

# 2020 Technology Briefing

**Scott DeBoer, EVP**  
**November 30, 2020**

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# Scott DeBoer

Executive Vice President  
Technology and Products



# The New Micron's Journey

## Closing the Gap

2016-2020

- Faster node transitions
- Investments towards vertical integration and scale
- Build quality leadership
- Grow high value solutions mix
- Supply growth in line with demand

## Technology & Product Leadership

2021+

- Introduce leading tech nodes at a typical industry cadence, while maintaining our improved competitive position
- Differentiated solutions ready for heterogenous computing architectures
- Supply growth in line with demand

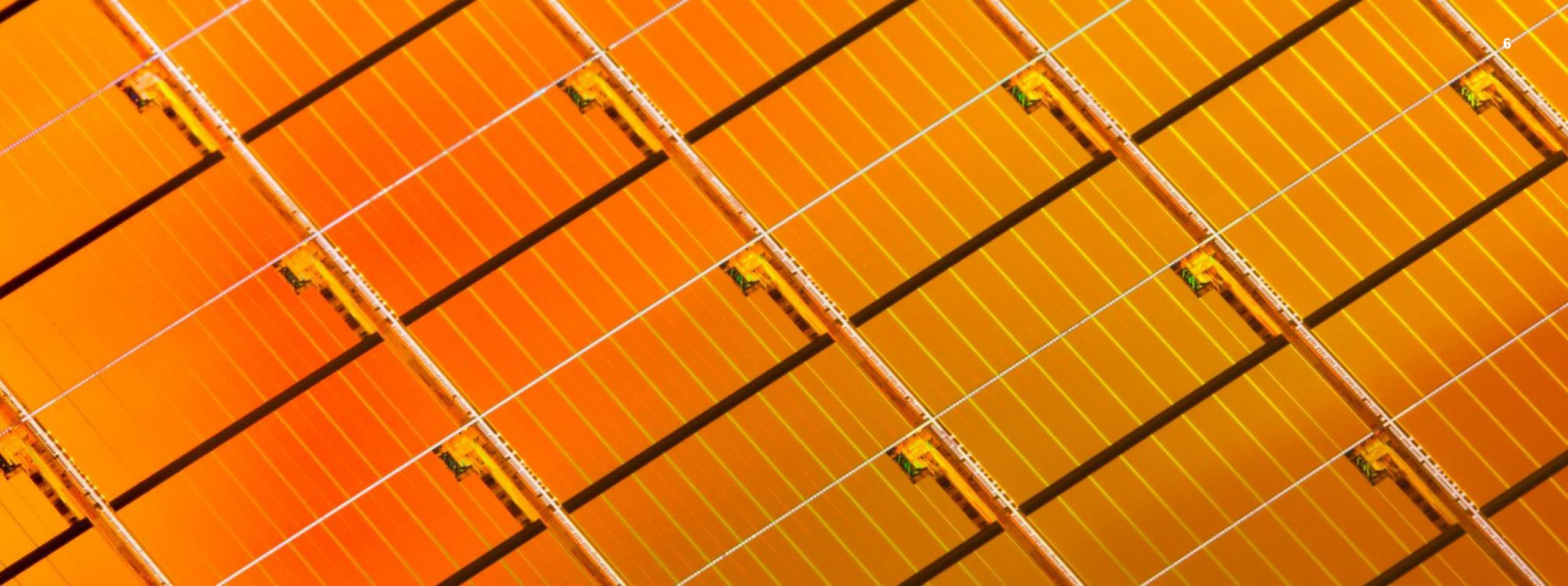


# Agenda

Strategy

Technology

Product



# Strategy





7

# The New Micron is Strong and Getting Stronger

**R&D Efficiency**

**Broadest Portfolio**

**Team & Culture**

The diagram illustrates a process flow where four interlocking gears represent different R&D stages: Process and Package R&D (purple), Product and Test Engineering (light blue), Solutions R&D (blue), and Silicon Design (teal). Arrows indicate a clockwise flow between these stages. A large black arrow points from this gear assembly to a vertical stack of four rectangular boxes representing key outcomes: Time to Market, Differentiated Performance, Best-in-Class Quality, and Cost Competitiveness.



