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Disruptive Tech: A Force Multiplier for the Future Fight

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Disruptive Tech: A Force Multiplier for the Future Fight

Introduction

It is a time of significant change and uncertainty in defense. The war in Ukraine, geopolitical instability, climate change, and rapid developments in disruptive tech are all having an impact on how the US military operates and maintains overmatch. To maintain its operational advantage, the Pentagon will have to rapidly procure emerging technology, learn lessons from recent conflicts, and modernize to deal with an ever-changing geopolitical landscape. In this whitepaper, we explore the challenges that face the US military and how it, and wider industry, is responding.

The last decade has been a tumultuous period for the US. The rise of China, the invasion of Ukraine by a belligerent Russia, and its own messy withdrawal from Afghanistan have altered the US' geopolitical standing and given rise to an increasingly multipolar world.

The 2022 National Defense Strategy (NDS) highlighted that the US is now facing a number of strategic challenges that will likely be present for at least two decades, these include: the changing global balance of military capabilities; emerging technologies; competitor doctrines that pose threats to the US homeland; malign activities in the 'gray zone'; and 'transboundary' challenges such as climate change that will put new demands on the Joint Force.[1]

What is the current conflict in Ukraine showing us?

State-on-state conflict was thought to be a thing of the past, especially with the end of the Cold War and the US shift to counterinsurgency campaigns; but the Russian invasion of Ukraine has abruptly changed this outlook. The conflict's bloody battles are a reminder of how wars between well-equipped state-backed forces are fought, as well as a glimpse of how future peer conflicts are likely to be waged.

The Ukraine War has demonstrated that traditional warfare tactics, doctrine and equipment – including long-range artillery barrages, defensive fortifications and massed mechanized attacks – are still critical for winning the fight, but this also needs to be supplemented with new capabilities that will tip the balance in favor of allied nations, particularly those that are under threat from larger aggressors.

Ukraine was believed to be vastly outnumbered and out-equipped by Russia at the beginning of the conflict, but as the old saying goes, "necessity is the mother of all invention", and that has certainly been on display during the conflict.

To dent Russia's advantage, Ukraine has been able to blend traditional capabilities with a range of commercial technologies, including for intelligence gathering as well as strike operations. This includes autonomous drones, space technologies such as satellite imagery and communications, and open-source data gathering and AI-enabled analysis from sources such as social media and other intelligence sources.[2]

In the face of a clear and present threat, commercial tech has been effectively utilized by Ukrainian forces owing to its availability, low cost and enhanced capabilities.

It is well reported that Ukrainian forces have used commercial drones to significant effect, including for intelligence, surveillance and reconnaissance (ISR), and strike operations using so-called kamikaze drones, or modified first-person-view (FPV) drones with added munitions.

These operations have required significant coordination between various units but have demonstrated that relatively low-cost UAVs can have an asymmetric impact on operations by targeting expansive platforms both on Ukrainian soil, as well as in Russia itself. There have been numerous examples of drones destroying static Russian aircraft on airfields, as well as strategic targets such as infrastructure and air defense systems.[3]

The effective use of commercial drones in Ukraine has given the US DoD an impetus to explore how it can also build a drone army akin to Ukraine.

In August 2023, it was revealed that the Pentagon was looking to field thousands of attritable, autonomous systems in all domains to compete with China, as part of a program called Replicator.

"Replicator will galvanize progress in the too-slow shift of U.S. military innovation to leverage platforms that are small, smart, cheap and many," said Deputy Defense Secretary Kathleen Hicks, as reported by Defense News.[4]

This also aligns with DARPA's 'Mosaic Warfare' concept for the multi-domain battle, which aims 'to take complexity and turn that into an asymmetric advantage', especially using uncrewed assets that can overwhelm an adversary.

"It sounds like it should be something very doable, but it's not right now," said Dr Thomas Burns, DARPA's former Strategic Technology Office director. "The interfaces are not made to communicate that kind of information and the Army doesn't have air and ground vehicles that it can send forward," he added.[5]

The Systel advantage: *The proliferation of uncrewed assets across the battlespace, as evidenced by the Ukraine conflict, will significantly increase the requirement for rugged computers that are able to collect, process, and analyze the data that is being collected through each platform's sensors "on-prem" in austere environments.*

Small form factor edge computers with AI-enabled processing – such as Systel's Sparrow-Strike – will be critical for platform autonomy, rapid decision-making and reducing latency from sensor to shooter.

