Spart energieeffziente Hardware Strom?

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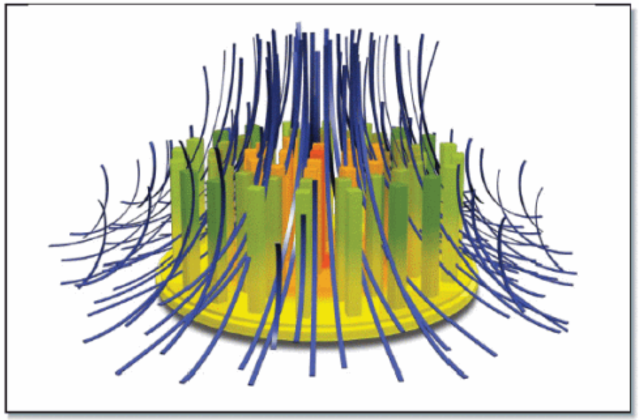
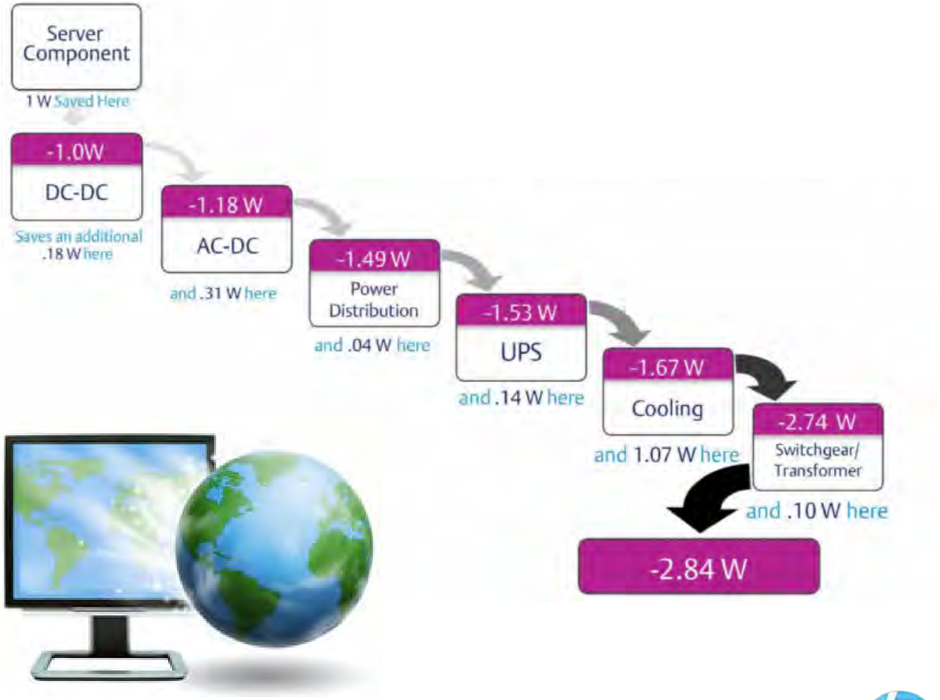
Was bedeutet “energieeffiziente Hardware”?

– Je weniger Energie für die gleiche Leistung benötigt wird, desto höher ist die Energieeffizienz. Die Energieeffizienz lässt sich in erster Linie durch effizientere Technik steigern.





Server Component

1 W Saved Here

-1.0W

DC-DC

Saves an additional .18 W here

-1.18 W

AC-DC

and .31 W here

-1.49 W

Power Distribution

and .04 W here

-1.53 W

UPS

and .14 W here

-1.67 W

Cooling

and 1.07 W here

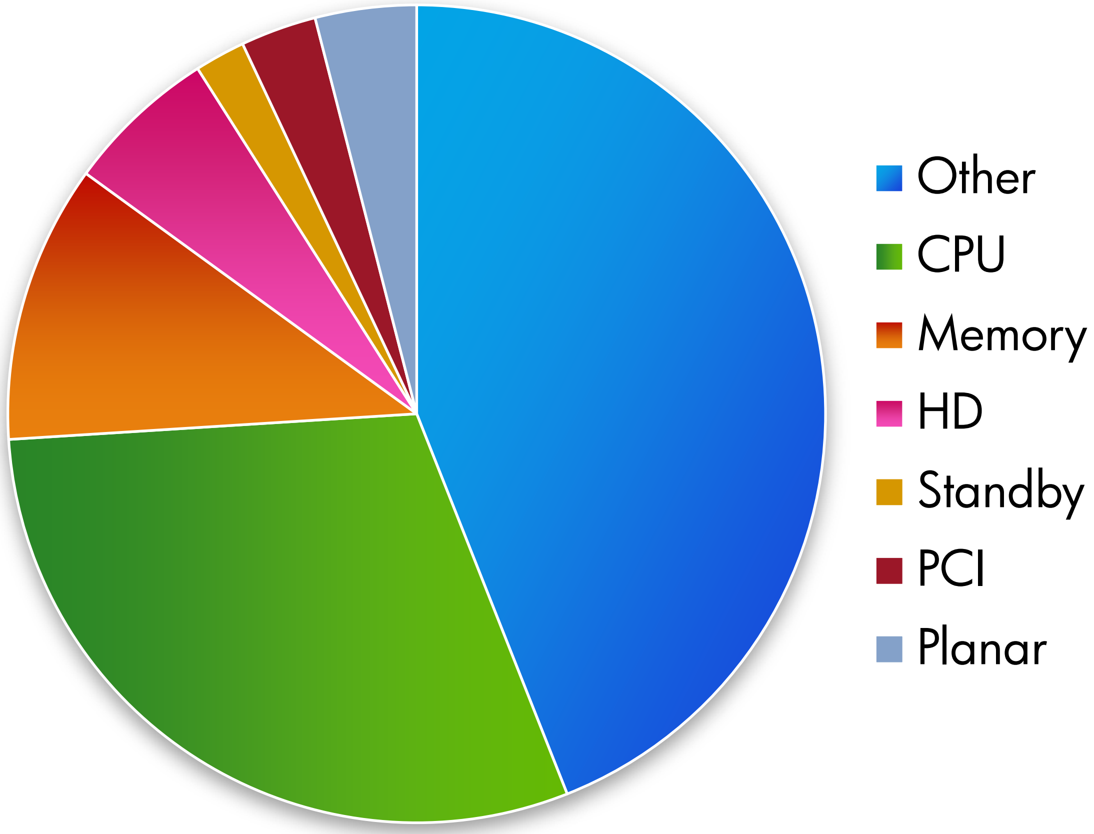
-2.74 W

Switchgear/ Transformer

and .10 W here

-2.84 W

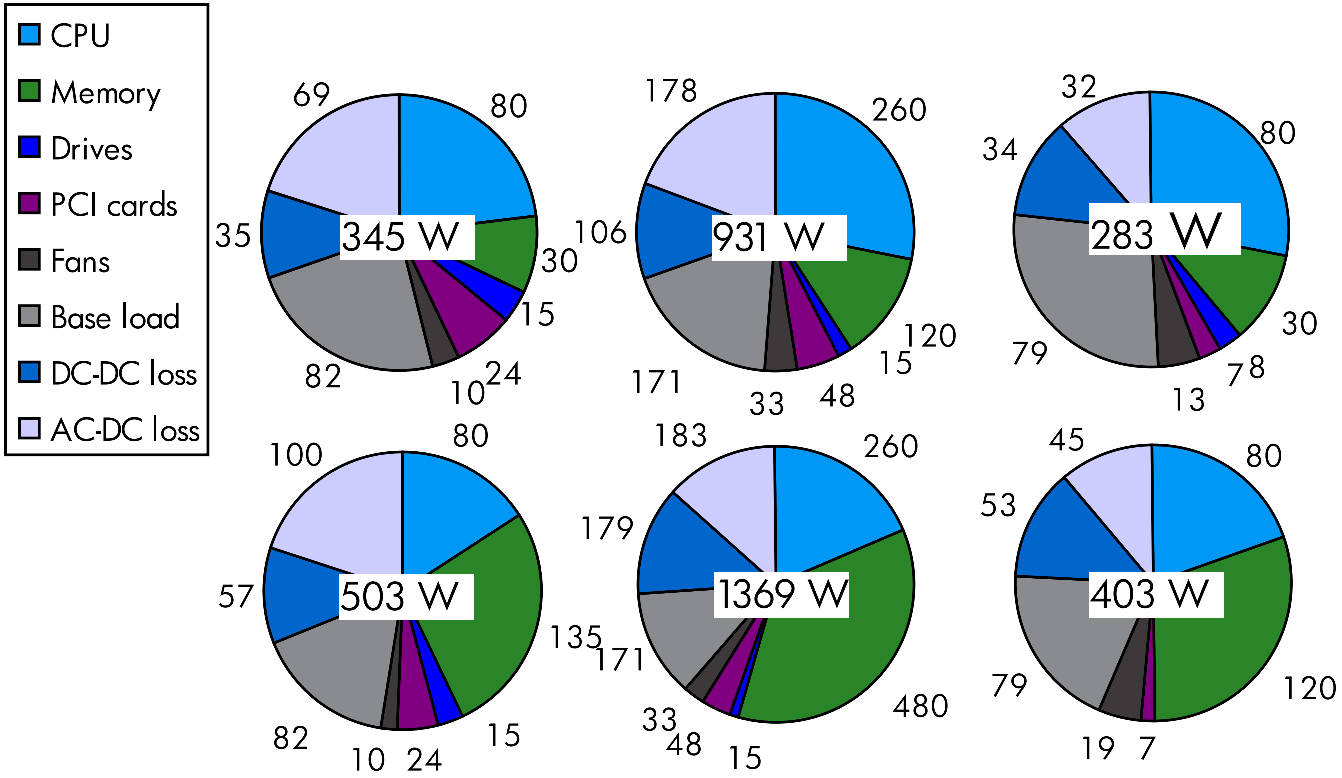
Wo bestehen Einflussmöglichkeiten?



OTHER?

- AC to DC Transitions (25%)
- DC to DC Deliveries (10%)
- Fans and air movement (9%)

Es gibt beliebige viele Verteilungen



DL380 G6
2-socket rack*

DL580 G6
4-socket rack*

BL460c/490c
G6 blade
2-socket*†

Typical config

Rank:

1. CPU
2. Base
3. AC-DC
4. DC-DC

Max memory

Rank:

1. Mem
2. CPU
3. AC-DC
4. Base

* Predictions based on early analysis

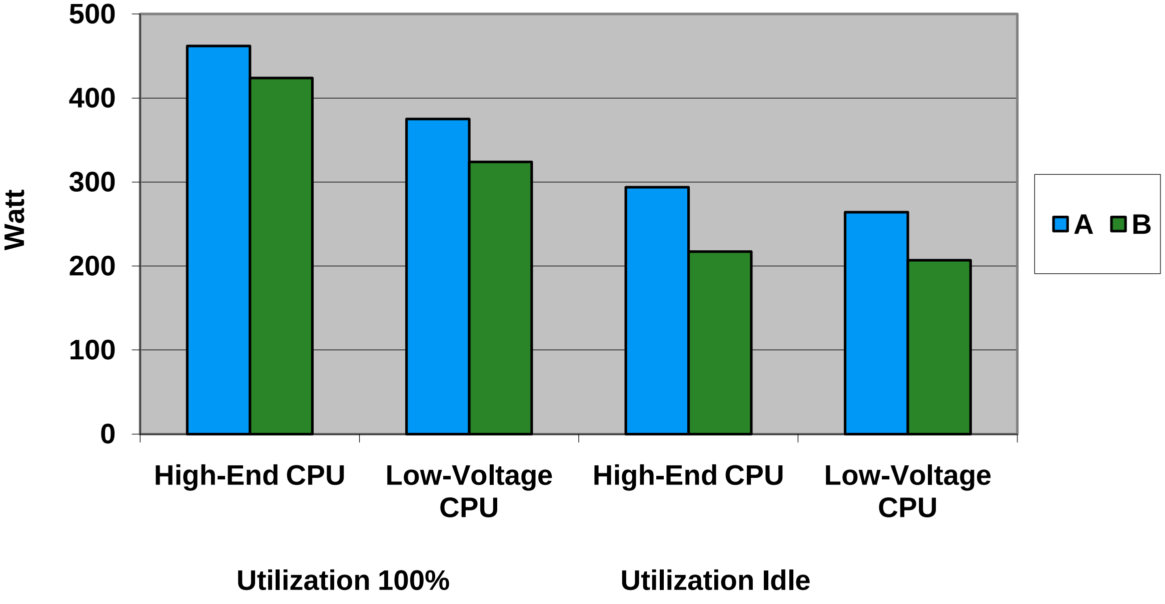
† Assumes 2 OA's, 2 switches, 10 fans @22 °C amortized across 16 blades

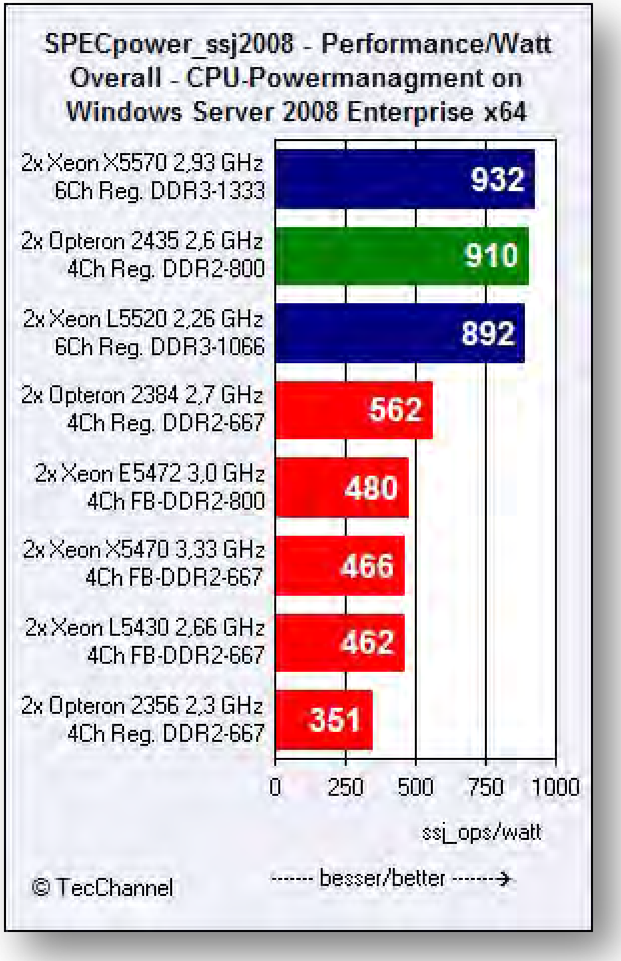
Power Management Elemente

- Processor
- Chipset
- Platform
- Operating System (not user settable policy)
- Operating System (user settable policy)
- Application

Low Power Prozessoren – Einsparung?

- Lohnt sich die LP Variante?
- Gibt es Vergleiche?





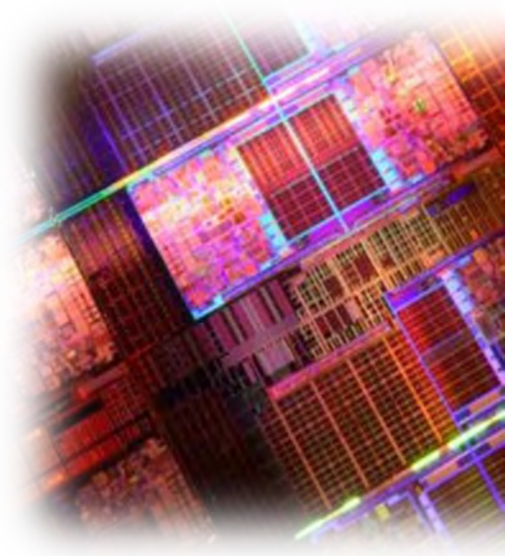
Low Power Prozessoren – Einsparung?

