Hardware Acceleration for CST MICROWAVE STUDIO®

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2. Why use Hardware Acceleration?
3. Hardware Acceleration Technologies
4. Current Features and Product Family
5. Benchmarks
6. Upcoming Features
Quick Acceleware History

Highlights

Feb 04  Founded
Oct 05  Shipped First Product
Jan 07  NVIDIA Invests
Jun 07  Announced third generation of products
Feb 08  71 Employees
Feb 08  Acceleware turns 4 years old

Publicly-Traded: Toronto Venture Exchange (TSX), Symbol: AXE

EM Market: 8 announced software partners
Seismic Market: Field trials completed; launch January 30
Image Reconstruction: Customer trials successful; launch Q1 2008

HQ: Calgary, Canada
Processing Evolution

Application Example
- Antenna
- Cellphone
- Head/Cellphone
- Full Body/Object

Application Size & Complexity
- 10 - 15 Years Ago
- 5 - 10 Years Ago
- Today
- Tomorrow

Hardware Option
- Supercomputer
- Cluster
- PC
Acceleware – What Do We Do?

Leverage the Massive Parallel Computational Capabilities of the GPU

Result is a Supercomputer
Why Acceleration?

**Performance**
- Size of problem
- Time to solution
- Cost

**Infinite appetite for increased performance**
- Today … users *Compromise*
- Larger and more complex problems
  - Currently taking days, weeks, or longer to run
  - Computer-aided optimization

**Increased performance results in …**
- Faster time-to-market = Increased revenues
- Safer, better products = Reduced cost
- Better, more-informed decisions
Options for Acceleration

- **Multi-Core CPU**
  - CPU (four cores)
  - Quad-Channel ~21 GB/s

- **FPGA**
  - Four Memory Banks ~21 GB/s
  - To Host CPU
  - System I/O Bus < 1 GB/s

- **GPU**
  - Ultra-Fast Video Memory
  - Wide Memory Bus ~70-90 GB/s
  - “GPU”
  - To Host CPU
  - Highest Speed System I/O Bus < 8 GB/s

- **Others**
  - Cell - microprocessor architecture designed by Sony, Toshiba and IBM (ex. Playstation 3)
  - Clearspeed – proprietary microprocessor architecture
  - ASICs

- **Others**
  - Sony, Toshiba and IBM
  - Cell microprocessor architecture
  - Playstation 3
  - ClearSpeed microprocessor architecture
  - ASICs
## Performance Comparison

<table>
<thead>
<tr>
<th></th>
<th>Maximum Practical Speed</th>
<th>Maximum Size of Application</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-core</td>
<td></td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>FPGA</td>
<td></td>
<td></td>
<td>$</td>
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<tr>
<td>GPU</td>
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<td>Cell</td>
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<tr>
<td>ClearSpeed</td>
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</tbody>
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*acceleware*

*PROCESSING SUPERPOWER*
GPU Technology

- NVIDIA Quadro FX chipset
- 128 cores, 1.35 GHz, ~500 Gflops
- 76.8 GB/s memory bandwidth
- 1.5 GB GDDR3
- PCI Express x16 interface
Accuracy and Stability of Hardware Acceleration

• Both GPU and CPU are 32-bit floating point precision
• Order of operations and rounding are slightly different between the two
• However, time domain results are virtually identical

The calculations normally done on the CPU are transferred to the Accelerator A30 – this is handled within CST MICROWAVE STUDIO

Port21 Time Signal

<table>
<thead>
<tr>
<th>Hardware Results</th>
<th>Software Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td></td>
</tr>
<tr>
<td>1.00E-01</td>
<td>1.00E-01</td>
</tr>
<tr>
<td>2.00E-01</td>
<td>2.00E-01</td>
</tr>
<tr>
<td>3.00E-01</td>
<td>3.00E-01</td>
</tr>
</tbody>
</table>

Time
Product Family for CST MICROWAVE STUDIO

**Accelerator™**
- Installs in your existing workstation (PCI-Express x16 slot)

**ClusterInABox™**
- Two Accelerator cards
- Installs using interface card into your existing workstation
Accelerator A30 Performance

• 1M – 24M meshcells fully accelerated
• >24M meshcells via Soft Memory Limit*
• ~7x speed up (referenced against a 4-core Woodcrest system running in software only)

* Soft Memory Limit extends the maximum simulation size beyond that of the memory on the Accelerator by sharing memory with the host computer. Performance will depend on the proportion of memory shared.
ClusterInABox Dual D30 Performance

- Contains two Accelerator A30 cards
- 1M – 48M meshcells supported on hardware
- >48M meshcells supported in Soft Memory Limit
- ~12x speed up (vs. typical software only run on a 4-core Woodcrest system)
Within the **Time Domain Solver** of CST MICROWAVE STUDIO, the following types of simulations up to 24M meshcells (for one Accelerator A30) or up to 48M meshcells (for a ClusterInABox D30) will be best suited to hardware acceleration:

1. Antennas, cell phones.
2. PCB, signal integrity and package analysis.
3. Cables, connectors, waveguides, RF components.
Currently Supported Features

Features Supported by hardware acceleration:
• PBA® (Perfect Boundary Approximation)
• Open and closed boundaries
• TST™ (Thin Sheet Technique)
• Lossy metal model
• Lossless and lossy heterogeneous dielectric materials
• Far field monitors
Currently Supported:

- Windows® XP (32-bit)
- Windows XP 64-bit (strongly recommended)

Future Supported:

- Red Hat Enterprise Linux® WS 4
- Windows Vista™
Note: Above speed up factors are determined by comparison to a 4-core Woodcrest system.

ClusterInABox D30
Accelerator A30
Software Only
IBM Challenge Problem

Size of Model: 27 million meshcells
Shape: X: 677  Y: 1159  Z: 36

Calculation times:

<table>
<thead>
<tr>
<th></th>
<th>Model run in Software Only</th>
<th>Model run on a ClusterInABox D30</th>
<th>Speed Up Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solver Time (hrs)</td>
<td>273.8</td>
<td>18.4</td>
<td>14.9</td>
</tr>
<tr>
<td>Total Run Time (hrs)</td>
<td>276.2</td>
<td>20.0</td>
<td>13.8</td>
</tr>
</tbody>
</table>

Note: All 36 ports were run in this simulation. Above speed up factors are determined by comparison to a 4-core Woodcrest system.
Note: Above speed up factors are determined by comparison to a 4-core Woodcrest system.
Hardware Acceleration is supported in CST MICROWAVE STUDIO 2008 and beyond.

Future Developments:
- Red Hat Enterprise Linux
- Windows Vista
- ClusterInABox Quad Q30 Hardware
- Dispersive Materials
- Periodic Boundaries
- And More…
Thank You