IRIA Defense Review

Use of Advanced Technologies and AI in Shaping Modern Warfare

International Relations Insights & Analysis

International Relations Insights & Analysis

IRIA Defense Review

Use of Advanced Technologies and AI in Shaping Modern Warfare

For more information visit:
www.ir-ia.com

International Relations Insights & Analysis

International Relations Insights & Analysis (IRIA) is a research institute focusing on critical issues that threaten international peace & security. IRIA investigates and offers research and analysis on security, energy, terrorism, foreign affairs as well as global political agendas. We formulate independent, concise, and meaningful research presented in an informative and interactive manner.

IRIA special reports include experts' opinions, special features, cost & benefit analysis. IRIA also examines risk & opportunities, highlight common threats and misconceptions and provide improved set of strategies and countermeasures. The key findings of reports and analysis highlight pragmatic policy options and revise strategies.

IRIA aims to support grassroots democracy, promote peace-building processes and cultural harmony by working with scholars, policymakers, and institutions.

IRIA Publications include Exclusive Reports, Defense Review, and Journal of International Affairs & Politics.

Overview

We live in a world constantly engulfed by the shadows of ongoing wars and conflicts. With two wars raging in Ukraine and Gaza and violent conflicts in Africa, there is more chaos, bloodshed, and insecurity.

With increasing wars and conflicts, advancements in defense capabilities and military technology add layers of complexity to the evolving geopolitical landscapes.

This comprehensive IRIA Defense Review delves into a diverse array of critical topics shaping the contemporary defense landscape, ranging from cutting-edge innovations in aerospace technology to the complex dynamics of cyber warfare. With a focus on global trends and military modernization, this report aims to provide a nuanced understanding of the multifaceted dimensions of modern warfare, as well as defense and military strategies adopted by different countries.

Russia's war of aggression in Ukraine, and the ongoing crisis in the Middle East have pushed the world powers to reevaluate defense strategy and prioritize defense investments while strengthening partnerships. This IRIA Defense Review highlights the rise of new technologies and their expanding roles within military contexts. Emerging technologies such as artificial intelligence (AI), cyber capabilities, and unmanned systems are altering the nature of warfare and defense strategies worldwide.

As nations become increasingly dependent on digital infrastructure, they are exposed to increased cyber threats. Cybersecurity has emerged as a cornerstone of modern national security policies to protect sensitive infrastructure and data and bolster overall security. This year's report details the cybersecurity challenges and development of cyber defense capabilities, and its role in modern conflicts and underscores the importance of cybersecurity in contemporary conflict dynamics.

One of the key focuses of military technology in this year's Defense Review is the integration of AI and its transformative potential including its role in decision-making, logistics, and autonomous systems. United States, United Kingdom, China, France,

Overview

Russia, South Korea, and Israel are heavily investing in autonomous weapons systems. AI's applications in military and defense span land, air, space, sea, and cyber domains, enhancing situational awareness, decision-making, and operational efficiency.

The integration of advanced robotic and autonomous weapon systems across military domains is also gaining momentum. The U.S. Army is actively integrating advanced robotic and autonomous systems into its units, spanning ground and aerial platforms, with promising experiments conducted at the operational level. The U.S. Army envisions a future where soldier formations are more efficient and lethal due to these advancements.

The Defense Review also focuses on the use of electric Vertical Takeoff and Landing (eVTOL) technology in enhancing military mobility, highlighting its potential impact on tactical operations and diverse applications in the military domain. Spearheaded by the Agility Prime program, the U.S. Air Force (USAF) has adopted the eVTOL technology and driving innovation by collaborating with the commercial industry to develop a new class of air mobility systems.

In the Indo-Pacific region, the world's largest navy is actively seeking to bolster its maritime capabilities with advanced guided-missile destroyers, amphibious assault ships, and aircraft carriers. The chapter on China's naval modernization delves into the country's rapidly modernizing and diversifying navy, and the Chinese Navy's aspiration to evolve into a world-class navy. Key areas of focus in the report include China's aircraft carriers, underwater drones, unmanned systems, submarines, destroyers, frigates, and corvettes, illustrating the breadth and depth of China's naval modernization efforts.

As naval prowess grows worldwide, so does the global contest for supremacy in advanced fighter aircraft. Several countries and their aerospace firms are deeply involved in researching and developing sixth-generation fighter jets. These next-gen aircraft incorporate features like stealth technology, advanced avionics, high-performance engines, and modern weaponry for air-to-air and air-to-surface combat. The Defense

Overview

Review dedicates a chapter and delves into several prominent sixth-generation fighter jet projects, including the United States NGAD and F/A-XX Program, the Mitsubishi F-X Jet, and the BAE Tempest, examining their advancements and strategic implications in shaping future aerial warfare.

In the context of rapid technological advancements, drone technology has been significant in revolutionizing modern warfare. Recent conflicts have showcased the transformative impact of drones on the battlefield, from compact palm-sized drones to larger models, enabling militaries to conduct surveillance, air raids, and attacks remotely. The Defense Review focuses on the evolving role of unmanned aerial vehicles and their applications in reconnaissance, surveillance, and targeted strikes. It also explores the ten most advanced and lethal combat drones utilized by various militaries worldwide, highlighting their capabilities and strategic significance in contemporary warfare.

Growing tensions in the Pacific and North Korea's barrage of new missile tests have remained a significant cause of concern since 2022. In this context, Japan's ambitious military modernization efforts have been noteworthy. This report provides an analysis of Japan's expansion of military power, marked by a substantial increase in defense spending. The report sheds light on Japan's evolving defense capabilities, objectives, and strategies in land, air, sea, and cyber domains. The surge in defense investment underscores Japan's commitment to bolstering its deterrent capabilities and readiness for potential conflicts.

As nations navigate the evolving threat landscape and strive to maintain strategic advantage, this report explores the multifaceted landscape of contemporary defense and technological innovation and seeks to provide policymakers, defense analysts, and stakeholders with valuable insights into the complex dynamics shaping modern warfare and defense strategies in the 21st century.

Table of Contents

How Artificial Intelligence is Transforming Modern Warfare and Strategies

Recent advancements in artificial intelligence (AI) and the potential of this technology have led to the development and deployment of technologies that were once considered science fiction. From autonomous drones to military robots, the integration of AI into various sectors is reshaping warfare, national security, diplomacy, economy, governance, health, and beyond.

AI refers to the ability of machines to perform tasks that would otherwise require human intelligence, such as reasoning, perception, decision-making, recognizing patterns, learning from experience, drawing conclusions, and making predictions. The U.S. Department of Defense (DoD) describes AI as "the ability of machines to perform tasks that normally require human intelligence" and the Defense Advanced Research Projects Agency (DARPA) defines AI as "a programmed ability to process information."

Military AI capabilities include weapons as well as decision support systems that help leaders at all levels make better and timely decisions, from the battlefield to the boardroom, from combat to tactical to operation level.

Though rudimentary forms of AI have existed for decades, recent years have seen an enormous leap in the technology's capabilities. The roots of AI development trace back to the 1940s with the creation of artificial neurons by Warren McCulloch and Walter Pitts. Alan Turing, the father of modern computer science, introduced the Turing Test in 1950 to determine a machine's ability to exhibit human-like responses and intelligence. Japan developed the first 'intelligent' humanoid robot WABOT-1 in 1972.

In the 2000s, the key AI developments included the emergence of machine learning, the expansion of robotics and computer vision, and the rise of data mining and pattern recognition. The 2010s saw remarkable progress in AI across various domains, driven by deep learning breakthroughs, open-source collaboration, increasing computing power, and more research funding and investment. In 2015, OpenAI's establishment laid the groundwork for the current AI boom. In 2016, Google DeepMind's AlphaGo program defeated professional Go player, demonstrating deep reinforcement learning's potential for

(Image Credit: Rawpixel/via Freepik)

complex strategic games. In 2019, the world saw the launch of the first AI-enabled astronaut assistant.

The true turning point came with the launch of ChatGPT in late 2022, which brought AI into the public spotlight, generating widespread interest and investment. The post-2020 era is marked by groundbreaking developments in Generative AI, with large language models like OpenAI's ChatGPT-4, Google's Gemini (formerly Bard), Microsoft's Bing AI, and Mistral AI's Mixtral 8x7B, pushing the boundaries of human-machine interactions. Generative AI refers to programs that can create high-quality text, images, and other content based on the data they were trained on.

Artificial Intelligence Transforming Modern Warfare

With continuous advances in technology, the United States (U.S.), United Kingdom (UK), China, France, Russia, South Korea, and Israel are heavily investing in the development of weapons with increasing autonomy as other states are considering how to respond to the automation of warfare.

As more countries look to incorporate this technology into their militaries, these machines have prompted a debate about the development and deployment of weapons that can perform increasingly advanced functions with little or no human oversight. This led to the first-ever debate on AI at the United Nations Security Council meeting in July 2023, with a focus on the opportunities and risks posed by AI to international peace and security.

Beyond this initiative, several countries have started paying greater attention to the growing role of AI for military purposes. This culminated in the Responsible AI in the Military Domain (REAIM) summit, held in 2023 at The Hague.[1] The summit, which the Netherlands co-organized with South Korea, issued a declaration titled "call to action" on the responsible development, deployment, and use of AI in the military domain. This was endorsed by 57 states, including the U.S., UK, China, Japan, Germany and France, excluding Russia. The summit discussed general military and defense-related applications of AI as well as the lethal autonomous weapon systems (LAWS).

Countries have also made progress in governing military AI. In February 2020, the US Department of Defense (DoD) became the first military department in the world to adopt ethical principles for all its military AI applications.[2] This builds upon Directive 3000.09, established in 2012 and updated in January 2023, which governs the development and fielding of autonomous and semi-autonomous weapon systems. Other countries like the UK and France have developed national policies on military AI. Additionally, NATO unveiled its first AI strategy in 2021 for the responsible future use of AI.

---

1. Responsible AI in the Military Domain Summit 2023, Ministry of Foreign Affairs, Government of the Netherlands, January 24, 2024. https://www.government.nl/ministries/ministry-of-foreign-affairs/activiteiten/reaim/

2. U.S. Department of Defense, DOD Adopts Ethical Principles for Artificial Intelligence, DOD Release, February 24, 2020. https://www.defense.gov/News/Releases/Release/Article/2091996/dod-adopts-ethical-principles-for-artificial-intelligence/

U.S. Ambitions to Become an AI-Empowered Military

(Image Credit: DARPA)

The United States is leading the way in AI technology development, driven by its ambition to become an AI-empowered military. In September 2018, the Pentagon pledged to make the largest investment to date in artificial intelligence (AI) systems for US weaponry, committing to spend US$2 billion over the next five years through its Defense Advanced Research Projects Agency (DARPA), to "develop next wave of AI technologies".[3] DARPA has a long history of funding research on advanced technologies, including AI, at universities like the Massachusetts Institute of Technology (MIT) and Stanford University.

Recently, the U.S. military sought billions of dollars from lawmakers to enhance its AI and networking capabilities in the fiscal year 2024, aiming to become a more agile and interconnected force. The Pentagon aims to leverage AI for improved decision-making and to enhance unmanned platforms and other systems.A Chief Digital and AI Office (CDAO) has been established to facilitate technology integration.[4] The 2024 budget request includes $1.8 billion for artificial intelligence and machine learning (AI/ML) to deliver responsible AI-enabled capabilities and support workforce development and data management efforts. Additionally, the Defense Department in fiscal 2024 requested $1.4 billion for Joint All-Domain Command and Control (JADC2) initiatives to "transform warfighting capability."

CJADC2 – the future of joint warfare: The Combined Joint All-Domain Command and Control (CJADC2) is a warfighting concept of digitally connecting the joint force across air, land, sea, cyber, and space domains. This system is meant to connect data-centric information from all branches of service, partners, and allies, into an internet of military things, making information and cutting-edge decision support tools accessible anywhere, anytime for quick battlefield decisions. The Internet of Military Things (IoMT) is a network of sensors, wearable devices, robots, munitions, weapons, vehicles, and IoT devices that use cloud and edge computing to increase military capabilities and safety. The Defense Department has awarded contracts to four technology companies, Amazon Web Services, Google, Microsoft, and Oracle, to provide services in support of its joint warfighting cloud capability. The Pentagon's portfolio includes more than 800 AI-related unclassified projects, many in the testing phase.[5]

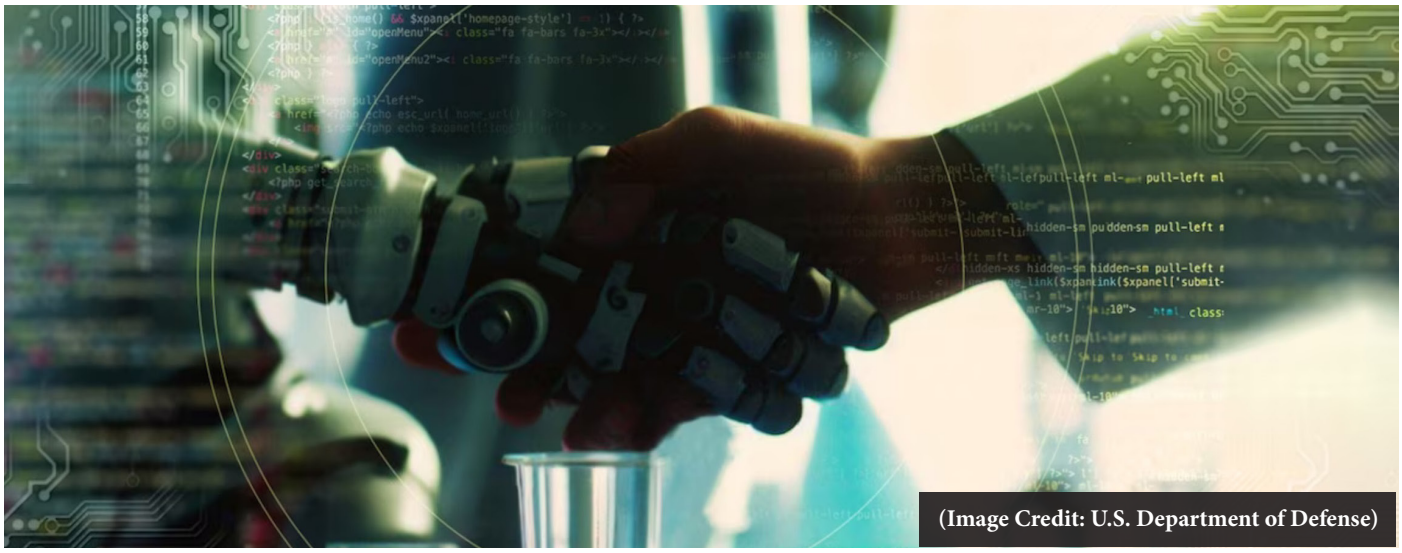
In October 2023, U.S. President Biden issued an executive order to promote the adoption of AI safety standards, harness AI's game-changing cyber capabilities, and reduce the potential

---

3. DARPA, AI Next Campaign (Archived), Defense Advanced Research Projects Agenct, March 25, 2024. https://www.darpa.mil/work-with-us/ai-next-campaign/

4. Chief Digital and Artificial Intelligence Office, U.S. Department of Defense, April 24, 2024. https://www.ai.mil/

5. Frank Bajak, Pentagon's AI initiatives accelerate hard decisions on lethal autonomous weapons, The Associated Press, November 25, 2023. https://apnews.com/article/us-military-ai-projects-0773b4937801e7a0573f44b57a9a5942/



(Image Credit: U.S. Department of Defense)

risks that AI can pose. To keep up with the ever-evolving technology, DoD is adopting these innovations and integrating AI into operations to "develop a more modernized, data-driven, and AI-empowered military" to progress decision advantage by improving the speed, quality, and accuracy of decisions that can be decisive in a fight.

AI Strategy 2023: In late 2023, the Pentagon released a new data, analytics, and AI strategy to accelerate the department's adoption of AI capabilities to ensure U.S. warfighters maintain decision advantage on the battlefield. The document provides a foundation for DoD to leverage emerging technology in the years to come.[6] Developed by the CDAO, the strategy describes the approach to improving the organizational environment within which "DoD leaders and warfighters will be able to make rapid, well-informed decisions by expertly leveraging high-quality data, advanced analytics, and AI for enduring decision advantage".[7]

Former U.S. Chief Digital and AI Officer Craig Martell said the strategy prioritizes an agile approach by focusing on the fundamentals of speed, agility, responsibility, and learning. "Accelerating the adoption of advanced data, analytics, and artificial intelligence technologies presents an unprecedented opportunity to equip Department leaders, at all levels, with the data they need, to make better decisions faster, from the boardroom to the battlefield," he said.[8]

AUKUS: The U.S. is also collaborating with its international partners in the AI realm. The AUKUS alliance, comprising Australia, the United Kingdom, and the United States, conducted the first joint AI and autonomy trial held in the UK in April 2023. This test was followed by the Trusted Operation of Robotic Vehicles in a Contested Environment (TORVICE) trial conducted in the fall of 2023 at Cultana Training Area, South Australia. A team of AUKUS scientists participated in successful TORVICE trials for the integration of advanced autonomy

---

6. Jospeh Clark, DOD Releases AI Adoption Strategy , U.S. Department of Defense News, November 2, 2023. https://www.defense.gov/News/News-Stories/Article/Article/3578219/dod-releases-ai-adoption-strategy/

7. U.S. Department of Defense, Data, Analytics, and Artificial Intelligence Adoption Strategy, DOD, June 27, 2023. https://media.defense.gov/2023/Nov/02/2003333300/-1/-1/1/DOD_DATA_ANALYTICS_AI_ADOPTION_STRATEGY.PDF

8. U.S. Department of Defense, Deputy Secretary of Defense Kathleen Hicks Announces Publication of Data, Analytics and AI Adoption Strategy, DOD Release, November 2, 2023. https://www.defense.gov/News/Releases/Release/Article/3577857/deputy-secretary-of-defense-kathleen-hicks-announces-publication-of-data-analyt/

and artificial intelligence (AI) in robotic vehicles for military operations.[9]

TORVICE was aimed at identifying and resolving vulnerabilities in autonomous systems in contested electronic warfare environments. Ground vehicles from the U.S. and UK simulated autonomous multi-domain launchers and conducted various missions, including long-range precision fires. This trial demonstrated the commitment of AUKUS nations to advanced capabilities in AI and autonomy, promoting security and stability in the Indo-Pacific region. Additionally, AUKUS partners are advancing resilient and autonomous AI technologies in land and maritime domains for force protection, precision targeting, intelligence, surveillance, and reconnaissance, with plans to integrate these technologies into national programs by 2024.

Believing that technology with global impact demands collective action, the U.S. is also engaging with other countries on responsible military use of AI applications. U.S. defense officials plan to meet with representatives from over 50 nations by mid-2024 to discuss a newly established framework for the responsible development and deployment of AI and autonomous military technologies. The 'Political Declaration on Responsible Military Use of Artificial Intelligence and Autonomy', initiated in early 2023, has garnered endorsements from more than 51 countries. This declaration aims to create international consensus and provide guidance for states in the military AI domain, fostering exchanges of best practices and facilitating capacity building among endorsing states.[10]

China's Application of AI in Military

China is also at the forefront alongside the United States in advancing AI technology for military applications. The country is aggressively pursuing AI capabilities with ambitions to lead the world in AI by 2030.[11] China has spearheaded a global surge in investment in generative artificial intelligence (AI) in the first half of the year, with the country leading in the number of startups in the sector to secure funding, according to a 2023 research report.[12] In the first half of the year 2023, China had 22 generative AI startups that received funding, followed by the US with 21 and the UK with four, according to a report by Zhidongxi, a Chinese AI-focused research firm.[13]

Despite having the highest number of generative AI start-ups securing funding, U.S. firms received more total funding, the report indicated. China's leading tech firms and startups are striving to close the gap with their US counterparts following the launch of ChatGPT by

9. IRIA, AUKUS conducts trials for advanced AI-controlled robotic vehicles, IRIA News, February 7, 2024. https://www.ir-ia.com/news/aukus-conducts-trials-for-advanced-ai-controlled-robotic-vehicles/

10. U.S. Department of State, Political Declaration on Responsible Military Use of Artificial Intelligence and Autonomy, DOS Bureau of Arms Control, Deterrence, and Stability, November 9, 2023. https://www.state.gov/political-declaration-on-responsible-military-use-of-artificial-intelligence-and-autonomy-2/

11. Rabi Sankar Bosu, China's presence glorifies the AI Safety Summit 2023, CGTN News, November 2, 2023. https://news.cgtn.com/news/2023-11-02/China-s-presence-glorifies-the-AI-Safety-Summit-2023-1ooX4T0Iev6/index.html/

12. Xinmei Shen, China leads world in number of generative AI start-ups to receive funding in first half of 2023, report finds, South China Morning Post, July 10, 2023. https://www.scmp.com/tech/tech-trends/article/3227197/china-leads-world-number-generative-ai-start-ups-receive-funding-first-half-2023-report-finds/

13. Global Times, Companies rush to launch LLMs amid global AI frenzy, GT, November 7, 2023. https://www.globaltimes.cn/page/202311/1301370.shtml/

Microsoft-backed OpenAI last year. Chinese tech giants including Tencent Holdings, Baidu, and Alibaba Group are investing heavily in the field with a focus on developing their own large language models (LLMs).

China is also extending its lead over the U.S. in AI patent filings, with Chinese institutions submitting 29,853 AI-related patents in 2022, compared to a decrease in U.S. filings. China now accounts for over 40% of global AI patent applications, according to data from the UN-affiliated World Intellectual Property Organization.[14]

China is actively pursuing AI supremacy, aiming to become a global leader in both economic and military applications. China was probably the first to enter into the ranks of AI-empowered countries with the launch of its 'New Generation Artificial Intelligence Development Plan' in 2017, laying out a comprehensive blueprint for AI development in private and public sectors.

Robots are displayed at the opening of the three-day 2023 World Artificial Intelligence Conference in Shanghai on July 6, 2023. (Image Credit: VCG/GT)

Over the years, China has been actively capitalizing on the application of AI in the People's Liberation Army (PLA), with significant implications for international and regional security dynamics. The Chinese leadership's vision encompasses utilizing AI to bolster both economic competitiveness and military capabilities. The Chinese government has implemented a multifaceted approach encompassing various strategies such as 1) resource mobilization for AI development, including financial investments, and research initiatives, 2) cultivating a skilled workforce in AI-related fields through educational and academic programs, 3) engaging with international partners and institutions to acquire knowledge and expertise in AI through collaborations, joint research initiatives, and technology transfer agreements.[15]

In the realm of military affairs, the PLA views AI as a transformative force that is reshaping the nature of warfare. PLA strategists and academics describe current trends as heralding a new military revolution driven by AI and related technologies. The application of AI in military operations encompasses a wide range of capabilities, including:

Unmanned Intelligent Combat Systems: China is heavily investing in the development of unmanned intelligent vehicles, platforms, and weapons systems, leveraging AI to enhance

14. Bloomberg News, China Widens Lead Over US in AI Patents After Beijing Tech Drive, Bloomberg, October 24, 2023. https://www.bloomberg.com/news/articles/2023-10-24/china-widens-lead-over-us-in-ai-patents-after-beijing-tech-drive

15. Jiayu Zhang, China's Military Employment of Artificial Intelligence and Its Security Implications, The International Affairs Review, August 16, 2020. https://www.iar-gwu.org/print-archive/blog-post-title-four-xgtap/

battlefield reconnaissance, surveillance, communication, and combat assessment. These AI-enabled systems are expected to disrupt traditional warfare paradigms by enhancing speed, accuracy, and operational effectiveness.

Multi-Domain Offense and Defense: AI is being integrated into offensive and defensive capabilities across multiple domains, including nuclear, cyber, and space. The PLA seeks to leverage AI-driven big data analytics, machine learning, and automation to enhance situational awareness, defense of critical networks, and the scalability of offensive cyber operations.

Training, Simulation, and Wargaming: AI technologies are being utilized to enhance the sophistication of military simulations, war-gaming, and training exercises. With limited opportunities for actual combat experience, the PLA places great emphasis on simulation-based training methods to prepare commanders and soldiers for diverse operational scenarios.

Ukraine War – A Testing Ground for Military AI

Russia's ongoing invasion of Ukraine has been a testing ground for new applications. Some Pentagon officials see it as a valuable learning opportunity for the U.S. military regarding the strategic use of drones and artificial intelligence, particularly evident in the significant role played by drones with semi-autonomous capabilities.

While low-cost unmanned systems have appeared in recent conflicts, including the 2021 war between Armenia and Azerbaijan, the war in Ukraine offers a unique learning opportunity about AI-enabled platforms. As Ukraine increasingly integrates AI into its military systems, there is a growing emphasis on understanding the evolving nature of warfare and harnessing technology for strategic advantage. The Pentagon is closely observing Ukraine's advancements in AI as it develops its own algorithms and AI-enabled platforms, recognizing the transformative impact of technology on modern warfare.

In addition to autonomous weapons, there have been other noteworthy AI tech adaptions. For instance, Ukrainian AI company Primer modified its commercial AI-enabled voice transcription and translation service so that it could process intercepted Russian communications and automatically highlight information concerning the Ukrainian forces. Ukraine has also used U.S.-based startup Clearview AI's facial recognition technology software to identify deceased Russian personnel through their social media profiles to notify their relatives and transfer their bodies. The Clearview AI database helped Ukraine identify the dead easily without the need to match fingerprints and works even if there is facial damage.

