Results of Field and Lab Testing of PCs

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EIST, PowerMaster and Efficient PS

Energy Savings in Intel Socket T Processors

Idle State Power (AC watts)

- no-EIST (P4 552)
- EIST (P4 630) + PowerMaster
- + 80% efficient power supply

Base system: 1024 MB DDRI, on-board video, 80 GB SATA HD, DVD/CD-RW
Future: PowerMaster II

- Expected to launch late 2005
- Dynamic scaling of:
  - Frequency (through FSB)
  - Voltage
- Used to ease cooling loads as AOpen moves to smaller form factor designs
AMD Socket 939 System

• Cool ‘n Quiet capable
AMD Systems Close to Meeting Proposed Spec with Conventional Power Supplies

**Base system:** 1024 MB DDRI, nVIDIA GeForce 4 MX 440 video card, 80 GB HD, DVD/CD-RW, stock power supply
With 80% efficient power supply, all Athlon systems we tested pass

**AMD Athlon System with High Efficiency PS**

<table>
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<tr>
<th>System</th>
<th>Base system</th>
<th>+ Cool 'n Quiet</th>
<th>+ 80% efficient power supply</th>
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</thead>
<tbody>
<tr>
<td>Athlon FX-53</td>
<td>60</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>Athlon 3500+</td>
<td>60</td>
<td>60</td>
<td>80</td>
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*Base system: 1024 MB DDRI, nVIDIA GeForce 4 MX 440 video card, 80 GB HD, DVD/CD-RW*
Pentium M System

- Low voltage, 1.8 GHz Pentium M on desktop motherboard
- Accepts lower power DDRII memory
- Prior testing indicated big energy savings potential, while preserving adaptability of desktop form factor
Lowest idle power yet...

Pentium M System Configurations

Idle State Power (AC watts)

+ high-end video card
Base system
+ 80% efficient power supply

Base system: 1024 MB DDRII, on-board video, 80 GB HD, DVD/CD-RW
Desktops Built with Mobile Processors Can Compete Well Against Traditional Desktops

Results courtesy of SilentPCReview
2.0 GHz Pentium M vs. 3.0 GHz Pentium 4
Impact of Various Processors on Desktop Idle Power and Benchmark Score

Performance and Idle Mode Power

- Intel Desktop Processors
- Intel Mobile Processors
- AMD Processors

PCMark '04 Benchmark Score vs. Idle State Power (AC watts)
Impact of Various Components on Desktop Idle Power and Benchmark Score

Performance and Idle Mode Power

PCMark '04 Benchmark Score vs. Idle State Power (AC watts)

- Desktop systems
- Mobile systems
- High-performance video cards
- Stock power supply/video card
- No power scaling
- Power scaling and high efficiency PS
Enabling Monitor Sleep through the Computer Makes No Difference to Computer Idle Power

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<th>System Configuration</th>
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<th>Idle Power with Monitor in Sleep</th>
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<td>45.8</td>
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<td>P4 540J w/on-board video</td>
<td>65.5</td>
<td>65.2</td>
</tr>
<tr>
<td>P4 540J w/PCI Express video card</td>
<td>79.7</td>
<td>79.9</td>
</tr>
<tr>
<td>AMD Athlon 64 3500+ w/AGP 8X video card</td>
<td>70.2</td>
<td>69.7</td>
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</table>

Design changes to video cards are needed
Video cards crucial to meeting idle state requirements

Effect of Video Card on System Idle State Power

- Intel P4 2.66 GHz
- AMD Athlon 64 +3500 2.2 GHz
- Intel P4 552 3.46 GHz
- Intel P4 630 3.0 GHz
- Intel P4 540J 3.2 GHz

Idle State Power (AC watts)

- Power scaling & 80% efficient PS
- + high performance video card
Assessing the Continuum of Measures to Reduce Energy Use in Idle Mode and/or through Power Management