Beispiel auf Basis Intel E/L 5520 QuadCore

- Intel® Xeon® Processor E5520 (2.26 GHz, 8MB L3 Cache, **80W**, DDR3-1066, HT, Turbo 1/1/2/2)
- Intel® Xeon® Processor L5520 (2.26 GHz, 8MB L3 Cache, **60W**, DDR3-1066, HT, Turbo 1/1/2/2)

Gleiche Performance aber 2* 20 Watt Unterschied in einem 2 Sockel System

- Preisdifferenz ~200$, bei 2 Sockeln ~400$
- Preisdifferenz Energiekosten nach 3 Jahren: ~263 $

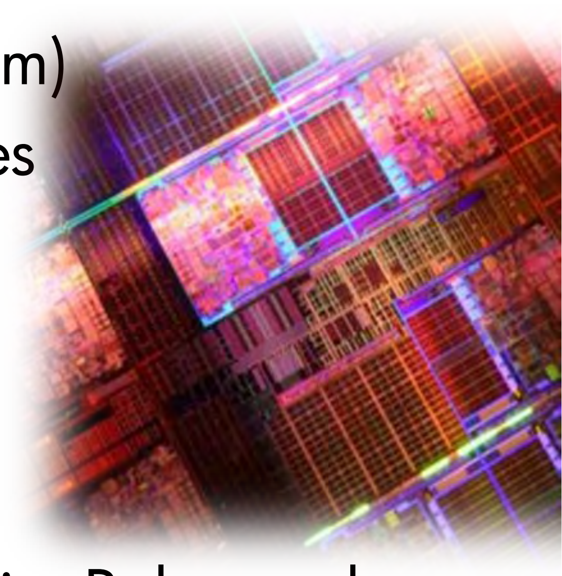


Welche Performance ist überhaupt notwenig?

*Berechnungen auf Basis Listpreis und Power Advisor

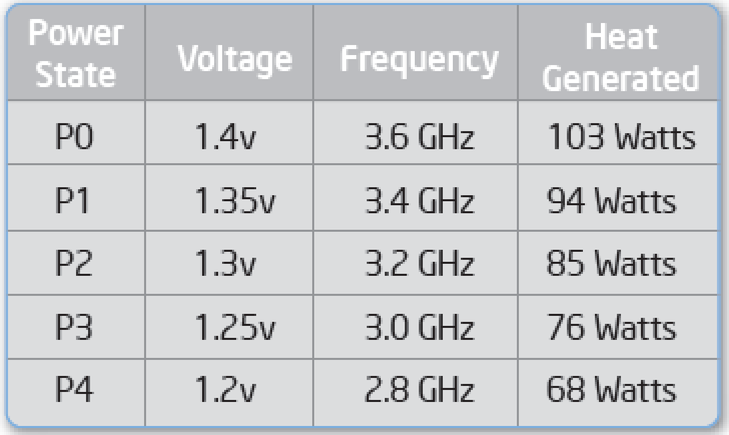
Low Power Prozessoren – reicht das?

- Effektives Design (heute 45nm, morgen 32 nm)
- Ausnutzung von Prozessor Performance States
  - Intel's Demand Based Switching
  - AMD's PowerNow!
- AMD's Dual Dynamic Power Management
  - Getrennte Ansteuerung von CPU und Memory Controller
- Intel Nehalem Turbo Boost: mehr Flexibilität im Rahmen der TDP
  - Übertacktung solange die TDP nicht überschritten wird

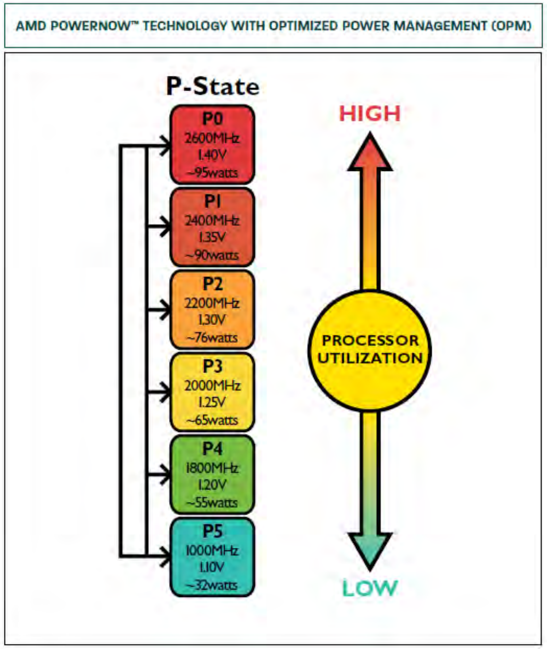


P-State

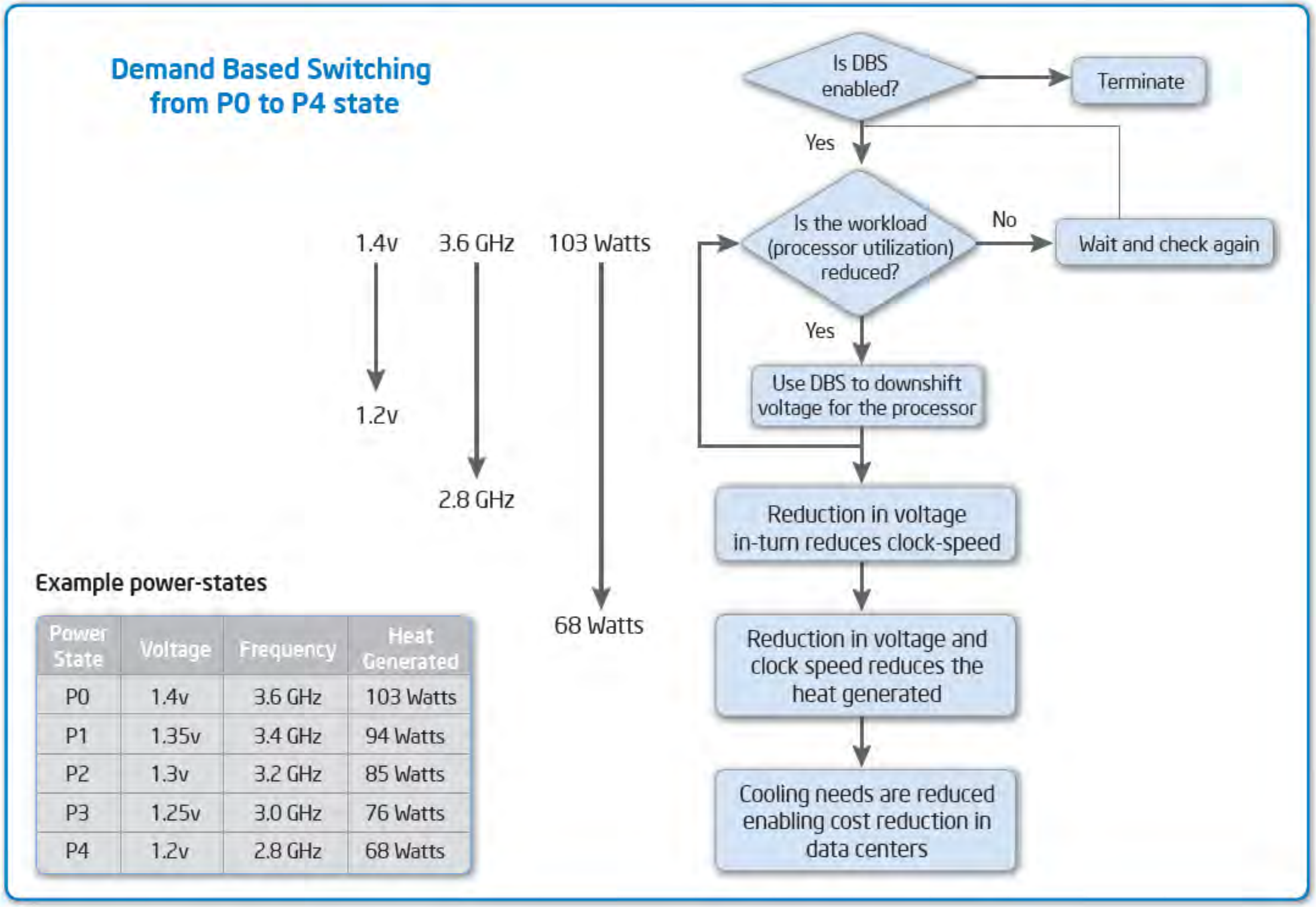
– Processor performance states (P-states) are a predefined set of frequency and voltage combinations at which a given processor can operate correctly. The processor P-state is the capability of running the processor at different voltage and/or frequency levels. Generally, P0 is the highest state resulting in maximum performance, while P1, P2, and so on, will save power but at some penalty to CPU performance.



Power State	Voltage	Frequency	Heat Generated
P0	1.4v	3.6 GHz	103 Watts
P1	1.35v	3.4 GHz	94 Watts
P2	1.3v	3.2 GHz	85 Watts
P3	1.25v	3.0 GHz	76 Watts
P4	1.2v	2.8 GHz	68 Watts


AMD POWERNOW™ TECHNOLOGY WITH OPTIMIZED POWER MANAGEMENT (OPM)
P-State
P0 2600MHz 1.40V ~95watts
P1 2400MHz 1.35V ~90watts
P2 2200MHz 1.30V ~76watts
P3 2000MHz 1.25V ~65watts
P4 1800MHz 1.20V ~55watts
P5 1000MHz 1.10V ~32watts
HIGH
PROCESSOR UTILIZATION
LOW

Demand Based Switching



Demand Based Switching from P0 to P4 state

Is DBS enabled?

Terminate

Yes

Is the workload (processor utilization) reduced?

No

Wait and check again

Yes

Use DBS to downshift voltage for the processor

Reduction in voltage in-turn reduces clock-speed

Reduction in voltage and clock speed reduces the heat generated

Cooling needs are reduced enabling cost reduction in data centers

Example power-states

Power State	Voltage	Frequency	Heat Generated
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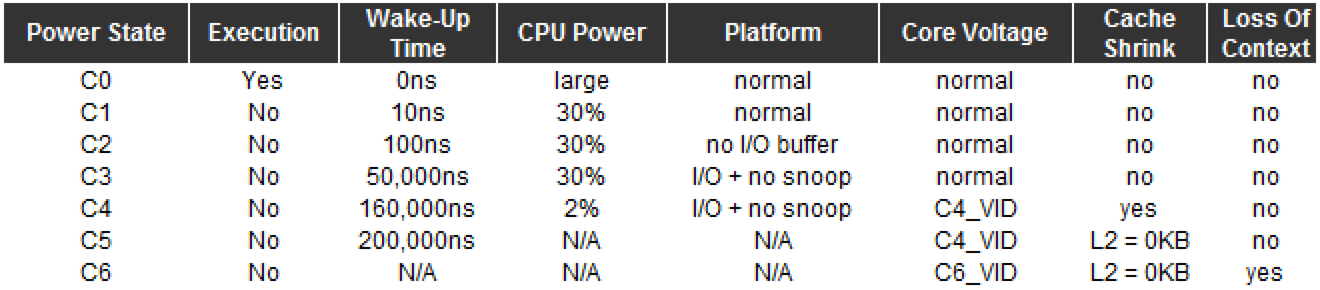
C-States



Power State	Execution	Wake-Up Time	CPU Power	Platform	Core Voltage	Cache Shrink	Loss Of Context
C0	Yes	0ns	large	normal	normal	no	no
C1	No	10ns	30%	normal	normal	no	no
C2	No	100ns	30%	no I/O buffer	normal	no	no
C3	No	50,000ns	30%	I/O + no snoop	normal	no	no
C4	No	160,000ns	2%	I/O + no snoop	C4_VID	yes	no
C5	No	200,000ns	N/A	N/A	C4_VID	L2 = 0KB	no
C6	No	N/A	N/A	N/A	C6_VID	L2 = 0KB	yes

– With the exception of C0, where the CPU is active and busy doing something, a C-state is an idle state.

– It provides a power savings tradeoff which depends on the length of time the CPU sleeps. The deeper the sleep, the longer it takes for the CPU to wake up, but the more power you save. The operating system selects which state you enter, based on when you anticipate the CPU will be waking up.

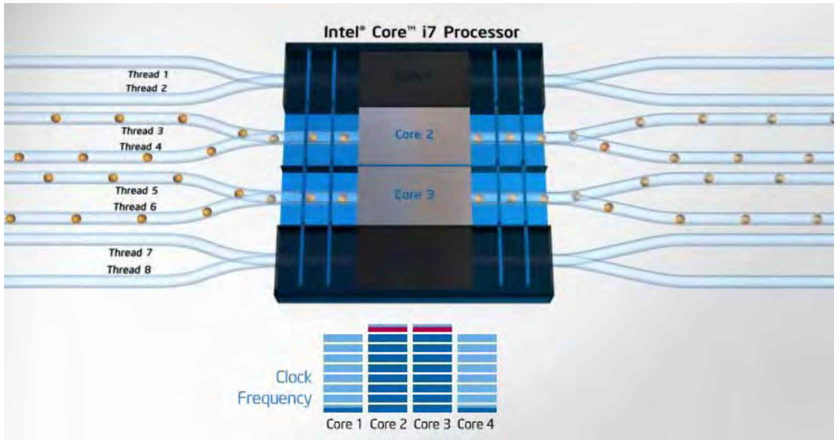
– Intel® processors based on *Nehalem* microarchitecture support core C0, C1, C3, and C6. C0 and C1 are always supported; the availability of the remaining C-states may vary by processor number. Any core within the processor can go into any C-state independent of the state of the other cores.

T-State

- "T"-states (throttling states) which will further throttle down a CPU (but not the actual clock rate) by inserting STPCLK (stop clock) signals and thus omitting duty cycles.
- The T state is one of the three execution states that CPUs execute code in. Much like the emergency brake of a car, the T state is used to forcefully reduce the CPU’s execution speed.

Intel® Turbo Boost Technology

– **Intel Turbo Boost Technology** allows a processor's cores to run faster than the base operating frequency if the package is operating below its power, current, and temperature specification limits. Intel Turbo Boost Technology is activated when the OS requests the highest processor performance state (P0). Maximum frequency depends on the number of active cores. The amount of time the processor spends in the Intel Turbo Boost Technology state depends on the workload and operating environment, providing the extra performance.

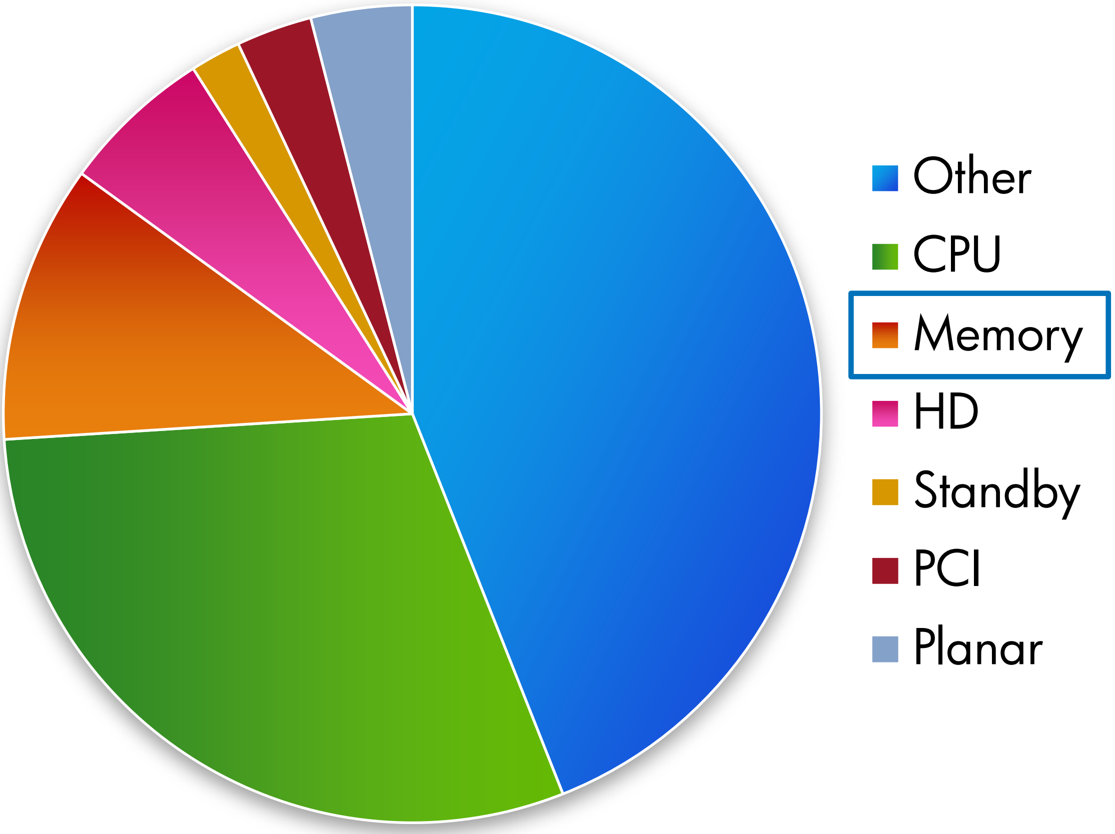


AMD-P Technologies

AMD Opteron processors offer outstanding energy efficiency

- **Enhanced AMD PowerNow!™** Technology with Independent Dynamic Core Technology allows each core to vary its frequency, based on the specific needs of the application. This allows for more precise power management to reduce data center energy consumption and thereby reduce total cost of ownership (TCO).
- **Dual Dynamic Power Management™** allows each processor to maximize the power-saving benefits of Enhanced AMD PowerNow! technology without compromising performance. Dual Dynamic Power Management can reduce idle power consumption and allow for per-processor power management in multi-socket systems to decrease power consumption.
- **AMD CoolCore™ Technology** evaluates which parts of the die - the cores, the memory, or both - are needed to support currently running applications. It can cut power to unused transistor areas to reduce power consumption and lower heat generation.
- **AMD PowerCap Manager** gives an IT manager the ability to put a cap on the P-state level of the cores via the BIOS. This can help reduce processor power consumption of a system.
- **AMD Smart Fetch Technology** enables inactive cores to write contents of their L1 and L2 caches to the shared L3 cache. This can allow the inactive cores to enter a "halt" state and draw less power, reducing CPU power consumption

Wo bestehen Einflussmöglichkeiten?



