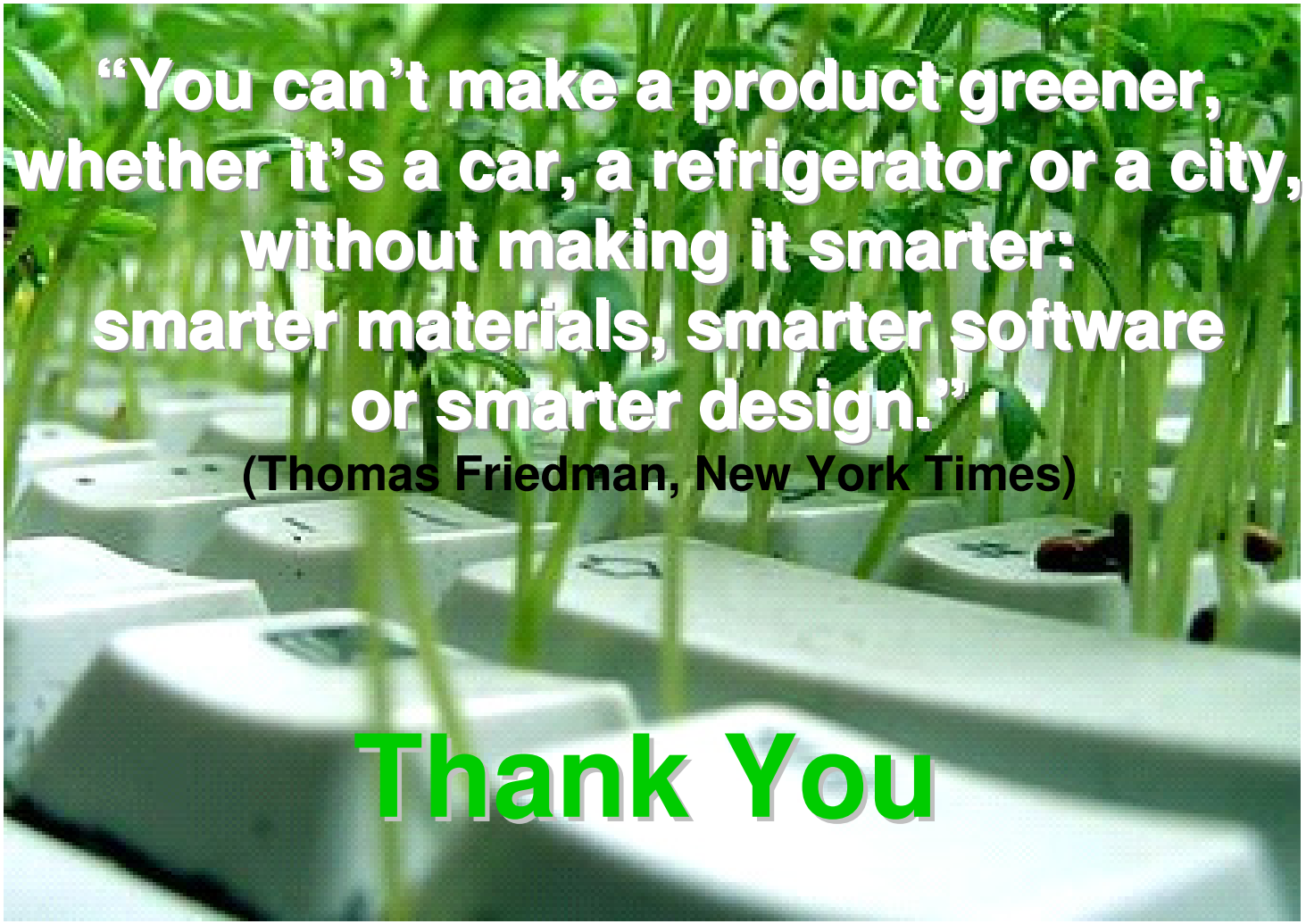
Discover and Manage IBM Systems

Data Center Infrastructure Assets



zEnterprise 196 – Energy Efficiency and Management Summary

- Significant improvements in energy efficiency
  - Tremendous performance improvement with same energy footprint
- Enables additional efficiency gains
  - Water cooling option
  - Overhead cabling option
  - HV DV power input option
- Energy Monitoring and Management delivered as part of Unified Resource Manager
  - Extensive monitoring of energy consumption and key environmental parameters
    - Includes detailed and aggregated data for zEnterprise 196 and BladeCenter Extension
  - Integrated Energy Management Controls
- Integration into IBM Energy Management stack through Active Energy Manager



