Advanced Mobile Memory Technology (LPDDR4)

Mobile Forum 2013

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36% of Email is Now Opened on a Mobile Device

Source: KPCG Internet Trends
Where Will Users Spend their Time?

Average Traffic Per Mobile Device Type

<table>
<thead>
<tr>
<th>Device Type</th>
<th>2012 MBs per Month</th>
<th>2017 MBs per Month</th>
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<tbody>
<tr>
<td>Non-Smartphone</td>
<td>6.8</td>
<td>31</td>
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<tr>
<td>M2M</td>
<td>64</td>
<td>330</td>
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<tr>
<td>Smartphone</td>
<td>342</td>
<td>2,660</td>
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<tr>
<td>4G Smartphone</td>
<td>1,302</td>
<td>5,114</td>
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<tr>
<td>Tablet</td>
<td>820</td>
<td>5,387</td>
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<tr>
<td>Laptop</td>
<td>2,503</td>
<td>5,731</td>
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</table>

Smartphones and Tablets will Soon Drive Similar Data Levels as PCs

Source: Cisco VNI
What is Driving High Bandwidth - 1

Larger screen size

- Smartphone: 6"
- Tablet: 7"
- Notebook: 11"

JEDEC
Global Standards for the Microelectronics Industry
What is Driving High Bandwidth - 2

High resolution

1X
1280/720 HD
2.3X
1920/1080 FHD
3.4X
2048/1536 QXGA
4.5X
2560/1600 WQXGA
5.7X
2560x2048 QSXGA
9X
3840x2160 UHD

Global Standards for the Microelectronics Industry
What is Driving High Bandwidth - 3

Advanced camera functionality

- Burst Shot Feature
- HDR
- Augmented Reality

- Panoramic Shot
B/W Requirement is Driven by Graphics

Source: Samsung
What is LPDDR4?

**Low Power DDR4**
- Evolutionary solution
  - Higher “Pin Bandwidth”

– vs. Wide IO2: Revolutionary solution
  - Much wider “Pin Width”
LPDDR4 Key Features

Evolutionary DRAM technology enables 3.2Gbps and faster

<table>
<thead>
<tr>
<th>Items</th>
<th>LPDDR3</th>
<th>LPDDR4</th>
<th>Comments</th>
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<tr>
<td>Speed</td>
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<tr>
<td>CLK</td>
<td>400-800MHz (=1066MHz w/ LP3E)</td>
<td>800-1600MHz</td>
<td>2X, Pursues higher speed</td>
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<tr>
<td>CMD/ADDR</td>
<td>DDR</td>
<td>SDR</td>
<td>-</td>
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<tr>
<td>DQ</td>
<td>DDR</td>
<td>DDR</td>
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<tr>
<td>Band Width</td>
<td>12.8GB/s+ (2ch)</td>
<td>25.6GB/s+ (2ch)</td>
<td>2X</td>
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<td>Voltage</td>
<td>VDD2/VDDQ/VDD1 1.2/1.2/1.8</td>
<td>1.1/1.1/1.8</td>
<td>Total Pd 10%↓</td>
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<td>Architecture</td>
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<td># of Ch &amp; DQs</td>
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<td>2x16</td>
<td>IDD4 20%↓</td>
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<tr>
<td># of Bank/channel</td>
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<td>8</td>
<td>-</td>
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<td>Page Size</td>
<td>4K</td>
<td>2K</td>
<td>IDD0 10%↓</td>
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<tr>
<td>BL</td>
<td>8</td>
<td>16</td>
<td>32B/ch</td>
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<tr>
<td>Interface</td>
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<tr>
<td>I/O interface</td>
<td>HSUL</td>
<td>LVSTL</td>
<td>40% I/O power reduction (vs. POD)</td>
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<td>Internal</td>
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Innovative Low Power Interface - LVSTL

LVSTL (Low Voltage Swing Terminated Logic)
- High frequency operation with less IO power consumption
- No DC power consumption when driving “low”
- Lower Cio, small Xtalk and SSN, because of small swing
- Stronger reference plane
- Easy voltage scaling
LPDDR4 3.2Gbps and Beyond

LPDDR4 LVSTL enables stable 3.2Gbps with 70% UI
- Initial SI study result shows prominent 4.3Gbps with 60% UI @ 350mV swing
- Further enhancement by reducing trace length, optimizing channel - SOC/PKG/DRAM and lower Cio

Source: Samsung memory, DRAM Design Team (Feb’13)
Close Collaboration for Timing Closure

Less than half of UI & less than 1/3 of Amplitude
- Accurate simulation $\rightarrow$ Board level verification $\rightarrow$ Set level optimization
- Verification/test/FA tools required

[Real scale]
Power Efficiency Enhanced Architecture

Core power reduction by adopting advanced low power-friendly architecture

Low Power 32-bit Architecture

Access Granularity & Page-size/Ch

LPDDR3 : Activated Page 4KB (1Kx32)
- BL16
- x16

LPDDR4 : Activated Page 2KB (1Kx16)
- BL8
- x32

~20% IDD4 reduction

~10% IDD0 reduction
Power Efficiency by DRAM Technology

More than 40% power efficiency improvement by adopting new architecture, circuits and low VDD

Source: Samsung
Power Saving with Advanced Technology

LPDDR4 consumes much less power than LPDDR3 for performing certain tasks

Power(Area)@LP4 << Power@LP3
### New Technology is Just Around the Corner

JEDEC is working diligently to define the LPDDR4 spec to prepare for production in ‘15

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- **JEDEC**
  - Consensus
  - Ver 0.5
  - Ver 0.9

- **Industry (Est.)**

  Production
Thank you !!