BREAKING DEFENSE / GAME CHANGER

What milestone advancements in computer chips mean for the military

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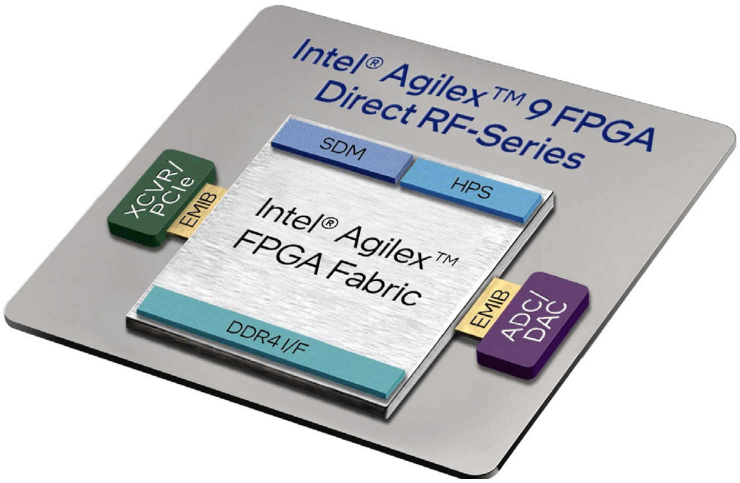
At a microscopic level, advanced semiconductors are packed with modular chiplets to meet dynamic needs of air defense, robotics, and satellites.



Under the SHIP Program, chiplets provide advanced functionality, low power, smaller size and cutting-edge performance with Intel Agilex advanced field programmable gate array (FPGA) technology. Image courtesy of Intel Corporation.

Napoleon Bonaparte's observation that an army marches on its stomach is only partially true in today's vulnerable environment. Now it's more likely that armies, navies, and air forces operate on the back of computer chips, because without them in plentiful supply their air defense systems, unmanned vehicles, and satellites are out of the fight.

Access to a plentiful and balanced supply of chips is essential to all sovereign nations including America and its allies.

"We all know that microelectronics are ubiquitous and essential to the nation," said DoD Chief Technology Officer Heidi Shyu. "Advanced microelectronics enable our troops with an advantage by making possible adaptive secure communications, electronic warfare, and long range weapon systems, just to name a few. To stay ahead, we need reliable access to secure microelectronics to meet our current and future systems requirements."

Re-balancing the supply chain and investing in American chip making

Shyu was commenting on what the DoD recently called a "milestone development in advanced computing chips for the US military." That was the April delivery of Intel's first prototype multi-chip package (MCP) created under the State of the Art Heterogeneous Integrated Packaging (SHIP) program led by BAE Systems.

Intel's delivery of the MCP — six quarters ahead of schedule — marks a significant step in assuring access to state-of-the-art microelectronics packaging. It creates pathways for sustained DoD access to advanced microelectronics capabilities, leveraging commercial-industry best practice and production.

The SHIP program includes two elements — Intel's Multi-Chip Package (MCP-1) for what's called "SHIP Digital," and another company's Multi-Chip Module (MCM-1) for "SHIP Radio Frequency". Under SHIP Digital, Intel's MCP-1 is in prototype production. MCP-2 will begin the prototype production process in the near term. Both MCPs contain advanced chiplets that feature low power requirement, smaller size, and cutting-edge performance, along with Intel's Agilex advanced Field Programmable Gate Array (FPGA) technology.

The future of chip innovation lies in moving to modular designs based on chiplet building blocks, like the Intel MCP, essentially moving from System-on-Chip (SoC) architectures to System-on-Package (SoP) architectures. This allows designers to bring together design IP and process technologies from multiple vendors. Which increases the level of modularity and design freedom so chip makers can respond faster to dynamic battlespaces and new and novel threats in Europe, the Middle East, and across the vast distances of the Indo-Pacific.

On the cover: *An Intel engineer in Santa Clara, CA, inspects a "mask," which is a six-by-six-inch piece of quartz, a quarter-inch thick, that is used as the template to print circuitry onto a silicon wafer. (Credit: Tim Herman/Intel)*

It's all part of what Intel calls the "digital mission infrastructure."

"Digital mission infrastructure is what equips military organizations with the end-to-end capabilities they need to carry out their mandates across the C4ISR and operations landscape," explained Cameron Chehreh, vice president and general manager of Intel's public sector business. "Having digital technologies with silicon at their heart is how kinetic platforms like ships, planes, and next-generation tanks become smart."

The Digital Mission Infrastructure in action

Historically, the DoD developed systems to meet specific needs. That approach resulted in stove-piped systems that don't interoperate well. Data formats from different sensors, for example, often can't be consumed by other disparate systems even though the basic nature of the data such as location, track, and time is much the same.