Emerging technology

As evidenced in Ukraine, technology will play a central role in the defense landscape now and well into the future. According to the 2022 NDS, a number of new and rapidly evolving technologies are creating significant challenges for strategic stability. This includes hypersonics, counter-UAS weapons, cyber capabilities, autonomy, quantum computing, and AI.

As we have already seen, the rise of AI and autonomy is especially noteworthy. Away from the battlefield, the growing use of generative AI tools for everyday tasks – epitomized by the huge interest seen in ChatGPT – has only served to highlight how pervasive this disruptive tech is becoming. AI's potential in industry has been known for some time, and AI is now being rolled out by various sectors to help companies seek competitive advantages in their respective verticals, whether that is improving the manufacture of products, the delivery of a service, or improving company processes and driving efficiencies.

As its name suggests, AI is a way of bolstering and augmenting human cognitive ability and allowing machines to take on the work that was traditionally done by skilled humans. The fact that AI can perform complex tasks in more timely and efficient ways than humans is one of the biggest value propositions for AI and machine learning, especially when it comes to giving organizations an advantage over others. Unsurprisingly, this is why many militaries – both friendly and adversaries – are interested in the use of AI and how it can be applied to the future battlefield. AI is of particular importance in areas such as autonomous systems, where robotic platforms have to operate and make decisions alongside human operators, as well as intelligence gathering, with AI helping to make sense of the large datasets and information collected by high-fidelity multi-spectral sensors.

The US Army, for example, has been studying how AI and machine learning can reduce the kill chain in precision fires, and along with a modernized unified communications and data network, "enable commanders to make well-informed decisions far more quickly than their opponents".[6] AI will also be a force multiplier in applications such as electronic warfare (EW), where, unlike current systems that rely on defined databases and responses, systems can quickly detect, classify and adapt to new threat systems, as well as counter them intelligently.[7]

AI and ML-enabled missions will require the processing of data at the edge, rather than being sent back to a command center or centralized data hub that will add latency to the mission kill chain. Edge processing is critical in areas such as threat detection, classification and neutralization, as well as autonomous navigation.

Sparrow-Strike Product Brief

USFF Edge Processor

systelusa.com/sparrow-strike

Sparrow-Strike is an ultra-small-form-factor (USFF) MIL-SPEC rugged edge compute solution.

With a modular chassis and architecture design, integrating either the NVIDIA Jetson Orin NX edge AI system on module (SOM) or an Intel x86-based processor, Sparrow-Strike provides the performance and flexibility demanded by emerging autonomous and uncrewed missions, in an ultra-compact and lightweight form factor.

Sparrow-Strike is engineered to withstand austere environments and is SWaP-optimized for integration and deployment in highly space-constrained platforms. Sparrow-Strike is designed using a Modular Open Systems Approach (MOSA).

Sparrow-Strike features robust IO and configuration options including multiple USB 3.0, GbE with TSN and POE options, CAN, serial, display, and RF.

Sparrow-Strike reduces data latency at the tactical edge, and decreases the cognitive burden and workload on the operator. Purpose-built for deployment in austere environments for demanding AI and ML sensor ingest and data analytics mission-critical applications with installation in highly constrained space claims.

Ultra-compact and lightweight. 6.7″W x 5.5″D x 3.0″H. 3.1lbs. Alternate chassis materials available for further weight reduction.

NVIDIA Ampere Architecture: 1024 CUDA Cores and 32 Tensor Cores. 8-Core ARM CPU. 100 TOPS.

Modular architecture design: NVIDIA Jetson Orin NX or Intel x86-base processor.

-40C to +55C passive cooled. MIL-STD-810H, MIL-STD-461G, MIL-STD-1275E, MIL-STD-704F, DO-160G.

This will require powerful yet small form factor computers – with dedicated GPUs that can run powerful AI/ML algorithms – that are able to be integrated on platforms of all types across the battlespace, not large rack server-type computers that were seen on legacy ISR platforms.

The Systel advantage: *Systel's rugged edge compute solutions, including Sparrow-Strike, are designed from the outset for AI applications with the use of modern GPUs such as the NVIDIA Jetson series of embedded AI systems on module.*

Sparrow-Strike's ultra-low size profile is also optimal for small platforms, and along with NVIDIA's Jetson family of products that are built specifically with robotics and autonomy in mind, Systel delivers a powerful computer solution for platforms such as drones or ground robots.

Systel's solutions are able to run complex AI algorithms, which enable us to deliver best-in-class performance at the edge.

