Server Solutions – Power Management and SmartGrid

9/10/2013

Change Log

Version	Change
3/19/2012	Initial release
5/23/2012	Add projected power savings by workload and application aware dynamic power control (pp. 38, 39)
6/11/2012	Add demo screenshots
9/10/2013	Update SmartGrid supported servers and new features for v 1.1

Outline

- Power management in PC's and Servers
  - Compare and contrast methods for power management
- Power management's impact on server TCO
  - IT capacity requirements increasing
  - Infrastructure costs increasing
- Approaches to solving the problem
  - Modernize servers
  - Manage power usage
- Server modernization – fastest path to efficiency gains
  - Summary messages
  - ThinkServer design features
  - Integrated Intel technologies
  - Node Manager
  - Examples if performance and energy efficiency improvements
  - ROI
- Strategically manage power usage – increase server density and data center efficiency
  - Planning
    - RackPlanner Tool – How much power and cooling infrastructure do I need?
    - Rack Planner feature
  - Management
    - SmartGrid
    - SmartGrid use cases
    - Performance examples
    - Smart Grid features
    - Deploying Smartgrid

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Power Management in PC's and Servers

- Power Management in PC's generally means:
  - Turning off components (e. g. monitors and HDD's) after set periods of inactivity
  - Putting the PC to sleep (Suspend and Hibernate)
  - Employing technologies like Intel "Speed Step" to reduce a processor's power consumption
  - Using low power components (SSD's, energy efficient power supplies, …)
- Turning off / suspending PC's provides large saving potential, it is also the reason why servers are completely excluded from PC power management
- Servers must remain active (performing work), but similar tactics to reduce power consumption can be employed
- Servers also use much more power; instrumentation and reporting is also important

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Power Management's Impact on Server TCO

- IT computing capacity requirements are increasing
- Power and cooling-driven utility bills can represent 25% - 40% of the operational expenditures in most data centers (IDC 11/2010)
- Costly power and cooling infrastructure approaching capacity limits; more servers cannot be added to existing facilities
  - Actual capacity
  - Perceived capacity due to overprovisioning of requirements
- Capital construction is not happening
  - Construction costs are projected to exceed $1,000 per square foot or $40,000 per rack (Intel estimates)

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Approaches to solving the problem

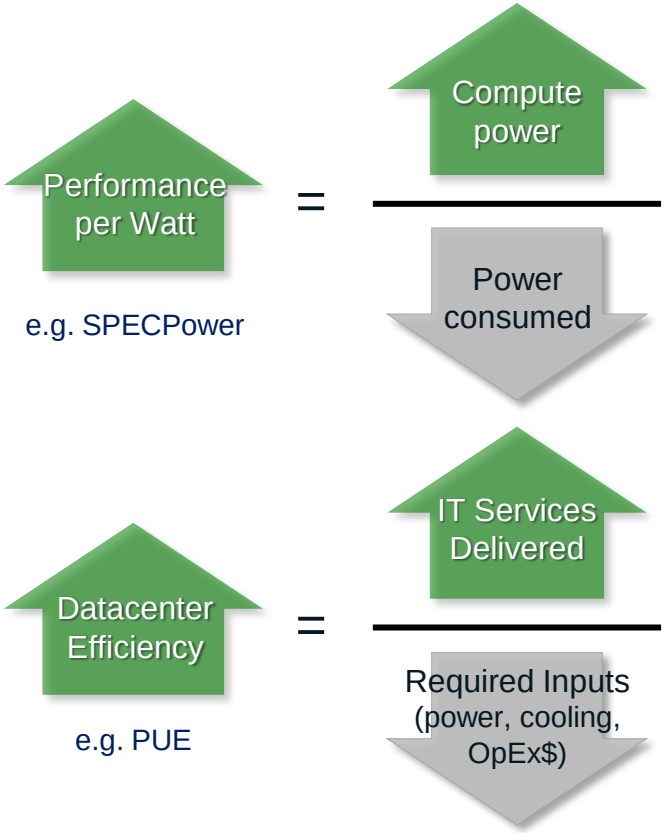
Improve usage of existing capacity through better power utilization

Modernize Servers

Increase performance & energy efficiency with server refresh

Manage Power Usage

Monitor, track & strategically cap power to increase server density & datacenter capacity



Server modernization – fastest path to efficiency gains

ThinkServer provides improvements in performance and energy efficiency (performance/watt) easily justifying economics of a server refresh

- ThinkServer incorporates design features that reduce power consumption
  - High efficiency power supplies
  - Low voltage components
  - Intelligent cooling algorithms
- Latest Intel technologies help cut and manage power consumption
  - CPU Intelligent Power Technology
  - Intel Intelligent Power Node Manager (Node Manager)
- Enable TCO savings and quick ROI
  - Consolidating multiple older servers on a single new ThinkServer, or
  - Increasing compute capacity with same infrastructure footprint

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Lenovo design features reduce power consumption

- High efficiency power supplies
  - 80 Plus Bronze on TD330 [Fixed Power]
  - 80 Plus Gold on TD330 [Redundant Power]
  - 80 Plus Gold on RD330 / RD430 / RD530 / RD630 / RD540 / RD640
- Energy Star Compliance (Computer Server Ver 1.1)
- Low-voltage components for power savings (available CPU, Memory, SSD)
- Low power laptop style optical drive
- Internal USB port enables diskless hypervisor support
- Unused devices moved to a minimum power consumption state

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Latest Intel technologies help cut and manage power consumption

- Intel “Intelligent Power Technology” minimizes power consumption when server components are not fully utilized
  - Processor and memory automatically put into lowest available power state that meets current workload requirements
    - Results in power consumption based on real-time load
  - Integrated power gates allow individual idle cores to be reduced to near-zero power independent of other operating cores
    - Idle power consumption cut to 10 watts, versus 16 or 50 watts in prior-generations of Intel quad-core processors
    - Reduces server idle power consumption up to 50% vs. previous generation two-socket server processors
- Turbo Boost Technology provides performance on demand
  - Processors can operate above the rated frequency to meet specific workload demands
  - Lowers frequency to reduce power consumption during low utilization periods

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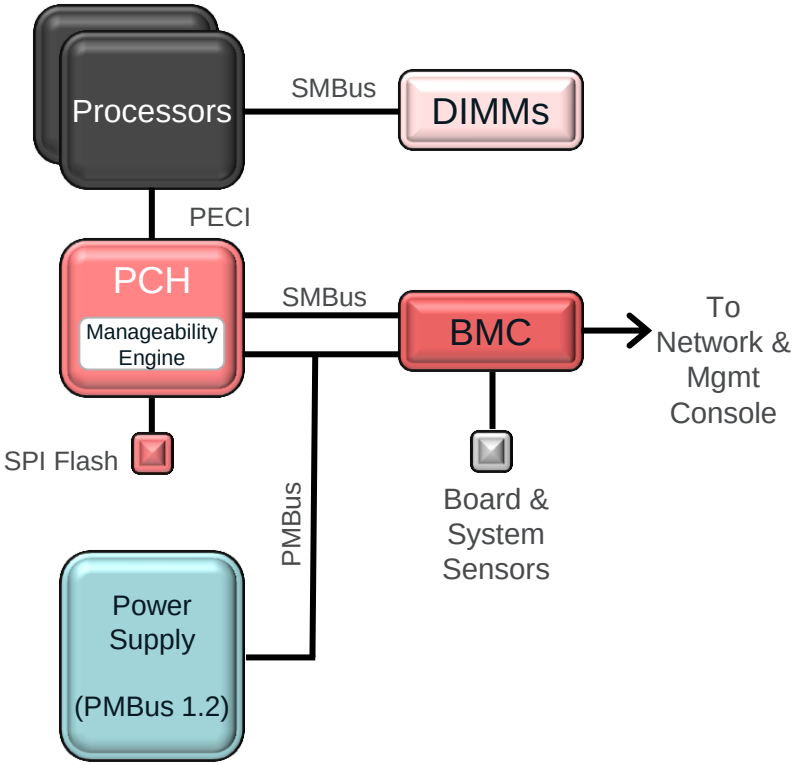
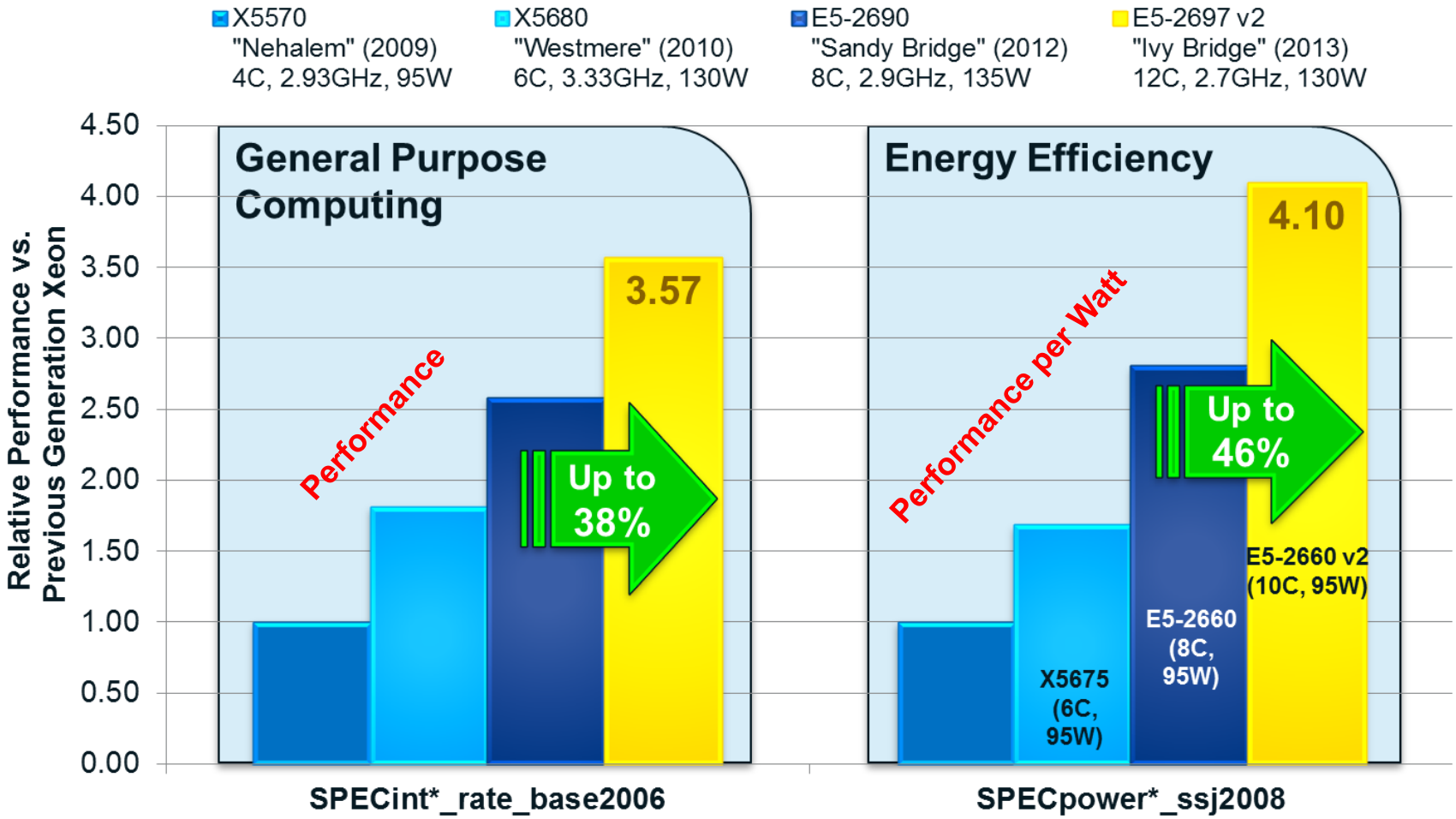
Intel Node Manager monitors and regulates server power consumption

- Integrated technology accessible through industry standard IPMI interface
- Dynamic power monitoring
  - Measures / reports actual system level, CPU and memory power consumption (+/-5%)
  - Provides real-time data
- Platform power capping
  - Receives policies setting platform power budget while maintaining maximum performance for the given power level
  - Enforces power caps – dynamically adjusts processor performance, memory power, or dynamically allocating processor cores
- Power threshold alerting
  - If targeted power budget (policy) cannot be maintained, sends alerts to the management console



Achieving Operational Excellence



Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Any change to any of those factors may cause the results to vary. For more information go to http://www.intel.com/performance Intel does not control or audit the design or implementation of third party benchmark data or Web sites referenced in this document. *Other names and brands may be claimed as the property of others.SPECint*rate_base2006: X5570 (48GB, HDD) , X5680 (24 GB, SSD), E5-2690 (128GB, HDD), E5-2697 v2 (128 GB, HDD) SPECpower*ssj2008: X5570 (8GB, SSD) , X5675 (16GB, SSD), E5-2660 (16GB, SSD), E5-2660 v2 (48GB, SSD)

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Strategically manage power usage – increase server density and data center efficiency

Lenovo provides tools to manage server power consumption

- Lenovo RackPlanner provides power and cooling requirements for new ThinkServer racks based on configuration requirements

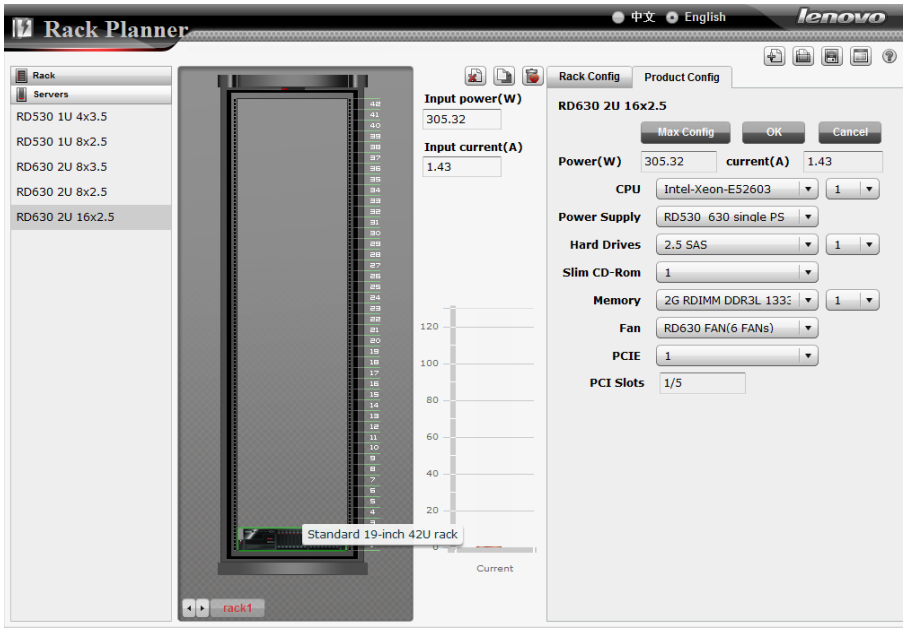
- Lenovo SmartGrid software provides power management for servers, enabling server density and datacenter capacity to be increased through use of power capping

RackPlanner

Planning power usage in the datacenter – RackPlanner

How much infrastructure is needed?