# Industry's Broadest Portfolio

Ability to leverage core technology across the memory and storage hierarchy

**DRAM**

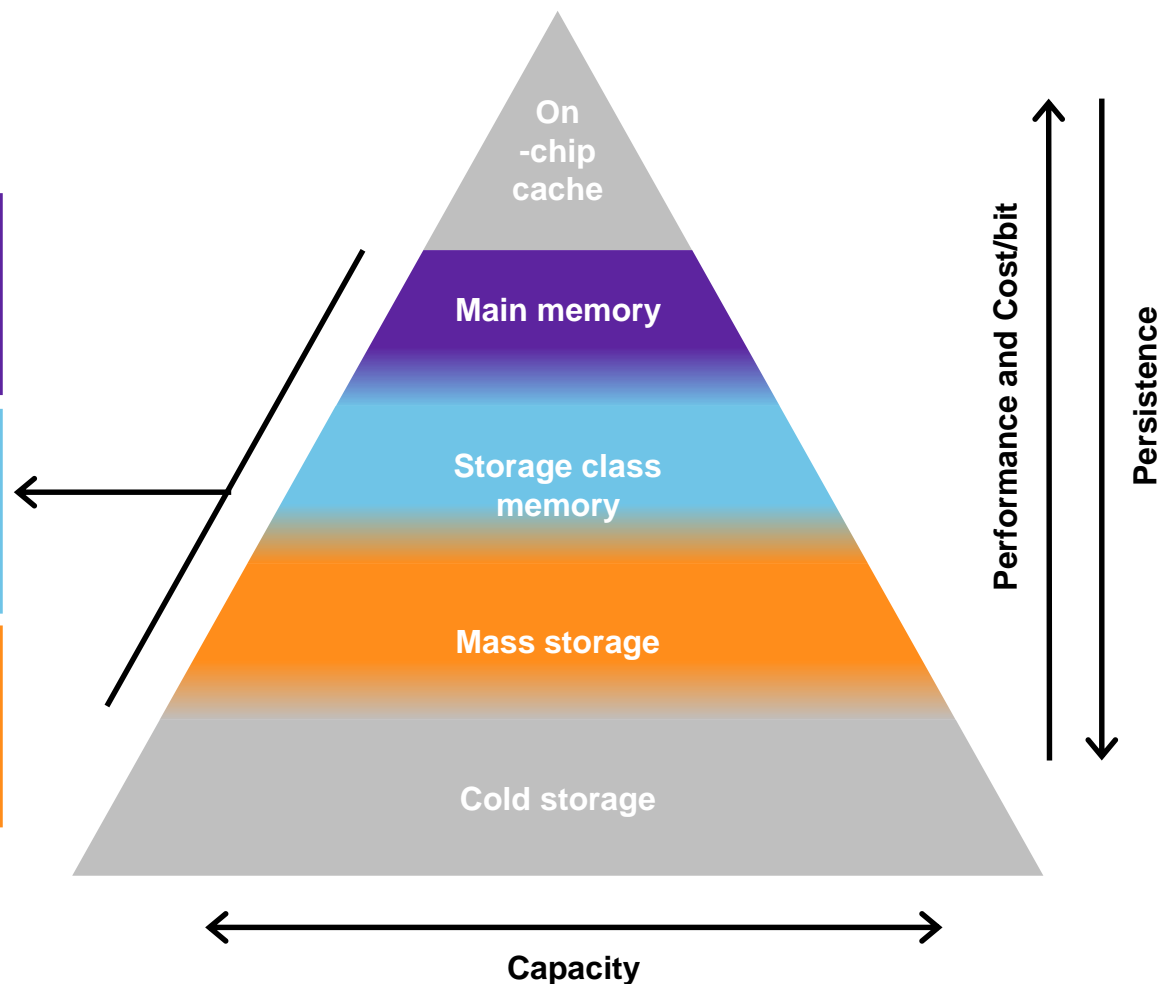
Ultra-Bandwidth: HBM2E, GDDR6X  
Compute: DDR5  
Mobile: Low power leadership

**3DXP**

Memory: Future development  
Storage: X100 – world's fastest SSD

**NAND**

Managed NAND: UFS3.1/2.x, uMCP5  
SSD: Client, Datacenter NVMe/SATA  
QLC: HDD replacement trajectory



# Team & Culture

Uniquely positioned to attract the industry's best global talent

## Process, Product and Solutions R&D

United States  
Italy  
Germany

India  
China

## Technology Development Embedded with Manufacturing

Japan  
Taiwan  
Singapore

## Team

- Global talent fuels innovation
- >50% of R&D new hires with MS, PhD
- >60% technical with industry experience
- Strong talent pipeline, engaged with top global universities

## Culture

- Team Member Health & Safety
  - Excellence in Execution
  - Certified 2020 Great Place to Work
  - Forbes 2020 “The Best Employer for Diversity”
  - Focus on Environmental Sustainability
- Learn more: [August 24, 2020 Sustainability Update](#)

