REPORT OBJECTIVES

- The Quarterly Market Monitors (NAND & DRAM) provide both a high-level perspective on the current memory market dynamics while also providing very detailed analysis on all aspects of the memory markets.

- The Market Monitors are in-depth, Excel-based reports covering all things related to the DRAM or NAND market: pricing, supply/demand, supplier and technology analysis.

- The accompanying slides provide a convenient and effective way to visualize the data and make sense of what is happening in the market.

- The Monthly Pricing Monitors provide a monthly snapshot of market pricing across a variety of products, including components and packaged solutions spanning multiple densities and technologies.
COMPANIES MONITORED IN THE PRODUCT

DRAM Monitor
Micron, Nanya, Powerchip, Samsung, SK Hynix, Winbond, and more...

NAND Monitor
Samsung, KIOXIA, Western Digital, Micron, SK Hynix, Intel, YMTC, and more...
### TABLE OF CONTENTS – DRAM MONITOR

#### DRAM Quarterly Market Monitor
- **DRAM overview data**
  - Market forecast
  - Supplier dashboard
  - Supply and demand
  - Capex
  - Revenue and market share
  - Segment revenue and market share
  - Regional revenue and market share
  - Company revenue by segment
  - Company revenue by region
  - ASP
  - Financial data
  - DRAM demand data

- **DRAM demand data**
  - Demand summary
  - PC demand
  - Datacenter demand
  - Mobile demand
  - Auto demand
  - Graphics demand
  - Wafer demand by application*
  - DRAM production data
  - Industry production process mix
  - Production by supplier
  - Wafer production by supplier
  - Wafer production by technology*
  - Samsung production
  - SK Hynix production
  - Micron production
  - Nanya production
  - Samsung production
  - Powerchip production
  - Other production

- **DRAM shipment data**
  - Shipments (historical & forecast)
  - Shipments by technology (historical and forecast)
  - Shipments by density (historical and forecast)
  - Module shipments*
  - Emerging memory
  - Samsung shipments
  - SK Hynix shipments
  - Micron shipments
  - Nanya shipments
  - Winbond shipments
  - Powerchip shipments

#### DRAM Monthly Pricing Monitor
- **Monthly Price Evolution looking back six months and forward 12 months:**
  - **Mobile DRAM ($/unit)**
    - LPDDR2 8Gb
    - LPDDR2 16Gb
    - LPDDR3 8Gb
    - LPDDR3 12Gb
    - LPDDR3 16Gb
    - LPDDR3 24Gb
    - LPDDR4 16Gb
    - LPDDR4 32Gb
    - LPDDR4 48Gb
  - **Server DRAM ($/unit)**
    - DDR3 2GB R-DIMM
    - DDR3 4GB R-DIMM
    - DDR3 8GB R-DIMM
    - DDR3 16GB R-DIMM
    - DDR4 8GB R-DIMM
    - DDR4 16GB R-DIMM
    - DDR4 32GB R-DIMM
    - DDR4 64GB R-DIMM
  - **PC DRAM**
    - DDR3 1GB DIMM
    - DDR3 2GB DIMM
    - DDR3 4GB DIMM
    - DDR4 8GB DIMM
    - DDR4 4GB DIMM
    - DDR4 16GB DIMM
  - **Components**
    - SDR 16Mb
    - SDR 64Mb
    - DDR 256Mb
    - DDR 512Mb
    - DDR2 512Mb
    - DDR2 1Gb
    - DDR3 1Gb
    - DDR3 2Gb
    - DDR3 4Gb
    - DDR4 4Gb
    - DDR4 8Gb
    - DDR4 16Gb
    - DDR4 32Gb

*Other shipments a complete Excel file with the analysis’ numerical data is included with the PPT presentation.
TABLE OF CONTENTS – NAND MONITOR

NAND Quarterly Market Monitor

- NAND market overview
  - Market dynamics
  - Revenue – historical and forecast
  - Shipments
  - Pricing
  - Operating margins
  - Sufficiency
  - Near-term supply and pricing outlook
  - Capex
  - PCM forecast

- NAND market shares
  - Revenue-based market share
  - Shipment-based market share
  - Regional market share
  - Segment market share

- NAND demand
  - Segment bit demand and share
  - Mobile
  - SSD – PC (client) and Datacenter (enterprise)
  - Automotive
  - Gaming
  - Removable storage

- NAND supply
  - Wafer production by supplier, process, and technology
  - Bit production by process, technology, and density
  - GB per wafer, by supplier
  - 3D NAND supplier roadmaps
  - SLC bit production and bit market share

- NAND supplier profile
  - New cleanroom updates
  - Samsung
  - KIOXIA
  - Western Digital
  - Micron
  - SK Hynix
  - Intel
  - YMTC
  - Others
  - A complete Excel file with the analysis’ numerical data is included with the PPT presentation

NAND Monthly Pricing Monitor

Monthly Price Evolution looking back six months and forward 12 months:

- QLC NAND ($/unit)
  - 1Tb (128GB)

- TLC NAND ($/unit)
  - 128Gb (16GB)
  - 256Gb (32GB)
  - 512Gb (64GB)

- MLC NAND ($/unit)
  - 16Gb (2GB)
  - 32Gb (4GB)
  - 64Gb (8GB)
  - 128Gb (16GB)
  - 256Gb (32GB)

- SLC NAND ($/unit)
  - 1Gb
  - 2Gb
  - 4Gb
  - 8Gb (1GB)

