Memory Modules for ATCA and AMC

Bill Gervasi
Vice President, DRAM Technology
Chairman, JEDEC JC-45.3
Server Market
### Old Roadmap #1... Divergence

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
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</thead>
<tbody>
<tr>
<td>HE Server</td>
<td>DDR2-400 RDIMM 2 Rank</td>
<td>DDR2-533 FB-DIMM 2 Rank</td>
<td>DDR2-667 FB-DIMM 2 Rank</td>
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<tr>
<td>Mid Server</td>
<td>DDR2-400 RDIMM 2 Rank</td>
<td>DDR2-533 FB-DIMM 2 Rank</td>
<td>DDR3-800 FB-DIMM 4 Rank</td>
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<tr>
<td>LE Server</td>
<td>DDR2-400 RDIMM 2 Rank</td>
<td>DDR2-533 FB-DIMM 2 Rank</td>
<td>DDR3-800 FB-DIMM 4 Rank</td>
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<tr>
<td>HPC</td>
<td>DDR2-533 UDIMM 2 Rank</td>
<td>DDR2-667 UDIMM 2 Rank</td>
<td>DDR3-1066 UDIMM 2 Rank</td>
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</table>

“RDIMMM is obsolete in 2006”
## Server Market Perspective #2

<table>
<thead>
<tr>
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<th>2006</th>
<th>2007</th>
<th>2008</th>
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<tr>
<td><strong>HE Server</strong></td>
<td><strong>DDR2-533</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
<td><strong>DDR2-533</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
<td><strong>DDR3-800</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
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<td><strong>Mid Server</strong></td>
<td><strong>DDR2-667</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
<td><strong>DDR2-667</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
<td><strong>DDR3-1066</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
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<td><strong>DDR2-667</strong>&lt;br&gt; RDIMM&lt;br&gt; 4 Rank</td>
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</tr>
<tr>
<td><strong>HPC</strong></td>
<td><strong>DDR2-533</strong>&lt;br&gt; UDIMM or RDIMM&lt;br&gt; 2 or 4 Rank</td>
<td><strong>DDR2-667</strong>&lt;br&gt; UDIMM or RDIMM&lt;br&gt; 2 or 4 Rank</td>
<td><strong>DDR3-1066</strong>&lt;br&gt; UDIMM or RDIMM&lt;br&gt; 2 or 4 Rank</td>
</tr>
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</table>
Mainstream Dual-CPU Server

Dual channel CPU or memory controller

RDIMM
2 ranks of 512Mb

8GB/CPU

16GB Total

RDIMM
4 ranks of 512Mb

16GB/CPU

32GB Total

Conclusion: 2 slot enablement allows DDR3 RDIMM to continue to meet the needs of server market
New Roadmap #1... Convergence

<table>
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<tr>
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<td>DDR2-533 UDIMM 2 Rank</td>
<td>DDR2-667 UDIMM 2 Rank</td>
<td>DDR3-1066 UDIMM or RDIMM? 2 Rank</td>
</tr>
</tbody>
</table>
FB-DIMM
FB-DIMM Summary: High Risk

- DDR2 FB-DIMM intro under way (2 rank only)

...but...

- Price decline in DDR2 FB-DIMM not likely

- ATCA FB-DIMM efforts halted
  - ATCA FB-DIMM solution requires angled sockets

- DDR3 FB-DIMM will die off
ATCA DDR2 RDIMM
Case Study: Blade Server, LP DIMM

- Angled Socket
- Cool Air
- Heated Air
- CPU
- CPU
- 17700 mm²
- Top View
- 30 mm DIMM

SimpleTech
Case Study: Blade Server, VLP DIMM

- Angled Socket
- Vertical Socket

- Cool Air
- Heated Air

- 7000 mm²
- 60% Reduction!

- 30 mm DIMM
- 18.3 mm DIMM

Top View

SIMPLETECH
Lessons Learned from VLP

- One size does NOT fit all
- Angled sockets create big problems
- VLP reduces board space consumed
- VLP simplifies internal routing
- VLP improves flexibility DIMM location
- VLP enables wider slot spacing
- Holistic system thermal analysis needed
Full family of VLP DDR2 RDIMMs approved: 1Rx8, 2Rx8, 1Rx4, 2Rx4

However, height of VLP is a little too high for ATCA
ATCA Blade Form Factor

- 21.33 mm maximum component height on side 1
- maximum component height on side 2 depends on the board design
- ~2.41 mm without side 2 cover and 1.6 mm PCB
- ~1.61 mm without side 2 cover and 2.4 mm PCB
- ~2.53 mm with 1 mm side 2 cover and 1.6 mm PCB
- ~1.73 mm with 1 mm side 2 cover and 2.4 mm PCB
Statistical Analysis Under Way

