

DRAM & NAND Quarterly Market Monitor

Memory Service 2020

REPORT OBJECTIVES

- The Quaterly 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...

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DRAM Quarterly Market Monitor

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- DRAM demand data

○ DRAM demand data

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- Samsung production
- Powerchip production
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○ 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

Other shipments a complete Excel file with the analysis' numerical data is included with the PPT presentation

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

- DDR3 8GB DIMM
- DDR4 4GB DIMM
- DDR4 8GB 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



NAND Quarterly Market Monitor

- **NAND market overview**
 - Market dynamics
 - Revenue – Historical and forecast
 - Shipments
 - Blended pricing
 - Market shares – Revenue and bit shipments
 - Supplier ASPs
 - Sufficiency
 - Near-term shipment and pricing outlook
 - Capex
 - PCM forecast
- **NAND demand**
 - Emerging demand drivers
 - Segment bit demand and share
 - Mobile
 - SSD – PC (client) and Datacenter (enterprise)
 - Automotive

○ NAND supply

- Wafer production by supplier, process, and technology
- Bit production by process, technology, and density
- GB per wafer, by supplier
- 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

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*

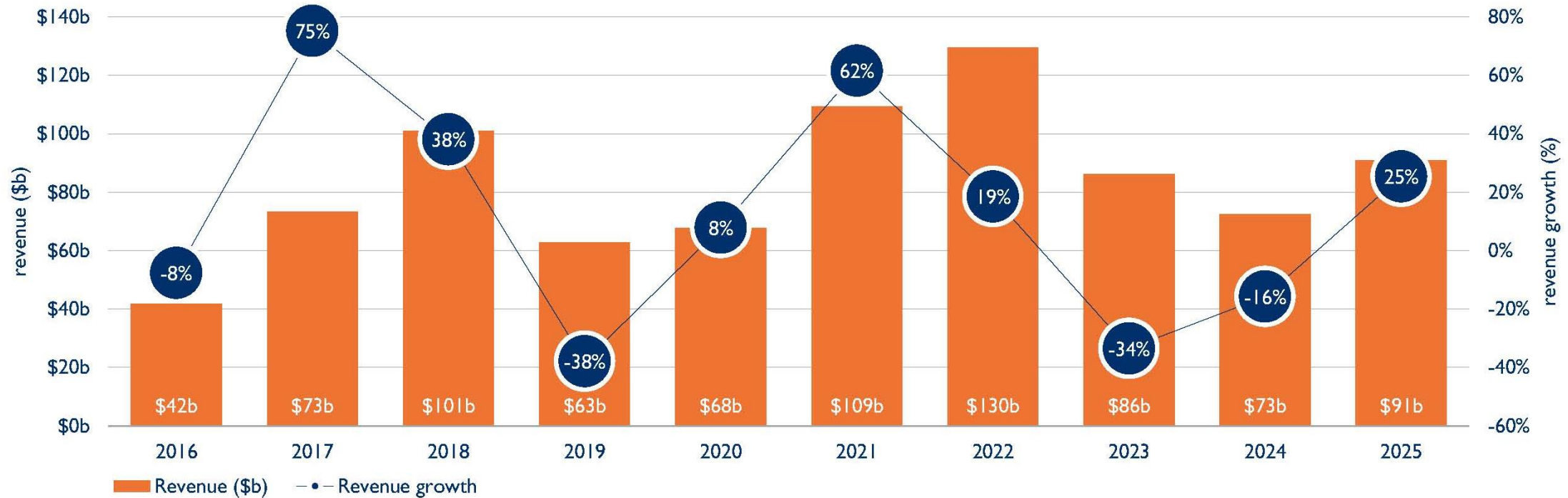


Mike Howard, VP of DRAM and Memory Research

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*

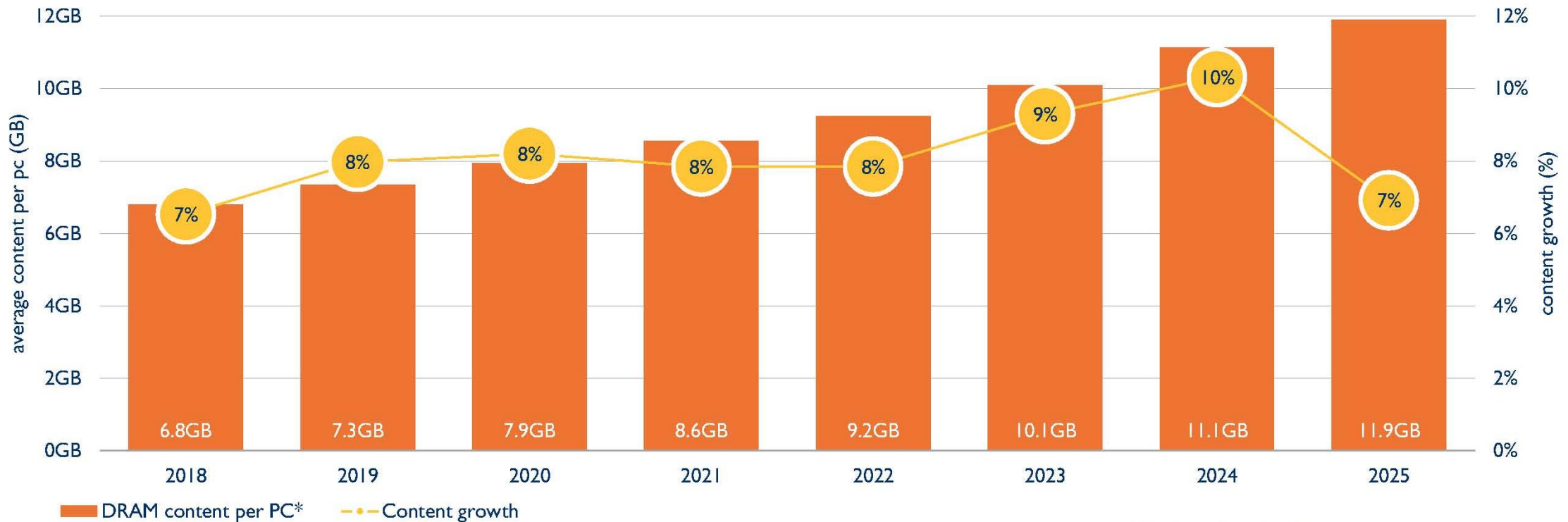
Report sample – DRAM

DRAM MARKET REVENUE



- DRAM market is expected to recover in 2020 with revenue growing 8%
- 2021 & 2022 are expected to be excellent years for DRAM with revenue growing each year
- The emergence of significant Chinese DRAM production after 2022 will push the DRAM market into a downturn for two years before.

If China takes longer to ramp competitive DRAM, then the market will likely remain healthy longer

