

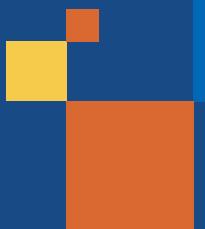
Solid State Drives

By: Emanuel Onofre and Matthew Mendoza

CSC137 - Technical Presentation

Crash Course: Solid State Drives

By: Emanuel Onofre and Matthew Mendoza



intel®

We are in a data-centric world

All data must be
stored, processed, and analyzed



Data growth is happening all over



1. Source: <http://www.cisco.com/c/en/us/solutions/service-provider/vni-network-traffic-forecast/infographic.html>

2. Source: https://www.cisco.com/c/dam/m/en_us/service-provider/ciscoknowledgenetwork/files/547_11_10-15-DocumentsCisco_GCI_Deck_2014-2019_for_CKN_10NOV2015_.pdf

Learning Objectives



- Kinds of memory devices
 - Primary vs Secondary
- Introduction to SSDs
 - HDD vs SSD
 - SATA vs NVME
- Anatomy of an SSD
 - Components of an SSD
 - NAND
 - 3D NAND vs 3D XPoint – Intel
- Software Components

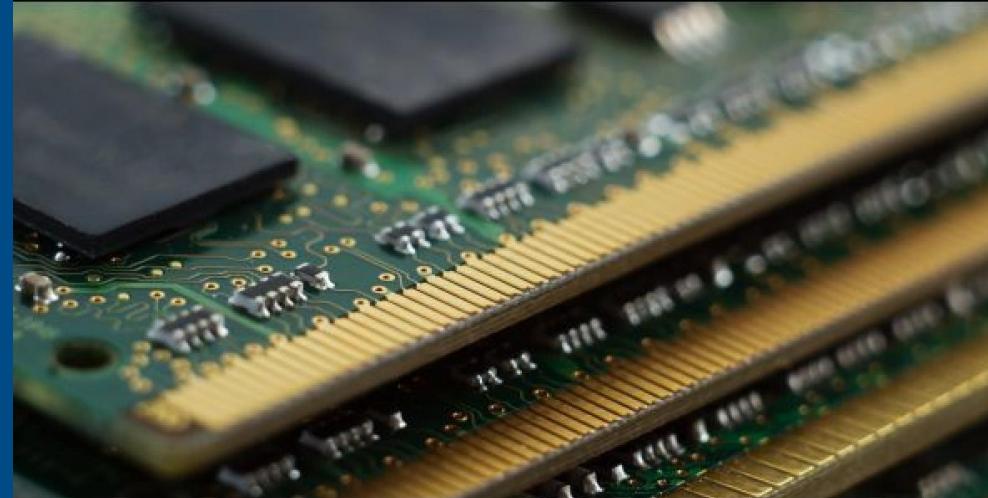
All Kinds of Memory Devices



Types of Memory

Memory comes in two flavors

The Difference	
Primary Memory <ul style="list-style-type: none">• Volatile• Smaller storage capacity, but provides faster access to data and files	Secondary Memory <ul style="list-style-type: none">• Non-Volatile• Slower, but holds a large amount of media, software, and files



Primary Memory - RAM



Secondary Memory - HDD



Introduction to SSDs

As Secondary Memory



Introduction to SSDs

HDD vs SSD



Hard Disk Drives

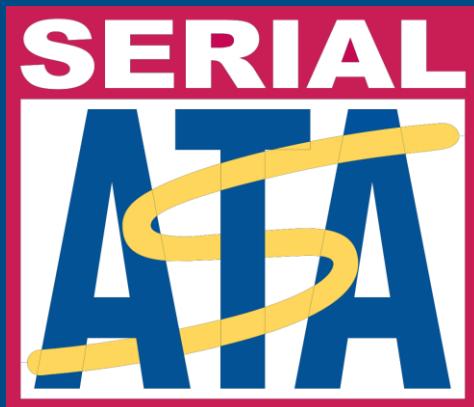
- Non-volatile Memory
 - Magnetic-Based Storage
- Moving parts
- Lower cost per gigabyte



Solid Disk Drives

- Non-volatile Memory
 - NAND Flash Storage
 - 3D XPoint (Intel and Micron)
- No moving parts
- Better Performance
- Higher cost per gigabyte

SATA vs NVME



SATA (Serial AT Attachment)

