Transforming Joint Air and Space Power

THE JOURNAL OF THE JAPCC

Looking Ahead with 20 Years of Experience

Joint Air Power Competence Centre

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Editorial

It is an honour to introduce my first edition of the JAPCC Journal as the new Assistant Director, especially during the significant milestone of **JAPCC's 20th anniversary**. This moment invites reflection on the past two decades and offers insight into the future. I look forward with great enthusiasm to continue our proud tradition of insightful and innovative analysis.

JAPCC's first two decades coincided with a rapidly evolving global landscape, beginning with the 'War on Terror' after the 2001 attacks in the USA, and subsequent attacks in London, Sharm El Sheikh, and Amman in 2005. This was followed by the 2008 global economic crisis, the Arab Spring in 2010, the rise of ISIS in 2014, a worldwide pandemic in 2020, and ongoing crises in Ukraine and the Middle East in 2022 and 2023.

Throughout this period, NATO and Western coalitions operated with near-uncontested air dominance in Iraq, Afghanistan, Syria, and Libya. However, this era of assured air superiority is rapidly ending. Today's affordable, advanced technologies empower adversaries to challenge Western air power, raising a vital question: **How can NATO sustain air superiority in an era where disruptive threats increasingly undermine its technological advantage?**

Additionally, the post-Cold War 'peace dividend' has led Western nations to significantly downsize their military forces. The focus shifted from quantity to capability, favouring fewer but more technologically advanced platforms. However, recent conflicts in Ukraine, the Middle East and the Red Sea demonstrate that mass still matters. Even fifth-generation assets face challenges when outnumbered by multiple lower-generation systems. Simply put, in air power, capacity matters as much as capability.

In this edition, we begin with strategic insights from the Air Chiefs of the Hellenic and Romanian Air Forces. *The Transformation and Capabilities* section explores advances shaping NATO's future ranging from AI in Air Command and Control, integration of fourth- and fifth-generation aircraft, autonomous collaborative platforms, to cyber-electromagnetic activities.

Our *Viewpoints* section features analysis on SATCOM in the Arctic, adaptation of air and missile defence training, and the crucial role of Host Nation Support. Lastly in our *Outside the Box* piece, represent a proposal to a new NATO air base to enhance operational reach and agility.

We look forward to working with you over the next 20 years and beyond. Your continued feedback is vital to NATO's Joint Air and Space Power evolution. Visit us at www.japcc.org, follow us on LinkedIn, or reach out at contact@japcc.org.

Vito Cracas
Colonel, ITA AF
Assistant Director, JAPCC

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Please email submissions to: **contact@japcc.org**

We encourage comments on the articles in order to promote discussion concerning Air and Space Power. Current and past JAPCC Journal issues can be downloaded from: **www.japcc.org/journals**

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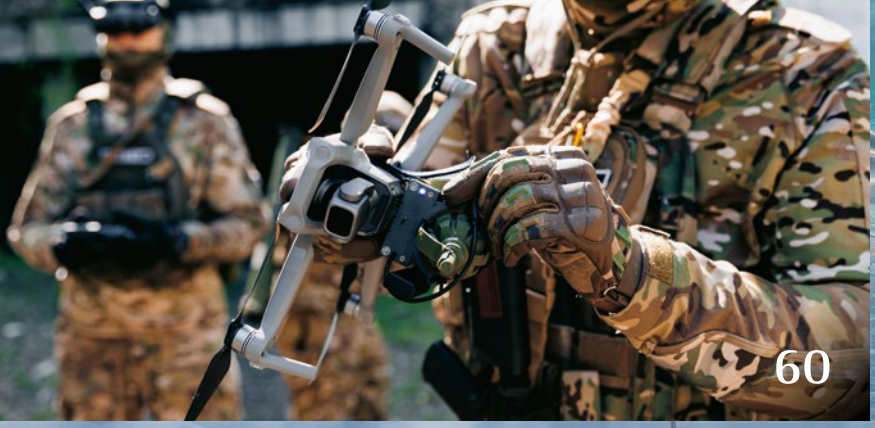

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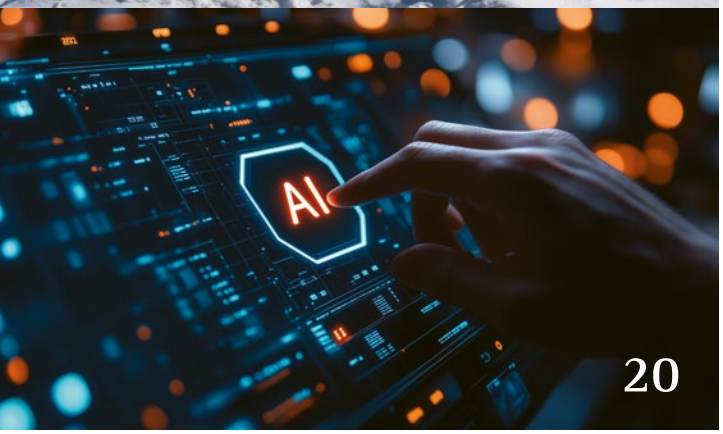

Out of the Box

Inside the JAPCC

Book Reviews

Imprint

Transforming Joint Air & Space Power:
The Journal of the Joint Air Power Competence Centre (JAPCC)

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Purpose
The JAPCC Journal aims to serve as a forum for the presentation and stimulation of innovative thinking about strategic, operational and tactical aspects of Joint Air and Space Power. These include capability development, concept and doctrine, techniques and procedures, interoperability, exercise and training, force structure and readiness, etc.

Cover Photo: A pilot confidently navigates towards the horizon, flying boldly into the dawn of a new era. Marking JAPCC's 20-year milestone, this compelling image symbolizes two decades of visionary leadership and experience shaping NATO's joint air and space power. With eyes firmly set on future challenges, this image underscores JAPCC's unwavering commitment to innovation, transformation, and collective security in air and space domains.

The Hellenic Air Chief Leadership Perspective: Shaping Superiority and Security

The Critical Role of Air Power in Modern Warfare and NATO Security

By Lieutenant General Dimosthenis Grigoriadis,
Chief of the Hellenic Air Force General Staff

Introduction

In modern warfare, where skies serve as both battlegrounds and corridors of deterrence, the mastery of **air power** stands paramount. It is the backbone upon which nations' and alliances' defence and deterrence capabilities rest.