z196 – Helping to Control Energy Consumption in the Data Center

- **Better control of energy usage and improved efficiency in your data center**
- **New water cooled option allows for energy savings without compromising performance**
  - Maximum capacity server has improved power efficiency of 60% compared to the System z10 and a 70% improvement with water cooled option
- **Savings achieved on input power with optional High Voltage DC by removing the need for an additional DC to AC inversion step in the data center**
- **Improve flexibility with overhead cabling option while helping to increase air flow in a raised floor environment**
- **z196 is same footprint as the System z10 EC[1]**

1 – Water cooling option adds 10.2 cm to depth, overhead cable option adds 30.5 cm to width

Watercooling for zNext

Three fundamentals of power management

Measure/Trend Power Consumption

- Determine the power being consumed now
- Trending energy and thermals over extended periods of time

Allocate Power Correctly

- Power consumed is a function of the HW configuration, environmental, application mix and system utilization.
- Allocate power based on past history using power measurements
- Rightsizing of power and cooling allocations
- Enable deployment of more servers within the physical limits of a data center

limit peak power

Reduce power consumed

- Reduce power in periods of low utilization to limit energy cost
- Allows reduction of power budget to either
  - Reduce energy footprint of data center
  - Typically increase power budget other system(s)

reduce average power

Management stack

Building an architectural construct of hardware, software, services

Service Management

- Visibility, Control and Automation for Applications, Transactions, Databases and Data Center Resources
- End-to End Workload Management and Service Level Objectives that Align IT Management with Business Goals
- Common Usage and Accounting for business accounting
- Dynamic/Centralized Management of Application Workloads based on Policies
- Business Resilience for multi-site recovery
- End to end Enterprise Security