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<tr>
<th>Idle Measures</th>
<th>Power Management Measures</th>
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<td><strong>Efficient Power Supply</strong></td>
<td><strong>Enable Hard Drive Sleep</strong></td>
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<td><strong>Efficient Cooling</strong></td>
<td><strong>Enable Monitor Sleep</strong></td>
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<td><strong>Processor Throttling</strong></td>
<td><strong>Wake on LAN Solution</strong></td>
</tr>
<tr>
<td><strong>Video Card Power Scaling</strong></td>
<td><strong>Enable Computer Sleep</strong></td>
</tr>
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<td><strong>Manually Switch Off Computer</strong></td>
<td></td>
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<tr>
<td>Wait Time Imposed</td>
<td>&lt;5 sec</td>
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<tr>
<td>Performance Impact</td>
<td>&lt;5 sec</td>
</tr>
<tr>
<td>Magnitude of PC Power Savings</td>
<td>10 sec</td>
</tr>
<tr>
<td>Extent of User Control</td>
<td>10-30 sec</td>
</tr>
<tr>
<td>Certainty of Power Savings</td>
<td>&gt;60 sec</td>
</tr>
<tr>
<td>Timeframe of Solution</td>
<td>15-25%</td>
</tr>
<tr>
<td>Extent of User Control</td>
<td>10-15%</td>
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<td>Magnitude of PC Power Savings</td>
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Graphs of CPU Utilization vs. Time Can Be Deceptive...

CPU Utilization for Typical Computer

- Time (hours)
- CPU Utilization (%)
Sorting Reveals that a Typical Computer Spends > 80% of Time at Less than 5% CPU Utilization
How Much Consecutive Time Does a Computer Spend in Idle State During Typical Workday?

![Graph showing duration of idle mode segments in typical workday for Laptop User 1 and Laptop User 2.]
CPU Utilization Differences between Typical Office Usage and an Unattended Computer Are Small

CPU Utilization in Typical Computers

- Laptop User 1
- Desktop at "Pure" Idle

% of Time CPU Utilization is Less Than Y Value
Most Computers Cannot Scale Total Power Use Effectively with CPU Utilization

Dell Power Edge 2400 (Web/SQL Server)

- Very Low Processor Activity does not relate to very low power consumption
- Very Low Processor Activity does not relate to very low power consumption
Results of Field Testing of Servers

![Graph showing CPU utilization over time for different types of servers]
Processor Throttling is a Well-Established Way to Reduce Power Use and Protect Processors from Excess Heat

- Processor throttling can cut *processor* power use by roughly 25 to 70% during periods of inactivity (idle)
- Processor throttling can cut *system* power use by roughly 12 to 24%, depending on system configuration and duty cycle
- AMD and Intel both employ this technology to varying degrees today
CPU Families

**Desktop**
- Celeron
- Pentium 4
- Pentium D

**Mobile**
- Pentium M
- Pentium 4-M
- Celeron M

**Server**
- Itanium 2
- Xeon

**Desktop**
- Athlon XP
- Athlon 64
- Athlon FX
- Athlon X2
- Turion

**Mobile**
- Turion

**Server**
- Opteron

**Desktop**
- Sempron
- Athlon FX
- Athlon 64
- Athlon 64

**Mobile**
- Turion

**Server**
- Opteron

**Desktop**
- PowerPC G5
- PowerPC G4
- PowerPC G3

**Mobile**
- PowerPC G4
- PowerPC G3

**Server**
- PowerPC G5
Next-generation Desktops

EIST/PowerMaster

Cool ‘n Quiet

Pentium M
Socket T/Pentium System

- Enhanced Intel SpeedStep (EIST) power scaling technology
- AOpen PowerMaster technology on motherboard allows dynamic power scaling for any Socket T
What is PowerMaster?

- Lowers processor power by adjusting frequency of FSB when processor idling
- Brings a degree of power scaling to non-scaling processors
- Configurable in system BIOS
- http://usa.aopen.com/
High Efficiency in Socket T Systems

Base system: 1024 MB DDRI, on-board video, 80 GB SATA HD, DVD/CD-RW

Idle State Power in Intel P4 Processor Line

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<tr>
<td>P4 630 3.0 GHz</td>
<td>3874</td>
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<td>P4 540J 3.2 GHz</td>
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