- Interface to connect and communicate with the computer
- Max out at 600 MB/s

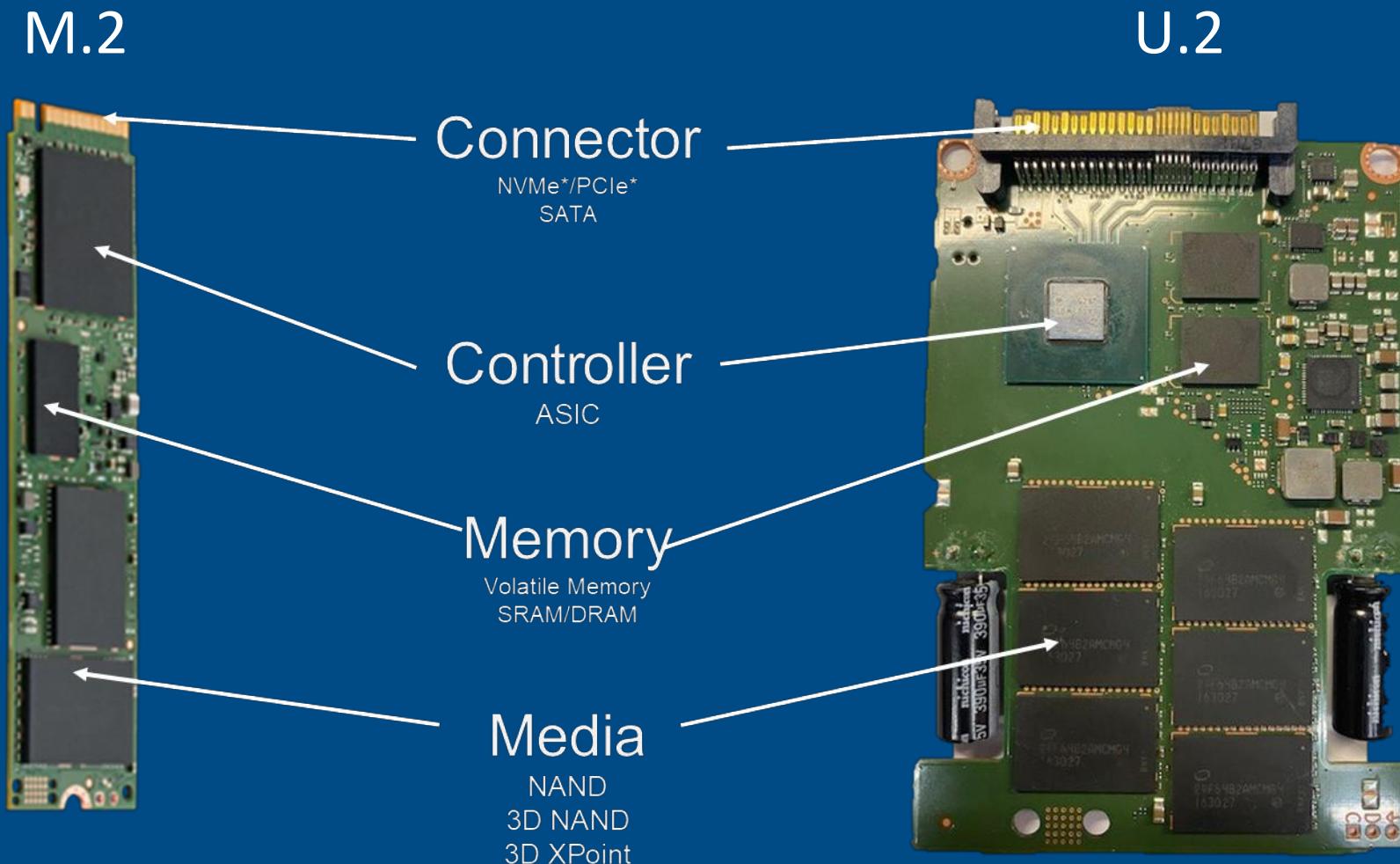
NVMe (Non-Volatile Memory Express)

