Current and Future Memory Technologies for your Intel® Architecture Based Platforms

Geof Findley, Sr Manager, Platform Memory Operation, Intel
Harry Yoon, Principal Engineer, Samsung
Agenda

- Intel Memory Usage Roadmap
- Memory industrial status and projection
- DDR3 Health & Industry Enabling Status
- DDR3 Value for DT/WKST/MB/SVR
- Memory education from leading supplier in industry – Samsung

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URL is on top of Session Agenda Pages in Pocket Guide
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- Memory education from leading supplier in industry - Samsung
Memory Technology Roadmap

Intel offers right memory for the right products

<table>
<thead>
<tr>
<th>Technology</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDR3</td>
<td>1333</td>
<td>1600</td>
</tr>
<tr>
<td>DDR2</td>
<td>667-800</td>
<td>800-1066</td>
</tr>
<tr>
<td>LPDDR2</td>
<td>667-1066</td>
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</tr>
</tbody>
</table>

All unreleased products, computer systems, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice.
## DDR3 Across Many Major Segments

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Desktop</strong></td>
<td></td>
</tr>
<tr>
<td>HEDT</td>
<td>Intel® Core™ i7 Extreme Processor</td>
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<tr>
<td>MS</td>
<td>Intel Core i7 and Core i5 Processor</td>
</tr>
<tr>
<td><strong>Mobile</strong></td>
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<tr>
<td>XE</td>
<td>Intel Core i7 Processor</td>
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<td>T &amp; L</td>
<td>Intel Core i5 Processor</td>
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<tr>
<td><strong>Server</strong></td>
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<tr>
<td>MC/EX</td>
<td>Intel® Itanium® Processor 9100/Intel® Xeon® Processor 7500</td>
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<tr>
<td>EP</td>
<td>Intel Xeon Processor 5600</td>
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<tr>
<td>WK/UP</td>
<td>Intel Xeon Processor 3400</td>
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<tr>
<td><strong>Netbook</strong></td>
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<td></td>
<td>Intel® Atom™ Processor N450</td>
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<td><strong>Tablet</strong></td>
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<tr>
<td></td>
<td>Intel Atom Z760</td>
</tr>
</tbody>
</table>
Agenda

• Intel Memory Usage Roadmap
• Memory industrial status and projection
• DDR3 Health & Industry Enabling Status
• DDR3 Value for DT/WKST/MB/SVR
• Memory education from leading supplier in industry - Samsung
Mobile DRAM is gaining bit share
- 12% in 2010 growing to 25% in 2015
- DDR3 shipments surpassed DDR2 in Q1 2010
  - DDR3 now accounts for ~70% of bit shipments
- DDR4 will launch in 2012, crossover with DDR3 in mid 2015
Agenda

- Intel Memory Usage Roadmap
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- **DDR3 Health & Industry Enabling Status**
- DDR3 Value for DT/WKST/MB/SVR
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Intel® Memory Validation

- DRAM Component Validation
  - AC/DC testing using Automated Tester at extreme test condition according to specifications
  - RLC testing using Vector Network Analyzer extracting package parasitic data
- Thermal, Temp Sensor, and Heat Spreader Validation
- DIMM System Validation
  - Functional stress testing at extreme test corners according to specifications
  - System power management testing – power/reset cycle test, S3, C-state test
  - Platform margin testing
- Thousands of platforms tested for reliable operation by launch

Comprehensive Validation to Specifications, use Intel® products with reliable memory
Memory Ecosystem for DDR3

-> Leading suppliers shipping in volume...