## Innovation

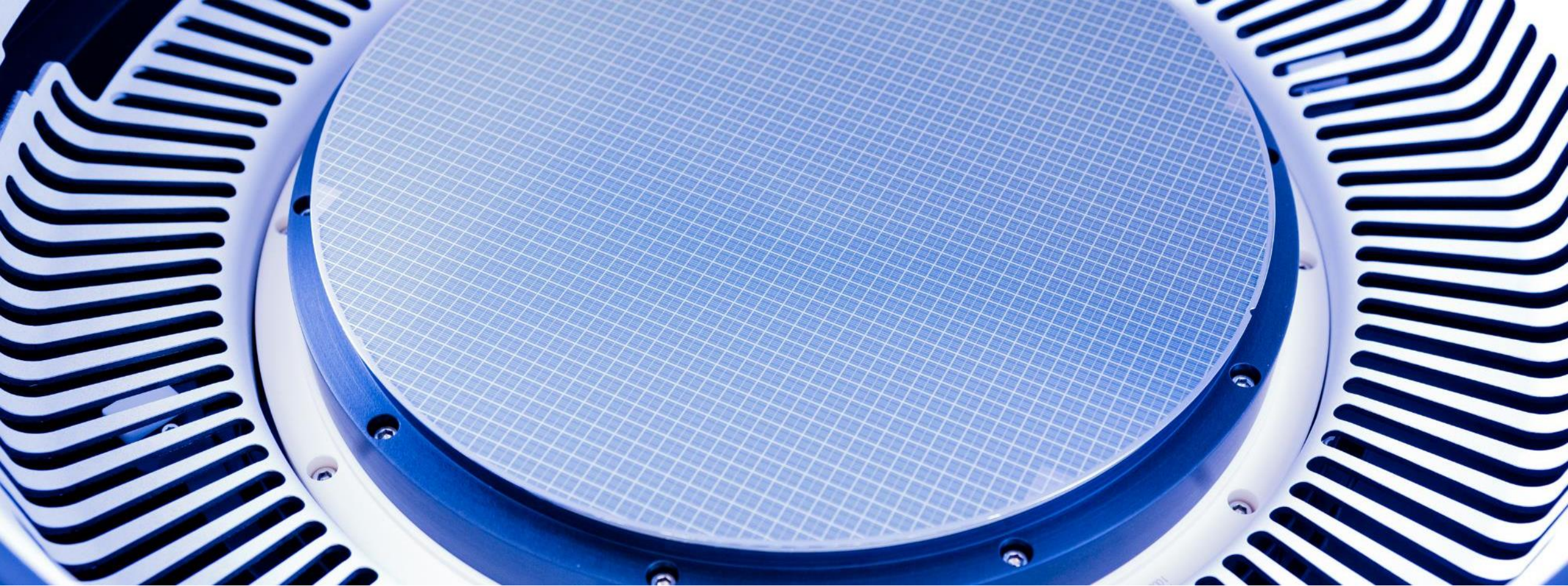
- Over 44,000 patents granted and growing\*
- Top 25 on US Patent list
- Micron Women Innovate program

\*Micron data as of September 3, 2020.



# Technology





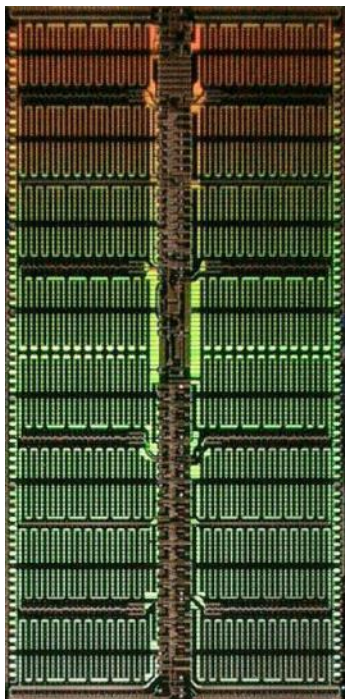
# Technology

## DRAM



# 1 $\alpha$ nm: Industry's Most Advanced DRAM

Volume production in 1H-CY21



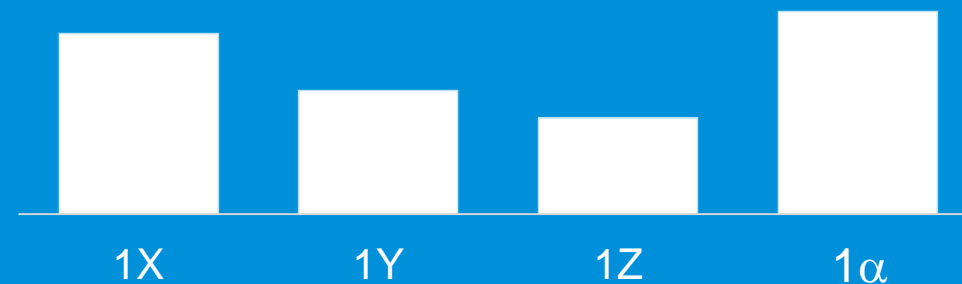
1 $\alpha$ nm DRAM: 8Gb DDR4

- ✓ Lowest power mobile DRAM with 15% improvement vs. prior gen
- ✓ Roadmap for highest speed DRAM available across comprehensive portfolio

## Achieved with Leading Design Efficiency and Process Technology

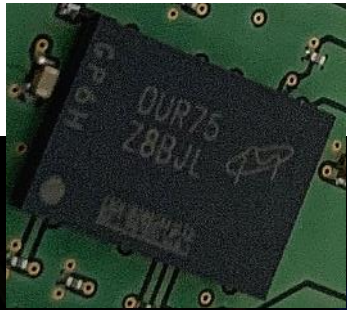
- ✓ Industry's most advanced lithography
- ✓ 40% improvement in density vs. 1Z with ~10% driven by design efficiency