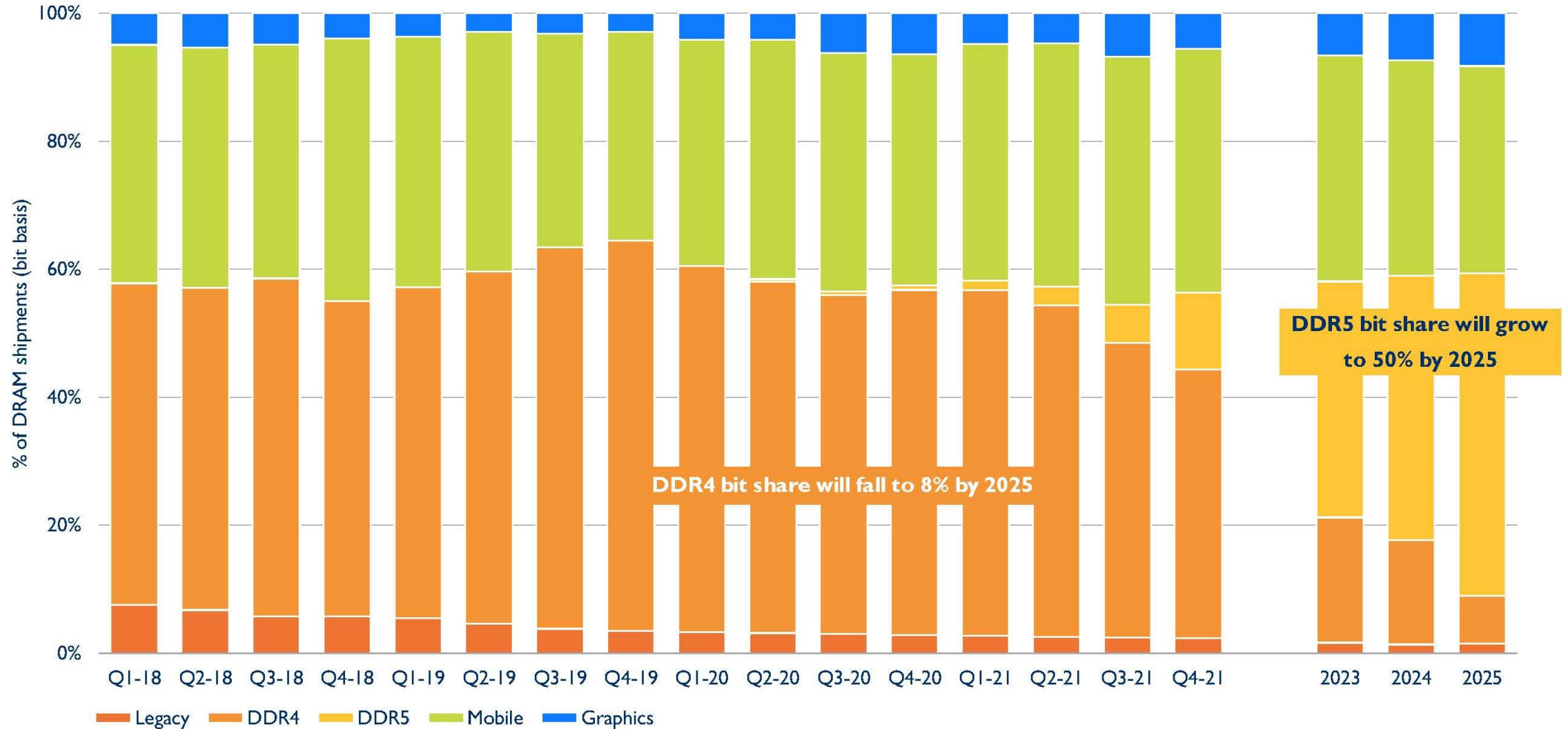


* desktop + notebook

- Content growth in PCs has slowed dramatically over the last decade and is expected to remain low in the coming years
- PC DRAM demand is much less elastic today than it was a decade ago