Our era, defined by geopolitical volatility and evolving security threats, underscores the unparalleled importance of air power within NATO forces. As conflicts around the globe continue to unfold, the imperative to **shape superiority and ensure security** in the skies remains the only route to a stable and prosperous future for our nations.

Enhancing NATO's Air Power Strategy: Agile Deployment and Cohesive Operations

Recent armed conflicts have underscored the importance of adaptability and innovation in modern air warfare. Lessons learned from operations in the Eastern Mediterranean and Black Sea regions have highlighted the need for **agile, interoperable air forces** capable of responding swiftly to dynamic threats and changing battlefields.

Within the NATO Alliance, air forces play a pivotal role in safeguarding collective security and projecting stability across the Alliance's borders. From conducting air patrols and surveillance missions, to providing close air support and strategic airlift capabilities, NATO air forces are at the forefront of deterring aggression and ensuring the integrity of Allied nations' airspace.

A key tenet of NATO's air power strategy lies in the seamless integration and interoperability of Allied Air Forces. Through joint training exercises, multinational operations, and intelligence-sharing mechanisms, NATO Air Forces enhance their ability to operate cohesively and effectively in diverse operational environments. Thus, the **Agile Combat Employment (ACE)** concept has emerged as a cornerstone of NATO's strategy to enhance operational flexibility, resilience, and dissuasion against evolving threats. By dispersing forces, leveraging expeditionary basing, and maximizing the use of existing infrastructure, ACE enables NATO air forces to rapidly deploy and sustain operations in contested environments, enhancing their ability to project power and respond decisively to emerging threats.

Hellenic Air Force: A Strategic Hub in NATO's Framework

Greece, as a strategic nexus within NATO, is nestled at the crossroads of Europe, Asia, and Africa. The Hellenic Air Force (HAF), often hailed as the 'Guardian of the Aegean and the southeast Wing of the Alliance', embodies the ethos of **reliability, readiness, and resilience**. For that, the HAF, tracing its origins back to the turbulent days of the early 20th century, has undergone a metamorphosis to evolve from humble beginnings into a formidable force in modern air warfare. From the iconic Spitfires of World War II to the sleek F-16 Fighting Falcons and the Rafales of today, the HAF's journey has been one of **adaptation, innovation,** and unwavering **dedication to excellence**. With a diverse fleet of aircraft, including F-16s, Rafales, Mirage 2000-5s, and soon, the cutting-edge F-35 Lightning II, the HAF boasts a formidable array of capabilities designed to meet the challenges of contemporary warfare. In addition to its aircraft inventory, the HAF has invested heavily in surveillance systems, missile defence technology, and cyber capabilities, ensuring its readiness to confront emerging threats in the digital age. Thus, from conducting Air Policing missions over NATO Balkan States to supporting maritime security efforts in the Mediterranean, the HAF's contribution serves as a testament to its reliability and readiness in times of crisis.

The Hellenic Air Force's exceptional reliability within NATO makes it a strong contributor to the **NATO 2030 Initiative**. Its advanced capabilities, operational excellence, and steadfast dedication to collective defence ensure it is well-equipped to support NATO's goals effectively. Investments in next-generation capabilities such as the F-35 are essential to maintaining a credible preventive posture and staying ahead of emerging threats. The HAF's arsenal, supported by the powerful Patriot Surface Based Air Defence System (SBAD) systems, and other advanced capabilities, aligns with NATO's objectives to modernize and adapt to the evolving security

An impressive formation of Allied fighter aircraft, including F-35s, Rafales, Mirages, and Gripens, conducts a coordinated flyover above the Aegean Sea, highlighting interoperability and collective defence capabilities among NATO partners.

landscape to ensure the Alliance remains prepared to confront 21st-century challenges.

Whether patrolling the skies of the Aegean, the Southeastern Mediterranean Sea, the Balkan NATO states, or participating in multinational exercises alongside NATO Allies, the HAF's operational prowess remains unparalleled. It is a testament to the dedication and professionalism of the men and women who don the uniform, their unwavering resolve echoing through the annals of history and resonating across the vast expanse of the skies they defend.

Strengthening Collective Defence and Security Architecture

Greece has long been a dependable and committed contributor to NATO's collective defence and security efforts. Our country's defence policy is closely aligned with NATO's strategic objectives, and we consistently invest in our military to ensure that we meet the Alliance's operational demands. Greece consistently exceeds NATO's 2% GDP target, often exceeding 3%, demonstrating our enduring commitment to maintaining a strong defence posture.

Our contribution to air defence and NATO's Integrated Air and Missile Defence (IAMD) stands as a cornerstone of the Alliance's collective security architecture. Designed to detect, track, and neutralize a broad range of airborne threats – from ballistic missiles to unmanned aerial vehicles – it provides a vital layer of protection for NATO member states, with Greece, as a key member of the NATO Alliance, playing a significant role in supporting and enhancing its effectiveness. Positioned strategically in southeastern Europe and equipped with advanced air defence capabilities, Greece serves as a vital hub within NATO's IAMD network, delivering critical surveillance and early warning systems to identify and monitor potential regional threats.

[...] *'Greece remains a steadfast security provider within NATO, contributing on land, at sea, and in the air to ensure the collective defence of the Alliance while promoting peace and stability in the region.'*