Data analytics company Palantir's role in facilitating targeting efforts in Ukraine underscores the pivotal role of advanced targeting capabilities and algorithms in modern warfare. The U.S.-based company's software helps Ukraine target, for instance, tanks and artillery. Palantir CEO Alex Karp has said Ukraine's use of emerging technologies has given it the edge over one of the world's foremost military powers. Speaking at the Dutch government's Responsible AI in the Military Domain (REAIM) event. Karp said that in modern warfare, militaries lacking advanced targeting capabilities and algorithms are significantly disadvantaged. "The old way of targeting where algorithms aren't used is clearly a failure. If you go into battle with old-school technology even if you're spending $65 billion a year and you're highly accomplished

Serviceman of the 80th Airborne Assault Brigade of the Armed Forces of Ukraine prepares to operate an FPV-drone in Donetsk region on November 7, 2023. (Image Credit: Reuters/Alina Smutko)

warfighters like Russia, and you have an adversary that knows how to install and implement digitalized targeting and AI, you're at a massive disadvantage," Karp said.[16]

With AI-driven targeting becoming commonplace in warfare, the strategic significance of AI technologies has risen to the top of global military and political agendas. "We are really convinced that ongoing and future conflicts may be won, lost or heavily impacted by AI speed, AI efficacy and who is actually using AI in the battlefield," Dr Nikos Loutas, NATO's head of data and artificial intelligence (AI) policy said at the AI Summit London.

Applications of Artificial Intelligence in Military and Defense

Artificial intelligence is revolutionizing military and defense operations across the land, air, space, sea, and cyber domains, enhancing situational awareness, decision-making, and operational efficiency. Its applications span from autonomous weapons systems and drones to predictive analytics, from intelligence analysis to reconnaissance, cybersecurity, and logistics, marking a new era of warfare characterized by advanced technology. Some of the key applications are as follows:

- Training and Simulations
- Logistics and Transport
- Medical Support and Healthcare
- Cybersecurity
- Decision Support Systems
- Autonomous Weapon Systems
- Target recognition and tracking

AI-powered Training and Simulations

The integration of simulators in military training has revolutionized soldier preparedness for combat. These simulators offer a cost-effective, safe, and immersive alternative to traditional methods, providing realistic scenarios without endangering lives. Advanced AI technologies and immersive virtual reality (VR) and augmented reality (AR) simulators are critical to keep soldiers ready and improve their skills for an ever-changing battlespace.[17]

---

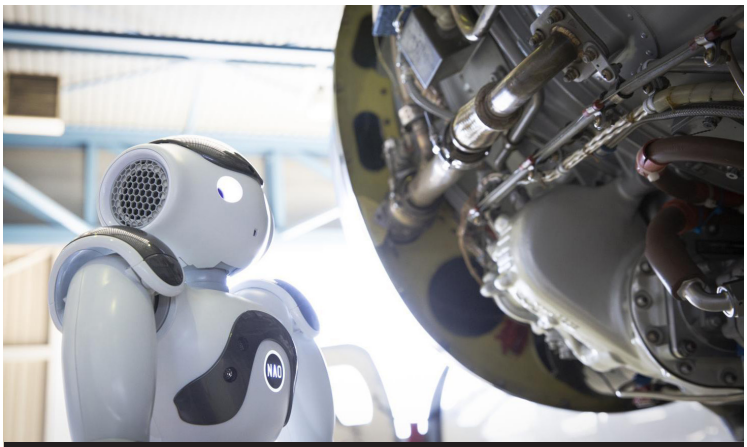
16. Ben Wodecki, Ukraine War One Year On: How AI Has Shaped the Battlefield, AI Business, February 24, 2023. https://aibusiness.com/verticals/ukraine-war-one-year-on-how-ai-has-shaped-the-battlefield/

17. Aerospace and Defense Review, Military Simulations: The Power of AI, AR/VR, and Machine Learning, October 9, 2023. https://www.aerospacedefensereview.com/news/military-simulations-the-power-of-ai-arvr-and-machine-learning-nwid-1389.html/

The U.S. Army's new training simulators, set for delivery in 2024, would become a crucial component of modern warfare preparations. These tools allow soldiers to coordinate helicopters, tanks, and infantry effectively. Recent tests showcased the equipment's capabilities, with drones coordinating artillery strikes against attacking forces, demonstrating their effectiveness in combat simulations. The simulators cover a range of vehicles and aircraft, including the M1 Abrams tank, Black Hawk helicopter, CH-47 Chinook transport helicopter, RQ-7 Shadow drones, and MQ-1C Gray Eagle drone, enhancing training realism and readiness for future missions.[18]

Dr. George Lecakes, director of Rowan University's Virtual Reality Center and Rowan senior Garrett Williams demonstrate a training scenario designed for the U.S. Army. (Image Credit: Rowan Today)

In 2023, Rowan University secured a $3 million grant from the U.S. Department of Defense (DoD) to develop virtual and mixed-reality combat simulations enhanced by AI. This initiative builds upon a $5.5 million partnership between Rowan University and the U.S. Army Combat Capabilities Development Command Armaments Center. Led by Dr. Nidhal Bouaynaya, the project aims to refine next-generation gunner turret systems by developing immersive and autonomous mixed-reality environments. These environments simulate combat scenarios, utilizing virtual, augmented, and mixed-reality technologies, along with secure communication systems and sensor suites. By integrating AI algorithms, the project seeks to enhance situational awareness and threat detection capabilities for military personnel. The team has made significant progress, developing a virtual environment with realistic visuals and demonstrating the AI system's ability to detect real-time aerial drone threats.[19]



NLR robotic mechanic ARVI. (Image Credit: NLR)

In Europe, the Netherlands Aerospace Center (NLR) has developed ARVI (autonomous robot for visual inspections) which features a sophisticated sensor system, and autonomous vehicle, allowing it to navigate through hangars and conduct aircraft inspections, serving as an apprentice to the human mechanic, enhancing the productivity of maintenance workforce.[20] NLR is engaged in initiatives to automatically or autonomously detect damage to components such as helicopter

18. Sam Skove, Army's new training simulators on track for 2024 delivery, Defense One, July 24, 2023. https://www.defenseone.com/technology/2023/07/armys-new-training-simulators-track-2024-delivery/388797/

19. Rowan Today, Using AI and simulations, Rowan engineers are helping the Army reshape the future of combat, Rowan University, January 6, 2023. https://today.rowan.edu/news/2023/01/ai-engineering-reshaping-future-combat.html/

20. Netherlands Aerospace Center, Maintenance Technology, NLR Aerospace Systems Division. https://www.nlr.org/capabilities/maintenance-technology/

rotor blades using cameras, robotics, and software, reducing human involvement in tedious and difficult aircraft inspections. Arjan de Jong, NLR's principal for maintenance and engineering, says their focus is on automating inspections, requiring sensors, robots, and automation technology for assessing aircraft and components for damages.

Lockheed Martin, one of the largest contractors for aerospace, security, and military support systems, invests heavily in AI to bolster US military capabilities. The creation of Lockheed Artificial Intelligence Center (LAIC) demonstrates its commitment to AI development, with initiatives like the AI Factory aimed at scaling AI implementation. This Factory standardizes tools and processes across divisions, streamlining access to ML/AI and alleviating complexities in infrastructure and machine learning operations. Through initiatives like the AI Factory, the American aerospace and defense firm Lockheed aims to democratize AI development and ensure compliance with ethical and privacy standards while fostering partnerships with innovative companies like RedHat, Microsoft, and NVIDIA.[21]

BAE Systems, the British defense company and leading provider of cutting-edge defense and aerospace solutions, is working with different companies to harness the power of AI and VR in the next generation of military training. In November 2023, BAE Systems announced a collaboration with Red 6, an augmented reality (AR) technology firm specializing in military air combat training, and PLEXSYS, a simulation software company.[22] Together, they aim to transform military training by integrating Red 6's AR headset technology and PLEXSYS's immersive simulation into BAE Systems' synthetic training environment under 'Project OdySSEy.'[23] This partnership seeks to enhance mission readiness in future contested battlespaces, leveraging the collective expertise of the three companies.

BAE Systems Project OdySSEy single synthetic military training environment. (Image Credit: BAE)

21. Lockheed Martin News, Accelerating Artificial Intelligence (AI) at Scale, Lockheed Martin, May 05, 2022. https://www.lockheedmartin.com/en-us/news/features/2022/accelerating-artificial-intelligence-ai-at-scale.html/

22. BAE News, Project OdySSEy to form backbone of new military training collaboration, BAE Systems, November 28, 2023. https://www.baesystems.com/en/project-odyssey-to-form-backbone-of-new-military-training-collaboration/

23. BAE, Project OdySSEy, BAE Systems. https://www.baesystems.com/en/feature/project-odyssey/

Logistics and Transport

"One way to avoid war is being so prepared to prevail on the logistics front that the enemy understands the folly of aggression" - U.S. Army Brig. Gen. Stephanie Q. Howard.

Advances in emerging technologies such as autonomous drones, 3D printing, and mixed reality have revolutionized whole industries. It can revolutionize the defense logistics too. Innovation in logistics is considered crucial to deter aggression and new threats. Logistics and sustainment are vital for military effectiveness, readiness, and endurance, serving as the backbone of military power. Recognizing this, the Department of Defense is exploring the use of AI/ML technologies to enhance military logistics and sustainment, aiming to maintain equipment, lower operational costs, and boost readiness. AI in military logistics has the potential to enhance efficiency and decision-making capabilities.

The U.S. Air Force's Air Mobility Command (AMC) is currently testing a new cloud-based AI tool, called Artiv, designed to streamline logistics planning amid challenging conditions and disruptions such as an enemy attack or natural disaster. Developed by DEFCON AI, the tool has the potential to complete "highly complicated operational wargaming analysis" in a matter of minutes instead of days, according to Col. Bradley Rueter, who leads the AMC Commander's Initiative Group.[24]

In the context of modern warfare and contested logistics, defense organizations can leverage AI to enhance resilience and efficiency. Here are some of the key applications of AI in defense logistics:
1. Utilizing AI-driven preventive maintenance to enhance efficiency and effectiveness
2. Leveraging cloud services for centralized logistics data storage and processing to facilitate informed decision-making
3. Exploring self-driving vehicles for autonomous resupply missions.
4. Using AI-powered analytics to forecast demand for critical supplies and make informed decisions regarding the defense supply chain.
5. Utilizing self-driving vehicles and AI-powered autonomous systems for logistics and route planning, and fleet management and to resupply outposts and bases, reducing risks associated with traditional supply convoys.
6. Facilitating joint forces collaboration through AI and automation, enabling faster, coordinated decision-making.
7. Proactively detecting and mitigating risks in logistics operations using AI. This will help safeguard defense supply chains against unforeseen challenges.

The integration of AI in military logistics holds the potential to revolutionize operations through process optimization, task automation, and enhanced effectiveness. While cybersecurity and ethical concerns remain, valuable insights from the commercial sector's extensive AI utilization in logistics can inform the military's implementation of AI-enabled solutions.

---

24. Audrey Decker, Can AI reduce Air Force logistics planning from days to minutes?, Defense One, February 1, 2024. https://www.defenseone.com/threats/2024/02/can-ai-reduce-air-force-logistics-planning-days-minutes/393850/

Medical Support and Healthcare

While AI is already being used in weapons technology, it has a restorative role in military medicine. AI can be deployed by military doctors to speed up the decision-making process in triaging the injured based on who needs medical attention first.

AI has become an increasingly powerful tool for emergency room triage, providing critical care to the right person at the right time. A recent study published by the American College of Surgeons highlights AI's crucial role in supporting clinicians in triaging post-operative patients for intensive care. At Brussels University Hospital, AI has seamlessly integrated into the radiology department's daily workflow, providing essential support in managing large volumes of images. With its potential to alleviate the burden on emergency rooms (ERs) and intensive care units (ICUs), AI is poised to become more reliable in supporting physicians in the coming years.

Navy Hospital Corpsman Second Class Jeffrey Ortberg with Marine Medium Tiltrotor Squadron 265 (Reinforced), 31st Marine Expeditionary Unit, asks for assistance on simulated casualty during mass casualty exercise aboard amphibious assault ship USS America, Pacific Ocean, June 19, 2023. (Image Credit: U.S. Marine Corps/Christopher R. Lape)

Artificial intelligence holds immense potential for enhancing the capability to care for combat casualties during large-scale operations. To fully leverage this technology, U.S. Colonel Benjamin Donham suggested that the military health system must establish a cross-functional team comprising data scientists, computer experts, communications specialists, and battlefield medicine providers. This team should create a standardized data dictionary to consolidate various datasets and transition from analog to digital data organization. With the foundational data infrastructure in place, it will facilitate the development of diverse medical AI capabilities. While numerous applications exist for medical AI in battlefield medicine, priority should be given to developing a high-quality mass casualty triage algorithm, to optimize medical care impact, and a dedicated medical AI capability strategy to improve combat casualty care and reduce strategic risk to the joint force.[25]

The U.S. Defense Health Agency, which ensures medical readiness for Army, Navy, and Air Force units, is spearheading the shift towards digital-first healthcare delivery, integrating cutting-edge technologies like AI and ML. At the forefront of this effort is Dr. Lester Martinez-Lopez, who sees immense potential in AI, machine learning, and predictive algorithms to improve healthcare.

---

25. Benjamin P. Donham, It's Not Just About the Algorithm: Development of a Joint Medical Artificial Intelligence Capability, Joint Force Quarterly 111, National Defense University Press, October 2023. https://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-111/Article/Article/3569597/its-not-just-about-the-algorithm-development-of-a-joint-medical-artificial-inte/

Experts at the Defense Health Information Technology Symposium 2023 in New Orleans, underscored the pivotal role of AI and machine learning in driving down costs, boosting readiness, and optimizing performance. "From predicting emergency room wait times to advanced medical diagnostics, the underlying techniques of machine learning have huge potential to improve how we provide health care in an impactful and meaningful way," Martinez said. U.S. Navy Cmdr. (Dr.) John de Geus believes that AI will enable doctors to quickly and efficiently access all the various military and occupational standards relevant to service members and the clinical care being provided to them. However, he emphasized that despite the emergence of AI tools altering healthcare delivery, they will never replace the human element in healthcare. AI will continue to serve as a tool to enhance the effectiveness of medical staff in their roles. The success of the tech initiatives hinges on robust data accessibility and interoperability, ensuring timely and accurate support for healthcare providers.

The future of healthcare technology in the military health system was also explored at the Digital Health Transformation Summit in Maryland, held in December 2023. Discussions highlighted the need for the military health system to adapt to the fourth industrial revolution, the era of connectivity, advanced analytics, and automation, emphasizing the role of technology in enhancing healthcare delivery. The use of AI, machine learning, and other digital tools to address future challenges in military medicine, such as evolving conflicts and advances in medical treatment, were among the key topics discussed. "The breakthroughs happening in medical technology and in artificial intelligence are not just central to our responsibilities as medical professionals — they're central to our responsibility as national security professionals," said Martinez.

Cybersecurity

In an ever-changing cyber threat landscape, AI emerges as a robust tool for strengthening the country's cyber defenses and military cybersecurity efforts. By consistently monitoring and analyzing network traffic, AI-powered cybersecurity systems can swiftly identify anomalies, detect potential cyber threats, and promptly respond to them.

Cyber defense experts at NATO's flagship exercise Cyber Coalition 2023. (Image Credit: NATO/Paolo Giordano)

Industry experts have repeatedly highlighted the rising opportunities and challenges in using AI for cybersecurity. In May 2023, Eric Horvitz, Microsoft's Chief Scientific Officer, testified before the U.S. Senate Armed Services Committee Subcommittee on Cybersecurity, emphasizing the growing importance of AI in cyber defense. He stressed the need for significant investments in cybersecurity workforce training, monitoring, engineering, and research to counter the evolving AI-powered cyberattacks.[26]

26. Microsoft Corporate Blogs, Applications for artificial intelligence in Department of Defense cyber missions, Microsoft, May 3, 2022. https://blogs.microsoft.com/on-the-issues/2022/05/03/artificial-intelligence-department-of-defense-cyber-missions/

AI methods are being applied across all stages of security, including prevention, detection, investigation and remediation, discovery and classification, threat intelligence, and security training and simulations, he said. AI technologies can alleviate the workload of cybersecurity experts by enabling automated and large-scale detection, prioritization, and response. However, advances in AI also raise concerns, particularly regarding the fabrication of deepfakes, which pose threats to national security. In March 2022, a deepfake video of Ukrainian President Zelenskyy surfaced, asking Ukrainians to lay down their weapons and surrender to Russia emerged on social media. To address these vulnerabilities in AI systems, Horvitz recommended securing engineering supply chains, raising awareness among development and cybersecurity teams, and investing in research on trustworthy and secure AI systems.

To develop systems to identify and fix software vulnerabilities, the U.S. administration is working with four leading artificial intelligence firms – OpenAI, Anthropic, Microsoft, and Google – to launch a cybersecurity contest. Led by DARPA, the "AI Cyber Challenge" is aimed at protecting the US's critical infrastructure and making software more secure.[27]

To address the challenge of weapon system cybersecurity, the U.S. Army recently partnered with Shift5, a cyber defense and predictive maintenance company, to enhance the security of its M142 High Mobility Artillery Rocket Systems (HIMARS) against virtual threats. Through this engagement, HIMARS will be equipped with digital anomaly detection capabilities to bolster cyber resilience and enable predictive maintenance assessments.[28] Josh Lospinoso, co-founder and CEO of Shift5, has emphasized the need for implementing best practices to accelerate weapon system cybersecurity. Arguing that "We cannot solve weapon system cybersecurity without AI," he has warned that "Without AI, the DoD will never be able to keep these weapon systems cyber secure." Effective AI systems depend on high-quality data, he says, and to ensure that military weapon systems can capitalize on the advancements in AI-powered technology, every major weapon system should collect, translate, enrich, and disseminate its data.

Decision Support Systems

An AI system can replicate the human decision-making processes. This means it can offer support, augment, and potentially substitute human decision-making in certain cases. Some of its applications in the defense domain include aiding decision-making in conflict scenarios, object recognition from images or videos, data analysis, equipment failure prediction, and automated defensive responses.

Military decision-making occurs in complex realms and often requires coordination across domains — land, air, sea, space, and cyberspace. Artificial Intelligence (AI) plays a crucial role in enhancing decision-making by processing vast amounts of data effectively. AI systems in the

27. The White House, Biden-Harris Administration Launches Artificial Intelligence Cyber Challenge to Protect America's Critical Software, U.S. White House Briefing Room, August 9, 2023. https://www.whitehouse.gov/briefing-room/statements-releases/2023/08/09/biden-harris-administration-launches-artificial-intelligence-cyber-challenge-to-protect-americas-critical-software/

28. Shift 5, Shift5 Partners with U.S. Army to Secure High Mobility Artillery Rocket System (HIMARS) Against Cyber Threats, December 5, 2023. https://shift5.io/press-release/shift5-army-himars-contract/

military can process data more efficiently than traditional systems, facilitating command and control. It can act as a powerful aid for human decision-making, significantly improving the decision support systems (DSS) to improve decision-making in the military. Decision support systems are also defined as "interactive computer-based systems that aid users in judgment and choice activities". However, the decision-making should be a collaborative effort collaboration between humans and intelligent machines, where both parties recognize each other's strengths, limitations, and objectives.

In his paper, U.S. Marines Corps Major James D. Pineiro explored the AI adoption by the Marines as a DSS to enhance planning-decision-execution cycles and gain an advantage over near-peer adversaries. He concluded that AI, through data analytics and machine learning, provides faster information processing and decision-making capabilities compared to human processes. The Marine Corps can no longer rely on outdated decision support systems for tactical decision-making as a commander "equipped with an AI-DSS will make more informed decisions at a faster rate than his adversary." However, implementing AI DSS for Expeditionary Advanced Base Operations (EABO) requires addressing hurdles, such as developing an AI concept of support, prioritizing and resourcing AI efforts, enhancing data management, and leveraging Army AI experimentation for multi-domain operations.[29]

But it all comes down to the humans developing and utilizing these systems. As highlighted in the U.S. Marines publication: "Whatever the age or technology, effective command, and control will come down to people using the information to decide and act wisely. And whatever the age or technology, the ultimate measure of command and control effectiveness will always be the same: Can it help us act faster and more effectively than the enemy?"

The latest advancements in data, analytics, and AI technologies empower leaders to make faster and better decisions, improving defense operations and warfighting capabilities. Accelerating the adoption of these technologies presents a unique opportunity to equip leaders at all levels with the necessary data and unlock the full potential of human decision-making capabilities.

For the United States and its military, the emphasis has always been on improving decision-making. "As we focused on integrating AI into our operations responsibly and at speed, our main reason for doing so has been straightforward: because it improves our decision advantage," U.S. Deputy Defense Secretary Kathleen Hicks said while unveiling the data, analytics, and AI adoption strategy 2023. The strategy emphasizes an agile approach to AI development and application, prioritizing speed of delivery and scalability to achieve five specific decision advantage

U.S. Deputy Secretary of Defense Dr. Kathleen Hicks with Vice Chairman of the Joint Chiefs of Staff Admiral Chris Grady. (Image Credit: Department of Defense)

29. Major James D. Pineiro, Gaining a Cognitive Advantage: Artificial Intelligence (AI) as a Decision Support System (DSS), Master of Military Studies (MMS) thesis, USMC Command and Staff College Marine Corps University, March 31, 2020. https://apps.dtic.mil/sti/trecms/pdf/AD1177825.pdf

outcomes: superior battlespace awareness, adaptive force planning, fast, precise, and resilient kill chains, sustainment support, and efficient enterprise operations. Additionally, the strategy outlines key goals related to data, analytics, and AI, including investment in interoperable infrastructure, ecosystem advancement, talent management, foundational data improvement, capability delivery, and governance enhancement.

Command and Control Systems: In the dynamic realm of defense operations, efficient command and control (C2) systems are paramount. Integrating AI into C2 systems can provide real-time data analysis, situational awareness, and decision support for commanders, enabling swift responses to emerging threats and more effective coordination of forces. By streamlining communication and improving response times, AI holds transformative potential in enhancing the overall effectiveness of military operations. A research report suggested that "the side that successfully implements AI in its command and control system can become the best and fastest at analyzing information and as a result can make quicker decisions and gain an operational advantage over its opponent."[30]

Autonomous weapons system

There is no internationally agreed definition of autonomous or lethal autonomous weapons but the U.S. Defense Department offers one. It describes an autonomous weapon system as "a weapon system that, once activated, can select and engage targets without further intervention by an operator. This includes, but is not limited to, operator-supervised autonomous weapon systems that are designed to allow operators to override operation of the weapon system, but can select and engage targets without further operator input after activation."

The Department of Defense announced an update to DoD Directive 3000.09 on Autonomy In Weapon Systems, reaffirming its commitment to responsible policies regarding military use of autonomous systems and AI. U.S. Deputy Secretary of Defense Dr. Kathleen Hicks emphasized the importance of safety and lawful use in developing and employing weapon systems with autonomous features. "Given the dramatic advances in technology happening all around us, the update to our Autonomy in Weapon Systems directive will help ensure we remain the global leader of not only developing and deploying new systems but also safety," Hicks said. The Directive aims to minimize the risk of unintended engagements by ensuring human judgment is exercised over the use of force. Key requirements include designing autonomous and semi-autonomous weapon systems for human oversight, adhering to legal and ethical guidelines, and demonstrating reliability and effectiveness under realistic conditions.

Replicator initiative: Meanwhile, the United States is heavily investing in modernizing its autonomous capabilities. The Pentagon intends to deploy thousands of small autonomous systems within the next two years to counter China's extensive military buildup and dominance in robotic platforms. "Replicator is meant to help us overcome the PRC's biggest advantage,

30. Johan Schubert, Joel Brynielsson, Mattias Nilsson, Peter Svenmarck, Artificial Intelligence for Decision Support in Command and Control Systems, Department of Decision Support Systems Division of Defence and Security, Systems and Technology, Swedish Defence Research Agency, 23rd International Command and Control Research & Technology Symposium "Multi-Domain C2", 2018. https://www.foi.se/download/18.41db20b3168815026e010/1548412090368/Artificial-intelligence-decision_FOI-S--5904--SE.pdf

which is mass. More ships. More missiles. More people. Before Russia invaded Ukraine again in February, they seemed to have that advantage too," according to Kathleen Hicks. The goal for Replicator is highly ambitious: to field "multiple thousands" of drones in "multiple domains" within the next 18-24 months.[31]

V-BAT drones: Shield AI is one of the defense tech startups working with the Pentagon to transform military tools using cutting-edge technology. The company is helping advance the goal of deploying powerful unmanned aerial vehicles, and autonomous drones. In December 2023, Shield AI announced the expansion of its funding to $500 million which will accelerate the development of artificial intelligence (AI) pilots without the need for remote operators or GPS. Shield AI is now the fourth startup valued in the multi-billion-dollar range in the past 20 years, joining SpaceX, Palantir, and Anduril. The startup's AI pilot, Hivemind, has flown a fighter jet (F-16), a vertical takeoff and landing drone (V-BAT), and a quadcopter (Nova). The V-BAT Teams, enable one human operator to command a minimum of four V-BATS, generate real-time AI-driven flight paths, and exhibit dynamic read-and-react behaviors autonomously. In December 2022, Shield AI made aviation history by autonomously maneuvering a modified F-16 in real-world air-combat scenarios, laying the groundwork for the jets to be piloted by computers.