SHIPMENTS BY TECHNOLOGY

- The DRAM market is no longer dominated by any single technology





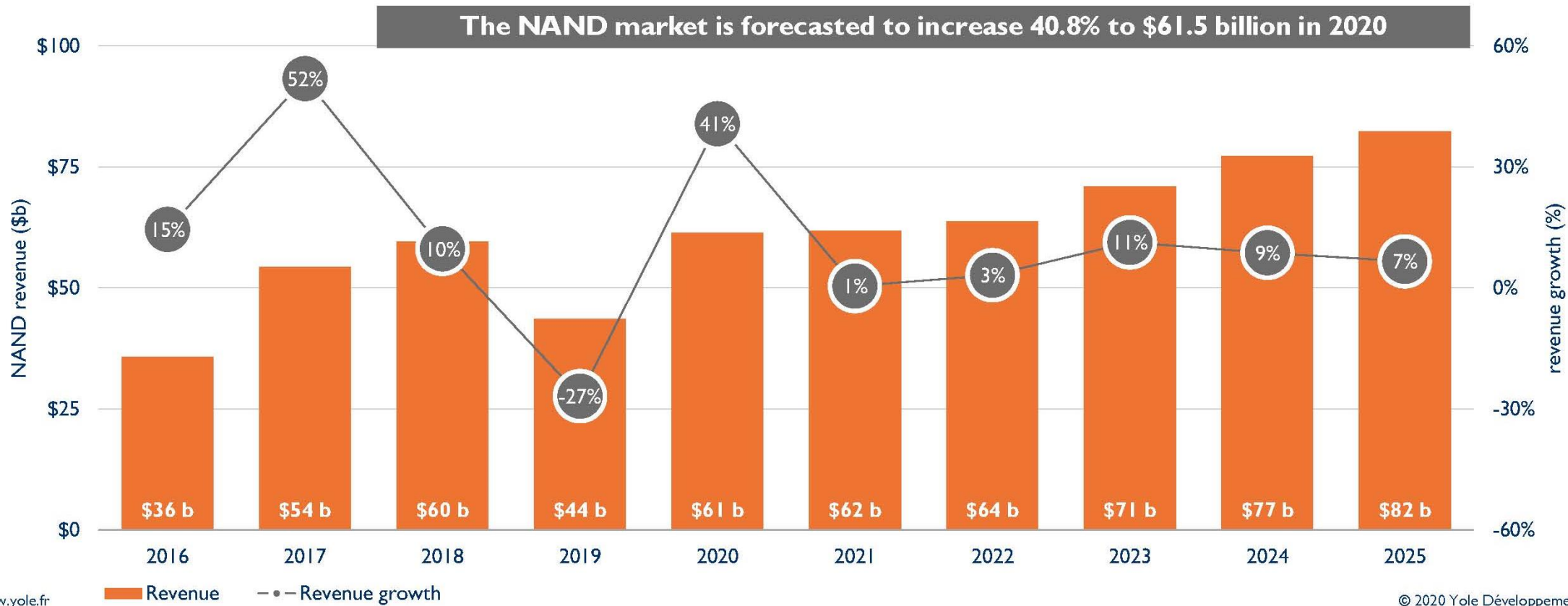
DRAM Monthly Pricing Monitor

February 2020

	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Jan-21	Feb-21
Mobile DRAM (\$/unit)	Historical						Forecast		Forecast	
LPDDR2 8Gb	x	x	x	x	x	x	x	x	x	x
LPDDR2 16Gb	x	x	x	x	x	x	x	x	x	x
LPDDR3 8Gb	x	x	x	x	x	x	x	x	x	x
LPDDR3 12Gb	x	x	x	x	x	x	x	x	x	x
LPDDR3 16Gb	x	x	x	x	x	x	x	x	x	x
LPDDR3 24Gb	x	x	x	x	x	x	x	x	x	x
LPDDR4 16Gb	x	x	x	x	x	x	x	x	x	x
LPDDR4 32Gb	x	x	x	x	x	x	x	x	x	x
LPDDR4 48Gb	x	x	x	x	x	x	x	x	x	x
Server DRAM (\$/unit)										
PC DRAM (\$/unit)										
Components (\$/unit)										

