The AMD Fusion APU

Bradley Wideman and Jack Stokes
Outline

- Origin of the APU
- APU Design
- Other CPU / GPU Integration Technologies
- Performance
The Origins of the APU

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**Generation One:**
Frequency and Architecture

**Generation Two:**
Homogeneous Multicores

**Generation Three:**
Heterogeneous Multicores

*Higher frequency = better performance*

*Improved throughput = better performance*

*Best hardware for the task = better performance, energy efficiency, and lower cost*
Multicore Speedup Needs Parallelism

Amdahl's Law

\[
\text{Speed-up} = \frac{1}{S_w + \frac{(1 - S_w)}{N}}
\]

- \(S_w\) = % Serial Work
- \(N\) = Number of Processors

- 0% Serial
- 10% Serial
- 35% Serial
- 100% Serial
Accelerated Processing Unit
AMD Fusion

• AMD's first APU design
• CPU and GPU on a single die
  ○ Faster interconnects
  ○ Shared memory
Current AMD Fusion Platforms

Brazos
- Ultra-portable
- Low power usage
- Low thermal output
  - TDP of 6-18W
- 1-2 'Bobcat' cores
- 80 Radeon cores

Lynx
- Desktop/Mobile
- High-performance
- Higher power usage
- High thermal output
  - 25-100W
- 2-4 K10 cores
- 160-400 Radeon cores
CPU Design (Llano)
APU Design (Llano)
Future APUs
OpenCL

- Heterogeneous Computing Language
- Portable
  - Supports x86 CPUs, AMD GPUs, and nVidia CPUs
- Similar to C
  - No recursion
  - Fixed Length Arrays Only
- Requires Explicit Memory Management
  - Example: Moving from main memory to GPU memory
- Other technologies:
  - DirectCompute, CUDA
Other CPU / GPU Integration Technologies

- Intel Sandy Bridge and Ivy Bridge
- Intel Larrabee / MIC
- Cell
- ARM SoC
Intel Sandy Bridge and Ivy Bridge

• Sandy Bridge is currently available.
• Ivy Bridge is scheduled to be available later this year.
• Hardware Dedicated to:
  ○ Graphics
  ○ Video Decoding and Encoding
  ○ Generation of Random Numbers (Ivy only)
Intel Larrabee / MIC

• Not yet released
• Intended for High Performance Computing
• Simplistic x86 cores
• Powerful vector processing units
• Could potentially be added to a future Intel CPU.
• Cache control instructions
Cell

- Currently Available
- Contains both traditional cores and vector cores
- Each vector core has a small amount of memory that is separate from main memory.
ARM SoC

• Integrates:
  ○ CPUs
  ○ GPUs
  ○ Memory
  ○ Input / Output

• Integration is mainly for power consumption reasons, not performance reasons.
# Netbook Performance Comparison

<table>
<thead>
<tr>
<th></th>
<th>AMD Fusion</th>
<th>Intel Atom</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU</strong></td>
<td>C-50</td>
<td>N570</td>
</tr>
<tr>
<td></td>
<td>E-350</td>
<td>D525</td>
</tr>
<tr>
<td><strong>GPU</strong></td>
<td>Radeon 6250</td>
<td>GMA 3150</td>
</tr>
<tr>
<td></td>
<td>Radeon 6310</td>
<td>nVidia ION</td>
</tr>
<tr>
<td><strong>Screen Size</strong></td>
<td>10.1 inches</td>
<td>10.1 inches</td>
</tr>
<tr>
<td></td>
<td>12.1 inches</td>
<td>12.1 inches</td>
</tr>
</tbody>
</table>
Netbook CPU Performance

**Peacekeeper, FF7**

- AMD E-350: 780
- AMD Brazos: 512
- Intel Atom D525: 443
- NVIDIA ION2: 387
- AMD C-50: 573
- AMD Brazos: 443
- Intel Atom N570: 387
- Intel Pine Trail: 573

**H.264 Transcode, MediaShow Espresso, sec**

- AMD E-350: 563
- AMD Brazos: 900
- Intel Atom D525: 260
- NVIDIA ION2: 387
- AMD C-50: 260
- AMD Brazos: 512
- Intel Atom N570: 573
- Intel Pine Trail: 573

Better →
Netbook GPU Performance

**3DMark Vantage, GPU**

- AMD E-350: 4672
- AMD Brazos
- Intel Atom DS25: 4144
- NVIDIA ION2
- AMD C-50
- AMD Brazos
- Intel Atom N570
- Intel Pine Trail

