White Paper

Data Center Memory and Storage Hierarchy

Memory Tiering: A New Approach to Solving Modern Data Challenges

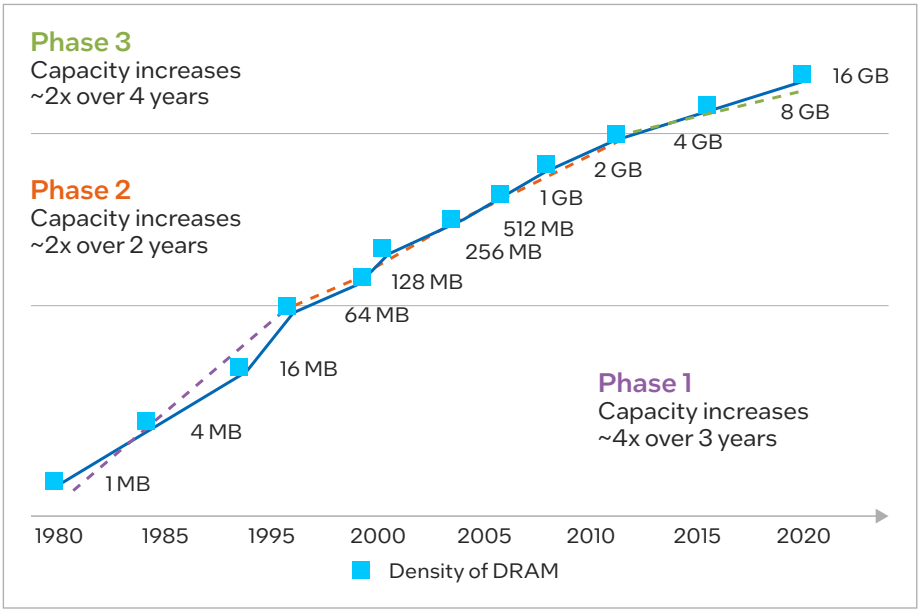
Evolving data center demands require a new memory architecture

In the coming years, we predict that memory tiering adoption will continue to increase in data centers and IT departments across industries. Alongside this shift, a robust ecosystem of vendors and technologies designed to operate within a tiered memory architecture will grow and thrive.

Today's businesses require improved data management and modern architectural approaches to effectively enable data-driven operations. Dramatic data growth, limitations in DRAM density, and the constant need to do more with existing budgets and resources are combining to create memory challenges for IT departments and the organizations they support.

Data center infrastructure needs to be optimized for accessing and analyzing massive data sets to deliver business value. Large volumes of data are required to maximize business insights. As DRAM density reaches its limits, this presents a challenge for IT and business leaders: *how can we provide more memory capacity without breaking our budget?*

DRAM density evolution is slowing down



Business data is also increasing exponentially, but traditional DRAM is not scaling to meet this demand. With the end of Dennard scaling, the growth rates for DRAM density slow over time because it has become costly and complex to scale to higher and higher capacities.[1]

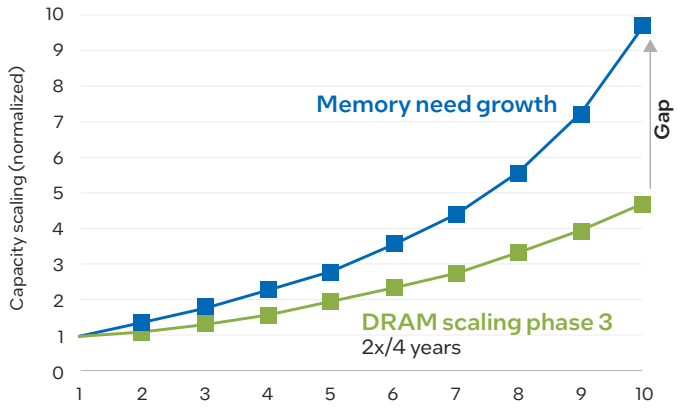
The growing gap between DRAM density and memory needs

Intel makes tiered memory architecture possible

To meet memory needs in the most-efficient and cost-effective way, IT departments are embracing a new approach called memory tiering. Like its philosophical counterpart, storage tiering, memory tiering involves deploying different types of memory technology to fit different data types, use cases, technological needs, and budget constraints.