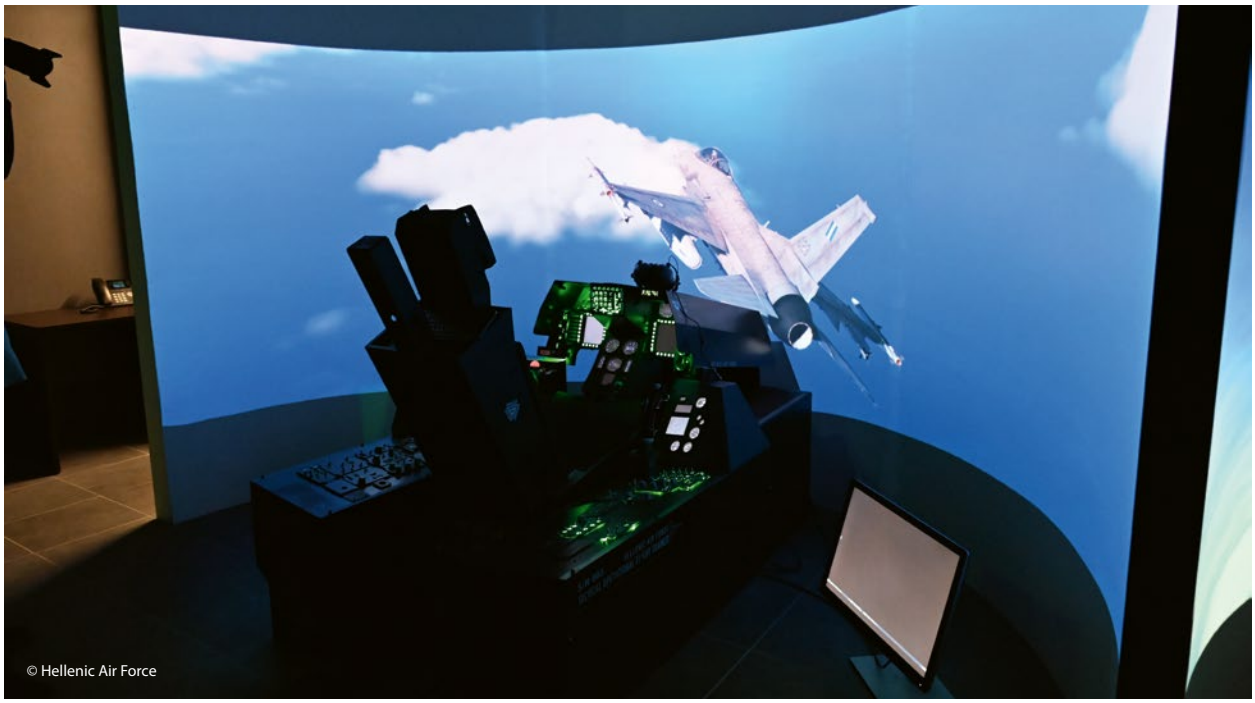
Greece makes a vital contribution to NATO's Integrated Air and Missile Defence System (NATINAMDS), the operational system implementing NATO's IAMD strategy, through its deployment of the Patriot SBAD system. As a key component of NATINAMDS – a network of interconnected national and NATO assets including sensors, command and control infrastructure, and weapons – the Patriot, with its long-range surveillance radar and sophisticated fire control, significantly enhances NATO's ability to defend Allied airspace

against a wide range of airborne threats, from ballistic and cruise missiles to advanced aircraft.

Greek air power has also been an essential addition to NATO's defence, through **air policing** and surveillance operations over the Eastern Mediterranean and Balkans. Our pilots play a vital role in securing Allied airspace, ensuring protection against unauthorized incursions and potential threats. Greece's strategic location allows us to act as a vigilant guardian of these critical air corridors, and our participation in numerous NATO missions underscores the professionalism and dedication of the HAF. By maintaining an advanced fleet of fighter jets and continuously upgrading our capabilities, Greece remains at the forefront of NATO's collective air defence efforts.

Furthermore, Greece has consistently demonstrated its commitment to NATO's crisis response and humanitarian efforts, actively supporting the Alliance's operations. Our strategic location enables us to provide essential logistical support for NATO missions in the Middle East and North Africa, whether during conflict or natural disasters. Greece regularly contributes to disaster relief and humanitarian assistance missions, reflecting the values of solidarity and cooperation that define both our nation and the Alliance. Through these efforts, Greece upholds its role as a reliable partner and a key pillar in NATO's security architecture, contributing to global stability and regional security beyond our immediate borders.

Finally, our participation in joint air defence exercises, training programs, and information-sharing initiatives strengthens NATO's interoperability and overall air defence posture. By conducting regular drills and exercises with Allied forces, Greece enhances its ability to integrate seamlessly into NATO's air defence network and coordinate joint initiatives in support of Alliance objectives. Thus, the HAF, through its innovative training programs, has developed and utilized its brand new Live Virtual and Constructive concept of training via the Synthetic Training Squadron and through modern technologies. Under this capability, which allows us to conduct complex and joint tactical scenarios, the HAF supports training at various courses such as Ground Forces Support, Maritime Warfare Support, and Operations.



The HAF employs its innovative Live Virtual Constructive training concept, enabling complex joint tactical scenarios across courses like Ground Forces Support, Maritime Warfare, and Operations.

Adapting to Hybrid Threats: The Evolution of NATO's Airpower Doctrine

Moreover, hybrid threats and hybrid warfare pose significant challenges to NATO's security and stability, requiring a comprehensive and adaptive response. The HAF's participation in NATO's efforts to counter hybrid threats, including cyber-attacks, disinformation campaigns, and irregular warfare tactics, underscores its commitment to collective defence and resilience in the face of multifaceted challenges.

[...] *'From the iconic Spitfires of World War II to the sleek F-16 Fighting Falcons and the Rafales of today, the HAF's journey has been one of* ***adaptation, innovation****, and unwavering* ***dedication to excellence****.'*

The modern landscape of military aviation demands a nuanced understanding of both historical precedent and future trajectory. In the age of asymmetrical warfare and rapid technological advancement, the ability to anticipate, adapt, and innovate defines the success of air power doctrine.

One of the fundamental lessons gleaned from recent conflicts is the need for **flexibility and interoperability** in air operations. No longer confined to traditional theatres of war, air forces must navigate complex, multidimensional battlegrounds where the lines between friend and foe blur with alarming frequency. This necessitates a paradigm shift in both strategy and tactics, where **agility and adaptability** reign supreme. In addition to that, the evolution of air power extends beyond the realm of traditional warfare to encompass a wide array of security challenges, including cyber warfare, information warfare, and hybrid threats. As the boundaries between physical and virtual battlegrounds blur, air forces must adapt to confront these new and evolving threats head-on.

In the pursuit of air superiority, modern Air Forces must embrace a multifaceted approach that combines advanced technology, strategic planning, and operational excellence. The F-35 Lightning II, with its advanced capabilities, is a key enabler. Moreover, the ACE concept further maximizes the F-35's potential by enabling rapid dispersal and redeployment, enhancing responsiveness and resilience in dynamic threat environments. While managing the logistical and security aspects of ACE is crucial, the resulting increase in operational tempo and adaptability significantly strengthens the F-35's effectiveness, delivering a decisive advantage on the battlefield.

Furthermore, additional NATO investments in Unmanned Aerial Systems (UAS) and Remotely Piloted Aircraft Systems (RPAS) must be in place to revolutionize the battlefield, offering the Alliance persistent surveillance, reconnaissance, and strike capabilities without the unnecessary exposure of airmen or more costly means. At the same time, in any future conflict, the **innovation cycle** must be significantly shortened from current expectations. The Russian invasion of Ukraine demonstrated that innovation cycles cannot extend beyond a few weeks; otherwise, the adversary will quickly develop countermeasures to neutralize our capabilities.

