Intersect360 Research White Paper:
AI AND THE NEW HPC:
SECURING NATIONAL INTERESTS

MARKET DYNAMICS

Where Leadership Matters Most

In all its use cases, High Performance Computing (HPC) is about innovation. Many industries make use of HPC—to design new products, to improve efficiency, to maintain competitive advantage. Academic and scientific research leverage HPC as well, pushing the boundaries of understanding through modeling and simulation. Wherever HPC is applied, it is tied to leadership, and as such, there is an inherent emphasis on doing something beyond what one's peers have done, or beyond what others are capable of doing.[1]

As important as leadership is for business and for research, it can take on a new level of criticality in the context of national security. Although many HPC applications in national defense are classified, it is not so difficult to infer basic areas in which HPC superiority can translate directly secure borders and military capability.

In a testimony to the U.S.-China Economic & Security Review Commission (USCC) for its hearing on "China's Pursuit of Next Frontier Tech," Intersect360 Research CEO Addison Snell described the usage of HPC in national defense:[2]

> *For starters, advancements in industry and research can have direct translation to military efforts: for example, in the manufacture of a new helicopter or the availability of an ultra-local weather forecast supporting an operation. Many supercomputing endeavors may be classified when it comes to military and defense issues, but there nevertheless several categories of applications we can be sure of:*
>
> - Combat simulations: *One of the most straightforward ways in which supercomputing is deployed for national defense is in combat simulations, ranging from "person-in-the-loop" models like flight and tank simulators to large-scale wargames. (The 1983 movie* WarGames *was based on exactly this concept.)*
> - Nuclear stockpile stewardship: *HPC allows the maintenance of a nuclear stockpile without the need for nuclear testing. Nuclear explosions can be simulated using supercomputing technologies.*

[1] Intersect360 Research, *What Is HPC?*, https://www.intersect360.com/what-is-hpc.

[2] Addison Snell testimony to USCC, March 16, 2017, available at https://www.uscc.gov/Hearings/hearing-china's-pursuit-next-frontier-tech-computing-robotics-and-biotechnology-video.

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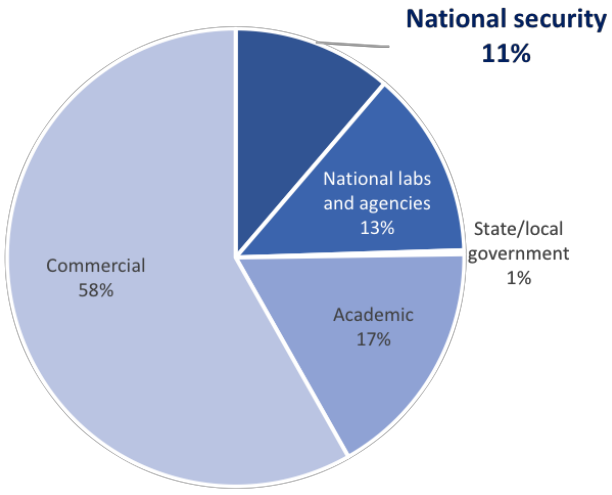
- Defense and response simulations: *In addition to simulating combat, HPC can be used to simulate defensive responses to possible attacks, modeling, for example, how to respond to an attack on the electrical grid or the release of a chemical agent in a metropolitan area. (Theoretically, these simulations could also be used offensively, not just defensively.)*
- Intelligence and security: *HPC is used in the gathering and analysis of data streams that can provide evidence of planned attacks or point toward an enemy's weaknesses. Information analysis can also be used to make borders safer, including linking the analytics with emerging advancements such as facial recognition.*
- Cybersecurity and cyberattack: *Cybersecurity is an issue that affects companies and private citizens, but at the government level, it is a matter of national security. HPC is now being used in some cases to model defensive responses to cyberattacks. That said, this is an instance in which HPC is used offensively more frequently than defensively, and at larger scale. Supercomputing can be used to break passwords, to hack into systems, and to analyze any information that is acquired.*

This reliance on HPC for national security is evident in its proportion of market spending, accounting for more than 10% of HPC hardware, software, and services worldwide, with over $4 billion in spending in 2018, forecast to grow to over $5 billion in 2023.[3] (See figure below.) This investment occurs disproportionately in the United States—whereas the U.S. represents 49% of worldwide HPC consumption, its proportion of HPC spending on national defense is much higher—however, it is important to remember that this is a worldwide figure, and many countries invest in military, defense, and security. China and Russia, for

National Security as Proportion of Worldwide HPC Market, 2018

Intersect360 Research, 2019



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[3] Intersect360 Research, *HPC 2018 Market Model and 2019-2023 Forecast: Vertical Markets*, 2019.

example, are both known to make significant investments in computing capability for military purposes.