- Protocol to communicate with the computer
- Can reach 1 GB/s per lane

Anatomy of an SSD

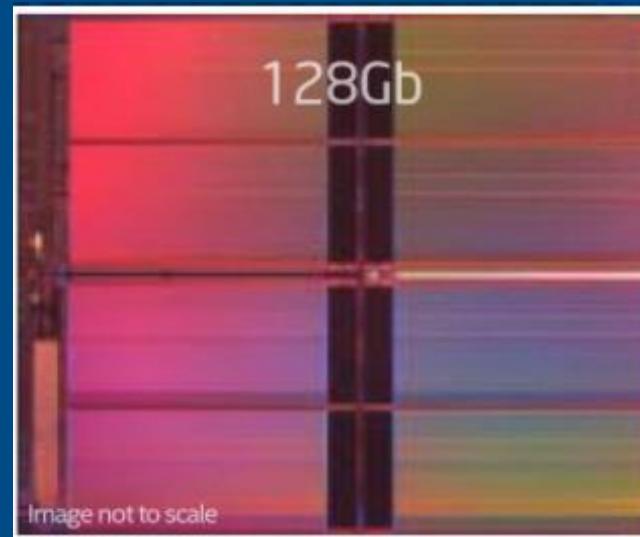


Components of an SSD



NAND

NAND Flash Memory



65nm

50nm

45nm

34nm

25nm

20nm

16nm

Intel® 3D
NAND
32L/TLC
→
64L/TLC

Intel® 3D
NAND
64 L/QLC
96L/TLC

Intel® 3D
NAND
144L/TLC
QLC