OTHER?

- AC to DC Transitions (25%)
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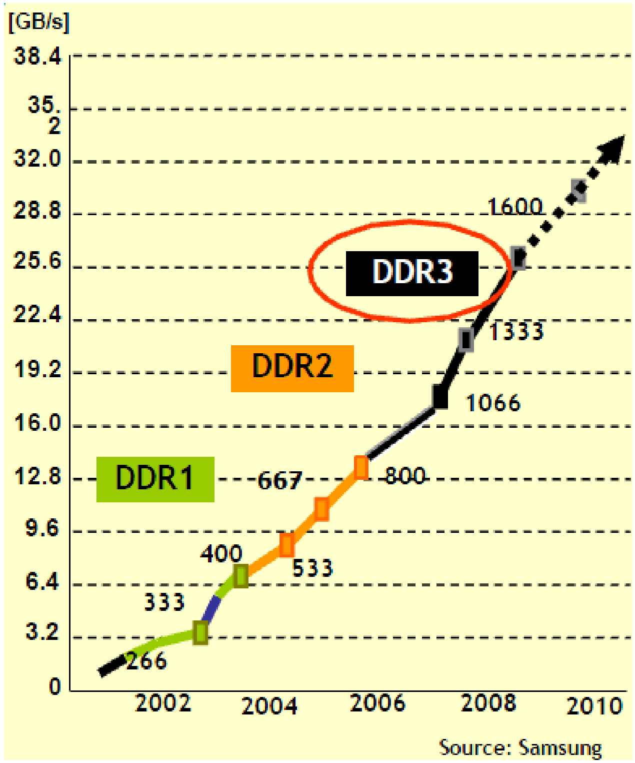
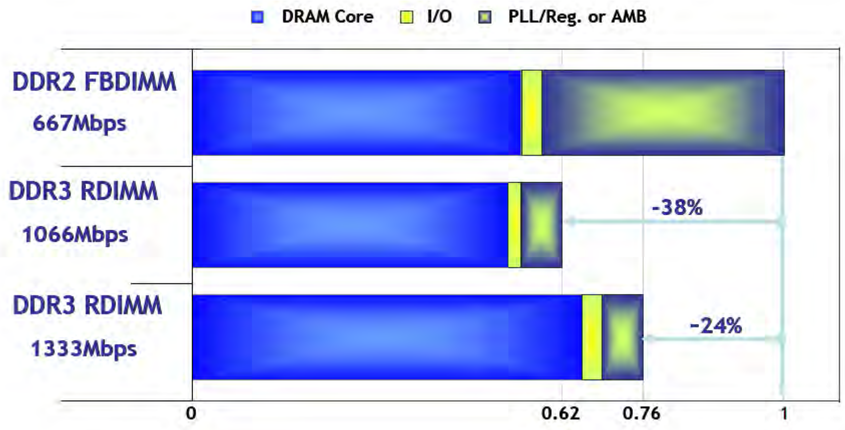
- Fans and air movement (9%)

Speicherausbau/Entwicklung



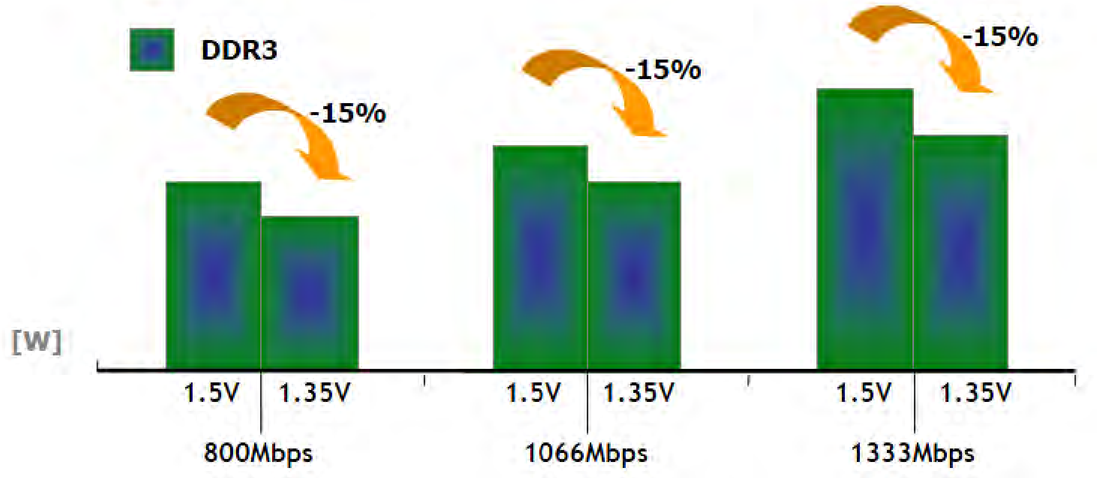
- – DDR3 has lower power architecture, due to lower core voltage
- – >25% power savings over DDR2 (DDR2-800 vs. DDR3-800)
- – DDR3-1066 consumes less power than DDR2-800.



Source: Samsung

Speicherausbau – was bring die Zukunft?

- Over time, DDR3 memory will consist of three voltage ratings; Standard at announce (1.5V); future plans call for Low Voltage (1.35V) and Ultra Low Voltage (TBD; ~1.25V)
- Early data with 1.35V shows approx 15 % reduction in total power
- Reduce output-swing voltage for the driver reduces with 18 DIMMs the power usasge of the system by 22W

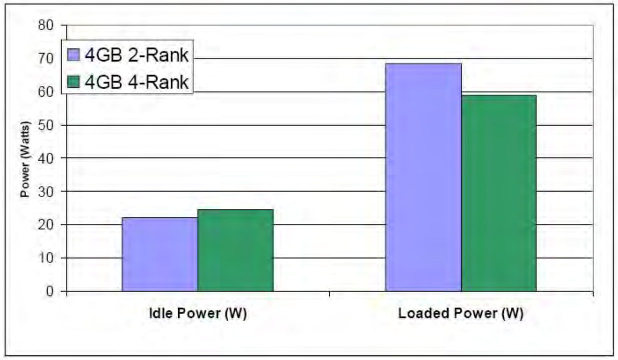


Source: Samsung

Speicherausbau – Einsparung?

- Kleiner Module sind günstiger, Ausbaufähigkeit begrenzt, geringere Verbrauch
- Größere Module sind wesentlich teurer, besser Skalierbar, mehr Verbrauch
- Quad-Ranked DIMMS verbrauchen ca. 15% weniger als dual-ranked DIMMS

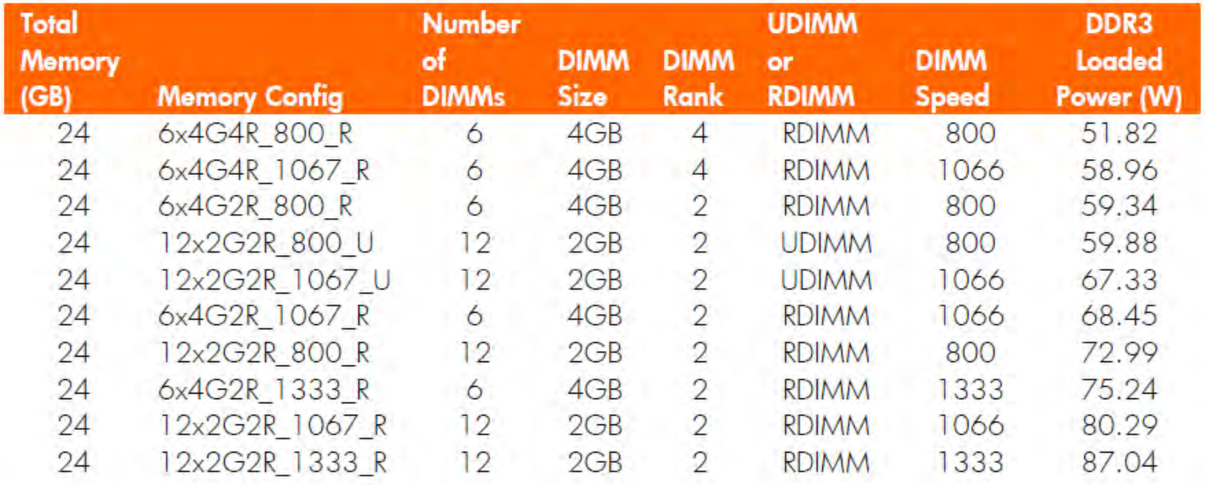
Impact of Ranks on Power Used (DDR3-1066)



- Low Power DIMMs: In the dual-rank DIMM half of the DRAM chips are active at a time. In the quad-rank DIMM, a quarter of the DRAM chips are active at a time resulting in 15% less power consumption.

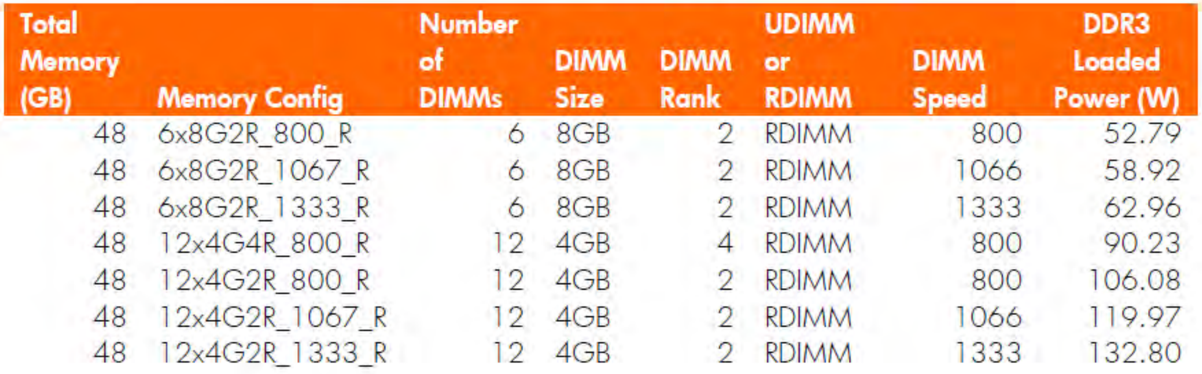
Speicher Optimierung: Energieverbrauch

Table 14 : Power of various 24GB Configurations



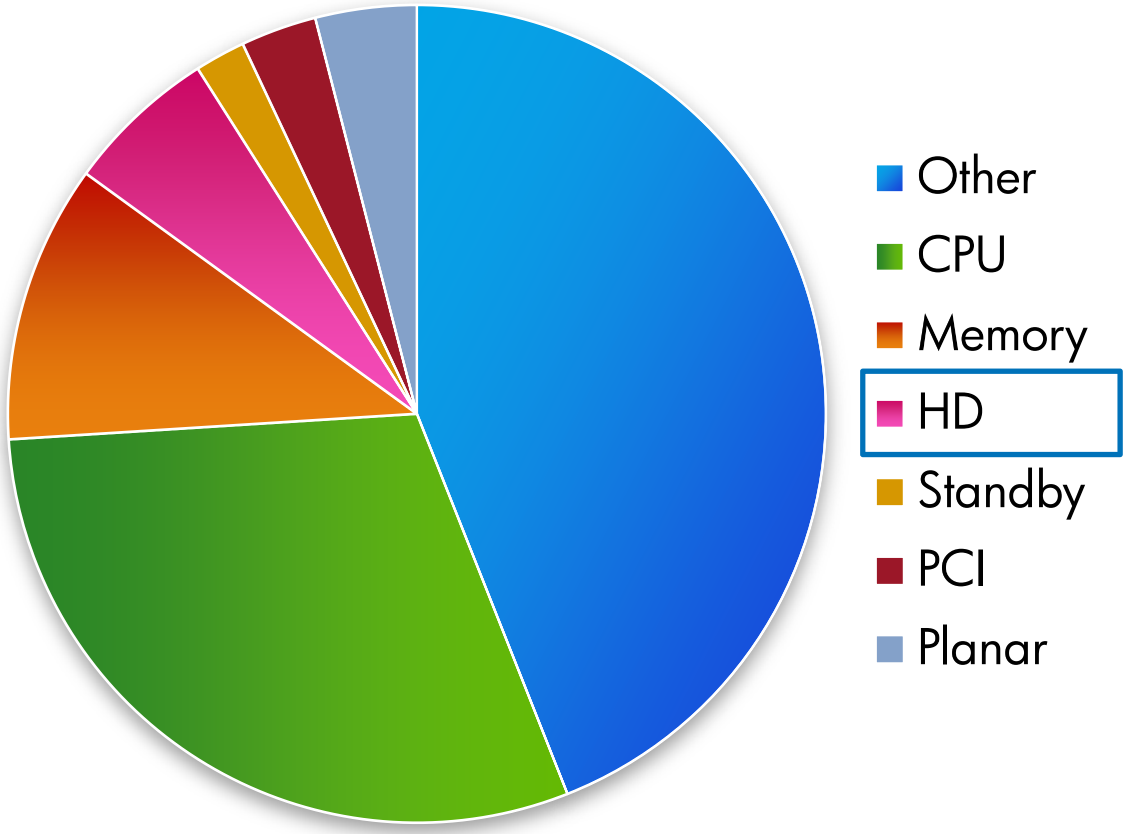
Total Memory (GB)	Memory Config	Number of DIMMs	DIMM Size	DIMM Rank	UDIMM or RDIMM	DIMM Speed	DDR3 Loaded Power (W)
24	6x4G4R_800_R	6	4GB	4	RDIMM	800	51.82
24	6x4G4R_1067_R	6	4GB	4	RDIMM	1066	58.96
24	6x4G2R_800_R	6	4GB	2	RDIMM	800	59.34
24	12x2G2R_800_U	12	2GB	2	UDIMM	800	59.88
24	12x2G2R_1067_U	12	2GB	2	UDIMM	1066	67.33
24	6x4G2R_1067_R	6	4GB	2	RDIMM	1066	68.45
24	12x2G2R_800_R	12	2GB	2	RDIMM	800	72.99
24	6x4G2R_1333_R	6	4GB	2	RDIMM	1333	75.24
24	12x2G2R_1067_R	12	2GB	2	RDIMM	1066	80.29
24	12x2G2R_1333_R	12	2GB	2	RDIMM	1333	87.04