The fact that HPC is not a one-country game is exactly what spurs ongoing investment. There is an inherent interest in maintaining capabilities that are superior to—or at least competitive with—other countries', coupled with a healthy fear of what fate could befall the nation if it found itself at a computing disadvantage. New areas of capability are of particular concern, such as with new technologies like quantum computing, or new computational approaches like artificial intelligence.

AI and the New HPC

The very nature of HPC applications is that they are constantly reinvented. Once one problem is solved, it unlocks the approach to a new, harder category of problem, which itself spurs investment to solve it. New HPC applications, architectures, and approaches are driven by the perpetual need to solve the next big problem. Thanks to advancements in the availability of data, the scale of HPC, and investment by hyperscale web companies, there has been a revolution in using artificial intelligence (AI)—or more specifically, *machine learning*—as a complement or component of HPC.

Historically, most scientific applications have been *deterministic*: based on a set of inputs, a program runs a bunch of calculations and comes up with an output, which is the answer. A second type of applications is *probabilistic*. Rather than computing one answer, we test a multitude of scenarios to see what happens. This would be the approach to answering the question, "If you shuffled together ten decks of cards at random, what is the probability that some sequence of 20 cards would contain at least 18 spades?" It is a very difficult math problem to compute exactly, but relatively simple to have a computer try it 10 million times to come up with a likely answer. In HPC, this is called a Monte Carlo simulation, and it is a common approach, for example, in strategic military planning.

Machine learning represents a third category of application that is *experiential*. Based on patterns seen previously, a machine learning algorithm makes inferences about current or future situations. This approach is called "artificial intelligence" because it mimics how humans learn: "Although I have never seen this cat before, I am confident it is a cat based on my lifetime of experience and learning involving cats."

Machine learning can be deployed any time there is a wealth of data to draw on, coupled with a reward from making more intelligent inferences based on that data. This is a perfect description of predictive models for homeland security. HPC-using organizations in general are trending toward the incorporation of AI, and in this regard, government organizations are keenest of all in investigating new capabilities, with focused investments on AI-capable architectures.

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As with other HPC technologies, AI has the potential to be used either offensively or defensively in national defense contexts. Rather than having human operatives individually monitoring countless voice and electronic data streams in search of clues and coded messages, machine learning algorithms can potentially be trained to do the same at larger scale, tagging messages and people of interest to be monitored or investigated further. Consider also that AI can be used for facial recognition, assisting in tracking or recognizing known threats. From an offensive perspective, Russia is already suspected of using social media "bots" for influence in U.S. elections. This only scratches the surface of AI's potential.

For national defense, there is an additional effect of the incorporation of AI with the already-existing thirst for relentless performance. Now systems must be tunable for high performance across a wider range of applications. HPC users in defense and beyond are exploring solutions with new types of processing elements for application acceleration.

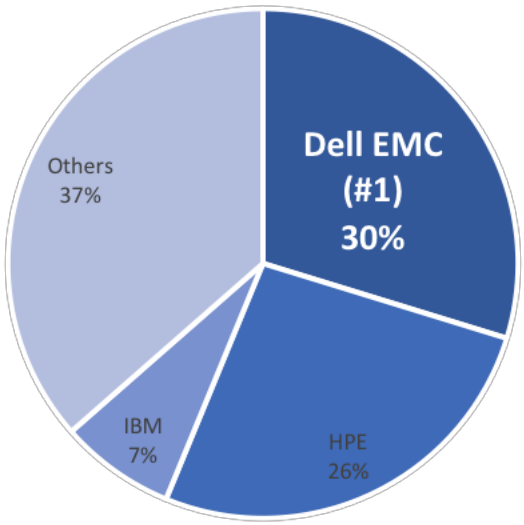
INTERSECT360 RESEARCH ANALYSIS

Today's (and tomorrow's) challenges in national defense are representative of the "new HPC," combining scientific computing with large-scale data analytics and artificial intelligence. Successful solution providers will be those that have technologies that can span this expanded workflow, combined with domain-specific expertise in helping organizations achieve meaningful breakthroughs.

