Supply, Sufficiency and ASP
2014 NAND market revenue continues to grow with solid demand from diversified applications.
2014 NAND Market: Balance is the Theme

- 2014: Supply growth @38% YoY, Demand growth @39% YoY.
- NAND makers are profit-oriented and conservative toward supply strategy.
- Supply & Demand balance is a new paradigm.

Source: DRAMeXchange, June 2014
CAPEX: Preparation for 3D-NAND Era

- Memory CAPEX is US$15-16 Bn level, allocation favor on NAND.

**NAND Flash CAPEX**

**CAPEX: DRAM vs. NAND**

Source: DRAMeXchange, June 2014
2014 Quarterly Sufficiency

- 1H14 Weaker OEM and retail market results in over-supply pattern.
- Momentum from new OEM demand helps to ease S&D imbalance in 2H14.

Source: DRAMeXchange, June 2014
Embedded (eMMC, SSD) price stably declined QoQ, mostly reflecting cost down from migration.

Channel chip price is the mix of market supply and demand.
NAND Capacity: Added Slightly for 2014

- 2014 NAND capacity +8% YoY.
- Hynix NAND capacity will be fully recovered from 142Q (150k/m).
- Micron Singapore fab transition will be completed, total Micron/Intel NAND capacity is up 235k/m from 142Q.
- Toshiba Fab5 Phase2 infrastructure is set from 14Q3, equipment installation from 14Q4.
- Samsung Xian fab and 3D-NAND schedules fall behind.

Source: DRAMeXchange, June 2014
2014 Bit Output: Derived from Node Migration more

- Bit output is strongly driven by 1ynm embedded adoption and 1znm-class migration from 2H14.
Supply Dynamics: Limited Growth & Constant Share

- Supply bit growth is 7-year-low level.
- Market Share: SEC@37%, TSB/SNDK@35%, MU/INTL:@17%, Hynix:@10%
- Rational supply strategy is predictable under game theory.

**Bit Supply Trend**
- Unit: 2GB M equiv.
- 2008: 133%
- 2009: 54%
- 2010: 80%
- 2011: 75%
- 2012: 59%
- 2013: 41%
- 2014E: 38%

**Market Share (Production Base)**

Source: DRAMeXchange, June 2014

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Operating profit margin stabilization is challenging.
SSD, eMMC and eMCP margin > card, UFD.
Customer and product portfolio is the key to margin management.

Source: DRAMeXchange, June 2014
Migration: 1xnm-class Embedded is through 2014, Limited Exposure for 3D-NAND

- Samsung full lineup for 19nm eMMC, eMCP and SSD is ready in 1Q14.
- Toshiba & SanDisk 1ynm eMMC MP schedule is in 142Q.
- Hynix 16nm eMMC MP schedule is in 142Q.
- Mostly 1xnm-class SSD for PC schedule from 14Q13.
- 3D-NAND (%): <2% in 2014

Source: DRAMeXchange, June 2014
3D-NAND is the Next Super Star

- 2D-NAND migration comes to bottleneck from 2015 (1znm is the last generation).
- 1znm node will be paralleled to 3D-NAND in 2015 and 2016.

Source: DRAMeXchange, June 2014
- 128Gb portion is up to 25% in 4Q14 and cost-efficient in 1znm node production.
- SSD requires 128Gb or higher chip for larger capacity design.
- Enterprise-SSD content per box reaches ~600GB in 2014.
Technology: 3-Bits-Cell Embedded is the Key

- 3-bits-Cell eMMC, eMCP and SSD are the next drivers for client OEMs.
- Samsung is pioneering 3-bits-cell SSD for enterprise market from 14Q3.

