Building a Controller That Can Handle Any Type of Flash

Brent Przybus – Sr. Director eASIC Corporation
A Changing Flash Enabled Landscape

- Flash Is Needed for Enterprise Storage
- Flash is Evolving Rapidly Due to Demand
- The Controller Architecture Must Evolve
Expanding Role of Flash in Enterprise Storage

- Application and Data Velocity is Increasing Exponentially
  - Flash based storage is faster than disk
  - But this speed is not needed across the spectrum
- Flash is More Reliable Than Ever
  - Suitable for broad use in the data center
  - Provided you are using the right controller
Redefining the Boundaries

- Transitioning to Scale-out Architecture
  - Better suited for data centers
  - Better support for different data types
- Opportunity to Redefine the Controller
  - Support flexible hardware / software partitioning
  - Support for virtualization
Anatomy of the Ideal Controller

- Low Power
  - <5 Watts
- Flash Memory Interface Speed
  - ONFI 4 800MT/s, Multiple instances
- Host side Flexibility
  - PCIe Gen3 x8/16 or SAS/SATA or Ethernet…
- Fast, Flexible FTL Memory
  - DDR4, DDR3, LPDDR, etc.
- Flexible Processor Support
  - FTL Control and Management
- Efficient ECC
  - Multiple Instances of BCH or LDPC
- Independent Channel Support
  - Flexible Multiple Channel DMA Support
## eASIC Nextreme-3 ONFI Support

<table>
<thead>
<tr>
<th>Capability</th>
<th>ONFI Requirement</th>
<th>eASIC Nextreme-3 eIO Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signaling Standard</td>
<td>1.2V/1.8V SSTL</td>
<td>✓</td>
</tr>
<tr>
<td>Data rates (MT/s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONFI 3.0/3.2</td>
<td>400, 533</td>
<td>✓</td>
</tr>
<tr>
<td>ONFI 4.0</td>
<td>667, 800</td>
<td>✓</td>
</tr>
<tr>
<td>ZQ Calibration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver impedance (ohms)</td>
<td>25, 35, 50</td>
<td>✓</td>
</tr>
<tr>
<td>ODT (ohms)</td>
<td>50, 75, 100, 150</td>
<td>✓</td>
</tr>
<tr>
<td>I/O Leakage Currents (uA)</td>
<td>+/- 10</td>
<td>✓</td>
</tr>
</tbody>
</table>

![Diagram](eASIC.png)

**Data Rate Load Count Operation**

<table>
<thead>
<tr>
<th>Data Rate</th>
<th>Load Count</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>533 MT/s</td>
<td>16</td>
<td>Read/Write ✓</td>
</tr>
<tr>
<td>667 MT/s</td>
<td>8</td>
<td>Read/Write ✓</td>
</tr>
<tr>
<td>800 MT/s</td>
<td>8</td>
<td>Read/Write ✓</td>
</tr>
</tbody>
</table>

**U2 = eASIC Nextreme-3**

**U1 = Micron NAND Flash**

**eASIC Nextreme-3 eIO NV-DDR3 Load Analysis**
RX-CDR implemented with fully independent PLL (2nd order high-pass function)

- Allows much faster tracking of phase variation on incoming data
- Meets the 5600 ppm SRIS-required spread-spectrum tracking capability
The Evolution of Flash

- Flash Controller Trend
  - Constant Change
  - Faster/Lower Latency
  - Faster, Denser, Cheaper

Flash Memory Summit 2015
Santa Clara, CA

http://evertiq.com/design/35204
Avoiding Obsolescence

Flash Memory Summit 2015
Santa Clara, CA

Flash Roadmap
- 2015: 16nm – 2D (3D Gen 1)
- 2016: 10nm – 2D (3D Gen 2)
- 2017: 8nm – 2D (3D Next Gen)
- 2018: Xnm – 2D (3D Next Gen)

Host Roadmap
- PCIe Gen3: 12G SAS (Start 2015, Production 2016)
- PCIe Gen4: 24G SAS (Start 2015, Production 2016)

ASIC/ASSP Controller
- 16nm -2D, PCIe Gen3 (Start 2015, Production 2016)

eASIC Based Controller
- 3D Gen 1, PCIe Gen3 (2015)
- 3D Gen 2, PCIe Gen3 (2016)
- 3D Gen 2, PCIe Gen4 (2017)

eASIC Flexibility
- eASIC Fast Time to Market
- eASIC Low NRE – 1/10 ASIC
- eASIC Low Power
### Comparing Controller Options

<table>
<thead>
<tr>
<th>Requirements</th>
<th>FPGA</th>
<th>ASIC/ASSP</th>
<th>eASIC Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Side Flexibility</td>
<td>Any Host</td>
<td>Fixed Interface</td>
<td>Any Host</td>
</tr>
<tr>
<td>Flash Interface</td>
<td>Flexible</td>
<td>Fixed</td>
<td>ONFI 4 at 800MT/s</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>12 Watts</td>
<td>2 Watts</td>
<td>5 Watts</td>
</tr>
<tr>
<td>Ability to Customize</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Time to Market</td>
<td>RTL to Proto – Very Short</td>
<td>12 + Months</td>
<td>RTL to Proto – 7 weeks</td>
</tr>
<tr>
<td>DDR Memory Speeds</td>
<td>DDR4 2.6Gbps</td>
<td>Fixed</td>
<td>DDR4 2.1Gbps, DDR3 2.1Gbps</td>
</tr>
<tr>
<td>Development Cost</td>
<td>No NRE</td>
<td>Millions in NRE</td>
<td>1/10 ASIC NRE</td>
</tr>
<tr>
<td>Unit Price</td>
<td>Highest</td>
<td>Lowest</td>
<td>Low</td>
</tr>
</tbody>
</table>
Top 5 Things to Ask About Your Controller Architecture

1. Does it support the latest Flash technology…. Will it keep up?
2. Are your competitors using the same controller?
3. Does it deliver the performance per watt you need?
4. Does the same controller multiple host interfaces?
5. How fast is the Flash interface?
Summary

- Flash is Changing Storage
- Flash is Evolving Fast to Deliver More
- You Need a Flexible Controller that Keeps Up