- A standalone Windows tool for datacenter planners to conservatively predict power (W) and cooling (BTU/hr) requirements for new ThinkServers
- Estimates based on custom configuration and maximum device power (an estimate of maximum workload)
- Supports single systems and racks of systems



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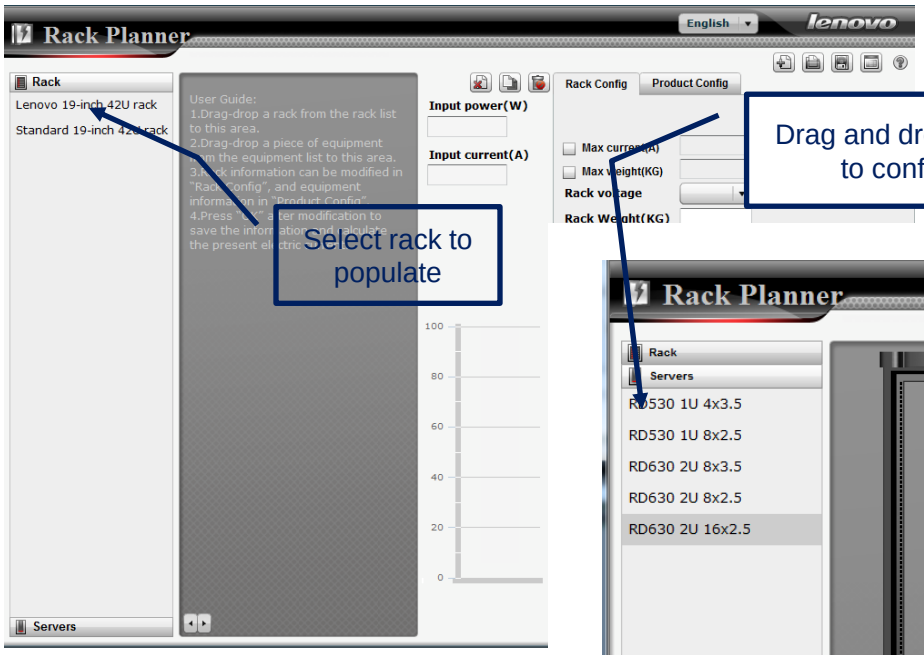
RackPlanner Offering

- Available as no charge application:
  - Web based tool on Lenovo.com
  - Stand-alone downloadable application for Windows

- Supports:
  - RD330 / RD430 / RD530 / RD630

RackPlanner Features



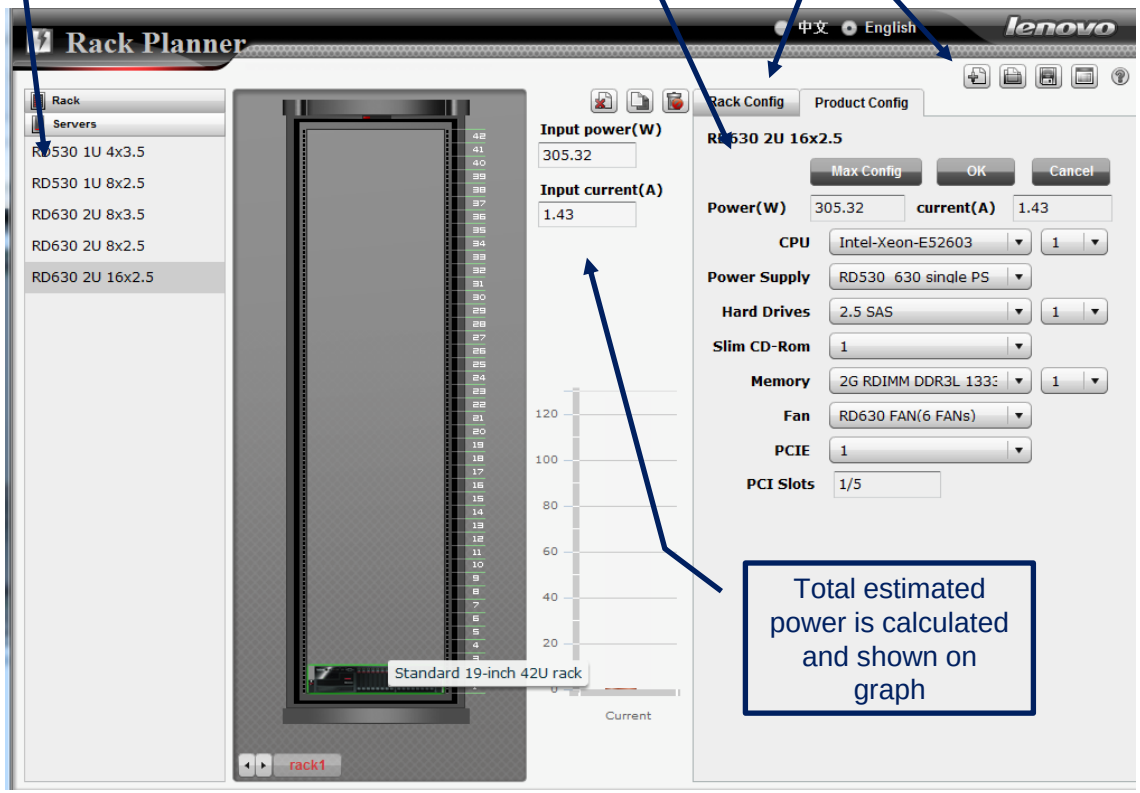
Select rack to populate

Drag and drop servers to configure

Configure server with CPU, drives, expansion cards, etc.

Configure rack input power

Save, recall and print configurations



Total estimated power is calculated and shown on graph

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Planning vs. Measurement

- Planning tools are necessarily conservative – tend to overstate requirements
  - Without detailed information about actual server power consumption, computing capacity is based on nameplate power, peak server power consumption, or de-rated power
  - Results in overprovisioned data center power, overcooling of IT equipment, and increased TCO
- In practice, server power consumption is nearly always lower than planning estimates
  - results in underutilization of the budgeted rack power
- Improved datacenter efficiency requires optimizing power for the actual work being delivered
- The challenge is determining how much power each server really requires to handle its workload

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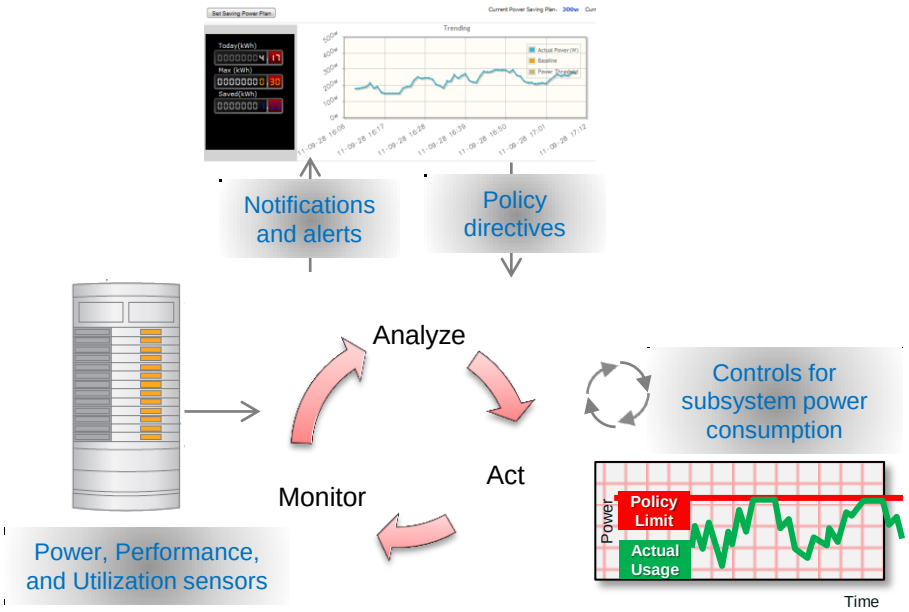
SmartGrid

ThinkServer SmartGrid Overview

- Provides power management for servers, racks, and groups of servers
- Uses Intel Node Manager to monitor server power – aggregates data and reports trends
- Tracks server CPU and memory utilization / performance to aid in development of policies
- Enables administrators to develop policies that adjust power caps based on server utilization, business conditions, and power consumption trends
- Uses policies to enforce power consumption of individual servers or groups of servers
- Alerts administrators to policy violations or other configurable indications



SmartGrid availability

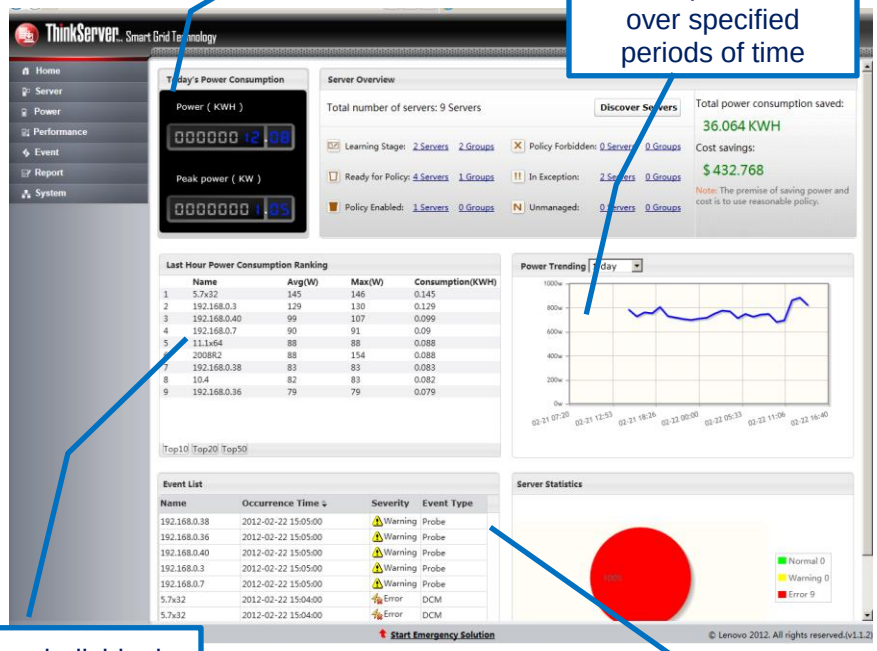
- Available as a web download from Lenovo.com
  - Free trial limited to 90 days and 50 managed systems
  - Local activation via serial number provided online
- Systems supported
  - RD330, RD430, RD530, RD630
  - Version 1.1 required for RD340, RD440, RD540 & RD640 (supports RD330/430, RD530/630)

SmartGrid Features

- An easy to use web based console
- Each instance of SmartGrid supports up to 1,000 managed servers
- Agentless
  - Controls system out-of-band
  - No footprint on server to impact performance or require maintenance

Shows overall power consumption statistics

Shows power consumption trends over specified periods of time



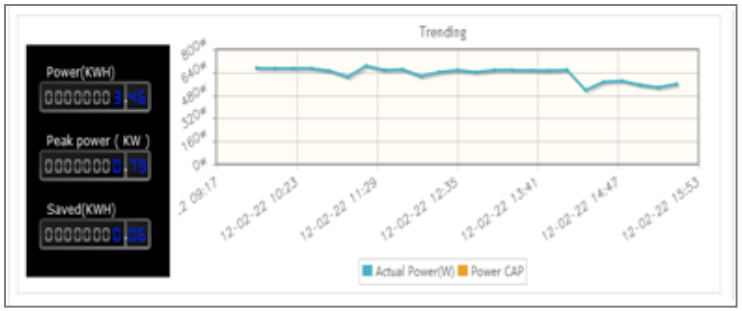
Shows individual server consumption rates in rank order

Main Dashboard

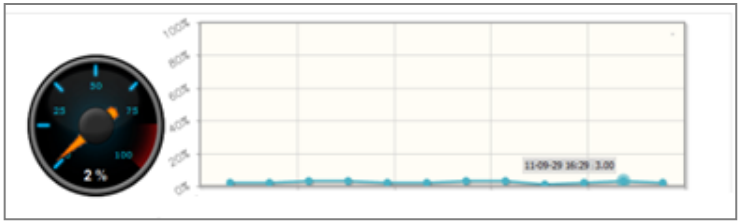
Displays events and event statistics

SmartGrid Features (cont.)

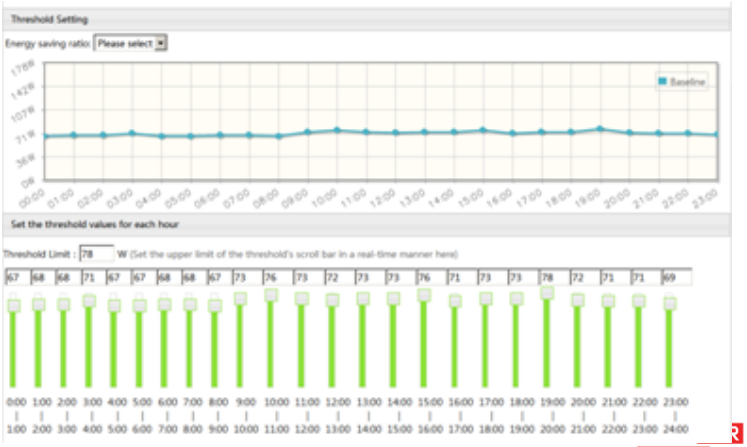
- Gathers power consumption data for single server, and groups of servers, over a defined period of time



- Monitors CPU, and memory utilization



- Power policy definition
  - New policies are initialized with recommended settings based on measured power consumption trends without compromising application performance
  - Preset policies for database and webservers
  - All policies can be customized for specific need



Additional Features

- Sends email notification of alerts to designated users
  - Events include threshold crossings, loss of connectivity to managed server, power policy transgressions
- Generates Reports
  - Provides reports of power usage for various server groups and time periods

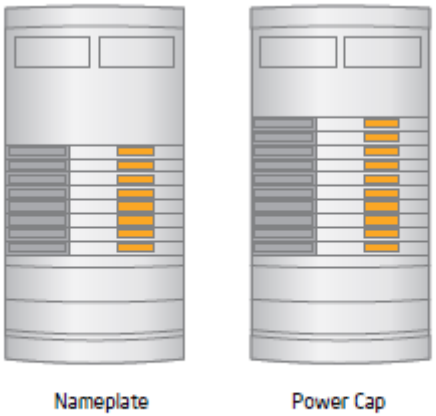
New Features in v 1.1

Available November 2013

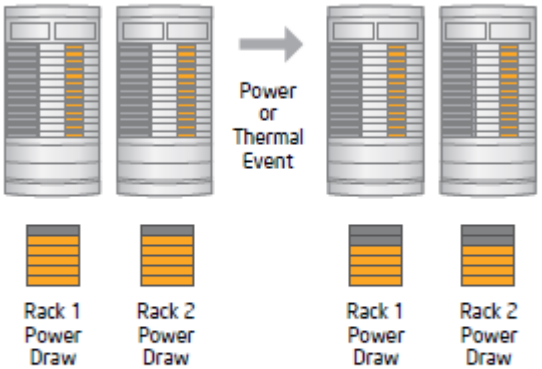
- Enable hot spot monitoring and alerting
  - Monitors the inlet temperature of servers to help users locate a hot spot in the Data Center, which reduces the risk of data loss or device damage
- Datacenter Physical Layout Management
  - Adds “Datacenter – Room – Row – Rack” hierarchy perspective to Tree View
- Version Upgrade & Data migration
  - Eases upgrade to v 1.1 and provides ability to backup and restore existing data

SmartGrid Use Cases

- Increase server density
  - Set server power budget policies to actual workload power requirements
  - Capping servers to those limits
  - Exploits existing unused power capacity to increase server density in a power-constrained data center
- Power savings
  - For workloads not constrained by processor performance (e.g. I/O-intensive and memory-intensive workloads), throttle server CPU without affecting overall performance, reducing server power consumption without risk to compute SLAs
  - Manage power when energy provided has variable pricing (e.g. cheaper at night)
- Maintain business continuity
  - When power outages or temperature events occur, dynamically cap power to shed load and distribute remaining power to servers prioritizing business-critical workloads



Increase Compute Density



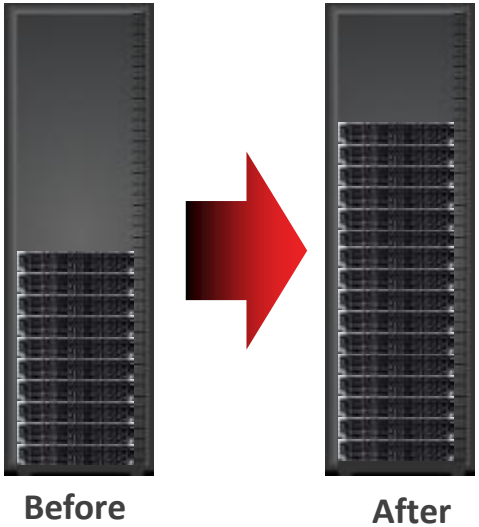
Improve Business Continuity

Example – Increase Server Density

Capping can be used to increase number of servers within a given power envelope

Traditional method: static provisioning

- Assume 4KW available to rack
- 650 watt server power supply rating (max 6 servers)
- Use 400 watts max as safe bet from lab measurements for expected configuration
- Install 4000 W/400 W per server = 10 servers