- DRAM – Samsung*, Hynix*, Micron*, Elpida*, and Nanya*
- Register/Buffer – Inphi*, IDT*, Montage*, and Ti*

DDR3 Ecosystem Very Healthy
Validated DDR3 Memory for Intel® Core™ i7 Processor

http://www.intel.com/technology/memory/

New DDR3 modules added regularly. Please check URL for the most up to date list

Use Intel Validated Memory For Efficient Platform Development
Agenda

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Differentiated Desktops
Focused Strategy is Driving Growth

- **Enthusiast**: Performance opportunities
- **Lifestyle**: Form factor is Key
- **Business**: Stable & Reliable
- **Home Hub**: Stable & Reliable
- **Entry DT**: Volume opportunities

Undifferentiated, high volume, low ASP
# UltraBook™ Redefining the PC Experience

## Experience

<table>
<thead>
<tr>
<th>Ultra Thin</th>
<th>Aesthetics w/Sleek Industrial Design</th>
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<tbody>
<tr>
<td>Ultra Mobile</td>
<td>Minimum 12 hr Battery Life</td>
</tr>
<tr>
<td>Ultra Mainstream</td>
<td>Mainstream SPP &lt;$999</td>
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## Memory

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<tbody>
<tr>
<td>Ultra Thin</td>
<td>Soldered Down Memory</td>
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<td>Ultra Mobile</td>
<td>Low Power Self Refresh Memory</td>
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<tr>
<td>Ultra Mainstream</td>
<td>Balance Memory Cost &amp; Capacity</td>
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</table>

## UltraBook™ Redefining PC Memory
## DDR3 Support in Intel® Server Products

- DDR3 continues to be the technology of choice for Intel’s server platforms launching in 2011

### 2011 and beyond

<table>
<thead>
<tr>
<th>Processor Series</th>
<th>Memory Support</th>
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<tbody>
<tr>
<td>Intel® Itanium® processor 9000 series</td>
<td>RDIMM</td>
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<tr>
<td>Intel® Xeon® processor 7500/ 6500 series</td>
<td>RDIMM</td>
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<tr>
<td>Intel Xeon processor 5600 series</td>
<td>RDIMM, UDIMM with ECC, 1.35V RDIMM</td>
</tr>
<tr>
<td>Intel Xeon processor E5 series</td>
<td>RDIMM, UDIMM with ECC, 1.35V, LR-DIMM</td>
</tr>
<tr>
<td>Intel Xeon processor 3400 series</td>
<td>RDIMM, UDIMM with ECC</td>
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<tr>
<td>Intel Xeon processor E3-1200 product family</td>
<td>UDIMM with ECC</td>
</tr>
</tbody>
</table>

- Intel’s Expandable and Mission Critical server products support large memory configurations with the Intel Xeon processor 7510 Scalable Memory Buffer

**Intel® server products offer flexibility of memory type to address the range of end user priorities**

*All unreleased products, computer systems, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice*
Intel® Extreme Memory (Intel® XMP) Profile

- Intel® XMP - expansion of the standard DDR3 memory specification. Enables speeds, latencies outside of JEDEC Specification
  - Contains profiles of pre-tested memory timings in SPD for easy OC
  - DIMM supporting 2010 Intel® Core™ i7, i5 and 2nd Generation Intel Core i7, i5, i3
  - Enables robust, overclocking solution designed to take advantage of the unlocked capability of Intel® CPUs
- Intel® XMP compliant DIMMs available

http://www.intel.com/consumer/game/extreme-memory.htm
Intel® Extreme Memory Profile (Intel® XMP)

How It Works

1. Intel® XMP Enabled BIOS reads module SPD at power-on. JEDEC and XMP Profiles are stored on UDIMM or SODIMM SPD

2. System boots with highest supported JEDEC defined parameters

3. Predefined and tested Intel XMP profiles can be selected by the end user through BIOS setup

4. Reset system to apply

Intel® XMP exceeds JEDEC timings and system voltages: It is overclocking
Summary

• DDR3 provides improved power consumption and performance over previous generations

• Intel continues to promote mobile, desktop, workstation, server adoption of DDR3

