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• BUSINESS UPDATE
  MEMORY MARKET OPPORTUNITIES
  SAMSUNG STRATEGY
SAMSUNG MEMORY BUSINESS REVIEW

#1 in Memory Worldwide Since 1993, Well Balanced DRAM/NAND Portfolio

2019 Market Share

<table>
<thead>
<tr>
<th>Year</th>
<th>DRAM</th>
<th>NAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td></td>
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<tr>
<td>2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>43%</td>
<td></td>
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</tbody>
</table>

Revenue

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
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<td></td>
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<td>2016</td>
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<tr>
<td>2017</td>
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</tr>
<tr>
<td>2018</td>
<td>$44B</td>
</tr>
<tr>
<td>2019</td>
<td>$44B</td>
</tr>
</tbody>
</table>

Source: IDC Preliminary, Feb. '19
MEMORY BIZ. PARADIGM SHIFT LED BY SAMSUNG

Samsung is Powering the Technologies that bring Innovation to Lifestyle

Big Fluctuations

1st Jump

2nd Jump

3rd Quantum Jump

Memory Revenue

1990

2000

2010

2016

Big Fluctuations

1st Jump

2nd Jump

3rd Quantum Jump

Memory Revenue

1990

2000

2010

2016
Beyond The Boundary

HUMAN

Samsung Memory

AI
SPREAD-OUT OF PUBLIC CLOUD
Explosive Growth of Unstructured Data

1st WAVE
Cloud Service Providers
2016

2nd WAVE
.com & Forbes Top100

3rd WAVE
5G
Telco Companies
2020

4th WAVE
Automotive Companies

THE FLOOD OF DATA
SMART CITY & AUTONOMOUS CAR FUELED BY 5G NETWORK
Huge Amounts of Data Generated by Hyper-connected Devices
MARKET OPPORTUNITY IN BIG DATA ANALYTICS

Demand Increase for High Density & Performance Memory to Enhance Computing Power

- SSD
- CLOUD
- Big Data
- Unstructured Data
- Structured Data

- Accelerator + HBM
  - (GPGPU, FPGA, ASIC)
  - High Density / Performance

- CPU
  - Low Latency
  - Fast Response

- DRAM
  - More Density

*Latency: Time delay between input and output in a system
CONTINUOUS GROWTH OF MEMORY DEMAND
Memory Growth led by Server & Mobile Applications based on Big Data Ecosystem
CONTENTS

BUSINESS UPDATE
MEMORY MARKET OPPORTUNITIES
• SAMSUNG STRATEGY
SAMSUNG STRATEGY

Break-through Technology

Enhanced Solutions

Advanced Manufacturing

COST LEADERSHIP

S/W & CONTROLLERS

EFFICIENCY & FLEXIBILITY
CONTINUOUS TECHNOLOGY SCALING
Thru Technology Evolution

Cost/Gb

35nm    28nm    25nm    20nm    1xnmm    1ynm    1znm

BEYOND < 10nm

FUTURE DRAM TECHNOLOGY

DPT    QPT    EUV

*DPT : Double Patterning Technology
*QPT : Quadruple Patterning Technology
*EUV : Extreme Ultra Violet

ADVANCED DESIGN TECH

Source: Samsung
PUSHING THE LIMITS OF V-NAND
Thru Innovative Layer Stacking Technology

NAND

Cost/Gb

Planer 21nm 19nm 16nm 14nm V32 V48 V64 V9x V12x ...

Source: Samsung

FUTURE V-NAND TECHNOLOGY

- Vertical Stack-up
- Multi-Stacking
- Lateral Shrink
- Cell Over Peri

QLC

* QLC: Quad-Level Cell
UNIQUE CAPABILITIES FOR DIFFERENTIATED SOLUTIONS
Integrating Key Components to Deliver Value-added Solutions

ADVANCED PROCESS TECHNOLOGY
Wafer / Chip
- Smaller
- Higher Density
- Less Power Consumption
- Faster

ADVANCED PACKAGING TECHNOLOGY
Stacking / TSV
- Thinner
- Smaller
- No Performance Loss

VERTICAL INTEGRATION
Software & Logic (Controller)
- Customized
- Expandable
- Smarter
- Secure
SAMSUNG SOLUTIONS FOR THE 5G ERA
Enhanced Processing for Massive Data with Lower Latency & Less Power Consumption

FASTER DATA RATES WITH LOW POWER

TSV RDIMM, Z-SSD & NF1
- Low Latency *
- High Capacity
- Stable QoS

LPDDR5
- Higher Speed
- Lower Power Consumption
- Smaller Package

* Latency: Time Delay between input and output in a system
SAMSUNG SOLUTIONS FOR ARTIFICIAL INTELLIGENCE
Superlative Performance and High Reliability Using Less Energy

ENHANCED PERFORMANCE FOR DATA-INTENSIVE TASKS

16GB HBM2E
- Fastest Performance
- Energy Efficiency

32TB SAS SSD, 16TB NVMe SSD
- Largest Density
- Higher Reliability
- Unparalleled Performance

* HBM: High Bandwidth Memory
SAMSUNG SOLUTIONS FOR AUTOMOTIVE INDUSTRY
Advanced Total Memory Solution for Automotive Applications & Connected Car

Dedicated Support for automotive

Diverse Memory Line-ups
Dedicated Manufacturing Line & Organization

ELECTRIFIED
CONNECTED
AUTOMATED

Automotive eStorage
- High Density
- Temperature Notification
- Data Refresh

Automotive DRAM
- High Bandwidth
- Lower Power Consumption
- Higher Reliability
APPLICATION-ORIENTED LINE MANAGEMENT

2-Track Strategy for Efficient Production & Capacity Allocation

- **Performance**: Leading Process Technology
- **Flexibility**: DRAM/NAND Conversion
- **Longevity**: Proven Process Technology

- **Advanced Manufacturing**
- **Automotive**
- **Industrial**
- **Network**

- **Artificial Intelligence**
- **High Performance Computing**
EVOLUTION TO SMARTER FACTORY
Customer Value Improvement through High Productivity and Enhanced SCM*

* SCM: Supply Chain Management
QUALITY BY DESIGN
Meet the Industry Standard and Expectation of AI & Automotive Customers
Placing Memory at the Forefront of Future Innovation and Creative IT Life

Technology
Leading Technological Breakthroughs

Customers
Supporting Customers’ Future Innovation

Employees
Fostering Employees’ Creativity

Society
Enriching a New Way of Digital Life

http://www.samsung.com/semiconductor