Table 15 : Power of various 48GB Configurations



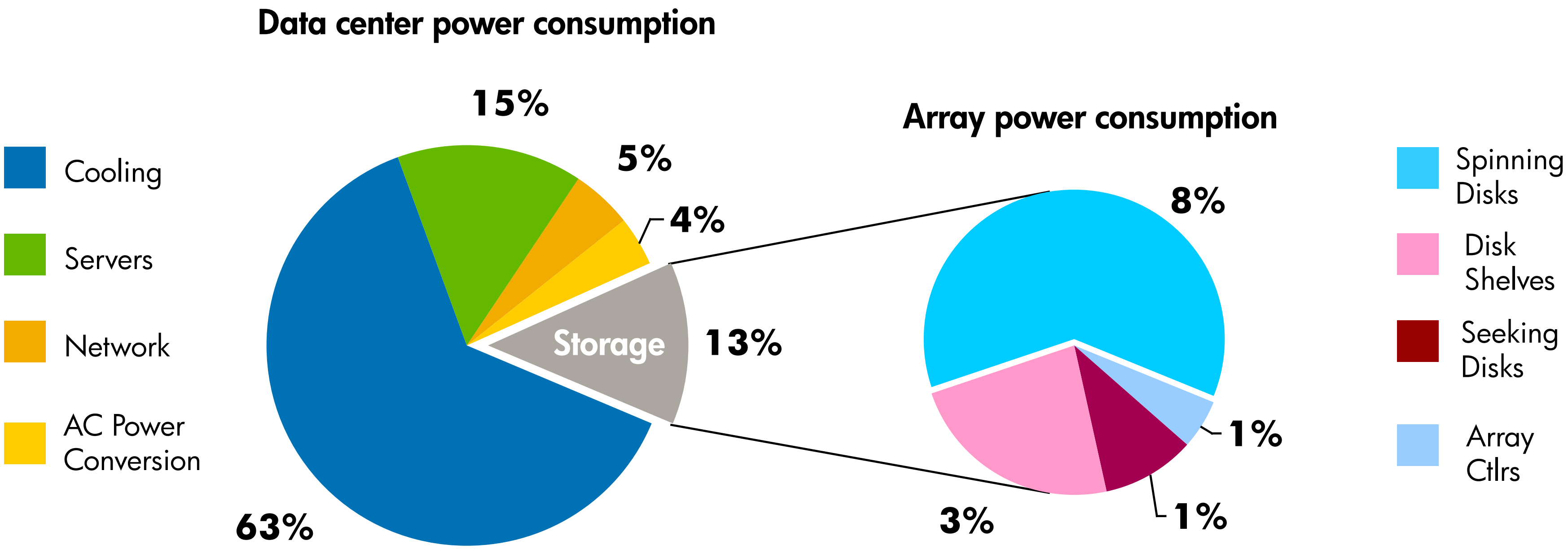
Total Memory (GB)	Memory Config	Number of DIMMs	DIMM Size	DIMM Rank	UDIMM or RDIMM	DIMM Speed	DDR3 Loaded Power (W)
48	6x8G2R_800_R	6	8GB	2	RDIMM	800	52.79
48	6x8G2R_1067_R	6	8GB	2	RDIMM	1066	58.92
48	6x8G2R_1333_R	6	8GB	2	RDIMM	1333	62.96
48	12x4G4R_800_R	12	4GB	4	RDIMM	800	90.23
48	12x4G2R_800_R	12	4GB	2	RDIMM	800	106.08
48	12x4G2R_1067_R	12	4GB	2	RDIMM	1066	119.97
48	12x4G2R_1333_R	12	4GB	2	RDIMM	1333	132.80

Wo bestehen Einflussmöglichkeiten?



OTHER?
- AC to DC Transitions (25%)
- DC to DC Deliveries (10%)
- Fans and air movement (9%)

Stromverbrauch bei Storagesystemen



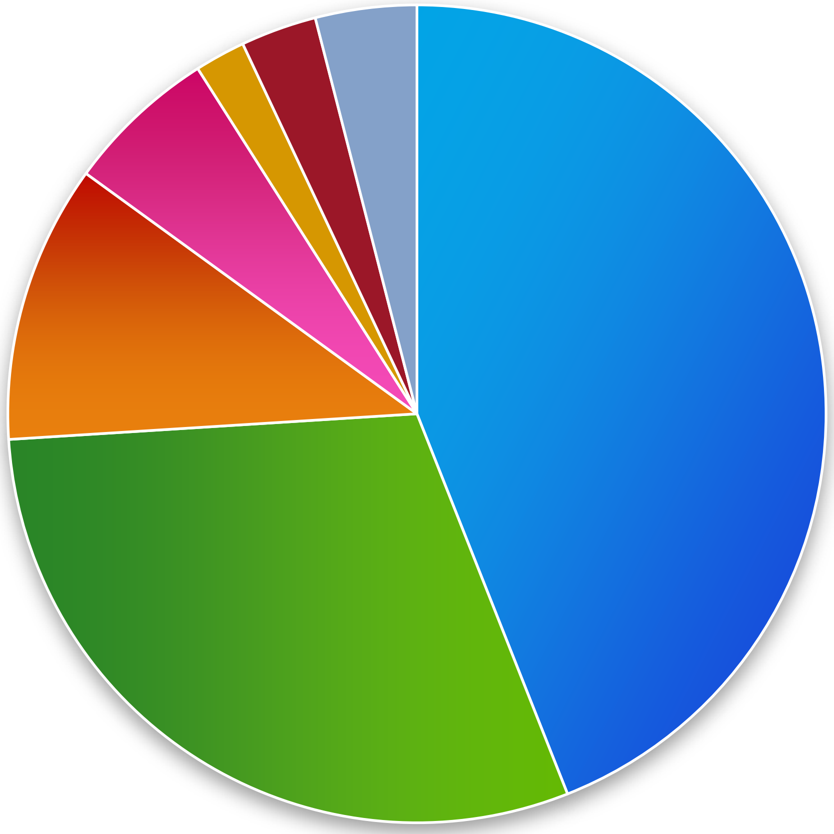
~60% des Stromverbrauchs von Storage Systemen ist für den Betrieb (spinning) der Platten notwendig

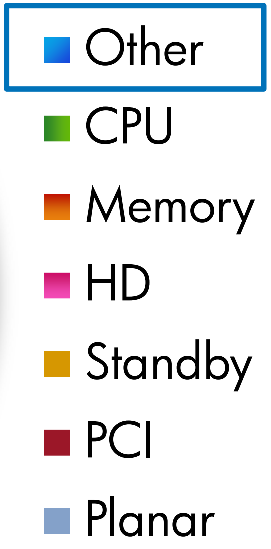
Sources: Preliminary assessment from Uptime Institute; IDC Data Center of the Future US Server Power Spend for 2005 as a baseline ($6bn); applied a cooling factor of 1; applied a 0.6 multiplier to US data for WW amount; Belady, C., Malone, C., "Data Center Power Projection to 2014", 2006 ITHERM, San Diego, CA (June 2006). NetworkWorld "Green storage means money saved on power", May 2007, EVA 4400 Power Measurements

Solid State Drive (SSD)

- **Extreme Ruggedness**
  - Extended Operating Temperature (0° up to 70°C)
  - Shock and Vibration almost a non-issue
- **High Read Performance**
  - > 50x SATA random read performance
  - > 15x SAS random read performance
  - No seek time means high IOPS
  - Limited write performance (relative to 15k SAS)
- **Increased Reliability**
  - No moving parts
  - Virtually eliminates the need to RAID SSDs
- **Up to 10x Reduced Power**
  - < 2 Watts, versus 9 Watt for 15k 2.5″ SAS
- **Thermal, Size and Acoustic Advantages**
  - No Noise, Low Heat
  - Small and light weight

Wo bestehen Einflussmöglichkeiten?





OTHER?

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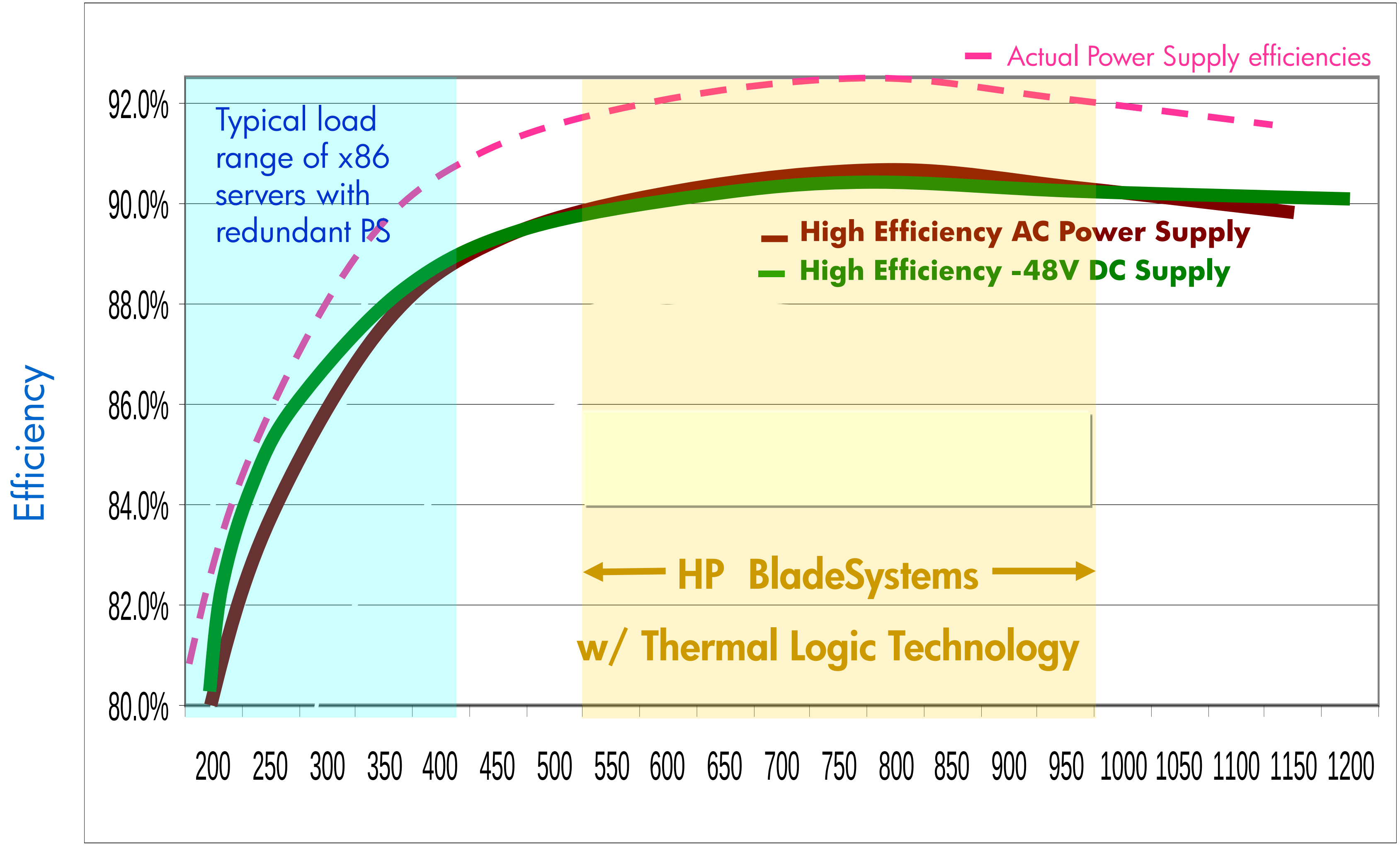
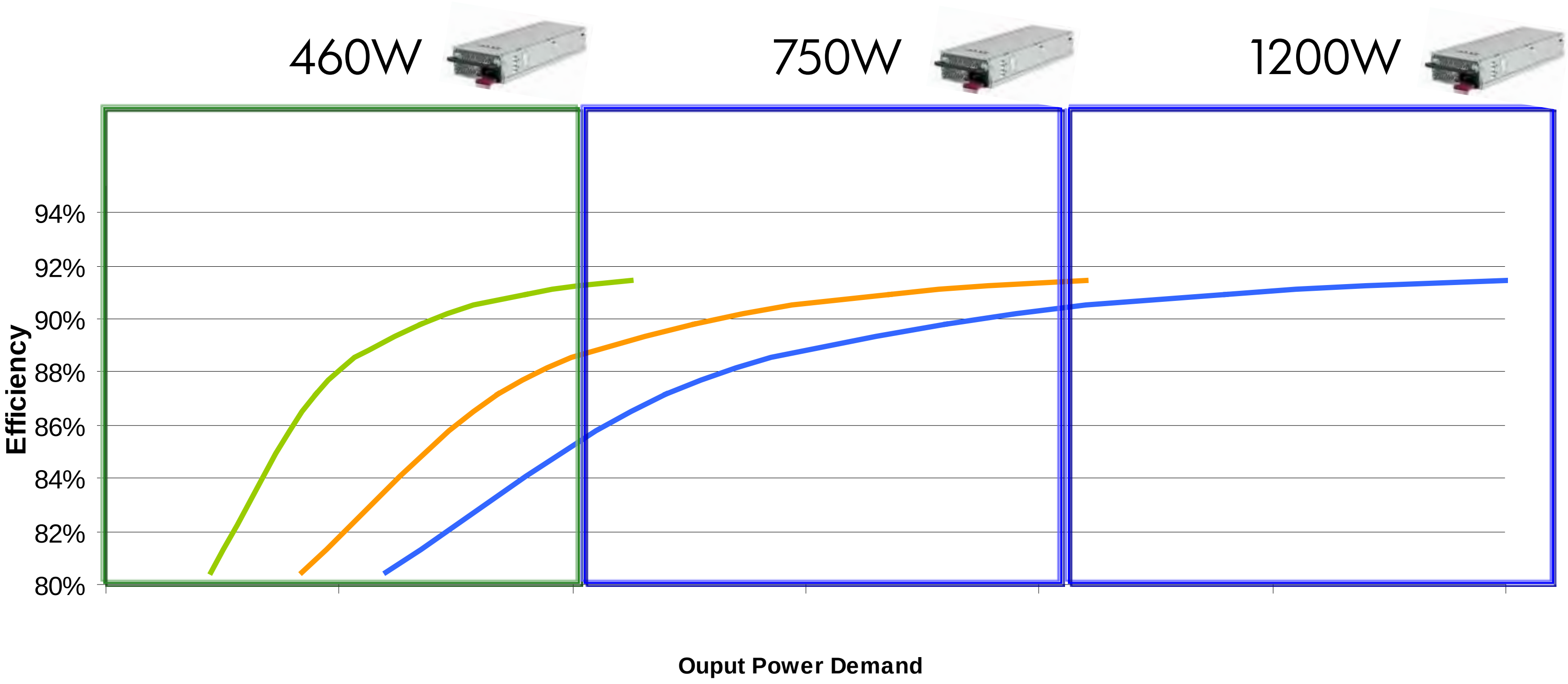
Power Supply Efficiency Curves



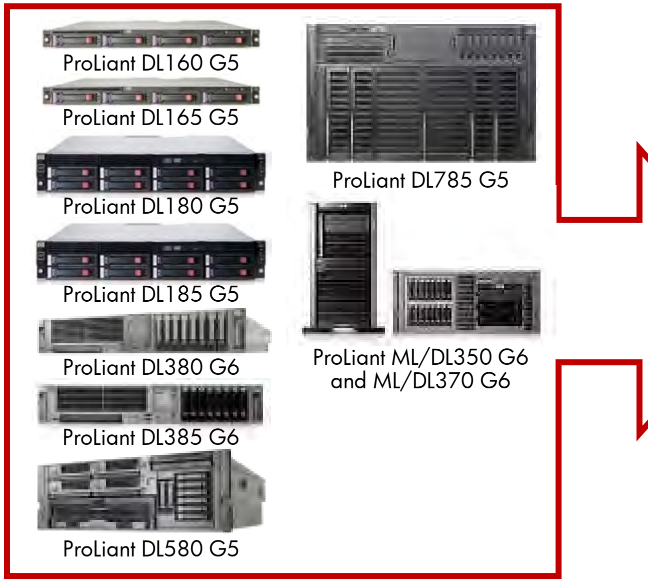
Right-sizing your Power Supply

- Stay on the healthy part of the curve…
- choose the Power Supply to fit your application

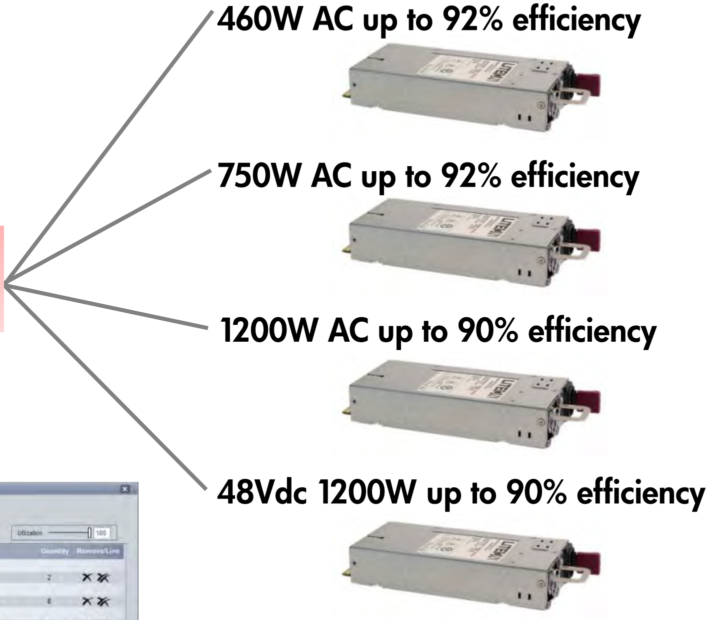


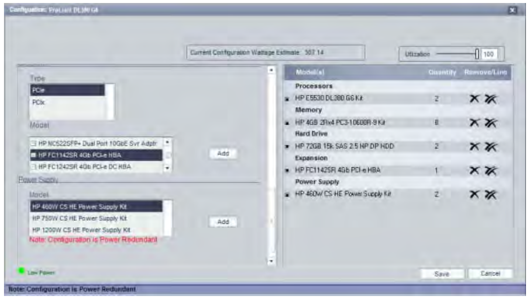
Netzteile

Ein Netzteil-Steckplatz für unterschiedliche Systeme



Common Slot


460W AC up to 92% efficiency
750W AC up to 92% efficiency
1200W AC up to 90% efficiency
48Vdc 1200W up to 90% efficiency