Hynix and Micron is ready for TLC

1. TSB & SNDK TLC-embedded
2. SEC TLC enterprise-SSD

Source: DRAMeXchange, June 2014
### Roadmap for 3-Bits-Cell Schedule

- Samsung is introducing full lineups for 3-Bits-Cell embedded products from 14Q3.
- Other NAND makers 3-Bits-Cell products will be unveiled from 2Q14

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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<th>Q3</th>
<th>Q4</th>
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<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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</tr>
</tbody>
</table>

**Source:** Company data, compiled by DRAMeXchange, June 2014
2014 target bit growth: 40% YoY
- Xian-An Fab production has been initiated from 1Q14 and dedicated on 3D-NAND.
- TLC-basis eMMC and SSD is the key in 2014.
- Strength: Strong leverage with Samsung smartphone and tablet.
2014 target bit growth: 35% YoY
Fab5 Phase2 infrastructure will be completed in 3Q14 for 1znm and 3D-NAND.
TLC-Basis embedded products are scheduled from 3Q14.
Toshiba is seeking more engagement with more 1st-tier OEMs.
SanDisk targets >25% SSD revenue contribution in 2014, strongly focus on enterprise-SSD.
NAND capacity is recovered to normal level (150k/m) from late 1Q14.
In-house eMMC and SSD controller is the key to embedded product success.
TLC-basis eMMC and SSD schedule to ramp from 2H14.
2014 target bit growth: 45-50% YoY.
Singapore fab fabrication transition to NAND will be completed in 142Q.
Next generation mobile embedded will catch up from 4Q14 when Elpida mDRAM and new controller is fully utilized.
Intel positioned itself as a enterprise-SSD technology enabler in the field.
Demand and Applications
NAND Demand Outlook

- Demand catalyst continues with strong mobile and enterprise applications.
- SSD is #No.1 growth driver in 2014.
- Smartphone+ Tablet+ SSD consumes ~80% of total NAND.

Demand Bit Volume

Unit: 2GB M equiv.

Source: DRAMeXchange, June 2014

Demand by Application

CAGR~60%

80%

SSD

Tablet

Handset

Source: DRAMeXchange, June 2014
Apple and Samsung have series of new product launch at from 143Q.

Demand bit growth from Apple and Samsung outperforms market average in 3Q14, significantly helps to ease the market imbalance.

Apple and Samsung steadily consume ~30% of total NAND.

Source: DRAMeXchange, June 2014
**eMMC Market Outlook**

**eMMC Consumption (%)**

- Total NAND Demand
- eMMC Demand

**Consumption by Application**

**Shipments by Density**

- eMMC market grows along with solid mobile devices.
- Middle/Low-end models stifles eMMC content per box.
eMMC in Mobile Device: A Common Standard

- eMMC is widely adopted for better performance and advanced O.S.
- eMMC is storage standard for major AP vendors.
- Apple use pure NAND only.

eMMC % in Smartphone

<table>
<thead>
<tr>
<th>Quarter</th>
<th>1Q12</th>
<th>3Q12</th>
<th>1Q13</th>
<th>3Q13</th>
<th>1Q14</th>
<th>3Q14F</th>
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</thead>
<tbody>
<tr>
<td>eMMC %</td>
<td>36%</td>
<td>43%</td>
<td>63%</td>
<td>65%</td>
<td>71%</td>
<td>81%</td>
</tr>
</tbody>
</table>

Unit: Million

Source: DRAMeXchange, June 2014

eMMC % in Tablet

<table>
<thead>
<tr>
<th>Quarter</th>
<th>1Q12</th>
<th>3Q12</th>
<th>1Q13</th>
<th>3Q13</th>
<th>1Q14</th>
<th>3Q14F</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMMC %</td>
<td>24%</td>
<td>20%</td>
<td>48%</td>
<td>53%</td>
<td>52%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Unit: Million

Source: DRAMeXchange, June 2014
Smartphone: Weak 1Q14 and Low-End Drives 2Q14

- 1Q14 smartphone drops 6% qoq for seasonality. 2Q14 pick-up from low-end models.
- Middle/Low-end models are carrying the catalyst in 2014. (60% in 2013-80% in 2014)

Source: DRAMeXchange, June 2014
eMMC is Penetrating from Top to Bottom

- Slowing eMMC content growth is attributed by middle-low end devices.
- Traditional MCP is replaced by eMMC or eMCP for new Android O.S and apps.

Source: DRAMeXchange, June 2014
Tablet: Market Continues to Raise with Limited Content Growth.