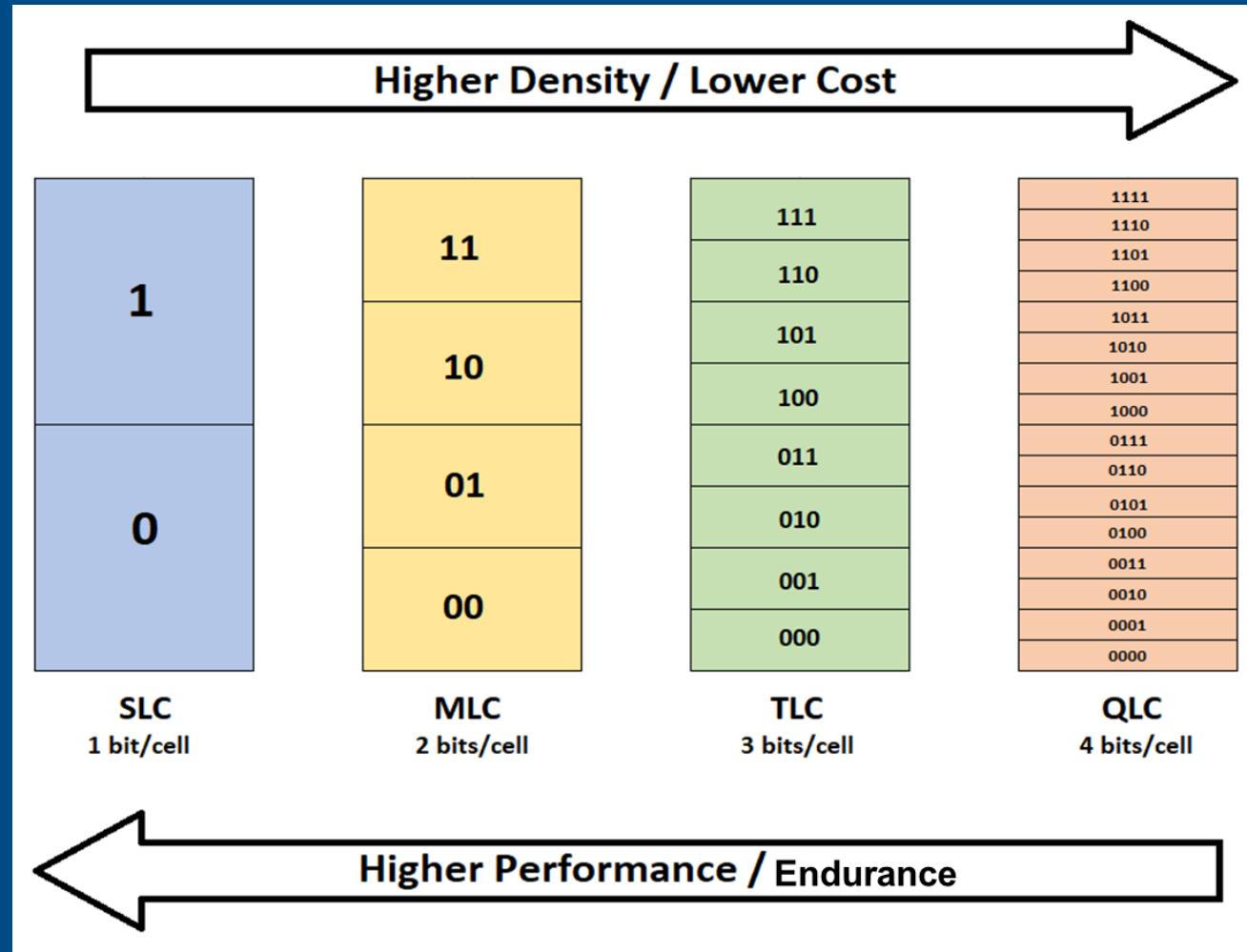
2005-2009

2010-2015

2016-2017 2018-2019

2020

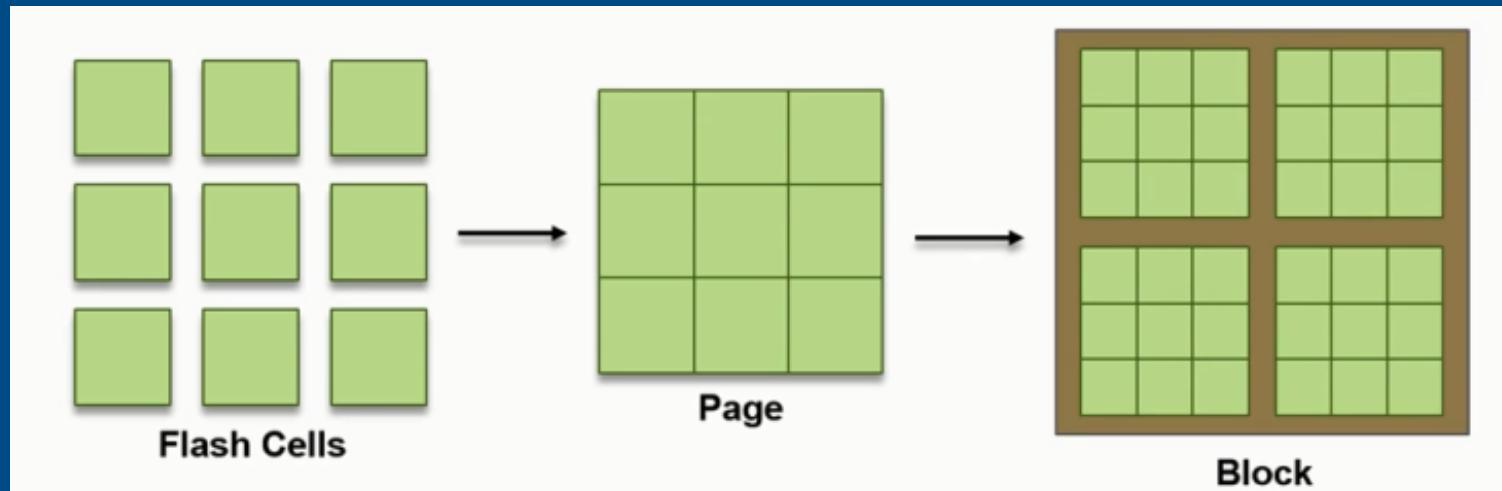
Cell Layers



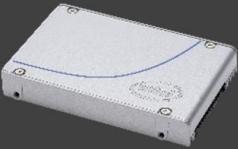
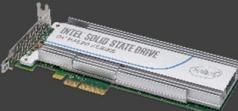
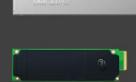
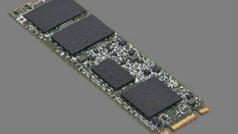
NAND Structure