DDR4 % Gb/Wafer Increase from Prior Node

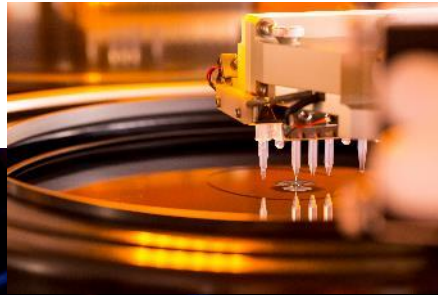


# DRAM Technology Leadership

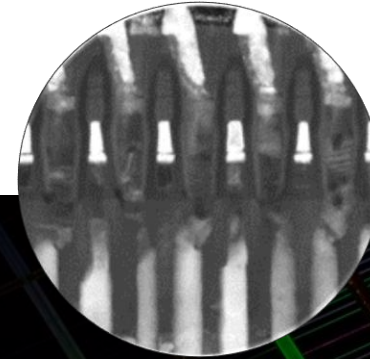
Continuing to extend roadmap for cost and performance improvement



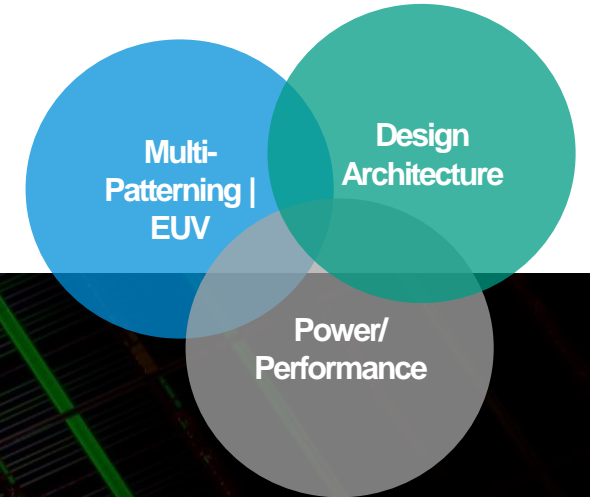
**1 $\alpha$**  Customer Qualification



**1 $\beta$**  Early Development



**1 $\gamma$**  Early Process Integration

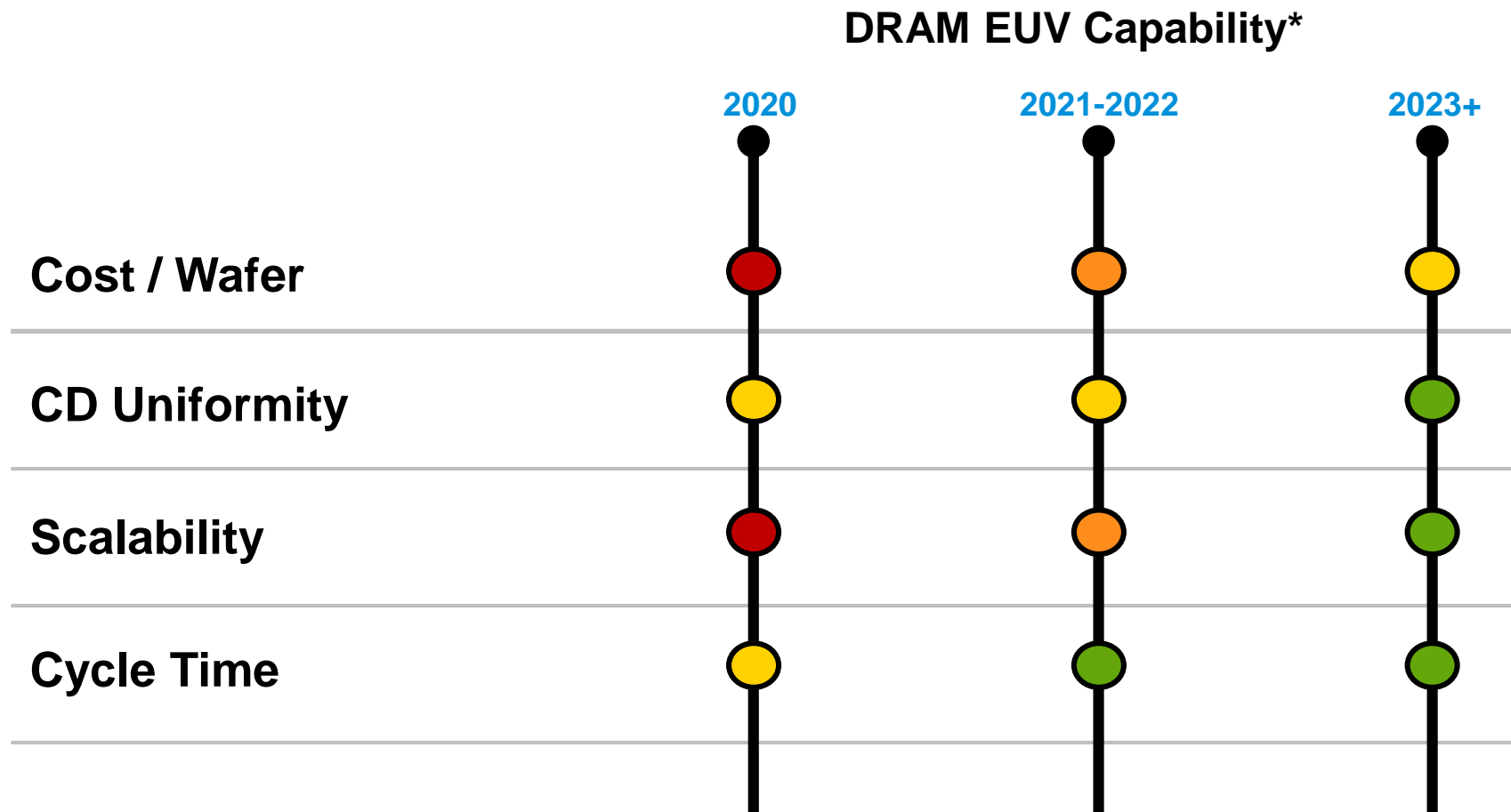


**1 $\delta$**  Pathfinding

- Path for continued scaling over the next decade
- High performance/low power transistor roadmap enabled by High- $\kappa$  CMOS