Current Configuration Wattage Estimate: 307.14

Utilization 100

Type: PCIe / PCIx

Model:
- HP NC522SFP+ Dual Port 10GbE Svr Adptr
- HP FC1142SR 4Gb PCI-e HBA
- HP FC1242SR 4Gb PCI-e DC HBA

Power Supply Model:
- HP 460W CS HE Power Supply Kit
- HP 750W CS HE Power Supply Kit
- HP 1200W CS HE Power Supply Kit

Note: Configuration is Power Redundant

Model(s)	Quantity	Remove/Line
Processors		
HP E5530 DL380 G6 Kit	2	✕ ✕
Memory		
HP 4GB 2Rx4 PC3-10600R-9 Kit	8	✕ ✕
Hard Drive		
HP 72GB 15k SAS 2.5 HP DP HDD	2	✕ ✕
Expansion		
HP FC1142SR 4Gb PCI-e HBA	1	✕ ✕
Power Supply		
HP 460W CS HE Power Supply Kit	2	✕ ✕

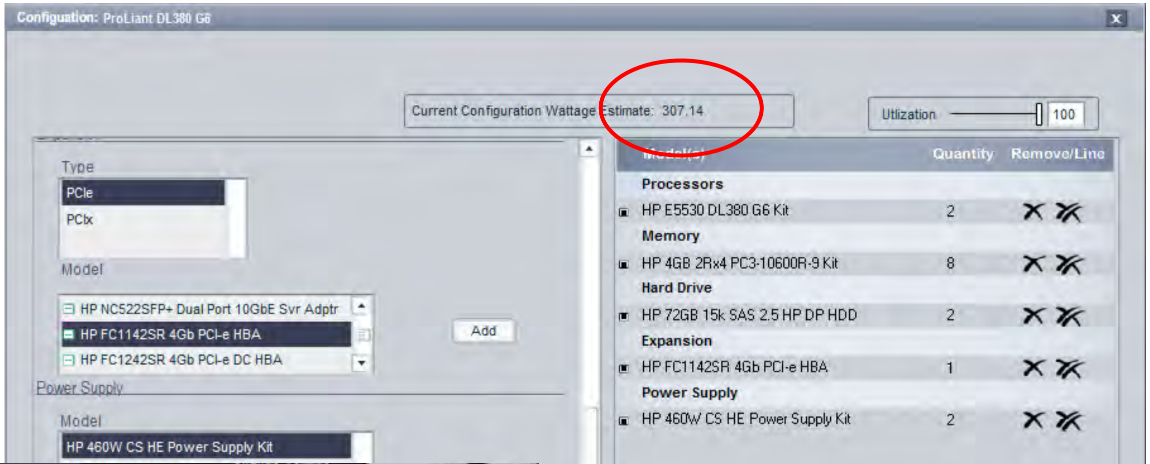
Note: Configuration is Power Redundant

HP Proliant Power Advisor

Netzteile

307 W - 460 W Netzteil
352 W - 1200W Netzteil

~13% Stromersparnis



Configuation: ProLiant DL380 G6

Current Configuration Wattage Estimate: 307.14

Utlization 100

Type
PCIe
PCIx

Model
HP NC522SFP+ Dual Port 10GbE Svr Adptr
HP FC1142SR 4Gb PCI-e HBA
HP FC1242SR 4Gb PCI-e DC HBA

Add

Power Supply

Model
HP 460W CS HE Power Supply Kit

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Power Supply		
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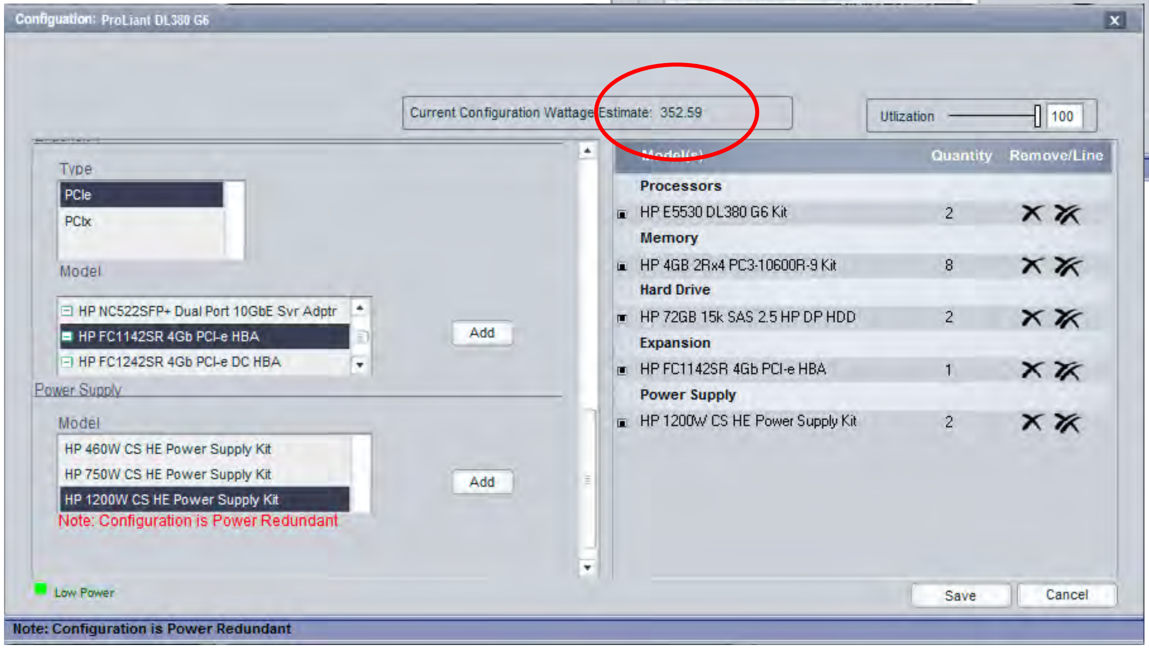
Save Cancel



Configuation: ProLiant DL380 G6

Current Configuration Wattage Estimate: 352.59

Utlization 100

Type
PCIe
PCIx

Model
HP NC522SFP+ Dual Port 10GbE Svr Adptr
HP FC1142SR 4Gb PCI-e HBA
HP FC1242SR 4Gb PCI-e DC HBA

Add

Power Supply

Model
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HP 750W CS HE Power Supply Kit
HP 1200W CS HE Power Supply Kit

Add

Note: Configuration is Power Redundant

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Power Supply		
HP 1200W CS HE Power Supply Kit	2	

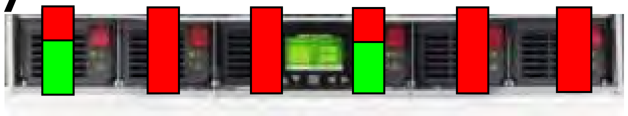
🟩 Low Power

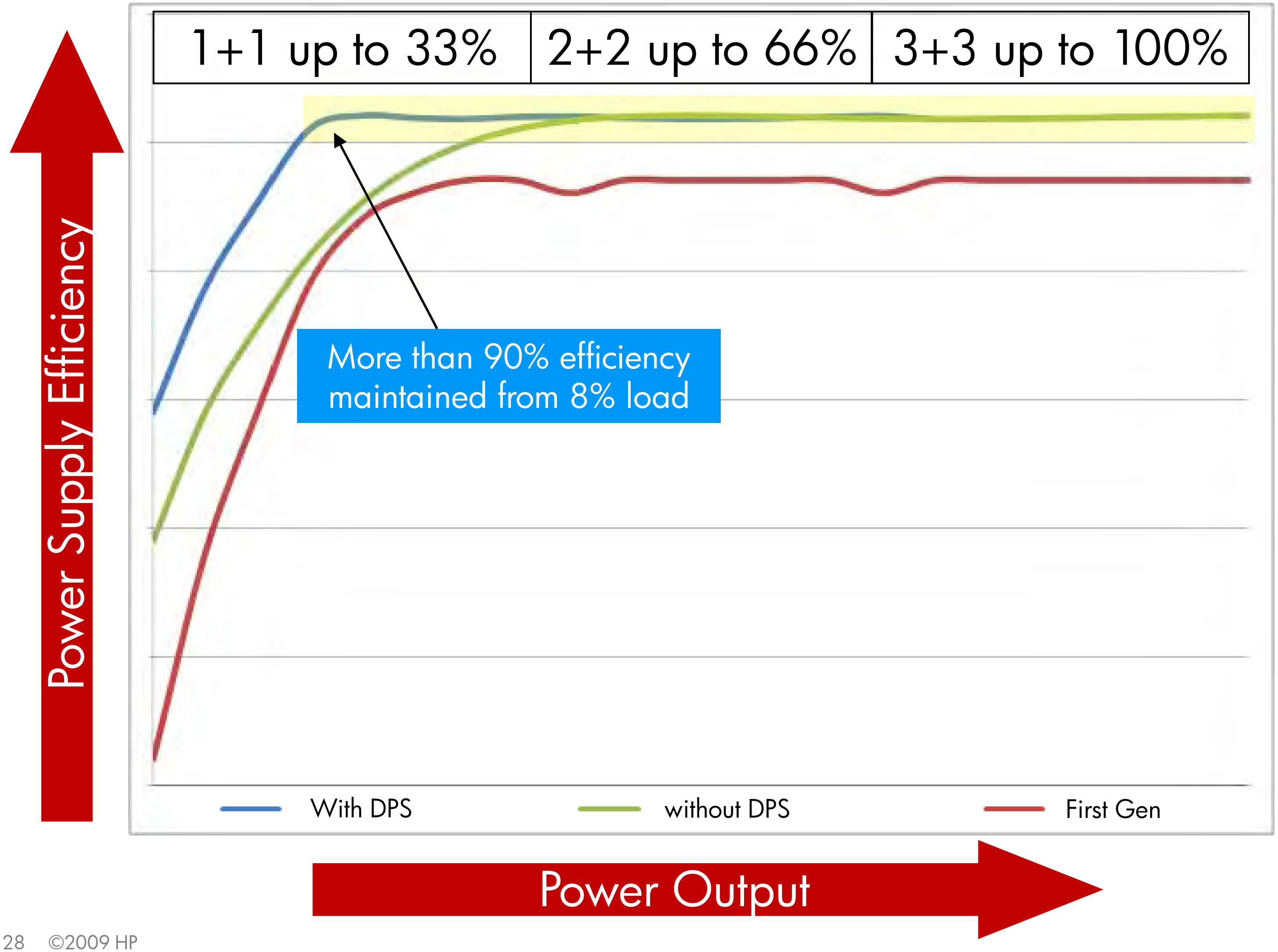
Save Cancel

Note: Configuration is Power Redundant

geringere Anschaffungskosten

Mehr Effektivität durch Dynamic Power Saver



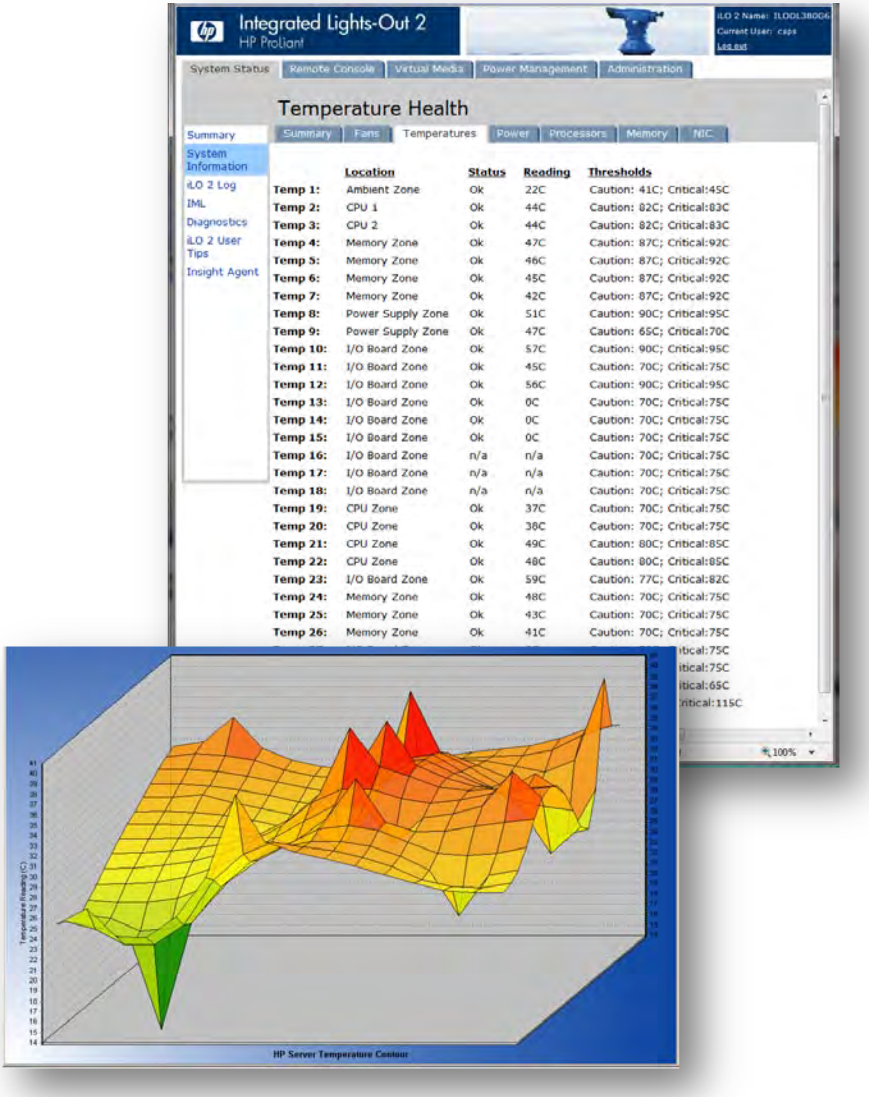


More than 90% efficiency maintained from 8% load

Intelligente Lüfter Steuerung

Power Efficient Fan Control

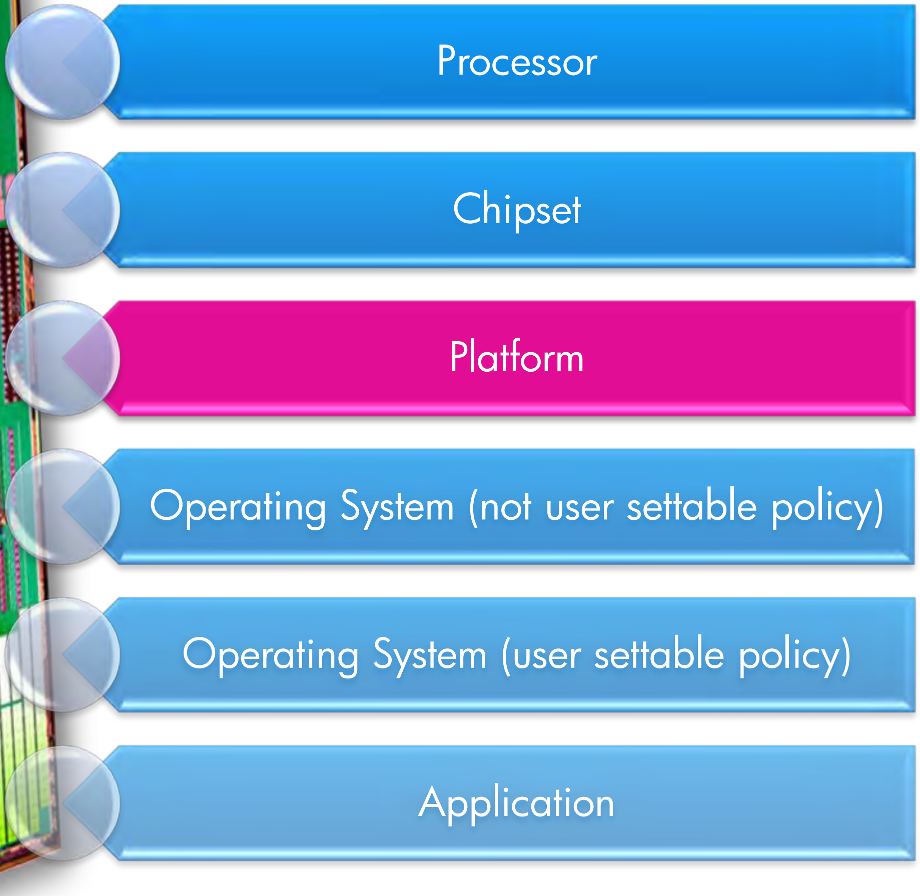
- 30+ temperature sensors in G6 servers
- DIMM temperature monitoring
- Hard Drive temperature monitoring
- CPU sensor(s), air inlet sensor, power supply temps
- Additional fan zones – individual fan control
- Intelligent iLO fan speeds using process control algorithms
- Lower fan RPMs result in power and noise savings