Report sample – NAND

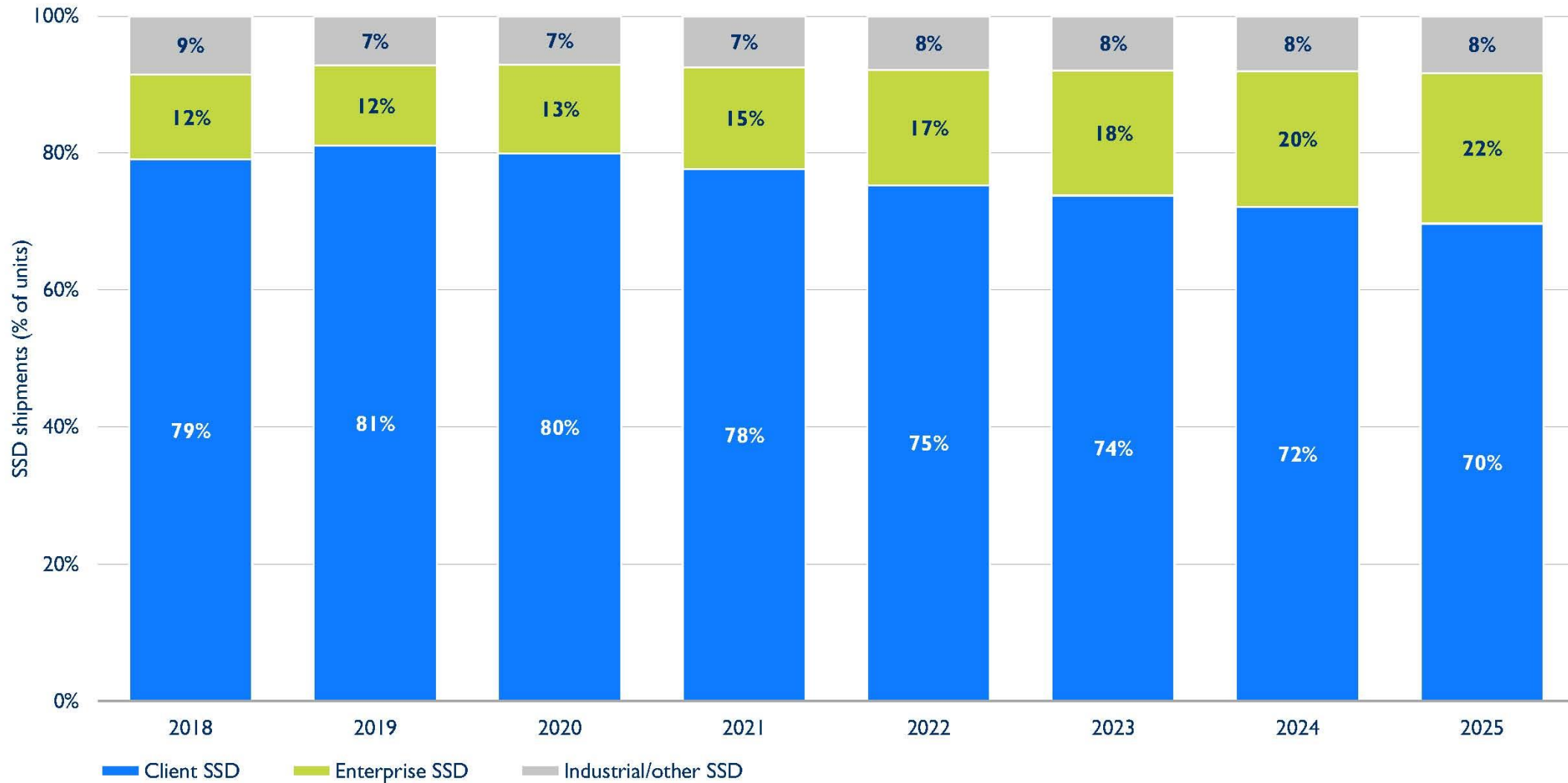
NAND MARKET REVENUE



- NAND revenue in 2019 contracted significantly from record revenue in 2018, with excess inventory and sluggish demand leading to substantial ASP declines
- Revenue in 2020 is expected to reach a record high, driven by constrained supply growth and expanding demand
- Revenue is expected to expand over time, as cost declines enable further penetration of NAND-based storage solutions into traditional HDD markets

