

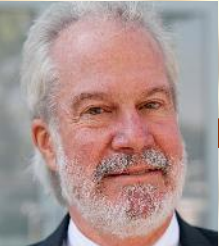


# Where Are We in the Current Flash Cycle?

**Jim Handy**

**OBJECTIVE ANALYSIS**

# OBJECTIVE ANALYSIS

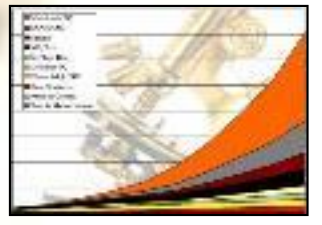
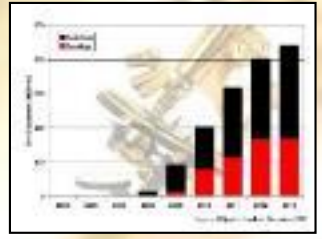


**Profound Analysts**



**Reports & Services**

**Custom Consulting**



# OBJECTIVE ANALYSIS

## Semiconductor Forecast Accuracy

Year	Forecast	Actual
<u>2008</u>	Zero growth at best	-3%
<u>2009</u>	Growth in the mid teens	-9%
<u>2010</u>	Should approach 30%	32%
<u>2011</u>	Muted revenue growth: 5%	0%
<u>2012</u>	Revenues drop as much as -5%	-2.7%
<u>2013</u>	Revenues increase nearly 10%	4.9%
<u>2014</u>	Revenues up 20%+	9.9%
<u>2015</u>	Revenues up ~10%	-0.2%
<u>2016</u>	Revenues up ~10%	1.1%
<u>2017</u>	Revenues up ~20%	22%
<u>2018</u>	Strong start supports 10+% growth	14%
<u>2019</u>	Semiconductors down -5%	TBD

# Agenda

- Status of Current Cycle
- Emerging Memories
- 3D XPoint/Optane
- China & Trade Wars
- Summary

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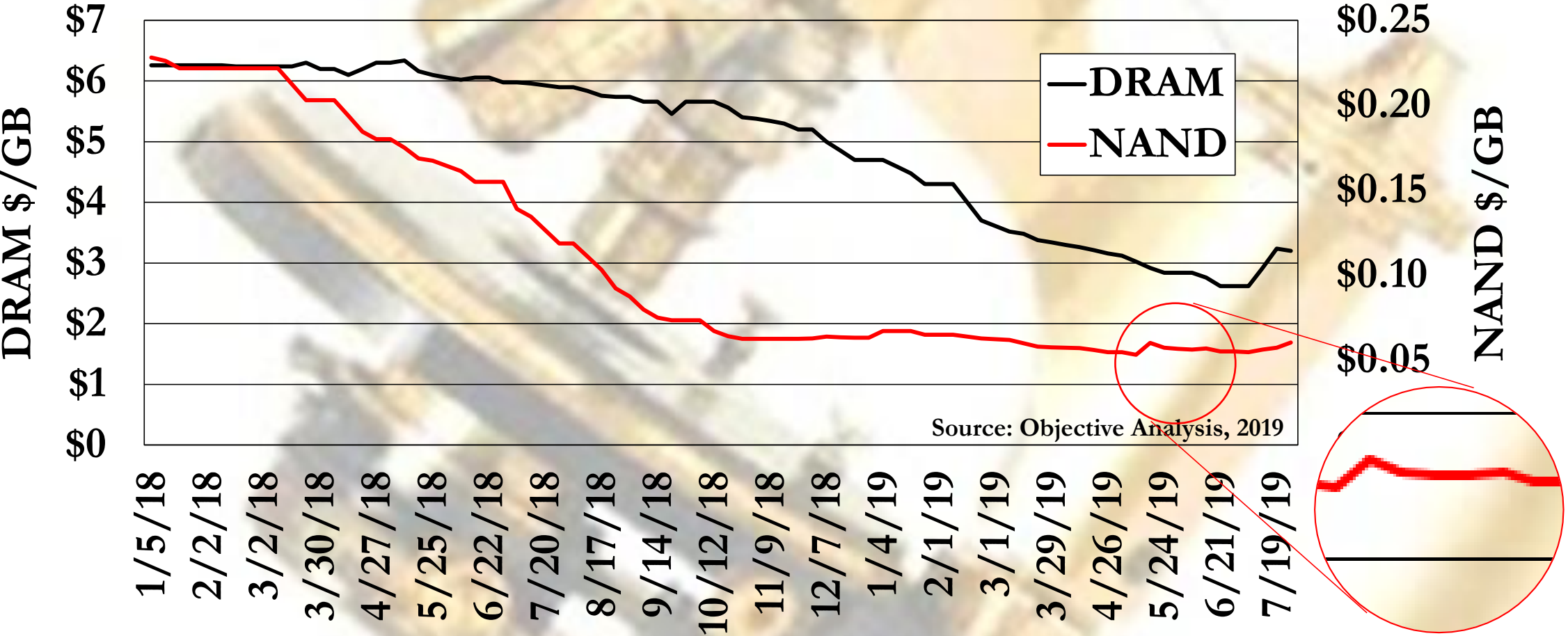


# Where Are We in the Current Flash Cycle?

# How Collapse Will Evolve

- NAND oversupply
  - Prices plunge to 3D-64 cost: <\$0.08/GB
  - Planar capacity no longer viable
    - Closed or converted to DRAM
- Subsequent DRAM oversupply
  - Some facilities no longer viable
    - Closed or converted to SRAM/NOR/Foundry
- Subsequent other oversupplies