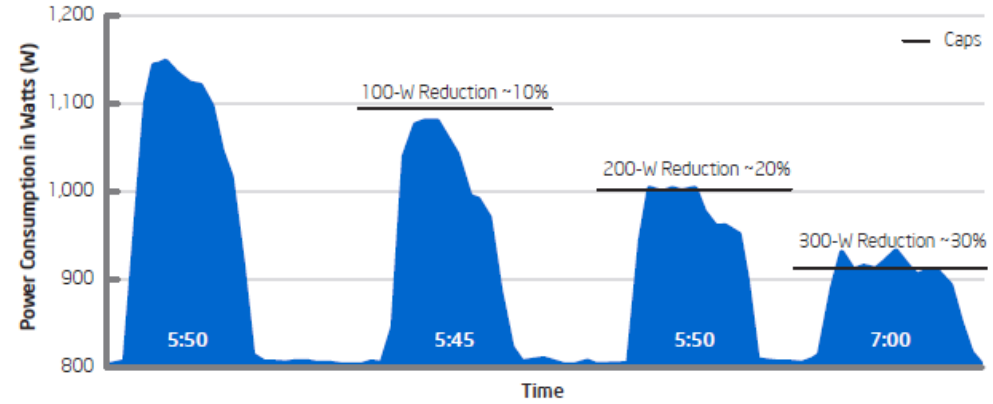
6 → 10 → 16

Improved method: Real time monitoring with power budget enforcement

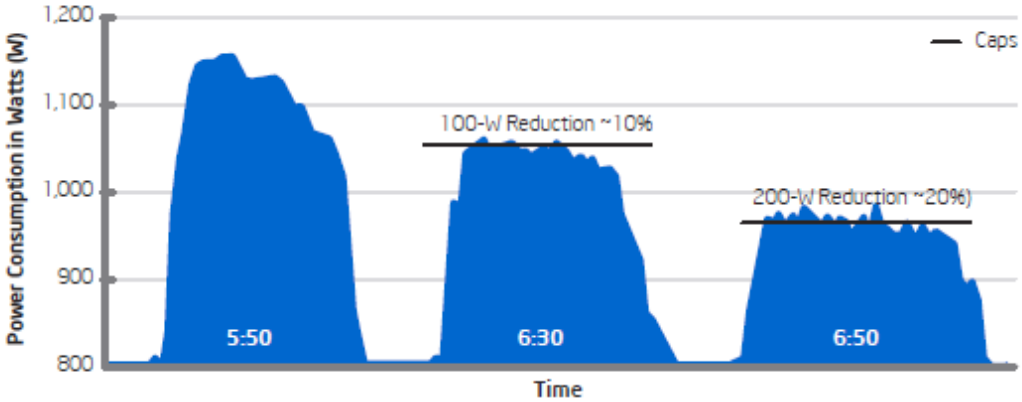
- Actual measurements indicates power/server rarely exceeds 250 watts
- Use 250 watts as power budget per server
- Enforce 4 KW global cap for rare cases where demand would exceed 4 KW
- Install 4000 W/250 W per server = 16 servers
- Payoff: increase rack loading by 60 percent

Example – Power Savings

Capping can be used to optimize power consumption without affecting performance – For workloads that were not processor-intensive server power consumption was reduced by up to 20% without impacting performance



Capping used to reduce server power consumption ~20% with I/O intensive workload without affecting performance.



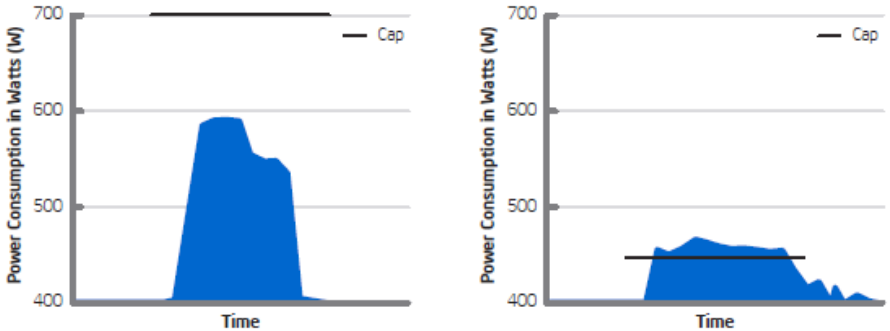
With CPU intensive workload, reducing power consumption 20% resulted in 18% runtime increase.

Source: Intel studies

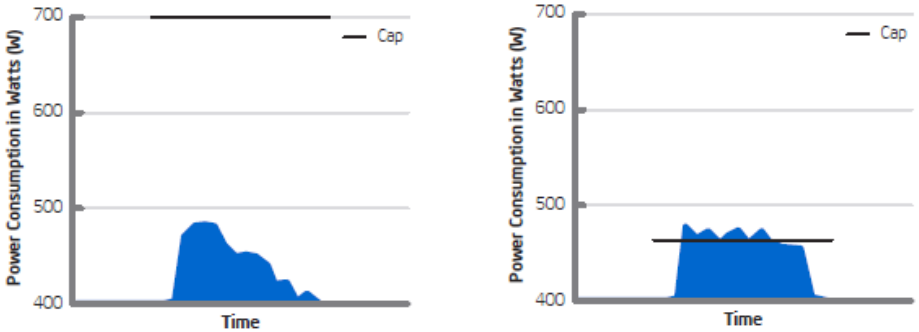
Example – Maintaining Business Continuity

Capping can be used to avoid downtime and maintain performance of high-priority workloads in the event of a partial outage.

Simulating a partial loss of data center power, use capping to allocate remaining power among all servers, enabling all workloads to keep running. Prioritize workloads by capping power consumption at different levels.



With CPU intensive workload, aggressively capping power increased runtime ~35%

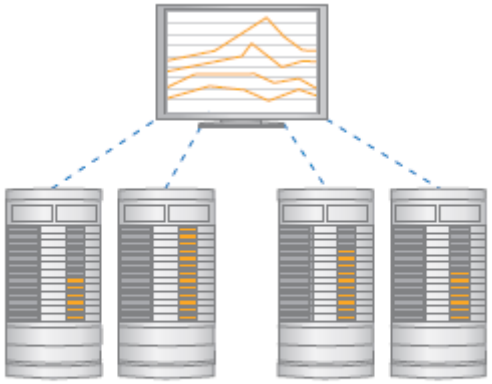


Contrast with non-CPU intensive workload, capping power resulted in minimal performance impact

Source: Intel studies

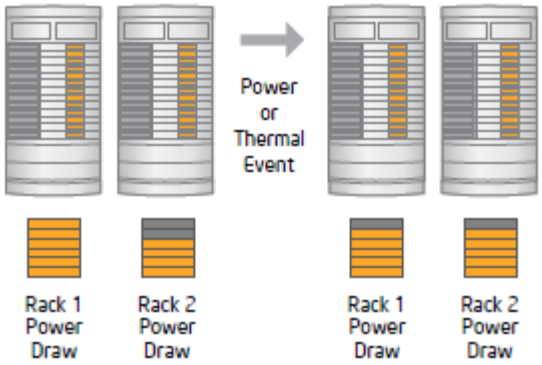
Other use cases that can be managed at a facilities level

- Link cooling to actual power demand
  - Coordinate individual server power consumption, CPU utilization, and temperature, to cooling controls
  - Cooling capacity can be linked to actual rack temperatures, insuring adequate, but not excessive cooling is provided



Link Cooling to Actual Demand

- Facilitate power-based load balancing
  - Use load balancing and migration tools in virtual environments to move workloads to racks with available power headroom



Dynamically Balance Resources

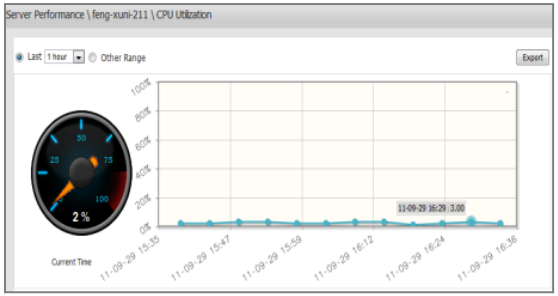
Deploying SmartGrid

Deploying SmartGrid

Measure actual usage under real-world conditions

Learning Phase

- Record historical performance data
- Determine and analyze usage model



Determine policy requirements

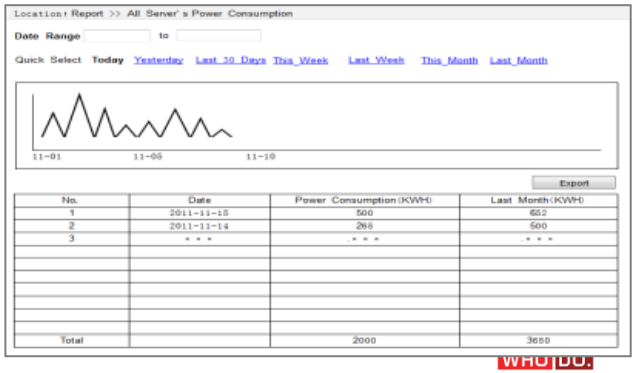
Power Discovery Phase

- Determine optimal power settings without affecting performance

Implement policies and monitor

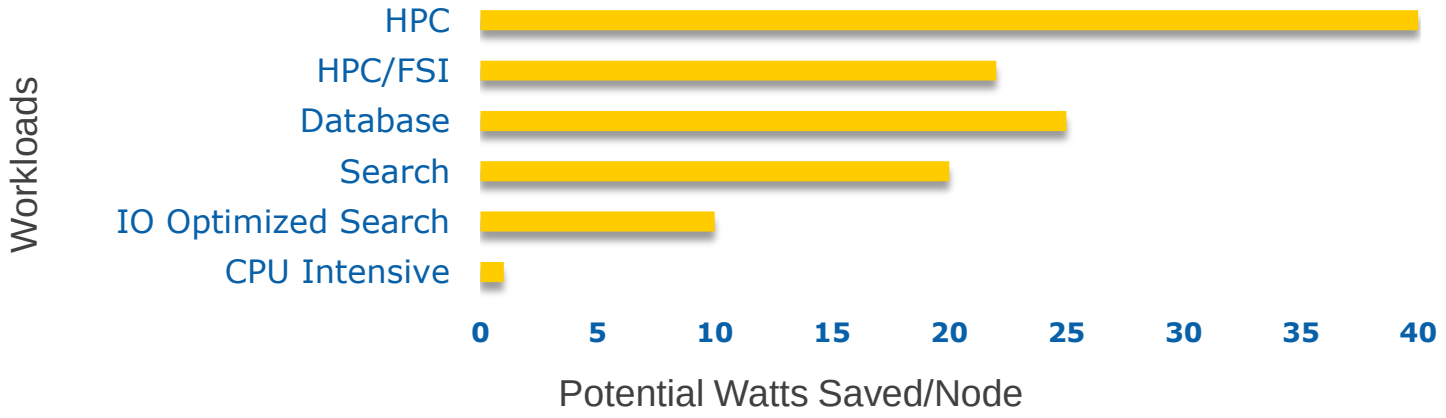
Power Savings Execution Phase

- Setup system workloads
- Apply optimum power settings (policies)
- Determine power gains and savings



Backup

Opportunity for Power Savings



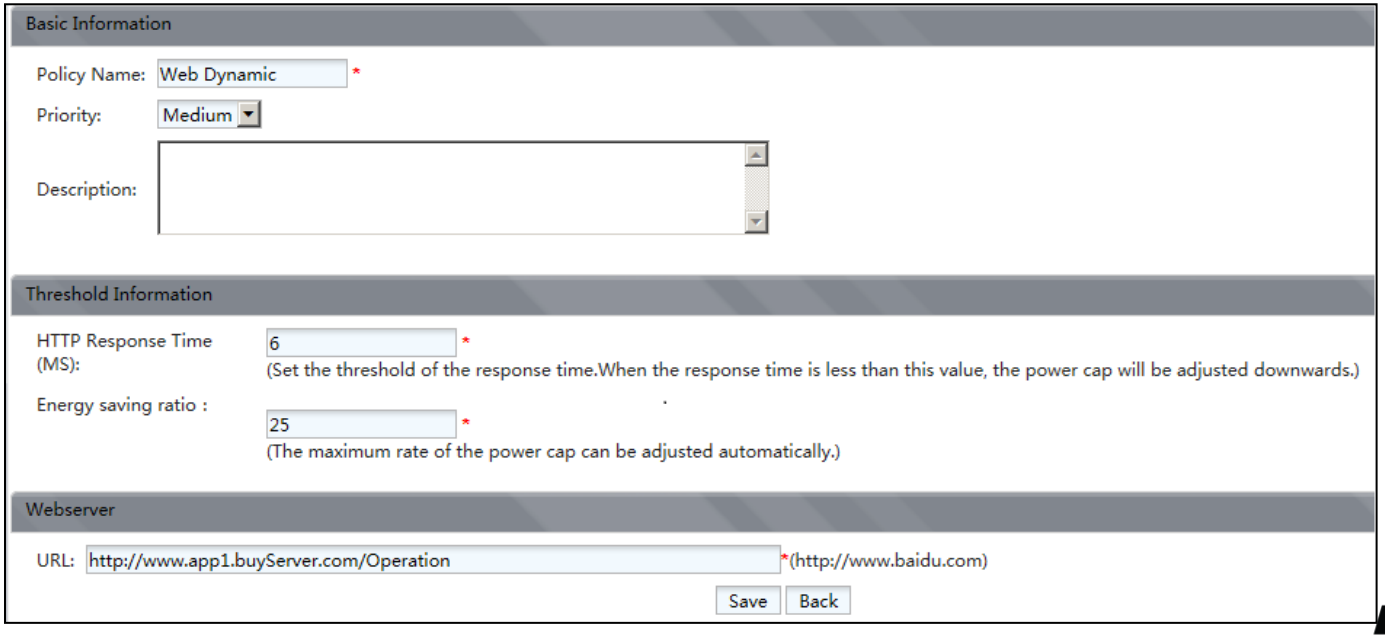
Power Optimization results are dependent on the system configuration and the workload – results will vary accordingly

Savings based on CPU utilization:

- Optimal power savings were achieved with CPU utilization of approximately 45%. In general, expect power savings of 15-20% when CPU utilization is between 40% to 70%.
- Potential savings decreases when the CPU utilization is below 40% or above 70%.

Application Performance Aware Dynamic Power Control

- Completely Automatic
  - Best effort to reach the power saving target
- Power Saving Without Performance Compromise
  - Check the performance indicator every 3 minutes to see if it's within the threshold
  - Database Server Performance Indicator: SQL Statement Execution Duration
  - Web Server Performance Indicator: Web Page Response Time



Measures of server power efficiency

New technology and product designs improve products generation to generation as measured by “performance per watt”

- SPECpower_ssj2008 is the first industry-standard benchmark that evaluates the power and performance characteristics of volume server class computers
- Performance per watt is a measure of the energy efficiency measuring the rate of computation that can be delivered by a computer for every watt of power consumed
- SPECpower include measurements at a series of load levels

Measures of data center efficiency

- Power Usage Effectiveness (PUE), a metric developed by The Green Grid, calculated by dividing Total Facility Power by IT Equipment Power
- Total Facility Power is defined as the power measured at the utility meter that is used in the data center
  - It includes the power used in the infrastructure for lighting and cooling the building, the power used by IT equipment, and the power lost in the distribution/conversion system
  - IT Equipment Power, on the other hand, is the power used to manage, process, store, or route data within the data center.

Automated Low Power States (P-States)

What is it?

- This automatically put processor lowest available power states by reducing clock frequency to meet workload demands while not impacting performance.
- P-states are controlled by the OS. P0 as the highest-performance state (Turbo), P1 as the processor "rated" frequency, and "Pn" being successively lower-performance states.
- Known as Demand Based Switching (DBS) or Enhanced Intel® SpeedStep® Technology (EIST) for DT/mobile

End user benefits

- Automatically reduces CPU power consumption during periods of lower server activity

Competitive offering

- AMD calls it AMD* PowerNOW!* for servers, and AMD* Cool'n'Quiet for client (desktop and mobile)
- AMD* Independent Dynamic Core Technology*, a component of PowerNow!, allows each core to independently operate at different P-state frequencies. Intel doesn't implement this because clock frequency reduction provides minimal power savings. The majority of power savings comes from reducing voltage to the processor which is the Intel implementation.