V-BAT Unmanned Aircraft System. (Image Credit: MartinUAV)

LAWS: As advancements in autonomous weapons accelerate, an increasing number of states and non-governmental organizations are urging the international community to regulate or ban these technologies due to ethical concerns. The major concern is about lethal autonomous weapon systems (LAWS). The 2022 U.S. defense policy on LAWS defines it as "a special class of weapon systems that use sensor suites and computer algorithms to independently identify a target and employ an onboard weapon system to engage and destroy the target without manual human control of the system." DoDD 3000.09 defines LAWS as "weapon system[s] that, once activated, can select and engage targets without further intervention by a human operator." These systems are categorized as fully autonomous weapons that operate without human involvement, autonomous weapons that require human oversight, and semi-autonomous with varying degrees of human oversight but possessing "fire-and-forget" capability.[32]

Meanwhile, concerns over the ethical implications of LAWS have led to international appeals for regulation or bans, with more than 30 countries calling for legal controls on "killer robots." Amnesty International's Secretary General Agnès Callamard warned of the deeply worrying development of autonomy in weapons and said that "These machines risk automating killing,

31. U.S. Department of Defense, Deputy Secretary of Defense Kathleen Hicks Keynote Address: 'The Urgency to Innovate' (As Delivered), DOD Speech, August 28, 2023. https://www.defense.gov/News/Speeches/Speech/Article/3507156/deputy-secretary-of-defense-kathleen-hicks-keynote-address-the-urgency-to-innov/

32. Congressional Research Service, Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems, In Focus, CRS, February 1, 2024. https://crsreports.congress.gov/product/pdf/IF/IF11150

treating it as a technical undertaking which raises human rights risks as well as humanitarian, legal and ethical concerns. Autonomous machines will make life and death decisions without empathy or compassion."[33]


Milrem Robotics THeMIS combat vehicles. (Image Credit: Milrem Robotics)

Fully autonomous weapons raise questions about accountability and adherence to international humanitarian law. Stop Killer Robots, a global coalition of more than 160 organizations working to address autonomy in weapons systems, emphasized the need to protect humanity, saying that "These 'killer robots' could be used in conflict zones, by police forces, and in border control. A machine should not be allowed to make a decision over life and death. Let's act now to protect our humanity and make the world a safer place."

China supports a ban on the use of fully autonomous lethal weapons systems despite advancing its AI capabilities in military domains. Speaking at the first UN debate on AI risks in July 2023, Zhang Jun, China's permanent representative to the UN, urged all countries to maintain responsible defense policies, reject the use of AI for military dominance or territorial aggression, and prevent any misuse of AI weaponry. Stressing the importance of peaceful AI use, he emphasized the need for human oversight in all AI-equipped weapon systems.

Target recognition and tracking

AI-driven systems enhance precision and minimize collateral damage by detecting, tracking, and identifying potential targets. These systems integrate data from various sources to provide comprehensive situational awareness, allowing for rapid analysis, timely decisions, and actionable insights.

AI's image and video analysis capabilities can revolutionize target identification, as demonstrated by the integration of an AI-enabled target recognition prototype with a U.S. Army M1 Abrams tank. This prototype, known as ATLAS (Advanced Targeting & Lethality Aided System), aids soldiers in locating and classifying enemy vehicles more efficiently. ATLAS "uses cutting-edge sensing technologies and machine-learning algorithms to automate manual tasks during passive target acquisition, allowing crews to engage three targets in the time it would normally take for them to engage one," according to the U.S. military's Defense Visual Information Distribution Service (DVIDS).

One of the most difficult tasks on the battlefield is forecasting where the enemy will attack next. The U.S. Army's Artificial Intelligence Task Force (AITF) is working on a project called

33. Amnesty International, More than 30 countries call for international legal controls on killer robots, February 24, 2023. https://www.amnesty.org/en/latest/news/2023/02/more-than-30-countries-call-for-international-legal-controls-on-killer-robots/

Members of CMU's NREC set up equipment during the data collection event at Fort Hunter Liggett, on January 13, 2020. The partnership between CMU and the AITF focuses on modernizing the Army and its processes, through AI, by giving Soldiers the proper tools needed to succeed on the future battlefield. (Image Credit: U.S. Army/Artificial Intelligence Task Force)

Aided Threat Recognition from Mobile Cooperative and Autonomous Sensors (ATR-MCAS). This program utilizes drones, AI, and machine learning to predict enemy attacks and enhance battlefield operations. The drones identify the enemy weapons systems, such as tanks, then pass on the sightings of the identified threats to the AI which "identify, classify, and geo-locate entities, obstacles, and potential threats, generating a "common operating picture" (COP) of the battle zone for the soldier.[34] This COP is then processed by an AI-enabled decision support agent for recommendations. This dynamic approach improves interoperability across ground and air systems, enhancing warfighters' situational awareness and decision-making capabilities on the battlefield, and keeping them safer and smarter on the battlefield.

The ATR-MCAS system enhances ground warfare missions such as route reconnaissance, screening, and target verification, offering increased situational awareness and faster decision-making for soldiers. Its adaptable design boosts soldier lethality and survivability by enabling swift target identification and tracking.

---

34. Patrick Ferraris, Aided Detection on the Future Battlefield, Army Artificial Intelligence Task Force, DVIDS, January 24, 2020. https://www.dvidshub.net/news/360225/aided-detection-future-battlefield/

Future Battlefield: Cybersecurity and AI in National Security Policy

As defense technology advances, nations become increasingly reliant on digital infrastructure, making them vulnerable to cyber threats. The technological advancements in modern warfare techniques have compelled the world powers to develop a strong policy to address these challenges and enhance the overall security posture.

Cybersecurity has become an integral part of any national security policy. The year 2023 witnessed substantial progress on this particular front as several of the world's leading powers, including the U.S., the UK, and NATO, brought forward their respective cybersecurity policies to eliminate threats posed by modern technologies including artificial intelligence (AI).

The advancements in AI and related technologies will completely transform the approach to national defense and war-fighting strategies. Those who fail to induce this perspective into modern security strategy would succumb to a quick death on the future battlefields.

By the end of the year 2023, it became evident that cyberattacks are as effective of a tool to get leverage in conflict as any other modern. It can be used as a deterrence and offense. In November 2023, the United Kingdom hosted an AI safety summit which several world and industry leaders, including representatives from China, attended. The summit gave the world's first-ever AI agreement, signed by the leaders and representatives of 28 different countries.

According to the UK government, the declaration affirms that whilst safety must be considered across the AI lifecycle, actors developing frontier AI capabilities, in particular those AI systems that are unusually powerful and potentially harmful, have a particularly strong responsibility

World leaders attend the AI Safety Summit in Bletchley Park, Britain, on November 2, 2023. (Image Credit: Toby Melville/Reuters)

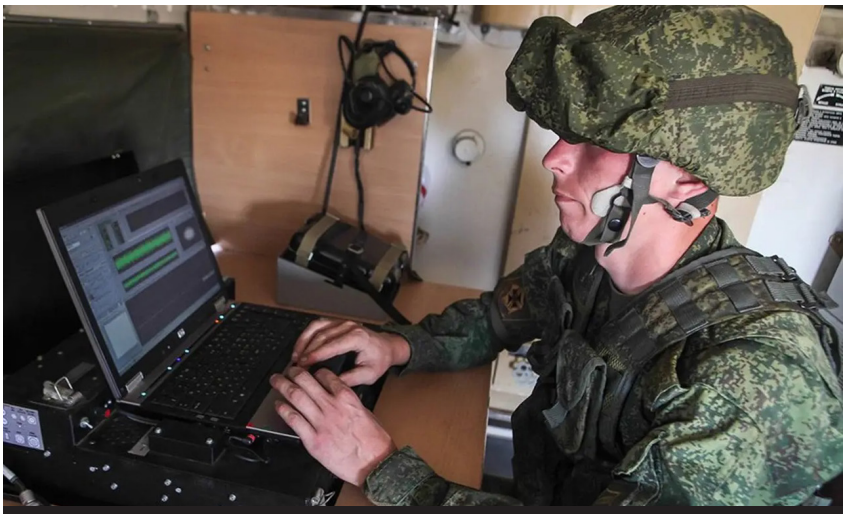
to ensure the safety of these AI systems, including through systems for safety testing, through evaluations, and by other appropriate measures.[1]

Around the same time, the United States also devised its own set of rules and regulations to ensure the safe and trustworthy development of AI. An executive order from U.S. President Joe Biden in October 2023, stressed the urgency of devising governing legislation for the development and use of AI safely and responsibly.[2]

Role of Cyber in Modern Conflicts

The use of the term cyberwarfare or cyberattacks has become more frequent in the security-related literature of the modern defense doctrine. Russia's territorial invasion of Ukraine in February 2022 was accompanied by significant cyberattacks marking the first modern conflict that was fought simultaneously in the cyber realms as it was fought on the ground.

Similar instances of cyber warfare have been observed in conflicts involving states such as Russia and Georgia, Israel and Iran, as well as ongoing cyberattacks by Russia against Ukraine since 2014. According to a European Union report, the Switzerland-based Cyberpeace Institute recorded more than 1,998 cyberattacks and operations conducted by 98 distinct actors only in the first quarter of 2023.



Russian military personnel of the electronic warfare unit of the Southern Military District during a combat training exercise.
(Image Credit: Russian Ministry of Defense/Global Look Press)

These attacks have targeted 23 different critical infrastructure sectors, impacting not only Ukraine and the Russian Federation but also 49 other countries. The documentation of these incidents contributes to a comprehensive analysis of the use of cyber means in times of war.

Types of Cyberattacks Against Ukraine

Based on the attacks conducted on Ukrainian telecommunication and administrative infrastructure, cyberattack operations can be categorized into the following types.

---

1. IRIA News, US, China, and EU sign first AI safety agreement at global AI summit hosted by UK, International Relations Insights & Analysis, November 4, 2023. https://www.ir-ia.com/news/us-china-and-eu-sign-first-ai-safety-agreement-at-global-ai-summit-hosted-by-uk/

2. The White House, Fact Sheet: President Biden Issues Executive Order on Safe, Secure, and Trustworthy Artificial Intelligence, U.S. White House Briefing Room, October 30, 2023. https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/30/fact-sheet-president-biden-issues-executive-order-on-safe-secure-and-trustworthy-artificial-intelligence/

- **Destructive Attacks:** These cyberattacks are characterized by their intent to permanently delete data or inflict irreparable damage on systems, rendering them unrecoverable. The consequential impact on organizations can be prolonged, particularly if backup retrieval or system reset proves challenging. Notable instances include the utilization of wiper malware targeting Ukrainian government entities and various sectors. A recent incident involved the resurgence of a destructive wiper malware named 'CaddyWiper,' identified by Ukraine's Computer Emergency Response Team (CERT-UA).[3] In January 2023, Ukraine reported the CaddyWiper attack on its national news agency Ukrinform.[4] Other data-wiping malware deployed against Ukrainian targets include ZeroWipe, DoubleZero, HermeticWiper, WhisperKill, WhisperGate, IsaacWiper, and AcidRain, according to security researchers.

- **Disruptive Attacks:** Cyberattacks designed to disrupt services and operations have been prevalent during the conflict. These attacks targeted Ukrainian organizations in the early stages of the invasion, Russian organizations following a Ukrainian government appeal to civilians, and public institutions in some NATO member countries after security or economic announcements. Distributed Denial of Service (DDoS) attacks, particularly impacting the public and financial sectors, have been predominant. DDoS attacks accounted for more than 99% of all recorded cyberattacks against Ukraine between July and September 2023, according to the CyberPeace Institute.[5] Financial, public administration, and information and communication technology (ICT) sectors were the primary targets A concerning trend is the targeting of vulnerable Ukrainian non-profit organizations, which often lack preparedness and resilience measures.

- **Data Weaponization:** This category includes cyberattacks leading to data theft or exfiltration, primarily for espionage, surveillance, or intelligence purposes. While the latter activities are expected in the context of war and geopolitics, collective actors engaged in the theft of data for activist purposes have been notably active. Data, about both private and public organizations, is exfiltrated and published online at an unprecedented rate. Hack and leak operations involve the weaponization of data, exemplified by a recent incident in March 2023 targeting EU countries. A state-sponsored Russian threat actor used spear-phishing emails containing information about the Polish Ambassador's visit to the United States. This campaign mimicked real information exchange systems used by EU nations, employing malware to infiltrate networks and collect data.

- **Disinformation:** Information operations centered on disinformation and propaganda, although not new, have gained unprecedented speed and scale in the cyber domain. Cyberattacks focused on spreading false information and propaganda are prominent in this armed conflict. Threat actors aim to influence the information space, restricting access to timely, reliable, and official information for the population, or intentionally sowing confusion and undermining information integrity.

---

3. WeLive Security, CaddyWiper: New wiper malware discovered in Ukraine, ESET, Ukraine Crisis - Digital Security Resource Center, March 15, 2022. https://www.welivesecurity.com/2022/03/15/caddywiper-new-wiper-malware-discovered-ukraine/

4. Sergiu Gatlan, Ukraine links data-wiping attack on news agency to Russian hackers, Bleeping Computer, January 18, 2023. https://www.bleepingcomputer.com/news/security/ukraine-links-data-wiping-attack-on-news-agency-to-russian-hackers/

5. CyberPeace Institute Quarterly Analysis Report, Cyber Dimensions of the Armed Conflict in Ukraine, Q3 July to September 2023. https://cyberpeaceinstitute.org/wp-content/uploads/2023/12/Cyber-Dimensions_Ukraine-Q3-2023.pdf

Strengthening Cybersecurity in the Defense Industry

Cybersecurity is crucial within the defense industry to protect sensitive information, critical infrastructure, and military capabilities from cyber threats. This includes employing strong security measures, conducting regular analysis of threats and measures, providing specialized training to personnel, and securing communications. Collaboration with government agencies and cybersecurity experts is also essential to develop effective strategies to address evolving challenges.

A comprehensive national defense policy requires a multi-layered approach to cybersecurity. Below are the key components that contribute to robust cybersecurity measures in national defense policies:

- ***Critical Infrastructure Protection:***

National defense policies emphasize the protection of critical infrastructure, including energy grids, transportation systems, and communication networks, against cyber threats. Disruptions to these systems could have severe consequences for national security.

A Ukrainian sailor uses equipment on board an armored gunboat. (Image Credit: Reuters/Anastasia Vlasova)

- ***Secure Communication:***

For government and defense agencies, ensuring the security of communications within defense networks and among military entities is a top priority. Encryption, secure communication protocols, and intrusion detection systems are implemented to protect the confidentiality and prevent unauthorized access or manipulation. Best practices and tools should be utilized to secure sensitive communications, maintain data privacy, and ensure the complete security of the systems.

- ***Cyber Defense Strategy:***

National defense policies outline comprehensive cyber defense strategies that include proactive measures to detect, prevent, and respond to cyber threats. This may involve the development of cybersecurity frameworks, incident response plans, and collaboration with other agencies and allies.

- ***Intelligence and Surveillance:***

Cybersecurity efforts in national defense policies often involve intelligence gathering and surveillance activities to identify potential cyber threats. This includes monitoring activities in cyberspace, assessing vulnerabilities, and staying informed about emerging threats.

- ***Collaboration and Alliances:***

Engaging in international partnerships and alliances is crucial in the realm of cybersecurity to address global challenges and shared threats. Countries often work together to share threat

intelligence, and best practices, and collaborate on joint cybersecurity initiatives to enhance collective defense capabilities.

- ***Investment in Research and Development:***

National defense policies may allocate resources for research and development in cybersecurity technologies. This includes the development of advanced cybersecurity tools, artificial intelligence applications for threat detection, and other cutting-edge solutions to stay ahead of evolving cyber threats.

- ***Cyber Training and Education:***

Equipping government officials and military personnel with comprehensive cybersecurity training and awareness programs is crucial to enhance their understanding of cyber threats and ensure better preparedness.

- ***Threat Intelligence and Vulnerability Management:***

Collecting and analyzing data on existing and potential cyber threats is crucial to identify the tactics, techniques, and procedures of the adversaries, understand how technology is being weaponized, and deploy proactive defense measures. Identifying and addressing vulnerabilities within the defense systems and networks can help mitigate the risk of exploitation by cyber attackers.

Cyberwarfare specialists of the U.S. Army's 782nd Military Intelligence Battalion (Cyber) supporting the 3rd Brigade Combat Team, 1st Cavalry Division during a training exercise in 2019. (Image Credit: Steven Stover/Wikimedia Commons)

- ***Legislation and Regulations:***

National defense policies may include legislation and regulations that mandate cybersecurity standards for government agencies, military contractors, and critical infrastructure providers. Compliance with these standards helps ensure a baseline level of cybersecurity across the defense ecosystem.

- ***Deterrence and Offensive Cyber Operations:***

Some national defense strategies may include the development of offensive cyber capabilities for deterrence purposes. This involves responding to cyber threats with offensive measures, potentially disrupting or disabling adversary capabilities.

US Integrating Advanced Robotic and Autonomous Weapon Systems into Army Units

Robotics and Autonomous Systems have become increasingly vital in military operations, with significant impacts on defense capabilities. As countries invest in this technology, these systems will shape future conflicts and warfighting.

The United States Army's strategy emphasizes integrating autonomous systems and artificial intelligence (AI) into soldier formations to achieve domain superiority, protect soldiers, and provide the military with crucial advantages over adversaries. The U.S. Army Robotics and Autonomous Systems strategy focuses on empowering soldiers, enhancing unit capabilities and human-machine teaming, and achieving transformative operational advancements through the rapid fielding of robotic technologies.

The United States Department of Defense announced on March 22, 2024, that the Army is advancing modernization capabilities by integrating cutting-edge technology and autonomous systems both on the ground and in the air with promising experiments at the operational level.[1]

> "The Army is moving toward a future where soldier formations will be more efficient and lethal" - U.S. Department of Defense.

Members and leadership from the 49th Wing and 49th Security Forces Squadron watch a demonstration of a Vision 60 Q-UGV ground robot in action at Holloman Air Force Base, New Mexico, on April 17, 2023. (Image Credit: U.S. Air Force/Airman 1st Class Isaiah Pedrazzini)

1. Matthew Olay, Promising experiment signals future integration of advanced tech into Army units, U.S. Department of Defense News, March 22, 2024. https://www.defense.gov/News/News-Stories/Article/Article/3716688/promising-experiment-signals-future-integration-of-advanced-tech-into-army-units/

According to the Pentagon statement, Chief of Staff of the United States Army General Randy George discussed some of the advancements while talking with the Defense One digital media platform in Washington after observing Project Convergence Capstone 4 – an experiment involving the Army, Navy, Air Force, Marines, and Space Force.

The U.S. Army Gen. George said, "We've all seen how the battlefield is changing, [and] we know that you can't have these big C2 [command and control] nodes that are out there." George added, "We know that machines can do a lot of things right now much more effectively and much cheaper, and we're going to have to incorporate them into our formations."

The U.S. Army general received a briefing on the Army's latest experimental capabilities and technology advancements from Gen. James E. Rainey, the commanding general of Army Futures Command, at Project Convergence - Capstone 4, and highlighted the importance next-generation command and control (C2) system capabilities with industry partners.

Project Convergence Capstone 4

The Project Convergence Capstone 4 is the two-phase, joint and multination experiment that took place at Camp Pendleton, California, and the Army's National Training Center in Fort Irwin, California, from February 23 to March 20, 2024.

U.S. Chief of Staff of the Army Gen. Randy George receives a demonstration of next generation command and control (C2) system capabilities from a 1st Infantry Division officer during Project Convergence - Capstone 4 at Fort Irwin, Calif., on March 18, 2024. (Image Credit: U.S. Army/Sgt. Brahim Douglas)

Project Convergence is led by Army Futures Command and involves a series of experiments that allow warfighters an opportunity to experiment with the latest technologies at the operational level and further improve methods for synchronizing as a joint force. It involved all units including the United States Army, Navy, Marine Corps, and Air Force.

More than 4,000 military personnel of the joint force, civilians, contractors, and armed forces from the U.S. and allied forces including the United Kingdom, Australia, Canada, New Zealand, France, and Japan took part in the Army's largest experimentation exercises in beaches, oceans, air and deserts of the U.S. West Coast. Project Convergence Capstone 4 involved more than 200 defense systems and technologies in a real-world environment.

Project Convergence includes a continuous, structured series of demonstrations and experiments at various locations. It ensures that the U.S. Army can effectively overmatch and counter its adversaries in competition and conflict by rapidly and continuously integrating or converging effects across all domains including land, air, sea, space, and cyberspace.

The groundbreaking joint and multinational military experiment exercises enhanced and integrated the state-of-the-art defense capabilities of the U.S. Army units. It strengthened the effectiveness of joint and allied forces, with a particular emphasis on testing advanced air and missile defense systems as well as leveraging sensor capabilities from both drones and aircraft to enhance force protection and targeting strategies.[2]

The U.S. AUKUS partners the UK and Australia also joined the experimentation exercises to test cutting-edge systems and technologies and enhance force readiness with rigorous wargaming and experimenting with developed concepts.

The U.S. Army Futures Command deputy commanding general Lt. Gen. Ross Coffman said, "This year, we have increased the threat envelope to 10 times what we did last year. With the entire joint force and our U.K. and Australian teammates and allies, we were able to effectively move data for the first time in an Indo-Pacific scenario at a magnitude we've never seen before." The experiments conducted by the Joint Forces and international partners helped achieve the targets outlined in U.S. Force Design and enhanced the readiness of the U.S. and its allies and partners, particularly amid challenges posed by contested logistics.

U.S. Army Combat Capabilities Development Command experiment division's chief Mindy Gabbert said, "There are plenty of technologies we find out aren't mature enough or don't fill a gap or capability the way we thought, so they get withdrawn way before Capstone 4 takes place."[3]

During Project Convergence Capstone 4, several systems were tested including, the Quadruped Ghost robotic dog (unmanned ground vehicle), the HIVE unmanned aircraft system (UAS), Small Multipurpose Equipment Transport (SMET) vehicles, SkyDome with Drone Hunter counter-unmanned aircraft system, Ghost-X unmanned aircraft system, Tactical Resupply Vehicle-150, and unmanned transport vehicles with autonomous weapon systems. The U.S. Army soldiers also conducted sling load operations with autonomous UH-60 Black Hawk helicopters.

Ghost Robotics Vision 60

VISION 60 Quadrupedal Unmanned Ground Vehicles (Q-UGV) are high-endurance and agile unmanned ground vehicles that provide enhanced situational awareness and support for frontline soldiers and serve as their eyes and ears.

The Quadruped Ghost robot dogs are made for unstructured terrain where a typical wheeled or tracked device cannot operate efficiently. The Philadelphia-based firm Ghost Robotics started building Q-UGV in 2015 and unveiled the prototype of the robotic dog in early 2017.

---

2. Johannes Schmidt, Marines Drive Innovation, Collaboration Aboard Camp Pendleton for Army's PC-C4, Marine Corps Systems Command, March 19, 2024. https://www.marines.mil/News/News-Display/Article/3712753/marines-drive-innovation-collaboration-aboard-camp-pendleton-for-armys-pc-c4/

3. Matthew Murch, Transforming DOD: PC-C4 prepares for the future battlefield, U.S. Army, Futures and Concepts Center, March 22, 2024. https://www.army.mil/article/274758/transforming_dod_pc_c4_prepares_for_the_future_battlefield/

Since then, the VISION 60 Q-UGVs have been tested in several experiments and exercises and integrated with U.S. Army and Air Force teams.[4]

The size of the Q-UGV is about the same as a full-sized Golden Retriever dog that can be assembled and disassembled in about 15 minutes. It can be used in all weather conditions and extreme temperatures from -45 to 55 °C (-40 to 130 °F).[5]

> "They're unstoppable, with the ability to get right back up from any slip, fall, or failure and keep moving using our proprietary blind-mode operations" - Ghost Robotics.

The $165,000 midsized robot dog can be operated in all difficult terrains including steep sands. It can operate in completely unknown environments and even when it fails, slips, or falls, it is capable of getting "right back up and continue moving," the company said in a statement.

In November 2023, the U.S. Air Force engineers tested the range and various capabilities of the robotic canine in different environments. The robotic dog, equipped with a detector, was also tested to detect Chemical, Biological, Radiological, and Nuclear materials (CBRN) threats.[6]

Ghost Robotics remains focused on making the Q-UGVs "an indispensable tool" and improving its ability to "walk, run, crawl, climb, and eventually swim in complex environments" to keep warfighters and workers safe.