- Continued evaluation of EUV for cost optimized insertion

# DRAM EUV Performance Improving

Potential future option for Micron DRAM lithography



\*Micron Performance analysis relative to Micron DRAM requirements



# Technology

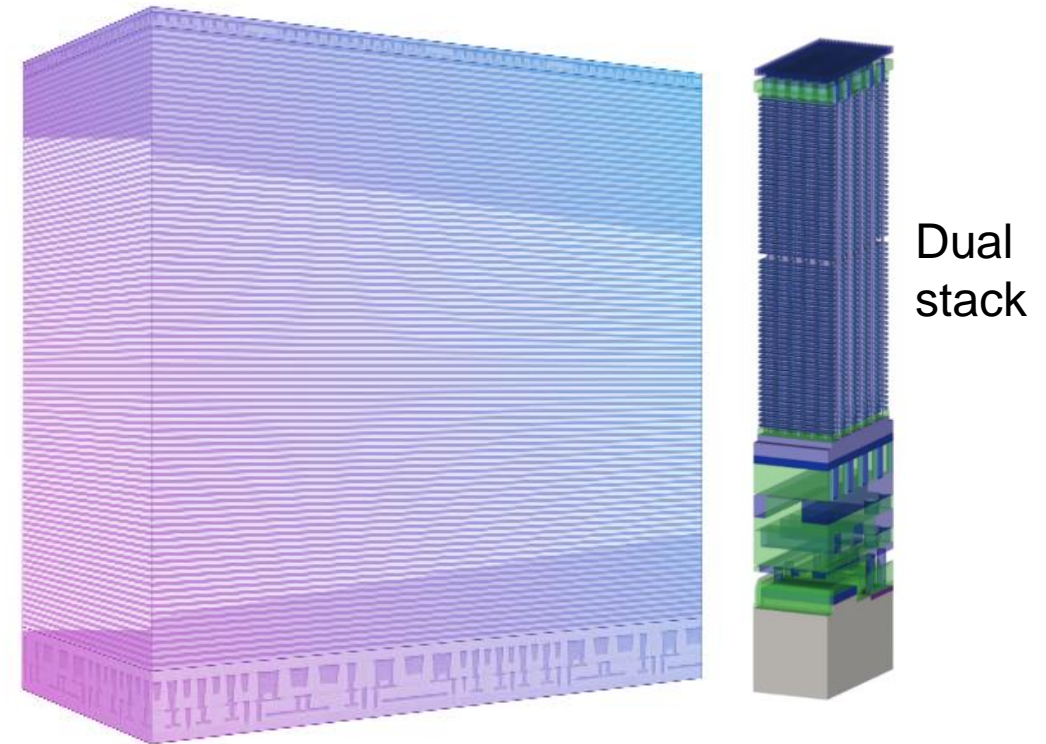
## NAND



# The World's First 176-Layer NAND

Innovation driving breakthrough speed, power efficiency and density

- ✓ 30% smaller die size than best-in-class competitive offerings
- ✓ ~1.5x cost reduction vs. 64L/96L transition\*
- ✓ >2x improved power efficiency†
- ✓ >2x better write times†
- ✓ 33% higher data transfer rate†