# NAND & DRAM Spot Prices

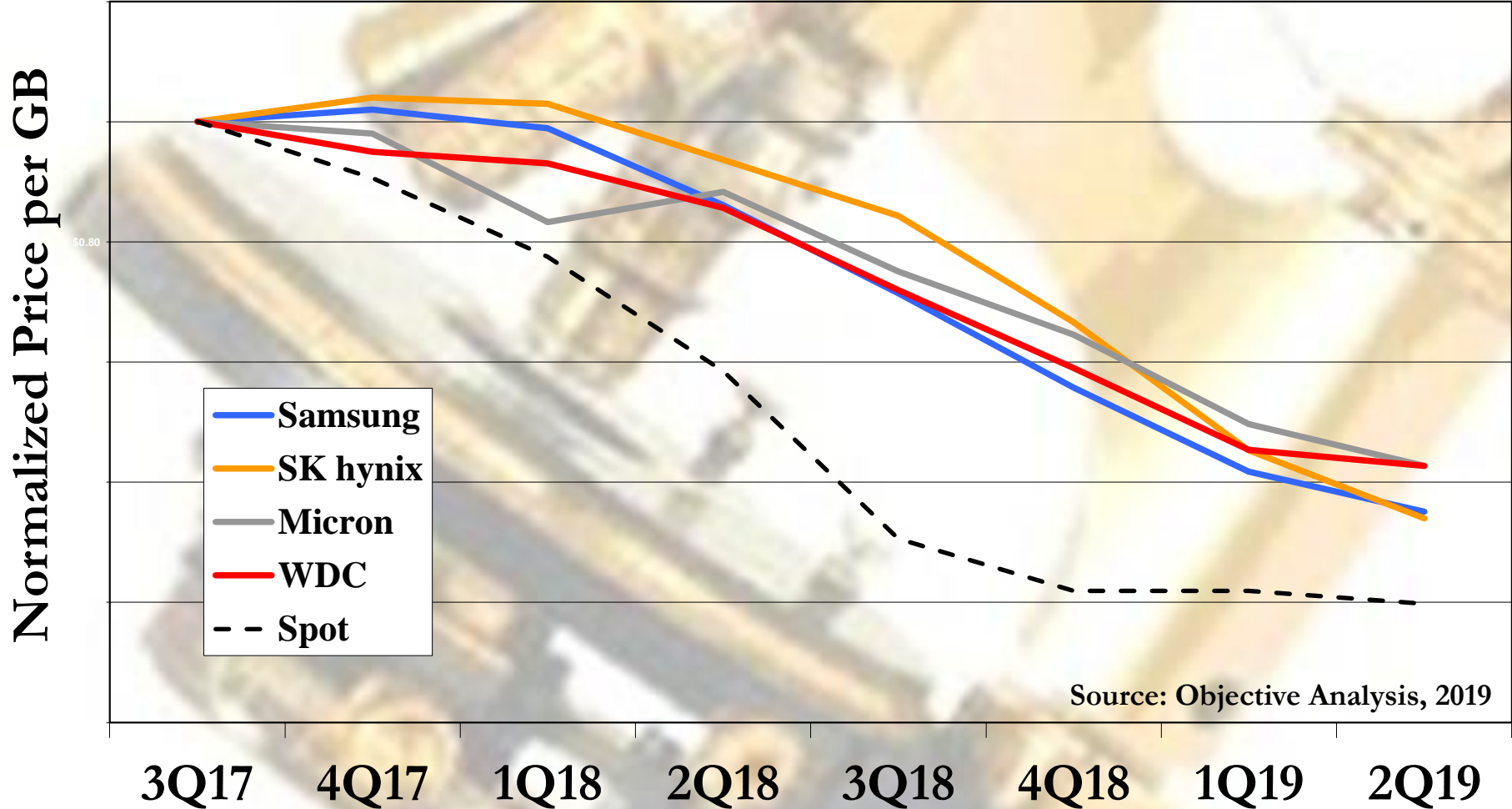




# Learning from Toshiba

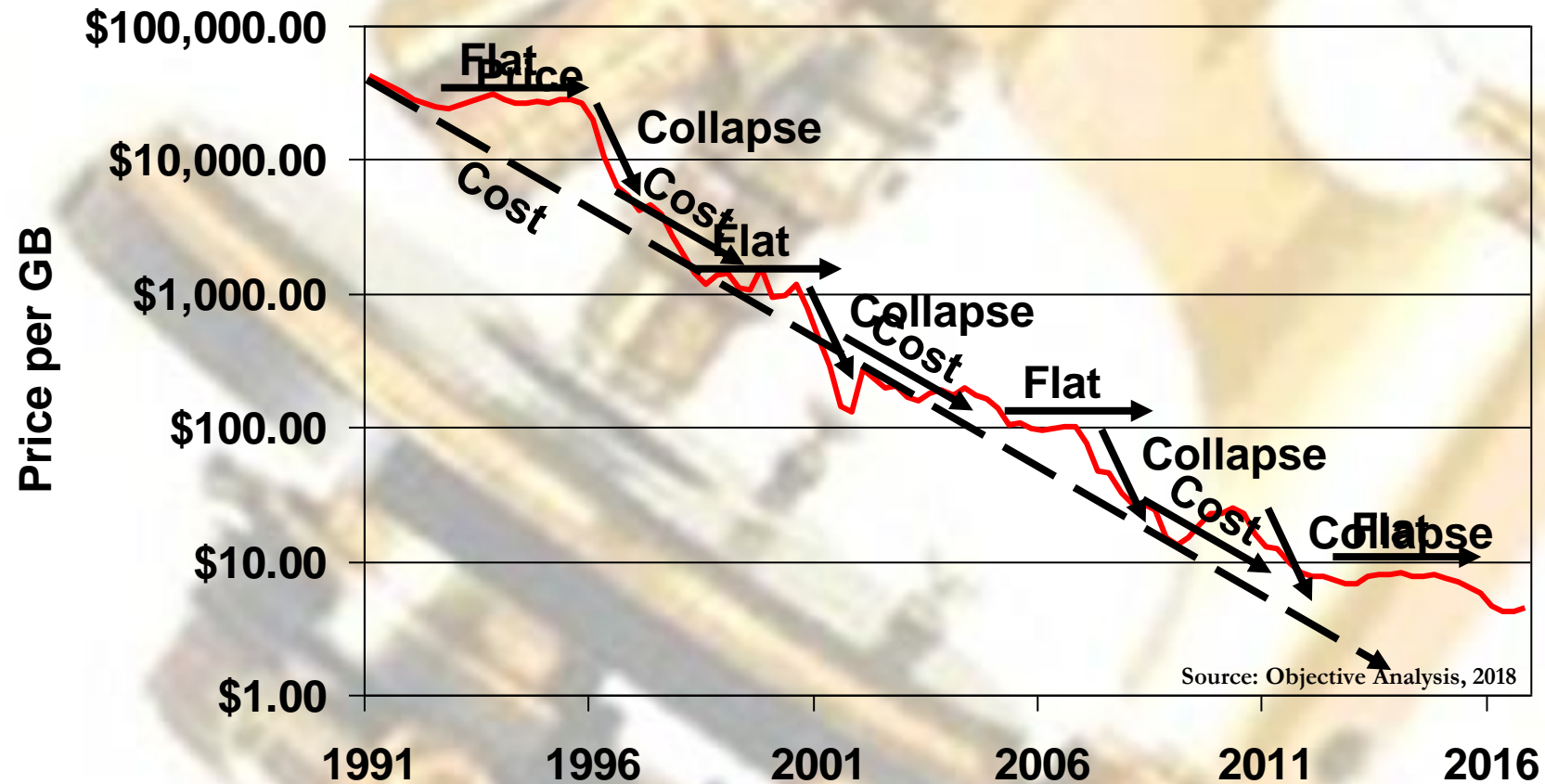
- June 15: 13-minute power outage
- Slight spot price impact
- Supplier inventories huge
  - 9-13 weeks
  - Up from 4-6 weeks
- Material loss <10%