Key Features

- Max Payload - 10 kg
- Top Speed - 3 M/S
- Max Distance - 10 km
- Max Power Runtime - 3 hours
- Weight - 51 kg
- CPU/GPU - Nvidia Xavier

U.S. soldiers take part in a human-machine integration demonstration using the Ghost Robotic Dog and the U.S. Army Small Multipurpose Equipment Transport (SMET) of new U.S. Army capabilities at Project Convergence - Capstone 4. (Image Credit: U.S. Army/Spc. Samarion Hicks)

HIVE UAS

The HIVE Unmanned Aircraft System provides soldiers on the ground with enhanced mission effectiveness and real-time situational awareness while conducting missions. The HIVE provides warfighters an enhanced mission efficiency, sensor performance, and reduced cognitive

4. VISION 60 Q-UGV, Ghost Robotics Corporation, March 25, 2024. https://www.ghostrobotics.io/vision-60/

5. Jessica Barron, Holloman Air Force Base tests new robotic dogs, KRQE, June 2, 2023. https://www.krqe.com/news/technology/holloman-air-force-base-tests-new-robotic-dogs/

6. Airman Rhea Beil & Master Sgt. Delia Martinez, Barksdale Airman innovates robotic dogs to save lives, Barksdale Air Force Base, United States Air Force, December 21, 2023. https://www.barksdale.af.mil/News/Display/Article/3624012/barksdale-airman-innovates-robotic-dogs-to-save-lives/

workload. BlueHalo employs Artificial Intelligence/Machine Learning (AI/ML) swarm logic capabilities, communications systems, and evolving technologies within an operationally driven system-of-systems framework.

The HIVE UAS can be easily tailored for specific operational requirements and operated in harsh weather conditions. It can be used for various missions ranging from Intelligence, Surveillance, and Reconnaissance to meteorological and atmospheric collection. BlueHalo's Intense Eye Version 3 (IEV3) is best suited to meet the U.S. Army's needs for small unmanned aerial systems.[7]

The HIVE unmanned aircraft system prepares to take flight during a human-machine integration experiment during Project Convergence – Capstone 4, on March 11, 2024. (Image Credit: U.S. Army/Pfc. Karla Guerrero)

IEV3 is a 750-mm class 4 rotor Vertical Take-Off and Landing (VTOL) drone. It can be modified for various applications, including autonomous swarming solutions, payload deployment, test targets, fire and rescue operations, and atmospheric profiling.

"The combined capabilities of the light, strong frame with the intelligent software core and autonomous capabilities make the Intense Eye UAS an ideal solution for military and commercial operations" - BlueHalo.[8]

In 2022, the U.S. Army Rapid Capabilities and Critical Technologies Office awarded BlueHalo a $14 million development contract for the HIVE small UAS. According to the BlueHalo statement, the company has "extensive technical experience delivering state-of-the-art capabilities with all aspects of unmanned and counter-unmanned systems including R&D, engineering, fabrication and prototyping, systems development, integration, and test activities."[9]

SkyDome with Drone Hunter system

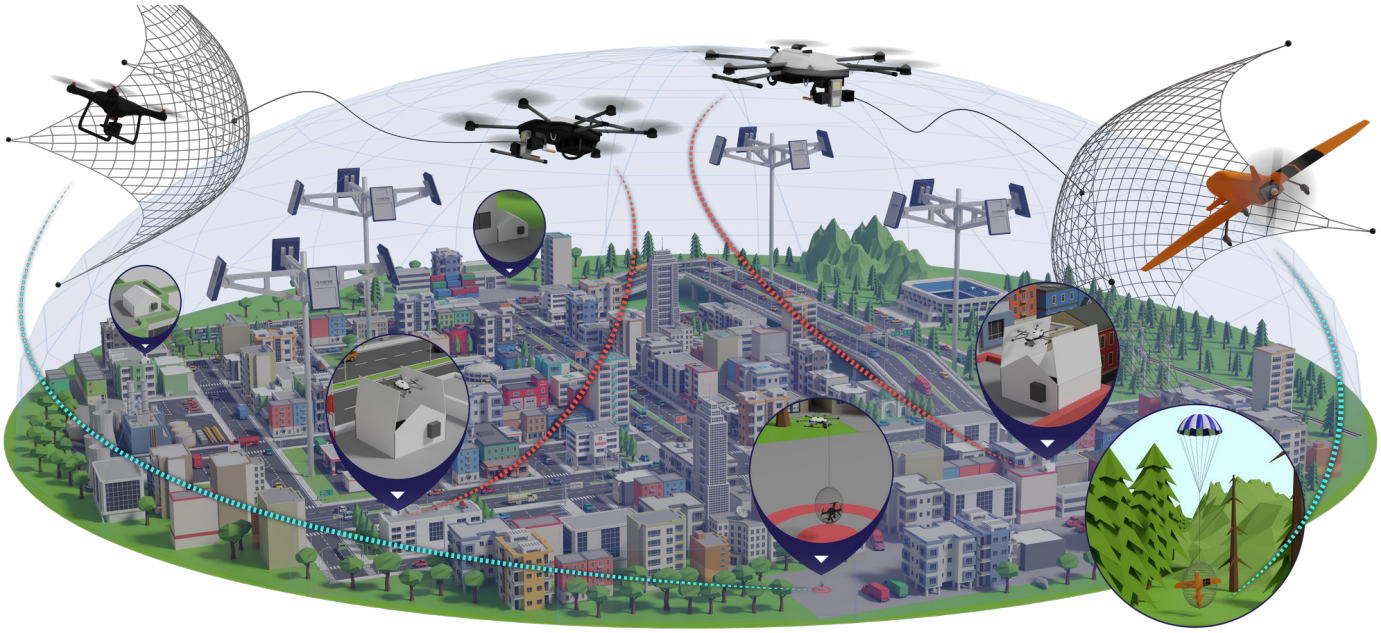
The U.S. Army units trained with the autonomous SkyDome system with Drone Hunter. The Fortem Technologies' Skydome with Drone Hunter is an autonomous, radar-guided, counter-unmanned aircraft system with modular attachments rapidly firing nets to ensnare enemy UAS.

---

7. BlueHalo Autonomous Systems, Harnessing Proxy Operations for Amplified Multi-Mission Impact, BlueHalo, March 25, 2024. https://bluehalo.com/c-uas-autonomous-systems/autonomous-systems/

8. BlueHalo Press Release, BlueHalo and Alpine Partner for Break-Through Innovations in Unmanned Systems, BlueHalo, October 10, 2023. https://bluehalo.com/bluehalo-and-alpine-partner-for-break-through-innovations-in-unmanned-systems/

9. Tiffany Sevieri, BlueHalo Awarded Army RCCTO HIVE Contract for the Development of Offensive Swarming UAS, BlueHalo, March 26, 2024. https://bluehalo.com/bluehalo-awarded-army-rccto-hive-contract-for-the-development-of-offensive-swarming-uas/



Concept mapping of how the SkyDome C-UAS solution works. (Image Credit: Fortem Technologies)

The SkyDome platform includes drone detection radars that can detect, locate, and classify enemy drones on the operator's screen. After the drone is detected, the operator can launch a DroneHunter F700 interceptor armed with NetGuns and DrogueNet to capture both rotary and fixed-wing aircraft.[10]

The DroneHunter Counter-Unmanned Aircraft System (C-UAS) is a fully autonomous and maneuverable counter-drone system with superior speed and agility compared to other same-class drones. The C-UAS can effectively counter rogue drones in difficult weather conditions both during the day and night time. It has six vertical rotors that allow it to hover and can also be used to protect ships from drone threats.

It is a multifunctional and versatile platform with different modes that can be selected autonomously by each drone, such as pursue mode, attack mode, defense mode, and tow-away mode. Several DroneHunters can be coordinated by the SkyDome Manager command and control system to counter multiple threats.

The DroneHunter uses NetGuns modular attachments to take down both group-1 and group-2 large drones. The NetGun projectiles trap the enemy's drone using a net and tow it away via a tether to a safe location for forensics or disposal.

The AI-enabled DroneHunter F700 weapon system has a high field success rate with more than 4,500 captured drones. The system can be operated alone or together with multiple units and can be equipped with different payloads and countermeasures to monitor and safeguard critical infrastructure, troop deployment, forward base, and military base.[11]

---

10. The SkyDome System, Fortem Technologies, March 26, 2024. https://fortemtech.com/products/

11. DroneHunter F700, Fortem Technologies, March 26, 2024. https://fortemtech.com/products/dronehunter-f700/

Ghost-X Unmanned Aircraft System

Ghost-X is a modular, expeditionary, and extended-range unmanned aircraft system platform that can be assembled by a single operator in less than 2 minutes and deployed in the most challenging environments. It can be used for surveillance and security as well as targeting and force protection missions.

The California-based Andruil Industries' Ghost-X system is not just a drone but an artificial intelligence and Intelligence, Surveillance, and Reconnaissance (ISR) system built for soldiering purposes. It has upgraded propulsion, communications, and dual-battery endurance which provides greater operational range and payload capacity. The multiple payload and sensor types provide enhanced situational awareness and mission flexibility, while the multiple layered advanced navigation and communications technologies enable resilience in low connectivity and denied environments.

> *"Ghost hosts onboard compute with advanced computer vision algorithms to autonomously detect, classify, and track objects of interest while intelligently navigating the terrain and airspace."* – Anduril.

According to Anduril Industries, the Ghost-X UAS is built to "meet the current and future demands of operators in the most challenging environments." It is capable of flying longer, covering more distance, and carrying more payloads, which provides the operator an extended reach to effectively complete missions in harsh conditions.[12]

Key Features

- Endurance - 75 min (cruise)
- Range - 15.5 miles (25km)
- Payload - 20 lbs (9kg)
- Weight (dual batteries) - 55 lbs (25kg)

U.S. Army Staff Sgt. Stetson Manuel, an infantryman and Robotics and Autonomous Systems platoon sergeant from Alpha Company, carries the Ghost-X Unmanned Aircraft System during experimentation at Project Convergence - Capstone 4 at Fort Irwin, Calif. (Image Credit: U.S. Army/Sgt. Charlie Duke)

12. Ghost-X, Anduril Industries, March 25, 2024. https://www.anduril.com/hardware/ghost-autonomous-suas/

Tactical Resupply Vehicle-150

The London-based Malloy Aeronautics' T150 (or TRV-150) is a remote-controlled uncrewed electric Vertical Take-Off and Landing (eVTOL) air cargo drone. The T-150 is capable of delivering food, goods, fuel, medical supplies, military hardware, parts, equipment, weapons, and ammunition to soldiers on the battlefield.

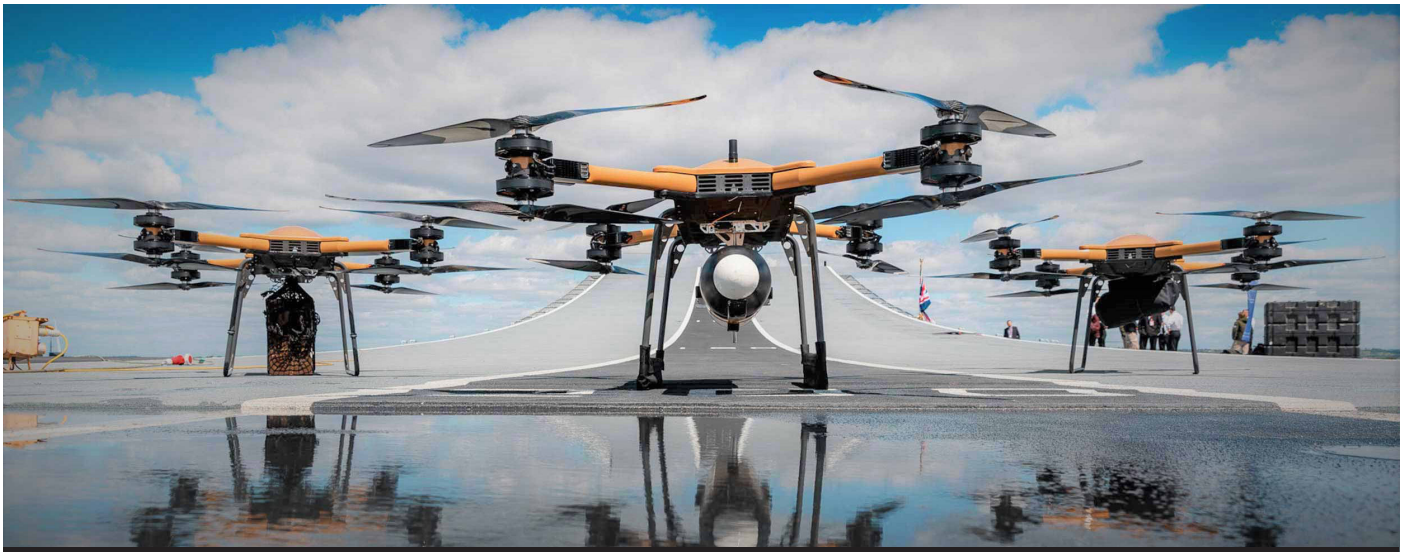
The T-150's flight can be controlled using a laptop and the remote pilot can set waypoints for autonomous delivery. The autonomous drone has eight propellers and eight electric motors and is equipped with batteries that can be easily removed and replaced which allows it to perform multiple missions.[13]

It can fly during both day and night time and carry a 68 kg (150lb) payload at a cruise speed of 108 km/h (67 mph). The drone has been successfully tested in all weather conditions including rain, snow, and gusty wind conditions, as well as in desert and sea.[14]

During the first phase of Project Convergence Capstone 4, T-150 drones took off from the deck of the Marine Corps Warfighting Laboratory's Stern Landing Vessel to test its ability to reach the shore and complete its journey back to the ship.

Key Features

- Maximum Payload: 68kg (150 lb)
- Maximum range: 70+ km (44 miles)
- Flight time: 36 minutes
- Cruise Speed: 108 km/h (67 mph)
- Propellers: 8
- Electric Motors: 8



Tactical Resupply Vehicles T-150. (Image Credit: Malloy Aeronautics)

13. Electric VTOL News, Malloy Aeronautics T150, The Vertical Flight Society, March 20, 2024. https://evtol.news/malloy-aeronautics-trv-150/

14. T150/TRV150, Malloy Aeronautics, March 24, 2024. https://www.malloyaeronautics.com/t150.html/

Small Multipurpose Equipment Transport Vehicle

The Small Multipurpose Equipment Transport (SMET) is an eight-wheeled transport vehicle with robotic technology for dismounted soldiers. It is an equipment-carrying "robotic mule" and can be used for combat missions, combat support, and combat service support functions and payloads.[15]

The SMET features a hybrid-electric powertrain and can be operated by a remote control. The unmanned ground vehicle can significantly reduce the load for the soldiers on a battlefield. The robotic equipment transport vehicle can be weaponized with the R600 autonomous system. The R600 remote weapon system has advanced surveillance capabilities that can assist soldiers in accomplishing missions in any future operational environment. R600 can be configured with various weapon systems including Javelin Surface-to-air missile, Stinger air-defense system, Coyote, and Advanced Precision Kill Weapon System (APKWS) rockets.[16]

Electro Optic Systems' R600 remote weapon system offers sophisticated ballistic solutions and integrates modern surveillance capabilities with rapid engagement features. It has a dual weapon configuration which allows operators options from a range of firepower, including .62 mm, 12.7 mm, and 40 mm automatic grenade launchers, for different mission requirements.

The Small Multipurpose Equipment Transport can also be used for casualty evacuation. During the PC-C4 human-machine integration exercise, soldiers used SMET with different configurations, including evacuation, armed with a Javelin anti-tank weapon, and other remote deployment firepower systems.[17]

British unmanned, eight-wheeled, all-electric, transport vehicles armed with autonomous weapon system from the Experimentation and Trails Group provide support to dismounted U.K. Soldiers in an urban environment at Fort Irwin, Calif, March 11, 2024. (Image Credit: U.S. Army/Pfc. Ivan Hernandez)

UK's Experimentation and Trails Group

The United Kingdom's Experimentation and Trails Group (ETG) participated in the PC-C4 and tested advanced military systems and technologies. The ETG is a "Future Soldier" organization that supports the experimentation of advanced weapon systems and trial activities of the Army.[18] More than 600 British Army soldiers took part in the U.S.-led experimentation exercises and trained with several autonomous systems and military technologies.

---

15. Matthew Murch, Transforming DOD: PC-C4 prepares for the future battlefield, U.S. Army, Futures and Concepts Center, March 22, 2024. https://www.army.mil/article/274758/transforming_dod_pc_c4_prepares_for_the_future_battlefield/

16. EOS, R600, Electro Optic Systems, March 26, 2024. https://eos-aus.com/defence/firepower-systems/r600/

17. Lockheed Martin, Unmanned Platforms and Beyond: Javelin's Growing Platform Integration, Lockheed Martin News, March 25, 2024. https://www.lockheedmartin.com/en-us/news/features/2024/unmanned-platforms-and-beyond-javelins-growing-platform-integration.html/

18. UK Army, Experimentation And Trials Group, United Kingdom Ministry of Defence, March 13, 2024. https://www.army.mod.uk/our-future/modernise/experimentation/experimentation-and-trials-group/

The ETG tested several defense technologies including small remote-controlled ground drones, JIM Compact multifunction infrared long-range binoculars, All Terrain Electric Mission Modul (ATeMM), and remote-controlled robotic dogs.

The allied soldiers also trained with Robotic Platoon Vehicles (RPVs) with mounted machine guns and unmanned eight-wheeled all-terrain transport vehicles armed with an autonomous weapon system that can support dismounted soldiers in an urban environment.[19]

> *"Hands-on approach to innovation during experiments like PC-C4 can be very advantageous when compared to more conventional, top-down innovation"* - U.S. Army Gen. Randy George.

General George said that during the experimentation exercise, he observed several scenarios where advanced technology was integrated into the Army's formations. General George highlighted that he observed, "a light infantry company that was operating in a simulated urban environment while incorporating robotic dogs and unmanned aircraft systems to sense the environment."

Gen. George highlighted that "There's nothing like testing… in the environments that you know you're going to need to operate in; this isn't about testing something in a showroom. This is actually getting to use [the technology] where they're going to use it … and I think that's where we do our best learning."

While commenting on the timeline for the integration of advanced technologies and modernization, U.S. Army General Randy George said that it depends on future budgets. He stressed, "We do have a sense of urgency," but noted that there is no specific date or timeline for modernization and the Army is focused on "incremental improvement."

U.S. Army Staff Sgt. Stetson Manuel, a Robotics and Autonomous Systems platoon sergeant and infantryman, assembles the Ghost-X Unmanned Aircraft System during the Project Convergence Capstone 4, on March 11, 2024. (Image Credit: U.S. Army Staff Sgt. LaShic Patterson)

19. The UK Army, British troops in major war-fighting experiment, United Kingdom Ministry of Defence, March 13, 2024. https://www.army.mod.uk/news-and-events/news/2024/03/british-troops-in-major-war-fighting-experiment/

USAF Embraces Electric Future with eVTOL Technology, Transforming Military Mobility

Just over a century after the Wright brothers' historic flight, the spirit of innovation soared once more. This time ushering in a new era of electric aviation.

In 2021, the United States Air Force (USAF) embarked on a new era of aviation, conducting the first government-sponsored, remotely piloted flight of an electric Vertical Takeoff and Landing (eVTOL) aircraft Kittyhawk Heaviside. In October 2023, Beta Technologies joined the air revolution, deploying its electric aircraft ALIA for testing with the Air Force. These milestones are expected to propel us towards a future where electric aviation electrifies military operations, and also overall air mobility.

Recent advancements in electric mobility and advanced autonomous systems are paving the way for transition into the next age of air mobility propelled by electric and hybrid VTOL aircraft technology.

How Air Force's Agility Prime Program is Fueling the Future of Air Mobility

The U.S. Air Force's AFWERX Agility Prime program is spearheading innovation in eVTOL technology. The Air Force Work Project (AFWERX), the innovation unit of USAF and a directorate within the Air Force Research Laboratory (AFRL) located at Wright-Patterson Air Force Base, Ohio, strives to cultivate an environment where innovative technology integrates with the expertise of air force, space, and cyberspace personnel to address defense challenges and expedite technology transition to operational capability.

Lift Aircraft's Hexa aircraft is a part of AFWERX's Agility Prime project demonstration during Emerald Warrior 22.1 at Hurlburt Field, Florida, on May 3, 2022. (Image Credit: U.S. Air Force/Staff Sgt. Taylor Crul)

Agility Prime is the Air Force's transformative vertical lift program that is partnering with the electric vertical takeoff and land (eVTOL) commercial industry to develop a new class of air mobility systems and advance the domestic industrial base for an aerospace market projected to be worth $1 trillion by 2040. This is the only all-electric passenger aircraft program in the U.S. Government.[1]

---

1. AFWERX, Agility Prime, Air Force Research Laboratory. https://afwerx.com/divisions/prime/agility-prime/

Launched in 2020, Agility Prime has so far awarded contracts to 23 contracts to 15 companies totaling more than $100 million.[2] In addition to Beta, several companies working with the service to produce VTOL aircraft, include Joby Aviation and Archer Aviation, Lift Aircraft, Moog, Wisk, Elroy Air, and others. Partnering with these companies and startups, the program aims to introduce zero-emission aviation to the military along with other benefits, including a quiet noise profile and the cost savings to operate and maintain its fleet and making flight operations more environmentally friendly than conventional aircraft that rely on fossil fuels.

An urban air mobility technology simulator facility has also been established at Springfield-Beckley Municipal Airport to foster collaboration among Beta Technologies, Joby Aviation, and Loft Aircraft, accelerating advancements in eVTOL and UAS technologies in the region.

Key Agility Prime Milestones

- December 2021 — First USAF remotely piloted eVTOL flight with Kittyhawk's Heaviside aircraft.[3]
- March 2022 — USAF pilots conduct first-ever crewed eVTOL flight with BETA aircraft.[4]
- July 2022 — Wes Ogden became the first U.S. Army aviator to fly an electric aircraft.[5]
- November 2022 — Two airmen remotely piloted the HEXA eVTOL developed by Lift.[6]

Military Applications of eVTOL

The eVTOL aircraft has diverse applications for the service, including personnel movement, cargo transportation, recovery missions, rapid aircraft maintenance, urban mobility, disaster response, firefighting, humanitarian aid efforts, medical evacuation, logistics support, base operations and support, communications relay, missile field support, emergency response, test support, training, range, support, and search and rescue.[7]

"The Agility Prime efforts reduce the risk for technology, regulatory, and financial aspects of the eVTOL industry, increasing the pace of development, and paving the way for early operations of eVTOL aircraft for both military and commercial applications" - Agility Prime lead, Maj. John Tekell.[8]

---

2. AFWERX, Agility Prime, Air Force Research Laboratory. https://afresearchlab.com/wp-content/uploads/2022/03/AFWERX_Agility-Prime_FS_0222.pdf

3. Katie Milligan, AFWERX Agility Prime completes the first USAF-piloted flight of an eVTOL vehicle with partner Kitty Hawk. USAF, January 21, 2022. https://www.af.mil/News/Article-Display/Article/2906946/afwerx-agility-prime-completes-first-usaf-piloted-flight-of-an-evtol-vehicle-wi/

4. Katie Milligan, U.S. Air Force and BETA Technologies make history with the first Airman flight of an electric aircraft through AFWERX Agility Prime Program, AFRL, March 14, 2022. https://www.afrl.af.mil/News/Article/2964766/us-air-force-and-beta-technologies-make-history-with-first-airman-flight-of-an/

5. Amy Tolson, DEVCOM Aviation & Missile Center Public Affairs, U.S. Army, October 7, 2022. https://www.army.mil/article/260948/army_electric_aircraft_research_takes_flight_in_partnership/

6. Samuel King Jr., Airmen fly HEXA for the first time, Eglin Air Force Base, November 29, 2022. https://www.eglin.af.mil/News/Article-Display/Article/3232095/airmen-fly-hexa-for-first-time/

7. AFWERX, 2.0 Program Overview, Air Force Research Laboratory, 2022. https://afwerx.com/wp-content/uploads/AFWERX_2.0_Program_Overview_CLEARED-AFRL-2022-5908_web-1.pdf

8. Air Force Research Laboratory Public Affairs, AFWERX Agility Prime – A New Era of Aerospace, AFRL, November 22, 2021. https://www.afrl.af.mil/News/Article/2850369/afwerx-agility-prime-a-new-era-of-aerospace/

Agility Prime identifies and fast-tracks emerging dual-use technologies, focusing on transformative vertical lift aircraft, including electric Vertical Takeoff and Landing (eVTOL) systems in the advanced air mobility (AAM) sector. These aircraft use distributed electric or hybrid propulsion for crewed, optionally crewed, or autonomous missions. Agility Prime minimizes technical risk using government assets to instill confidence in the technology, attract investors, and expedite domestic commercialization while addressing regulatory risks through early airworthiness reviews and collaborating with the Federal Aviation Administration (FAA), NASA, and others.

Key Players in the Advanced Air Mobility Race and Partnerships with USAF

The leading U.S. eVTOL companies like Joby, Archer Aviation, and Beta Technologies are racing for FAA certification to commence commercial flights, aiming to launch services by 2025. While the FAA targets robust air taxi operations by 2028, these companies seek defense contracts, given the FAA's lack of jurisdiction over military aircraft to prove flight capability.

The USAF is working with these companies testing, experimenting with, and evaluating the new technology for potential future national defense applications. This article details recent pivotal collaborations between the U.S. Air Force (USAF) and leading eVTOL manufacturers BETA Technologies, Joby Aviation, and Archer Aviation.