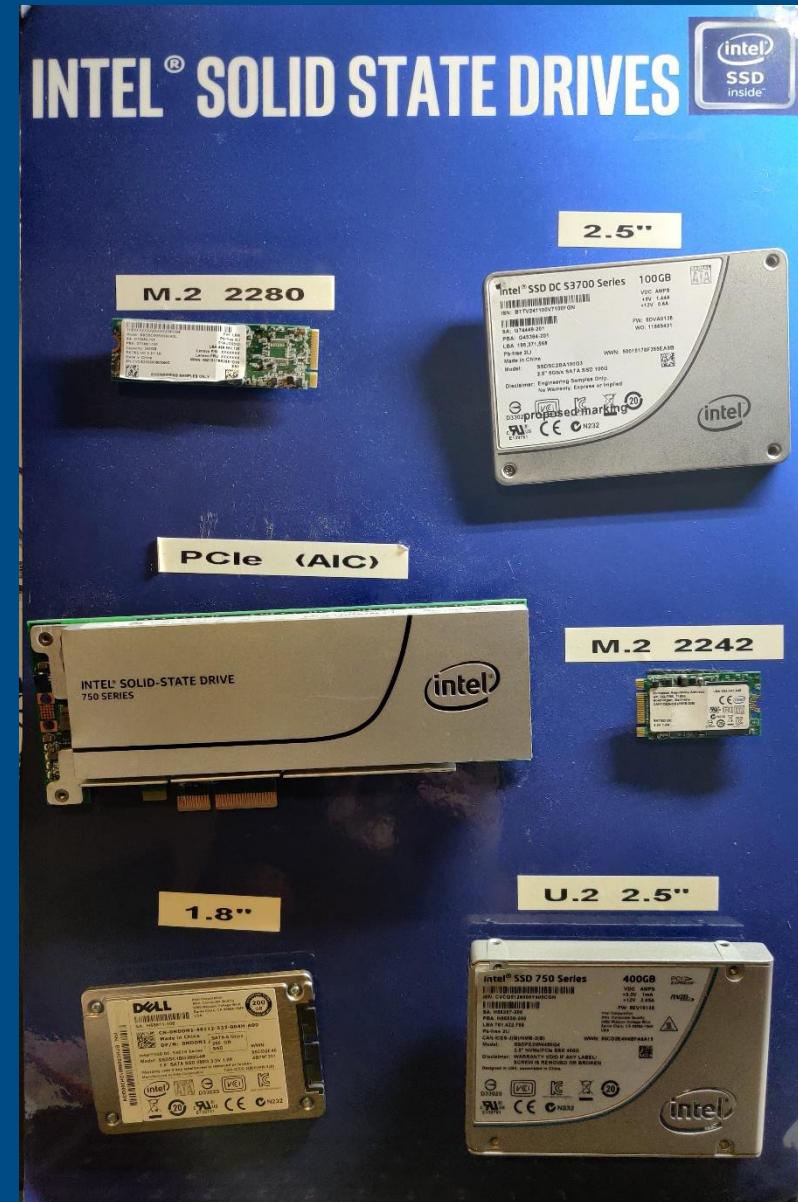
A Closer look at SSD

- Bits → Cells → Pages → Blocks
- SSDs write in Pages
- SSDs erase in Blocks



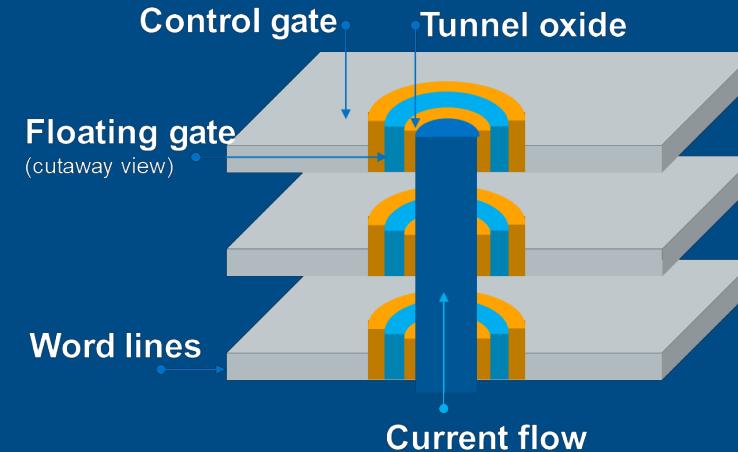
Form Factors

	2.5"	M.2	AIC (Add in card)	EDSFF "Ruler"
NVME				
SATA				

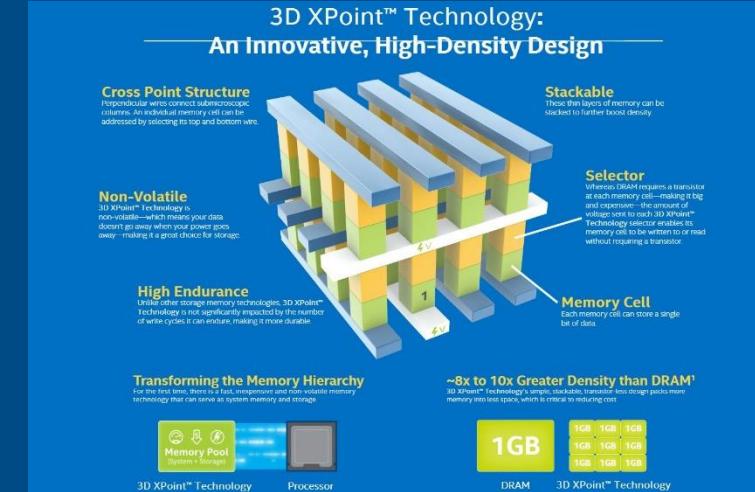


New Media Technologies - Intel

3D NAND vs 3D XPoint



- ① **Physics** of controlling electrons through tunnel oxide **deeply understood**
- ② **Discrete cell isolation** minimizes risk of cross-cell interference
- ③ ~6x more **electrons** in vertical cell increases control

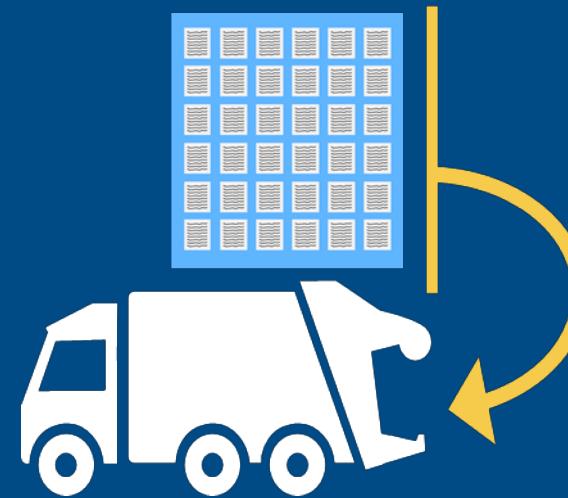


- ① **Cross Point Structure:** Selectors allow dense packing and individual access to bits leading to **Scalability** where Memory layers can be stacked in a 3D manner
- ② **Breakthrough Material Advances** leads to **Higher Performance**