# NAND Flash Prices Near Bottom

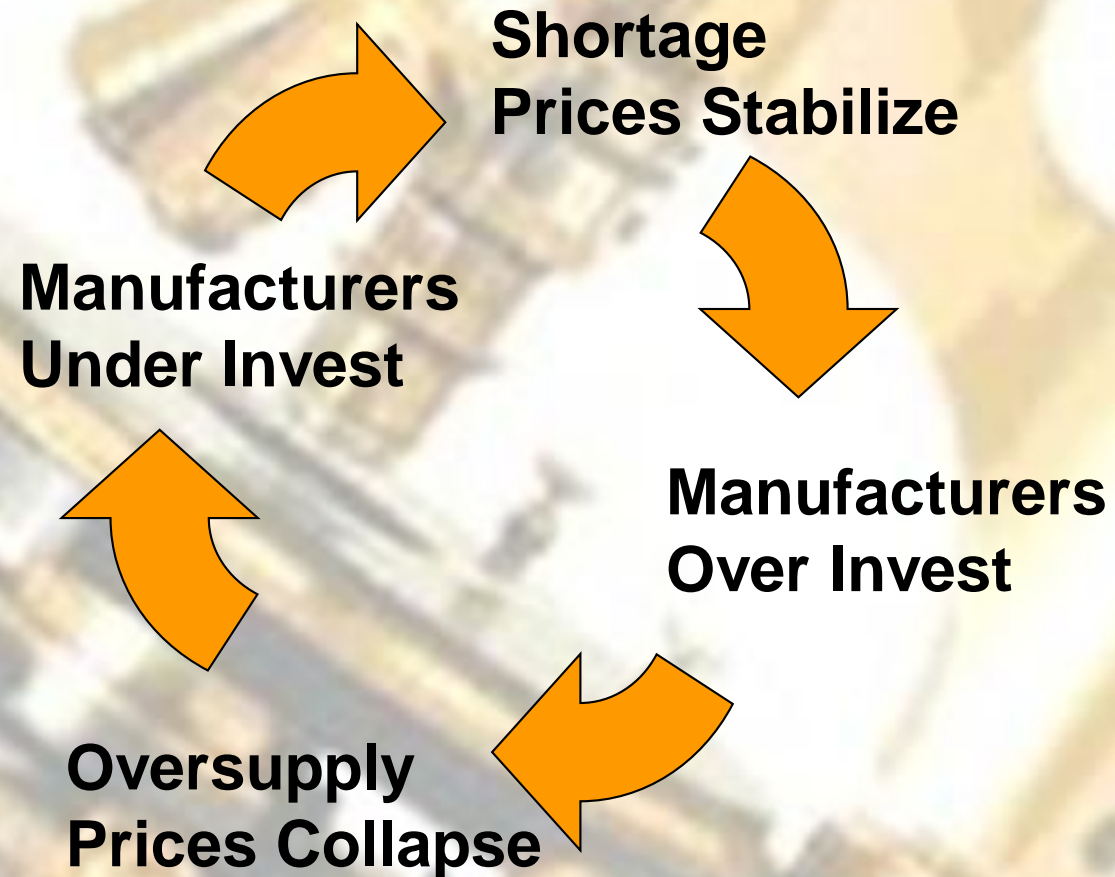


Source: Objective Analysis, 2019

# Memory's Price Dynamic

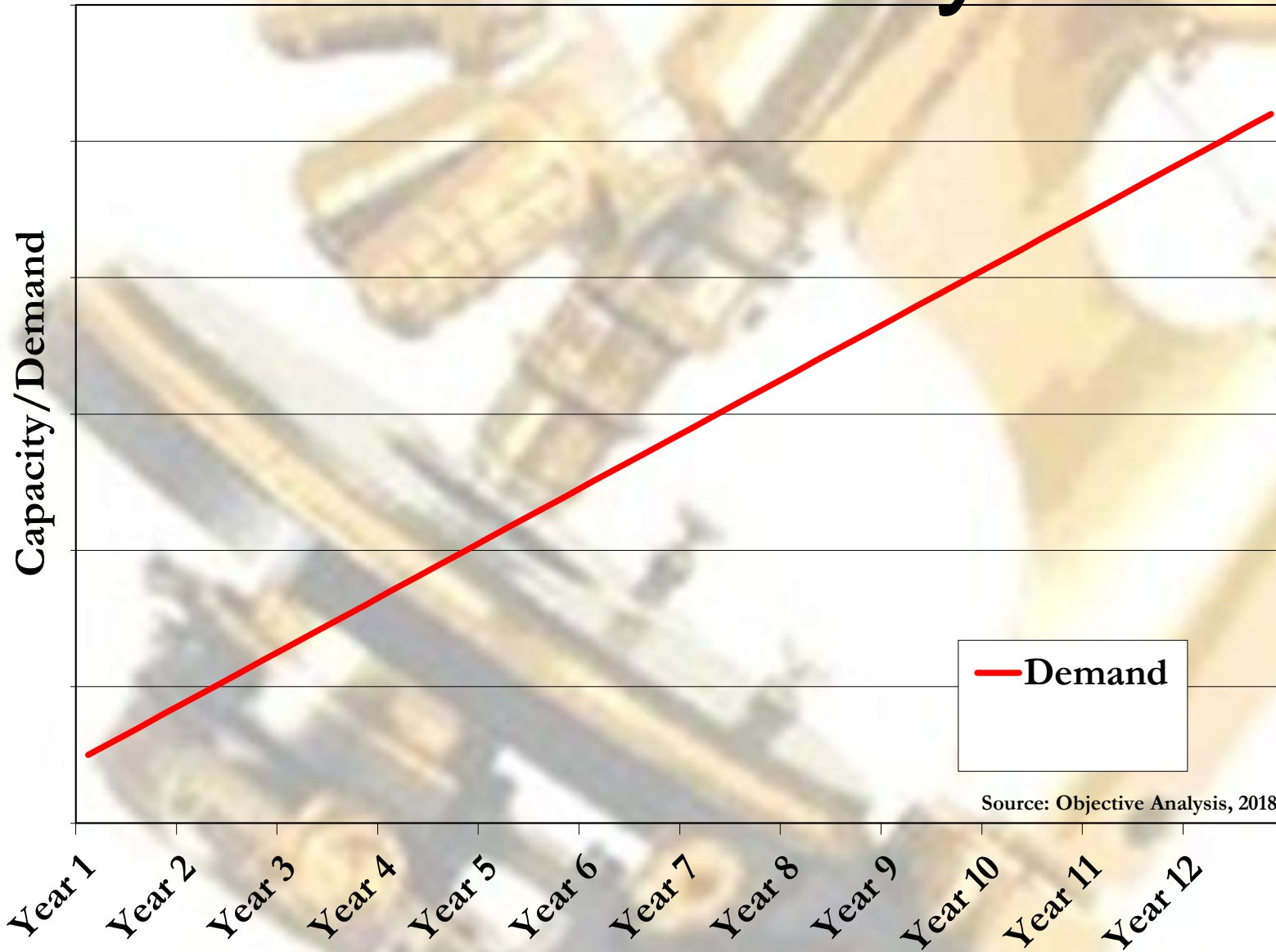


# Commodity Price Cycle



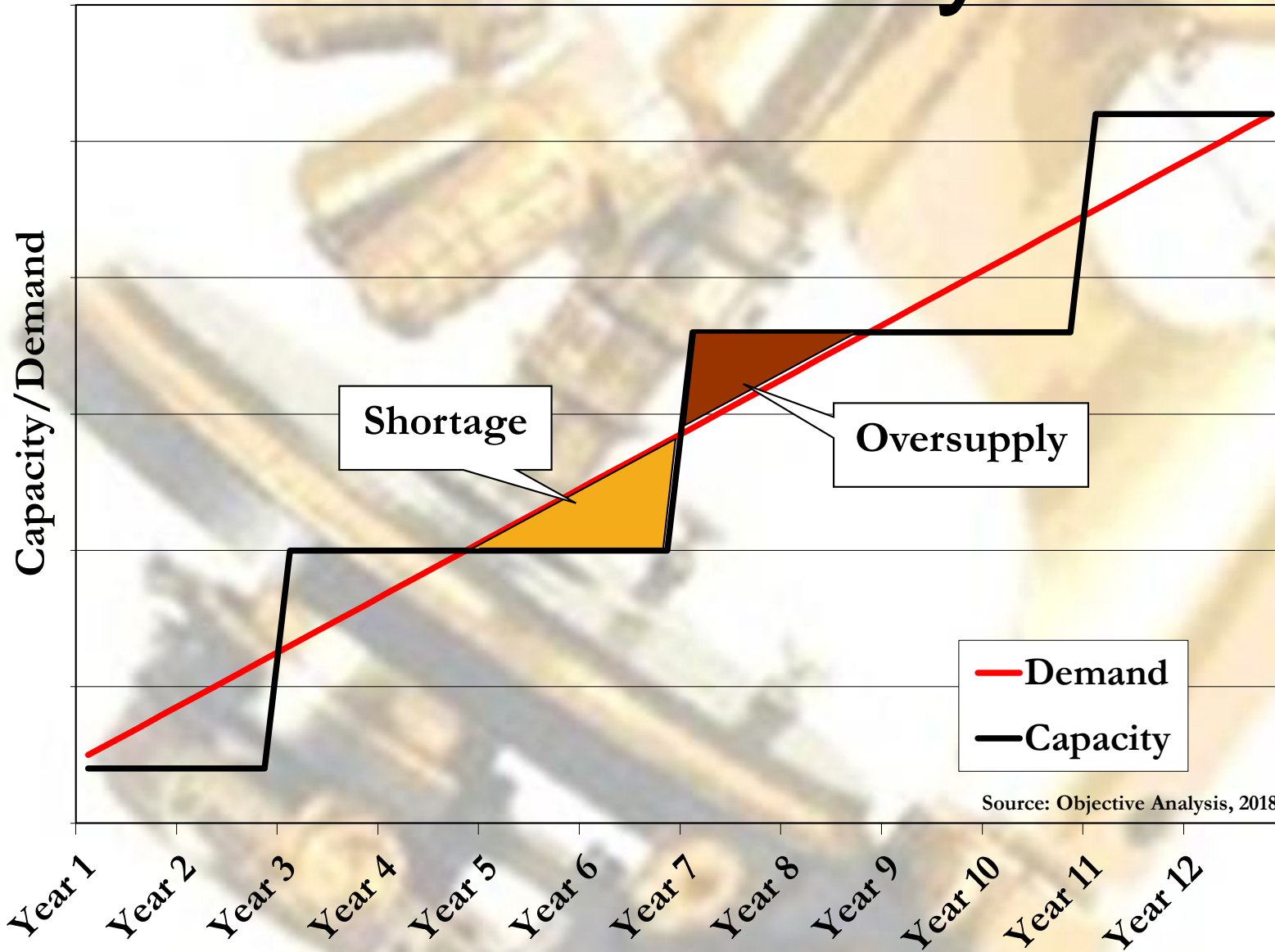
Source: Objective Analysis, 2019

# Boom-Bust Cycle

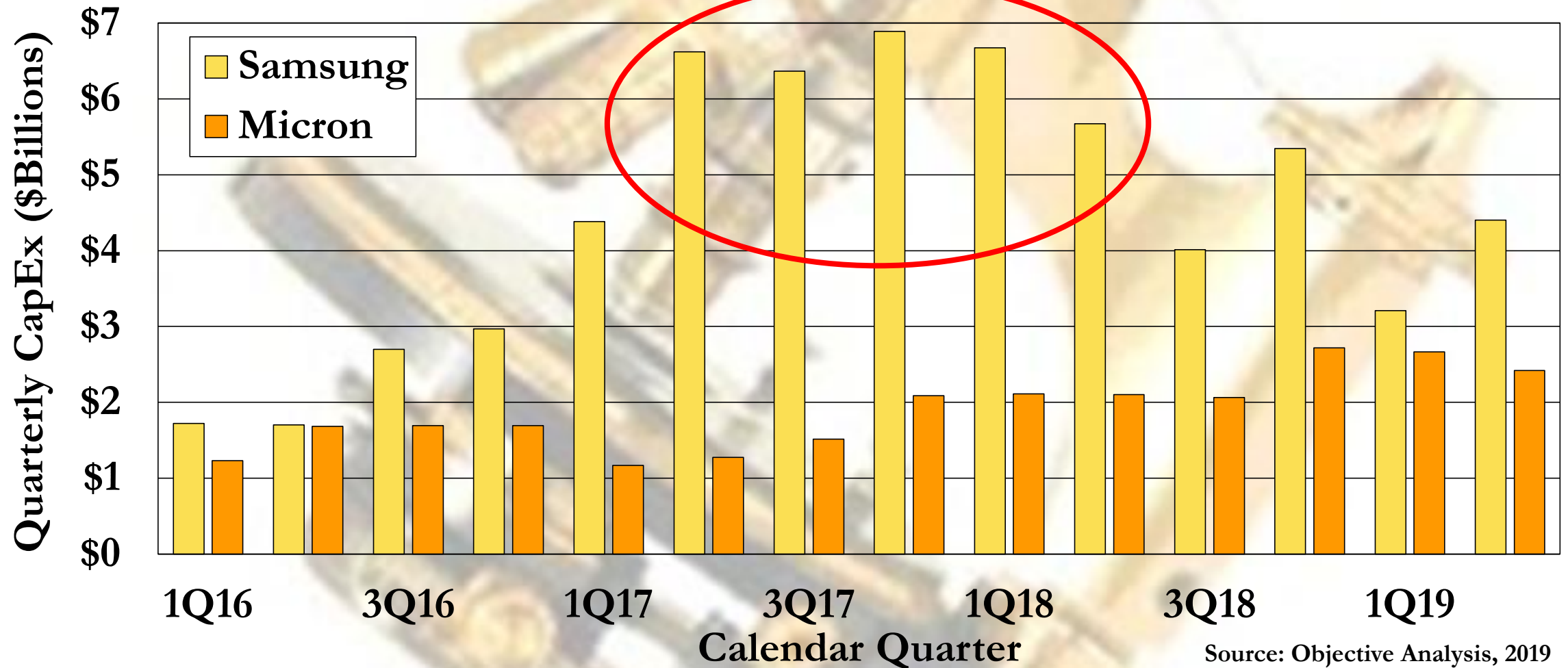


Source: Objective Analysis, 2018