USAF Collaborated with Beta in Electric Aircraft Trials

The most recent development is the completion of a three-month test deployment of Beta's all-electric aircraft ALIA with the U.S. Air Force. The ALIA conventional takeoff and landing (CTOL) aircraft has been developed by Beta Technologies, a Vermont-based aircraft manufacturing startup.[9]

Beta Technologies ALIA-250 electric conventional takeoff and landing aircraft. (Image Credit: Eric Adams/Electric VTOL News)

9. Ryan Finnerty, Beta completes USAF electric aircraft test deployment, Flight Global, January 31, 2024. https://www.flightglobal.com/fixed-wing/beta-completes-usaf-electric-aircraft-test-deployment/156728.article

Beta's ALIA light-weight electric aircraft has a 50-foot wingspan, a range of 250 miles with a top speed of 138 mph. The aircraft is 90% quieter than a helicopter and produces zero operational emissions. The ALIA aircraft can carry five passengers and a pilot, however, the Air Force test objective is to demonstrate its potential to support agile combat employment logistics with its payload capacity of 1,000 pounds.[10]

The ALIA aircraft first arrived at Duke Field on October 26, 2023, following a more than 1,500 nautical mile mission down the east coast.[11] Beta's ALIA aircraft carried out performance tests at Duke Field, Eglin Air Force Base, in Florida, with the 413th Flight Test Squadron (FLTS) as part of the USAF's Agility Prime program to assess electric aviation's applicability for DoD missions.

On January 11, 2024, the ALIA electric aircraft participated in a simulated casualty evacuation scenario with ground forces, a simulated quick reaction force, and an HH-60W helicopter. During the exercise, the HH-60 first transported the simulated casualty from a forward operating base to a location in friendly territory. The ALIA aircraft then transported the patient to simulated definitive medical care. This exercise at Eglin Air Force Base marked the first time a conventional take-off and landing aircraft conducted a direct operation mission directly with the Air Force and completed a live-casualty evacuation scenario. One of the goals of the exercise was to "augment the existing fleet with additional low-cost assets to assist in mission execution so battlefield aircraft can stay in the fight," said Maj. Riley Livermore, 413 FLTS Futures Flight commander.

Highlights of ALIA Electric Aircraft Test Deployment

• **Time-efficient:** Completed in less than 10 minutes, the exercise was aimed at assessing the ALIA's ability and performance in military scenarios when time is of the essence and aircraft are in high demand. This simulated mission demonstrated the key impacts electric aviation can have on military services, including an increase in response time at the forward operating base.

• **Low cost:** The aircraft promises to reduce fuel costs and resources significantly. In a similar casualty evacuation scenario, a C-130 would normally require a crew of at least three and about $1,600 in fuel to transport a patient whereas the Alia required a crew of two and about $5 in electricity, Beta said.[12]

BETA's ALIA electric aircraft arrives at Eglin Air Force Base, Florida, on October 26, 2023. (Image Credit: U.S. Air Force/Samuel King Jr.)

10. Matthew Clouse, BETA's ALIA electric aircraft arrives at Eglin AFB, Air Force Research Laboratory Public Affairs, October 30, 2023. https://www.af.mil/News/Article-Display/Article/3571824/betas-alia-electric-aircraft-arrives-at-eglin-afb/

11. BETA, The ALIA Platform, BETA Technologies. https://www.beta.team/aircraft/

12. BETA Press Release, BETA Technologies completes first deployment with U.S. Department of Defense, Vertical Mag, January 29, 2024. https://verticalmag.com/press-releases/Beta-technologies-completes-first-deployment-with-u-s-department-of-defense/

• **Faster response time:** ALIA also took part in a simulated Maintenance Recovery Team (MRT) mission, flying to Eglin to pick up a needed part for an F-35 that had landed at Duke. This mission demonstrated the impact of faster response time and reduced costs on training, exercise, and operational maintenance responses. Beta said that ALIA's two flights took about one hour and cost $25 in electricity. A standard truck, covering the same distance, would cost approximately $45 in fuel and four hours of driving.

• **First electric aircraft charging station:** Beta also installed a Level 3 DC fast charger (350kW) — the first-ever electric aircraft charging station at a U.S. military installation.[13]

Throughout the deployment, Beta's core flight test team worked with the U.S. Air Force and 413th FLTS to conduct hands-on experimentation and training with the technology to validate military use cases including critical resupply, cargo delivery, and personnel transport.

AFWERX first partnered with Beta in December 2019 and has since awarded the company several contracts. This partnership and tests aim to accelerate the development and adoption of electric aviation and infrastructure within the U.S. military and commercial market. Over the years, Beta has provided AFWERX with three simulators, including a mobile simulator that has conducted pilot training and demonstrations and two chargers. Through this partnership, Beta became the first electric aircraft developer to receive an airworthiness certificate for manned flight from the military and also conducted the industry's only manned qualitative evaluation flights with test pilots from the Air Force and Army. Beta's all-electric aircraft, ALIA CTOL and VTOL are on track for FAA certification, anticipating entry into service in 2025 and 2026, respectively.

Joby Aircraft is the First Electric Air Taxi Delivered to the U.S. Air Force

In September 2023, Joby Aviation successfully delivered its first electric vertical take-off and landing (eVTOL) aircraft to Edwards Air Force Base as part of a $131 million Agility Prime contract with the U.S. Air Force. This marks the first deployment of an electric air taxi on a U.S. military base, said Joby, a California-based company building quiet all-electric aircraft.[14]

Joby Aviation completed the construction of its second prototype aircraft for the U.S. Air Force. The company will deliver two of its aircraft to MacDill Air Force Base in 2025 under the AFWERX Agility Prime contract.

Joby's electric air taxi in the skies above New York City, piloted by James "Buddy" Denham. (Image Credit: Joby Aviation)

13. Matthew Clouse, Duke Field breaks ground on first electric aircraft charging station, USAF, Air Force Research Laboratory Public Affairs, September 23, 2023. https://www.af.mil/News/Article-Display/Article/3534361/duke-field-breaks-ground-on-first-electric-aircraft-charging-station/

14. Joby Aviation, Joby Delivers First eVTOL Aircraft to Edwards Air Force Base Ahead of Schedule, Joby Aviation Newsroom, September 25, 2023. https://www.jobyaviation.com/news/joby-delivers-first-evtol-edwards/

Capable of reaching speeds up to 200 mph and covering a range of 100 miles with energy reserves, the Joby aircraft offers quiet, emissions-free transportation for a pilot and four passengers. Besides logistics missions, such as cargo and passenger transportation, the Joby aircraft can also conduct on-base operations, facilitating Air Force pilot and aircraft maintenance crew training. This collaboration provides the DOD with valuable insights into eVTOL aircraft performance, while Joby gains operational and training experience in preparation for the 2025 launch of commercial passenger service.

The arrival of Joby's aircraft at Edwards AFB is a significant step towards achieving Agility Prime's objective in 2020 to "work towards an operational capability for transformative vertical lift in the DoD by 2023," according to Col Elliott Leigh, AFWERX director.

Joby's electric air taxi aircraft at the company's flight test and manufacturing facilities in Marina, California. (Image Credit: Joby Aviation)

The aircraft, a significant leap in electric aviation, will undergo joint flight testing and operations with the U.S. Air Force at Edwards AFB, contributing to the DOD's insights into eVTOL performance. The partnership aligns with Agility Prime's goal of achieving operational transformative vertical lift capabilities by 2023. Joby's collaboration with the DOD and NASA demonstrates the success of public-private partnerships in advancing electric aviation technology. The aircraft, boasting a range of 100 miles and a top speed of 200 mph, is poised to revolutionize urban air mobility with its zero-emission capabilities.

JoeBen Bevirt, Founder and CEO of Joby, has said that continued support from the Department of Defense (DoD) and NASA has been "critical to the rapid development of electric aviation and eVTOL aircraft" and demonstrated the significance of successful public-private partnerships in accelerating the application of new technology. Joby's partnership with the DoD dates back to 2016 and work with the DoD represents a total potential contract value of $163 million, believed to be the largest in the industry.

Archer Expands Military Partnership with USAF

As Joby Aviation and Beta Technologies, navigate the path towards advancing military aviation capabilities, Archer Aviation has emerged as a frontrunner in military eVTOL integration with its groundbreaking contract valued at up to $142 million with the U.S. Air Force. This includes the delivery of up to six of Archer's Midnight aircraft to the USAF for research and training purposes.[15]

In October 2023, the USAF provided the California-based Archer an initial payment of nearly $1 million, kickstarting the project under the AFWERX Agility Prime program to evaluate the transformational potential of the vertical flight market and eVTOL technologies for the U.S. military. Archer has been partnering with the DoD since 2021.

Archer's Midnight aircraft, with its vertical takeoff and landing capabilities, 1,000 pounds payload, proprietary electric powertrain, and low noise profile, has the potential to revolutionize military aviation.[16]

Archer's Midnight aircraft has been designed to execute personnel transport, logistics support, and rescue operations with agility, efficiency, and enhanced rapid response while providing a quieter and cost-effective alternative to traditional helicopters, according to the company.

Archer Midnight eVTOL. (Image Credit: Archer Aviation)

Adam Goldstein, Archer's CEO and founder, said that the rapid pace of the contract execution reflects the U.S. Department of Defense's strong commitment to invest in transformational technology. The contracts underscore the commitment to advancing aerospace technology and strengthening national defense capabilities.

Exploring the Challenges and Opportunities of eVTOL Technology

It may be a little early for flying cars but the world is approaching a new age of airpower. The age of sleek, silent, futuristic electric-powered vehicles with the potential to revolutionize personal, commercial, and military transportation.

Navigating the dynamic landscape of eVTOL technology involves addressing both challenges and opportunities. While the potential benefits of eVTOLs in urban transportation, logistics, and defense are promising, the complex terrain of regulatory hurdles, safety concerns, and infrastructure stand in the way of realizing this futuristic vision.

---

15. Archer Press Release, Archer Receives First U.S. Air Force Payment On Landmark Contracts Valued At Up To $142 Million, Archer Aviation, October 4, 2023. https://investors.archer.com/news/news-details/2023/Archer-Receives-First-U.S.-Air-Force-Payment-On-Landmark-Contracts-Valued-At-Up-To-142-Million/default.aspx

16. Archer Midnight Aircraft, Archer Aviation. https://archer.com/aircraft/

Potential Benefits of eVTOL Aircraft

Electric Vertical Take-Off and Landing (eVTOL) vehicles are small aircraft that use sustainable electric propulsion systems and batteries to take off and land vertically like helicopters, which means that these aircraft do not need runway infrastructure. The electric propulsion system offers significant environmental benefits compared to traditional engines, making the flight quieter, efficient, environmentally friendly, and cost-effective. Some of the several potential benefits include:

• **Zero emissions:** Electric propulsion means lower greenhouse gas emissions and quieter operation. As many eVTOL aircraft currently under development are electric, they do not produce any carbon emissions. Battery-powered eVTOL aircraft, especially those powered by renewable sources, have a reduced environmental impact.[17]

• **Quieter flights:** Unlike traditional aircraft that rely on combustion engines, eVTOLs use electric motors that are much quieter, and the distributed propulsion architecture in eVTOLs makes considerably less noise as compared with a large helicopter rotor. This feature makes eVTOL aircraft suitable for use in urban areas.

• **Lower operating costs:** The eVTOL aircraft have lower operating and maintenance costs compared to traditional aircraft. Electric motors are less complex and require less maintenance. Efficient Urban Mobility: eVTOLs could provide faster and more efficient transportation solutions as they fly above the ground traffic and do not need long runways required by a traditional airplane.

• **Connectivity:** Imagine medical responders using eVTOLs to reach remote accident sites much faster and save lives. This revolutionary technology promises to improve air connectivity, not just regionally but within cities without relying on extensive ground infrastructure.

Key Benefits of eVTOL Technology in Defense Applications

Electric aircraft are not only revolutionizing transportation but also offer game-changing advantages for military operations. These include:

1. Rapid troop deployment and access to remote areas with vertical takeoff, landing, and crucial maneuverability.

2. The eVTOLs promise cost-effectiveness with lower operating and maintenance costs compared to traditional aircraft and a reduced environmental impact. This means easier maintenance, reduced logistical complexities, and fewer operations and support costs.

3. The all-electric, battery-powered aircraft could make operations safer and more effective. High levels of real-time situational awareness can directly enhance officer and public safety.

4. Tactical benefits include faster medical evacuation, efficient supply delivery to remote or dangerous locations, reduced risk through remote-piloted reconnaissance and attack capabilities, and quieter engines for silent operations in covert missions and urban warfare.

---

17. Parker Aerospace, Electrification Of Aircraft Enables Sustainable, Net-zero Carbon Emission Aviation, Aviation Week, July 20, 2022. https://aviationweek.com/business-aviation/electrification-aircraft-enables-sustainable-net-zero-carbon-emission-aviation/

Archer Midnight eVTOL. (Image Credit: Archer Aviation)

Potential Challenges

While eVTOLs hold immense promise for advanced air mobility, the technology faces several hurdles before widespread adoption.[18] Aviation experts as well as Vertical Flight Society, which tracks the evolving eVTOL industry, pointed out these challenges for the fast-paced eVTOL industry:

Battery Technology: Current battery technology restricts range and payload capacity compared to traditional aircraft, limiting travel distance and cargo weight. Advances in battery technology to power aircraft that can carry a pilot and up to four passengers.

Infrastructure: Building a robust network of charging stations for electric eVTOLs is essential for the widespread adoption of eVTOLs. Dedicated vertiports or landing pads need to be developed in urban areas to efficiently manage eVTOL traffic.

Regulatory Approval: New regulatory frameworks need to be established to ensure the safety and airworthiness of eVTOLs and integrate these aircraft into existing airspace. NASA, the FAA, and the European Aviation Safety Agency (EASA) are working to ensure the safety and airworthiness of eVTOLs. That can long and complex process.

Sustainability Concerns: The environmental impact of lithium-ion batteries used in eVTOLs needs to be addressed through responsible sourcing, recycling, as well as alternative technologies. The long-term sustainability of eVTOLs depends on various factors, including the use of renewable energy sources such as solar and wind power, for charging.

Safety Concerns: Ensuring the safety of eVTOL operations is another challenge that requires the development of operational procedures and safety protocols.

Cost: While it is lower in the long run than traditional aircraft, the initial development and operational costs of eVTOLs are currently high. Achieving affordability and making these aircraft economically viable for mass adoption currently remains a challenge.

---

18. AeroCar Journal, eVTOLS: Challenges, Obstacles, and Opportunities, June 23, 2020. https://aerocarjournal.com/evtols-challenges-obstacles-and-opportunities/

Public Acceptance: Addressing public concerns about noise, safety, and privacy is crucial for gaining public trust and support for widespread eVTOL operations.

Despite these challenges, the manufacturers, government, and regulators are working in collaboration to overcome these challenges and unlock the full potential of eVTOLs to transform transportation.

Future of eVTOL Technology in Commercial and Military Domains

The latest technological advancements in the eVTOL industry have brought us closer to the era when the whirring noise of helicopters is replaced by the quiet hum of eVTOL aircraft. These futuristic vehicles hold immense potential to revolutionize both commercial and military domains, transforming everyday transportation.

In the commercial realm, eVTOLs promise to unlock new possibilities for urban mobility. Imagine ordering an eVTOL taxi for a quick commute, avoiding traffic jams, and reaching your destination in minutes. On-demand air cargo services could deliver packages faster and more efficiently, while eVTOL ambulances could provide swift medical response in congested areas. These aircraft have the potential to improve public service with applications in firefighting, public safety, search and rescue, and disaster relief.

For the military, eVTOLs offer a game-changer in terms of agility, efficiency, and versatility. Silent operations could enable covert reconnaissance and troop deployment, while rapid response capabilities could revolutionize casualty evacuation and disaster relief efforts. Smaller, more maneuverable eVTOLs could access remote locations and provide logistical support in challenging terrain. The possibilities for tactical applications are vast, promising to enhance military capabilities and redefine warfare strategies.

Collaborations between innovative companies like BETA Technologies, Joby Aviation, and Archer with the U.S. Air Force signify a strategic shift toward incorporating eVTOLs into military operations.

The advanced air mobility (AAM) sector has garnered substantial momentum, recording over 13,000 orders for eVTOL aircraft from more than 400 companies, as mentioned in the World eVTOL Aircraft Directory by The Vertical Flight Society (VFS). The directory also lists a diverse portfolio of 900 eVTOL designs and concepts globally as of January 2024.[19]

Despite being relatively new, the urban air mobility market has experienced remarkable growth. In 2021, five future air mobility companies, Joby Aviation, Lilium, Archer Aviation, Blade Air Mobility, and Vertical Aerospace, went public via special purpose acquisition company (SPAC) deals, with a combined market cap of $10.7 billion, according to McKinsey & Company.[20]

---

19. Electric VTOL News, VFS Electric VTOL Directory Hits 900 Concepts, Vertical Flight Society (VFS), October 10, 2023. https://evtol.news/news/vfs-electric-vtol-directory-hits-900-concepts/

20. Axel Esqué and Robin Riedel, A milestone year for future air mobility, McKinsey & Company, February 8, 2022. https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/a-milestone-year-for-future-air-mobility/

Morgan Stanley Equity Research has estimated that the urban air mobility industry could be worth $1.5 trillion by 2040. The financial services firm detailed in a new BluePaper how investment in autonomous flying aircraft is accelerating, with implications for the future of passenger travel, military and defense applications, and the transportation industry.[21]

Major tech companies like Amazon, Google, Apple, and Facebook are actively investing in the eVTOL sector, contributing significant capital and expertise. "The intersection of many technologies, such as ultra-efficient batteries, autonomous systems, and advanced manufacturing processes are spawning a flurry of activity in this space," says Adam Jonas, who leads Morgan Stanley's Global Auto and Shared Mobility research team.

Leading eVTOL manufacturers, including U.S.-based Joby Aviation, Archer Aviation, Beta Technologies, Wisk Aero, Germany-based Lilium, and Volocopter, have cumulated extensive flight hours and are moving toward mass production, collaborating with regulatory bodies to establish certification standards.

Meanwhile, outside the U.S., China-based EHang has achieved remarkable success, securing the Chinese air taxi manufacturer obtained the Civil Aviation Administration of China (CAAC) type certification in October 2023 for its EH216-S. This certification makes it the first eVTOL aircraft in the world with such approval. The approval is a major milestone for urban air mobility (UAM) providers worldwide, paving the way for EHang to operate pilotless passenger-carrying aerial vehicles on commercial transportation and tourism routes in China.[22]

Multiple EHang EH216-S multicopter aircraft parked on a vertiport. (Image Credit: EHang/via EVTOL News)

German startup Volocopter is on track to become the second globally to receive type certification in Spring 2024. Volocopter hopes to have EASA certification in time for the 2024 Olympics in Paris, where it plans to launch its commercial services.[23]

The future of urban mobility is no longer a distant dream. The year, 2024, marks a pivotal moment as global eVTOL manufacturers prepare to take eVTOLs to take to the skies, navigating crucial regulatory approvals. With substantial funding, government support, flight achievements, and certifications, these industry leaders are not only shaping the landscape of aerial transportation but are also laying the foundation for a new era of sustainable urban mobility, transforming both the commercial and military.

---

21. Morgan Stanley, Are Flying Cars Preparing for Takeoff?, Morgan Stanley Research, January 23, 2019. https://www.morganstanley.com/ideas/autonomous-aircraft/

22. EHang Press Release, EHang Successfully Obtains Type Certificate for EH216-S Passenger-Carrying UAV System Issued by Civil Aviation Administration of China, October 13, 2023. https://www.ehang.com/news/990.html

23. Volocopter, Urban Air Mobility, Volocity air taxi. https://www.volocopter.com/en/

Battle for Aerial Dominance: Drones and Modern Warfare

High-tech weapons and advanced battle equipment have changed the dynamics of modern-day warfare. Now militaries can carry out surveillance, air raids, and attacks on their enemies from hundreds of miles away using drone technology.

The U.S. Navy was the first to test the possibility of a pilotless aircraft in battle scenarios. They began experimenting with radio-controlled (RC) aircraft as early as the 1930s. In 1937, Curtis Aircraft developed N2C-2, the world's first-ever remotely piloted aircraft. Due to the short range of radio control signals, the N2C-2 could only be controlled through another aircraft, which killed the whole purpose of using drones in military operations.

Some early RC aircraft models were used by the U.S. Army Air Corps for mid-air target practice. Combining the maneuverability of an RC aircraft with the idea of cruise missiles, American aerospace company McDonnell built TD2T Katydid, the first-ever radio-controlled target drone that could carry a warhead.[1]

The use of unmanned aerial vehicles in modern security scenarios plays an important role in surveillance, reconnaissance, aerial raids, and finding target coordinates. The ever-evolving drone technology provides a promising replacement for the depleting number of skilled combat pilots all around the world.

The Russia-Ukraine war has unveiled how drones have completely transformed the modern-day battlefield. Ranging from compact palm-sized drones to ones exceeding the weight of 454 kilograms, Russia and Ukraine have developed and obtained a varied array of remotely piloted aircraft to disrupt and impede the enemy's military actions.

Ukrainian soldier operating FPV drone. (Image Credit: X/@ZelenskyyUa)

It was also during the Russia-Ukraine war that the world has seen the effectiveness of First Person View (FPV) drones on the battlefield.[2] FPV drones, equipped with cameras that provide

1. National Air and Space Museum, Katydid Drone, Smithsonian. https://airandspace.si.edu/collection-objects/katydid-drone/nasm_A19660162000

2. Yan Boechat, 'First Person View' drones in Ukraine usher in new era of warfare, Voice of America News, April 3, 2024. https://www.voanews.com/a/first-person-view-drones-in-ukraine-usher-in-a-new-era-of-warfare-/7556206.html

real-time video feeds to operators, offer valuable reconnaissance capabilities, allowing forces to gather intelligence, monitor enemy movements, and assess battlefield situations with enhanced situational awareness.

These drones provide a direct perspective of the operational environment, enabling more informed decision-making and tactical maneuvers for both Ukrainian and Russian forces. As a result, FPV drones have emerged as essential tools in modern warfare, shaping the strategies and outcomes of the ongoing conflict between Russia and Ukraine.

Nations around the world are investing in and developing drone technologies to bolster their defense capabilities and adapt to the evolving nature of conflicts. As the reliance on drone warfare grows, it continues to reshape military strategies, tactics, and the overall conduct of armed conflicts worldwide.

Here is the list of the most advanced and lethal combat drones currently used by militaries around the world.

1. MQ-9 Reaper

Built by the U.S.-based General Dynamics, the MQ-9 Reaper is an advanced long-range, high-altitude surveillance and attack drone. At the time of its induction in 2006, Reaper was the first of its kind hunter-killer UAV designed for long endurance and high-altitude target recognition. It has a large wingspan and long body that allows extended endurance and the ability to carry high volumes of ordnance payload and even cruise missiles.[3]

MQ-9 Reaper has a maximum speed of 480 kilometers per hour and a cruising speed of 300 kilometers per hour. Its weaponry is largely made up of air-to-surface missiles AGM-114 Hellfire.

MQ-9 Predator B Drone. (Image Credit: General Atomics)

An MQ-9 Reaper drone can carry up to eight laser-guided missiles under its wings. The United States Air Force (USAF) used different variants of the Reaper drones in Afghanistan and Iraq to carry out precise strategic attacks. Different variants of the Reaper drones are also used by militaries in France, Germany, Italy, the United Kingdom, and Australia.

Endurance: 27 hours
Payload capacity: 1,701 kilograms (kg)
Maximum altitude: Up to 50,000 feet (ft)
Primary function: Intelligence collection in support of strike, coordination, and reconnaissance missions.

3. GA-ASI, MQ-9A Reaper Drone, General Atomics. https://www.ga-asi.com/remotely-piloted-aircraft/mq-9a

2. TAI Aksungur

The Turkish drone industry has gained prominence globally in recent years. One of the most promising drones that have come out from Turkey is the Aksungur, a Medium Altitude Long Endurance (MALE+) class UAV System. Developed by the Turkish Aerospace Industries (TAI), the Aksungur entered service in 2021. Aksungur drone has been built using the existing technology that TAI employed in its previous successful drone named Anka.

The aircraft is 12 meters long with a wingspan that stretches up to 24 meters in width. It is powered by a twin-propellor design using PD-170 dual-turbocharged diesel engines developed by Turkey's Tusas Engine Industries (TEI). The drone is ideal for high-altitude reconnaissance, observation, and destruction of enemy targets. The UAV can carry guided missiles on its six underwing suspension nodes, including guided bombs, and laser-guided munition.[4]

Anka Aksungur UAV System. (Image Credit: Turkish Aerospace Industries)

Endurance: 50 hours
Payload capacity: 750 kg
Maximum speed: 110 mph (180 km/h)
Maximum altitude: Up to 25,000 ft
Primary function: Day and night Intelligence, Surveillance and Reconnaissance (ISR), and strike missions.

3. Hongdu GJ-11 Sharp Sword

Different variants of GJ-11 serve as the primary combat drones for the Chinese military. Introduced in 2013, the Hongdu GJ-11 Sharp Sword is a jet-powered stealth drone that carries a wide array of sensors and weaponry. The drone is about 12 meters long and 14 meters wide designed in a single-wing configuration. The tailless design provides extra stealth capabilities and high-speed maneuverability.[5]

---

4. TUSAS, Anka Aksungur UAV System, Turkish Aerospace Industries. https://www.tusas.com/en/products/uav/high-payload-capacity-uas/aksungur/

5. ODIN, GJ-11 Sharp Sword Chinese Unmanned Aerial Vehicle (UAV), Operational Environment Data Integration Network, U.S. Army. https://odin.tradoc.army.mil/WEG/Asset/bb664308b41d682ff0cf74e3355e22c0

GJ-11 is jointly designed and developed by China's Shenyang Aircraft Design Institute (SYADI), Shenyang Aerospace University (SAU), and Hongdu Aviation Industry Group (HAIG). It can carry more than 1,800 kilograms of payload inside its internal weapons bay. This includes air-launched decoys and precision-guided missiles. China's People's Liberation Army Navy (PLAN) also operates GJ-11 from its Type 075 amphibious assault ship, making it one of the few drones in the world that can be operated and stored on naval aircraft carriers.