Readiness through Multinational Training: The Cornerstone of NATO's Commitment to Success

In addition to technological advancements, modern air forces must **prioritize training and readiness** to ensure their personnel are prepared to meet the challenges of 21st-century warfare. This includes proficiency in complex air-to-air and air-to-ground operations, as well as joint and multinational exercises such as **Ramstein Flag 2024 (RAFL 24)** to enhance interoperability and cooperation with Allied forces. This includes common training standards, shared Tactics, Techniques, and Procedures (TTPs), and seamless communication and information-sharing mechanisms to ensure unity of effort and coordination in the event of a crisis or conflict.

The RAFL 24 exercise, held at Andravida Air Force Base in Greece, concluded from 30 September to 11 October, 2024, marking the first time this major NATO event was ever executed. The exercise brought together over 140

A Hellenic Air Force F-16V flies in formation with an F-35 over the Greek coastline, representing the transition to next-generation airpower as Greece prepares to integrate F-35s into its fleet in the coming years.

fighter and enabler aircraft, and more than 1,100 sorties were flown within the Athens Flight Information Region (FIR). Greece's leadership in facilitating this exercise highlighted its key role in multinational defence initiatives, leveraging its infrastructure and expertise.

Participants included 12 NATO nations such as France, which deployed Rafale jets and Airborne Early Warning (AEW) E-3F aircraft; Greece, contributing F-16s, Rafales, Mirage 2000-5s, and F-4Es; the US with F-35s and KC-135s; and a range of other nations like the UK, Spain, Italy, Canada, and Sweden, among others, bringing a diverse array of F-35s, Eurofighters, Gripens, and unmanned systems like the MQ-9. Notably, NATO's own AEW E-3A and AGS unmanned systems also took part, underscoring the Alliance's focus on IAMD.

This exercise exemplified NATO's focus on common training standards, shared TTPs, ensuring unity of effort in any future crisis. The exercise incorporated scenarios such as Counter Anti-Access/Area Denial (A2/AD), IAMD, Joint Engagement Zone Operations, Dynamic Targeting, and Air-to-Air Refuelling, emphasizing NATO's commitment to comprehensive defence strategies. These missions were conducted at a high operational tempo, day and night, mirroring the real-world challenges NATO forces might face.

Greece's extensive experience in hosting multinational exercises, particularly through INIOCHOS, was instrumental in ensuring the smooth execution of RAFL 24. The exercise, grounded in the 'Train as you Fight' concept, demonstrated the value of joint operational readiness and interoperability between NATO Allies, setting a new standard for future NATO exercises. It underscored the Alliance's commitment to maintaining peace and security across the Euro-Atlantic region by remaining adaptable and united in the face of emerging threats.

RAFL 24 not only showcased NATO's readiness to operate in contested environments, but also reinforced the bonds of cooperation and shared strategic purpose that are fundamental to the Alliance's strength. As NATO moves forward, RAFL 24 serves as a crucial milestone, enhancing the Alliance's ability to face modern threats with innovation, adaptability, and unparalleled coordination. By emphasizing training, readiness, and cooperation, it reinforced the bonds between Allied nations and ensured that NATO remains capable of defending the Euro-Atlantic region against evolving threats.

As we reflect on the challenges and opportunities that lay ahead, let us remain vigilant, united, and resolute in our pursuit of shaping superiority and security in the modern era. It is not only our capabilities that are tested

but also our resolve to uphold the principles of freedom, democracy, and solidarity that bind us together as members of the NATO Alliance. Now, more than ever, our collective strength lies not only in the advanced technologies and cutting-edge capabilities we possess, but also in the determined spirit of cooperation and camaraderie that defines us as Allies.

Shaping Airpower: Strategies for Superiority and Security

Looking ahead, the NATO 2030 initiative outlines a vision for the Alliance's future, emphasizing the need for greater **resilience, innovation, and strategic foresight**. As NATO air forces embrace this vision, they must remain vigilant in the face of evolving threats while also capitalizing on emerging opportunities to enhance collective security and stability. Thus, the journey towards shaping superiority and security in modern NATO air forces is an ongoing and dynamic process. It requires a multifaceted approach that encompasses not only traditional air force capabilities but also **agility and adaptability** in the face of evolving threats. By embracing these principles and leveraging the collective strength of Allied air forces, NATO can navigate the complexities of the modern security landscape and safeguard the skies for generations to come.

In conclusion, Greece remains a steadfast security provider within NATO, contributing on land, at sea, and in the air to ensure the collective defence of the Alliance while promoting peace and stability in the region. In an era of evolving threats, NATO's modern air forces play a pivotal role in shaping air superiority and safeguarding the Alliance's security. By leveraging advanced technology, rigorous training, and enhanced cooperation, these forces can maintain a strategic edge over potential adversaries, project stability across NATO's borders, and uphold the core values of freedom, democracy, and solidarity. United in purpose, NATO air forces are prepared to confront 21st-century challenges and safeguard peace in the Euro-Atlantic region. Despite facing a myriad of geopolitical challenges, the Hellenic Air Force remains committed to shaping the superiority and security within NATO for years to come. ●

ABOUT THE AUTHOR

Lieutenant General Dimosthenis Grigoriadis

Chief of the Hellenic Air Force General Staff

Lieutenant General Dimosthenis Grigoriadis is the Chief of the Hellenic Air Force General Staff (HAFGS), assuming his duties on 12 January, 2024. Born in Thessaloniki, he joined the Hellenic Air Force Academy in 1983 and graduated in 1987 as a 2nd Lieutenant. With over 4,000 flight hours, he has flown F-5A/B, and F-16C/D aircraft. Prior to his current role, he served as Commander of the HAF Support Command (January 2023–January 2024) and Deputy Chief of the HAFGS (March 2022–January 2023). As Chief, he oversees the organization, training, and equipping of all HAF personnel and serves as a military advisor to the Minister of National Defence as a member of the Joint Chiefs of Staff Council.

The Romanian Air Force

A Two-decade Transformation – From MiG-21 to F-35

By Lieutenant General Leonard-Gabriel Baraboi,
Chief of the Romanian Air Force Staff

Please reflect on the history of the Romanian Air Force and its major accomplishments since joining NATO 20 years ago.