18.3mm analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Nominal</th>
<th>± Tolerance</th>
<th>StDev</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Pitch</td>
<td>30.48</td>
<td>N/A</td>
<td>N/A</td>
<td>Per ATCA Spec</td>
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<tr>
<td>Faceplate Height</td>
<td>28.959</td>
<td>0.380</td>
<td>0.12867</td>
<td>Per ATCA Spec</td>
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<tr>
<td>PEM Standoff Height</td>
<td>3.800</td>
<td>0.080</td>
<td>0.02957</td>
<td>PEM Tolerance</td>
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<td>PEM Gap to PCB</td>
<td>0.130</td>
<td>0.130</td>
<td>0.04333</td>
<td>ATCA Tolerance Range: 0 - 0.28</td>
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<tr>
<td>PC Board Thickness</td>
<td>2.400</td>
<td>0.240</td>
<td>0.08030</td>
<td>± 10% (Industry Standard)</td>
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<tr>
<td>Socket Float off PCB</td>
<td>0.065</td>
<td>0.065</td>
<td>0.02167</td>
<td>Tyco Range: 0 - 0.13</td>
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<td>Socket Seating Plane</td>
<td>2.850</td>
<td>0.100</td>
<td>0.03333</td>
<td>Tyco Recommendation</td>
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<td>Module Rise in Socket (Variable)</td>
<td>0.10 &amp; 0.00</td>
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<td>0.0333</td>
<td>Variable: Tyco Range: 0 - 0.38, 0 analyzed</td>
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<td>Module Card Height (Variable)</td>
<td>17.90 to 18.30</td>
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<td>Variable Height and Tolerance</td>
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<td>Insulator Card Height (Variable)</td>
<td>0.13 &amp; 0.00</td>
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<td>Variable: 0.13 &amp; 0 analyzed</td>
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<tr>
<td>Top Cover Thickness</td>
<td>0.650</td>
<td>0.100</td>
<td>0.03333</td>
<td>Per AMC Spec</td>
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Worst Case

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<th>Symmetry</th>
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\[ J = \begin{bmatrix} 0.310 & 1.238 & -0.928 & 1.548 \\ 0.517 & -0.207 & 0.827 \end{bmatrix} \]
ATCA Vertical Stackup

- Rise from motherboard during reflow?
- Rise in socket from seating plane until latches engage?
- A current strawman proposal
  - DIMM @ 18.20 ±0.10 mm
  - Socket @ 2.85 ±0.10 mm
  - Rise effects = 0.80 mm total
Support for 2 ranks (36 DRAMs) and 4 ranks (72 DRAMs) – ATCA enabled
DDR3 RDIMM Summary

- Compatible with UDIMM controller
- Single register/PLL small enough for ATCA
- Integrated PLL with only 4 output pairs
- 4 rank support designed in
- Supported by AMD & Intel
Family of reference cards in definition

- 1Rx8 → 512MB to 2GB
- 2Rx8 → 1GB to 4GB
- 1Rx4 → 1GB to 4GB
- 2Rx4 → 2GB to 8GB
- 4Rx4 → 4GB to 16GB
Summary of Socket/DIMM Height

- Current DDR2 sockets (3.3 mm)
  - Module height < 17.9 mm
- Coming DDR2/DDR3 sockets (2.85 mm)
  - Module height < 18.2 mm

- Control socket to motherboard coplanarity

- Debate continues in JEDEC…
AMC
Advanced Mezzanine Card
HOLE CHART:
A = REQUIRED HOLE FOR MODULE FACE PLATE MOUNTING

DIM ** = DIMENSION DEPENDS ON FACE PLATE
AND LATCH IMPLEMENTATION. SEE APPENDIX
FOR EXAMPLES

```
Ø 2.5 NON-PLATED
THRU HOLE

2X

MODULE PCB
COMPONENT SIDE 2

181.5±0.1

DIM **

73.5±0.1

SEE DETAIL A

2X

Ø 3 NON-PLATED
THRU HOLE

2X

CARD GUIDE AND STRUT
MECHANICAL KEEP-OUT ZONE
BOTH SIDES

68.5
66.8
64.25
63.5

CONNECTOR
COMPONENT
KEEP-OUT ZONE
BOTH SIDES

0.75
3.3
0

LATCH MECHANICAL
KEEP-OUT ZONE
BOTH SIDES

18.5
125
```

SimpleTech
AMC With SO or Mini

- 244 pin Mini-RDIMM
- 200 pin Mini-RDIMM
- 200 pin SO-DIMM
Rotate Memory Module?

- Can’t rotate due to memory bus routing
- Airflow wrong for this orientation
Mini-RDIMM versus 72b-SO-RDIMM

**Mechanical**
- Module = 82 x 30mm
- 244 pins, 0.6 mm pitch
- New socket

**Features**
- x4 DRAMs supported
- Address parity

**Mechanical**
- Module = 67.6 x 30mm
- 200 pins, 0.6 mm pitch
- Reuses mobile socket

**Features**
- No x4 DRAM support
- No address parity
Register designed for Mini/SO

Customer feedback needed:
- Mini or SO?
- ATCA height or 30mm
Peripherals & Narrow Buses
Peripherals & Narrow Buses

<table>
<thead>
<tr>
<th>Year</th>
<th>Peripherals</th>
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<tbody>
<tr>
<td>2005</td>
<td>DDR1 32b-DIMM</td>
</tr>
<tr>
<td>2006</td>
<td>DDR1 16b-SO-DIMM</td>
</tr>
<tr>
<td>2007</td>
<td>DDR2 16b-SO-DIMM</td>
</tr>
</tbody>
</table>

- Devices that need smaller granularity
  - A single 512Mb chip contains 64MB of data!
- Small footprint is desirable
  - 1 to 4 DRAMs typical
- Reuses SDRAM 144-pin SO-DIMM form
- Common pinout for DDR1/2/3 and 16/32 bits
Summary
ATCA/AMC Memory Solutions

- **ATCA**
  - DDR2 solutions: RDIMM, FB-DIMM
    - RDIMM can be vertical
    - FB-DIMM must be angled
  - VLP modules a little too tall
  - DDR3 RDIMM designed for ATCA

- **AMC**
  - 72b-SO-DIMM
  - Mini-RDIMM
Thank You

Bill Gervasi
bilge@simpltech.com

For more information on JEDEC: www.jedec.org