- 1H14 tablet demand is muted, only 2%YoY compared with 1H13.
- Overall demand picks up from 3Q14 for new models unveiled.
- Tablet eMMC content declined in 2014 due to ultra-low price tablet raise.
- Raw NAND is still popular among Chinese white-box for cost concern.

Source: DRAMeXchange, June 2014
## WW eMMC+eMCP Market Share in 2013

### Vendor Controller House

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Controller House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samsung</td>
<td>In-House</td>
</tr>
<tr>
<td>SanDisk</td>
<td>In-House</td>
</tr>
<tr>
<td>SK Hynix</td>
<td>SMI</td>
</tr>
<tr>
<td>Toshiba</td>
<td>In-House</td>
</tr>
<tr>
<td>Micron</td>
<td>Phison</td>
</tr>
<tr>
<td>Kingston</td>
<td>Phison</td>
</tr>
<tr>
<td>Others</td>
<td>SMI, Skymedi, Phison, etc…</td>
</tr>
</tbody>
</table>

### 770mn eMMC units

- Samsung is leading with strong position in eMMC and eMCP, leveraged Samsung smartphone.
- SanDisk has most diversified customer portfolios than any other eMMC vendors.
- 3rd-party controller houses will find it difficult to compete with in-house solution.

Source: DRAMeXchange, June 2014
WW eMMC+eMCP Market Share in 2014

2014

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Controller House</th>
</tr>
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<tbody>
<tr>
<td>Samsung (19nm)</td>
<td>In-House</td>
</tr>
<tr>
<td>SanDisk (1ynm)</td>
<td>In-House</td>
</tr>
<tr>
<td>SK Hynix (16nm)</td>
<td>In-House, SMI</td>
</tr>
<tr>
<td>Toshiba (A19nm)</td>
<td>In-House</td>
</tr>
<tr>
<td>Micron (16nm)</td>
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<td>Others</td>
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</tr>
</tbody>
</table>

1,100mn eMMC units
- eMMC Market share pattern remains stable.
- In-House Solutions are dominating.
- TWN vendors are narrowing to supplementary role.

Source: DRAMeXchange, June 2014
SSD Market: Enterprise is the Bulls Eye

- PC-Client SSD shipment outnumbers but enterprise-SSD consumption is higher.
- Total SSD market size increases 87% /36%/37% for 2013/2014/2015

Source: DRAMeXchange, June 2014
Samsung is prevailing PC-OEM SSD in either MLC or TLC products. In-House SSD controller is facilitating to performance and time to market. Marvell flexible business model helps the PC-SSD makers on product differentiation.

Source: DRAMeXchange, June 2014

~34mn units
2014 NB market drops 2%YoY with limited growing SSD penetration rate. Expanded market share for Samsung is credit to higher TLC-SSD in 1st-tier PC makers.
WW Retail SSD Market Share and Controller in 2013

~10mn units

- LSI-SandForce remains No#1 for retail brand for comprehensive firmware support.
- Strong Samsung retail SSD sales is attributed by TLC-base SSD.

Source: DRAMeXchange, June 2014
LSI-SandForce is still No#1 due to Kingston.
Market share is consolidated to strong brand makers.
3rd-party SSD controller houses are moving to white-box or module houses.

Source: DRAMeXchange, June 2014
Key Takeaways

Supply

- 2014 supply bit growth is 38%, bit output is mainly derived from node migration while wafer capacity only increases by 8%.
- To cope with middle/low-end mobile devices, TLC-Basis eMMC and SSD are next battlefield. Most NAND makers will be ready from 2H14.
- 1xnm-class eMMC, eMCP and SSD will become mainstream products from 2Q14; 3D-NAND remains future story for 2015.

Demand

- 2014 demand bit growth is 39%. Smartphone, tablet and SSD continue to drive the market upward.
- Despite of strong end-device shipment pattern, content-per-box growth is limited due to cost concern and enhanced popularity of middle/low end models.
- SSD outperforms other applications in 2014, credit to solid demand from enterprise-SSD.
Thanks

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