In April last year, we marked an important milestone in Romania's recent history by celebrating the 20th anniversary of joining the North Atlantic Alliance. At the same time, we all celebrated the 75th anniversary of establishing the most powerful political and military Alliance and the 50th anniversary of establishing NATO's first air headquarters, now Allied Air Command. I want to offer the readers an overview of the current missions and challenges faced by the Romanian Air Force (ROU AF), and I want to highlight the efforts of the ROU AF personnel to fulfil their responsibilities amidst the unprecedentedly complex international security environment.

Over the past decades, we faced hybrid, conventional, and asymmetric threats, crossing from the Baltic Sea to the Black Sea, from the North Atlantic to the Mediterranean, and involving non-state actors and failed states. On top of that, on 24 February 2022, we all witnessed Russia's illegal and unjustified invasion of Ukraine, which proved that a long-term land war was still possible on European soil. Therefore, we need to keep pace with the new security environment and hybrid challenges, academically and doctrinally, and our equipment needs to have the embedded flexibility to adapt to future demands. We must execute our missions in partnership with our NATO Allies and partners to reinforce the cooperation and, at the same time, to effectively contribute to the collective effort to address the threats against Euro-Atlantic security.

The Romanian Air Force's main mission is to establish an adequately manned, trained, and equipped force able to generate, employ, and sustain air power in combat operations together with the allies or coalition partners. Moreover, besides accomplishing its missions assigned within national or collective defence arrangements, the ROU AF also supports civilian authorities during humanitarian crises and natural disasters.

Since joining NATO in April 2004, the ROU AF has made significant strides. The ROU AF immediately began supporting NATO missions abroad, first in 2005 with the deployment of four IAR-330 SOCAT helicopters to Bosnia for a year in support of Operation ALTHEA. Then in 2006, Romania took the lead nation role of Kabul Afghanistan International Airport (KAIA) for four months. In 2007, we deployed four MiG-21 LanceR aircraft to Lithuania to secure the Baltic Nations' airspace as part of the Air Policing mission, and in 2008, we played a crucial role in providing security for the NATO Summit in Bucharest together with our US allies.

In April 2011, we assumed the lead nation role at KAIA once more for an entire year until the end of March 2012. The Romanian Air Force has also contributed to international peacekeeping efforts by participating in MINUSMA – the UN Integrated Multidimensional Stabilization Mission in the Republic of Mali, with an Air Force detachment consisting of 120 military personnel and four IAR-330 L-RM helicopters, from October 2019 to October 2020. Most recently, from April to July 2023, the ROU AF took part in the NATO-led enhanced Air Policing mission in the Baltic States, with a detachment of 100 personnel and four F-16 Fighting Falcon aircraft.

Furthermore, this year, we will once more assume the enhanced Air Policing mission in Lithuania, and from April to July, we will contribute with our F-16s, along with our Allied partners, to safeguard the Baltic Countries' airspace. In addition, we provide support to the ALTHEA mission in Bosnia and Herzegovina from January to December 2025. This support will include four Puma 330 helicopters and 100 military personnel.

How does the Romanian Air Force use training and exercises to enhance interoperability and readiness for NATO missions and achieve its objectives?

It is worth mentioning that ROU AF assets and personnel are routinely involved in numerous multinational and bilateral exercises, including ADRIATIC STRIKE in Slovenia, LOYAL LEDA in Poland, ANATOLIAN PHOENIX in Türkiye, AMPLE STRIKE in Czechia, APROC in Spain, and WISE WOLF in North Macedonia, where

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Defending the national airspace is our main mission!

our IAR 330 Puma helicopters have trained on CAS, CSAR, SOF missions, and executed live firings. Exercises such as THRACIAN VIPER and THRACIAN STAR in Bulgaria, REAL THAW in Portugal, TLP in Spain, INIOCHOS, and RAMSTEIN FLAG in Greece have seen our F-16 aircraft participate in various missions and improve the interoperability of all participants while exchanging training concepts, doctrine, and multiple tactics, techniques and procedures specific to the air domain. In terms of Surface-Based Air and Missile Defence (SBAMD) training, the ROU AF has actively participated in multinational exercises to enhance operational readiness. Notably, Romania hosted RAMSTEIN LEGACY 24 in June 2024, where live firing and missile launches by different air defence systems from participating nations were the main ingredients, showcasing Romania's growing role as a key contributor to NATO's collective air and missile defence.

Since joining the North Atlantic Alliance, we've transformed the Air Force to accomplish the following objectives: achieve NATO's and EU's commitments, upgrading Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) systems, enhancing logistic support structures, and modernizing the force through new acquisition programmes. Our main goals were to develop an Air Force capable of performing a broad spectrum of tasks, including transport, Search and Rescue (SAR), Non-Combatant Evacuation Operations (NEO), air traffic management, reconnaissance, and, most importantly, protecting national and Allied airspace within the NATO Integrated Air and Missile Defence System (NATINAMDS).

What capabilities are you relying on to defend national and NATO airspace?

Romania plays a crucial role in maintaining security and stability in the Black Sea region, which has been strategically important for centuries. Our current capabilities and future enhancements are designed to address both national defence and regional security challenges.

Today, the core of the ROU AF is represented by our fighters (F-16 Fighting Falcon), helicopters (IAR-330

© ROU AF

The Romanian Air Force only operates as a team!

Puma), transport aircraft (C-130 H, B, C-27J Spartan, and An-26/30), radars, and air defence systems (PATRIOT and Hawk), all of which are seamlessly integrated into our Air Command and Control (Air C2) system.

> *'…the ROU AF effectively contributes to homeland and alliance security by safeguarding its airspace…As we embarked on different missions abroad, we not only carried the legacy of Romanian peacekeepers but also represented the enduring values of integrity, commitment, and tenacity…'*

We are committed to enhancing our operational capabilities through the multirole fighter aircraft procurement programme, projected to achieve full operational capability with three multirole fighter squadrons equipped with fifth-generation F-35 Lightning II Joint Strike Fighters (JSF), through a transition period covered by three F-16 squadrons. To date, in the first phase of the programme, we have acquired 17 F-16 Mid-Life Upgrade (MLU) aircraft from the Republic of Portugal and have trained our pilots and technicians. The first squadron was declared operational in 2019 and has since performed Air Policing missions. There are ongoing activities to continue the programme; we expect that by the end of 2025, we will receive a total of 32 aircraft from Norway, 16 of them already delivered as of January 2025. Concurrently, we are training additional personnel, and at the same time, we are facilitating the preparations of our national defence industry to perform maintenance and logistic services for our fleet. The F-16 programme proves its strategic importance at the national and regional levels, strengthening Romania's capacity to contribute to the deterrence and defence posture in the Black Sea region.