Dell EMC is just such a company. With trusted products across both computation and data management, Dell EMC, powered by Intel® technology, is the industry leader in total HPC

Share of Combined Worldwide HPC Server and Storage Revenue, 2018

Intersect360 Research, 2019



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solution revenue.[4] Dell EMC leverages this breadth of offerings with converged solutions that incorporate HPC, data analytics, and AI[5] and offers tailored solutions incorporating the latest in AI for national defense and other key vertical markets.[6]

Dell EMC has experience delivering solutions for national defense. Through a partnership with Tracewell Systems, Dell EMC provides ruggedized hardware solutions for C4 (Command, Control, Compute, Communicate) and combat scenarios, "which will operate in environments which would have killed IT equipment even a few years ago," according to Graham Porter, EMEA Director of Surveillance and Security at Dell EMC.[7] Dell also has experience with broad, trusted enterprise and cloud deployments for the U.S. military, with large-scale contracts for both the U.S. Navy[8] and U.S. Air Force.[9]

Dell EMC's HPC solutions for national defense leverage the company's close partnership with Intel®. Not only has Intel® refreshed its line of x86 high-performance processors with the second-generation Generation Intel® Xeon® Scalable Processors (formerly Cascade Lake), but the company also offers a breadth of additional solutions for HPC and AI. Reprogrammable FPGAs (field programmable gate arrays) can be tuned for specific applications, particularly those that are highly scalable and reliant on a high degree of integer-based (or fixed-point) arithmetic. These types of applications are common in signal processing, analytics, and certain aspects of AI, and Dell leverages Intel® FPGAs in its solutions for defense and security.

According to Intel's® Recommendations for the U.S. National Strategy on Artificial Intelligence, "Nations that invest in Artificial Intelligence (AI) stand to gain tremendous advantages across industry, government and society at large." The white paper also recommends, "Support for the recently established National Security Commission on Artificial Intelligence is imperative. This public-private body is tasked with reviewing advancements in AI and promoting a climate of investment and innovation to ensure the U.S.'s continued global competitiveness in AI."[10]

For national defense, the new HPC is fueled by analytics and AI. Across cybersecurity, analytics, and military intelligence, there is a deep wealth of data. AI can help process and activate that data for national security and military advantage. Although the fundamental drivers in HPC and national security remain the same, these converged, high-performance solutions are critical to maintaining leadership, making faster decisions and protecting both soldier and citizen.

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[4] Intersect360 Research, *Vendor Overview and Outlook: Dell EMC in HPC,* 2019.

[5] https://www.dellemc.com/en-us/collaterals/unauth/brochures/solutions/hpc_ai_convergence_brochure.pdf.

[6] https://www.emc.com/collateral/solution-overview/ready-solns-for-ai-machinedeep-learning-sol-overview.pdf.

[7] https://blog.dellemc.com/en-us/dellemc-interview-global-defence-summit-berlin-germany.

[8] https://www.datacenterdynamics.com/news/dell-wins-231-million-us-navy-it-contract.

[9] https://www.sdxcentral.com/articles/news/dell-emc-microsoft-win-1-billion-u-s-air-force-deal/2017/09/

[10] Intel Corporation, https://newsroom.intel.com/articles/intels-recommendations-u-s-national-strategy-artificial-intelligence/.

With its industry-specific knowledge and technology solutions across data management and computation for HPC, analytics, and AI, Dell EMC powered by Intel® technology, is well-positioned to help national defense interests achieve their new levels of innovation.

For more information about Dell EMC solutions for HPC, visit https://www.dellemc.com/en-us/solutions/high-performance-computing/index.htm.

For more information about Intel solutions for AI, visit https://www.intel.com/content/dam/www/public/us/en/documents/guides/enterprise-and-government-ai-theory-eguide.pdf.

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