• All major suppliers have DDR3 as their volume focused product

• UltraBook™ Redefining PC Memory

• Intel® Extreme Memory Profile defines new levels of memory performance

DDR3 Is Mainstream Now
Samsung DRAM Solution

2011. 09. 14

Memory Product Planning & Application Engineering
Samsung Electronics Co., Ltd.
## Server Segmentation & Memory Requirement

### Usage Model

<table>
<thead>
<tr>
<th>Usage Model</th>
<th>Trend</th>
<th>Requirement</th>
<th>Memory Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Performance Computing</td>
<td>MPP (RISC)</td>
<td>TCO, CPU, Memory, RAS</td>
<td>• High Density, • High Speed</td>
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<td></td>
<td>Cluster (x86)</td>
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<td>• Low Latency, • LRDIMM</td>
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<td></td>
<td>• Custom DIMM</td>
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<tr>
<td>Mission Critical</td>
<td></td>
<td>TCO, CPU, Memory, RAS</td>
<td>• High Speed, • High Capacity</td>
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<td></td>
<td>• 4Gb DRAM, Standard DIMM</td>
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<tr>
<td>Conventional (Cost Sensitive</td>
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<td>TCO, CPU, Memory, RAS</td>
<td>• Green Memory, 1.25V/1.35V</td>
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<td>Server)</td>
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<td>• Advance Process</td>
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<td>• Standard DIMM, High</td>
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<td>supportability</td>
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<td>Cloud Computing &amp; Low End</td>
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<td>TCO, CPU, Memory, RAS</td>
<td>• Small F/F DIMM, MiniDIMM</td>
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<td>• ECC SODIMM</td>
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<td>• 4Gb DRAM, Standardization</td>
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<tr>
<td></td>
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<td></td>
<td>• Green Memory</td>
</tr>
</tbody>
</table>

### Server Sales Portion

- HPC
- Mission Critical
- Infrastructure
- Cloud Service Provider
- Embedded
- Workstation
- Small Scale
- Storage

Source: Intel
## High Density Solution

- **With advanced technology, Samsung offers optimal solution for Server**
  - 35nm technology now, 20nm class product available soon

<table>
<thead>
<tr>
<th>Density</th>
<th>Type</th>
<th>Comp.</th>
<th>Org.</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2GB</td>
<td>RDIMM, ECC UDIMM</td>
<td>2Gb</td>
<td>1Rx8</td>
<td>Now</td>
</tr>
<tr>
<td>4GB</td>
<td>RDIMM, ECC UDIMM</td>
<td>2Gb</td>
<td>1Rx4, 2Rx8</td>
<td>Now</td>
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<tr>
<td></td>
<td></td>
<td>4Gb</td>
<td>1Rx8</td>
<td>Now</td>
</tr>
<tr>
<td>8GB</td>
<td>RDIMM, ECC UDIMM</td>
<td>2Gb</td>
<td>2Rx4, 4Rx8</td>
<td>Now</td>
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<td></td>
<td></td>
<td>4Gb</td>
<td>1Rx4, 2Rx8</td>
<td>Now</td>
</tr>
<tr>
<td>16GB</td>
<td>RDIMM, LRDIMM</td>
<td>2Gb</td>
<td>4Rx4</td>
<td>Now</td>
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<td></td>
<td></td>
<td>4Gb</td>
<td>2Rx4, 4Rx8</td>
<td>Now</td>
</tr>
<tr>
<td>32GB</td>
<td>RDIMM, LRDIMM</td>
<td>4Gb</td>
<td>4Rx4</td>
<td>Now</td>
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<tr>
<td>64GB/128GB</td>
<td>Under consideration</td>
<td></td>
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</tr>
</tbody>
</table>

**Samsung is investigating over 32GB solutions for Ultra High Density Application**
Low Power Green DDR3 Solution

- Advanced process technology is driving significant power reduction

Memory Power Consumption Cut by ~30% at Each Process Node

- Considered with an 8 hours active and 16 hours idle status in server

Source: Samsung Lab.
More Green & Smooth Transition – DDR4

- Efficient power/performance

- No significant die size impact with higher speed & less power over DDR3
  - DDR4 POD decreases IO Power & supports higher speed