Temperature Health

	Location	Status	Reading	Thresholds
Temp 1:	Ambient Zone	Ok	22C	Caution: 41C; Critical:45C
Temp 2:	CPU 1	Ok	44C	Caution: 82C; Critical:83C
Temp 3:	CPU 2	Ok	44C	Caution: 82C; Critical:83C
Temp 4:	Memory Zone	Ok	47C	Caution: 87C; Critical:92C
Temp 5:	Memory Zone	Ok	46C	Caution: 87C; Critical:92C
Temp 6:	Memory Zone	Ok	45C	Caution: 87C; Critical:92C
Temp 7:	Memory Zone	Ok	42C	Caution: 87C; Critical:92C
Temp 8:	Power Supply Zone	Ok	51C	Caution: 90C; Critical:95C
Temp 9:	Power Supply Zone	Ok	47C	Caution: 65C; Critical:70C
Temp 10:	I/O Board Zone	Ok	57C	Caution: 90C; Critical:95C
Temp 11:	I/O Board Zone	Ok	45C	Caution: 70C; Critical:75C
Temp 12:	I/O Board Zone	Ok	56C	Caution: 90C; Critical:95C
Temp 13:	I/O Board Zone	Ok	0C	Caution: 70C; Critical:75C
Temp 14:	I/O Board Zone	Ok	0C	Caution: 70C; Critical:75C
Temp 15:	I/O Board Zone	Ok	0C	Caution: 70C; Critical:75C
Temp 16:	I/O Board Zone	n/a	n/a	Caution: 70C; Critical:75C
Temp 17:	I/O Board Zone	n/a	n/a	Caution: 70C; Critical:75C
Temp 18:	I/O Board Zone	n/a	n/a	Caution: 70C; Critical:75C
Temp 19:	CPU Zone	Ok	37C	Caution: 70C; Critical:75C
Temp 20:	CPU Zone	Ok	38C	Caution: 70C; Critical:75C
Temp 21:	CPU Zone	Ok	49C	Caution: 80C; Critical:85C
Temp 22:	CPU Zone	Ok	48C	Caution: 80C; Critical:85C
Temp 23:	I/O Board Zone	Ok	59C	Caution: 77C; Critical:82C
Temp 24:	Memory Zone	Ok	48C	Caution: 70C; Critical:75C
Temp 25:	Memory Zone	Ok	43C	Caution: 70C; Critical:75C
Temp 26:	Memory Zone	Ok	41C	Caution: 70C; Critical:75C
				itical:75C
				itical:75C
				itical:65C
				ritical:115C

Power Management Elemente



Processor

Chipset

Platform

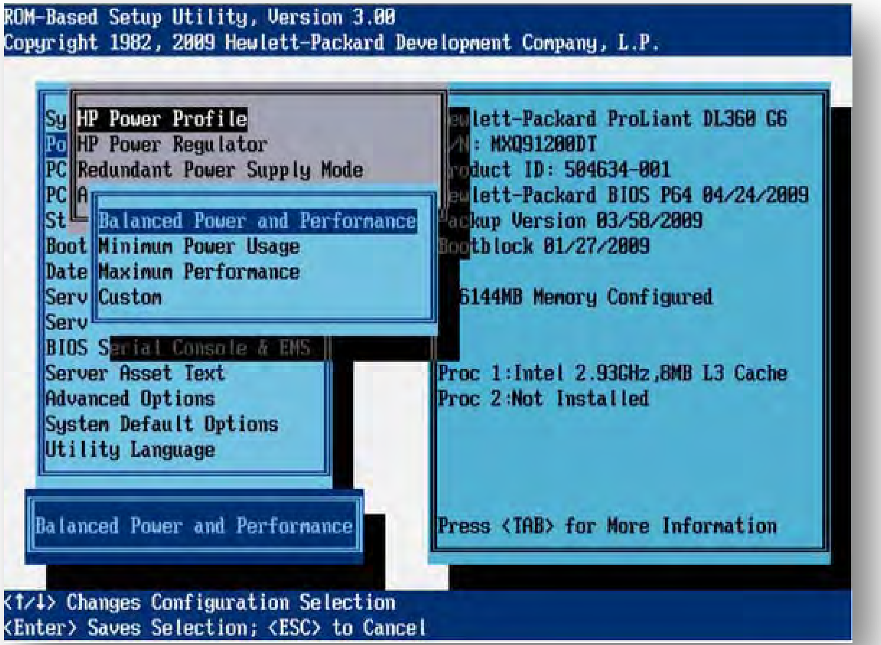
Operating System (not user settable policy)

Operating System (user settable policy)

Application

Power Profile

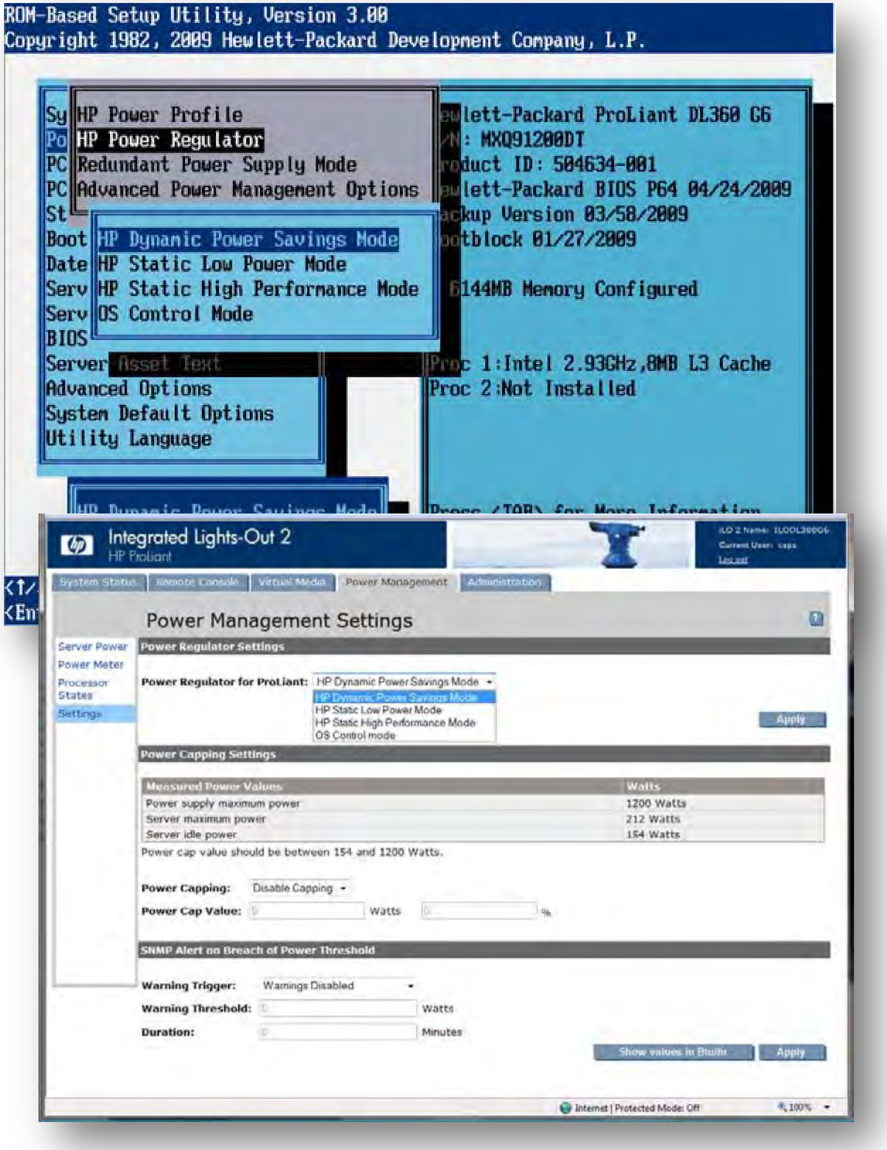
- **Balanced Power and Performance** provides the optimum settings to maximize power savings with minimal performance impact for most operating systems and applications.
- **Minimum Power Usage** enables power reduction mechanisms that may affect performance negatively. This mode guarantees a lower maximum power usage by the system.
- **Maximum Performance** disables all power management options that may affect performance negatively.



```
ROM-Based Setup Utility, Version 3.00
Copyright 1982, 2009 Hewlett-Packard Development Company, L.P.

Sy HP Power Profile                          ewlett-Packard ProLiant DL360 G6
Po HP Power Regulator                        /N: MXQ91200DT
PC Redundant Power Supply Mode               roduct ID: 504634-001
PC A                                         ewlett-Packard BIOS P64 04/24/2009
St    Balanced Power and Performance         ackup Version 03/50/2009
Boot  Minimum Power Usage                    Bootblock 01/27/2009
Date  Maximum Performance
Serv  Custom                                  6144MB Memory Configured
Serv
BIOS Serial Console & EMS
Server Asset Text                            Proc 1:Intel 2.93GHz,8MB L3 Cache
Advanced Options                             Proc 2:Not Installed
System Default Options
Utility Language

Balanced Power and Performance               Press <TAB> for More Information

<↑/↓> Changes Configuration Selection
<Enter> Saves Selection; <ESC> to Cancel
```

Power Regulator

- **HP Dynamic Power Savings Mode**
  - Automatically varies processor speed and power usage based on processor use (adjust P-States)
  - Reduces overall power consumption with little or no impact to performance
  - Does not require OS support
- **HP Static Low Power Mode**
  - Reduces processor speed and power usage
  - Guarantees a lower maximum power usage for the system
  - The impact on performance is greater for environments with higher processor utilization.
- **HP Static High Performance Mode**
  - Processors run in the maximum power and performance state, regardless of the OS power management policy.
- **OS Control Mode**
  - Processors run in the maximum power and performance state, unless the OS enables a power management policy.



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Sy|HP Power Profile                 ewlett-Packard ProLiant DL360 G6
Po|HP Power Regulator               /N: MXQ91200DT
PC|Redundant Power Supply Mode      roduct ID: 504634-001
PC|Advanced Power Management Options ewlett-Packard BIOS P64 04/24/2009
St                                  ackup Version 03/30/2009
Boot|HP Dynamic Power Savings Mode  ootblock 01/27/2009
Date|HP Static Low Power Mode
Serv|HP Static High Performance Mode  6144MB Memory Configured
Serv|OS Control Mode
BIOS
Server Asset Text                  Proc 1:Intel 2.93GHz,8MB L3 Cache
Advanced Options                   Proc 2:Not Installed
System Default Options
Utility Language