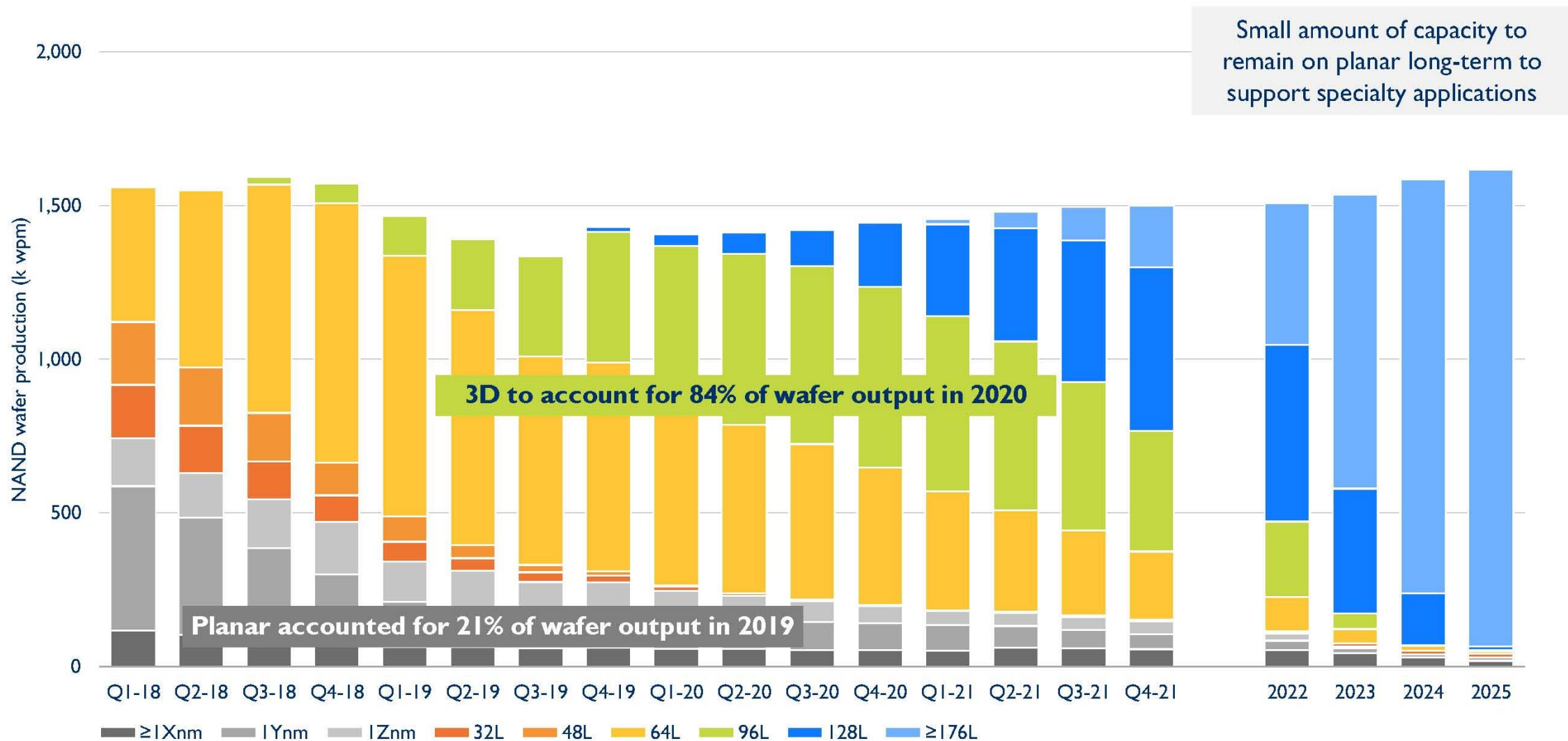
SSD – UNIT MIX

- Client SSDs dominate SSD unit shipments; enterprise gains as PCs become saturated



NAND WAFER PRODUCTION – BY PROCESS

- 3D NAND overtakes planar wafer output in Q4 2017





NAND Monthly Pricing Monitor

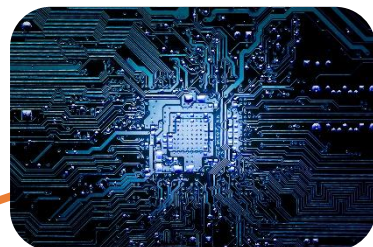
February 2020

	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Jan-21	Feb-21
	Historical						Forecast		Forecast	
QLC NAND (\$/unit)										
1 Tb (128GB)	x	x	x	x	x	x	x	x	x	x
TLC NAND (\$/unit)										
128Gb (16GB)	x	x	x	x	x	x	x	x	x	x
256Gb (32GB)	x	x	x	x	x	x	x	x	x	x
512Gb (64GB)	x	x	x	x	x	x	x	x	x	x
MLC NAND (\$/unit)										
SLC NAND (\$/unit)										
eMMC (\$/unit)										
UFS (\$/unit)										
eMCP (\$/unit)										

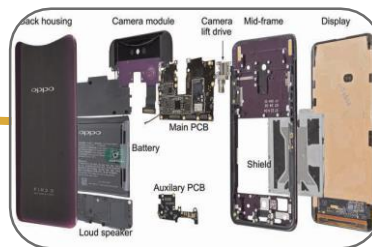
MONITORS AND TRACKS COMBINATION

From module technical content to market forecast and market shares

**Advanced Packaging
Quarterly Market
Monitor**
Packaging Service



**Consumer
Smartphones,
Smart Homes, Wearables**



Market Monitors
by Yole Développement

- › Market shares evaluation
- › Market and technology forecasts

Teardown Tracks
by System Plus Consulting

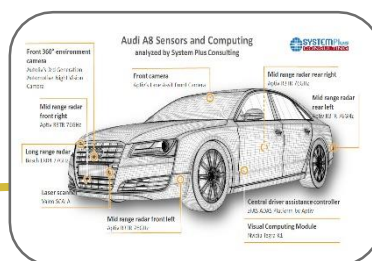
- › Design win identification
- › Technology assessment