Ecosystem Enabling / Readiness

- BIOS and OS support is required.
- BIOS is responsible for constructing a P-state table for the OS to use.
- All major OS vendors have been supporting p-states, both Intel and AMD, for several years.

Analogy: Automatic Transmission

- P-states are just like automatic transmissions in an automobile, truck, or motorcycle. The transmission tries to match up the right gear (p-state) to optimize performance, power, or both, based on how fast the car is going or the terrain you're traveling over (workload).

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Integrated Power Gates (aka C6)

What is it?

- C-states are processor core and package sleep states that reduce power when cores are idle (not executing any instructions).
- When cores are idle (not executing instructions), the OS can place the core in C6 which reduces power consumed by the core to near-zero through power gating.
- Each core can be idled independently and automatically by the OS, or can be controlled manually through BIOS core disabling

End user benefits

- Can reduce idle power consumption by up to 50 percent versus previous generation two-socket server processors

Competitive offering

- AMD doesn't have power gating (C6), but they have AMD* CoolCore* Technology which gates off sections of the processor during idle which reduces core power through clock frequency and voltage reduction, but their cores never get to near-zero power. They are expected to add a C6 like capability with Bulldozer (Interlagos) core.

Ecosystem Enabling / Readiness

- C6 is supported on Xeon® 5500 and 5600 platform and the and the Intel Xeon processor E7-2800/4800/8800 product families.
- OS support is required for C6. Current OS support from major OSVs:
  - MS Windows Server 2008
  - MS Windows Server 2003 SP2 with a patch
  - Linux 2.6.30 kernel or higher is recommended. Supported with Linux 2.6.18 kernel or higher, but power savings benefit will be less.
  - Solaris 10 or higher

Analogy: The Traffic Light

- Imagine being stopped at a long traffic light. If you turn off your car while waiting for the light to turn green, you'll save the most gasoline (similar to C6). However, it'll take you longer to start the car, shift into gear, and start moving when the light turns green.

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Intel® Node Manager

What is it?

- System level power monitoring & reporting and policy based, directed system level power capping to user specified values by adjusting CPU power states.
- Power cap policies sent from an enabled management console are dynamically accepted and enforced by Node Manager firmware, without need for system reboot.

End user benefits

- Enables IT to maximize perf/watt at the rack or datacenter level by limiting system power based on user-defined policies
- Allows IT to increase compute availability and prevent server damage by shedding load in real time during data center power and thermal excursions

Competitive offering

- AMD* PowerCap Manager* allows static upper limits to be placed on the processor p-states to reduce power (processor operates at Pn state or less)
- HP Dynamic Power Capping* is a BMC based implementation similar to Node Manager

Ecosystem Enabling / Readiness

- BIOS and OS support required. Most major OS releases meet ACPI compliance requirements.
- Server hardware required to support Node manager:
  - ✓ Intel Xeon® 5500 / 5600 processor
  - ✓ Intel 5500/5520 chipset with Node Manager firmware
  - ✓ Compliant server configuration, including BMC and PMBus enabled Power Supply

Analogy: Engine Speed Governor

- Node Manager is like a speed governor for an engine. If you want the engine to run normally, you do not turn the governor on. If you want to set a "not to exceed speed limit" to achieve a MPG target, you can set the level of the governor to your specific need.
- Low Power States and Integrated Power Gates save power autonomously – Node Manager caps power in a user defined, directed manner.

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80 Plus

80 PLUS certifies computer power supplies have more than 80% energy efficiency at 20%, 50% and 100% of rated load, and a power factor of 0.9 or greater at 100% load.

80 PLUS Test Type	115V Internal Non-Redundant				230V Internal Redundant			
Fraction of Rated Load	10%	20%	50%	100%	10%	20%	50%	100%
80 PLUS		80%	80%	80%				
80 PLUS Bronze		82%	85%	82%		81%	85%	81%
80 PLUS Silver		85%	88%	85%		85%	89%	85%
80 PLUS Gold		87%	90%	87%		88%	92%	88%
80 PLUS Platinum		90%	92%	89%		90%	94%	91%
80 PLUS Titanium					90%	94%	96%	91%

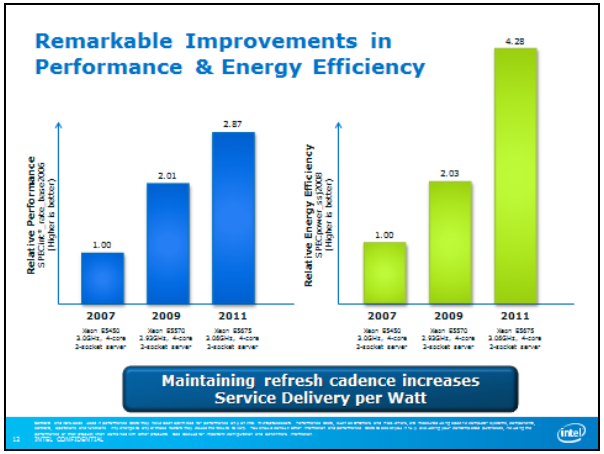
Source: Wikipedia

Performance & Energy Efficiency Claims

2011

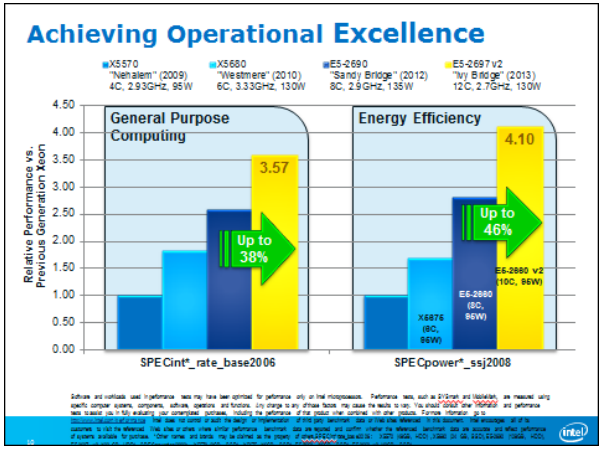
- Processor: 2S Xeon® X5675 (3.06GHz Westmere, 6C)
- SPECint_rate_base2006 performance: 376 See test and configuration info at http://www.spec.org/cpu2006/results/res2011q3/cpu2006-20110801-17800.html
- SPECpower: 3329 See test and configuration info at http://www.spec.org/power_ssj2008/results/res2011q4/power_ssj2008-20110713-00386.html

- Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.
- For more information go to http://www.intel.com/performance



2013

- Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to http://www.intel.com/performance Intel does not control or audit the design or implementation of third party benchmark data or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmark data are reported and confirm whether the referenced benchmark data are accurate and reflect performance of systems available for purchase.
- *Other names and brands may be claimed as the property of others.SPECint*rate_base2006: X5570 (48GB, HDD) , X5680 (24 GB, SSD), E5-2690 (128GB, HDD), E5-2697 v2 (128 GB, HDD) SPECpower*ssj2008: X5570 (8GB, SSD) , X5675 (16GB, SSD), E5-2660 (16GB, SSD), E5-2660 v2 (48GB, SSD)



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Node Manager Features

Value Vector	Capabilities & Features	2.0
Power & Thermal Monitoring	Platform power monitoring	✓
	Inlet Air temperature monitoring	✓
	Processor package power monitoring	✓
	Memory power monitoring	✓
Power Utilization Controls	Processor power limiting	✓
	Memory power limiting	✓
	Dynamic core allocation (core-Idling)	✓
	Configure core power off at boot time	✓
	Configure power-optimized boot at boot time	✓
Power and Thermal Policies	Concurrent policies	16
	Power limiting – OS operational	✓
	Power reduction upon temperature excursion	✓
	Power limiting - during OS failure	✓
	Response SLA	1s (adj)
Avoid Triggering HW Protection	Reduce power consumption to prevent tripping DC circuit breaker	✓
	Reduce power consumption during SMART ride-thru (SmaRT) or overcurrent	✓
Interfaces	IPMI-based commands over SMBus (monitoring, control & alert)	✓
	PECI Proxy and Pass-Through	✓

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How Node Manager Policy Addresses IT Use Cases

IT Problem	Platform Use Cases	Policy Directive
High energy cost in a fixed budget situation	Dynamically regulate power usage to a desired level that is averaged across a billing period	• Policy Parameters ○ Power or Temperature Budget ○ Correction Time Limit ○ Activation Period ○ Action on Exception • Report exception, or • Initiate power off to prevent thermal failure • Policy Execution ○ Power consumption or temperature reading is averaged over an averaging period ○ Using power controls, power consumption is reduced to meet budgets ○ If controls do not prevent a particular budget from being exceeded during the correction time limit, action on exception for that budget is taken
Low number of servers/rack due to limited power at rack level	Allocate power budgets to nodes to maintain overall rack-level limit	
Cooling capacity constraints resulting in hotspots in the data center	Restrict average power dissipation of a node to a level that eliminates hotspot by monitoring outlet air temperature	
Circuit breaker tripping due to power delivery constraints	Monitor platform average power consumption and ensure that it is maintained at a level that prevents CB tripping	

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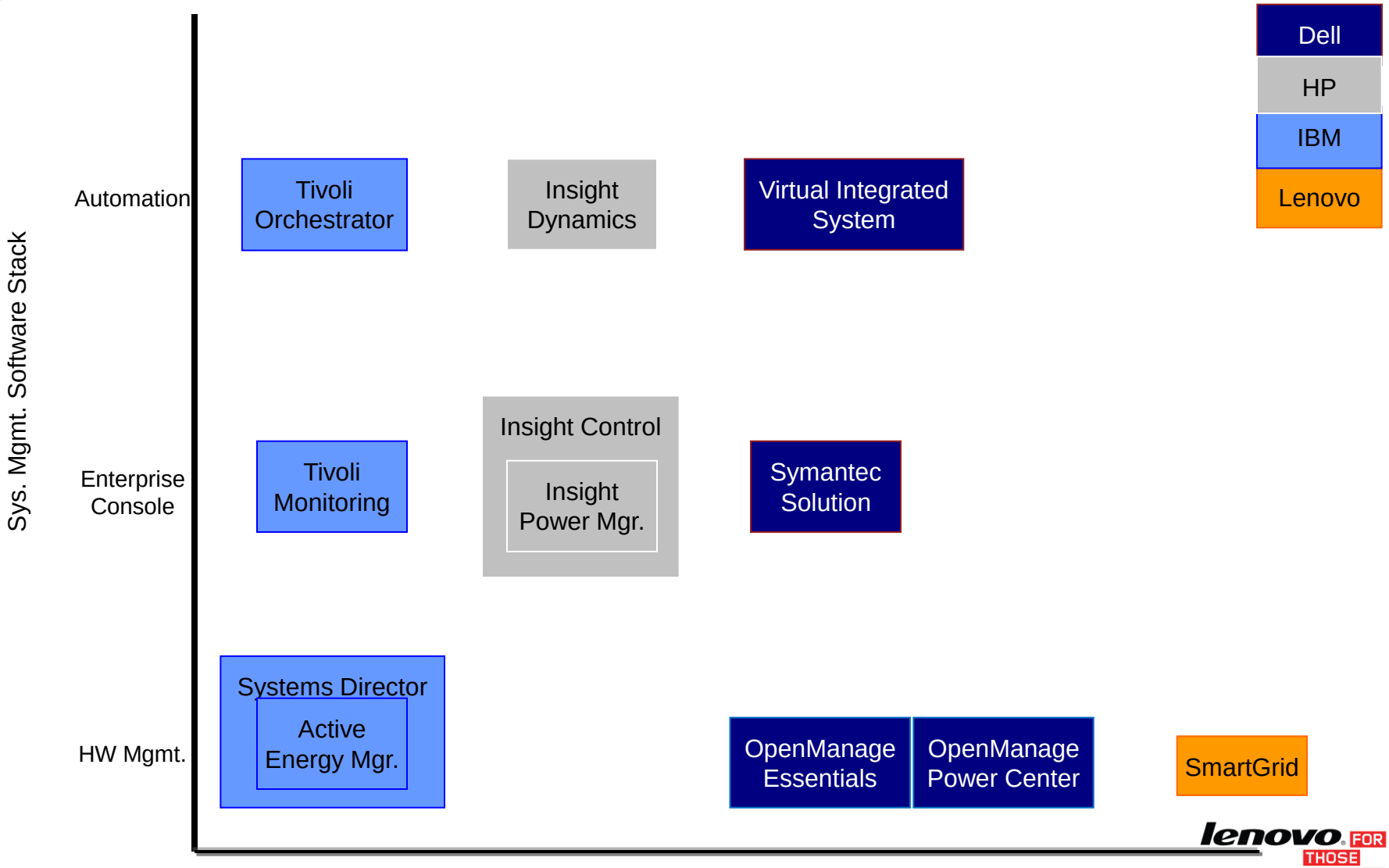
Competitive

SmartGrid Competitive Offerings



SmartGrid Competitive Analysis and Key Differentiation

Feature		IBM AEM v4.1	HP IPM v1.1	SCOM in Windows2008R2	Avocent DSView3, Power Manager	Lenovo SmartGrid (Based on Intel DCM)
Solution Pricing		$140/server	$300/server: SW $200/server: FW	N/A	Commercial, Price N/A	
Monitoring/Trending - Power & Thermal		Yes	Yes	Yes, but power only	Yes	Yes
Control – System Power	Node	Yes	Yes, but limited to built-in recommended range	Yes, static cap	Manage thru the iPDU, threshold only for notification & tripping circuit	Yes
	Group	Yes, budget evenly distributed	Yes, budget evenly distributed	N/A		Scheduling Multiple Policies Server Priority (SLA) Workload Aware Dynamic Power Allocation
Memory power monitoring & control		No	No	No	No	Yes
Power limiting - during OS failure		N/A	N/A	No	Manage thru iPDU, threshold only for notification & tripping circuit	Yes
Safe Turn-On (to Avoid Instantaneous Current Spike)		No	No	No	No	Yes
Manage cross-OEM servers		No (only Power System, System Z, System X, and Blade Center)	No (only HP ProLiant server or HP BladeSystem enclosure)	Yes, but require specific PSU (DMTF Power Supply Profile v1.01)	Yes, require Avocent iPDU	Yes. Require NM1.5 or 2.0 or DCMI

Note: analysis based on SmartGrid v 1.0

NO PARTIAL YES

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Competitive Analysis with Dell OpenManage Power Center

Category	Sub-item	Dell OMPC	Lenovo SmartGrid
General	Integration with existing Sys. Mgt. tools	No	No
	Pricing	The tool itself is free. Requires iDRAC Enterprise.	For fee. Optional.
	Device support	11th and 12th Generation PowerEdge servers. PDU, UPS, chassis	Lenovo Romley racks
	Supported languages	6	2
	Maximum Number of Managed Nodes	2,000	1,000
Features	Thermal monitoring	Yes	No
	Monitor & control by physical location	Yes	No
	Reporting	No	Yes
	Performance monitoring	No	Yes
	Virtual Power Meter	No	Yes
User Experience /GUI	Shortcut to launch the web console	Yes	No
	Integrated Windows login	Yes	No
	Wizard to set power policy	Yes	No
	Graphically displaying rack	Yes	No
	Number of navigations required to perform the same task	Less	More
Customization	Number of customizable settings	20+	3
Security	HTTPS support	Yes	No

Has advantage

Note: analysis based on SmartGrid v 1.0

Note: The above table is created by comparing to OMPC A00 1.0.1 which was released on 3/6/2012.