Software Components

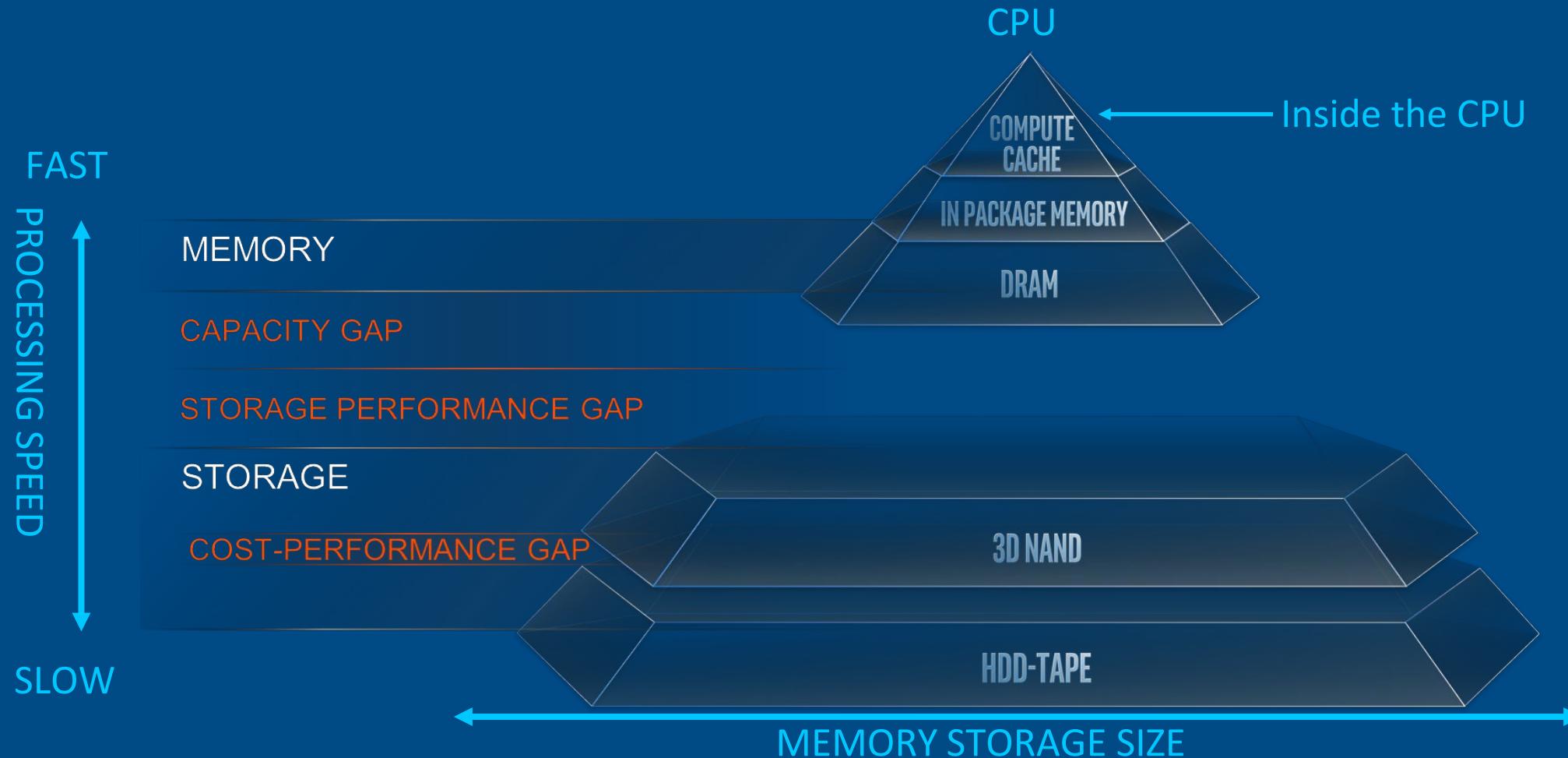
Internal NAND SSD Operations

- **Wear Leveling** - Maximizes the life of a drive.
- **Garbage Collection** - Optimize space, improve efficiency.
- **Trim Command** - Adds blocks to queues to be erased.
- **Over Provisioning** – Supplementary space for SSD Controller.