# Boom-Bust Cycle



# 2017 CapEx Drives 2019 Downturn



# Outlook

- Prices are approaching cost
  - Prices will follow cost until next shortage
- 2019 CapEx cuts imply 2021 shortage
  - Oversupply unlikely to end before then
- China's participation may extend down cycle
  - More on this shortly



# Agenda

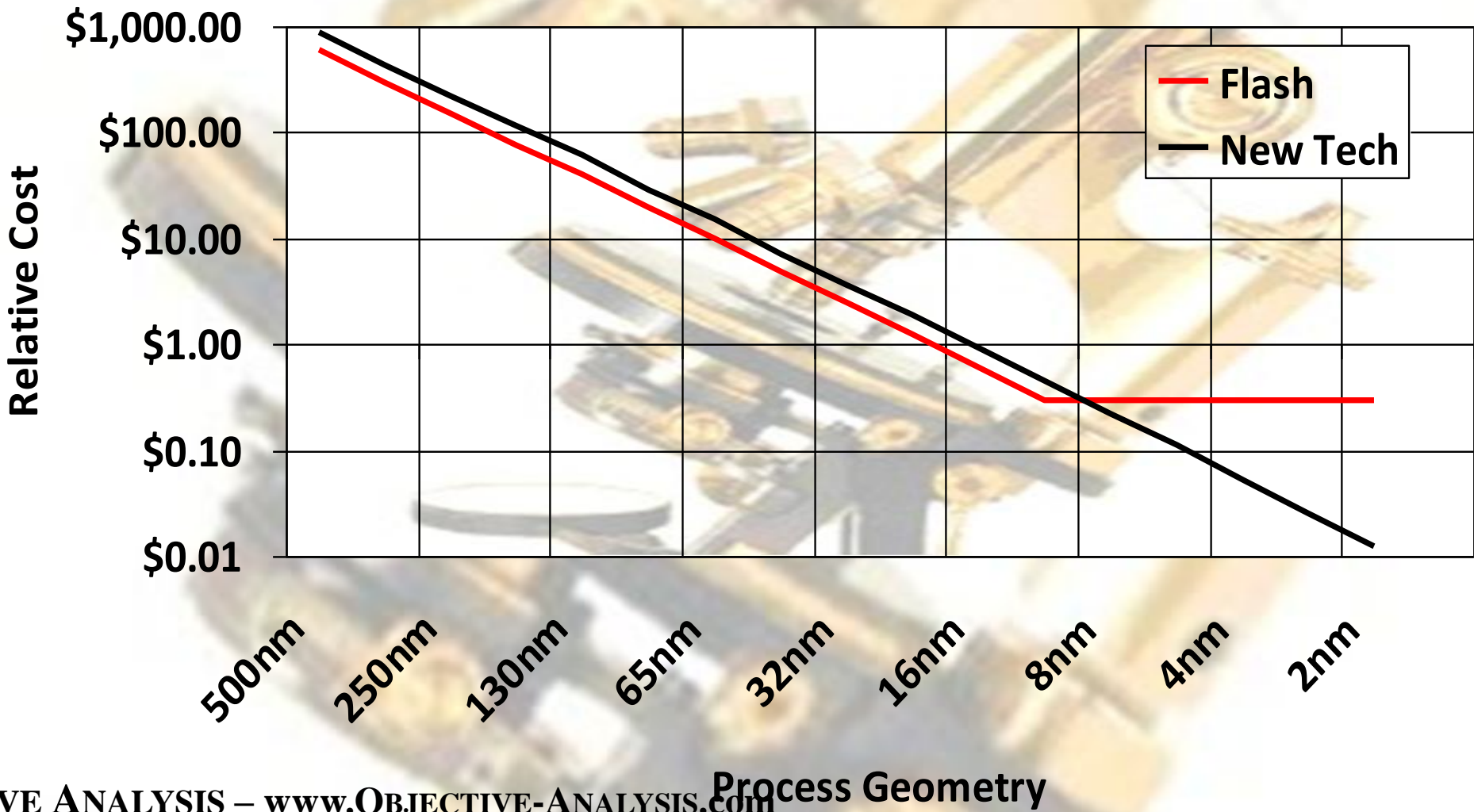
- Status of Current Cycle
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# Emerging Memory Technologies