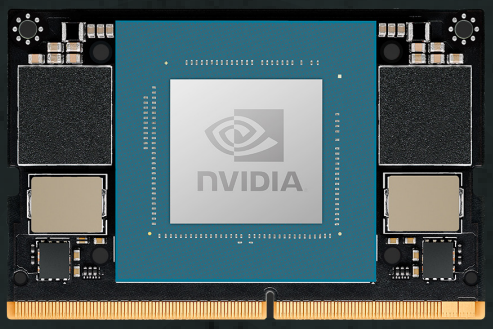
Developments in technology such as this are what is empowering this revolution in AI-centric operations and solutions, enabling computers to carry out tasks independently and reduce the burden on human operators.

AI-based solutions need to be powerful enough to handle the task at hand while also rugged enough to perform in the harshest of conditions. Sparrow-Strike meets these demands, ensuring that the warfighter has the best possible capabilities at their disposal.

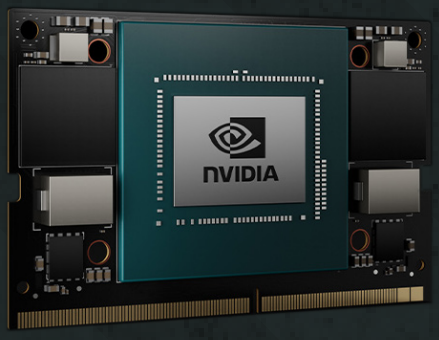
US DoD rapidly adopting commercial technology

The Pentagon is a behemoth organization and the issues surrounding its lengthy, expensive and inefficient procurement programs are well known. This slow procurement process has been flagged by industry as

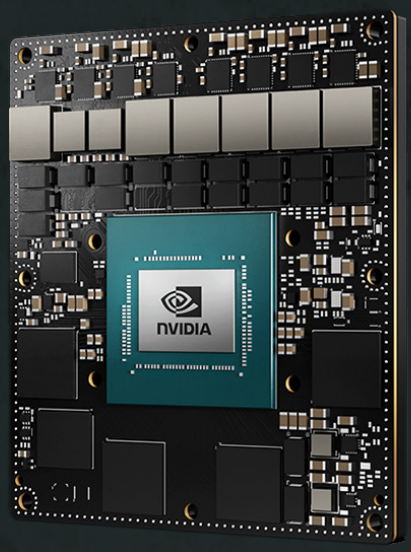
NVIDIA's Jetson Orin Embedded Series



Jetson Orin Nano



Jetson Orin NX



Jetson AGX Orin

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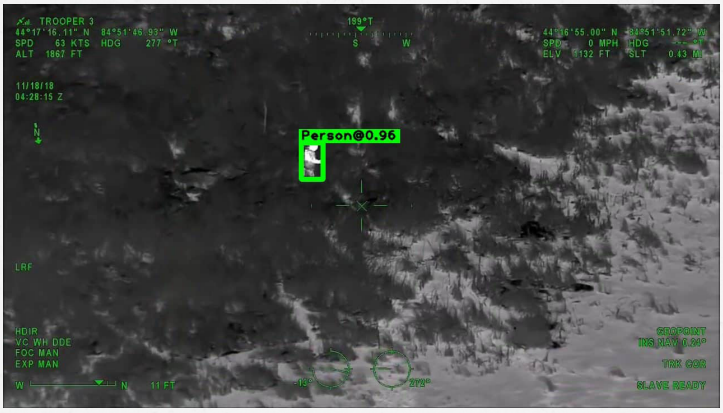
a reason for the DoD's poor performance when it comes to adopting emerging technologies such as AI, and that is a worry for Congress.[8]

The worry is that such sluggish procurement effectively nulls any technological progress vis-a-vis China, as capabilities are already outdated once fielded.

In the 2022 NDS, the US DoD highlighted that the current system is "too slow and too focused on acquiring systems not designed to address the most critical challenges we now face". Instead, the DoD highlighted in the NDS its intention of being a "fast follower where market forces are driving the commercialization of military-relevant capabilities in trusted artificial intelligence and autonomy, integrated network system-of-systems, microelectronics, space, renewable energy generation and storage, and human-machine interfaces".