     HP Dynamic Power Savings Mode     Press <TAB> for More Information
<↑/
<Ent
```

Integrated Lights-Out 2
HP Proliant

Power Management Settings

Power Regulator Settings

Power Regulator for ProLiant: HP Dynamic Power Savings Mode

HP Dynamic Power Savings Mode
HP Static Low Power Mode
HP Static High Performance Mode
OS Control mode
Apply

Power Capping Settings

Measured Power Values	Watts
Power supply maximum power	1200 Watts
Server maximum power	212 Watts
Server idle power	154 Watts

Power cap value should be between 154 and 1200 Watts.

Power Capping: Disable Capping

Power Cap Value: 0 Watts 0 %

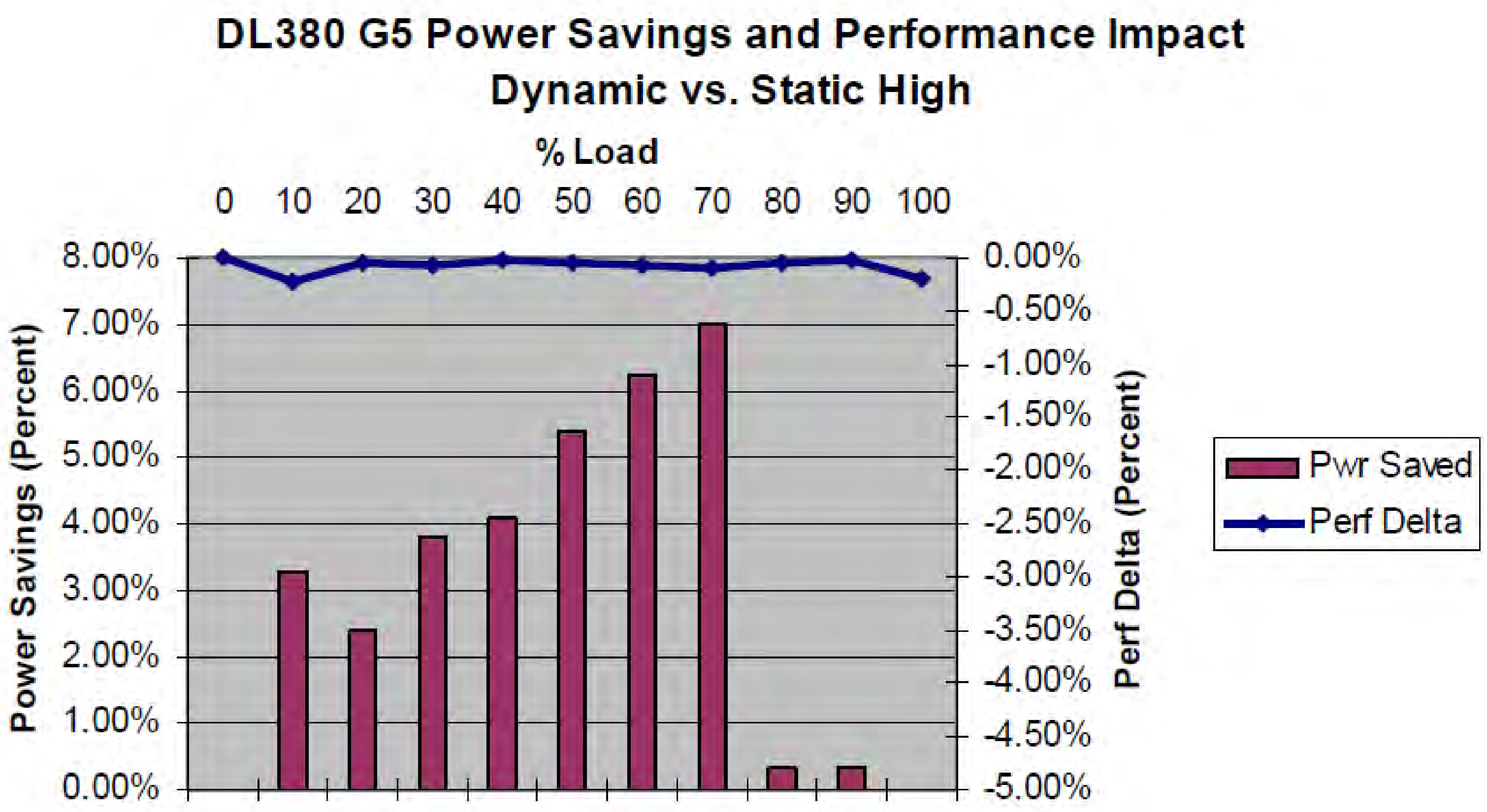
SNMP Alert on Breach of Power Threshold

Warning Trigger: Warnings Disabled

Warning Threshold: 0 Watts

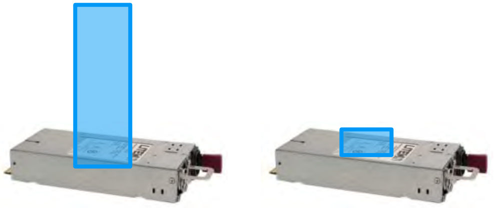
Duration: 0 Minutes

Dynamic Power Savings Mode im Vergleich

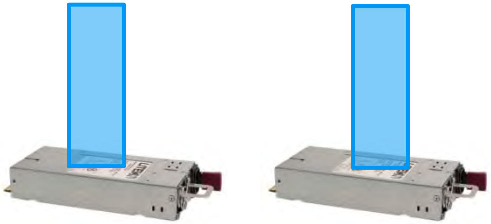


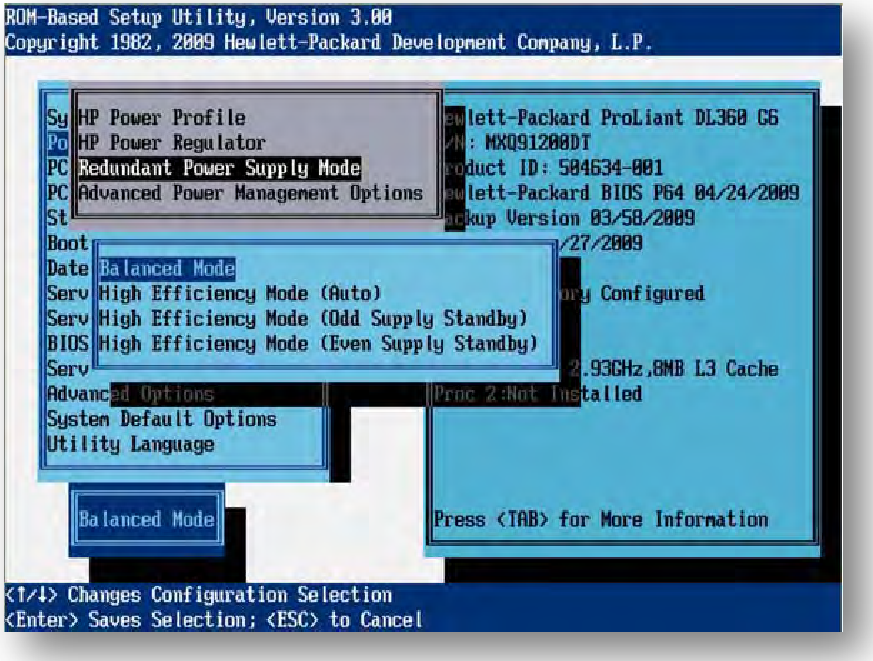
Redundant Power Supply Mode

- This feature enables the user to configure how the system handles redundant power supply configurations
- The High Efficiency Mode options allow the user to choose which power supply is placed in standby.



Balanced Mode





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Sy HP Power Profile                        ewlett-Packard ProLiant DL360 G6
Po HP Power Regulator                      /N: MXQ91200DT
PC Redundant Power Supply Mode             roduct ID: 504634-001
PC Advanced Power Management Options       ewlett-Packard BIOS P64 04/24/2009
St                                         ackup Version 03/50/2009
Boot                                           /27/2009
Date Balanced Mode
Serv High Efficiency Mode (Auto)               ory Configured
Serv High Efficiency Mode (Odd Supply Standby)
BIOS High Efficiency Mode (Even Supply Standby)
Serv                                           2.93GHz,8MB L3 Cache
Advanced Options                          Proc 2:Not Installed
System Default Options
Utility Language

     Balanced Mode                        Press <TAB> for More Information

<↑/↓> Changes Configuration Selection
<Enter> Saves Selection; <ESC> to Cancel
```
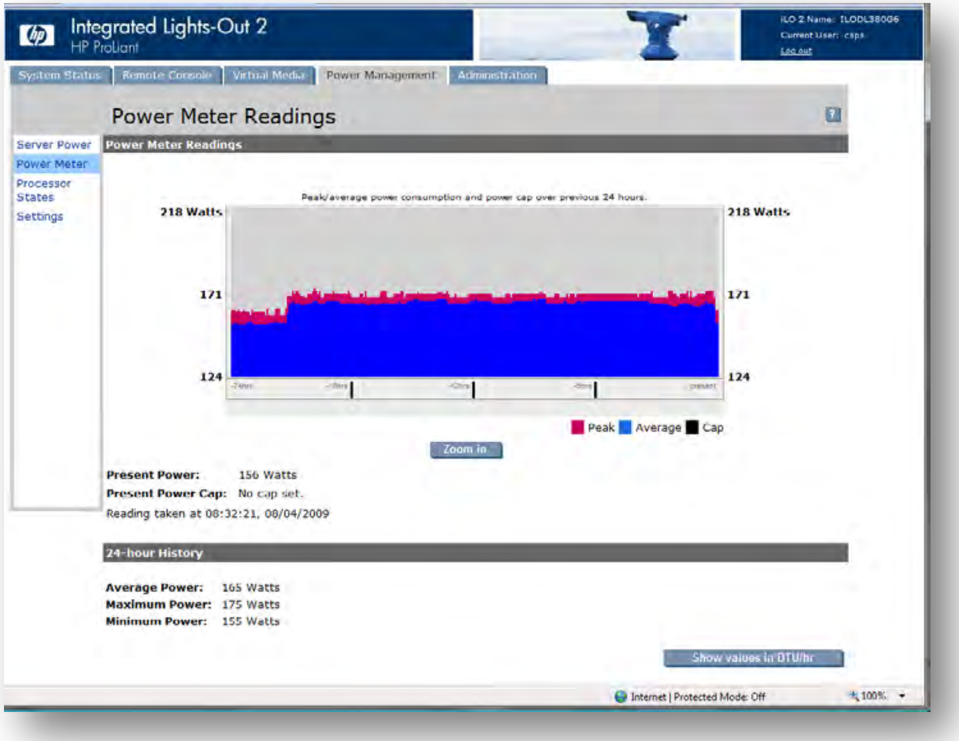

Optimum power efficiency even under light loads

Visualiserung: Power Meter

- The graph shows a 24-hour history with 5 minute samples.
- A 20-minute history with 10 second samples is available with the "Real Time" graph when a power cap is supported and configured.
- iLO periodically samples peak power, average power and power cap.
- An iLO 2 license is required to view the data



Power Meter Readings

Power Meter Readings

Peak/average power consumption and power cap over previous 24 hours.

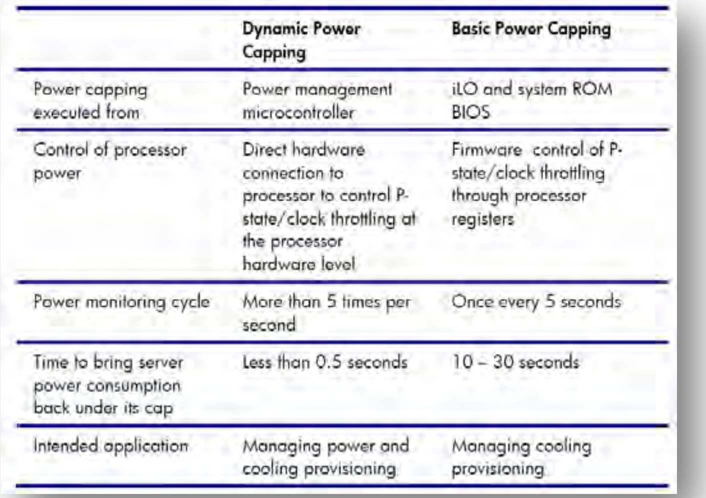
Present Power: 156 Watts
Present Power Cap: No cap set.
Reading taken at 08:32:21, 08/04/2009

24-hour History

Average Power: 165 Watts
Maximum Power: 175 Watts
Minimum Power: 155 Watts

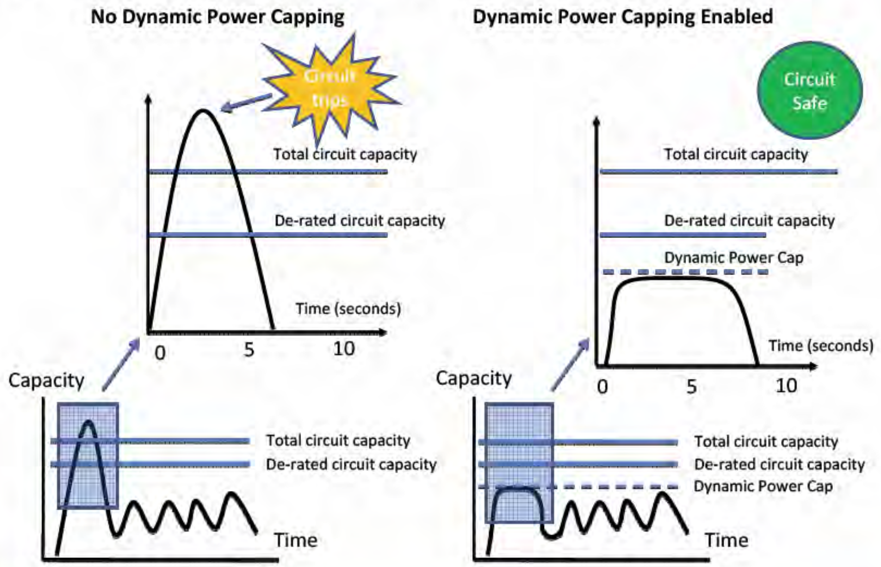
Differences between Dynamic Power Capping and Power Capping

- HP Dynamic Power Capping monitors power consumption and maintains a server's power cap much more rapidly than HP Power Capping.



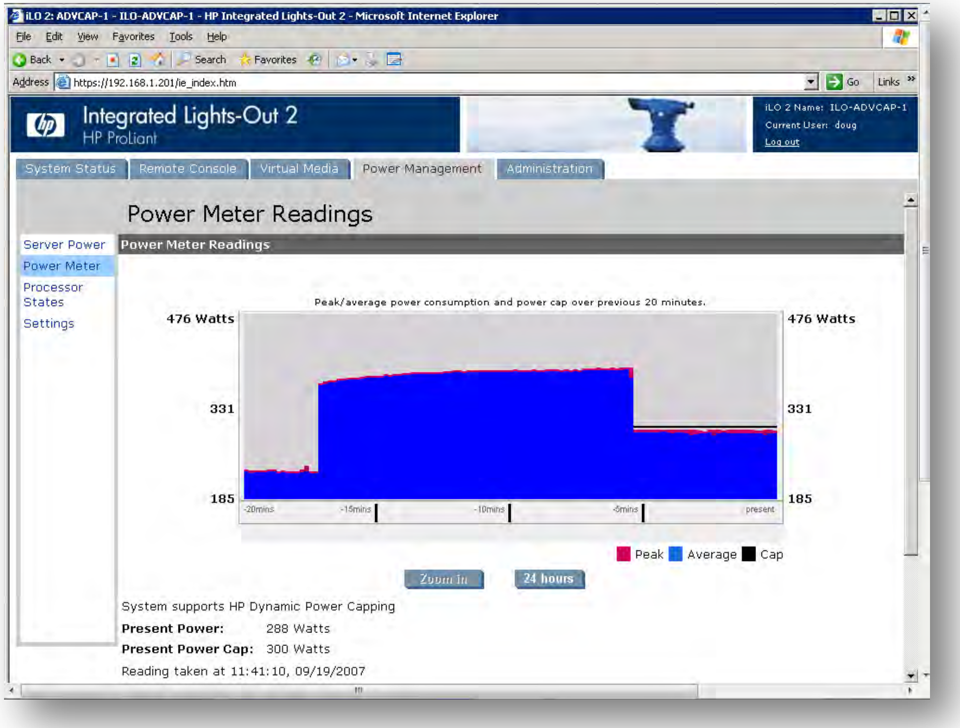
	Dynamic Power Capping	Basic Power Capping
Power capping executed from	Power management microcontroller	iLO and system ROM BIOS
Control of processor power	Direct hardware connection to processor to control P-state/clock throttling at the processor hardware level	Firmware control of P-state/clock throttling through processor registers
Power monitoring cycle	More than 5 times per second	Once every 5 seconds
Time to bring server power consumption back under its cap	Less than 0.5 seconds	10 – 30 seconds
Intended application	Managing power and cooling provisioning	Managing cooling provisioning

Figure 2. Rapid response of Dynamic Power Capping avoids circuit breaker trips



Single Server Dynamic Power Cap

- In this graph, the server starts out idle.
- The workload and the system utilization and power consumption went up dramatically. The peak power consumption was about 350 W.
- Setting a 300 W Dynamic Power Cap. The Dynamic Power Cap is represented by the black line.



System supports HP Dynamic Power Capping

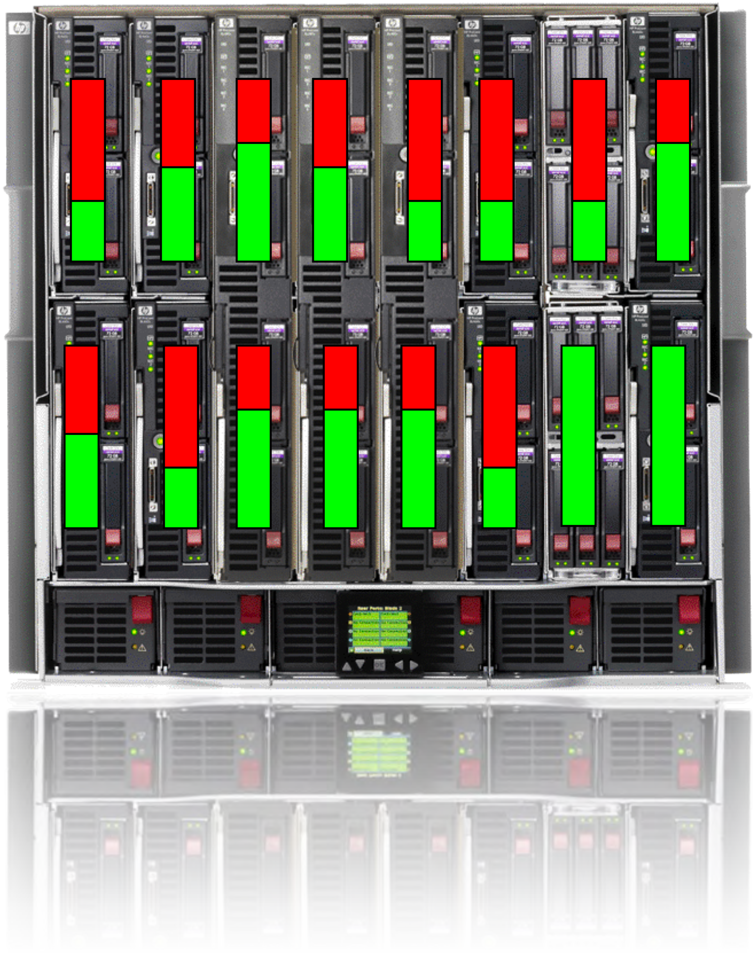
Present Power: 288 Watts

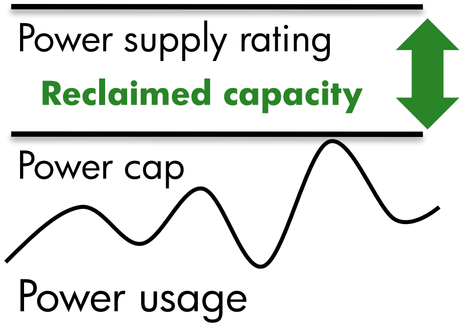
Present Power Cap: 300 Watts

Reading taken at 11:41:10, 09/19/2007

Enclosure Dynamic Power Capping

- Measure server power consumption
- Cap servers based on measurements
- Workload changes with time
- Change the power caps
  - Busy servers get more power
  - Idle servers get less