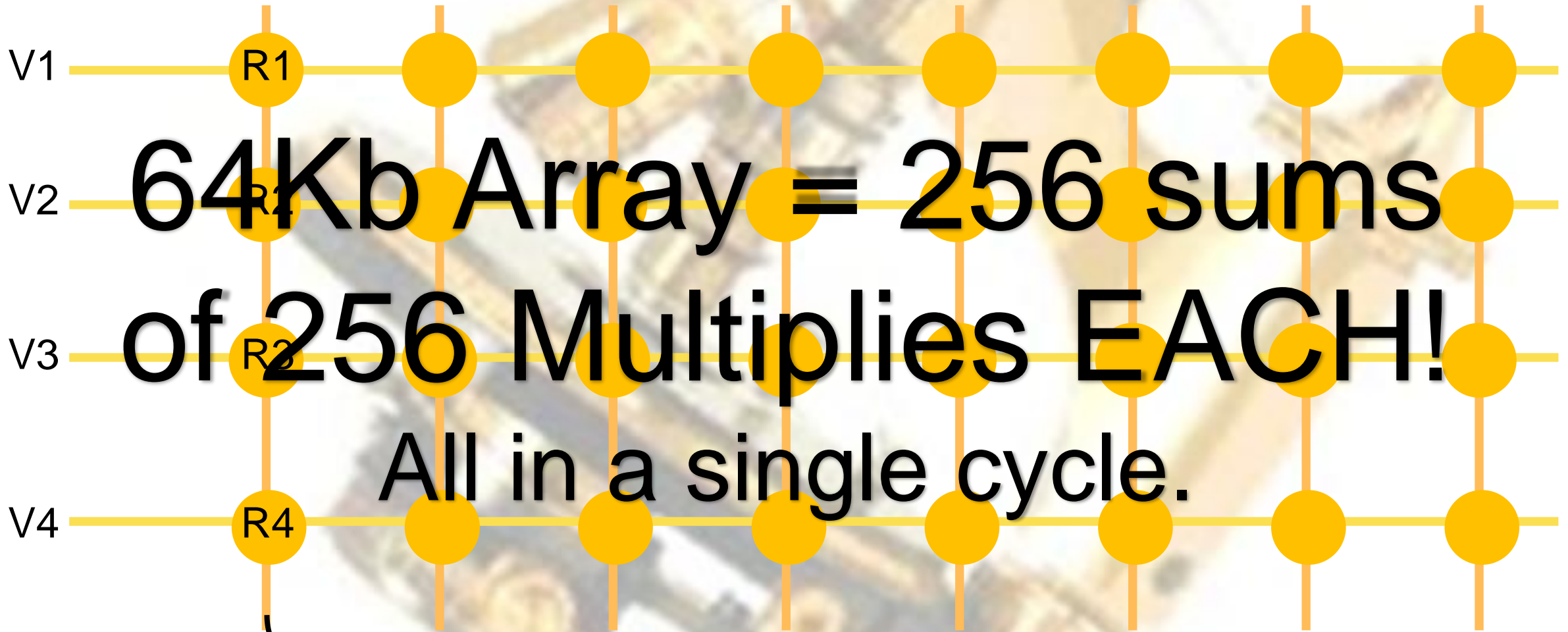
- MRAM: Magnetic RAM
- ReRAM: Resistive RAM
- PCM: Phase-Change Memory (i.e. 3D XPoint)
- FRAM: Ferroelectric RAM
- Etc.

All are nonvolatile memories: “NVM”

# Scaling Limits Help New Memories



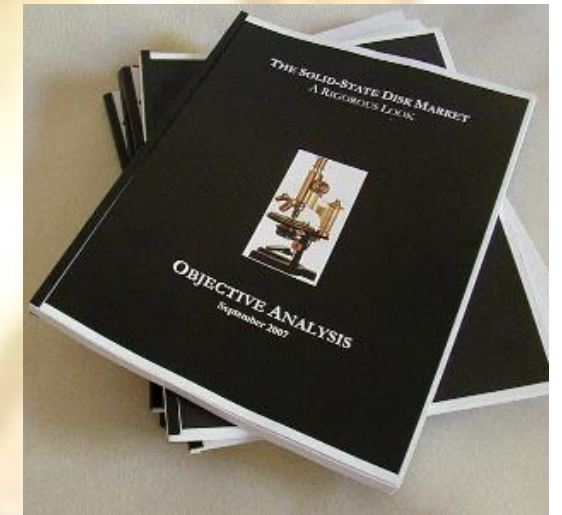
# Neural Networks for AI



$$=V1*(1/R1)+V2*(1/R2)+V3*(1/R3)+V4*(1/R4)$$

# Emerging Memories Report

- Emerging Memories Begin to Ramp
  - In-depth coverage emerging memory market
  - 171 pages, 125 figures, 30 tables
  - Can be purchased on-line for immediate download



<https://Objective-Analysis.com/reports/#Emerging>

# Agenda

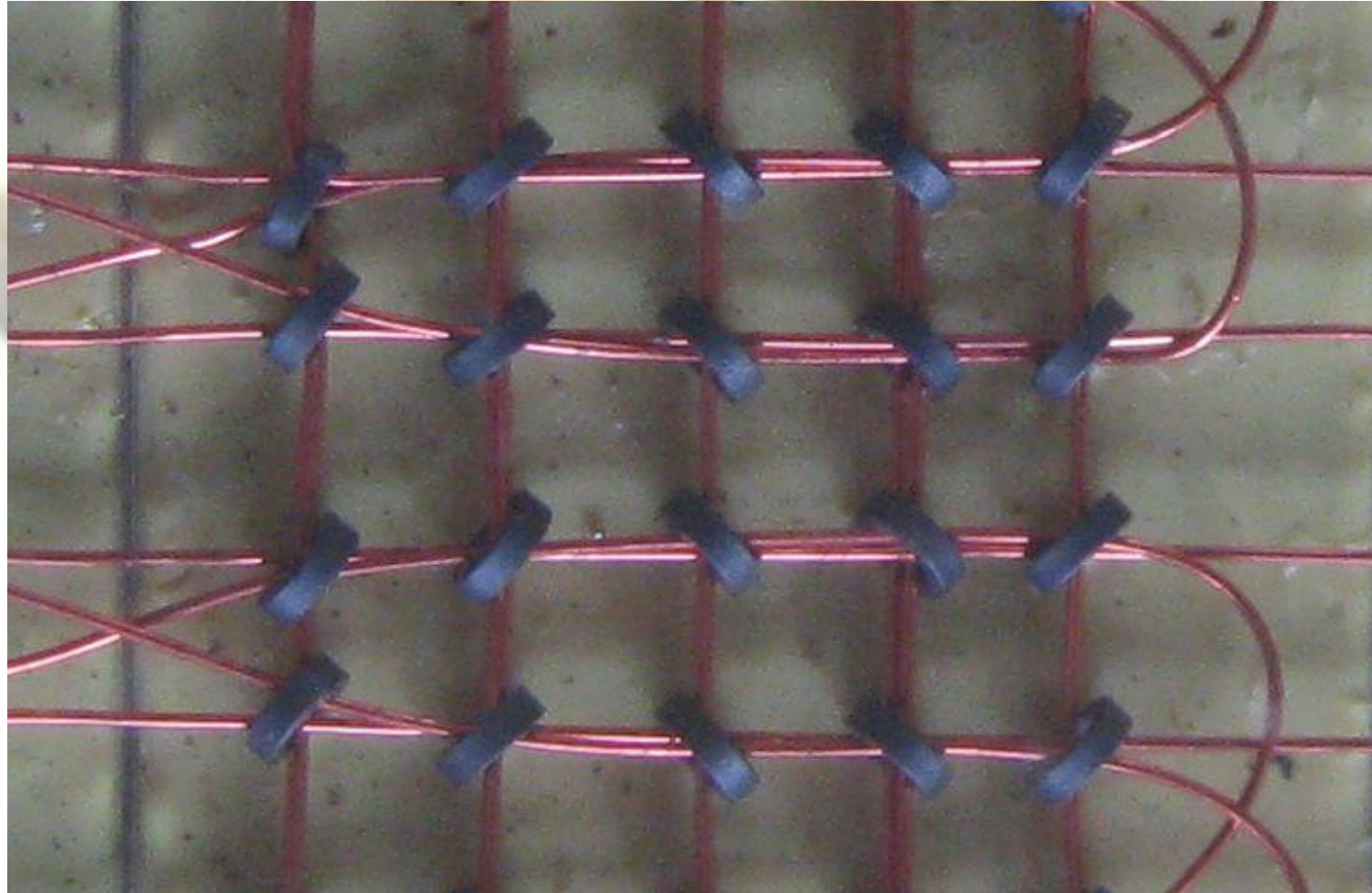
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# What is a Storage Class Memory?

Storage-class memory (SCM) combines the benefits of a solid-state memory, such as high performance and robustness, with the archival capabilities and ~~low cost~~ of conventional hard-disk magnetic storage.