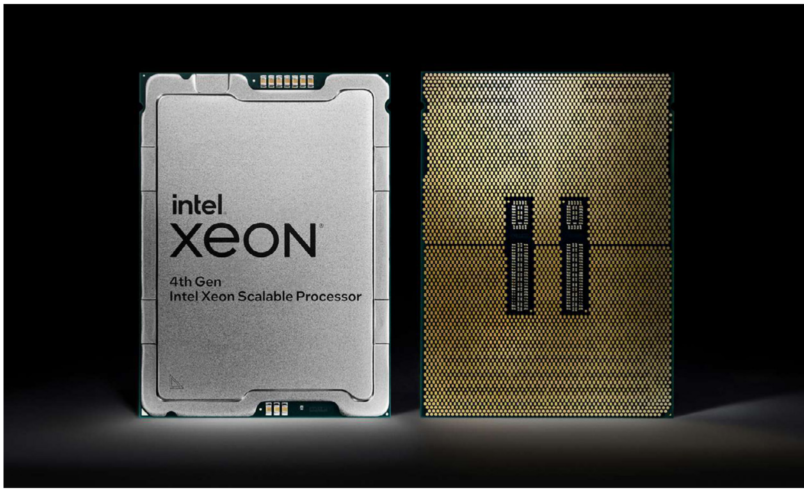
Stovepipes aren't the only problem. While military networks have grown more robust, mission communications have become more verbose. Sensor systems can generate enormous quantities of data. Transmitting all that information to a centralized datacenter for analysis can be slow or unreliable, particularly when operating in contested environments.

Intel operates on the belief that it is critical to start thinking with a "digital mission infrastructure" mindset to build, defend and protect against threats.

Here's an example of that. In a wartime setting, communications infrastructure can easily be damaged, which limits the military's ability to communicate at the edge and with its allies.

In such a contested environment, Chehreh described how new techniques are being field-tested that rely on drones to provide AI-enabled 5G networking. With this approach, AI intelligently follows emergency responders or military personnel and their equipment to dynamically maintain cell service. An airborne fleet of 5G-equipped drones automatically detects and works around mountains, trees, storms, smoke, and enemy combatants and self-heals if portions of the network are damaged. AI takes into account power consumption, battery life, and range to serve prioritized mission teams and expand or shrink the network as necessary.

"This innovation involves the full digital mission infrastructure: compute, connectivity, cloud to edge, AI and sensing," he said. "In addition, many military assets at the edge like tanks and planes essentially serve as mini data centers: collecting, analyzing and interpreting data — and sharing that data with other edge assets and the command center. These assets are also examples of digital mission infrastructure in action."



Intel's 4th Gen Intel® Xeon® Scalable processor series, which represents a major leap in speed, efficiency and capabilities. Image courtesy of Intel Corporation.

Chips for Artificial Intelligence

With System–on-Chip architecture in terms of the SHIP program, there is great potential for next-generation System-on-Package chip architectures. While development of SOP continues apace, new advancements in present-day SOC architecture continue to underlie the basis for most high-performance computing, including its integral usage for artificial intelligence and machine learning.

In January, Intel launched one of the most important products in its history: the [4th Gen Intel® Xeon® Scalable processor] series, which represents a major leap in speed, efficiency and capabilities. For general-purpose compute, it provides more than a fifty-percent average performance gain in real-world workloads.[1] For AI, they enable up to 10-times higher performance for inference and training.[2]

These processors also offer the most built-in accelerators of any CPU for AI/ML workloads, as well as analytics, cybersecurity, networking, and data storage. These accelerators enable a nearly three-times performance-per-watt efficiency improvement.[3] In other words, they require far less power to operate, contributing to a more sustainable and cost-effective final product.

"But here's a fact more significant than the numbers: the new processor is a system-on-a-chip design," said Chehreh, referencing what is today still the state of the art in semiconductors that can be manufactured at DoD levels of need right now.

"Conventional chips need to be combined in an integrated circuit to manage communication among CPU, memory, data storage, and so on. A System on Chip, in contrast, efficiently integrates these components, plus software, into a single piece of silicon. The outcome is not only higher performance and lower power consumption, but greater reliability and smaller space requirements. That will enable more use cases in more places — especially at the extreme edge. For government and the military, it's not just a next-gen processor. Rather, it's a next-gen compute paradigm."

Compute, connectivity, cloud, AI, and sensing

The DoD has embraced digital transformation to improve decision advantage and accelerate logistics and mission readiness. All branches of the military are digitizing both internal processes and external service delivery to fulfill their missions.

For example, a single mission might involve multiple military units and coalition partners, each with a varied and changing array of available sensors and systems at any given moment. Intel chips help mission leaders and teams integrate their resources, make decisions and act, sometimes in mere milliseconds to ensure decision advantage. Digital mission infrastructure makes this a reality.

As a leading semiconductor provider, Intel provides the building blocks for this digital transformation: ubiquitous compute, pervasive connectivity, cloud-to-edge infrastructure, artificial intelligence and sensing. These technologies drive every digital-enabled military function, and they're all interconnected and interdependent.

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[1] [Up to 1.53x average performance gain over the prior generation. See [G1] at intel.com/processorclaims: 4th Gen Intel Xeon Scalable processors. Results may vary.]
[2] [Up to 10x higher PyTorch performance for both real-time inference and training with built-in Intel AMX (BF16) versus the prior generation (FP32). See [A16] at intel.com/processorclaims: 4th Gen Intel Xeon Scalable processors. Results may vary.]
[3] [When compared with prior generations, 4th Gen Xeon customers can expect a 2.9×1 average performance per watt efficiency improvement for targeted workloads when utilizing built-in accelerators. Geomean of following workloads: RocksDB (IAA vs ZTD), ClickHouse (IAA vs ZTD), SPDK large media and database request proxies (DSA vs out of box), Image Classification ResNet-50 (AMX vs VNNI), Object Detection SSD-ResNet-34 (AMX vs VNNI), QATzip (QAT vs zlib).]