Third-Generation AMD Opteron™ “Barcelona” Processor

AMD Japan
Product Marketing
Hiroyuki Yamano

AMD Quad-Core Processor Architecture
A Closer Look at ‘Barcelona’

- Comprehensive Upgrades for SSE128
- Can quadruple floating point capabilities
- New Highly Efficient Cache Structure with Shared L3 Cache
- Balance of dedicated and shared cache for optimum quad-core performance
- CPU Core Enhancements
- To benefit applications by improving overall efficiency and performance of cores
- Virtualization Enhancements
- New “Rapid Virtualization Indexing” feature designed for near native performance on virtualization applications
- Advanced Power Management
- Provides granular power management resulting in improved power efficiency
- DRAM Controller Enhancements
- To improve overall memory performance with native quad-core processing
**'Barcelona’ ... Not Just Four Cores**

**Comprehensive 128-bit SSE Upgrades**

<table>
<thead>
<tr>
<th>Goal: Balanced SSE Execution</th>
<th>64-bit Platforms</th>
<th>Intel Clovretown</th>
<th>AMD Barcelona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction Fetch Bandwidth</td>
<td>1x</td>
<td>2x</td>
<td>2x</td>
</tr>
<tr>
<td>Data Cache Bandwidth</td>
<td>1x</td>
<td>1x</td>
<td>2x</td>
</tr>
<tr>
<td>L2 Cache / North-Bridge Bandwidth</td>
<td>1x</td>
<td>2x</td>
<td>2x</td>
</tr>
</tbody>
</table>

- Barcelona doubles Instruction and Data pipelines ... Intel's pipeline doesn't.
  - Helps keep 128-bit SSE pipeline full for optimum performance.
- Dedicated 36-entry floating-point scheduler can reduce application latency.
  - Intel 32-entry scheduler shared between floating-point and integer operations.
- Incredible performance boost, per core, on target applications!

---

**Balanced, Highly Efficient Cache Structure**

**Efficient memory handling reduces need for “brute force” cache sizes**

**Dedicated L1**
- AMD's 64KB/64KB (Data/Instruction) vs. Xeon's 32KB/32KB.
- Allows 2 loads per cycle.

**Dedicated L2**
- Dedicated cache designed to eliminate conflicts of shared cache structures.
- Designed for true working data sets.

**Avoid Thrashing**
- Minimize Latency

**Shared L3 - NEW**
- Designed for optimum memory use and allocation for multi-core.
- Ready for expansion at the right time for customers.

**Reducing Latency to Main Memory**

- Core 1: 64KB Cache Control, 64KB Cache Control, 64KB Cache Control, 64KB Cache Control.
- Core 2: 64KB Cache Control, 64KB Cache Control, 64KB Cache Control, 64KB Cache Control.
- Core 3: 512KB Cache Control, 512KB Cache Control, 512KB Cache Control, 512KB Cache Control.
- Core 4: 64KB Cache Control, 64KB Cache Control, 64KB Cache Control, 64KB Cache Control.
- Shared L3: 2MB+ Cache Control.
Native Quad-Core Benefit: Faster Data Sharing

Situation: Core 1 needs data in Core 3’s cache ... How Does it Get There?

1. Core 1 probes Core 3 cache, data is copied directly back to Core 1
2. Core 3 sends data back to the memory controller, which forwards it to Core 1

This happens at processor frequency
Result: Improved Quad-Core Performance

This happens at front-side bus frequency
Result: Reduced Quad-Core Performance

AMD-V™ Enhancements: Rapid Virtualization Indexing
Reduced Overhead for More Efficient Switching

- Provides the guest OS with the illusion that it is managing its own world
- Page tables are actually kept up by the hypervisor in software
- Requires more software intervention from the hypervisor

- Each guest physically has their own world to manage
- Memory lookups done in hardware which can be faster than software management
- Requires less hypervisor intervention
**Better Power Savings**

*With Dual Dynamic Power Management™*

Enables more AMD PowerNow!™ power saving opportunities

<table>
<thead>
<tr>
<th>Component Activity</th>
<th>Associated Core Voltage and Frequency by Platform</th>
<th>Example Workloads</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cores</strong></td>
<td><strong>Memory</strong></td>
<td><strong>Unified</strong></td>
</tr>
<tr>
<td>Busy</td>
<td>Busy</td>
<td>High Vols MHz</td>
</tr>
<tr>
<td>Idle</td>
<td>Idle</td>
<td>High Vols Low MHz</td>
</tr>
<tr>
<td>Idle</td>
<td>Busy</td>
<td>High Vols High MHz</td>
</tr>
</tbody>
</table>

DDPM can offer 66% more power savings!

**Example Workloads**

- Virtualization, Multi-Tasking, Data analytics, Rendering, HPC
- Many Workloads Benefit!

**Improving Processor Power Management**

*with AMD PowerNow!™ Technology enhancements*

**Dual-Core**

- MHz and voltage is locked to highest utilized core’s p-state

**Native Quad-Core**

- MHz is independently adjusted separately per core. Voltage is locked to highest utilized core’s p-state

Native Quad-Core technology enables enhanced power management across all four cores
Reducing Power with Advanced Logic Design

- Advanced logic design with additional clock gating
  - Hardware shuts down clock to areas of logic that are not used to reduce processor power consumption
    - **Coarse Gaters**
      - Shut down entire blocks of logic at a time
    - **Fine Gaters**
      - Shut down pieces of logic when appropriate

Reducing power consumption is a high priority in AMD processor designs

Seamless Quad-Core Power Migration Path Reduces Operations cost

Consistent power & thermals makes it easier to:

- Plan for long-term infrastructure needs
- Scale applications without increasing power consumption
- Upgrade to new systems without re-arranging racks
- Keep existing AC equipment instead of having costly upgrades

Wattage based on 2P systems with 512MB at max CPU wattage. Wattage for ‘Dempsey’, ‘Woodcrest’ and ‘Clovertown’ is estimated based on publicly available values (e.g. http://techrepert.com/etc/2006q2/woodcrest/index.php), and is subject to change. The examples contained herein are intended for use on a single server only. Other factors such as disk and drive consumption...
Actual Memory Power Measurements

Enormous power and heat penalties for memory capacity using FBDIMM

With 8 DIMMs:
- FBDIMM consumes ~83 watts during IDLE
- While only ~14 watts are consumed by DDR2

8x FBDIMMs consume over 100 watts at the highest measured LOAD vs. only ~37 watts for DDR2

Projected Infrastructure Impact of Quad-Core

- Second-Generation AMD Opteron™ processors with planned upgrade path to quad-core within existing power & thermal envelopes
- Clovertown raises power & thermal requirements within each power band
- Intel customers may be forced to choose between higher power & cooling costs or wasted rack space

7Kw Power Budget

- Dual-core: 65W
- Quad-core: 95W

- Dual-core: 120W
- Quad-core: 120W

AMD Opteron™ processors
- Designed to maximize server density and minimize transitions

Intel Xeon
- Can waste data center space and increase transition pain
まとめ

低消費電力と且つハイパフォーマンスな
「ダイレクトコネクト・アーキテクチャ」搭載のクアッドコア AMD
プロセッサを以下の様なお客様に推奨します。

◆最新技術でパフォーマンスを求めるお客様
◆消費電力・発熱に関心があるお客様
◆大容量メモリでアプリケーションをご利用になるお客様

ご清聴ありがとうございました。