China's GJ-11 stealth attack drone during the National Day parade held in Beijing on October 1, 2019. (Image Credit: Fan Lingzhi/GT)

Endurance: 6 hours
Payload capacity: 1000 kg
Maximum altitude: Up to 41,000 ft
Maximum speed: 621 mph (1000 km/h)
Primary function: Aerial surveillance, reconnaissance, and combat missions.

4. S-70 Okhotnik B

Russian-made S-70 Okhotnik (Hunter) is a long-range, stealth combat drone that can carry out reconnaissance, surveillance, and aerial attack missions. The UAV has been developed by the Novosibirsk aviation plant in western Siberia, a subsidiary of the aircraft company Sukhoi. It is equipped with a flat nozzle to increase its stealth capability.

Okhotnik's powerful engine allows the drone to fly more than 6,000 kilometers in a single flight. The Okhotnik drone can also fly collaborative missions with the Russian Air Force's fifth-generation Su-57.[6] The drone can take off with a net weight of twenty tons, making it one of the heaviest combat drones. It can reach a maximum speed of approximately 1000 kilometers per hour. So far, there are two flyable prototype models of Okhotnik B in existence. The drone is expected to be inducted into the Russian Air Force by 2024.

Russian stealth combat drone Okhotnik photographed in far east Russia. (Image Credit: X/@fighter_bomber)

Endurance: 24 hours
Payload capacity: 6,000 kg
Maximum speed: 1,400 km/h
Maximum altitude: 59,000 ft
Primary function: Complex reconnaissance missions and also carry rockets and bombs for strike missions.

6. IRIA News, Russia unveils first flight prototype of Okhotnik heavy attack drone, IRIA, December 17, 2021. https://www.ir-ia.com/news/russia-unveils-first-flight-prototype-of-okhotnik-heavy-attack-drone/

5. RQ-4 Global Hawk

Developed by the makers of the B-2 bomber aircraft, Northrop Grumman's RQ-4 Global Hawk combat drone is a prime example of a modern-day remotely piloted surveillance aircraft. Rather than focusing on packing advanced weaponry and attacking capabilities, the Global Hawk provides a broad overview and systematic surveillance using high-resolution Synthetic Aperture Radar (SAR) and Electro-Optical Infrared sensors.[7]

An RQ-4 Global Hawk from Andersen Air Force Base, Guam at Misawa Air Base, Japan. (Image Credit: U.S. Air Force/Staff Sgt. Nathan Lipscomb)

The drone can survey as much as 40,000 square miles of terrain per day. To put it in perspective, one Global Hawk drone can provide a detailed terrain map for the whole country of South Korea in a single day. Due to its highly precise surveillance capabilities, the U.S.-based space agency NASA also uses it to support its high-altitude, long-duration Earth science missions.

Northrop Grumman has also developed EuroHawk, a European variant of its RQ-4 drone with customized sensors. The EuroHawk variant is currently used by the German Air Force and other European forces.

Endurance: More than 34 hours
Payload capacity: 1,360 kg
Maximum speed: 357 mph (575 km/h)
Maximum altitude: 60,000 feet
Primary function: High-altitude and long-endurance ISR.

---

7. USAF, RQ-4 Global Hawk, United States Air Force.
https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104516/rq-4-global-hawk/

6. Wing Loong III

China's advanced Wing Loong-3 is the first in its series to reach the intercontinental range. The latest variant of the Wing Loong drone series can fly at an impressive maximum range of 10,000 kilometers (6,200 miles) at medium altitude. The drone was first unveiled at the Airshow China 2022 exhibition held in Zhuhai.

China's Wing-Loong 3 combat drone during the International Aviation and Aerospace Exhibition in Zhuhai 2022. (Image Credit: Twitter/ChinaDaily)

Developed by state-owned aerospace and defense firm Aviation Industry Corporation of China (AVIC), the medium-altitude long-endurance (MALE) UAV, has a 12.2-meter-long main body and a 24-meter wingspan. These features allow the UAV to achieve long-range flight while carrying heavy payloads. It has nine payload hard points and can carry as many as 16 missiles and bombs.[8]

Wing Loong-III's long-range, heavy payload and multirole capabilities address the requirements of both Chinese and international customers seeking extended mission capabilities and cross-regional long-range flights. The drone can conduct various missions such as maritime escort, anti-submarine operations, aerial fire support, anti-radiation attacks, low altitude alert patrols, electronic reconnaissance, communications relays, and collaborate with manned aircraft and other drones.

Endurance: 40 hours
Payload capacity: 2,300 kg
Maximum range: 6,200 miles (10,000 kilometers)
Primary function: Long-distance surveillance, strikes, and long-duration air patrol

7. Shahed 129

Iran has recently emerged as a bulk drone manufacturer. Most of the Iranian drones are cheaper and disposable, widely used by the Russian forces in their invasion of Ukraine. However, standing out among its array of inexpensive Kamikaze drones is Iran's Shahed 129, a multirole drone capable of carrying out reconnaissance missions and precision air-to-ground strikes with small guided munitions.


Iran's Shahed 129 UAV seen during the Eqtedar 40 defence exhibition in Tehran. (Image Credit: Fars Media Corporation)

Iran has reportedly used this drone for both external and internal missions since unveiling

8. J. Michael Dahm, Special Mission Aircraft And Unmanned Systems, South China Sea Military Capability Series - A Survey of Technologies and Capabilities on China's Military Outposts in the South China Sea, Johns Hopkins University Applied Physics Laboratory, 2020. https://apps.dtic.mil/sti/pdfs/AD1128646.pdf

the drone in September 2012. Iran has not released much information about the drone, however, experts believe that the design and making of Shahed 129 are highly inspired by the U.S.-made MQ-1 Predator and Israel's Hermes 450 drones. The UAV's maximum range reaches 1,700 km and a flight endurance of about 24 hours.[9]

Endurance: 24 hours
Payload capacity: 400 kg
Maximum speed: 150 km/h
Maximum altitude: 7,300 m (24,000 ft)
Primary function: Combat or intelligence and surveillance missions.

8. Kronshtadt Orion

Orion is a relatively smaller drone developed by Russia's Kronshtadt Group under a project funded by the Russian Ministry of Defense. Kronshtadt began the development of Orion in 2011. The prototype took to the skies in 2016 and the drone was inducted into the Russian Air Force in 2020.

Orion is primarily a reconnaissance system that is equipped with sensors to map the terrain and transmit coordinate targets. With 8 meters of length and 16 meters of wingspan, Orion can carry 250 kilograms of payload. It has a maximum speed of 120 kilometers per hour and a cruising speed of 200 kilometers per hour.[10] The drone can also be modified to carry missiles and other armaments. Kronshtadt has also developed Vikhr-1V guided missiles for its Orion drone.

Russia used Kronshtadt Orion Inokhodets drone armed with guided missile in Ukraine. (Image Credit: Russian Ministry of Defense)

Endurance: 24 hours
Payload capacity: 200 kg
Maximum speed: 120 km/h
Maximum altitude: 7,500 m (24,600 ft)
Primary function: Day and night aerial intelligence and surveillance missions.

9. Elbit Hermes 900

Hermes 900 is a successor to the Hermes 450, a series of drones produced by Israel-based international defense electronics company, Elbit Systems. Hermes 900 is a medium-altitude and long-endurance UAV designed for short-range tactical missions. It has an endurance of over 30 hours and can fly at an altitude of 30,000 feet to provide intelligence, surveillance, target

9. ODIN, Shahed-129 Iranian Medium-Altitude Long Endurance (MALE) Unmanned Aerial Vehicle (UAV), Operational Environment Data Integration Network, U.S. Army. https://odin.tradoc.army.mil/WEG/Asset/Shahed-129_Iranian_Medium-Altitude_Long_Endurance_(MALE)_Unmanned_Aerial_Vehicle_(UAV)

10. Kronshtadt, Orion-E Medium-Altitude Long-Endurance Intelligence, Surveillance and Reconnaissance Unmanned Aircraft System. https://kronshtadt.ru/assets/files/productfiles/Orion_eng.pdf

acquisition, and reconnaissance (ISTAR). The drone is equipped with several high-tech infrared and electro-optical sensors. It can also carry a 300-kilogram payload.

Elbit Hermes 900 has been in service with the Israeli Air Force since 2012. Due to its low cost and high endurance, several countries have made deals with Elbit to procure the Hermes 900 drone. The list includes Azerbaijan, Chile, Brazil, Canada, Iceland, the Philippines, and Switzerland.

Hermes 900 multi-role MALE UAS. (Image Credit: Elbit System)

Endurance: Up to 36 hours
Payload capacity: 350 kg
Maximum speed: 220 km/h
Maximum altitude: 9,144 m (30,000 ft)
Primary function: Intelligence, surveillance, target acquisition, and reconnaissance.

10. Turkish Aerospace Anka-3

Designed and produced by the Turkish Aerospace Industries (TAI), the Anka-3 drone is powered by a turbofan engine, which allows it to attain a maximum speed of 0.7 Mach and an altitude of 40,000 feet. The tailless design of the Anka-3 drone provides stealth capabilities with a high payload-carrying capacity.

The uncrewed combat aerial vehicle can be used for different missions such as reconnaissance, surveillance, and intelligence, with air-ground munitions, air-to-air ammunition, and radar systems. It has two store stations that can carry up to 630 kilograms of payload and weapons, while the outer wing stations will each have a capacity of 100 kilograms.

The drone also has internal weapons bays, which will be necessary to preserve its low-observable features. In total, Anka-3 has a payload capacity of 1,200 kilograms and is capable of taking off with a maximum weight of 6,500 kilograms.


Artist rendering of ANKA-3 Unmanned Combat Aircraft. (Image Credit: X/@ConflictTR)

Endurance: 10 hours
Payload capacity: 1200 kilograms
Maximum speed: 460 km/h
Maximum altitude: 3,000 feet
Primary function: Intelligence collection, coordination, reconnaissance missions, air-to-air, air-to-ground strike operations.

---

11. Elbit Systems, Hermes 900 UAS. https://elbitsystems.com/product/hermes-900/

12. TUSAS, ANKA-III Unmanned Combat Aerial Vehicle, Turkish Aerospace Industries. https://www.tusas.com/en/products/uav/operative-strategic-uav-systems/anka-III

Global Race to Develop Sixth-Generation Fighter Jets

Advanced countries and aerospace firms around the world are actively engaged in research and development endeavors aimed at conceptualizing and ultimately deploying sixth-generation fighter jets.

Despite the absence of operational examples currently, the global aerospace industry has already achieved significant technological milestones during the development of fifth-generation fighter jets. These advancements include stealth technology, advanced avionics, high-performance engines, and modern air-to-air and air-to-surface armaments.[1]

Generation of Fighter Jets

Fighter jet generations are typically delineated based on a combination of technological features, capabilities, and the era of development. While there is no universally agreed-upon definition, the following general criteria are commonly utilized to classify fighter jets into distinct generations:

First Generation: First-generation fighter jets emerged in the 1940s and were primarily subsonic aircraft. These jets often featured straight wings and were powered by early turbojet engines. Examples include the North American F-86 Sabre and the Soviet MiG-15.

Second Generation: Second-generation fighters appeared in the late 1950s and early 1960s. These introduced improvements such as more powerful engines, radar systems, and limited supersonic capabilities. Examples include the McDonnell Douglas F-4 Phantom II and the Soviet MiG-21.

Third Generation: Third-generation fighter jets emerged in the 1960s and featured significant advancements in avionics, radar, and weapon systems. These were capable of sustained supersonic flight and often incorporated innovations such as variable-geometry wings. Examples include the F-14 Tomcat and the MiG-23.

U.S. Air Force F-16 fighter jet. (Image Credit: Lockheed Martin/Thinh D. Nguyen)

Fourth Generation: Fourth-generation fighters emerged in the 1970s and continued into the 2000s. These jets featured advanced avionics, digital fly-

1. IRIA, Fifth-Generation Aircraft: Enhanced Agility - High Survivability - Superior Stealth Technology, International Relations Insights & Analysis, December 9, 2021. https://www.ir-ia.com/Fifth-Generation-Aircrafts.html

U.S. fifth generation fighter jets F-35 Lightning II.
(Image Credit: 1st Lt. Zachary Bodner/X/@thef35)

by-wire controls, improved radar and sensor systems, and the ability to carry a wide range of weapons. Examples of fourth-generation fighters include the F-15 Eagle, F-16 Fighting Falcon, and the Russian Su-27.

Fifth Generation: Fifth-generation fighters represent the latest evolution in fighter jet technology. These incorporate advanced stealth capabilities, highly integrated avionics and sensor fusion systems, advanced maneuverability, and network-centric warfare capabilities. Some of the advanced fifth-generation fighters are the Lockheed Martin F-22 Raptor and the F-35 Lightning II.

While many of the developing nations are utilizing third and fourth-generation fighter jets in their air force fleet while, most of the developed countries have their hands on advanced fifth-generation fighter jets.

Features of Sixth-Generation Fighter Jets

There are only a handful of projects in the world that have progressed to develop a prototype for sixth-generation fighter jets. All these ongoing projects have a common theme of integrating modern technologies, especially artificial intelligence (AI) into their projects. Some of the common technologies used by almost all sixth-generation fighter jets are as follows:

- **Enhanced Stealth Capabilities:** Building on the stealth technology of fifth-generation aircraft, sixth-generation fighters may incorporate even more advanced stealth features to minimize radar cross-section and infrared signatures, making them even more difficult to detect.

- **Integration of Directed Energy Weapons:** Sixth-generation fighters would feature directed energy weapons, such as high-powered lasers, for both offensive and defensive purposes. These weapons could provide precise targeting and engagement capabilities against various threats.

- **Adaptive structure:** Some of the sixth-generation fighter jets may incorporate adaptive structures that can change shape in flight to optimize aerodynamics and performance based on the current mission requirements and environmental conditions.

- **AI and Autonomous Systems:** Artificial Intelligence and autonomous systems will play a significant role in sixth-generation fighters, enabling enhanced decision-making, autonomous mission execution, and improved human-machine teaming capabilities.

- **Supercruise and Hypersonic Capabilities:** Sixth-generation fighters may have the ability to sustain supersonic speeds without the need for afterburners (supercruise) and potentially achieve hypersonic speeds, allowing for rapid response and engagement of distant targets.

• **Modularity and Scalability:** Sixth-generation fighter designs may emphasize modularity and scalability to accommodate future technology upgrades and mission-specific configurations, ensuring adaptability to changing operational environments.

Sixth-Generation Fighter Jet Projects Under Development

Projects focusing on the development of sixth-generation fighter jets started as early as 2010. Currently, there are a few publicly known sixth-generation fighter jet development projects.

1. United States NGAD and F/A-XX Program

United States has one of the oldest sixth-generation fighter jet programs dating back to 2008. The U.S. Air Force's Next-Generation Air Dominance (NGAD) and the U.S. Navy's F/A-XX programs are among the key sixth-generation fighter jet projects. These jets aim to integrate stealth, supermaneuverability, advanced weaponry, and digital technology.[2]

NGAD, a highly classified initiative, represents a paradigm shift for the USAF, adopting a network-centric system-of-systems approach rather than relying on a single platform. Anchored by a sixth-generation fighter aircraft, NGAD will encompass manned aircraft, unmanned loyal wingman drones, and advanced command and control systems. The NGAD program requires an estimated $16 billion over five years through 2028 for research, development, testing, and evaluation.[3]

The NGAD program originated from the Defense Advanced Research Projects Agency's (DARPA) Air Dominance Initiative study completed in 2014. A full-scale flight demonstrator

Concept art of the possible design for the US Air Force's future Next Generation Air Dominance stealth fighter. (Image Credit: Boeing)

2. Harrison Kass, F/A-XX: The 6th Generation Stealth Fighter That Will Replace the F/A-18, The National Interest, December 21, 2023. https://nationalinterest.org/blog/buzz/fa-xx-6th-generation-stealth-fighter-will-replace-fa-18-208097

3. Airforce Technology, Next Generation Air Dominance Programme, March 8, 2024. https://www.airforce-technology.com/projects/next-generation-air-dominance-programme-us/

was tested in September 2020, signaling the program's progress. Expected to replace the F-22 Raptor stealth fighters, the NGAD modern sixth-generation fighter is slated for deployment starting in 2030, with plans for 200 NGAD fighters and 1,000 collaborative combat aircraft.

Meanwhile, the Navy's F/A-XX is aimed at developing and acquiring a future sixth-generation air superiority fighter to replace the United States Navy's F/A-18E/F Super Hornet and work alongside the F-35C, with deployment scheduled to begin in the 2030s. The F/A-XX is likely to play a pivotal role in both manned and unmanned operations.

Shrouded in secrecy, not very much is known about the F/A-XX yet. Although, the F/A-XX did recently move into the design maturation phase. Three top American aerospace defense contractors – Boeing, Lockheed Martin, and Northrop Grumman – are competing to build the aircraft, while Pratt & Whitney and GE Aerospace are vying for the engine contract.[4]

2. Mitsubishi F-X Jet

The Mitsubishi F-X (also known unofficially as F-3) is a sixth-generation stealth fighter being developed for the Japan Air Self-Defense Force (JASDF). Serving as Japan's inaugural domestically developed stealth fighter jet, it is slated to replace the Mitsubishi F-2 by the mid–2030s. Its development aims to strengthen the nation's defense industry and possibly venture into the global arms market considering Japan's evolving defense stance.[5]

The F-X, a twin-engine stealth fighter, is engineered to achieve air superiority. According to the Japanese Ministry of Defense's classification, the technology, and capabilities inherent in the F-X align it with the criteria for a sixth-generation fighter jet.

The F-X jet would be larger than the U.S.-made F-22. The larger dimensions reflect the Ministry of Defense's intent for the aircraft to boast extensive range and payload capacity. Technologies trialed in the X-2 technology demonstrator are anticipated to be integrated into the F-X fighter. Japan's Defense Ministry has affirmed that the F-X will feature robust network capabilities and will accommodate a greater number of missiles compared to the F-35.

Concept design of Japan's F-X sixth-generation stealth fighter jet. (Image Credit: Japan MOD/Mitsubishi Heavy Industries)

In December 2022, Japan, Britain, and Italy revealed their decision to collaborate and jointly develop a sixth-generation fighter aircraft by 2035 under the Global Combat Air Programme (GCAP) partnership.[6]

4. John Hill, Pratt & Whitney's NGAD engine meets USAF design review, Airforce Technology, February 13, 2024. https://www.airforce-technology.com/news/pratt-whitneys-ngad-engine-meets-usaf-design-review/

5. Mike Yeo, Japan unveils timeline for indigenous fighter jet program, Defense News, July 9, 2020. https://www.defensenews.com/air/2020/07/09/japan-unveils-timeline-for-indigenous-fighter-jet-program/

6. IRIA News, UK, Italy and Japan team up to develop sixth-generation fighter jets, International Relations Insights & Analysis, December 11, 2022. https://www.ir-ia.com/news/uk-italy-and-japan-team-up-to-develop-sixth-generation-fighter-jets/

3. BAE Tempest

The BAE Systems Tempest is an envisioned sixth-generation fighter aircraft currently in development in the United Kingdom for the Royal Air Force (RAF). Scheduled to enter service by 2035, it will gradually replace the Eurofighter Typhoon in the European market. The aircraft is part of the Future Combat Air System (FCAS) program, spearheaded by a consortium known as Team Tempest, comprising the Ministry of Defense, BAE Systems, Rolls-Royce, Leonardo, and MBDA UK.[7] The British government plans to allocate more than $3 billion for the initial phase of the project until 2025.

According to BAE Systems, Tempest is designed to be a modular fighter jet, enabling easy adaptation to specific missions, and facilitating component upgrades throughout its operational lifespan. Featuring a delta wings design and double tail design, Tempest would incorporate stealth technology. The jet would also have the capability for unmanned flight, as well as utilize swarming technology to manage drones.[8]

Additionally, it will integrate artificial intelligence through deep learning algorithms and carry directed-energy weapons. The aircraft will be equipped with Cooperative Engagement Capability, enabling seamless data sharing and message coordination with other aircraft for synchronized actions. BAE Systems has unveiled that the jets' cockpit will feature a virtual display projected onto the pilot's helmet-mounted interface. Furthermore, Tempest will incorporate an adaptive cycle engine employing lightweight composite materials and advanced manufacturing processes for enhanced thermal management and cost efficiency.[9]

Tempest Artist Rendition. (Image Credit: Rolls-Royce/Reaction Engines graphic/UK MoD)

7. MBDA, Team Tempest, Future Combat Air System. https://www.mbda-systems.com/teamtempest/

8. Helena Pozniak, Tempest: the stealthy and stress-free future fighter plane, Engineering and Technology, July 13, 2021. https://eandt.theiet.org/2021/07/13/tempest-stealthy-and-stress-free-future-fighter-plane/

9. BAE, The future of Combat Air, Tempest, BAE Systems. https://www.baesystems.com/en/fcas-future-combat-air-system/

4. Mikoyan PAK DP (MiG-41)

Commonly referred to as the MiG-41, Russia's Mikoyan PAK DP is the country's flagship sixth-generation supersonic fighter jet still in development. So far, no official designation has been given to the project and the name MiG-41 comes from the project that has been named izdeliye 41 (product 41).

The design for the PAK DP had been finalized by 2019. And in 2020, the Russian Ministry of Defense initiated the progress on the project. Presently, the project is still in the research and development phase. Not much information has been unveiled by Russian official sources about the progress of the project. In an interview conducted in July 2020, Ilya Tarasenko, the general director of the MiG corporation, along with the head of the Sukhoi company, revealed that the PAK DP will be based on the design of the MiG-31.[10]

Russia's Mikoyan PAK DP MiG-41 concept plane. (Image Credit: RenderHub/NETRUNNER_pl)

The jet would be capable of cruising at speeds exceeding Mach 4 (5,270 km/h) and operating at high altitudes, typically between the stratopause and the tropopause, ranging from below 45,000 meters to above 12,000 meters. It would utilize a version of the Izdeliye 30 engines, presently in development for the Su-57. Reports suggest that the PAK DP will incorporate stealth technology.[11]

Apart from these mainstream sixth-generation fighter jet programs, China is also running a fighter jet program of its own. In February 2023, the Aviation Industry Corporation of China (AVIC) unveiled its concept for a sixth-generation fighter aircraft on social media. The concept showcased diamond-shaped wings and a tailless design, consistent with earlier images released in various AVIC presentations. In 2018, Chengdu Aerospace Corp purportedly submitted eight proposals for the sixth-generation fighter design, with four designs undergoing testing in low-altitude wind tunnels.

Conceptual image of the next-generation fighter jets. (Image Credit: BAE Systems)

10. Army Recognition, Rostec confirms development of PAK DP MiG-41 to replace MiG-31, January 25, 2021. https://armyrecognition.com/news/aerospace-news/2021/rostech-confirms-development-of-pak-dp-mig-41-to-replace-mig-31

11. MiGFlug, MiG-41 – A new Mach 4+ fighter?, MiGFlug & Adventure GmbH. https://migflug.com/jetflights/mig-41-a-new-mach-4-fighter/

China's Ambitions at Sea and Naval Modernization

China's Navy has been the world's largest naval force for several years. In recent years, the Chinese government has rapidly modernized and diversified the country's naval fleet and launched advanced guided-missile destroyers, amphibious assault ships, and aircraft carriers, revealing China's longstanding blue-water ambitions. China's People's Liberation Army (PLA) and its navy, PLA Navy or PLAN, currently have between 370 to 400 total service units in its active naval inventory and continue to grow in size and capabilities.

From 2005 to 2022, China's PLAN added as many as 135 ships to its inventory, while in the same period, the U.S. Navy added just two, according to a U.S. Congressional Research Service report and data from the annual Department of Defense (DoD) report. The newly added ships include a variety of vessels: ballistic missile submarines (SSB), nuclear-powered attack submarines (SSN), diesel attack submarines, aircraft carriers, cruisers, destroyers, frigates, corvettes, missile-armed coastal patrol craft, amphibious tank landing ships, amphibious transport dock ship, and amphibious medium landing ship.[1]

Key Highlights

PLAN has an overall battle force of over 370 ships and submarines, including over 140 major surface combatants, according to the DoD's annual 2023 report on military and security developments in China. The number of PLAN vessels is expected to increase to 395 ships by 2025 and 435 ships by 2030, according to the Pentagon's report.