**Starcraft 2, LQ**

- AMD E-350: 10.1
- AMD Brazos
- Intel Atom DS25: 6.5
- NVIDIA ION2
- AMD C-50: 5.3
- AMD Brazos
- Intel Atom N570
- Intel Pine Trail: 1.9
Netbook Power Comparison

Battery Life, Text Reading, min

- AMD E-350: 330 min
- AMD Brazos: 376 min
- Intel Atom D525: 280 min
- NVIDIA ION2: 280 min
- AMD C-50: 376 min
- AMD Brazos: 376 min
- Intel Atom N570: 376 min
- Intel Pine Trail: 376 min

Better →

Battery Life, Maximum Load, min

- AMD E-350: 150 min
- AMD Brazos: 208 min
- Intel Atom D525: 160 min
- NVIDIA ION2: 160 min
- AMD C-50: 208 min
- AMD Brazos: 208 min
- Intel Atom N570: 210 min
- Intel Pine Trail: 210 min

Better →
Desktop Performance Comparison

- **AMD Fusion APUs:**
  - A8-3850: 4x2.9GHz, 4MB L2 Cache, Radeon 6550D
  - A8-3500: 3x2.1GHz, 4MB L2 Cache, Radeon 6530D
  - A4-3300: 2x2.5GHz, 1MB L2 Cache, Radeon 6410D

- **Intel CPUs:**
  - Core i3-2130: 2X3.4 GHz, HyperThreading, 3MB L3 Cache, HD Graphics 2000
  - Core i3-2125: 2X3.3 GHz, HyperThreading, 3MB L3 Cache, HD Graphics 3000
  - Pentium G620: 2X3.3 GHz, HyperThreading, 3MB L3 Cache, HD Graphics
Desktop CPU Performance

![Chart showing MediaEspresso 6.5, H.264 Transcode, sec results for different CPUs.

- Core i3-2125: 113 sec
- Core i3-2130: 117 sec
- Core i3-2120: 117 sec
- A8-3850: 500 sec
- A6-3650: 545 sec
- A8-3800: 567 sec
- Pentium G860: 637 sec
- Pentium G840: 678 sec
- Pentium G620: 714 sec
- A6-3500: 809 sec
- A4-3400: 951 sec
- A4-3300: 1030 sec

Better performance is indicated by lower values.](chart.png)
Desktop GPU Performance

3DMark Vantage, GPU

- A8-3850: 3560
- A8-3800: 3554
- A6-3650: 2566
- A6-3500: 2537
- A4-3400: 1937
- A4-3300: 1433
- Core i3-2125: 1334
- Core i3-2130: 821
- Core i3-2120: 815
- Pentium G620: 820
- Pentium G860: 811
- Pentium G840: 812
Power Usage

Power Consumption, CPU Burn, W

- Pentium G620: 25.5 W, 52.5 W
- Pentium G840: 24.8 W, 53.0 W
- Pentium G860: 28.5 W, 56.3 W
- Core i3-2120: 30.8 W, 58.9 W
- A4-3300: 46.4 W, 64.6 W
- Core i3-2125: 35.2 W, 65.1 W
- Core i3-2130: 35.8 W, 65.2 W
- A6-3500: 47.7 W, 66.4 W
- A4-3400: 49 W, 67.5 W
- A8-3800: 55.7 W, 77.6 W
- A6-3650: 93.8 W, 113.6 W
- A8-3850: 108.5 W, 130.2 W

Power Consumption, GPU Burn, W

- Pentium G620: 15.3 W, 43 W
- Pentium G840: 15.4 W, 43.3 W
- Pentium G860: 15.5 W, 43.5 W
- Core i3-2120: 15.6 W, 44 W
- Core i3-2130: 17.1 W, 45.1 W
- Core i3-2125: 23.7 W, 54.3 W
- A4-3300: 34.7 W, 55.2 W
- A6-3500: 38.3 W, 56.8 W
- A4-3400: 40.3 W, 60.2 W
- A6-3650: 43.3 W, 64.7 W
- A8-3800: 45.4 W, 72 W
- A8-3850: 51.7 W, 75.1 W

Better performance indicated by shorter bars.
Works Cited

AMD Fusion:
http://sites.amd.com/us/fusion/Pages/whitepaper.aspx
http://sites.amd.com/us/Documents/48423B_fusion_whitepaper_WEB.pdf
http://realworldtech.com/page.cfm?ArticleID=WRT062711124854
http://www.pcmag.com/article2/0,2817,2399789,00.asp

OpenCL:

Performance Comparison:
http://www.xbitlabs.com/articles/mobile/display/amd-fusion-intel-atom.html

Other:
http://www.bit-tech.net/hardware/cpus/2011/10/10/all-about-ivy-bridge/6
Questions?