\*Cash cost per Gb vs. 64L/96L transition

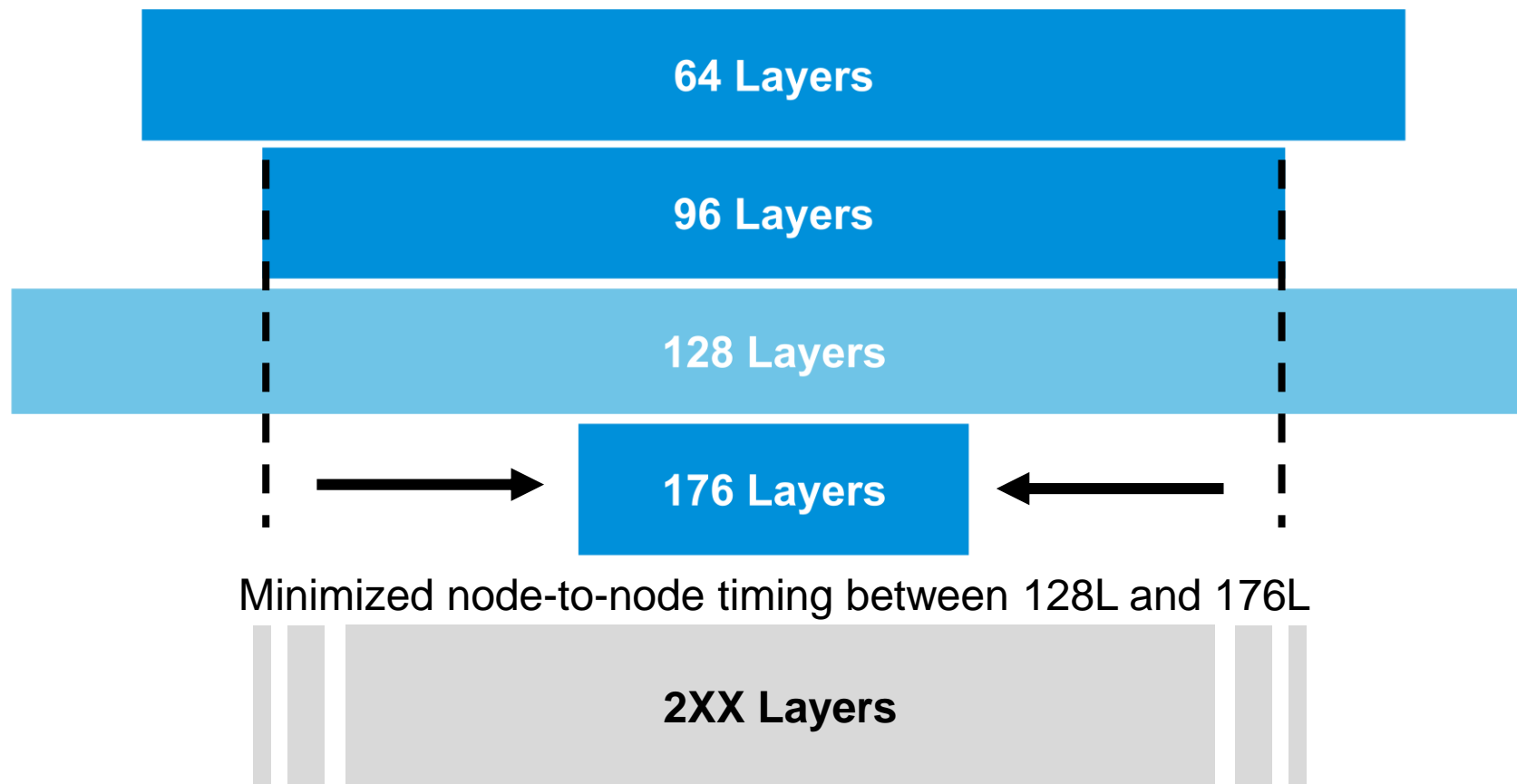
†versus Micron's high volume, floating-gate 96-Layer 3D NAND

Learn more [here](https://www.micron.com) on [micron.com](https://www.micron.com)

# Accelerating Time to Market for 176 Layer

Successful replacement gate (RG) transition enables industry leadership

## NAND

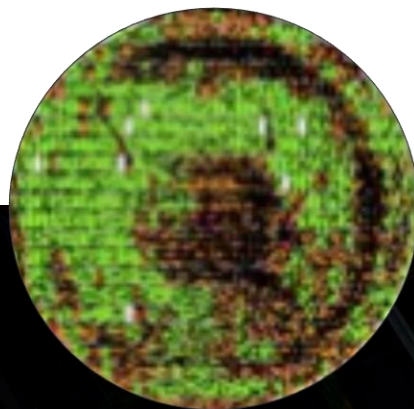


# NAND Technology Leadership

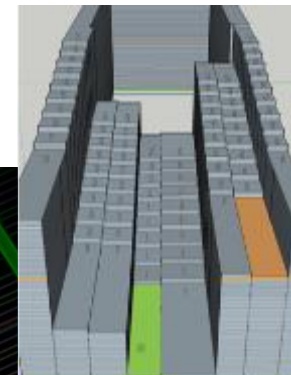
Continuing to extend roadmap for cost and performance improvement



**176 Layer RG**  
Volume Production



**2XX Layer RG**  
Yield Enablement



**Next Gen. RG**  
Early Development

- Continued 3D NAND scaling and cost reductions for several generations
- Combination of replacement gate (RG), charge trap and CMOS under Array delivers performance leadership
- Extend QLC performance leadership