Chinese warships pictured at the end of joint exercise with the Russian navy in 2016. (Image Credit: Xinhua)

Chinese Navy currently has 426 total units in its active naval inventory, according to the World Directory of Modern Military Warships (WDMMW). This includes frontline commissioned vessels including aircraft carriers, submarines, destroyers, frigates, corvettes, mine warfare and offshore patrol vessels, and amphibious assault ships; however, it does now count smaller patrol vessels, survey and replenishment ships.[2]

1. China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress, Congressional Research Service, May 15, 2023, https://sgp.fas.org/crs/row/RL33153.pdf

2. WDMMW, People's Liberation Army Navy's Current Inventory 2024, World Directory of Modern Military Warships. https://www.wdmmw.org/peoples-liberation-army-navy-china.php

The Chinese Navy's current inventory includes:

- Aircraft Carriers – 3
- Submarines – 72
- Destroyers – 49
- Frigates – 44
- Corvettes – 71
- Mine Warfare – 49
- Amphibious Assault Ships – 11
- Offshore Patrol Vessels – 127

The Chinese Navy's five branches are the Submarine Force, Surface Force, Coastal Defense Force, Marine Corps, and Naval Air Force. The PLAN consists of three major fleets: the North Sea, the East Sea, and the South Sea.

China's Naval Ambitions

In recent years, the Chinese Navy has made its presence felt regionally and globally, driven by the PLAN's ambition to become a "world-class navy." The scale and pace of China's naval expansion serve as a key instrument in safeguarding the PRC's regional interests, surrounded by regional naval powers, including Russia, Japan, and India, and the frequent presence of the U.S. Navy in nearby waters.[3] China views a robust naval force as essential to counter potential challenges to its interests in the Asia-Pacific region from the United States and its allies.

China's Liaoning aircraft carrier takes part in a military drill in the western Pacific Ocean. (Image Credit: VCG/Reuters)

3. PLAN Party Committee, Strive to Comprehensively Build the PLAN into a World-class Navy, Qiushi, April 32, 2018. https://www.qstheory.cn/dukan/qs/2018-05/31/c_1122897922.htm

China's growing shipbuilding capability accelerated the rapid expansion of the PLAN and also facilitated China's transition into a commercial shipbuilding superpower. In 2023, China retained its lead in the global shipbuilding market followed by South Korea and Japan, and this trend is expected to continue in 2024. The modernization and expansion of the shipyards have resulted in increased shipbuilding capacity and capability for different military projects, such as submarines, and surface combatants.

China's leading state-owned shipbuilding companies, including China Shipbuilding Industry Corporation (CSIC) and China State Shipbuilding Corporation (CSSC), which merged in 2019 to form China Shipbuilding Group Corporation (also known as CSSC) dominate both commercial and military shipbuilding, producing three-quarters of China's ships and all domestically built vessels for the Chinese navy. Changxing Island in Shanghai has transformed into a major shipbuilding hub, with the rapid expansion of its shipyard facilities, pivotal in constructing China's advanced warships.

The size, capability, and capacity of China's shipbuilding industry is considered a key challenge to the long-standing status of the United States as the leading military power in the Western Pacific by U.S. military officials and observers. Amid growing apprehensions from the U.S. and its regional allies regarding the expanding global presence of PLAN and its evolving naval mission capabilities, Chinese officials have consistently denied any intention of seeking expansion or spheres of influence beyond its borders. Instead, they have criticized the United States for maintaining an extensive network of approximately 800 military bases across over 70 countries and territories. Beijing accuses Washington of destabilizing global security and meddling in the internal affairs of other nations through these overseas installations.[4]

A brigade of the Eastern Theater Command Army during an exercise. (Image Credit: Lin Jiayu/China Ministry of Defense)

Western observers often view the Chinese naval modernization effort as being aimed at developing capabilities to:

- Strengthen control over China's maritime domains and near-seas region, especially in the South China Sea.
- Assert China's right to conduct activities within its 200-mile maritime exclusive economic zone (EEZ).
- Safeguard China's vital commercial sea routes (SLOCs),
- Actively respond to the situation in the event of a conflict in China's near-seas region over Taiwan
- Counterbalance U.S. influence in the Western Pacific region and strengthen China's status as the leading regional and world power.

---

4. GT, Recent heightened tensions in South China Sea have a lot to do with US meddling: FM spokesperson, Global Times, April 10, 2024. https://www.globaltimes.cn/page/202404/1310380.shtml

However, China has claimed that its naval expansion is not aimed at competition but at safeguarding national sovereignty, territorial integrity, and rights. Some of the other roles and missions include maritime security operations such as antipiracy operations, humanitarian assistance, disaster relief operations, and noncombatant evacuation operations.

China's Naval Modernization Efforts

The Navy constitutes one aspect of China's overall defense modernization endeavors. The Chinese military aims to upgrade its capabilities and improve its proficiencies across all warfare domains for an efficient joint force that can conduct the full range of land, air, and maritime as well as nuclear, space, electronic warfare, and cyberspace operations.

To achieve its goal of building a "strong and modernized navy force," the PLAN has substituted or upgraded its previous generations of platforms with larger, modern multi-mission combatants. The naval modernization efforts began in the mid-1990s. Presently, the Chinese Navy primarily comprises state-of-the-art multi-role vessels equipped with sophisticated anti-ship, anti-aircraft, and anti-submarine weaponry and sensor systems. Aligning with the strategic imperative of safeguarding both near and far sea territories, the PLAN is accelerating its shift from near-sea defense to broader protection missions in distant waters. It is enhancing capabilities for strategic deterrence, counterattack, maritime maneuvering, joint operations, comprehensive defense, and integrated support, to build a robust and modernized naval force.

The PRC's 2019 defense white paper mentioned PLAN as adjusting to changes in the strategic requirements by "speeding up the transition of its tasks from defense on the near seas to protection missions on the far seas." A significant focus of the PLAN's modernization is upgrading and expanding its littoral warfare capabilities, especially in the South China Sea and East China Sea, and more recently in the Taiwan Strait.[5]

The recent Chinese exercises demonstrate that China is continuously testing and exploring the capabilities of its naval fleet. In August 2022, China held its biggest-ever show of military force in and around Taiwan in response to the controversial visit to the island by former U.S. House Speaker Nancy Pelosi. China exhibited its military might and naval capabilities during the exercise as it conducted anti-submarine operations and air-to-sea strikes in the sea and airspace near Taiwan Island. The drills focused on organizing joint anti-submarine and sea assault operations. Experts have claimed that China is currently building amphibious vessels

Naval vessels attached to a destroyer flotilla under the PLA Eastern Theater Command sail in formation during a training exercise on May 14, 2024. (Image Credit: China Military/Wan Haichao)

5. Chinese Government, Full Text: China's National Defense in the New Era, The State Council Information Office of the People's Republic of China, Xinhua, July 24, 2019. https://english.www.gov.cn/archive/whitepaper/201907/24/content_WS5d3941ddc6d08408f502283d.html

and helicopters that can help stage a possible full-scale invasion of Taiwan if needed.[6]

In April 2023, China conducted 'United Sharp Sword' military drills in the Taiwan Strait. The drills featured a wide array of modern weaponry including long-range rocket artillery, naval destroyers, missile boats, air force fighters, bombers, jammers, and refuellers.[7]

According to the U.S. Office of Naval Intelligence, the design and quality of Chinese ships is in many cases comparable to that of U.S. Navy ships, and it is believed that China is rapidly closing the gap in any areas of deficiency.[8]

China's naval modernization effort covers an extensive range of platforms and programs, including anti-ship ballistic missiles (ASBMs), anti-ship cruise missiles (ASCMs), submarines, surface ships, aircraft, unmanned vehicles, sophisticated sensors and weapons, stealth features, and C4ISR (command and control, communications, computers, intelligence, surveillance, and reconnaissance) systems. The transformation also includes enhancements in logistics, personnel education and training, and naval exercises.

Key Overview Points Concerning China's Naval Modernization Effort:

• The Chinese Navy has eight Type 055 Destroyers (NATO designation: Renhai-class) in active service. Type 055 Renhai-class guided-missile cruisers are among the most formidable warships. China's Type 055 destroyer is compared with its U.S. and British counterparts, the U.S. Navy's Ticonderoga-class cruiser, and the Royal Navy Type 45.

• China launched its fourth amphibious assault ship, a Landing Helicopter Dock (LHD) known as Type 075 (Yushen-class), in Shanghai in December 2023. The Type 075 amphibious assault carrier is comparable to but slightly smaller than the American Tarawa- and Wasp-class amphibious assault ships, displacing around 35,000 tons.

• In 2022, China launched its largest and most advanced third aircraft carrier, Fujian. The 80,000-ton ship, the first of China's three aircraft carriers to be fully designed and built domestically, is a major step towards the modernization of the Chinese military.

• The new classes of surface combatants include Type 054A Jiangkai II–class guided-missile frigates, Type 055 cruisers (or large destroyers), Type 052 Luyang III-class destroyers, and Type 056A next-generation corvettes specialized in anti-submarine warfare.

• The Amphibious Ships include Type 071 amphibious ships, Type 071 (or Yuzhao), and Type 075 amphibious assault ships.

---

6. IRIA Report, China demonstrates military strength around Taiwan, International Relations Insights & Analysis, August 9, 2022. https://www.ir-ia.com/China-demonstrates-military-strength-around-Taiwan.html

7. IRIA News, China conducts 'United Sharp Sword' military drills in Taiwan Strait, International Relations Insights & Analysis, April 9, 2023. https://www.ir-ia.com/news/china-conducts-united-sharp-sword-military-drills-in-taiwan-strait/

8. U.S. Naval Institute Staff, Document: Office of Naval Intelligence's Chinese People's Liberation Army Navy, Coast Guard Ship Identification Guide, USNI News, April 30, 2024. https://news.usni.org/2024/04/30/document-office-of-naval-intelligences-chinese-peoples-liberation-army-navy-coast-guard-ship-identification-guide-2

This aerial photo taken on January 2, 2017, shows a Chinese navy formation, including the aircraft carrier Liaoning (center), during military drills in the South China Sea. (Image Credit: STR/AFP/Reuters)

Aircraft Carriers Expand China's Growing Naval Presence

Amidst strategic shifts and advancements in naval capabilities, the People's Republic of China (PRC) is in the beginning stages of operating what the PLA calls its multi-carrier force. Chinese Navy currently has three aircraft carriers:

- Liaoning (Type 001)
- Shandong (Type 002)
- Fujian (Type 003)

China's first aircraft carrier, Liaoning (Type 001), entered service in 2012. Shandong (Type 002), was the country's second aircraft carrier and first fully indigenously built carrier, which entered service in December 2019. Chinese Navy launched its third carrier, Fujian (Type 003) in June 2022. Fujian is expected to conduct sea trials this year and enter service by 2025. China's third carrier Fujian, with a displacement of more than 80,000 tons, is larger than its two predecessors. The carrier is capable of deploying up to 70 aircraft, including fighter jets, early-warning aircraft and anti-submarine helicopters.

Fujian has electromagnetic catapult systems, also called Electromagnetic Aircraft Launch System (EMALS), that rely on strong magnetic fields and electricity to launch aircraft.[9] This technology allows planes to be launched more frequently and with more fuel and munitions. The United States is the only other country with aircraft carriers equipped with this technology. China's first two aircraft carriers launched planes using ski-jump take-off ramps.

Reports suggest that China is building a fourth aircraft carrier, which may be China's first nuclear-powered surface ship.[10] The new aircraft carriers and the latest developments demonstrate

9. Orange Wang, China says its Fujian carrier is world's largest conventionally powered warship, South China Morning Post, June 23, 2024. https://www.scmp.com/news/china/military/article/3267713/china-says-its-fujian-carrier-worlds-largest-conventionally-powered-warship

10. Liu Xuanzun, China to unveil fourth aircraft carrier soon: PLA Navy political commissar, Global Times, March 6, 2024. https://www.globaltimes.cn/page/202403/1308323.shtml

PLAN's endeavors to upgrade its status to a blue-water navy for near-seas defense and far-seas protection, and to safeguard national sovereignty, territorial integrity, and national interests. A blue-water navy is essentially a maritime force capable of capable of operating globally, across the deep waters of open oceans, functioning far away from its home ports. The fleet of a blue water navy constitutes aircraft carriers, submarines, and large surface ships such as destroyers, frigates, and cruisers.

Chinese Navy's Carrier-based Aircraft:
The PLAN continues to develop a range of aircraft for deployment on its carriers and combat vessels. China's primary carrier-based fighter aircraft is the J-15 'Flying Shark', which can operate from carriers equipped with a ski-ramp instead of catapults. China has developed an upgraded, catapult-capable variant of the J-15 carrier-borne multirole fighter aircraft for its third aircraft carrier, which features an electromagnetic catapult system.[11]

A J-15 ship-borne helicopter prepares to land on the flight deck of the aircraft carrier Liaoning (Hull 16). (Image Credit: China Military/Zhang Lei)

Latest reports suggest that China is developing a carrier-capable variant of its FC-31/J-31 fifth-generation stealth fighter to complement or succeed the J-15 on catapult-equipped carriers. The FC-31 is a twin-engine stealth fighter developed by Shenyang Aircraft Corporation (SAC), a subsidiary of the state-owned Aviation Industry Corporation of China (AVIC). China is also developing a carrier-capable variant of the fifth-generation J-31 fighter, known as the J-35, which conducted its maiden flight in 2021. The aircraft features a catapult launch bar and a wing-fold mechanism.

In February 2024, Chinese media reported the presence of a stealth fighter jet mockup, identified as the J-35, on the flight deck of the country's first aircraft carrier, the Liaoning. The photos and reports suggested that China's advanced carrier-based fighter jet J-31 can be deployed on both the catapult-equipped carrier Fujian as well as the ramp-assisted carriers Liaoning and Shandong.[12]

Liaoning aircraft carrier during an exercise in the western Pacific on April 20, 2018.. (Image Credit: China Military/Zhang Lei)

Beyond fighter aircraft, the Chinese Navy is also improving its situational awareness. China is developing a carrier-based airborne early warning (AEW) aircraft, the KJ-600, which is reportedly similar to the U.S. Navy's carrier-based E-2 Hawkeye AEW aircraft.

---

11. Andreas Rupprecht Mainz and Jon Grevatt, "Shenyang Produces First Catapult-Capable J-15," Jane's Defence Weekly, December 16, 2021. https://www.janes.com/defence-news/news-detail/shenyang-produces-first-catapult-capable-j-15

12. Liu Xuanzun, Aircraft carrier Liaoning to finish the upgrade, mockup of stealth fighter spotted on deck, Global Times, February 19, 2024. https://www.globaltimes.cn/page/202402/1307283.shtml

Early warning aircraft can detect and track other aircraft at extreme ranges, and guide attacks against targets, all of which increases the aerial and maritime situational awareness, and effectiveness of its combat aircraft. Experts say that once it enters service on the carriers, the KJ-600 early warning aircraft will be a massive boost to the Chinese Navy's blue-water aspirations. Chinese analysts believe that KJ-600's addition to China's third aircraft carrier, the electromagnetic catapult-equipped Fujian, will improve coordination between carrier-based fighter jets and early warning aircraft and accelerate combat capabilities. China is also developing the anti-submarine-warfare (ASW)-capable variant of the Harbin Z-20 helicopter for its navy.

Underwater Drones and Unmanned Systems

As part of its naval modernization efforts, the Chinese Navy has embraced the use of drones for intelligence, surveillance, reconnaissance, mine countermeasures, anti-submarine warfare, electronic warfare, and underwater sensor grid development, among other missions. Chinese Navy has been conducting sea trials on multiple surface combatants with vertical take-off and landing (VTOL) unmanned aerial vehicles (UAVs).

China has significantly expanded its deployment of underwater reconnaissance drones to bolster its presence in the South China Sea with the development of a range of unmanned vessels, such as the Qianlong III autonomous underwater vehicle (AUV), and the L30 unmanned patrol boat, for missions encompassing patrol, monitoring, anti-terrorism, law enforcement, and search and rescue operations. Additionally, China is actively pursuing the development of extra-large uncrewed underwater vehicles (XLUUVs), with notable examples including the HSU-001.

In a landmark achievement, China introduced the world's first autonomous seaborne drone carrier, the Zhu Hai Yun, in 2023. Equipped for autonomous navigation and remote control, this carrier can serve as a mothership for smaller unmanned air, surface, and undersea research and monitoring vehicles. It is capable of carrying over 50 unmanned systems across air, sea surface, and underwater domains.[13]

China's Type 022 Houbei class catamaran missile boat. (Image Credit: Chinese Military/Sina/PLAN)

Also in 2023, China unveiled a naval variant of its Guizhou WZ-7 drone, resembling the U.S. Navy's MQ-4C Triton. Built by Guizhou Aircraft Corporation, this drone is designed for maritime surveillance and reconnaissance tasks.

China's advancements in underwater technology are underscored by projects like the Haidou-1, which set a depth record of 10,908 meters, going down to the sea bed of the Challenger Deep in the Mariana Trench, the deepest point recorded in the earth's seabed. The Chinese underwater

13. Liu Xuanzun, China makes breakthroughs in unmanned ship technologies, Global Times, June 26, 2023. https://www.global-times.cn/page/202306/1293216.shtml

glider Haiyan achieved a record endurance of 3,600km during a 141-day voyage in the South China Sea.

Moreover, a less-publicized yet noteworthy addition to the Chinese Navy's capabilities is the development of what is known as the 'Underwater Great Wall' initiative.[14] This refers to the establishment of a network of ship and underwater sensors for real-time tracking and detection of surface and subsurface targets. This strategic endeavor is aimed at enhancing China's capability to detect enemy submarines and reinforcing its maritime presence in critical regions like the South China Sea and the vicinity of Guam.

Submarines: Stealth and Dominance below the Surface

Modernizing its submarine force has been a key priority for the Chinese Navy. Nearly 50 years after the commissioning of the first Type 091 nuclear-powered attack submarine (SSN), China has steadily advanced its capabilities through continuous enhancements, expansion of shipyard facilities, and the integration of cutting-edge technologies, to produce world-class submarines. China possesses a nuclear-powered submarine fleet and a diesel-electric submarine fleet, which remains the backbone of China's submarine force. China's People's Liberation Army Navy Submarine Force (PLANSF) operates a fleet of approximately 60 submarines.[15] These include:

- Nuclear-powered ballistic missile submarines (SSBNs): 6
- Nuclear-powered attack submarines (SSNs): 6
- Diesel-electric attack submarines (SSKs): 48

A nuclear-powered Type 094A Jin-class ballistic missile submarine of the Chinese Navy in the South China Sea on April 12, 2018. (Image Credit: Reuters)

14. Lyle J. Goldstein, China Is Building a "Undersea Great Wall" To Take on America in a War, The National Interest, October 27, 2019. https://nationalinterest.org/blog/buzz/china-building-undersea-great-wall-take-america-war-90601

15. Christopher H. Sharman and Terry Hess, PLAN Submarine Training in the "New Era", China Maritime Report 34, Newport, RI: Naval War College China Maritime Studies Institute, January 2024. https://www.andrewerickson.com/2024/01/china-maritime-report-34-plan-submarine-training-in-the-new-era/

China's submarine fleet is expected to increase to 80 units by 2035, according to the United States government's annual report on China's military power.[16]

In recent years, China's navy and its submarine force have undergone significant advancements with substantial investments in research and development (R&D) and the enhancement of production infrastructure at its three submarine shipyards: Bohai Shipyard in Huludao, Jiangnan Shipyard in Shanghai, and Wuchang Shipyard in Wuhan. Construction of nuclear-powered submarines primarily occurs at the Bohai Shipbuilding Heavy Industry Company shipyard, while Wuhan serves as the focal point for the design and construction of conventionally powered submarines.

China's inventory of nuclear-powered attack submarines and ballistic missile submarines includes the Yuan-class (Type 039) diesel-electric attack submarines, the Shang-class (Type 093) SSN, Ming-Class (Type 035) SSKs, , Song-Class (Type 039) SSKs equipped with torpedoes and anti-ship missiles, and Jin-class (Type 094) SSBN, which is the newest additions to its nuclear submarine fleet.[17]

Latest reports suggest that China has started equipping its nuclear-powered ballistic missile submarines with advanced JL-3 submarine-launched ballistic missiles (SLBMs), first tested in 2018. With an estimated range of more than 10,000 kilometers and capable of carrying multiple nuclear warheads, the JL-3 SLBMs are capable of targeting the continental United States, according to the commander of U.S. Strategic Command Air Force Gen. Anthony Cotton.[18]

China has also made strides in the submarine export market, with the state-owned China Shipbuilding Industry Corporation (CSIC) selling indigenous designs to Thailand and Pakistan. In 2016, Pakistan approved the purchase of eight submarines equipped with AIP systems from China, based on the Yuan-class (Type 039). China also delivered two Ming-class submarines to Bangladesh in 2016, followed by the sale of two Type 053H3 frigates to Bangladesh and four Type 054A frigates to Pakistan.[19]

Destroyers, Frigates and Corvettes: Guardians of Maritime Sovereignty

Warships form an integral part of a naval surface fleet, showcasing a diverse array of capabilities and functions. Among these, frigates and destroyers stand out as common types utilized by most navies. Both excel in maneuverability and serve as escorts, safeguarding larger vessels against threats from air, surface, and underwater domains.

Frigates are more common and are used by several navies globally, whereas destroyers are part of only 14 nations, as per the Global Fire Power Index 2024. The U.S. Navy has the highest number

16. U.S. Department of Defense, Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2023. https://www.defense.gov/Spotlights/2023-China-Military-Power-Report/

17. Peter Suciu, China's Type 094 Nuclear Missile Submarines Has Just One Mission, The National Interest, March 16, 2024. https://nationalinterest.org/blog/buzz/chinas-type-094-nuclear-missile-submarines-has-just-one-mission-210049

18. Luke Caggiano, China Deploys New Submarine-Launched Ballistic Missiles, Arms Control Association, May 2023. https://www.armscontrol.org/act/2023-05/news/china-deploys-new-submarine-launched-ballistic-missiles/

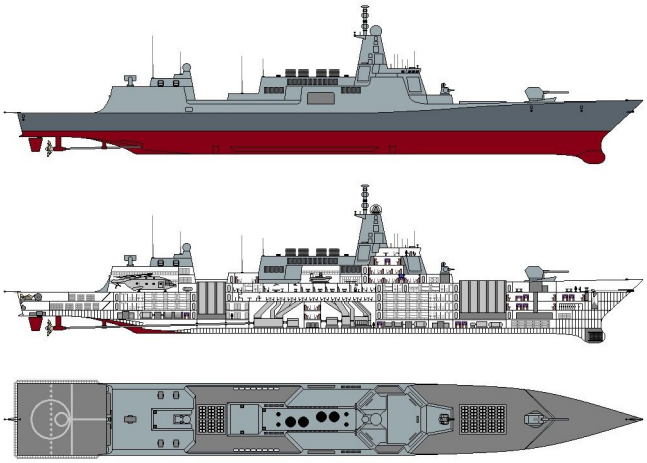
19. IRIA News, Pakistan Navy receives second Type 054A/P Frigate from China, International Relations Insights & Analysis, June 25, 2022. https://www.ir-ia.com/news/pakistan-navy-receives-second-type-054a-p-frigate-from-china/

of destroyers in service at 75, followed by China with 49.[20] Both frigates and destroyers boast cutting-edge weaponry and defense systems, underlining their critical roles in naval operations.

Frigates are smaller, versatile vessels designed for various missions such as anti-submarine warfare, maritime security, and patrol duties. Destroyers are larger, multi-role surface combatants with extensive firepower and advanced capabilities, capable of engaging threats in multiple domains including air, surface, and subsurface. Cruisers are larger than destroyers and are equipped with advanced sensors and weaponry, offering air defense and missile strike capabilities. Corvettes are smaller than frigates and typically used for coastal defense, patrol, and escort missions, offering cost-effective solutions for maintaining maritime security.

In recent years, the People's Liberation Army Navy (PLAN) has undergone significant modernization efforts, with a focus on building advanced multi-role platforms equipped with cutting-edge anti-ship, anti-air, and anti-submarine weaponry and sensors. This initiative is part of a robust shipbuilding program aimed at bolstering the PLAN's surface combatant capabilities with new guided-missile cruisers and destroyers, as well as guided missile frigates.

Type 055 Renhai-class Guided-Missile Cruiser: Representing a key achievement in the maritime domain, China's Type 055 Renhai-class guided-missile cruisers are among the most formidable warships globally, boasting a displacement of approximately 12,000 to 13,000 tons.[21] The first batch of Type 055 Destroyers consists include Nanchang (101), Lhasa (102), Anshan (103), Wuxi (104), Dalian (105), Yan'an (106), Zunyi (107), and the latest Xianyang (108).



Chinese Navy Type 055 Destroyer. (Image Credit: X/Social Media)

Type 052D Destroyer: China has introduced multiple destroyer classes since the 1990s, with the latest being the Luyang III (Type 052D) class. These vessels, displacing about 7,500 tons, feature advanced phased-array radars and vertical launch missile systems akin to those on U.S. Navy cruisers and destroyers. In 2023, China launched an upgraded version of the Type 052D, called the Type 052DL, that incorporates an extended-length helicopter flight deck, new radar and is equipped advanced air-defense system and is capable of launching a range of missiles including the YJ-18 anti-ship cruise missile, YJ-21 hypersonic anti-ship missile, HHQ-9 long-range air-defense missile, Type 8 (YU-8) rocket-assisted torpedo, and the CJ-10 land-attack cruise missile.

Type 054A Frigate: China's frigate capabilities have seen advancements with the Jiangkai II (Type 054A) class, boasting a displacement of around 4,000 tons. Reports suggest China is

20. Global Firepower, Destroyer Fleet Strength by Country (2024). Ranking total number of destroyer warships by country, from highest to lowest. https://www.globalfirepower.com/navy-destroyers.php

21. Eric Wertheim, Type 055 Renhai-class Cruiser: China's Premier Surface Combatant, U.S. Naval Institute, Vol. 149/3/1,441, March 2023. https://www.usni.org/magazines/proceedings/2023/march/type-055-renhai-class-cruiser-chinas-premier-surface-combatant

constructing a new batch of Type 054A frigates for the PLAN, signifying continued growth in naval capabilities. There are an estimated 30 Type 054As in service with the Chinese Navy.