**DRAM
& NAND
Quarterly Market
Monitor**
Memory Service



**Application Processor
Quarterly Market
Monitor**
Computing Service



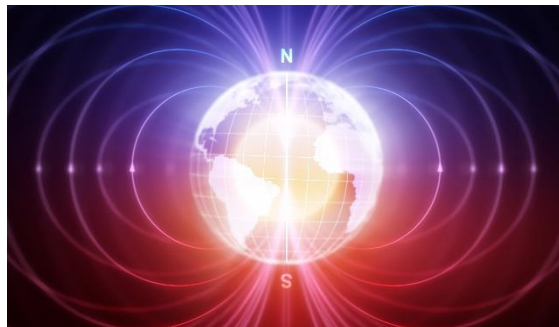
**Automotive
ADAS, Infotainment,
Connectivity**

Combine the expertise of **Yole Développement** and **System Plus Consulting** : with our products, get a deep understanding on the technology, market and trends of the semiconductor industry

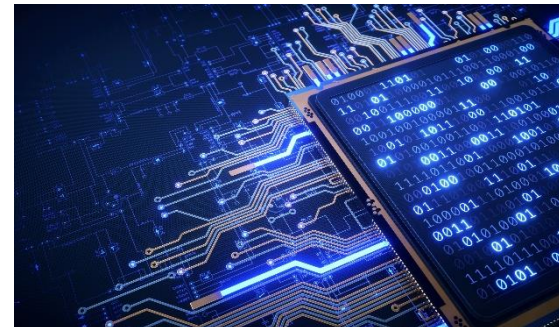
YOLE GROUP OF COMPANIES RELATED REPORTS

Yole Développement

MRAM Technology and Business 2019



Status of the Memory Industry 2019



Emerging Non-Volatile Memory 2020



Contact our Sales Team for more information



CONTACT INFORMATION

○ CONSULTING AND SPECIFIC ANALYSIS, REPORT BUSINESS

• North America:

- Steve LaFerriere, Senior Sales Director for Western US & Canada
Email: laferriere@yole.fr – + 1 310 600-8267
- Chris Youman, Senior Sales Director for Eastern US & Canada
Email: chris.youman@yole.fr – +1 919 607 9839

• Japan & Rest of Asia:

- Takashi Onozawa, General Manager, Asia Business Development (India & ROA)
Email: onozawa@yole.fr - +81 34405-9204
- Miho Ohtake, Account Manager (Japan)
Email: ohtake@yole.fr - +81 3 4405 9204
- Itsuyo Oshiba, Account Manager (Japan & Singapore)
Email: oshiba@yole.fr - +81-80-3577-3042
- Toru Hosaka, Business Development Manager (Japan)
Email: toru.hosaka@yole.fr - +81 90 1775 3866

• Korea: Peter Ok, Business Development Director

Email: peter.ok@yole.fr - +82 10 4089 0233

• Greater China: Mavis Wang, Director of Greater China Business Development

Email: wang@yole.fr - +886 979 336 809 / +86 136 61566824

• Europe & RoW: Lizzie Levenez, EMEA Business Development Manager

Email: levenez@yole.fr - +49 15 123 544 182

○ FINANCIAL SERVICES (in partnership with Woodside Capital Partners)

- Jean-Christophe Eloy, CEO & President
Email: eloy@yole.fr - +33 4 72 83 01 80
- Ivan Donaldson, VP of Financial Market Development
Email: ivan.donaldson@yole.fr - +1 208 850 3914

○ CUSTOM PROJECT SERVICES

- Jérôme Azémar, Technical Project Development Director
Email: azemar@yole.fr - +33 6 27 68 69 33

○ GENERAL

- Camille Veyrier, Director, Marketing & Communication
Email: veyrier@yole.fr - +33 472 83 01 01
- Sandrine Leroy, Director, Public Relations
Email: leroy@yole.fr - +33 4 72 83 01 89
- Email: info@yole.fr - +33 4 72 83 01 80