Third Party Management Applications Supporting Node Manager

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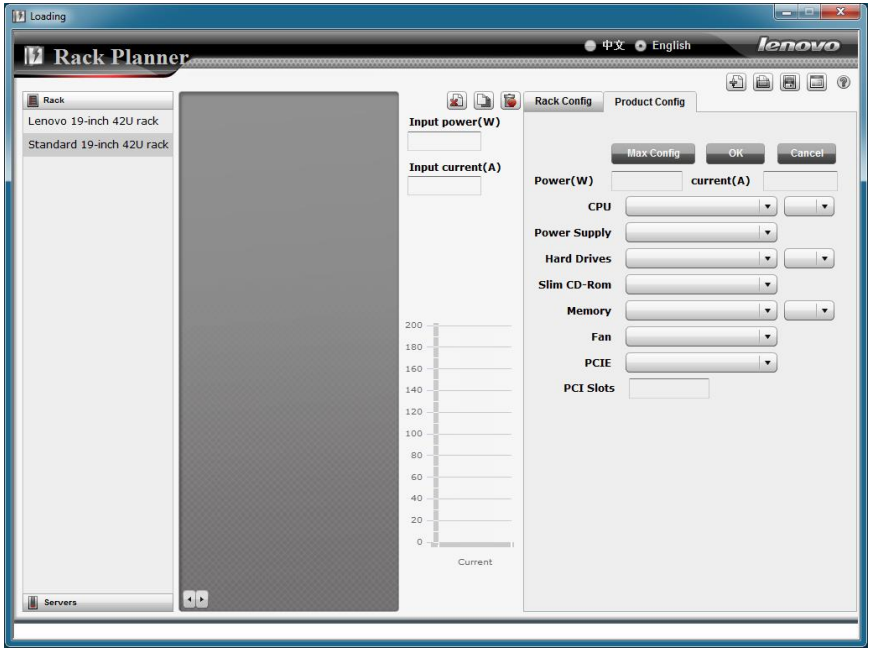
RackPlanner Demo

Launching the application

- Specify infrastructure parameters (optional)
- Configure rack and server parameters
- Save and recall configurations
- Print reports



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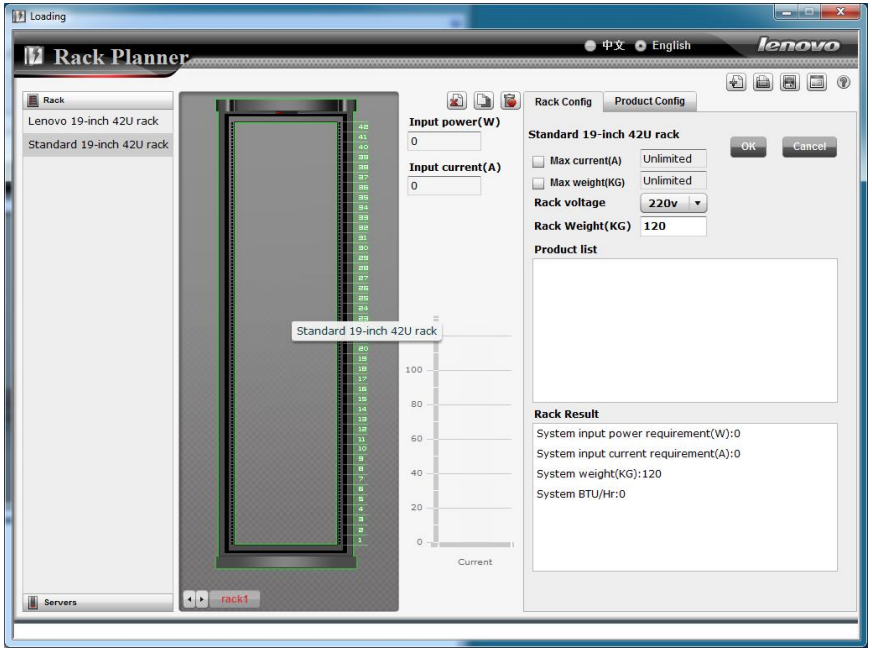
Adding a rack

- Drag and drop a rack from the list to the configuration area
- Configure rack parameters
  - Input power / voltage / weight
  - Specify maximums allowed (optional)



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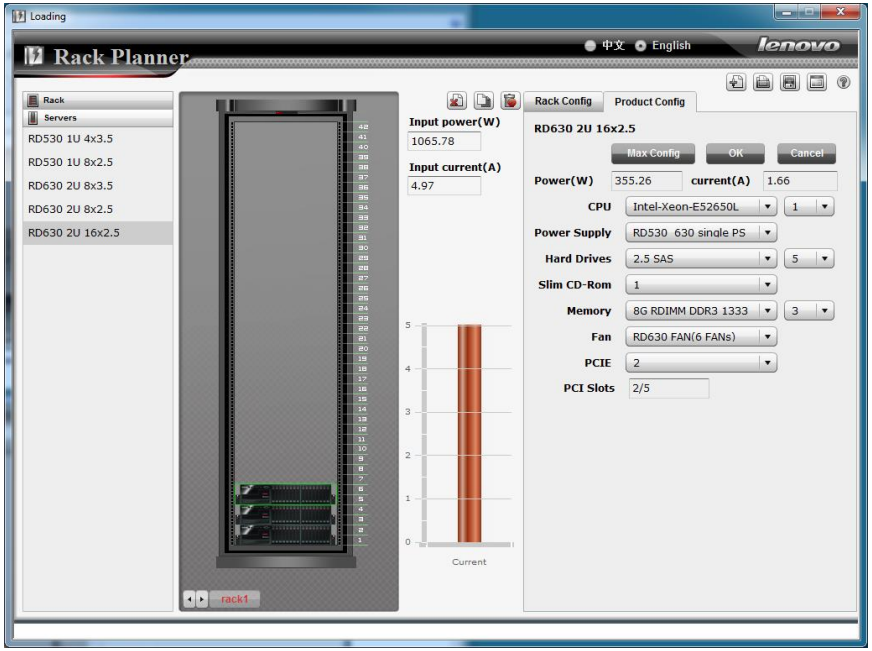
Adding a Server

- Drag and drop server model from the list to the configuration area
- Configure server parameters
  - Hardware and options
  - Option for “Max Config”
- Cumulative totals added to graph area
- Rack parameters can limit configuration



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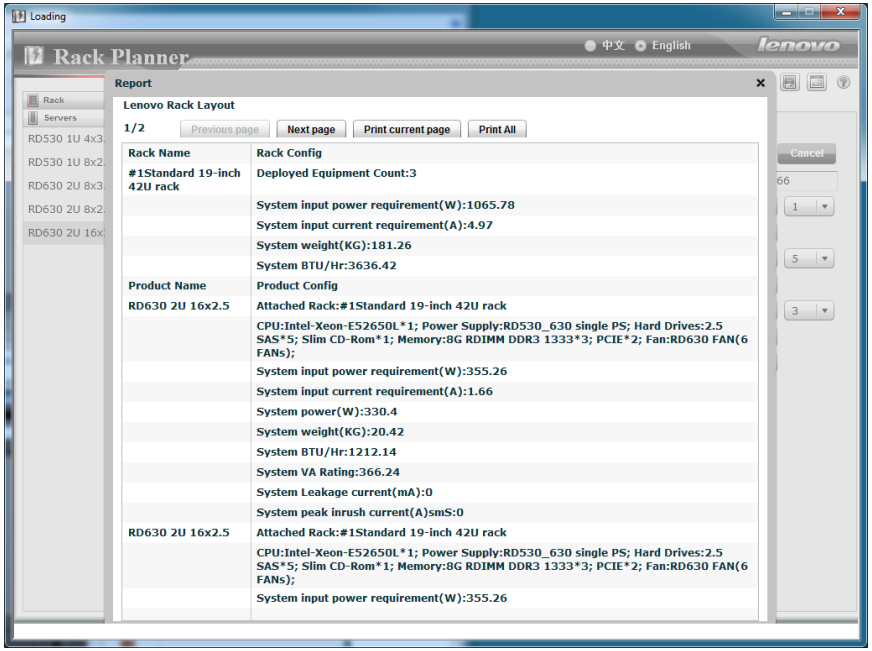
Print Reports

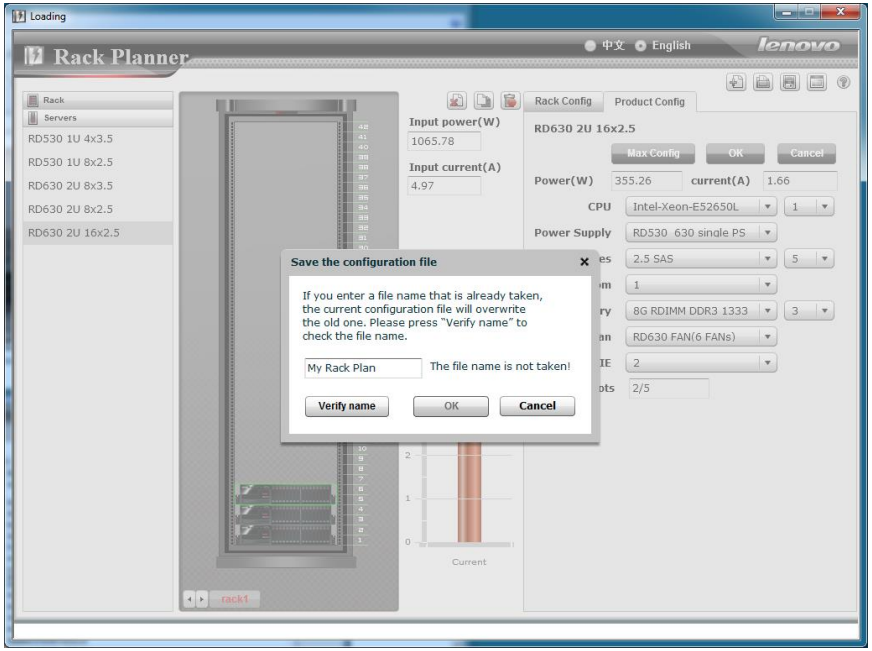
- Reports for current configuration available



Rack Name	Rack Config
#1Standard 19-inch 42U rack	Deployed Equipment Count:3
	System input power requirement(W):1065.78
	System input current requirement(A):4.97
	System weight(KG):181.26
	System BTU/Hr:3636.42
Product Name	Product Config
RD630 2U 16x2.5	Attached Rack:#1Standard 19-inch 42U rack
	CPU:Intel-Xeon-E52650L*1; Power Supply:RD530_630 single PS; Hard Drives:2.5 SAS*5; Slim CD-Rom*1; Memory:8G RDIMM DDR3 1333*3; PCIE*2; Fan:RD630 FAN(6 FANs);
	System input power requirement(W):355.26
	System input current requirement(A):1.66
	System power(W):330.4
	System weight(KG):20.42
	System BTU/Hr:1212.14
	System VA Rating:366.24
	System Leakage current(mA):0
	System peak inrush current(A)smS:0
RD630 2U 16x2.5	Attached Rack:#1Standard 19-inch 42U rack
	CPU:Intel-Xeon-E52650L*1; Power Supply:RD530_630 single PS; Hard Drives:2.5 SAS*5; Slim CD-Rom*1; Memory:8G RDIMM DDR3 1333*3; PCIE*2; Fan:RD630 FAN(6 FANs);
	System input power requirement(W):355.26

Save and recall configurations

- Configurations can be saved for reuse within the application



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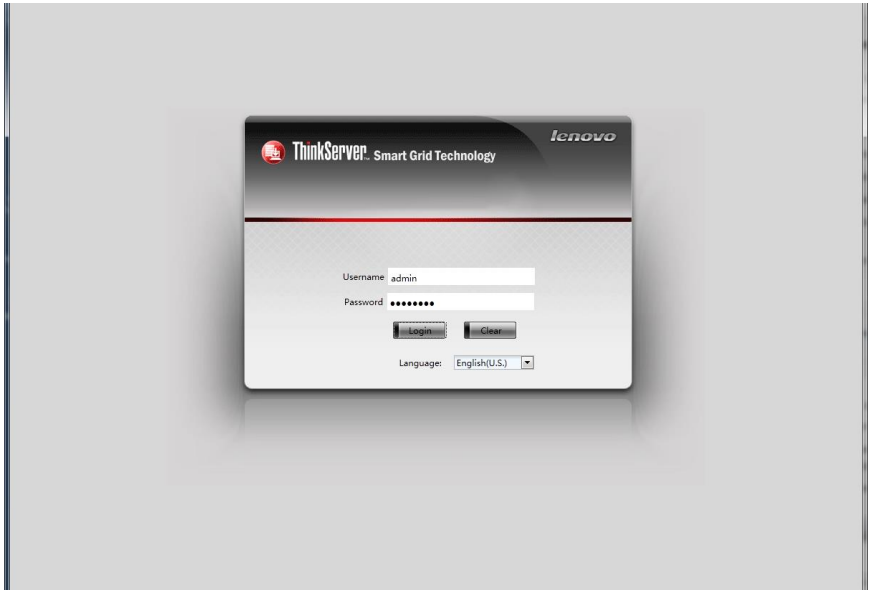
SmartGrid Demo

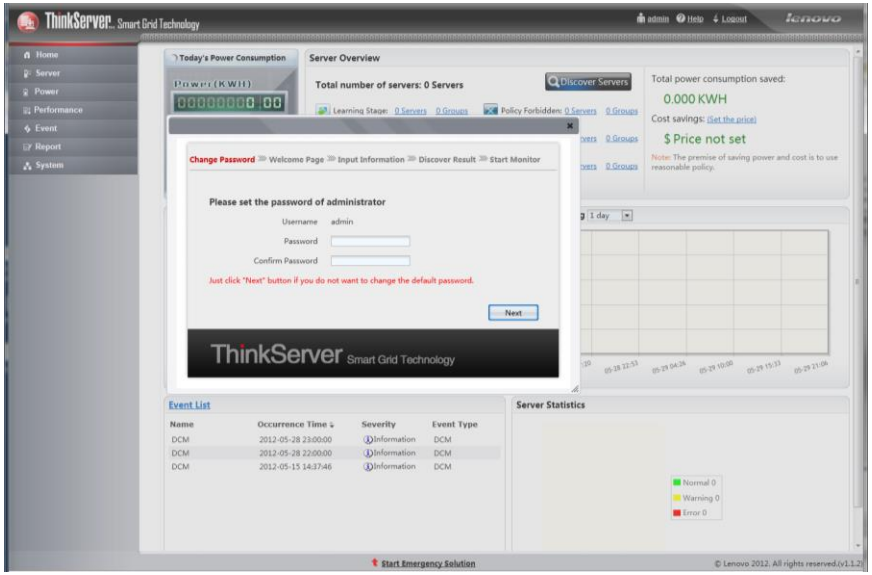
Launch the application

- Login to Smartgrid using the server's IP address
  - http://ip:8888/smartgrid
  - Default user id = "admin"
  - Default password = "Passw0rd"



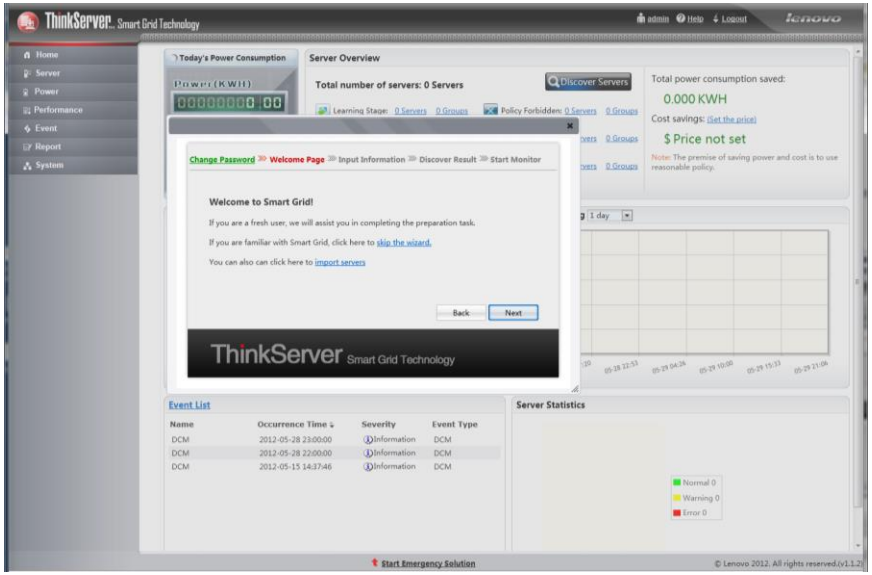
Reset default user password

- Optionally, change the default administrator password at this time and click next
- Can also change in “System / User” settings later