Power supply rating

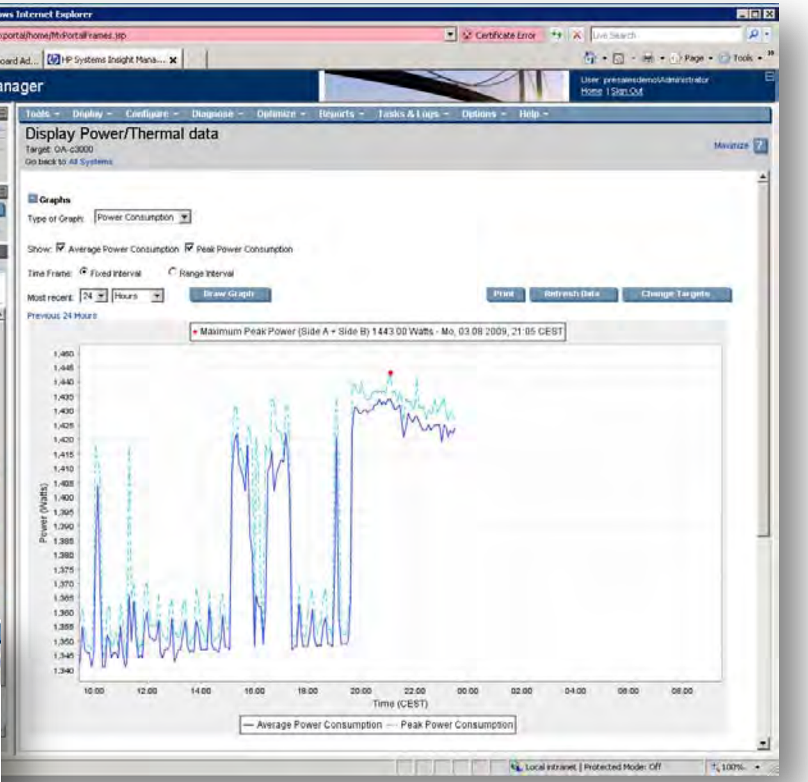
Reclaimed capacity

Power cap

Power usage

Insight Power Manager

- Talks directly to iLO
- Use power history to determine actual power usage
- Set power cap to observed peak
- Monitor power usage to detect potential performance impact



Display Power/Thermal data

Target: OA-c3000

Go back to All Systems

Graphs

Type of Graph: Power Consumption

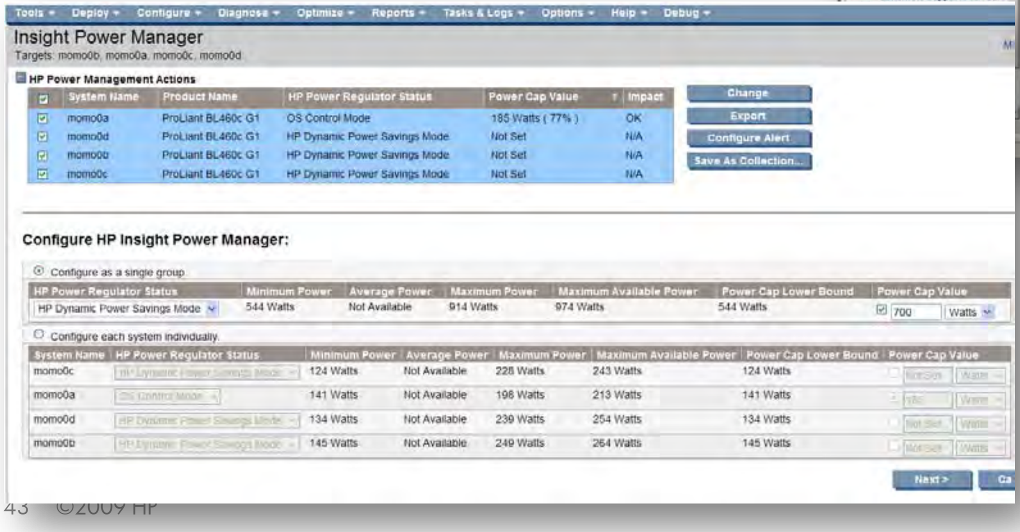
Show: ☑ Average Power Consumption ☑ Peak Power Consumption

Time Frame: ● Fixed Interval ○ Range Interval

Most recent: 24 Hours

Previous 24 Hours

• Maximum Peak Power (Side A + Side B) 1443.00 Watts - Mo, 03.08.2009, 21:05 CEST



Insight Power Manager

Targets: momo0b, momo0a, momo0c, momo0d

HP Power Management Actions

☑	System Name	Product Name	HP Power Regulator Status	Power Cap Value	Impact
☑	momo0a	ProLiant BL460c G1	OS Control Mode	185 Watts (77%)	OK
☑	momo0d	ProLiant BL460c G1	HP Dynamic Power Savings Mode	Not Set	N/A
☑	momo0b	ProLiant BL460c G1	HP Dynamic Power Savings Mode	Not Set	N/A
☑	momo0c	ProLiant BL460c G1	HP Dynamic Power Savings Mode	Not Set	N/A

Configure HP Insight Power Manager:

● Configure as a single group

HP Power Regulator Status	Minimum Power	Average Power	Maximum Power	Maximum Available Power	Power Cap Lower Bound	Power Cap Value
HP Dynamic Power Savings Mode	544 Watts	Not Available	914 Watts	974 Watts	544 Watts	☑ 700 Watts

○ Configure each system individually.

System Name	HP Power Regulator Status	Minimum Power	Average Power	Maximum Power	Maximum Available Power	Power Cap Lower Bound	Power Cap Value
momo0c	HP Dynamic Power Savings Mode	124 Watts	Not Available	228 Watts	243 Watts	124 Watts	□ Not Set Watts
momo0a	OS Control Mode	141 Watts	Not Available	198 Watts	213 Watts	141 Watts	185 Watts
momo0d	HP Dynamic Power Savings Mode	134 Watts	Not Available	239 Watts	254 Watts	134 Watts	□ Not Set Watts
momo0b	HP Dynamic Power Savings Mode	145 Watts	Not Available	249 Watts	264 Watts	145 Watts	□ Not Set Watts

Power Management Elemente

- Processor
- Chipset
- Platform
- Operating System (not user settable policy)
- Operating System (user settable policy)
- Application

OS basiertes Processor Power Management (PPM)

- Offers considerable power savings
- Negligible impact to server performance, responsiveness
- Capable processors are prevalent in the market today
- Mature, reliable technology
  - Significant deployments in mobile and desktop systems

Requirements

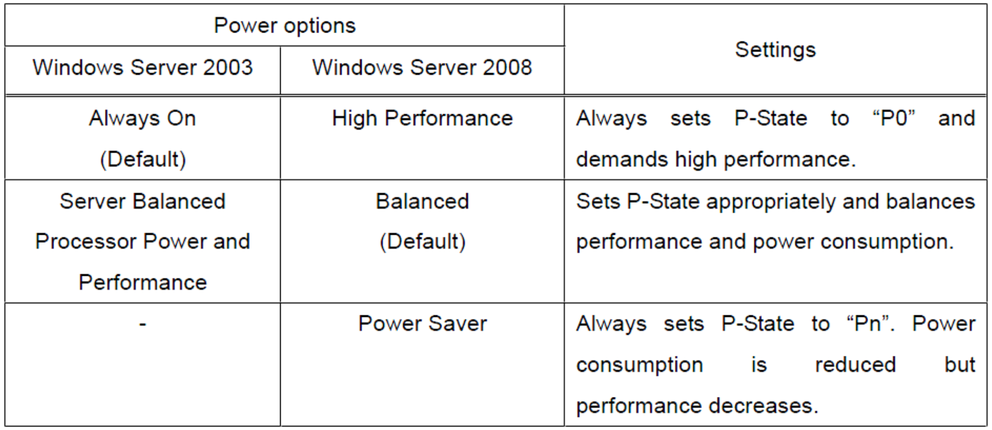
- Hardware must support PPM capabilities
- ACPI namespace must described capabilities and contain processor objects
- Windows processor driver required for specific CPU make/model

Operating System: Vergleich

The evaluation shows that Windows Server 2008 requires approximately 10% less

– Multiprocessor support
  The P-State and C-State controls of Windows Server 2003 support only single processors, whereas Windows Server 2008 supports multiple processors and can individually control processors and cores.

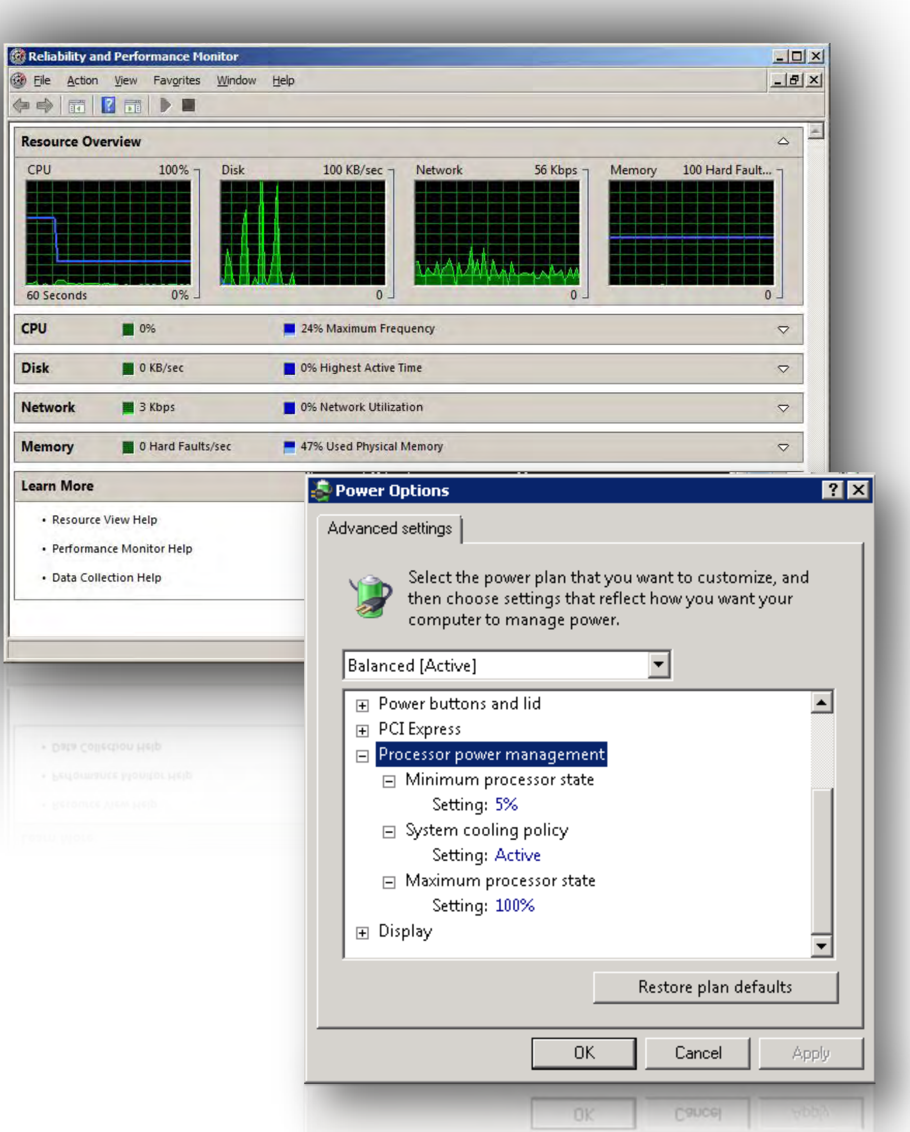
– Improved P-State and C-State Controls
  The algorithms of P-State and C-State control have been refined, and power management in Windows Server 2008 improved over that of Windows Server 2003.



Power options		Settings
Windows Server 2003	Windows Server 2008	
Always On (Default)	High Performance	Always sets P-State to “P0” and demands high performance.
Server Balanced Processor Power and Performance	Balanced (Default)	Sets P-State appropriately and balances performance and power consumption.
-	Power Saver	Always sets P-State to “Pn”. Power consumption is reduced but performance decreases.

Processor Power Management in Windows 2008

- Power policy will always use "Demand Based Switching" (DBS) between the range defined by max, min frequency
  - Full range of available states, or
  - A subset of available states
  - Will not include linear clock throttle states
- Policy may be set to use only one performance state
  - Max, min, or any intermediate state

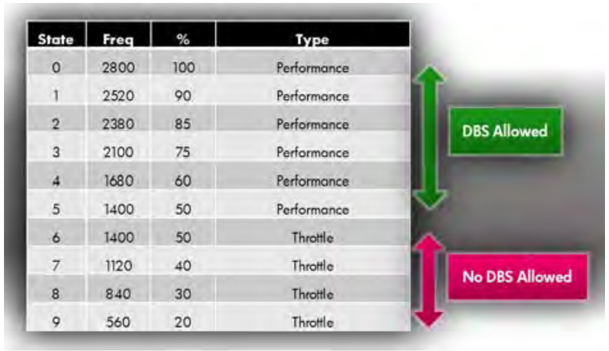


CPU	🟩 0%	🟦 24% Maximum Frequency
Disk	🟩 0 KB/sec	🟦 0% Highest Active Time
Network	🟩 3 Kbps	🟦 0% Network Utilization
Memory	🟩 0 Hard Faults/sec	🟦 47% Used Physical Memory

Select the power plan that you want to customize, and then choose settings that reflect how you want your computer to manage power.

Balanced [Active]

- ⊞ Power buttons and lid
- ⊞ PCI Express
- ⊟ Processor power management
  - ⊟ Minimum processor state
    - Setting: 5%
  - ⊟ System cooling policy
    - Setting: Active
  - ⊟ Maximum processor state
    - Setting: 100%
- ⊞ Display



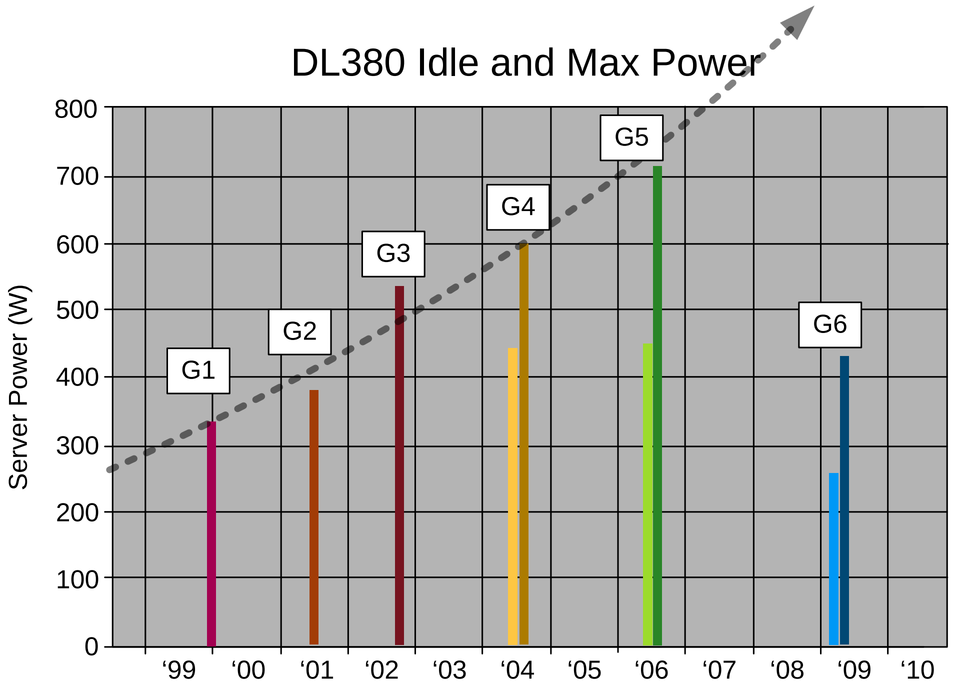
State	Freq	%	Type
0	2800	100	Performance
1	2520	90	Performance
2	2380	85	Performance
3	2100	75	Performance
4	1680	60	Performance
5	1400	50	Performance
6	1400	50	Throttle
7	1120	40	Throttle
8	840	30	Throttle
9	560	20	Throttle

DBS Allowed

No DBS Allowed

Die Entwicklung spricht für sich

- Low-power options: CPU, DIMMs, drives
- Scalable performance
- Efficient component selection and design



HP ENERGY STAR Servers

ENERGY STAR PARTNER

– HP is *first* to publicly announce ENERGY STAR servers

– Thermal Logic technology enables ENERGY STAR qualification

– ENERGY STAR DL360 G6 and 380 G6 configurations are currently available

– More ENERGY STAR servers will be announced soon

"The EPA is glad to be working with HP, the leading server vendor in the world, to accelerate the reduction of energy consumption in the data center, help businesses reduce operating costs, and encourage companies to be more environmentally responsible." *-Andrew Fanara, Director, EPA´s ENERGY STAR specifications team.*

Links

- HP Power Advisor http://h18000.www1.hp.com/products/servers/power-advisor/index.html
- DDR3 Memory Configurations Recommendations http://h20195.www2.hp.com/v2/GetPDF.aspx/c01750914.pdf
- DDR3 Memory Configuration Tool http://h18000.www1.hp.com/products/servers/options/tool/hp_memtool.html
- Power Regulator for ProLiant servers http://h20000.www2.hp.com/bc/docs/support/SupportManual/c00300430/c00300430.pdf