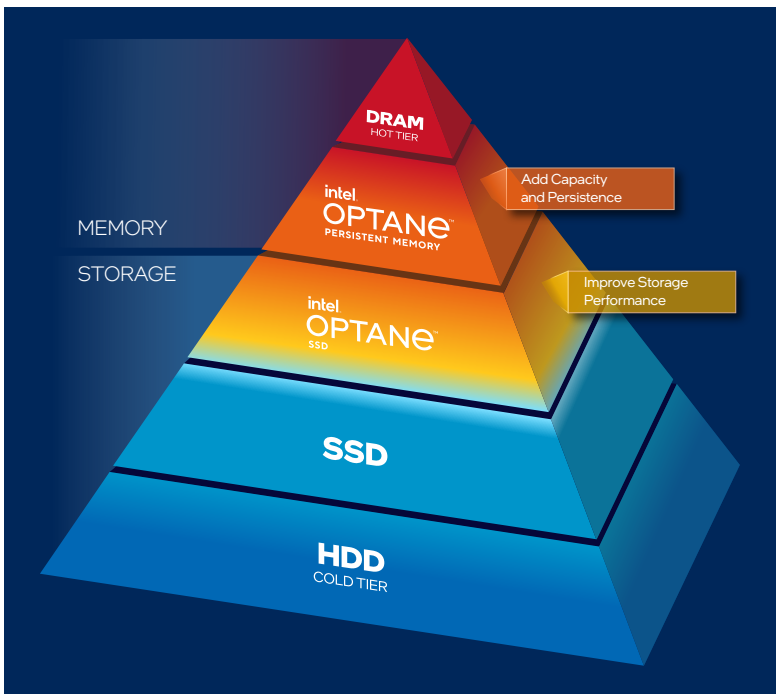
The end goal is to achieve an ideal balance of cost, capacity, and performance. Because today's workloads require faster access to data—and because today's businesses depend on rapid, actionable insights—they need solutions that offer both scalability and accelerated performance.

Intel® Optane™ persistent memory makes the memory tiering approach possible today. While DRAM has seen evolutions such as UDIMM and RDIMM over time, the core technology and its limitations remain. The need for a new kind of more scalable memory is clear—and Intel is answering the call.



The evolution of DRAM density is slowing. While previous decades saw exponential growth every few years, the last decade has seen DRAM capacity double only about every four years. At the same time, data continues growing rapidly, creating a widening gap between memory needs and DRAM capacity capabilities.[1]

The modern storage and memory architecture



Intel® Optane™ technologies can help enable an ideal tiered memory and storage strategy for your organization.

Using a tiered memory approach, you can reserve DRAM capacity for hot data that requires rapid performance. Meanwhile, you can use the capacity tier for less-performance-intensive tasks that still require large-scale capacity.

The memory tiering approach, enabled by Intel Optane persistent memory, is ideal for cloud or on-premises use cases such as:

- Artificial intelligence and machine learning
- High performance computing applications
- Virtualized infrastructure
- Advanced and real-time analytics
- Databases

The business advantages of memory tiering

1. Provide more memory capacity at lower cost
2. Deliver high performance and meet workload service level agreements
3. Lower total cost of ownership by increasing memory per server and workload density to reduce footprint

The time is now

Today, Intel is excited to help customers seize their memory tiering opportunity using Intel® Optane™ technology. In the coming years, we predict that memory tiering adoption will continue to increase in data centers and IT departments across industries. Alongside this shift, a robust ecosystem of vendors and technologies designed to operate within a tiered memory architecture will grow and thrive.