Initial configuration wizard

- Perform initial server discovery and define learning period



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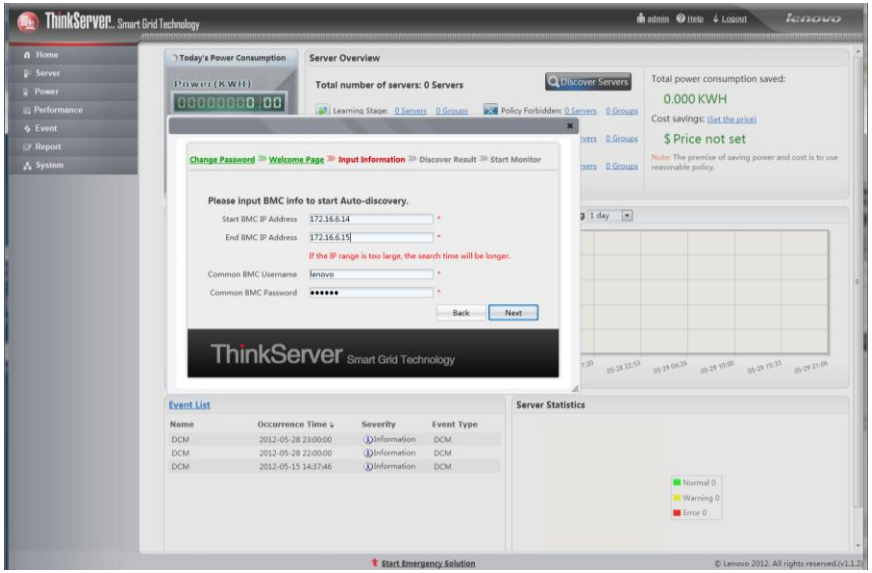
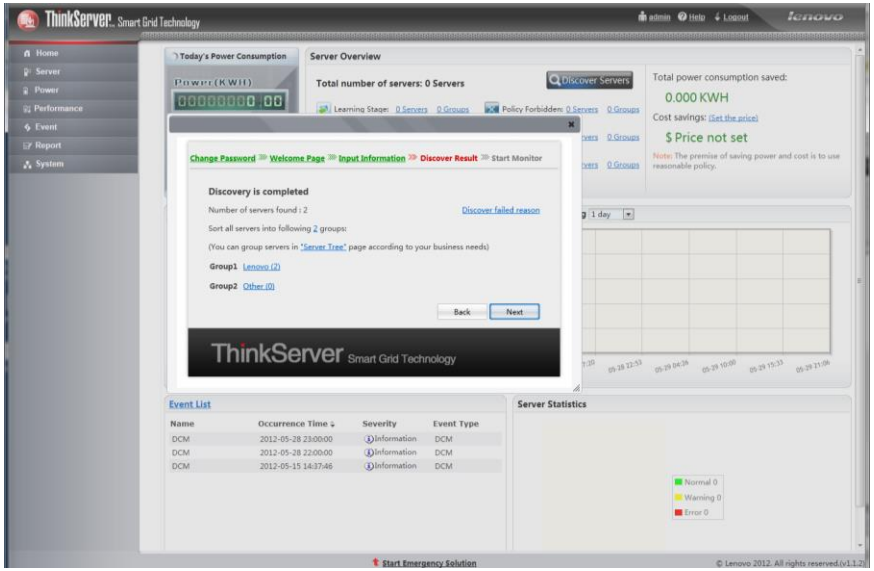
Specify discovery parameters

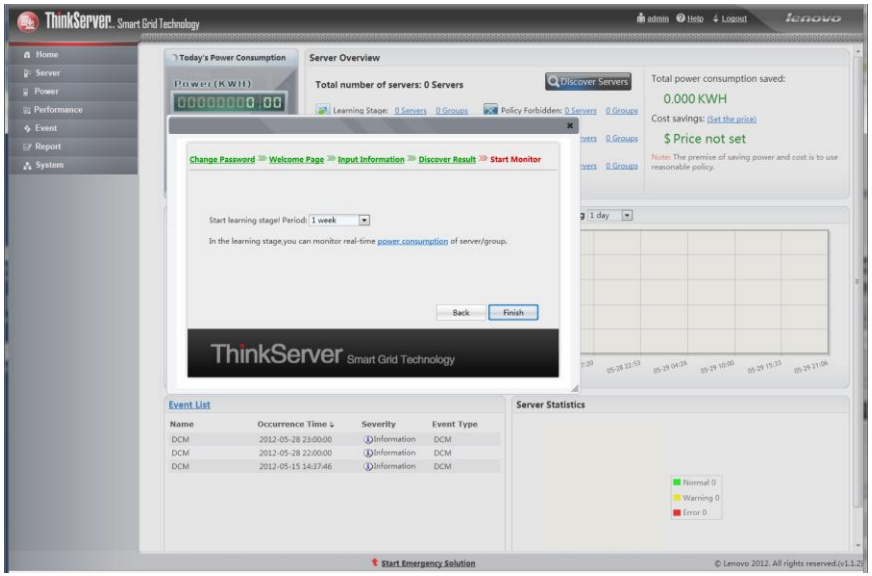
- SmartGrid communicates with each server TMM (BMC). User credentials must be provided in order to communicate with the TMM. Provide them now.
- Provide an IP address range to search for servers, and credentials.
  - The default credentials for TMM are “Lenovo” “Lenovo”, and are prepopulated for you.
  - The address range should be as input in the figure.



Server Discovery

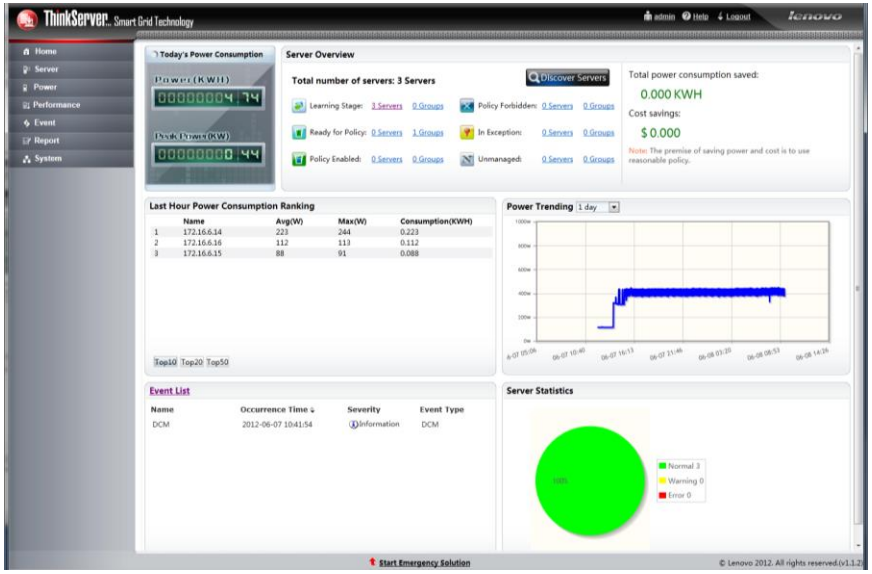
- Discovery completes and displays the number of servers found.
  - Automatic placement into groups
- Specify learning period for new discoveries
  - Default period is one week





Home page

- Home page after discovery shows individual consumption, aggregate power trends, errors and warnings statistics
- “Today’s Power Consumption” shows sum of power consumed by all managed servers today; “Peak Power” shows maximum power for that day for managed servers
- “Total Power Consumption Saved” calculates saved power based on power reduction after power policies are applied using defined cost / KW
- “Server Overview” displays policy details and error status for managed servers



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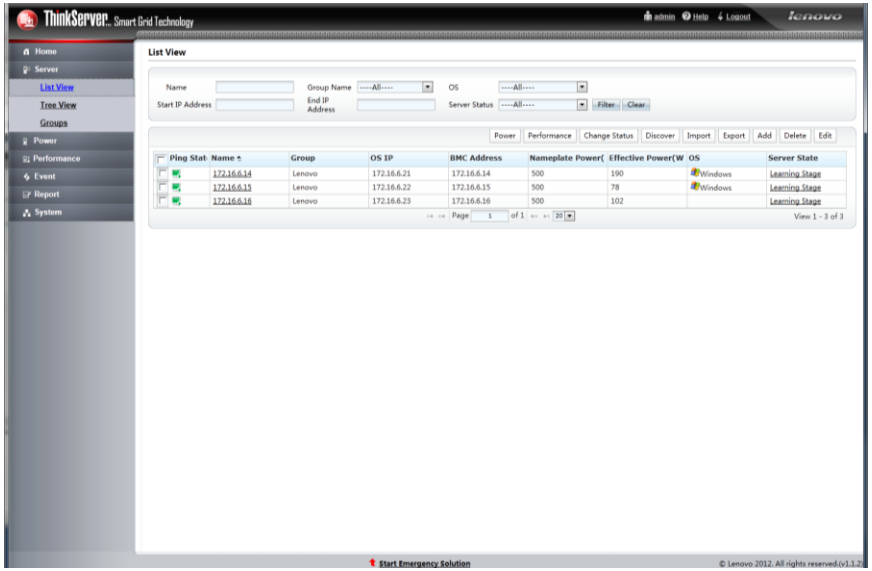
Server page (list view)

- Provides current status of discovered machines
- “Effective Power” is the average power of the server during it’s learning phase
- “Nameplate Power” is rating from the PSU



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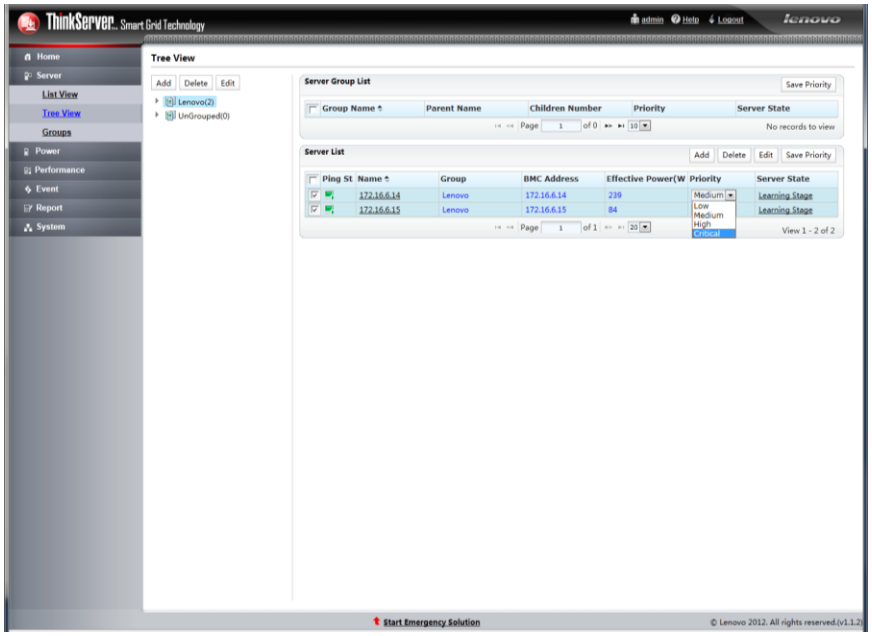
Server page (tree view)

- Provides current status of discovered machines
- Adds policy “priority” feature
  - Effective priority of policies within the group – aims to allocate more power to higher-priority nodes, however, does more power than the node needs



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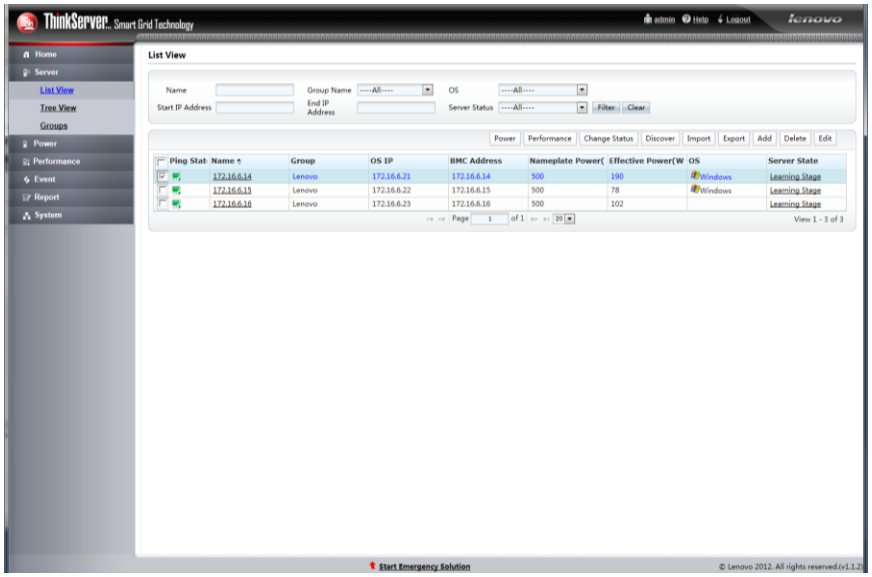
Enable performance data collection

- For Windows and Linux servers, prepare OS to accept performance monitoring (see user's guide)
- Configure servers to associate OS environments with respective TMMs. Select the server to modify and press "Edit"



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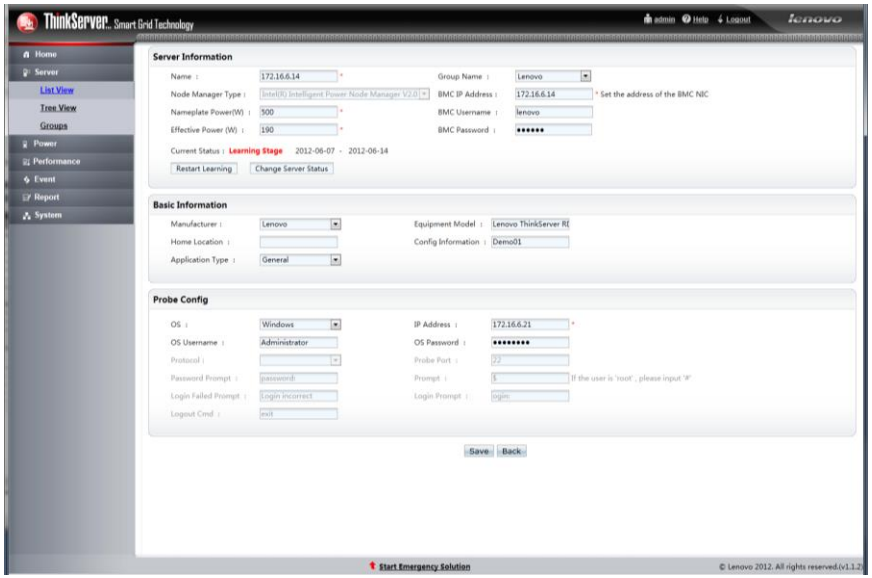
Associate TMM with Server OS

- Enter IP address OS type (configures management protocol to use), and Administrator credentials