- Support 1.2V VDD/VDDQ same as LPDDRx

**Special Functionality**

| Low Power for Server/Mobile Application | 1.2V |
| CAL (CMD/ADDR Latency)                 | MPSM (Max Power Saving Mode) |
| POD                                    | CRC |
| Better Reliability for Server/On Board solution | Connectivity Check |
Emerging Application – Micro-Server

Micro-server is a newly emerging server segment aiming the efficiency of performance/power

Small form factor module for space minimization
- Requires power efficient solution (4Gb base 4GB)
- Samsung is supporting 3 types solutions for small form factor requirement

[Small F/F Solutions of Samsung]
- MiniDIMM, 2GB/4GB
- VLP ECC UDIMM, 2GB/4GB/8GB
- ECC SoDIMM, 2GB/4GB/8GB

[Micro-server Applications]
- Web Server
- Application Server
- Data base Server

[Target]
- Stretch Goal

[Applications]
- Application Server
- Data base Server
UX (User Experience) is driving new paradigm & Intel Ultrabook™ accelerates this movement

**Always Connected**

**Always On**

**Mobility**

**Instant ON**

**Thin & Light**

**Accessibility**

**Longer Battery Life**

**Conventional Notebook (‘11)**
- CPU
- x64
- x64
- SODIMM
- Fan
- Thick Battery
- HDD

**Ultra Thin Notebook (‘13)**
- CPU
- x64
- x64
- Solder Down DRAM
- Thin Fan
- Thin - Wide Battery
- SSD

**Low Power, Small, Thin & Light, Customized**
Memory Devices for Ultrathin Notebook

Memory properties required by new transition

- Always-on
- Always-connected
- Instant-on

- Low Power
- Fast Responsiveness

- Mobility

- Thin/Light

- Solder-down

---

**Thickness**
- 40-50mm
- 20-30mm
- 8-9 hr
- >12 hr

**Battery**
- 3 hr
- 5-6 hr
- 13-17mm
- <10mm

**Storage**
- HDD
- SSD
- Stick SSD

**Memory**
- Module
- On board
- (1 or 2 chip)
Investigating various memory configurations

- 4Gb would be a best-fit in ‘12~’13 timeframe in capacity, power consumption, smaller board area, price, etc.

<table>
<thead>
<tr>
<th>Mobile DRAM</th>
<th>’11</th>
<th>’12</th>
<th>’13</th>
<th>’14</th>
<th>System config.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2GB</td>
<td></td>
<td>4Gb DDP based 8Gb x64 Comp. 2ea</td>
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<tr>
<td>4GB</td>
<td>4Gb QDP based 16Gb x64 Comp. 2ea</td>
<td>8Gb x32</td>
<td>8Gb DDP based 16Gb x64 Comp. 2ea</td>
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<tr>
<td>8GB</td>
<td>4Gb QDP based 16Gb x32 Comp. 4ea</td>
<td>8Gb x32</td>
<td>8Gb QDP based 32Gb x64 Comp. 2ea</td>
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<table>
<thead>
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<th>4Gb Comp. 8ea</th>
<th>4Gb x16</th>
<th>4Gb Comp. 4ea</th>
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<tr>
<td>4GB</td>
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<td>4Gb DDP based 8Gb x16 Comp. 4ea</td>
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<tr>
<td>8GB</td>
<td>4Gb Comp. 16ea</td>
<td>4Gb x16</td>
<td>4Gb DDP based 8Gb x32 Comp. 4ea</td>
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</tbody>
</table>

128bit System 2ch x64

CPU

CS0 CS1 CS2 CS3

x64 x64
1. Server Trend & Memory Solution
2. PC Trend & Memory Solution
3. Tablet/Smartphone Trend & Memory Solution
4. Long Term Memory Projection
Paradigm Change from PC to Mobile Device