# Replacement Gate

Driving scalability and performance for 3D NAND generations to come

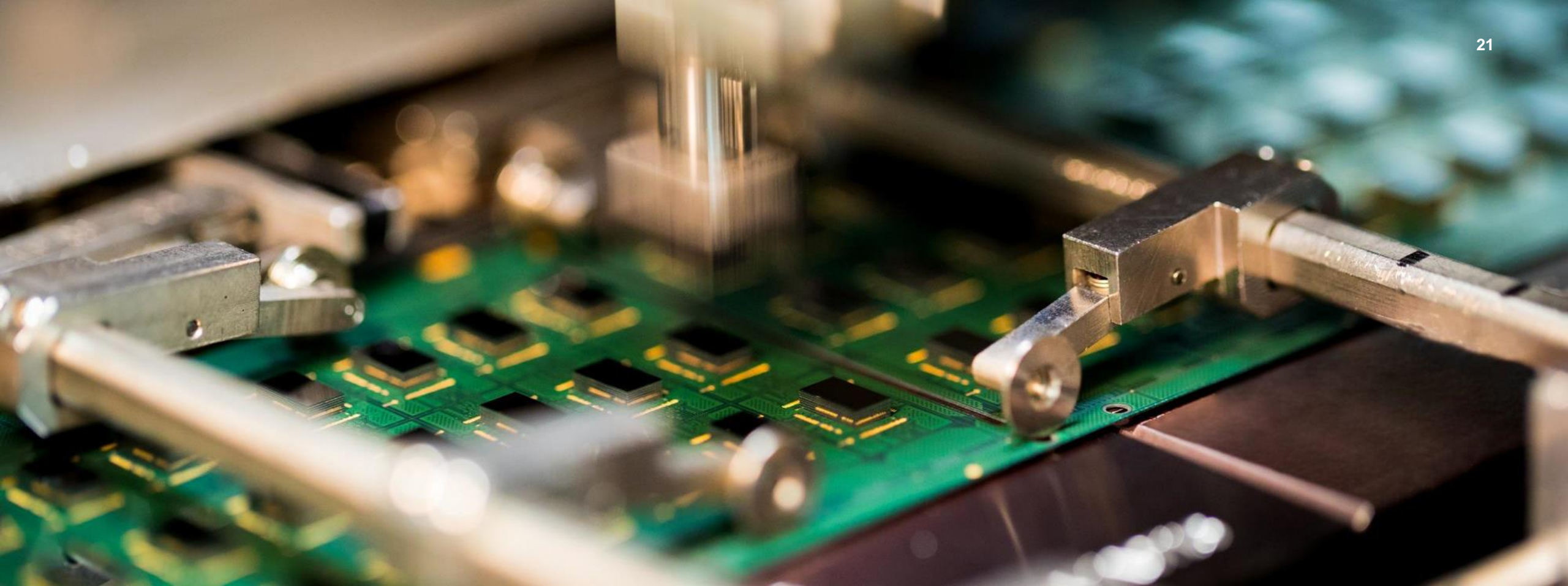
Attribute	<100 Layers		>100 Layers	
	Floating Gate	Replacement Gate	Floating Gate	Replacement Gate
Cost Scalability				
Power				
Performance				
Retention				
Endurance				
QLC Compatibility				

FG made sense  
for <100 layers

RG is superior  
for >100 layers

Note: Gradient indicates change over node transitions





# Product

# Broadest Portfolio of Memory and Storage Products

**Ultra-Bandwidth  
Solutions**

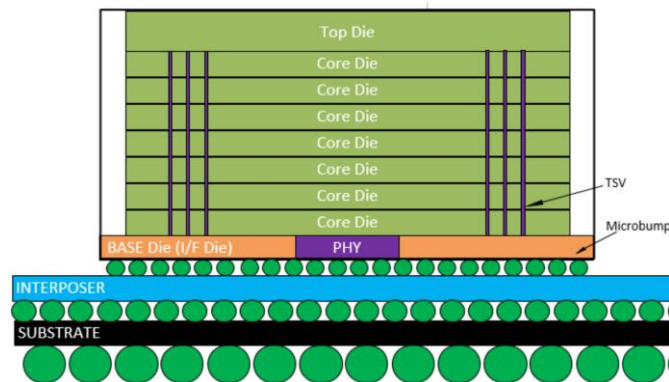
**Mobile Leadership**

**SSD Leadership**

# Ultra-Bandwidth Solutions for AI Training and Inference from Edge to Cloud

## HBM2E: AI Training & Inference for Cloud

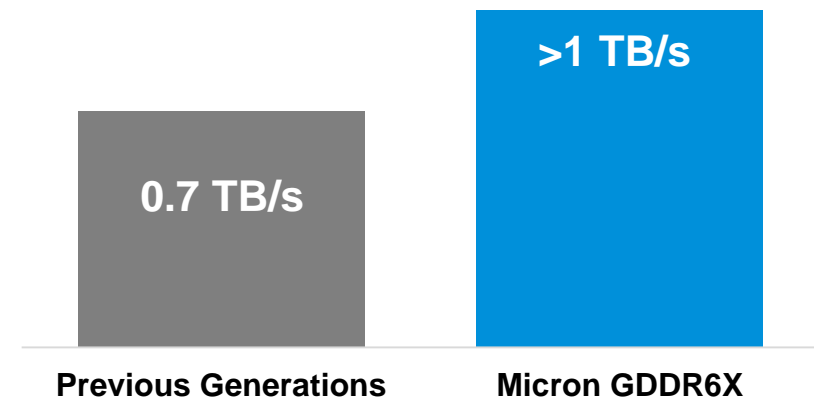
- Enabling system bandwidth >2 TB/s
- Shipping to Customers
- >20 years of experience in stacked TSV memory with thousands of patents



## GDDR6X: AI Inference for Edge

By using PAM4 multi-level signaling, Micron GDDR6X transfers more data at a much faster rate, moving two bits of information at a time, doubling the I/O data rate.