Over the last few years, the Pentagon has sought to address the procurement challenge by accelerating the adoption of innovative technology via newly created organizations. Possibly one of the best known of these is the Defense Innovation Unit (DIU), which was created in 2015 to accelerate the adoption of commercial technology in the military. According to the DIU, it remains the only DoD organization that has an exclusive focus on fielding and scaling commercial tech for US troops.[9]

In 2022, the DIU supported the transition of 17 commercial solutions from prototype to a production or service contract with the DoD or other federal government entity, the highest number of transitions in the DIU's history. These commercial solutions include technologies such as cyber and telecommunications, space-based solutions, autonomous uncrewed vehicles, and AI/ML.

In 2023, the House Defense Appropriations Subcommittee recommended that the DIU build a "hedge portfolio" that harnesses innovation from the commercial sector, including for drones, agile communications and computing nodes, and AI capabilities.[10] The idea of the portfolio is to hedge against the tactical and logistical risks to current weapon systems as well as a "hedge against industrial base risk", according to the HAC.

Slow procurement cycles are also a concern for start-ups and their VC backers. New entrants to the defense market find generating all-important revenues and ensuring long-term stability is challenging when contracts from key defense programs can take years to fully realize.

Despite this, investment in startups that specialize in disruptive tech for defense applications has risen sharply in 2023. Over 200 deals were done by venture capitalists in the first five months of 2023 worth an estimated $17 billion, a billion dollars more than was invested for the whole of 2019.[11] After years of shunning defense, established VCs are now seeing opportunities to invest in tech start-ups that could tap into the Pentagon's large budget.

The invasion of Ukraine by Russia significantly changed the market and investors' appetite for defense investment. Traditionally, it was something of a taboo for VCs to invest in defense but the geopolitical environment, and the US DoD's growing desire (and budget) for

innovative start-up tech to address operational requirements, has meant that many have come round to the idea of putting money into this area.

The Systel advantage: *Systel develops technology at the speed of relevance, using the latest in commercial GPUs and PC architecture standards – such as PCI Express – and as such benefits from leading off-the-shelf computing technology.*

Adopting commercial tech in certain areas speeds up development, ensuring that the most modern computers are delivered to customers and the avoidance of long development cycles that lead to premature inventory obsolescence.

It also enables Systel to deliver to its customers the most advanced computer design, which alongside the mil-spec ruggedness and edge performance that are at the center of all Systel products, delivers to customers the highest-performing military systems.

Rapid capability development

As well as being a concern for the wider Pentagon, individual services are also keen to accelerate the fielding of disruptive tech to the warfighter.

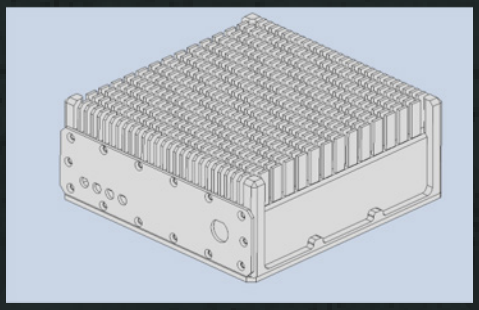
Rapid Capabilities Offices, such as the one formed by the Department of the Air Force, are primarily tasked with accelerating the development, acquisition and fielding of battlefield capabilities.[12] The ongoing war in Ukraine and the often lightning pace with which commercial technology was rerolled for military applications has once again put the spotlight on acquisition timelines.

In 2021, the US DoD introduced the Rapid Defense Experimentation Reserve (RDER – pronounced Raider), an initiative that takes prototypes from other organizations such as the Defense Advanced Research Projects Agency (DARPA) and runs them through real-world experimentation to accelerate their path to a fieldable capability. The Pentagon is expected to soon select the first capabilities that will be fielded to the military after successful testing, although what these technologies are remains undisclosed.[13]

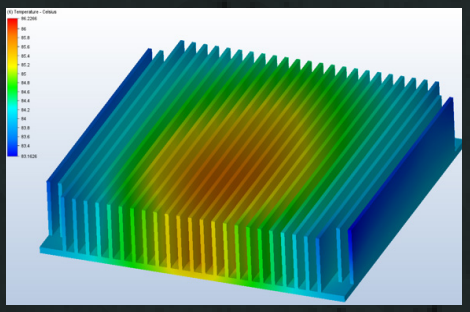
Experimentation exercises are also employed by all three services as a way of getting new equipment into the hands of soldiers while it is being developed and to iron out any problems. The US Army has ran experiments for its armored on-the-move communications capabilities[14], while the US Navy has looked to integrate uncrewed systems into its massive Rim of the Pacific (RIMPAC) exercise to experiment with a range of robotic platforms.