Training is a crucial component of our daily operations, which is why we have launched a programme to enhance the capabilities of the IAR-99 aircraft in order to transform it into an advanced training platform. As we integrate the multirole F-16 aircraft into our inventory, the IAR-99 requires updated avionics and flight control systems to transition pilots through

to the F-16. This programme aims to upgrade 20 IAR-99 aircraft to a new configuration, enhancing the reliability of onboard systems and extending the aircraft lifecycle. We are pleased that this upgrade programme was predominantly introduced by our national industrial capacity.

Concerning movement and mobility, the Air Transport fleet is vital for sustaining our Armed Forces' operations and deployments and national humanitarian relief efforts. Four C-130 B aircraft established our initial airlift capability, further improved by four C-130 H models from the US and the procurement of seven C-27J Spartan aircraft. Their operational flexibility is essential for responding to both military and civilian requirements.

To support missions, the ROU AF operates five Puma helicopter squadrons in different configurations, from the gunship version to transport, Medical Evacuation (MEDEVAC), and Search and Rescue (SAR). The versatility of our helicopter fleet enhances our ability to conduct a wide range of operations, from combat and peacetime mission support to central and local authorities during emergencies or disasters and participating in international missions as a part of Romania's commitment. We have recently started an upgrade programme for the remaining helicopters in order to modernize the whole fleet.

Due to our constant drive to better equip our Air Force to address emerging security challenges and to contribute to a robust and resilient defence network in the Black Sea region, a significant acquisition programme was triggered with the decision to procure the long-range surface-to-air PATRIOT missile system. This programme aims to equip the Air Force with seven modern PATRIOT missile systems (3+ configuration), encompassing the missiles, C2 elements, and initial logistic support and personnel training. This system will contribute to safeguarding national airspace and protect vital strategic military and civilian assets. The first four systems were delivered by the end of 2023, and plans are in place to acquire three additional firing units in the near future. The ROU government has since donated one system to Ukraine in order to support their fight to defend their own territory and population.

As part of its commitment to fully implement the Integrated Air and Missile Defence (IAMD) concept, Romania is considering acquiring the Short-Range Air Defence/Very Short-Range Air Defence (SHORAD/VSHORAD) integrated weapon systems.

To maximize our defence capabilities, we have upgraded our digital radar stations such as Fixed Radar Surveillance (FPS 117), Transportable Radar Surveillance (TPS-79), Gap Filler, and TPS-77. We further aim to establish a reliable and sustainable C4ISR system.

ROU air defence was enhanced by the acquisition of four PATRIOT systems.

A Romanian F-16 performing fourth-, and fifth-generation integration with two US Air Force F-22s.

What do you consider as the key factors as you transition from legacy systems to fifth-generation aircraft?

The MiG-21 LanceR served as the backbone of the ROU AF for decades, maintaining Quick Reaction Alert (QRA) to address potential airborne threats. With its retirement in May 2023, this task has been gradually assumed by the F-16s, ensuring increased responsiveness and reactivity.

In light of the MiG-21 LanceR's decommissioning and the acquisition of 32 F-16 fighter jets from Norway's surplus, the Ministry of National Defence has identified the need to train, in a relatively short time, a significant number of Romanian pilots to operate the F-16 fighter jets. Efforts to identify appropriate F-16 training solutions within the Alliance showed that the existing facilities could not accommodate the rapid training of a large number of pilots. Thus, at the proposal by the Kingdom of the Netherlands, negotiations were initiated and carried out for signing a Letter of Intent (LOI) between the Ministry of Defence of the Kingdom of the Netherlands, the Ministry of National Defence of Romania, and Lockheed Martin, the manufacturer of the F-16, to establish and operate an F-16 Training Centre in Romania.

The F-16 Training Centre, the first project of its kind in Europe, marks a significant milestone for Romanian-Dutch cooperation and demonstrates the solidarity and determination of the NATO members. Moreover, the Centre will accelerate the training of the Romanian pilots and technicians to operate the F-16 fighter jets acquired from Norway and to obtain new qualifications for those who already fly and operate the F-16 in Romania. Last year, the first seven Romanian pilots graduated from the F-16 Training Centre in July, and in September, a new batch of pilots started their training programme. Intended initially for training Romanian pilots, the training centre is also open for the participation of personnel from NATO Allies and partners, including Ukraine.

The advancements we have achieved thus far would not have been possible without the unwavering dedication of our Air Force personnel. Consequently, our human resources play a crucial role, and one of our primary objectives is to guarantee that our airmen and airwomen are well trained and equipped to tackle upcoming challenges.

Promoting the military profession and career, along with the selection and training of our personnel, is essential for increasing the force structure manning level. We continuously review our training methodologies and syllabus to enhance situational awareness and leverage knowledge. Ultimately, our goal is to ensure that the right airmen are making the right decisions to execute the mission most effectively and maintain a robust Air Force committed achieving national and allied objectives.

In summary, how do you envision the Romanian Air Force as a force multiplier within NATO's deterrence and defence plans?

The enhanced Air Policing missions, enhanced Vigilance Activities missions, and, if necessary, Flexible Deterrence Options missions executed in partnership with our NATO Allies and partners reinforce our cooperation and, at the same time, demonstrate Romania's effective contribution to the collective effort to deter and defend against threats to Euro-Atlantic security. In this respect, it is worth mentioning that we have set-up cross-border agreements with our neighbours, Bulgaria and Hungary, to allow our F-16 fighters under NATO Air Policing command (controlled by CAOC Torrejon) to execute cross-border operations and vice versa. On the same line of effort, the Allies have collectively carried out enhanced Air Policing missions in Romanian airspace alongside Romanian fighter jets with frequent common training and exercising for ten years already.

Moreover, Romania has made a significant leap in advancing its defence capabilities, signing a landmark

protocol to launch the Romanian Air Force's transition to fifth-generation F-35 aircraft. The programme includes the acquisition of 32 F-35 Lightning II aircraft, marking a pivotal moment in Romania's defence modernization efforts. The agreement, finalized through a Letter of Offer and Acceptance (LOA) between the Romanian and USA governments, enables the purchase of the aircraft under the USA's Foreign Military Financing programme. The deal also includes pilot and maintenance training, further enhancing Romania's operational and technical capabilities.