Platform Management

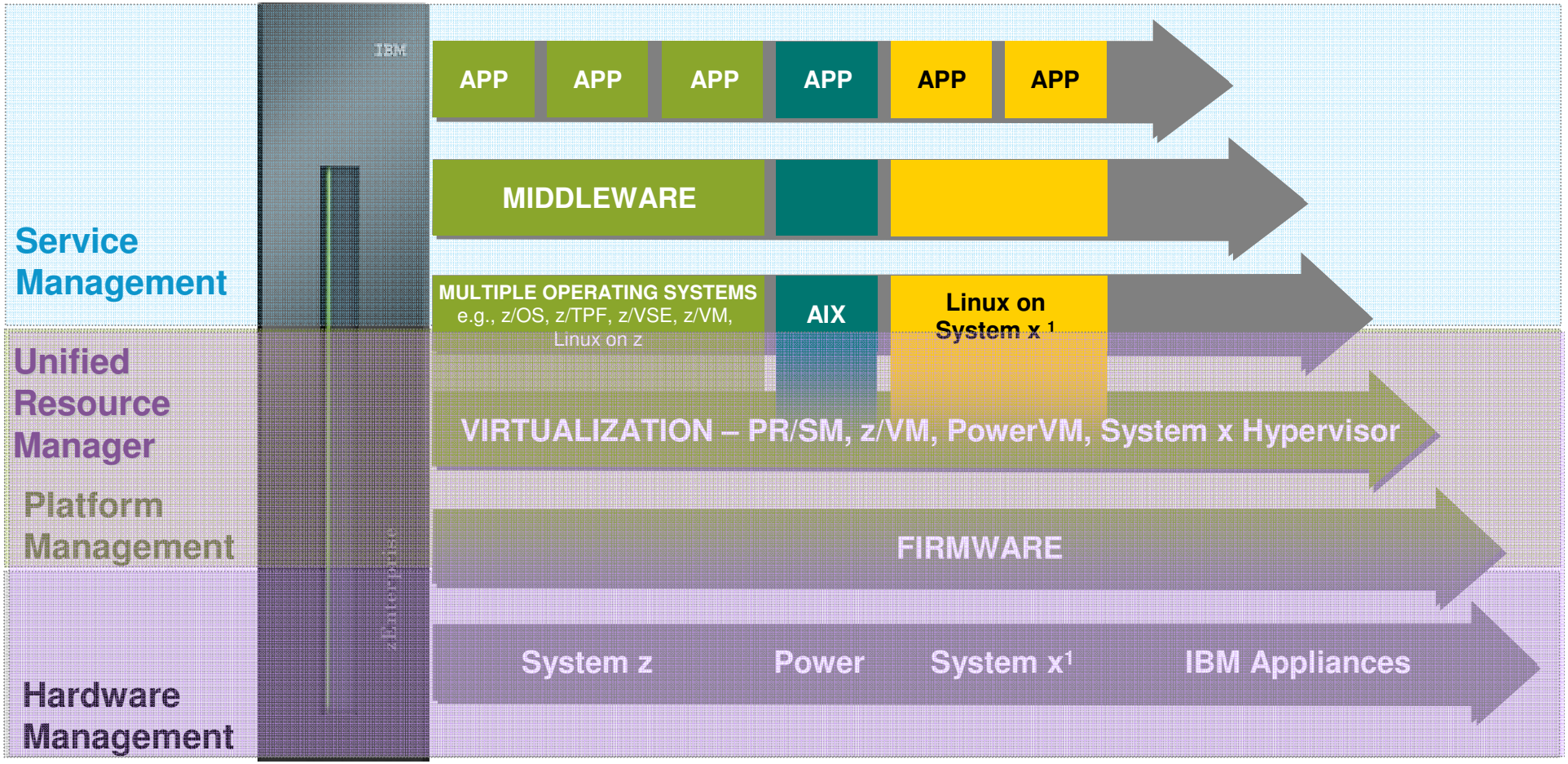
Hardware Management

Extending with

Unified Resource Manager

- **Hypervisor management and creation of virtual networks**
- **Operational controls, service and support for hardware / firmware**
- **Network management of private and secure data and support networks**
- **Energy monitoring and management**
- **Workload awareness and platform performance management**
- **Virtualization management – single view of virtualization across the platform**

Built on this construct -- zEnterprise -- Innovation at every level



Focused, collaborative innovation

A "complete systems" approach

[1] All statements regarding IBM future direction and intent are subject to change or withdrawal without notice, and represents goals and objectives only.

zEnterprise Ensembles
Clustering these heterogeneous systems to create an ensemble

What is it?

Unified Resource Manager allows for the management and optimization of a zEnterprise System as a single resource pool.

An ENSEMBLE is a group of one to eight zEnterprise Systems to be managed as one single logical virtualized system. Each zEnterprise is a single z196 with 0-1 zBX attached.

Now business objectives can be put in terms of a performance policy for a workload that spans across the ensemble – the multiple systems.