IBM Almaden Research Labs

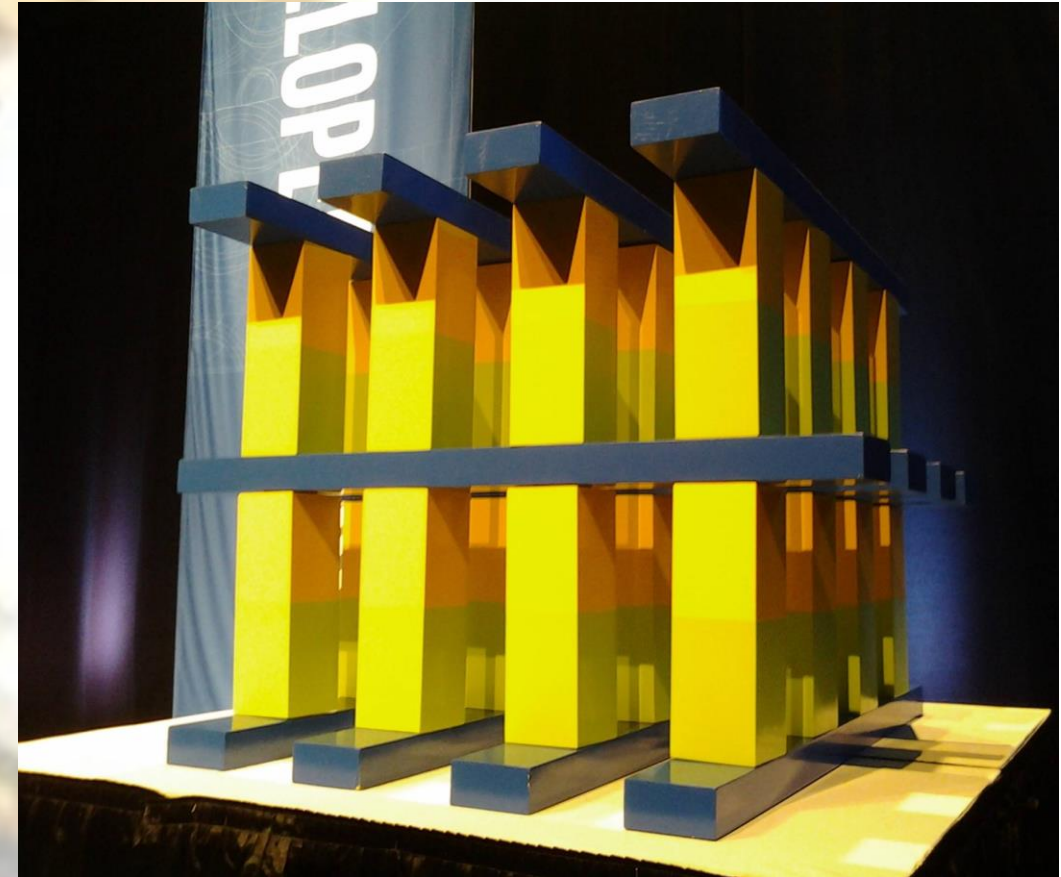
# SCM 1960



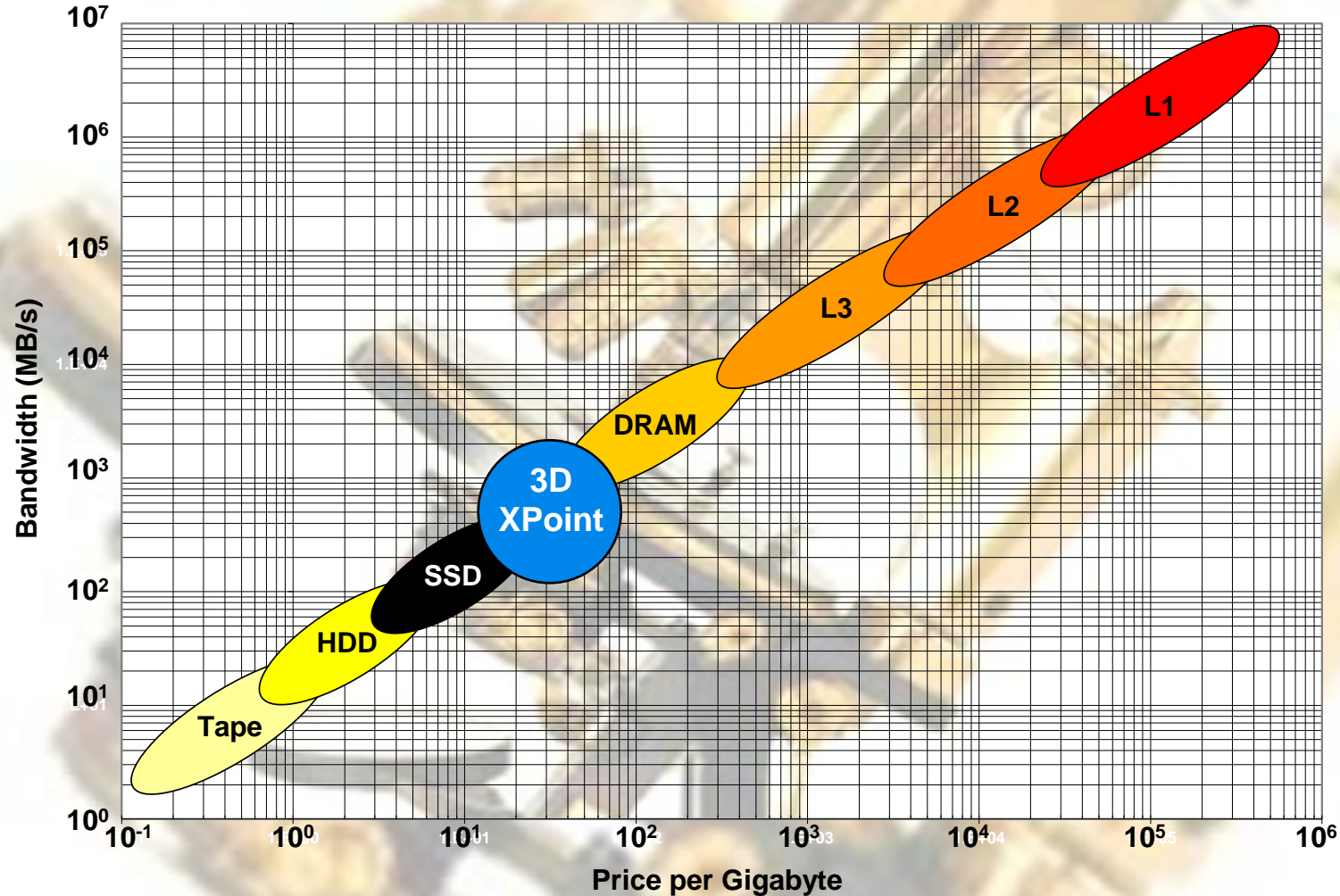


# 3D XPoint/Optane

- Sole-sourced part with commodity pricing
- Whole new way to store data
- High-impact architectural change