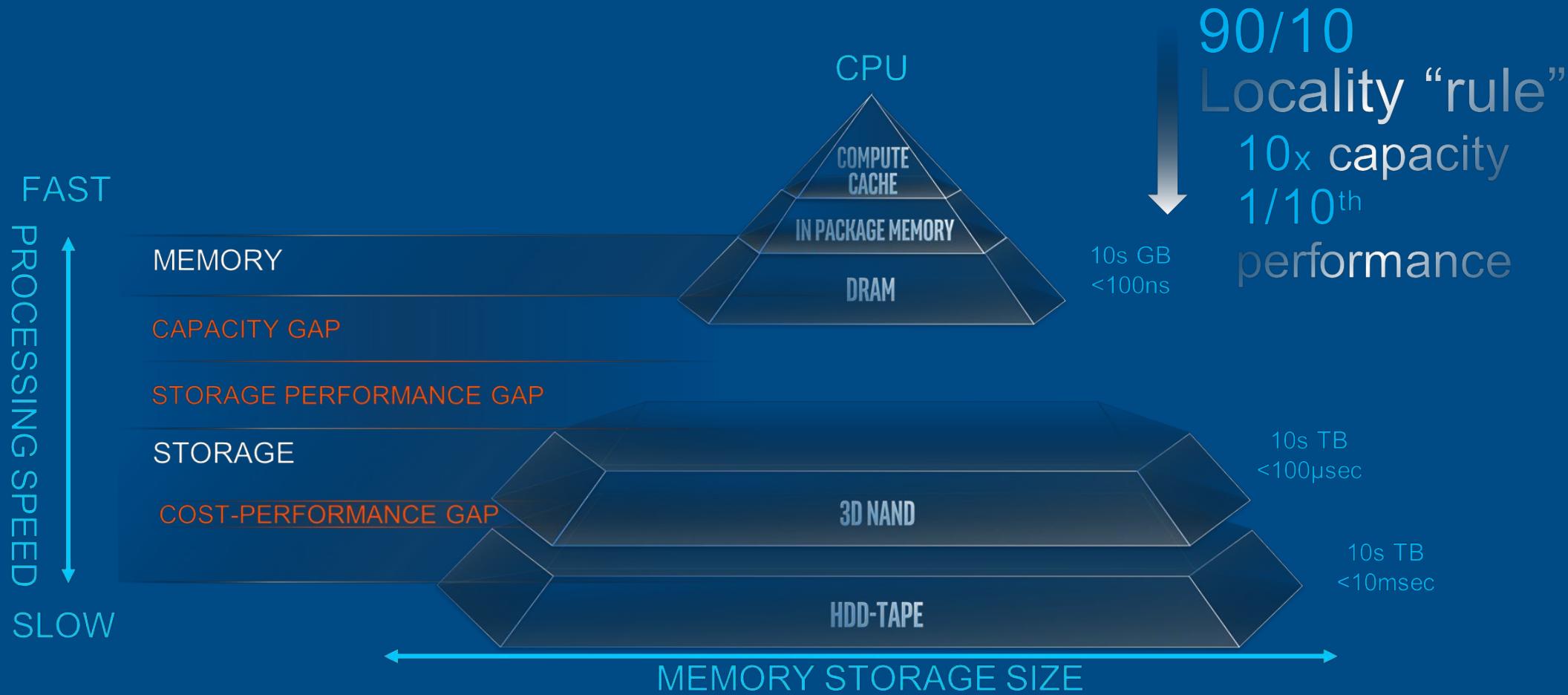
Memory and Storage Hierarchy

Hierarchy Gaps



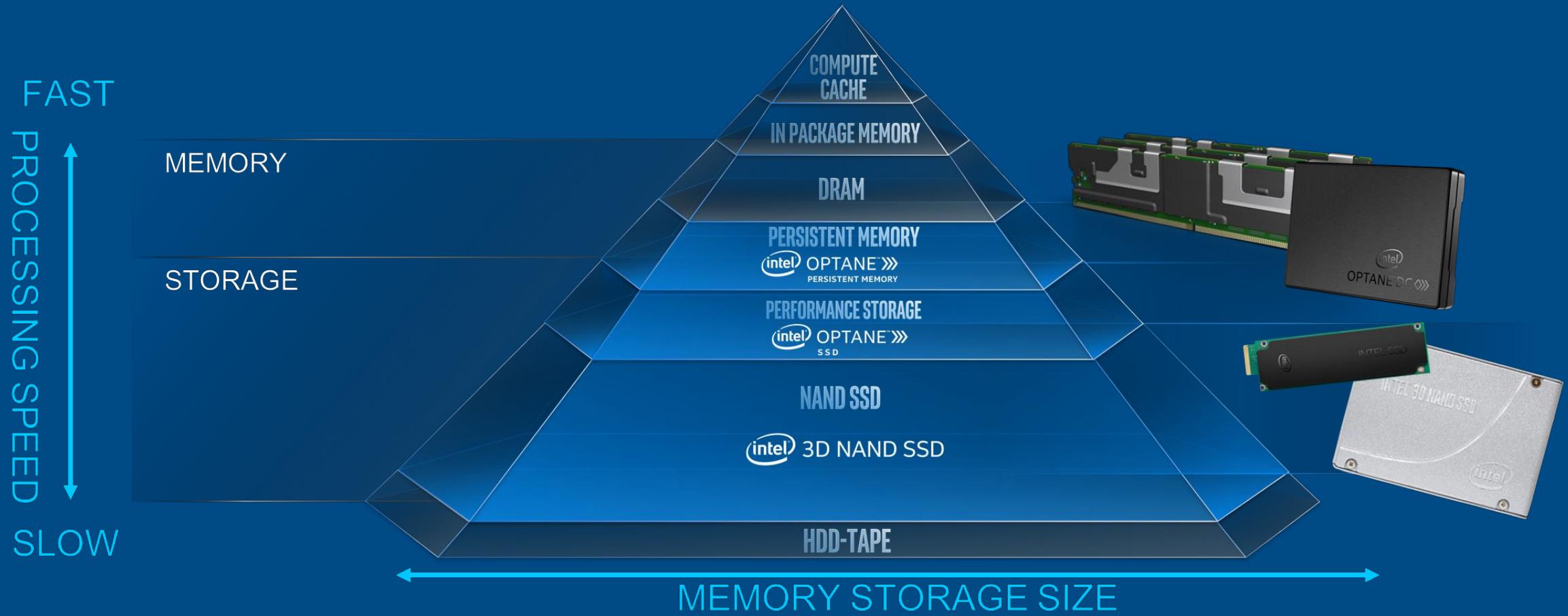
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Hierarchy Gaps