**PC Era**
- Desktop → Notebook
- Performance
  - Personal, Passive
  - Intermittent Connectivity
  - Always Plugged-In

**Mobile Era**
- Smartphone/Tablet → Mobile Computing
- Watt/Bandwidth
  - Shared, Interactive
  - Always Connected/On
  - Instant on

### Performance
- On/Off plug-in
- Limited mobility

### Desktop → Notebook
- Personal, Passive
- Intermittent Connectivity
- Always Plugged-In

### Watt/Bandwidth
- Shared, Interactive
- Always Connected/On
- Instant on

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* Source: Global Unit shipment by IDC, Morgan Stanley Research_Feb’11, 2014/2015 forecast based on 2005~2013 CAGR
LPDDR3, Next Mobile DRAM Interface

LPDDR3 (Low Power DDR3), next DRAM I/F for mobile application
- Successor of LPDDR2: Low VDD (1.2V), Low IDD6
- Spec under definition in JEDEC

LPDDR3 JEDEC draft spec will be available in Dec. ‘11

<table>
<thead>
<tr>
<th></th>
<th>‘11</th>
<th>‘12</th>
</tr>
</thead>
<tbody>
<tr>
<td>JEDEC</td>
<td>Spec under discussion</td>
<td>Draft Spec publish</td>
</tr>
</tbody>
</table>
Memory Solution for Tablet/Smartphone

- **Smartphone**: 512MB/1GB/2GB LPDDR2, **Tablet**: 2GB/4GB LPDDR3
  - LPDDR3 from ’12 (4Gb, ’12 → 8Gb, ’13)
  - Supporting both POP (2chx32) and discrete (1chx32 or 2chx32)
  - PKG height ≤1.0mm (up to 4-stacks)

<table>
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<tr>
<th>Application</th>
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<td>Smartphone/Tablet</td>
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LPDDR3 from ’12 (4Gb, ’12 → 8Gb, ’13)
Supporting both POP (2chx32) and discrete (1chx32 or 2chx32)
PKG height ≤1.0mm (up to 4-stacks)
Contents

1. Server Trend & Memory Solution
2. PC Trend & Memory Solution
3. Tablet/Smartphone Trend & Memory Solution
4. Long Term Memory Projection
Samsung builds up the product lineup for all segments

- Low power memory LPDDR2/3 for mobile device
- Standard DDR3/4 for computing device

<table>
<thead>
<tr>
<th>Mobile (LP)</th>
<th>’10</th>
<th>’11</th>
<th>’12</th>
<th>’13</th>
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<tr>
<td>Interface VDD/VDDQ</td>
<td>LPDDR2 1.2V/1.2V</td>
<td>LPDDR3 1.2V/1.2V</td>
<td>LPDDRx</td>
<td></td>
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</tr>
<tr>
<td>Bandwidth</td>
<td>6.4GB/s (800Mbps)</td>
<td>8.5GB/s (1066Mbps)</td>
<td>12.8GB/s (1600Mbps)</td>
<td>25.6GB/s+ (?)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EDP (DDR3)</th>
<th>’10</th>
<th>’11</th>
<th>’12</th>
<th>’13</th>
<th>’14</th>
<th>’15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface VDD/VDDQ</td>
<td>DDR3 (1.5V/1.5V, 1.35V/1.35V, 1.25V/1.25V)</td>
<td>DDR4 (1.2V/1.2V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td>10.6GB/s (1333Mbps)</td>
<td>14.9GB/s (1866Mbps)</td>
<td>17.1GB/s (2133Mbps)</td>
<td>25.6GB/s (3200Mbps)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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Additional Sources of Information on This Topic:

- Other Sessions – LRDIMM end to end Q&A right after this session in this room
- Demos in the showcase – Samsung, Hynix, and Inphi showing DDR3 and LRDIMMs
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