See how our customers are already achieving success with Intel Optane technology ›

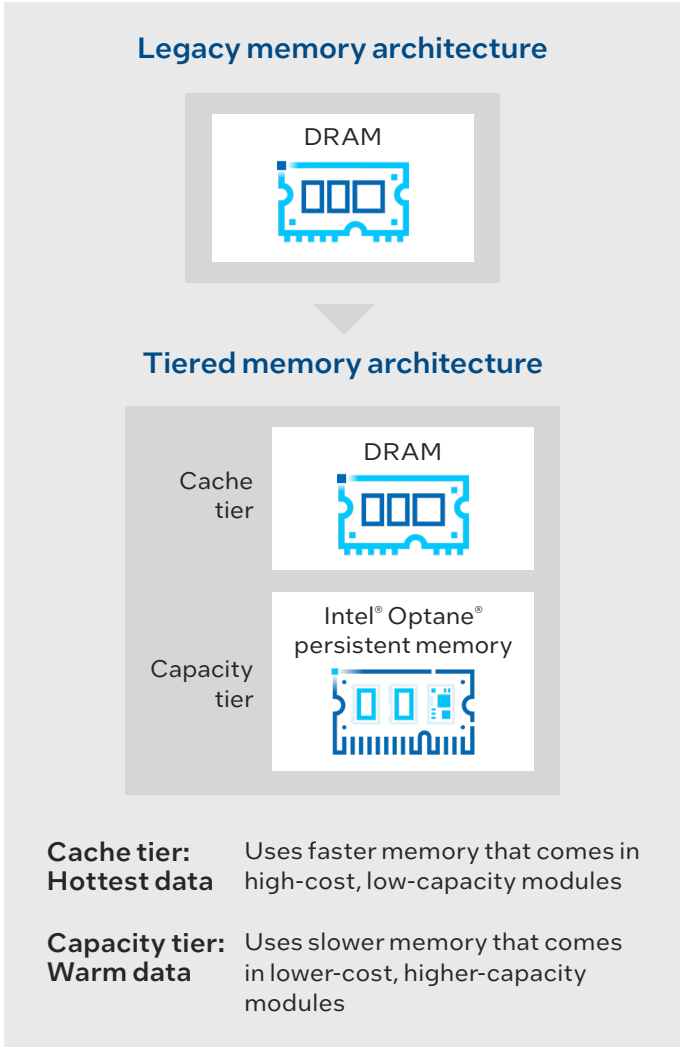
Intel Optane technology: A more scalable approach to data center memory

At the center of the memory tiering approach is Intel Optane persistent memory, **a more scalable type of memory that's available right now**. Intel Optane persistent memory is capable of two different operating modes, **memory mode** and **app direct mode**.

Intel Optane technology is available in a standard DDR4 DIMM form factor, so it's ready to deploy in your existing Intel® processor-based architecture with no system modifications required when used in memory mode. Memory mode delivers large memory capacity without application changes—and with performance close to that of DRAM, depending on the workload. Memory mode also delivers more capacity at a lower cost compared to DRAM. Memory mode is currently enabled in applications such as Redis Open Source and Redis Enterprise, as well as VDI solutions such as VMware Horizon, VMware Horizon with Citrix, and VMware vSAN/vSphere.

In app direct mode, Intel Optane technology allows you to move data closer to the CPU or workload to support hotter data and workloads as needed. Software and applications need to be enabled for the industry-standard persistent memory programming model to have the ability to talk directly to Intel Optane persistent memory in this mode. Because Intel Optane persistent memory is nonvolatile memory when used in app direct mode, it can retain data in the event of power loss or other downtime—helping promote availability and minimize the impact of downtime for your data and workloads. Currently, app direct mode is enabled and supported in popular software tools, including SAP HANA and Oracle Exadata.

By moving data from DRAM to Intel Optane persistent memory in either mode, you free up the faster DRAM capacity for performance-sensitive workloads. At the same time, because Intel Optane persistent memory is high capacity and affordable, you can cost-effectively support large-scale but less-performance-critical data sets.



Start building your tiered memory architecture

Intel is excited to help enable successful tiered memory architectures alongside our broad partner ecosystem. Partners such as SAP, VMware, Oracle, and Dell are already using the memory tiering approach to support their data needs.

Intel Optane technologies are available to unlock the strategy for your organization today, supported by our vast partner ecosystem that spans ISVs, CSPs, OEMs, and SIs.

Find out more about Intel Optane persistent memory at intel.com/optane

intel OPTANE PERSISTENT MEMORY

Intel® Optane™ persistent memory:

Available memory capacities for cost-effective memory expansion

128 GB 256 GB 512 GB

intel.

1. "DRAM scaling: 3D NAND Technology – Implications to Enterprise Storage Applications" by J. Yoon, IBM; 2015 Flash Memory Summit.

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