- eMMC NAND ($/unit)
  - 16GB TLC
  - 32GB TLC
  - 64GB TLC
  - 128GB TLC

- UFS ($/unit)
  - 32GB TLC
  - 64GB TLC
  - 128GB TLC
  - 256GB TLC

- eMCP ($/unit)
  - 16GB+8Gb LP3
  - 16GB+16Gb LP3
  - 32GB+16Gb LP3
  - 32GB+24Gb LP4
  - 64GB+32Gb LP4
  - 64GB+48Gb LP4
  - 128GB+32Gb LP4

- SSD ($/unit)
  - > 128GB TLC PCIe
  - > 256GB TLC PCIe
  - > 512GB TLC PCIe
  - > 1TB TLC PCIe
ABOUT THE AUTHORS

Biographies & contacts

Walt Coon, VP of NAND and Memory Research

Walt Coon joins Yole Développement’s memory team as VP of NAND and Memory Research, part of the Semiconductor & Software division. Walt is leading the day-to-day production of both market updates, Market Monitors and Pricing Monitors, with a focus on the NAND market and semiconductor industries. In addition, he is deeply involved in the business development of these activities. Walt has significant experience within the memory & semiconductor industry. He spent 16 years at Micron Technology, managing the team responsible for competitor benchmarking, and industry supply, demand, and cost modeling. His team also supported both corporate strategy and Mergers & Acquisitions analysis. Previously, he spent time in Information Systems, developing engineering applications to support memory process and yield enhancement. Walt Coon earned a Master of Business Administration from Boise State University (Idaho, United-States) and a Bachelor of Science in Computer Science from the University of Utah (United-States). Contact: walt.coon@yole.fr

Mike Howard, VP of DRAM and Memory Research

Mike Howard is a member of the Memory team at Yole Développement, serving as VP of DRAM and Memory Research within the Semiconductor & Software division. He is a daily contributor to the business development of memory activities, with a special focus on the DRAM industry. Mike’s mission is to propose a comprehensive understanding of the memory and semiconductor markets, with a dedicated collection of market updates, Market Monitors, and Pricing Monitors. Over the course of his career Mike has developed broad DRAM memory expertise, including an effective combination of industrial and market research experience. Prior to his position at Yole as VP of DRAM and Memory Research, Mike worked at Micron Technology for more than a decade. During this time he held several key roles in Corporate Development, Marketing, and as a photolithography engineer in R&D. Mike earned a master’s of Business Administration from The Ohio State University (United States), along with a B.S. in Chemical Engineering and a B.A. in Finance from the University of Washington (Washington, United States). Contact: mike.howard@yole.fr
Monitor sample – DRAM
• Revenue increased in Q4-20 by $0.3b. Q1-21 revenue is forecasted to increase $0.7b.
• Prices were down -6% in Q4-20 and shipments were up 8%, resulting in a 2% revenue increase.
**SEGMENT BIT DEMAND**

- *Datacenter and automotive will significantly outgrow the market over the next 5 years*

### '20-'26 CAGR

<table>
<thead>
<tr>
<th>Segment</th>
<th>Demand Growth (%)</th>
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<tbody>
<tr>
<td>PC</td>
<td>10.1%</td>
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<tr>
<td>Consumer</td>
<td>11.7%</td>
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<tr>
<td>Datacenter</td>
<td>28.6%</td>
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<td>Auto</td>
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<tr>
<td>Mobile</td>
<td>15.0%</td>
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<tr>
<td>Other</td>
<td>26.1%</td>
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</table>

### 2019 - 2026 Demand Growth

- **2019**:
  - PC: 17%
  - Datacenter: 21%
  - Mobile: 24%
  - Consumer: 20%
  - Auto: 18%
  - Other: 20%

- **2020 - 2026 CAGR**:
  - PC: 10.1%
  - Consumer: 11.7%
  - Datacenter: 28.6%
  - Auto: 42.3%
  - Mobile: 15.0%
  - Other: 26.1%
• Over the long-run, wafer production will increase to keep pace with bit demand

CXMT makes up 7% of wafers in 2026

CXMT 2022-2026 CAGR: 40%
# DRAM Pricing Monitor

**DRAM monthly pricing monitor**

*June 2021*

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## Server DRAM ($/unit)

## PC DRAM ($/unit)

## Components ($/unit)
Monitor sample – NAND
• Constrained supply growth and rebounding demand led to revenue growth in H1-2020; weak demand in H2-20 constrained further growth
• Pandemic-related demand recovery and shortages of controllers and other semiconductor sub-components expected to drive revenue growth in 2021
SSD – UNIT MIX

- Client SSDs dominate SSD unit shipments; enterprise gains as PCs become saturated
NAND WAFER PRODUCTION – BY PROCESS

3D NAND dominates wafer production; some planar capacity remains to support legacy/specialty applications
# NAND monthly pricing monitor

**June 2021**

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YOLE GROUP OF COMPANIES RELATED REPORTS

Yole Développement

Emerging Non-Volatile Memory 2021

Status of the Memory Industry 2020

Processor Quarterly Market Monitor

Advanced Packaging Quarterly Market Monitor
Teardown Tracks
Yole Group of Companies, including Yole Développement, System Plus Consulting and PISEO, are pleased to provide you a glimpse of our accumulated knowledge.

We invite you to share our data with your own network, within your presentations, press releases, dedicated articles and more, but you first need approval from Yole Public Relations department.

If you are interested, feel free to contact us right now!

We will also be more than happy to give you updated data and appropriate formats.

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