Furthermore, we are in the advanced process of implementing the Agile Combat Employment concept, which represents a basic pillar of our national and NATO air forces' resilience, based on the cooperation of all Allies in the fields of command and control systems, armaments, infrastructure, and personnel. To date, we have aligned the majority of required CIS equipment, developed the necessary infrastructure, and started revitalizing the Aircraft Cross Servicing programme. Our agile and deployable force structure, supported by the ongoing modernization and procurement programmes, will further strengthen our Air Force and the Alliance's deterrence and defence posture on the Eastern flank.

To conclude, the ROU AF effectively contributes to homeland and Alliance security by safeguarding its airspace. We will continue to upgrade and consolidate our combat capabilities to defend our national and rule-of-law values and respect our country's international commitments to bolster regional and Alliance security. As we embarked on different missions abroad, we not only carried the legacy of Romanian peacekeepers but also represented the enduring values of integrity, commitment, and tenacity. Our contribution to numerous missions executed under NATO, EU, or UN mandate is a testament to Romania's steadfast dedication to global security and cooperation.

As I have mentioned the anniversary of the Allied Air Command, I would also like to quote one of its former commanders, General Frank Gorenc, who said: 'Airpower is like oxygen. When you have enough, you don't have to think about it. When you don't have enough it's the only thing you can think about.'

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Lieutenant General Leonard-Gabriel Baraboi started his military career in 1998 and has flown IAK-52, L-39ZA, IAR 99 HAWK, MiG 21 LanceR and C-27J as a pilot and flight instructor, logging more than 1,400 hours. Throughout his career, Lieutenant General Baraboi has performed executive and command functions, both in Romania and in operational theatres.

Lieutenant General Baraboi has completed numerous military and civilian education courses. Most notedly he is a graduate of the US Air Command and Staff College in 2011 and the US Air War College in 2017 and holds several master's degrees. Between December 2017 and April 2023, he commanded the 95th Air Base in Bacău and the 71st Air Base in Câmpia Turzii. In May 2024, he was promoted from Deputy to Chief of the Romanian Air Force Staff. His guiding principle is 'Only as a team!'. He was promoted to the rank of Lieutenant General on 1 December 2024.

Navigating the Realm of Artificial Intelligence in AirC2, Education, Training, Exercise, and Evaluation

By Lieutenant Colonel Mark Meeuwissen, BEL Air Force, JAPCC

Introduction

Artificial Intelligence (AI) is not new in the military context. Often, however, AI is misunderstood as software able to create autonomous weapons systems (aircraft, robots, decision-making tools, etc.). Both the civilian and military realms have already been working for a long time to develop algorithms to deliver ever-greater levels of automation. In simple terms, generative AI is the technology that enables machines to generate new content. Unlike traditional automation, which follows predefined rules and patterns, generative AI leverages complex algorithms and neural networks to create something entirely new. As explained in Thinkbridge, 'It's important, however, to remember that this new creation is only based on the data used to train the AI model, which is the foundational cornerstone of generative AI. This is not an actual conception in the sense of a unique offering but something created to represent a specific ask of a user to the best of the model's ability.'[1]

There are several demand signals to explain the current AI boom that we notice in the military and civilian worlds. The main signals include, but are not limited to, decision speed, the ability to deal with big data, and the potential efficiencies to mitigate manpower shortages.

In the military environment, these advantages are not only 'nice to have' but rather a potentially decisive advantage in successfully conducting operations. Modern warfare requires processing a vast amount of data in

ever-shrinking timeframes. In addition, many Allies have encountered increasing difficulties in recruiting, training, and retaining the required number of military personnel. Therefore, our expectations of AI have become to process as much data as possible in a very short amount of time with the least possible personnel.

[...] *'Decision speed, accuracy, and efficiency will become increasingly difficult if AirC2 and ETEE are limited by human inputs and reasoning since the amount of data to be processed and considered will only increase in quantity and complexity.'*

This article applies our expectations of AI to two realms, (Air-) Education, Training, Exercise, and Evaluation (ETEE), and the Air Command and Control (AirC2) function, and asks: How can AI contribute? Although focused on the air domain, the observations should generally apply to the other domains.

AI in ETEE

The most significant contribution AI can give to ETEE will be saving manpower since effective ETEE is so labour-intensive. Students are taught, examined, and corrected to enhance their professional skills, with multiple repetitions and exercises to stay current. Evaluations need to make sure that personnel are trained to NATO standards. One common denominator in ETEE events is human supervision and organization, thereby taxing available manpower. They define the education, organize the training, build the exercises, run the scenarios, introduce injects, and steer the evaluation to meet training objectives. If the supervision function (monitoring and correcting the soldiers' actions) could at least partly be supported or taken over by AI, it would significantly reduce the manpower requirement.

In late 2017, NATO Allied Command Transformation (ACT) initiated a study titled 'AI in AirC2 Planning & ETEE'. The German Air Force led this study, supported by ACT, Subject Matter Experts (SMEs) from the German and French Air Forces, and the Joint Air Power Competence Centre. Finally, in 2018, a contract was awarded to CAE[2] to provide deliverables such as analysis, a demonstrator (software), and progress reports. The study investigated the development and use of AI in the AirC2 planning cycle in a Joint Force Air Component (JFAC) Headquarters (HQ). The second objective was to assess to what extent AI can contribute to ETEE in the JFAC by creating options during planning, thus speeding up planning and freeing up resources.

The study collected data on the challenges experienced by the staff throughout the planning process during a high-intensity command post exercise (CPX) in 2019. The German Air Force identified several planning tasks as potential candidates for further study, of which the offensive Composite Air Operations (COMAO) planning was the highest workload for planners. The scarcity of COMAO planners, the time constraints during planning, and the considerable amount of data necessary for the process consequently became the primary focus of the study. CAE also used the 2019 exercise to learn how AirC2 is conducted, enabling development of the demonstrator.

The study focused on building a demonstrator, consisting of an agent that can create an offensive COMAO in almost no time. This includes the targeting process (matching assets and their weapons with targets), adherence to SUPPLAN M (routing), reactions to the Red ORBAT (Order of Battle), etc. As it was the first demonstrator, some limitations were imposed: only known targets were attacked, and there were no night operations or weather limitations. Should the agent be considered for operational use, the technological future will look promising. The agent may also expand to include other planning processes, such as defensive fighter operations or others.