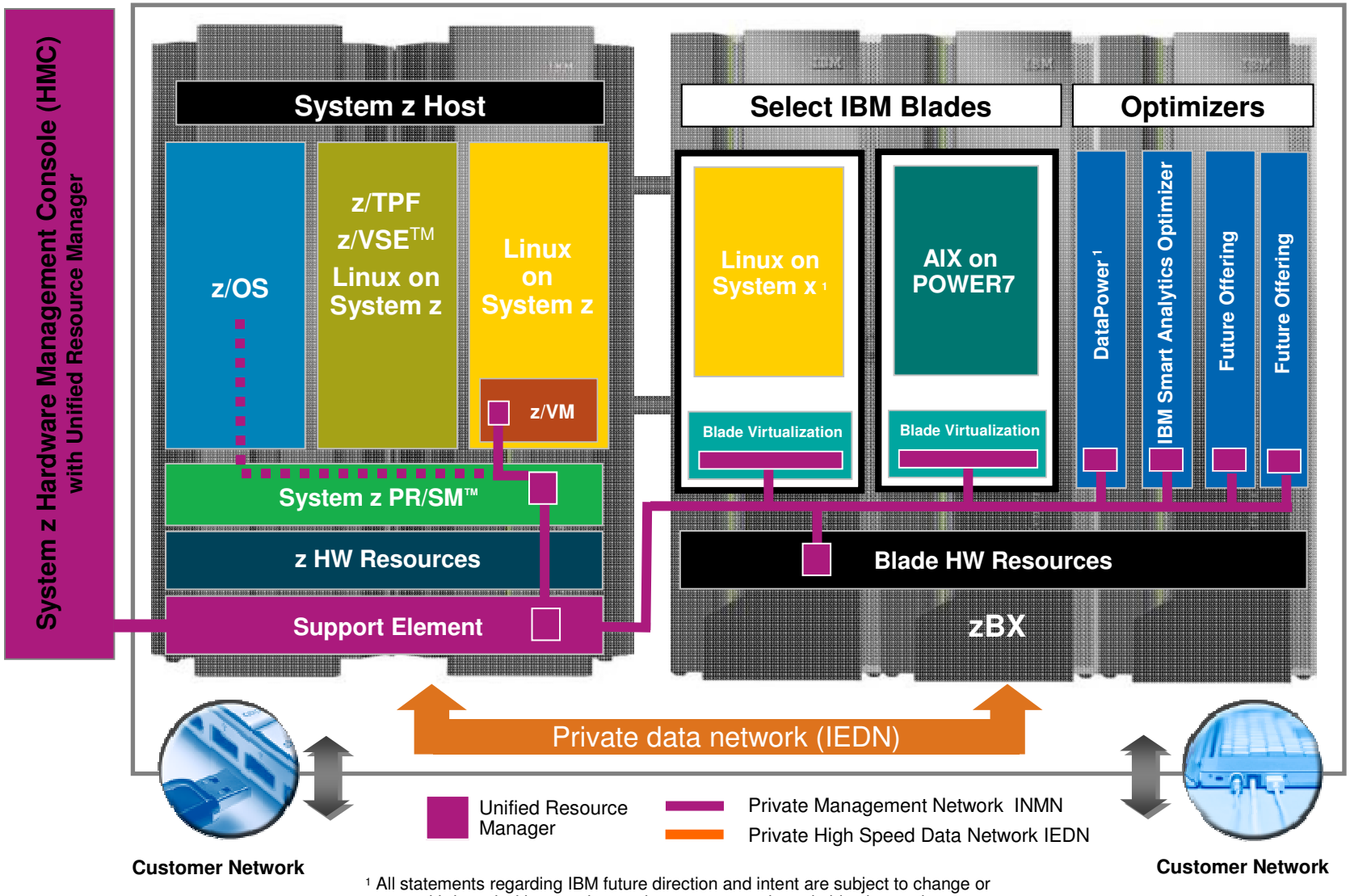
When multiple workloads are running across the ensemble, each can have it's own business objectives, and Unified Resource Manager can share the resources to meet all the business objectives.

How is it different?

- **Workload awareness:** Unified Resource Manager is able to optimize the **total** resources in the ensemble in accordance with the policies set for different workloads.
- **Single point of control:** Management of all resources in the ensemble is centralized on one Hardware Management Console. Dashboard monitoring of CPU resources and energy can allow time to react and make adjustments if necessary.
- **Integration:** The integrated management and built in networks of the ensemble are designed to reduce errors associated with distributed configurations. Reduction of complexity in day-to-day operations.

Putting zEnterprise System to the task

Use the smarter solution to improve your application design



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