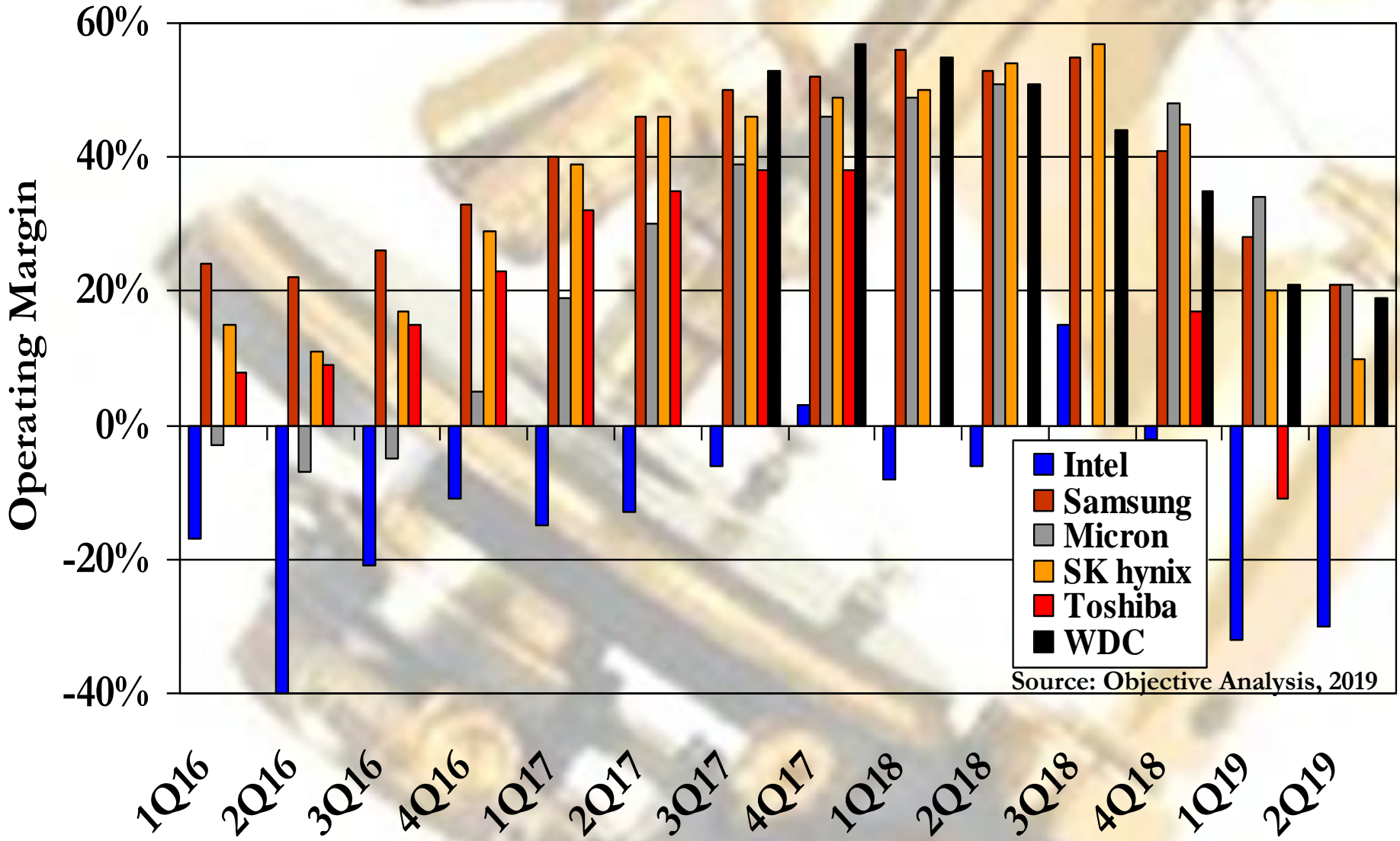


# 3D XPoint Reduces DRAM Needs

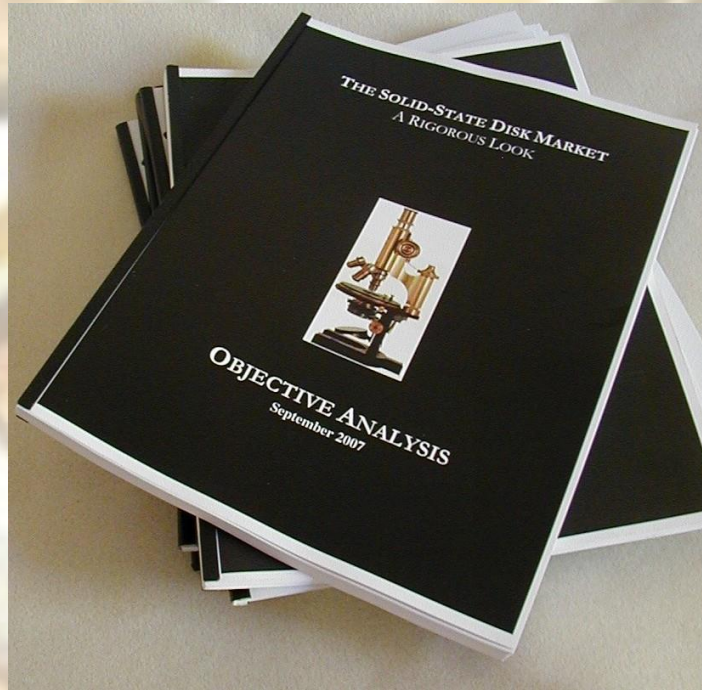


Source: *A Close Look at the Intel/Micron 3D XPoint Memory*, Objective Analysis 2015

# Intel's Ongoing XPoint Losses



Source: Objective Analysis, 2019



# There's a Report on That!

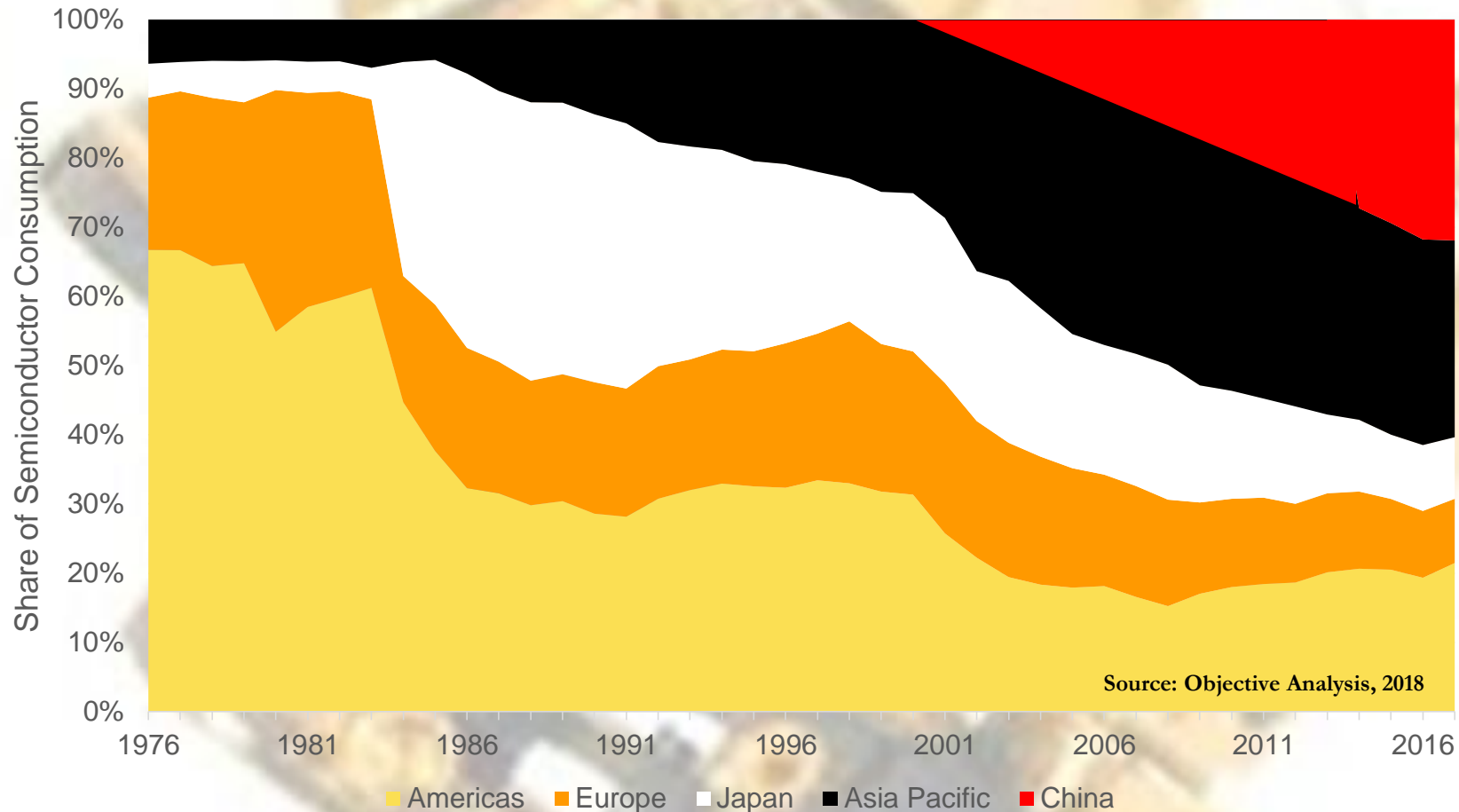
***Intel/Micron 3D XPoint/Optane Update***