The US Army has also carried out experiments as part of its effort to evaluate and eventually introduce a fleet of Robotic Combat Vehicles (RCV) of varying sizes and capabilities, which will work closely alongside crewed platforms on the future battlefield. In September 2023, it was also revealed that the US Army contracted four companies to build RCV-Light prototypes, marking that the program had officially moved from its experimentation phase to a fieldable platform by 2030.[15]

Sparrow Takes Flight



Initial Concept



CFD Analysis

"Ugly Sparrow" Functional Proof of Concept

First Article Prototype

Bringing products not powerpoints to customers

Systel offers a disruptive approach to defense contracting, bringing products not powerpoints to customers by identifying problem spaces and engaging in new product innovation to bring the right solutions to market, with COTS technologies and proven capabilities.

> **"...through spiral development, Systel uses Lean and Agile methodologies...always maintaining focus on the end user, the soldier..."**

A prime example is Systel's latest edge compute product, Sparrow-Strike. Sparrow-Strike underwent a very rapid development process, going from idea to functional proof of concept system to fully designed first article prototype in eight months.

Systel's "StrikeEdge" Advanced Development Group (ADG) iterated rapidly through initial design cycles to develop a fully functional proof of concept system, codenamed "Ugly Sparrow," getting it in the hands of potential users and collecting feedback.

"UGLY" SPARROW

Through spiral development, Systel uses Lean and Agile methodologies with continuous customer communication and feedback loops to ensure that design does not happen in a vacuum but instead utilizes direct voice of the customer as the driving mechanism for product requirements, while always maintaining focus on the end user, the soldier.

Multidomain operations

One of the critical areas for the US military is Joint All Domain Command and Control (JADC2), which is the DoD's ambitious effort to implement joint C2 capabilities across all operational domains and echelons. In simple terms, the DoD wants to connect all battlefield sensors and shooters across all domains, allowing information to be shared in real-time and resulting in information and decision advantage for US commanders.

Experimentation is also taking place – headed by the Chief Digital and Artificial Intelligence Office (CDAO) – to inform solutions that will relate to joint data integration and the use of AI/ML.

As articulated in the JADC2 Strategy document, JADC2 provides: "...a coherent approach for shaping future Joint Force C2 capabilities and is intended to produce the warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners, to deliver information advantage at the speed of relevance".

One of the four top-level defense priorities set out in the 2022 NDS is building a resilient Joint Force and defense ecosystem, which will strengthen US deterrence against pacing threats such as China.

The implementation of the JADC2 approach is guided by a number of overarching principles, including being data and interoperability standards driven, being cyber secure, and resilient in degraded environments. Resilience will be significant in any peer conflict as an adversary will attempt to counter any advantage created through JADC2.

The US Air Force's contribution to the JADC2 concept is the Advanced Battle Management System (ABMS), which is still in its infancy and analysis is still being undertaken for what ABMS will look like.

"What do we need to do for compute and processing?" Brig. Gen. Luke Cropsey, PEO for command, control, communications and battle management, was reported as saying by Breaking Defense in August 2023.[16] "How does the ability to put that capability out further towards the edge and maybe in disadvantaged locations otherwise influence and affect your ability to maintain your command and control through a variety of different operational environments?"

Meanwhile, the US Army has up until recently held large-scale exercises as part of what has been known as 'Project Convergence' to test technologies and operating concepts that align with JADC2. However, senior leaders decided not to go forward with the 2023 iteration of Project Convergence and there is no firm decision as to whether any more will be held in the future. Nevertheless, JADC2 remains central to the US Army's communications modernization roadmap.

The Systel advantage: *Edge computer processing will be critical to enabling the JADC2 concept.*

When integrating the NVIDIA Jetson AGX Orin NX embedded module, Sparrow-Strike edge can provide up to 100 TOPS, which alongside Systel's rugged design will deliver powerful AI computing even in the most demanding of conditions.

Furthermore, the small form factor of Sparrow-Strike enables the Edge AI variant of the system to be used in a multitude of applications, and soldier wear is in the technology roadmap to take it even closer to the edge.

Conclusion

The US military is facing, and will face, significant challenges in the future, from a myriad of sources. Next-generation technology will be a key force multiplier for US personnel, with units being able to leverage uncrewed platforms and AI-enabled systems that can analyze data lakes and make decisions far quicker and more effectively than is humanly possible today, reducing the latency from sensor to shooter on the connected battlefield. Edge computers, embedded into systems that are rapidly procured to meet emerging threats, will be central to this, and Systel is ready to meet this challenge.

Endnotes

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