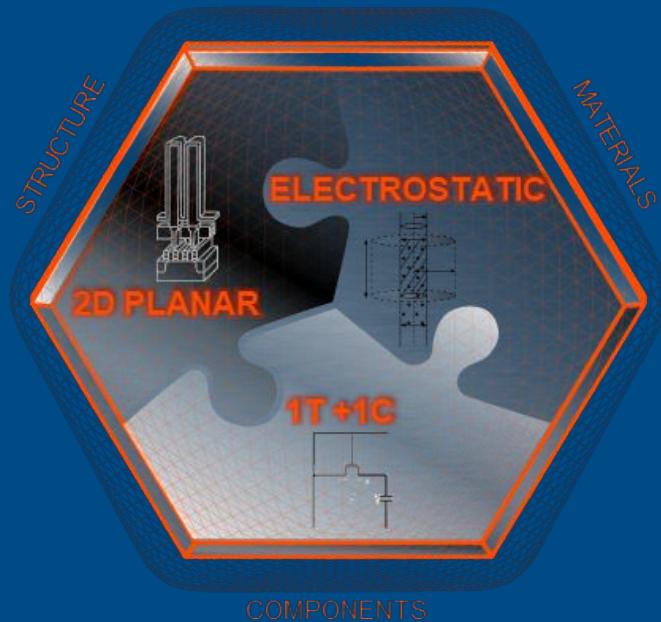
Memory and Storage Hierarchy

Hierarchy Gaps

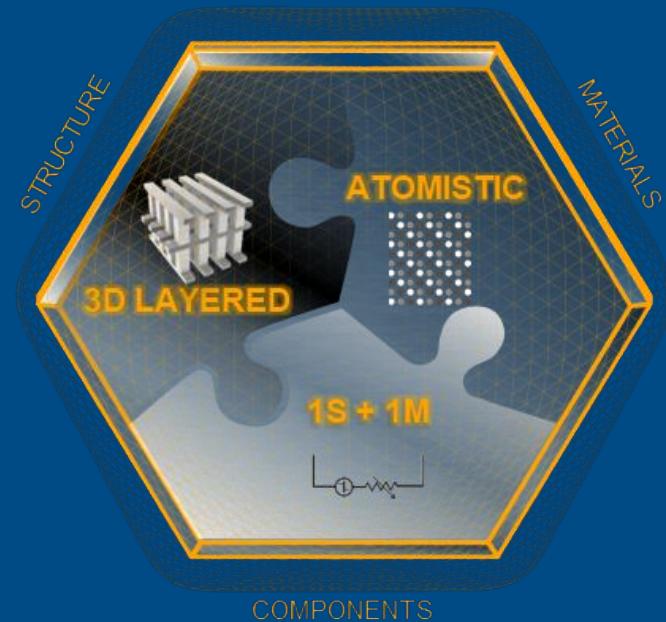


Fundamental Differences in Memory Technology

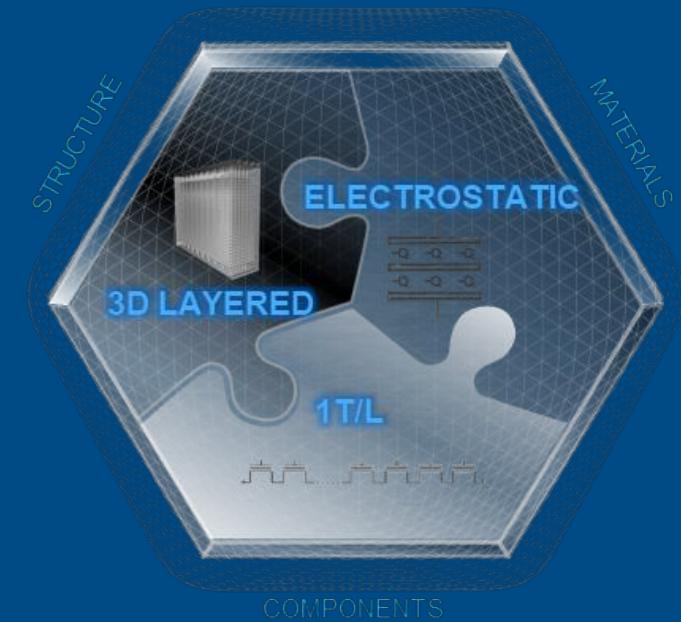
DRAM



Intel® Optane Technology



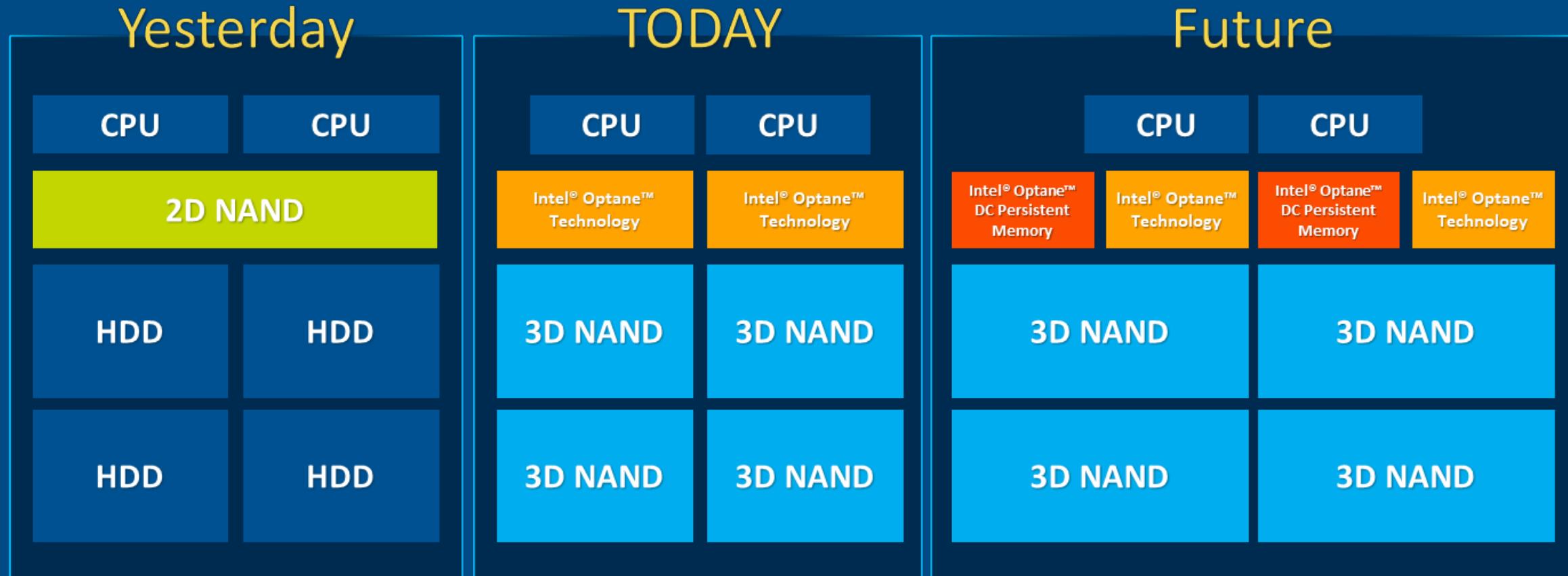
3D NAND



Higher Cost
Smaller Capacity
Faster Performance

Lower Cost
Larger Capacity
Slower Performance

A portfolio of solution components



Disciplined investment

Intel® Optane™ Technology



Intel Fab 11X: Rio Rancho, New Mexico

Intel® 3D NAND Technology



Intel Fab 68: China

Capacity for our Demand

INTERNSHIPS

<https://jobs.intel.com/page/show/internships>



Santa Clara – Intel Campus



Folsom – Fall 2019 Rotation



Folsom - Intel's Kids to Work Day



Folsom – Intel Outreach (Sac State)



Folsom – Spring 2019 Rotation



Folsom – Networking and Friends



Folsom – Intel Outreach Intern Panel



Folsom – Engineers