**<https://Objective-Analysis.com/reports/#XPoint>**

# Agenda

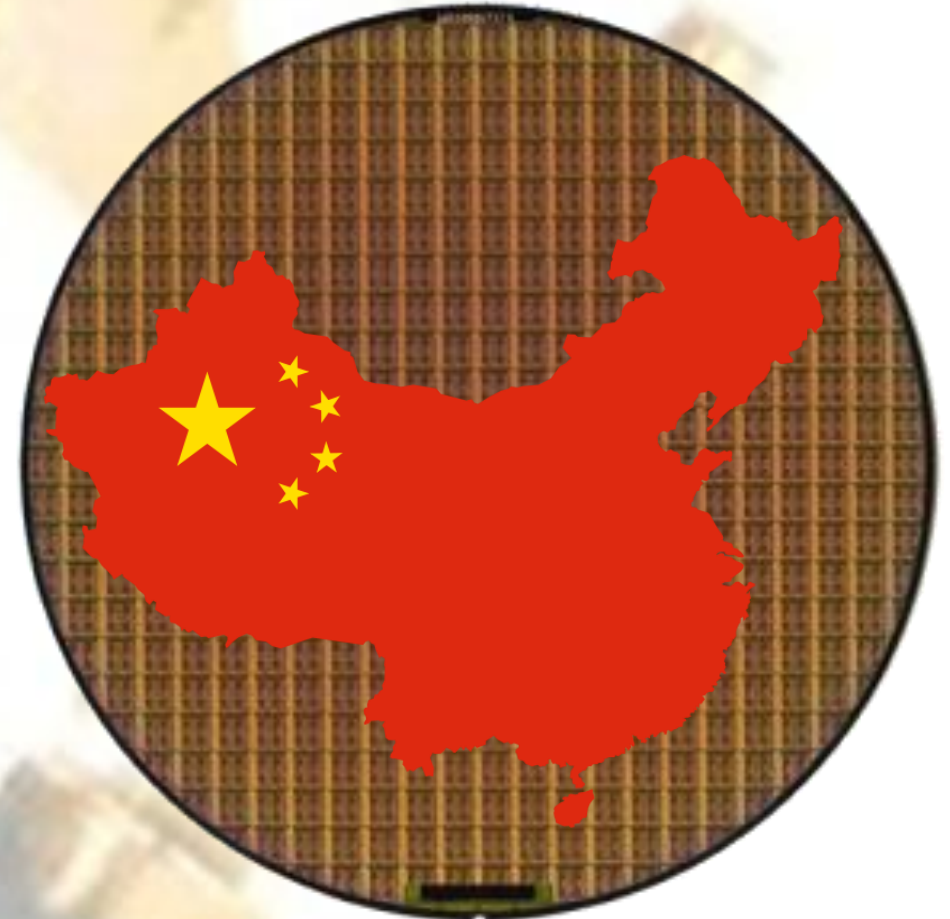
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# \$100 Billion+ of Chip Imports/Year!



# “Made In China 2025” Initiative

- Strategy: Achieve self-reliance
- Become a leading manufacturer in
  - Semiconductors
    - 2015: <20% of consumption
    - 2020: 40%
    - 2025: 70%
  - Autonomous vehicles
  - Artificial intelligence
  - Robotics



# China Has Abundant Cash



SOURCE: TRADINGECONOMICS.COM | PEOPLES BANK OF CHINA



# “Big Fund” Coordinates Financing

- Over \$20 billion in first phase
  - Subsequent investments could reach \$100B
  - A leading-edge fab is only ~\$10B
- Big difference from western approach
  - Centrally controlled vs. competing interests
  - Pooled fund vs. independent efforts

# Two-Element Market Entry

## 1. Invest heavily

- Wafer fab cost \$8-10 billion
- Hire talent at inflated salaries

## 2. Go after a commodity

- OEMs buy from the cheapest vendor
- Penetration is immediate
- NAND & DRAM fill the bill

*All it takes is money!*

# What About IP?

- Home-grown route is slow
- Partnering is faster
  - Path taken by Japan in the late '70s, Korea in the late '80s, and Taiwan in the middle '90s
  - Offer very cheap wafers in return for know-how
- Solutions rarely remain confidential
- Patents seldom used to block competition

# China Fabs Moving Ahead

YMTC



JHICC



CXMT

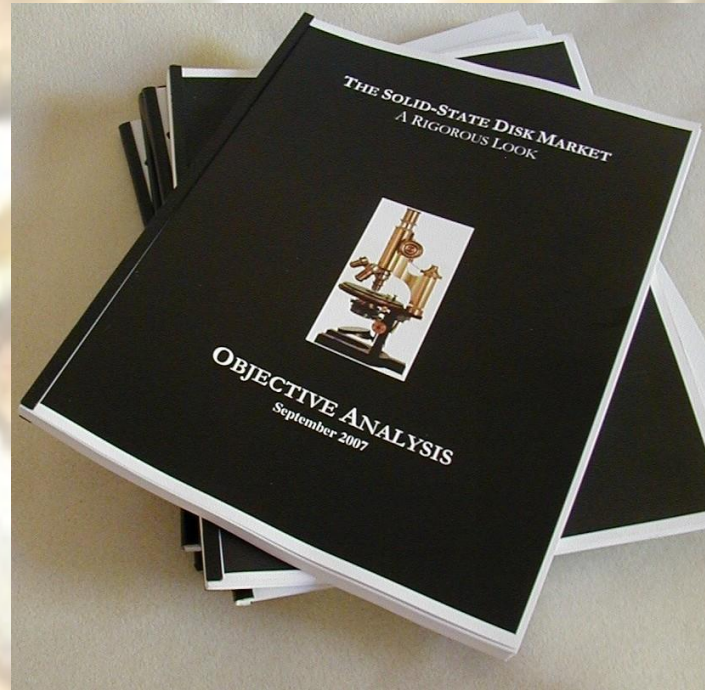


# Current Status

- Tooling incomplete
- YMTC sampling
- Others behind
  
- Trade war!

# Trade War!

- Proving to be a 2-edged sword
  - US companies suffering consequences
  - SIA working to get this straightened out
- World economy makes trade wars difficult
  - All semi & tool makers are multinationals
- It's worrisome



# There's a Report on That!

*China's Memory Ambitions*

<https://Objective-Analysis.com/reports/#China>

# Agenda

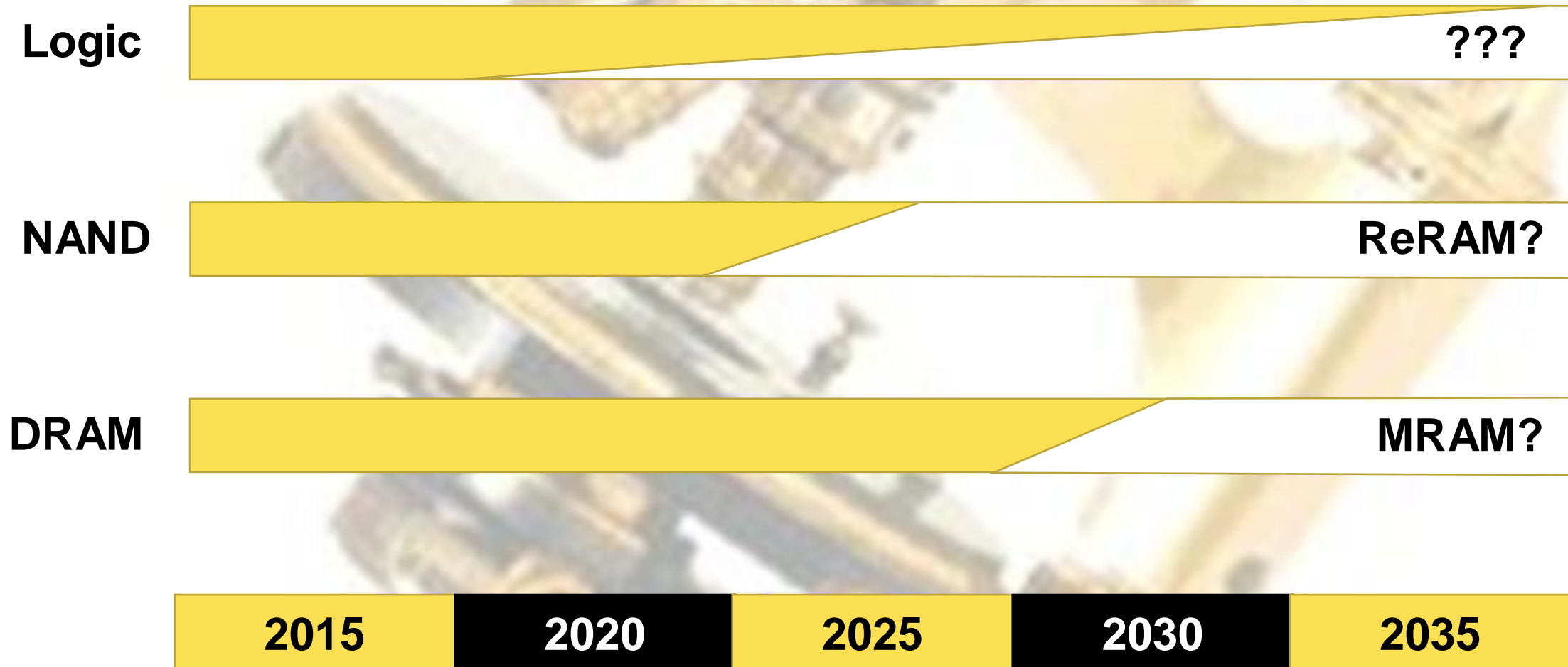
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# Year-By-Year Outlook

Year	Outlook
2018	Mid-year NAND flash oversupply/collapse
2019	DRAM, then overall semiconductor collapse
2020	Second “Down” year
2021	China’s participation extends oversupply
2022	Demand catches up with supply. New shortage creates profits

# Moving to New Memories





# QUESTIONS?