Type 056 Corvette: China has rapidly expanded its corvette fleet with the Jiangdao class (Type 056), displacing between 1,300 to 1,500 tons. A total of 72 Jiangdao units have entered service, and there are six export variants for the international market.

A Chinese navy helicopter during a joint naval exercise on the sea off Qingdao, China in April 2019. (Image Credit: Xinhua/Li Ziheng)

China's Next Generation Type 054B Frigate: Boasting several advanced features, China's new Type 054B frigate, which is larger and more capable than its predecessor, is nearing completion. Type 054B will feature a longer operational range, stronger combat capability, and cutting-edge technology. This next-generation warship is projected to become one of PLAN's most important vessels in the future and is expected to succeed the Chinese Navy's current workhorse Type 054A in missions related to China's defense and security, and regional peace, and stability. Type 054B has an estimated displacement of around 6,000 tons, compared to less than 4,000 tons for the Type 054A.

Launched at a Shanghai shipyard in August 2023, the Type 054B frigate is also expected to join PLAN's aircraft carriers, amphibious ships, and destroyers in far-sea voyages. It is believed to be "capable of carrying land-attack cruise missiles that will enable it to hit ground targets, a capability that previous Chinese frigates do not have," according to Cao Weidong, a former researcher from the PLA Naval Military Studies Research Institute. He added that the new frigate will also boast better information-processing capacity and stealth design, giving it "better agility and situational awareness as well as higher survivability in combat."[22]

The Type 054B is expected to be equipped with a 32-cell vertical launch system capable of firing various types of missiles and rocket-assisted torpedoes, a 100-millimeter-caliber main gun, and a rotating active electronically scanned array radar, HQ-10 short-range air defense missile system, and torpedo launchers. There are currently two Type 054B under construction, with the second ship being developed at Huangpu Shipyard in Guangzhou.

The PLAN's strategic emphasis on modernizing its naval capabilities underscores China's commitment to enhancing its maritime presence and influence on the global stage. The speedy developments and integration of the latest technology and advanced weaponry indicate China's endeavors and determination to assert maritime dominance and expand its strategic footprint.

From the deployment of aircraft carriers to the stealth capabilities of submarines and the versatility of destroyers, frigates, and corvettes, China's naval advancements signify a formidable force set to shape the dynamics of regional and global security in the years to come and influence the balance of power in the Indo-Pacific and beyond.

---

22. Zhao Lei, PLA Navy launches next-gen frigate, China Daily, September 7, 2023. https://www.chinadaily.com.cn/a/202309/07/WS64f9167ca310d2dce4bb45a5.html

Japan's Quest for Military Modernization

Japan has embarked on sweeping military modernization efforts with the most ambitious and rapid expansion of military power. The recent spendings mark the most substantial investment in defense since the establishment of the Japanese Self-Defense Forces in 1954.

This unprecedented modernization initiative seeks to bolster Japan's deterrent capabilities and ensure readiness for potential conflicts in an increasingly uncertain geopolitical landscape. The surge in defense spending since 2017 underscores Japan's commitment to fortifying its security posture. The record increase in defense spending by more than 16% in 2024 is aligned with Japan's new National Security Strategy that aims to increase military expenditure to 2% of GDP by 2027.

In September 2023, the Japanese Ministry of Defense submitted a request to the country's Finance Ministry seeking approval for a record-high 7.7 trillion Yen ($53 billion) defense budget for fiscal year 2024.[1] Tokyo has exponentially expanded its defense spending in recent years amid increasing tensions with China and North Korea.

Japan's pursuit of military modernization started in the year 2022 when Prime Minister Fumio Kishida unveiled a detailed ten-year plan for the country's defense spending. According to the plan, Japan would spend at least 2% of its annual GDP on defense each year, a standard also encouraged by NATO for its member states.[2]

Japan Ground Self-Defense Force troops marching. (Image Credit: JGSDF)

In 2022, Japanese Prime Minister Kishida told his Finance Minister Shunichi Suzuki and Defense Minister Yasukazu Hamada that in the first phase of the military modernization campaign, Japan needs to urgently increase its defense budget by the fiscal year 2027. He also said that the government needs to review expenditures and revenue streams to decide how it can secure extra funding to increase the defense budget.

---

1. IRIA News, Japan unveils record-high $53 billion defense budget for 2024, International Relations Insights & Analysis, September 2, 2023. https://www.ir-ia.com/news/japan-unveils-record-high-53-billion-defense-budget-for-2024/

2. IRIA News, Japan seeks to increase its defense budget to 2% of GDP, International Relations Insights & Analysis, December 3, 2022. https://www.ir-ia.com/news/japan-seeks-to-increase-its-defense-budget-to-2-of-gdp/

As proposed by the current administration, the gradual increase would total about $287 billion over the next five years. Japan typically holds are very limited approach toward defense spending. The $46 billion defense budget in 2023 was already a leap forward compared to the country's previous defense spending. The 2024 budget would exceed last year's budget by 16%.[3]

Japan's National Defense Strategy says that the country will fundamentally reinforce the current multidomain defense force and "will possess a capability that makes the opponent realize that the goal of invasion of Japan is not achievable by military means and that the damage the opponent will incur makes the invasion not worth the cost".

This strategic realignment signifies a pivotal shift in Japan's defense policy, previously constrained by stringent limitations on military spending. As Japan emerges as a key player in regional security dynamics, this transformation holds profound implications for the country's role in shaping the future of East Asian geopolitics.

Japan's Defense Objectives

Based on Japan's National Defense Strategy released in 2023, Tokyo has three main defense objectives and plans to utilize three different approaches to attain them.

Japan's JS HYUGA conducting a trilateral naval exercise with U.S. and Canadian naval forces. (Image Credit: Ministry of Defense Japan)

1. To shape the regional and global security environment to maintain the status quo by force.

2. To deter and respond to unilateral challenges to the regional security environment and to maintain collaboration with Japan's allies and like-minded countries on the matter.

3. To enhance military capabilities to deal with aggression unilaterally while receiving support from allies and like-minded partners.

Japan pursues its defense objectives through a multifaceted approach that combines both military and diplomatic efforts. Tokyo's National Defense Strategy puts a strong emphasis on enhancing defense cooperation and partnerships with like-minded countries, participating in joint exercises, information sharing, and capacity-building initiatives to strengthen regional security networks.[4]

---

3. Kosuke Takahashi, Japan Approves Record Defense Budget For Fiscal Year 2024, Naval News, December 22, 2023. https://www.navalnews.com/naval-news/2023/12/japan-approves-record-defense-budget-for-fiscal-year-2024/

4. The Yomiuri Shimbun, Govt Plans to Establish 'Joint Operations Command' in SDF, Looks to Prepare for Challenges in 'Complex Security Environment', The Japan News, February 10, 2024. https://japannews.yomiuri.co.jp/politics/defense-security/20240210-168103/

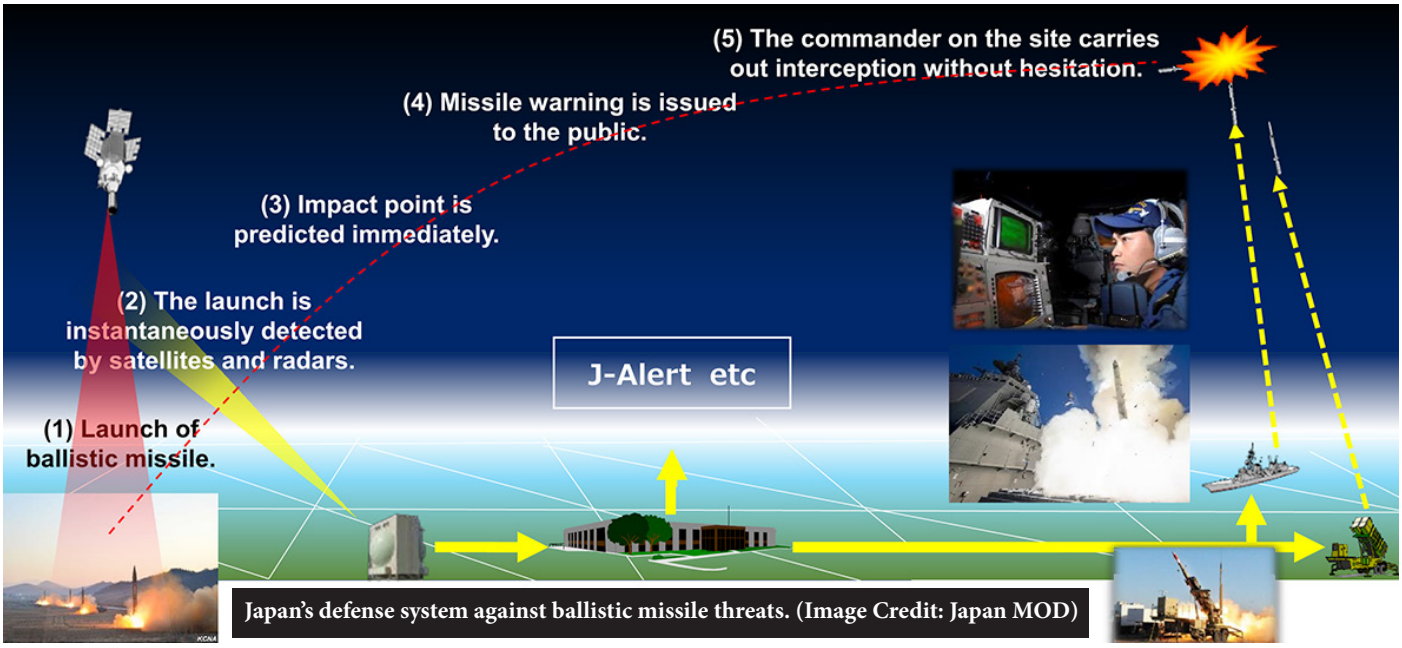
Japan emphasizes diplomacy and dialogue as key tools for promoting peace and stability in the region, engaging in multilateral forums and bilateral discussions to address security concerns and foster mutual understanding among nations.

Seven Fields of Fundamental Reinforcement

Japan's latest national defense strategy has outlined that the military modernization efforts are focused on enhancing seven key areas by 2027.[5]

1. Standoff Defense Capabilities: Strengthening of the ability to respond to the opposing forces by utilizing long-distance strike capabilities. In this regard, Japan has initiated at least two programs. First, Tokyo is acquiring U.S.-made Tomahawk missiles to enhance its long-distance strike capabilities. Secondly, Japan is working to upgrade its domestically developed Type-12 surface-to-surface long-range strike missile. The Japanese government plans to spend more the $33 billion over the course of five years to improve its standoff defense capabilities.

2. Integrated Air and Missile Defense: This program focuses on strengthening the capabilities to respond to airborne threats, including missiles. Japan has acquired, developed, and deployed several Aegis system-equipped naval vessels to enhance its missile defense capabilities. Tokyo plans to spend more than $19 billion over five years to upgrade its integrated air and missile defense capabilities. This program also includes counterstrike capabilities that leverage standoff defense capability and other capabilities in case an armed attack against Japan occurs using ballistic missiles and other means.



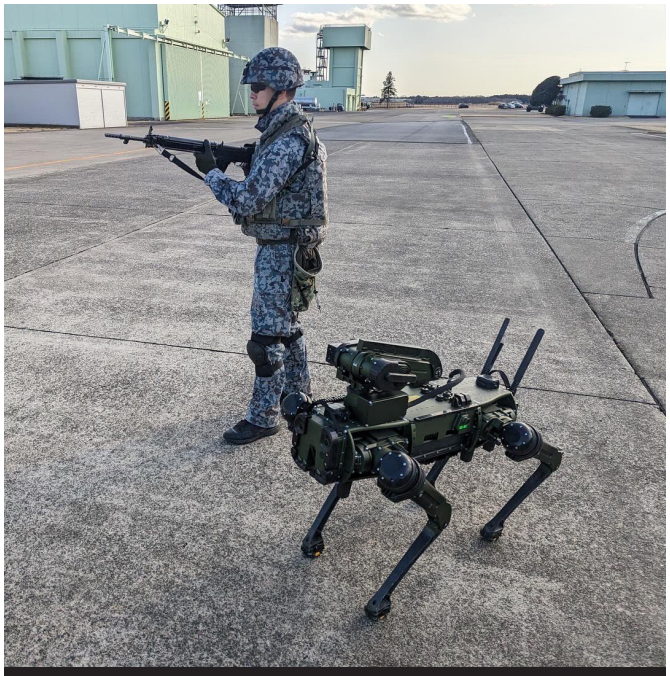
Japan's defense system against ballistic missile threats. (Image Credit: Japan MOD)

3. Unmanned Defense Capabilities: The importance of a strong defense capability against unmanned aerial and underwater threats has become more evident in recent years, especially

5. Kisho Yoshida, Acquiring counterstrike capabilities is no simple matter for Japan, Geoeconomic Briefing No.171, Asia Pacific Initiative, December 14, 2023. https://apinitiative.org/en/2023/12/14/53649/

after the Russia-Ukraine war. Japan is also rapidly enhancing its unmanned defense capabilities by developing and acquiring mid-range as well as long-range reconnaissance and combat drones. Tokyo is projecting to spend $6 billion by 2027 to enhance its unnamed defense capabilities.

4. Cross-domain Operation Capabilities: Cross-domain defense operation refers to the ability to manage defense operations in non-conventional domains such as space, cyber, and electromagnetic spectrum. According to the National Defense Strategy, Japan has put a strong emphasis on enhancing its defense capacities in these domains and plans to spend $53 billion over the next five years on enhancing its cross-domain operation capabilities.



The Japan Air Self-Defense Force is testing Vision 60 quadruped robots from U.S. firm Ghost Robotics at an air base in Japan. (Image Credit: JGSDF)

5. Command-and-Control and Intelligence-Related Functions: Another strong emphasis has been put on reinforcing military command and control operations as well as integrating AI and other modern technologies into the conventional security architecture for quick and accurate decision-making. A $6 billion budget has been estimated for such upgradation of command-and-control and intelligence-related functions by 2027.

6. Mobile Deployment Capabilities and Civil Protection: To reinforce, protect, and enhance the country's maritime and air transportation capability for rapid military maneuvering and deployment, Japan plans to $12 billion over the next five years.

7. Sustainability and Resiliency: Japan plans to spend extensively on developing a reliable military infrastructure and building up a sufficient ammunition backup as well as securing the ammunition and fuel storage facilities. A $12 billion fund has been projected to improve Japan's sustainability and resiliency.[6]

Japan's Defense Strategy for All Domains

Japan's ambitious initiative to overhaul all military domains by 2027, marks a significant milestone in Japan's defense modernization efforts. Enhancements across land, air, sea, and cyber domains, reflect Japan's commitment to bolstering its defense capabilities in the face of evolving security challenges.[7]

---

6. Japanese Ministry of Defense, Defense of Japan 2023. https://www.mod.go.jp/en/publ/w_paper/wp2023/DOJ2023_EN_Full.pdf

7. Yoshihiro Inaba, Here Are Some Of The Future Naval Systems Japan Is Working On, Naval News, October 18, 2023. https://www.navalnews.com/naval-news/2023/10/here-are-some-of-the-future-naval-systems-japan-is-working-on/

Key Projects Japan Plans to Complete by 2027:

Naval Defense

In 2023, The Defense Ministry requested a $2.6 billion budget for the construction of two Aegis system-equipped naval vessels to bolster defense against ballistic missile threats. Currently, Japan operates 8 Aegis system-equipped vessels.

After the approval of the required budget, the construction of the first vessels would begin in 2024 with commissioning planned for 2027. The second vessel is to join the Japanese Maritime Self-Defense Forces (JMSDF) in the following year.

USS George Washington (CVN-73) with the Japan Maritime Self-Defense Force Kongo-class guided-missile destroyer JS Kirishima (DDG-174) on Nov. 18, 2014. (Image Credit: U.S. Navy)

The two vessels would include 128 vertical launching system cells for ballistic missile interceptors as well as launchers for the indigenously produced Type 12 anti-ship, land-attack missile which is currently under development.[8]

Japan will also start the construction of a new class of frigates in 2024. The Defense Ministry has set a budget of $1.2 billion for the construction of the first two frigates. Japan plans to add 12 new Mogami class of frigates to its naval fleet. The frigates would also be equipped with the Type 12 missile.

Air Force

To bolster its air defense capabilities, Japan is actively pursuing the acquisition of air-to-air standoff weapons from international firms. The Japanese Defense Ministry has requested an additional budget in 2024 to purchase the Joint Strike Missile made by Norway's Kongsberg Defense, as well as the AGM-158 Joint Air-to-Surface Standoff Missile made by U.S. defense giant Lockheed Martin. The missiles will be paired with the F-35 fighters and upgraded Mitsubishi F-15J Eagle interceptors with the Japanese Air Force, called Japan Air Self-Defense Force (JASDF), respectively.

The Japanese Defense Ministry has requested a $739.3 million budget in 2024 to acquire eight F-35A conventional-takeoff-and-landing variants as well as $862 million for seven F-35B short-takeoff-and-vertical-landing versions in 2024.

Japanese Air Force is on track to become one of the largest operators of the F-35 jets outside the U.S. as it plans to acquire 105 F-35A and 42 F-35B jets. Japan has already finalized a deal for 83 F-35 jets and is set to receive some deliveries in 2025.

---

8. Dzirhan Mahadzir, Japan Locks in Funding for 2 New Aegis Destroyers, USNI News, December 20, 2023. https://news.usni.org/2023/12/20/japan-locks-in-funding-for-2-new-aegis-destroyers/

Japan's Defense Ministry also released a defense buildup strategy document in 2023, that outlines the ongoing and upcoming plans for the Japanese military strategy. The document highlighted that Japan would become the first country to replace its military helicopter fleet with unmanned aerial vehicles (UAVs).[9] The replacement would include combat, utility, and observation helicopters.

The Defense Ministry is strategizing to deploy hundreds of attack drones by approximately 2025. These drones will be tasked with launching assaults on enemy ships and troops that approach Japanese islands during emergencies, while also conducting surveillance and vigilance over specific encampments and bases. Japan plans to establish a drone unit at the Kanoya base of the JMSDF and integrate eight U.S.-manufactured MQ-9 Reaper attack drones into its existing fleet.

Japan's F-35A stealth fighter jet (Image Credit: JGSDF)

Sources indicate that the respective forces are exploring their application as an air combat platform for small drones. These small drones can potentially combine with the latest "Sparrowhawk" drones developed by General Atomics in the US, forming drone swarms capable of executing suicide attacks when deemed necessary.[10]

The Japanese Defense Ministry has also requested a budget of $82 million to upgrade the existing fleet of F-15J and F-2 jets. After upgradation, the jets would become capable of carrying air-launched Type 12 missiles.[11]

Army

The Japanese army, officially known as the Ground Self-Defense Force, is focused on designing a system prioritizing stand-off defense capability, swift maneuverability, dispersed deployment capabilities, and advanced command, control, and intelligence functions.

---

9. Janes, Rise of the machines: Japan plans to replace some manned air assets with UAVs, Janes OSINT Insights, June 8, 2023. https://www.janes.com/osint-insights/defence-news/defence/rise-of-the-machines-japan-plans-to-replace-some-manned-air-assets-with-uavs/

10. Zi Ge, Diversified UAV development layout underlines Japan's military ambitions, August 3, 2023. http://eng.chinamil.com.cn/OPINIONS_209196/Opinions_209197/16242512.html

11. Bradley Perrett, Japan could quickly build a more powerful fighter force, The Strategist -The Australian Strategic Policy Institute Blog, May 9, 2023. https://www.aspistrategist.org.au/japan-could-quickly-build-a-more-powerful-fighter-force/

H22 Parade of Self-Defense Force. (Image Credit: JGSDF)

The government is also seeking substantial funding for GSDF to acquire more combat vehicles. The Defense Ministry has asked for $561 million to buy 24 wheeled infantry fighting vehicles, eight self-propelled mortars, 19 Type 16 maneuver combat vehicles as well as 10 Type 10 main battle tanks. It is also asking for $215.4 million to procure 28 AMV wheeled armored personnel carriers from Finland.[12]

Japan is upgrading its military equipment transportation infrastructure by acquiring 15 new C-2 transport aircraft. Currently, the Japanese army only has one such aircraft. Japan is also in the process of purchasing the U.S.-made GSDF V22 Osprey tilt-rotor aircraft for personnel movement. The Japanese military is developing at least 6 new rapid deployment regiments.

The Japanese Self-Defense Forces have also gradually increased their participation in military exercises over the course of the last few years in an attempt to strategically develop an expansive plan aimed at fostering robust military interoperability, particularly with the United States as well as other allied military partners who share similar strategic objectives. This comprehensive plan underscores Japan's commitment to enhancing regional security, promoting stability, and fortifying collaborative defense capabilities in the Asia-Pacific region.

During the Exercise Talisman Sabre 2023, Japan's Ground Self-Defense Force conducted the first live-fire demonstration of its Type-12 anti-ship missile off the coast of Australia. The missile was launched from a truck-mounted system at the Beecroft Weapons Range and successfully hit the target in the East Australia Exercise Area off the coast of Jervis Bay.[13]

Japanese forces conducted a live fire demonstration of a Type 12 Surface-to-Ship Missile truck-mounted system. (Image Credit: X/@DefenceAust)

Missiles and Hypersonic Weapons

For 2024, the Japanese Defense Ministry has requested a budget to continue research and development for a land-based long-range Type 12 missile.[14]

---

12. Janes, Japan to procure Hawkei, Eagle light vehicles for trials, Janes OSINT Insights, June 26, 2023. https://www.janes.com/defence-news/news-detail/japan-to-procure-hawkei-eagle-light-vehicles-for-trials/

13. IRIA News, Japan fires Type-12 anti-ship missile for first time in Australia, International Relations Insights & Analysis, July 26, 2023. https://www.ir-ia.com/news/japan-fires-type-12-anti-ship-missile-for-first-time-in-australia/

14. Sheila A. Smith, How Japan Is Doubling Down on Its Military Power, Council on Foreign Relations, December 20, 2022. https://www.cfr.org/article/how-japan-doubling-down-its-military-power/

In April 2023, the Japanese Defense Ministry signed a $2.8 billion contract with Mitsubishi Heavy Industries, for the development and mass production of Type 12 long-range missiles. Under the contract, Japan's domestically produced Type 12 missile would be developed for surface, air, and sea launch. The project is also expected to explore the possibilities of developing Japan's first hypersonic weapons.[15]

The Hypersonic variant of the Type 12 guided missile has already been under development. According to the Japanese Defense Ministry, the missile would be put under mass production, however, due to the lack of testing space in the island nation, Japan plans to hold some of its hypersonic missile tests at military bases in the United States.

Japan is also working to improve the range of its domestically produced Type-12 surface-to-surface cruise missiles. The current range of these missiles is about 200 kilometers with a maximum range of up to 1000 kilometers. The Japanese Ministry of Defense's project to enhance the range of these missiles is expected to be completed by 2026.

In response to growing threats from North Korea, the Japanese Self-Defense Forces is focused on increasing long-range missile defense capabilities. The Japanese government has made a deal with the U.S. to acquire at least 400 units of Tomahawk long-range cruise missiles to reinforce its counterstrike capabilities. The introduction of the Tomahawk, a mainly land-attack cruise missile, is expected to allow Japanese forces to attack enemy bases and other targets overseas until its own domestically produced Type 12 long-range missile is ready for deployment.[16]

U.S. Air Force and Japan Air Self-Defense Force aircraft perform a wing capabilities demonstration during an exercise at Misawa Air Base, Japan, on May 13, 2022. (Image Credit: U.S. Air Force/Airman 1st Class Leon Redfern)

15. IRIA News, Japan signs $2.8 billion deal for long-range missile development, International Relations Insights & Analysis, April 13, 2023. https://www.ir-ia.com/news/japan-signs-2-8-billion-deal-for-long-range-missile-development/

16. IRIA News, Japan plans to acquire US-made Tomahawk missiles to increase counterstrike capabilities, International Relations Insights & Analysis, November 30, 2022. https://www.ir-ia.com/news/japan-plans-to-acquire-us-made-tomahawk-missiles-to-increase-counterstrike-capabilities/

INTERNATIONAL RELATIONS
INSIGHTS & ANALYSIS

IRIA Defense Review 2024

June Issue

Authors and Contributors

Camelia Maria Balaban
Sana Jamal
Syed Bahadur Abbas
Lina Wang
M. Ahsan Jamal
Tran Thanh Ha
Farid Baghirov
Sascha Salfeldar

For more information visit:
www.ir-ia.com

IRIA

Defense Review

June 2024

Use of Advanced Technologies and AI in Shaping Modern Warfare

Cover Image:
Pfc. Aiden Liendo, an infantryman with the MCoE Experimental Company, 1st Battalion, 29 Infantry Regiment, 316th Cavalry Brigade, demonstrates robotic experimentation at Fort Irwin, Clif., March 18, 2024. (Image Credit: U.S. Army/Sgt. Maxwell Bass)

Back Image:
AI Generated image by IRIA staff

www.ir-ia.com