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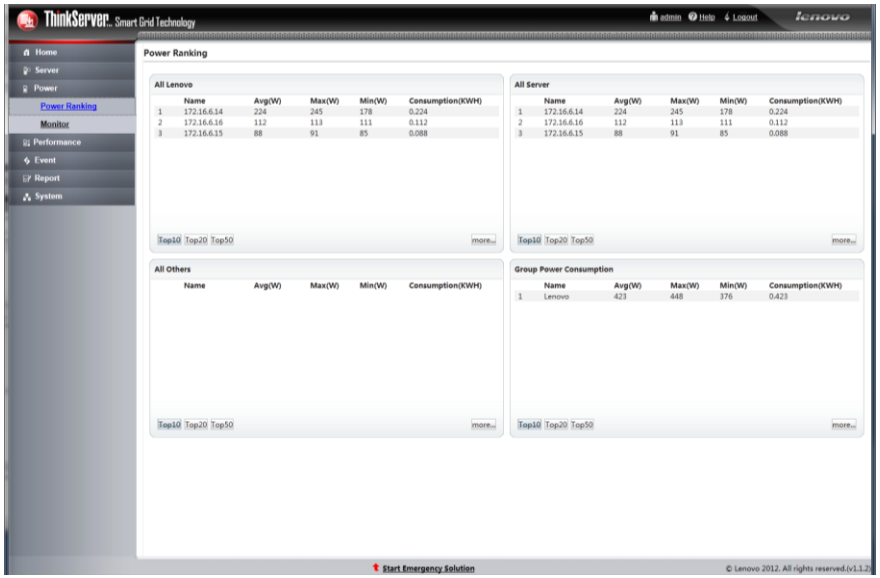
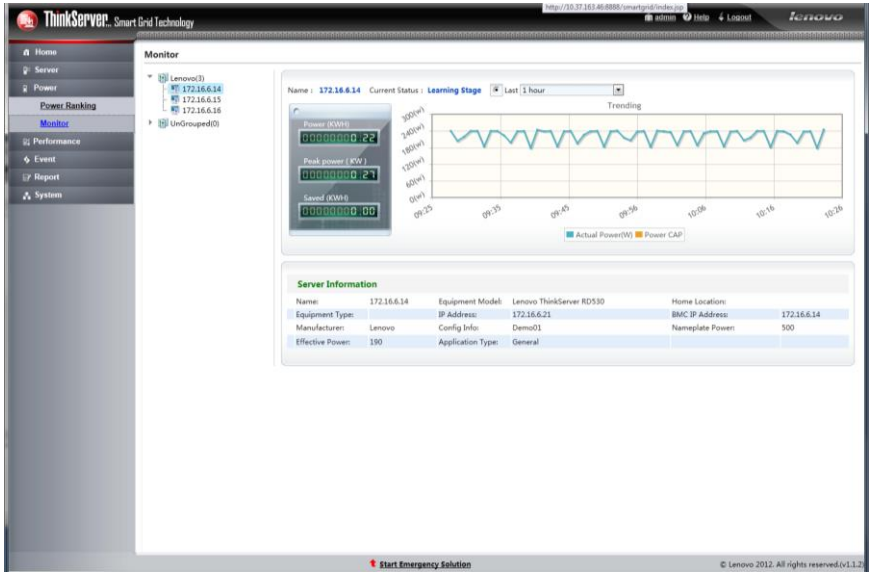
Power Monitoring

- Power ranking by usage
- Power monitoring by individual server





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Performance monitoring

- Performance ranking by usage
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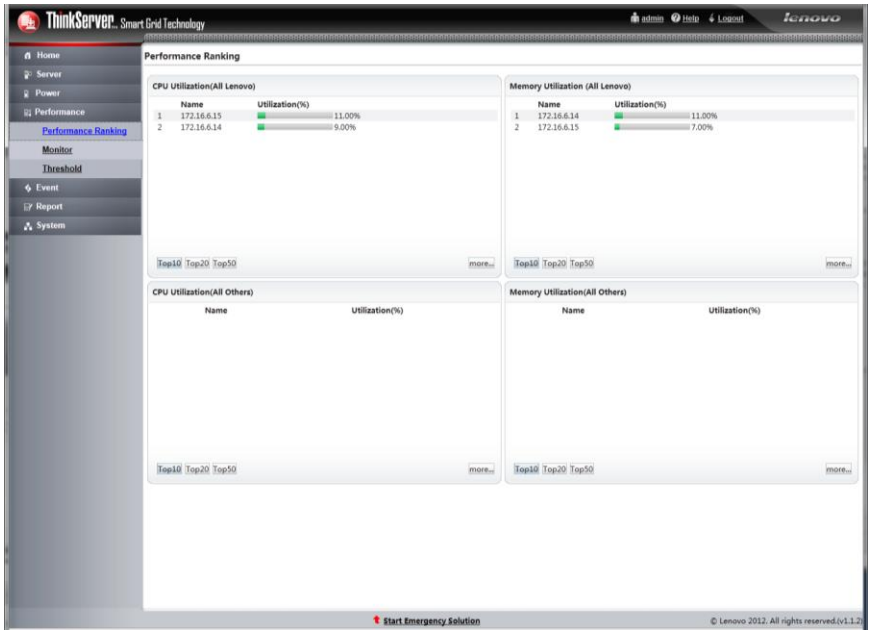

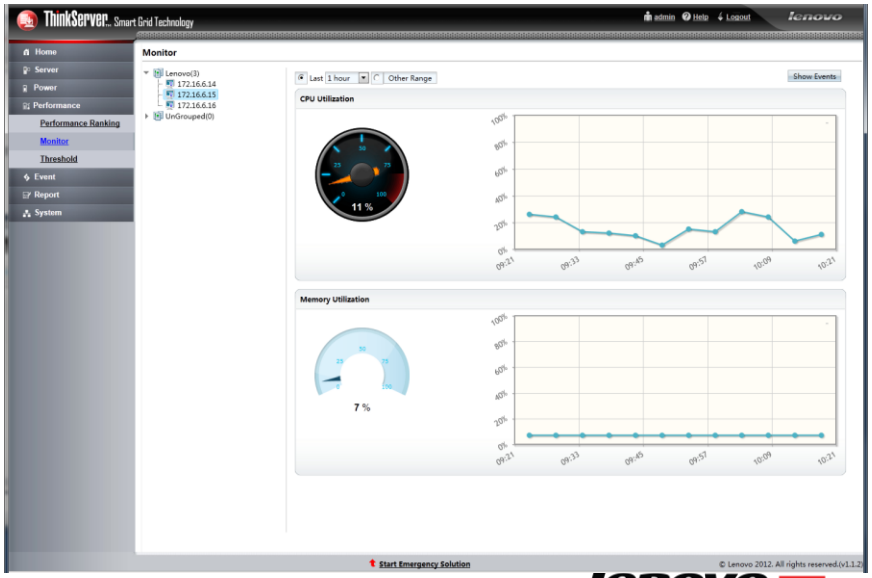

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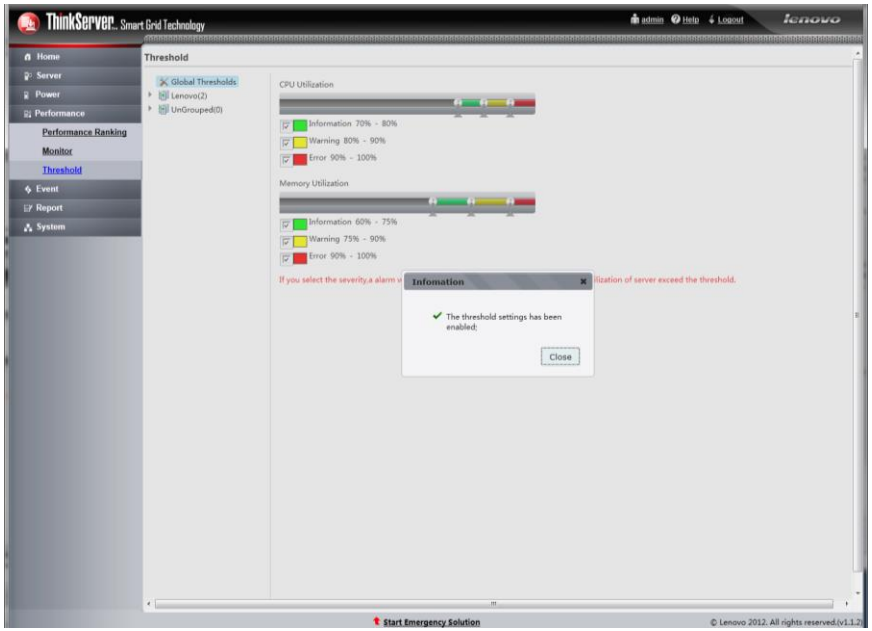
Performance thresholds

- Set performance thresholds – causes alerts to be sent when thresholds crossed.
- Grab sliders and move into desired position.



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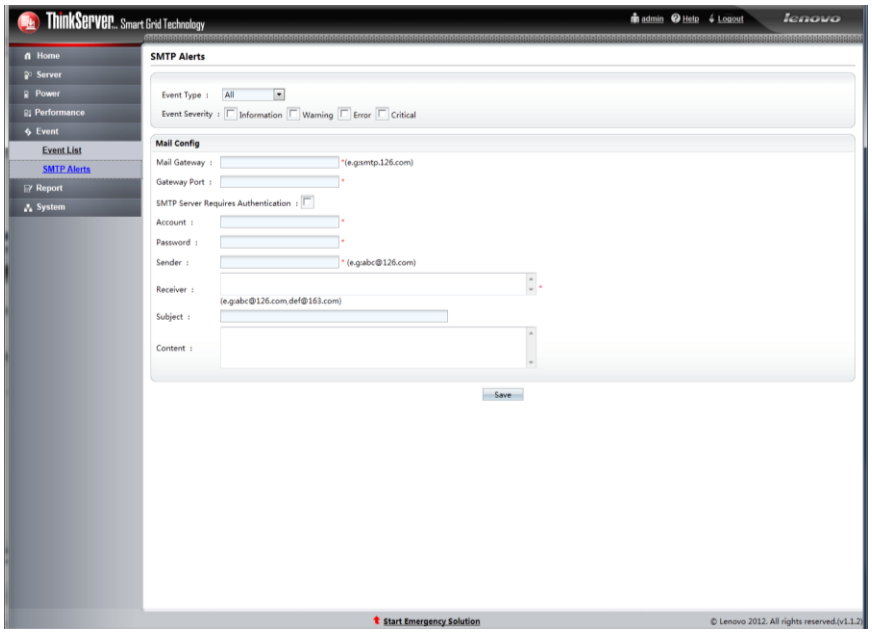
Configuring alerts

- Specify alert types to report
- Configure SMTP server and credentials / email addresses



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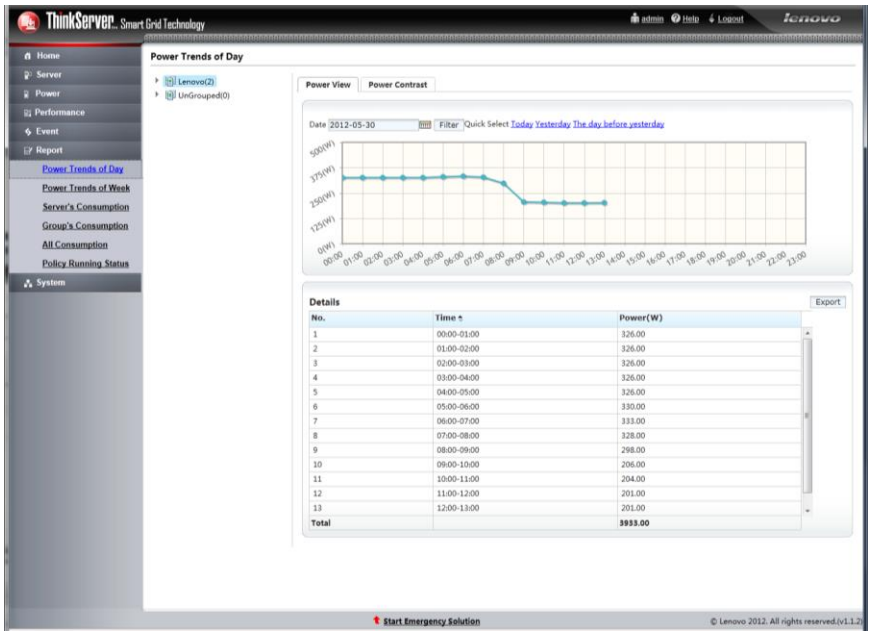
Reports

- Various reports available
  - Power trends by day
  - Power trends by week
  - Individual server power consumption
  - Group power consumption
  - Total consumption
  - Power policy status



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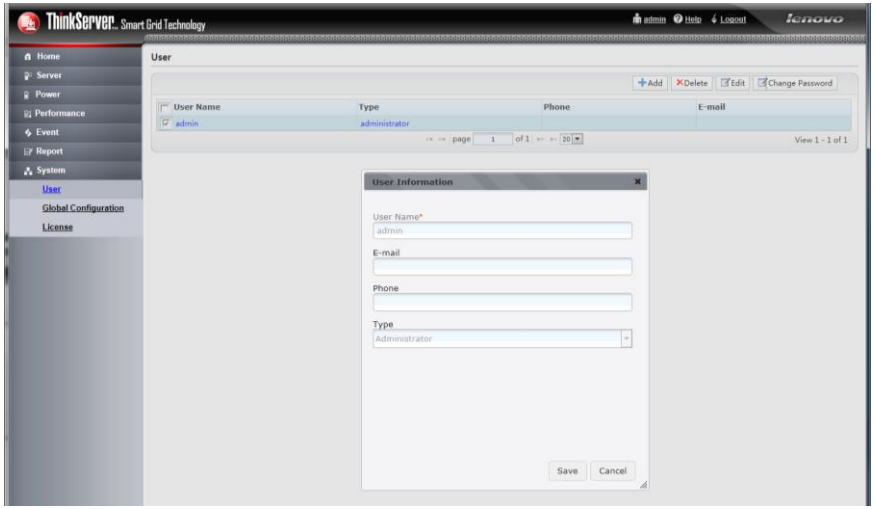
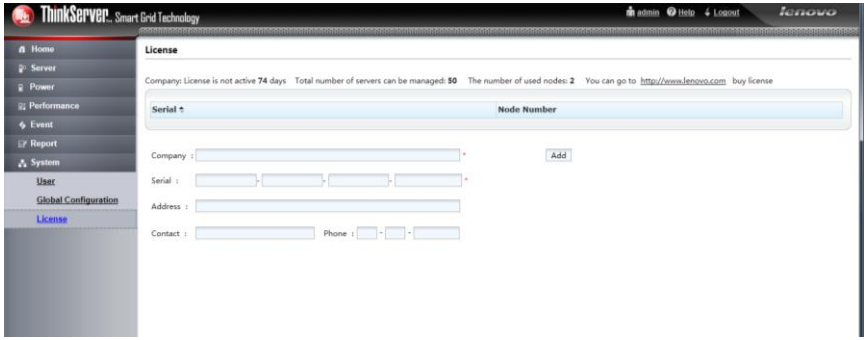
System Settings

- Authorized users
  - User or Administrator privileges
- Data retention periods
- Licensing





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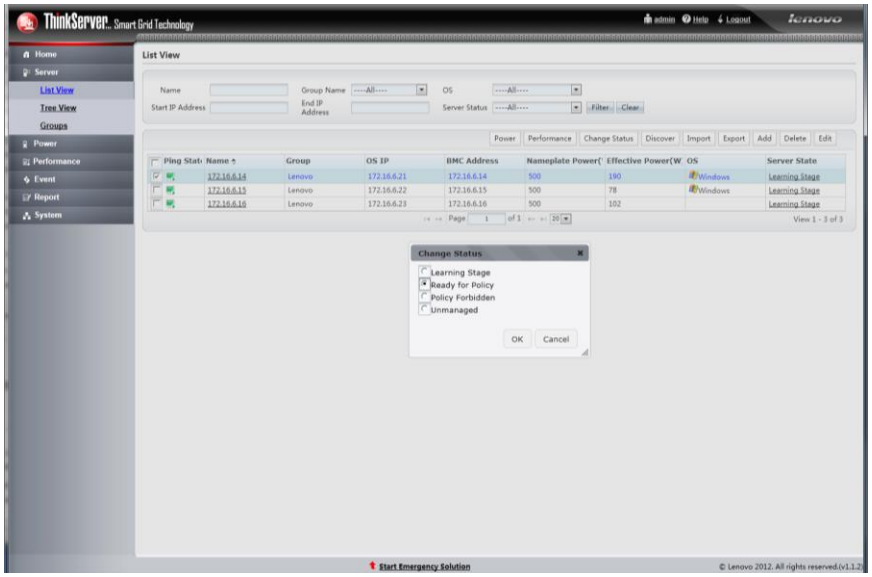
Defining Power Policies

Setting Power Policies

- After learning period, status changes automatically to “Ready for Policy”
- Change status manually to immediately enable setting power policy