### System Bandwidth





# Mobile Leadership

Qualified with all major chipsets

## Memory

LPDDR5, LPDDR4x

## Storage Solutions

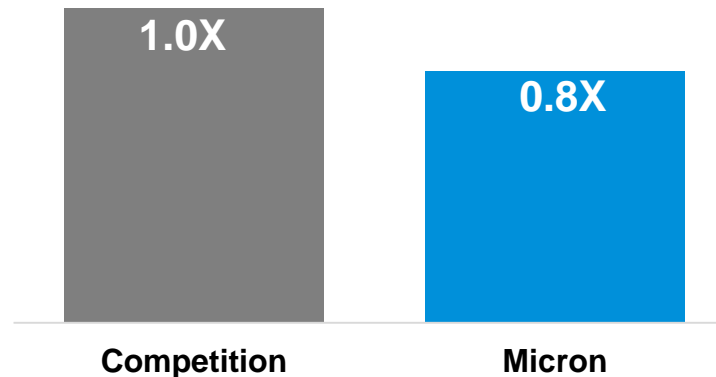
UFS3.1, UFS2.x, eMMC

## Multichip Packages (MCPs)

uMCP5, uMCP4x, eMCP4x

*Leveraging low power DRAM and NAND technology leadership*

## LP5 Power Consumption 8k Video Recording (lower = better)



Competition refers to LP5 products offered by our industry competitors

## Redefining the End-User Experience

- AI & machine learning
- Rapid high-resolution photo/video capture
- Longer battery life
- Shorter app launch times
- Multi-tasking capability



# Broad SSD Portfolio

Spanning cost, performance and end-markets

## Datacenter

NVMe, SATA leader,  
QLC, X100

## Client

NVMe, SATA, QLC

## Auto

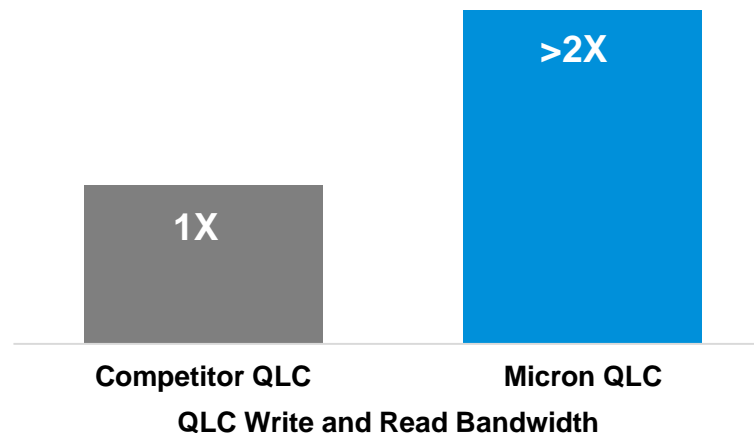
Specialized NVMe BGA SSD

*Leveraging 176 Layer leadership*

*Using a growing mix of internally  
developed controllers*

## QLC Performance Leadership

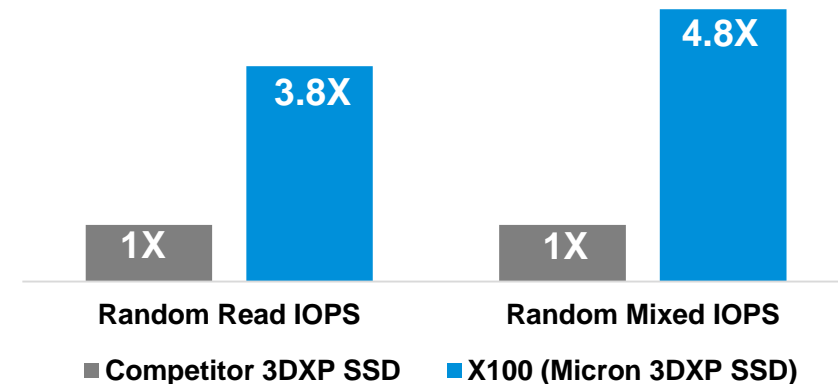
(higher = better)



QLC leadership accelerating  
opportunity for HDD replacement

## Breakthrough Performance with 3DXP

(higher = better)



X100 – world's fastest SSD pushing the  
frontier of possibilities

# Transforming how the world uses information to enrich life *for all*.

Industry's leading technology for DRAM and NAND

Industry's broadest portfolio, driving to deliver product leadership

Partnering with customers to unleash the value of data for all

