3D NAND and UFS for Mobile

High-Performance 32GB Mobile Memory
**Micron 3D NAND Technology Summary**

**High Capacity**
The thin 32-layer technology allows for high capacity solutions (MLC 64Gb, MLC 256Gb, TLC 384Gb) by vertically adding layers to the 3D stack without increasing the footprint.

**Proven Technology: Floating Gate**
Micron 3D NAND uses a floating gate cell, providing a proven cell foundation that limits the design variables and ultimately increases the quality and reliability of the design.

**High Performance Architecture**
Larger size cells enables higher electron counts, making it much easier to differentiate voltage levels in the cells which increases performance.
Micron Mobile 3D NAND Memory
BREAKTHROUGH STORAGE PERFORMANCE, POWER AND RELIABILITY

High Performance
Up to 30% faster sequential writes vs. 2D NAND*. UFS 2.1 interface delivers 33% higher bandwidth vs. e.MMC 5.1*.

Power Efficiency
Significantly reduce power with 3D NAND’s efficient sleep mode feature.

Enhanced Reliability
Unique floating gate technology provides superior data retention compared to charge trap gates.

Superior Mobile Experience
Faster boot up, seamless HD streaming, high bandwidth gaming, and responsive camera performance.

High Capacity
Higher storage capacity in a smaller space with 3D NAND’s vertically tiered die.

* Source: Micron. Theoretical performance values are based on specification capabilities using optimized controller/FW/NAND.
Universal Flash Storage (UFS) 2.1 Interface

- UFS 2.1 is the next-generation interface to the e.MMC 5.1 specification, delivering significantly faster random read speed performance
  - UFS uses a full duplex serial interface, allowing reading and writing at the same time, unlike e.MMC’s half duplex parallel interface
- Micron UFS 2.1 devices utilize High Speed Gear 3 specification to deliver industry-leading sequential read performance for mobile devices
- Increased IOPS and reduced read/write latencies provide additional performance improvements and security features that enhance multimedia transfer in mobile devices
Micron: World’s Smallest 3D NAND Die

- Micron 8GB 3D NAND die measures $60.217\text{mm}^2$, making it the smallest 3D NAND on the market*
  - ~30% smaller than 1y/1z planar NAND*
  - Enables ultra small form factor packaging such as 9x9mm ePOP or 8.5x11mm discrete UFS

- Tiny memory packaging can free up space for additional battery size or enable smaller form factor devices

* Based on Micron internal competitive measurements
## New Micron Mobile 3D NAND and UFS Products

32GB MULTICHIP PACKAGE AND DISCRETE MEMORY DEVICES

<table>
<thead>
<tr>
<th>Product</th>
<th>Interface</th>
<th>3D NAND</th>
<th>LPDRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMCP4</td>
<td>e.MMC 5.1</td>
<td>32GB MLC</td>
<td>3GB LPDDR4</td>
</tr>
<tr>
<td>eMCP4X</td>
<td>e.MMC 5.1</td>
<td>32GB MLC</td>
<td>3GB LPDDR4X</td>
</tr>
<tr>
<td>uMCP4X</td>
<td>UFS 2.1 HS-G3 1L</td>
<td>32 GB MLC</td>
<td>3GB LPDDR4X</td>
</tr>
<tr>
<td>Discrete UFS</td>
<td>UFS 2.1 HS-G3 1L</td>
<td>32GB MLC</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Micron 3D NAND Multichip Package

Micron 3D NAND Discrete UFS Package
32GB 3D NAND Targeted for Volume “Sweet Spot”

Flagship
- 4-6 GB+ RAM
- 64 GB+ NAND

High-End
- 3-4 GB+ RAM
- 32 GB+ NAND

Mid-End
- 2 GB RAM
- 16 GB+ NAND

Entry
- 1 GB+ RAM
- 8 GB+ NAND

Represents ~50% of smartphone volume*

* Source: Micron
Summary of 3D NAND Messages

1. New Micron Mobile 3D NAND-based 32GB memory delivers leading UFS 2.1 random write memory device performance

2. Industry’s first mobile product built on floating gate technology—a proven cell technology that enables better performance, quality, and reliability

3. Introducing industry’s smallest 3D NAND: Micron 8GB 3D NAND die, measuring 60.217mm²

4. 3D NAND-based MCP includes Micron’s first low power LPDDR4X, up to 20% more power efficient than standard LPDDR4

5. Micron 3D NAND and UFS products are now sampling with mobile customers and chipset partners for qualification; broad availability in end of 2016