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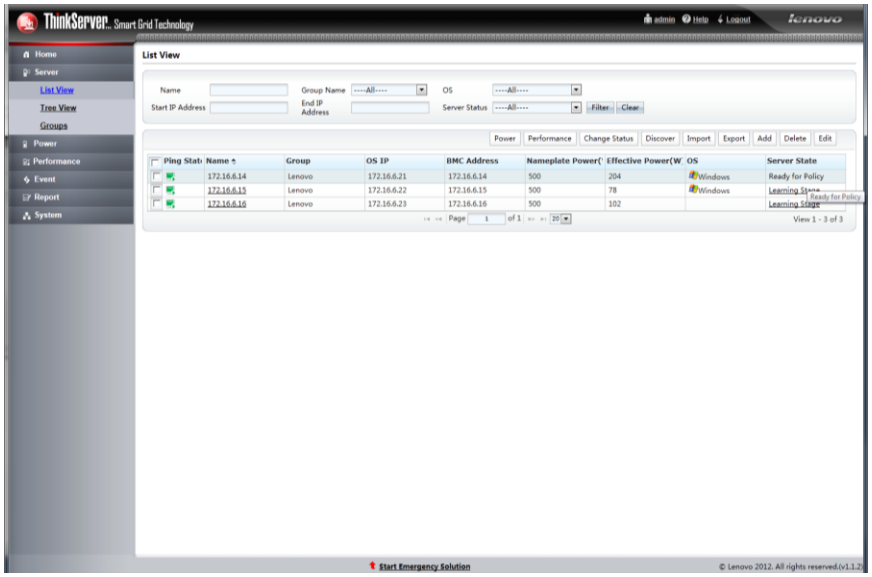
Define policy

- Click “Ready for Policy” from server page



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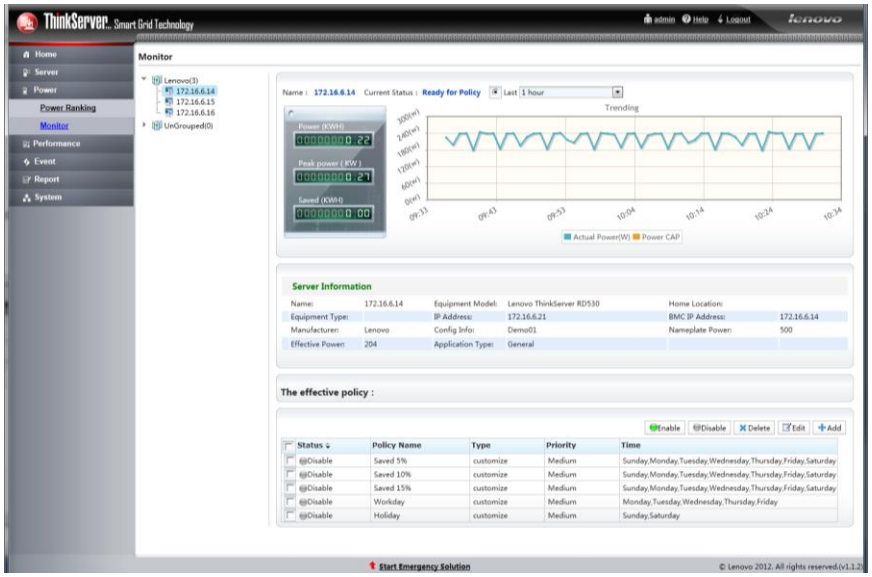
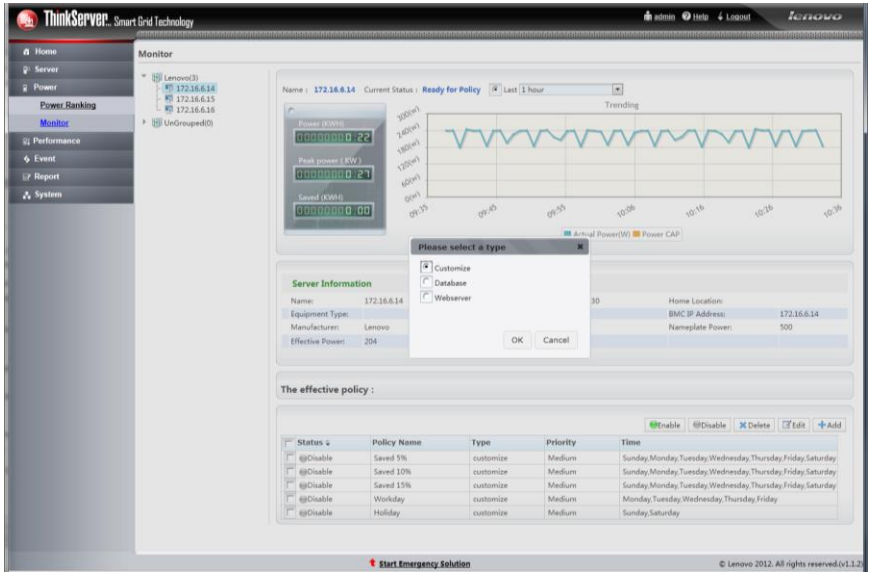
Define policy (cont.)

- When server status able to set policies, monitoring page changes (shows available policies)
- Several default policies available:
  - 5% – servers used mainly for CPU intensive applications (e.g. Web server). Higher CPU requirements provide less oppty to save power
  - 10% – servers used mainly for memory intensive applications. Greater opportunity to save power
  - 15% – servers used mainly for disk I/O intensive applications (e.g. database server). Have least CPU performance requirements, provides greatest opportunity for power savings



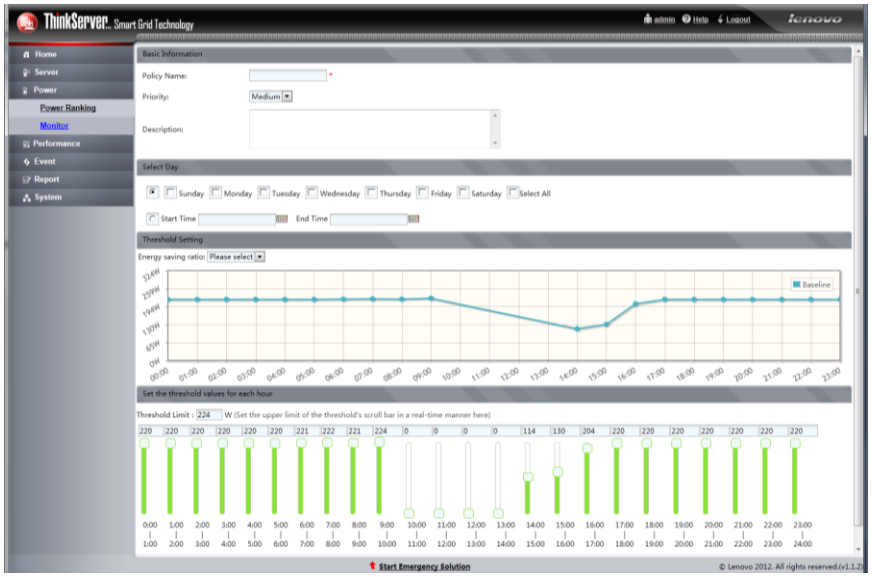
Create new policy

- Click add to create custom power profile



Power Policy – Historical Consumption Data

- History of actual consumption displayed
- Note periods where historical consumption is at zero. We interrupted learning phase so no data was collected. Must adjust this in final policy)



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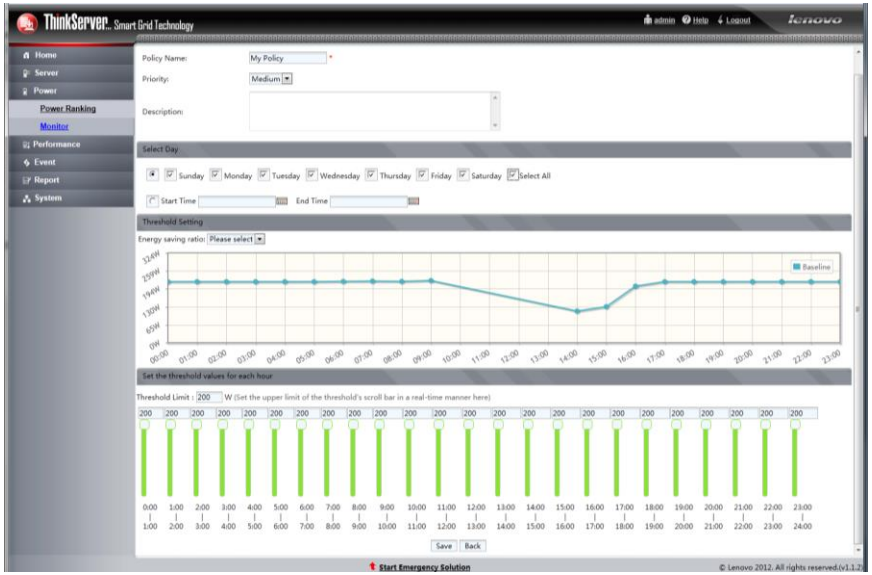
Power Policy Definition

- Adjust sliders to fit desired profile. In this case about a 10% saving (220 -> 200).
- Specify policy name and other details
- Set priority
  - If multiple policies are in affect at one time, policies with higher priority will be loaded first
  - For the policies that conflict with one another but have the same priority, the policy with the smaller energy saving control value will be loaded first



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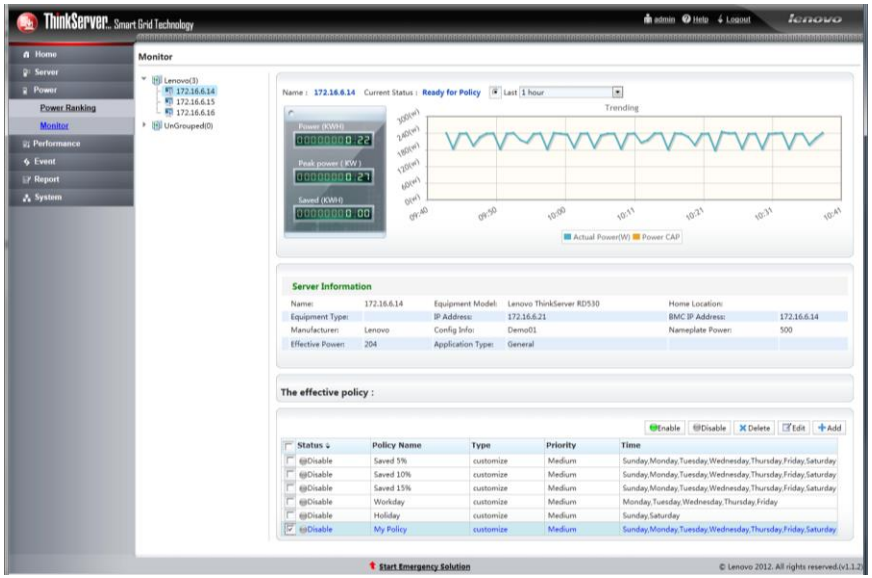
Enable Power Policy

- Click “Enable” for the selected policy to enable on the server



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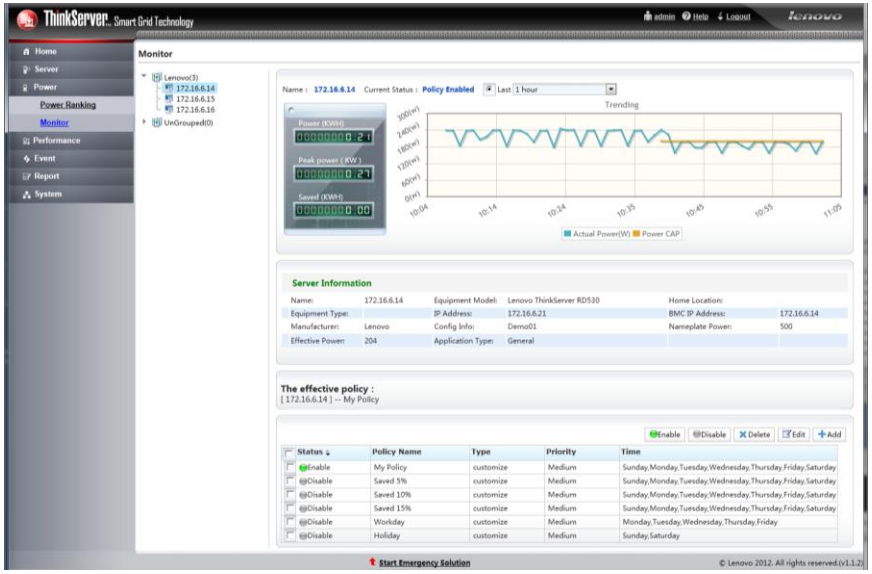
Policy in place

- Effective policy is shown with yellow line.
- NM on the server modifies CPU and memory operating frequency to maintain set power utilization.
- Alerts are sent if power policy cannot be maintained.



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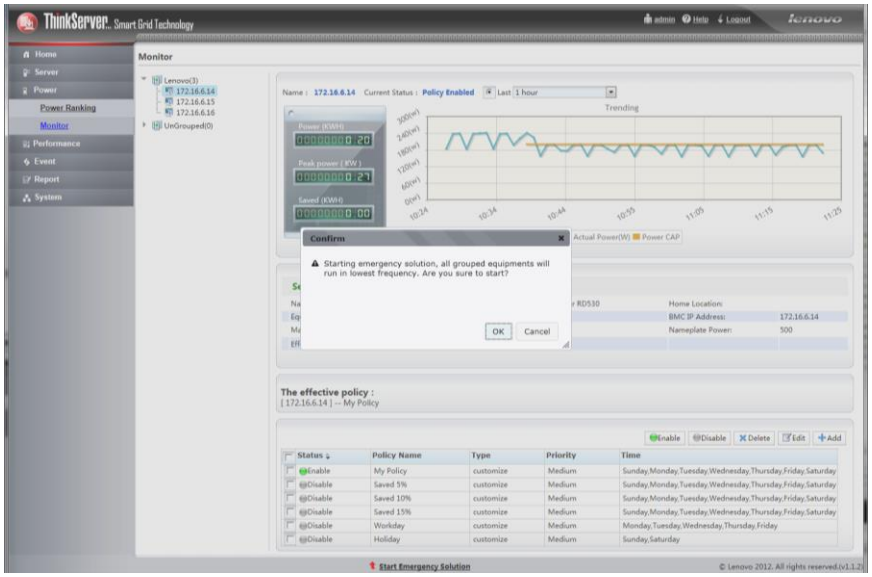
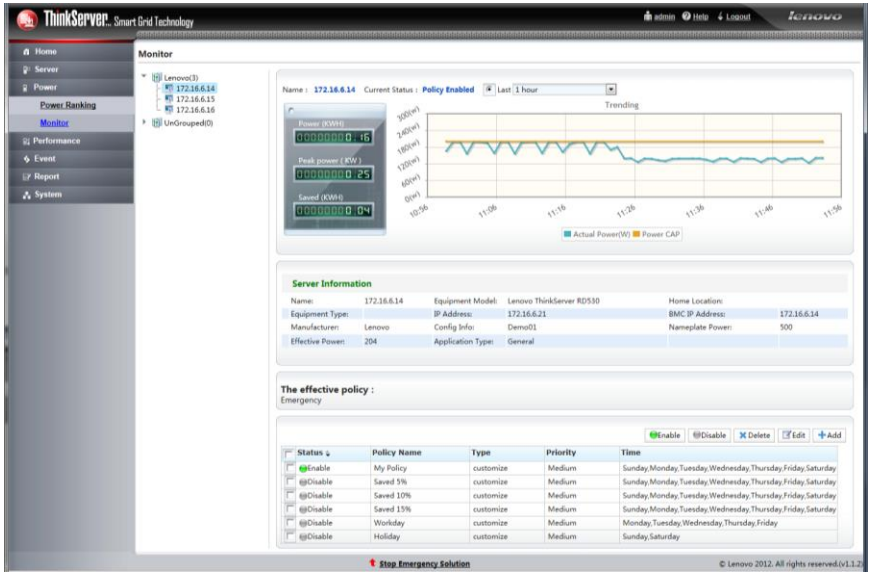
Emergency Solution

- Emergency solution sets all managed servers to lowest operating frequency – designed to prolong power-on time as much as possible to enable devices to shut down properly
- The emergency plan has the highest priority and overrides all policies currently in effect



Emergency Solution in Operation

- Shows operating power at lowest possible operational state.



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Backup

Gains in Performance & Energy Efficiency – Another View

2005

15 racks of Intel® Xeon® Single Core Servers

2011

Consolidate workloads to drive up system utilization

Efficiency Refresh 15:1

1 rack of Intel® Xeon® 5600 Based Servers

95% Annual Energy Cost Reduction (estimated)

As Low as 5 Month Payback

Or, increase computing capacity.

Performance Refresh 1:1

15 racks of Intel® Xeon® 5600 Based Servers

Up to 15x Performance

8% Annual Energy Costs Estimated Reduction (estimated)

Data is shown for replacement of servers with Westmere technology. Expect even greater benefits for Romley.

Source: Intel