In February 2022, before the start of the exercise Kalkar Sky,[3] the AI agent was deployed after learning from thousands of COMAO-based scenarios. During the exercise, the JFAC commander at Kalkar Sky received the agent's COA based on the same available

data that the human planners had at their disposal. By changing the parameters, multiple COAs were generated by the agent in a very short period of time. This allowed the commander to choose the best human or AI-generated option based on his knowledge and prevailing instructions.

Within the imposed limitations, the AI agent demonstrated that, for any given mission, it could provide a limited air plan within 30 seconds. The speed of the AI agent could also allow the human planners to immediately use the AI-provided plan as a baseline, upon which they could add further details such as timings, scheduling, and multi-mission aspects. This could save considerable time for the human planner and enable the generation of multiple plans for a given mission. Although the testing of this AI was conducted only on a very small scale, the AI agent proved successful.

After conducting the exercise and finishing the report, the German Air Force sought support and cooperation within NATO organizations and individual nations to continue this project and expand the use of AI in AirC2. In order for the procurement process to continue, more NATO nations must stand behind the exploration and expansion of AI in AirC2 Planning & ETEE. Only then can the procurement process be enabled to integrate properly scoped AI into NATO C2 and ETEE.

While the focus of exercise Kalkar Sky 2022 was testing the AI agent, other aspects could not be evaluated in detail, namely red air inputs, white cell interaction, defensive fighter operations, Air-to-Air Refuelling (AAR), and others. The German Bundeswehr University in Munich delivered the software for the demonstrator and is still improving it with the help of better and more robust hardware. This could address the missing aspects in future. Red air inputs

The Ramstein Flag 2024 exercise marked NATO's inaugural Flag exercise, highlighting a cutting-edge training concept. More than 130 fighters and enablers participated in joint training sessions aimed at enhancing tactics and promoting stronger integration among forces.

and white cell interaction are enablement functions where AI could be particularly beneficial since the impact on actual operations is non-existent. Therefore, the risk of expanded use of AI (limited to ETEE) is low.

In parallel, the project and its results were discussed during the Ramstein AB Tech Expo[4] and the Think Tank for Information Decision and Execution (TIDE) Sprint[5] in Dresden in March 2024. This should promote further development and support from NATO, NATO entities, and NATO Allies. No additional actions are planned so far, and organizers are currently focused on advertising the results of the study, with the aim of finding a team within NATO that will proceed with further development of AI in AirC2.

AI in AirC2

C2 is 'the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission.'[6] The C2 system consists of people, organizations, processes, methods, and equipment. The products of a C2 system are orders.[7] To generate orders, the system needs to facilitate data collection, reasoning, sensemaking, and planning.

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In today's fast-paced world, the sheer volume of data, multitude of connections, and need for quick decision-making necessitate reliable support systems. AI has the potential to revolutionize certain processes and enhance human decision-thinking.

This article will focus on the JFAC HQ as the hub of a larger AirC2 enterprise. The main product delivered by this HQ is the daily Air Tasking Order (ATO), which informs all concerned units what exactly they must do, when, and where. This order is the result of detailed planning by the Combat Plans Division. An ATO cycle takes 72 hours, from planning to execution. This means that the JFAC HQ is working on multiple ATOs at any time. Besides these ATOs, other plans and orders are generated daily by the JFAC HQ, including Airspace Control Order (ACO), Special Instructions (SPINS), and Operational Tasking Data Link (OPTASK LINK).

AirC2 is a complex and comprehensive set of processes, many of which depend on human judgement, so AI can only replace some human beings in the JFAC HQ to do the entire planning. Therefore, we should consider what tasks where AI would be most beneficial or most readily integrated into AirC2. In other words, what can AI do to make AirC2 more efficient? From this perspective, saving manpower, expediting the planning process, and working more efficiently are three interconnected tasks that can benefit significantly when supported by AI technology.

Saving manpower would probably not be the first or most significant benefit for a JFAC HQ. For every operation, the JFAC HQ is tailored to specific aspects of that operation, such as the objectives, potential targets, number of adversaries, weaponry used by opponents, geographical considerations, threat level, acceptable level of risk, available capabilities, etc. As a JFAC HQ is often undermanned, reducing manpower requirements is an immediate benefit. Deleting entire cells or sections may not be possible, but properly scoped and trained automation, applied to appropriate tasks, could mitigate shortfalls. Such tasks include routine processes that operate within defined parameters, categorization and calculation of large data sets, and other intermediate functions that do not require human judgment. This allows humans to supervise and incorporate automated outputs while focusing on their essential tasks.

However, the potential of AI to accelerate the planning process (72-hour ATO production cycle) may resonate even more with leaders and practitioners. Every operation is, by default, a very dynamic situation where the location of the adversaries, their movement, possible targets, and threat level continuously evolve. AI could accelerate the evaluation of these changing parameters, shortening the ATO development cycle. On the other hand, we also need to realize that AI cannot accelerate all aspects of the ATO cycle. A significant reason for the ATO timeline is to build enough lead time and predictability for execution, and to think several days in advance

on resource planning (munitions, aircraft, surge considerations, etc). AI cannot accelerate this.

Finally, using AI in the ATO planning cycle promotes efficiency by streamlining activities where human operators must manually manipulate and transfer data between incompatible systems. The current planning cycle is supported by software throughout NATO forces, mainly Integrated Command and Control (ICC). However, human interaction, assessment, and interpretation are needed during several phases of the ATO generation. This results in time-consuming activities for humans and interpretation and assessment mistakes where not all options are looked at or not in the required detail due to time constraints. It would have a significant impact If AI could accomplish these routine tasks with higher accuracy.

In addition to the COMAO planning discussed earlier in this article, other planning activities are very time-consuming, such as AAR planning. This is because multiple parameters, restrictions, and considerations must be taken into account. AAR planning was not tested during the study, but it is just one example of planning tasks worthy of further investigation for AI augmentation.

Challenges

Despite our optimism about AI, military tasks are special and have special consequences. Therefore, we should be frank about the challenges, ranging from training to reliability and transparency with AI-delivered products and processes.

AI is typically considered a subset of software. This means that if AI can enhance AirC2, it needs to be embedded in, or at least compatible with, the AOC weapons system, the software or applications used in AirC2 being part of it. Most commonly, NATO uses ICC in AirC2, a software that has existed for many decades and is still undergoing updates and maintenance. Besides supporting the planning cycle, ICC is also used for tasks like battle management, C2, and reporting. Another AirC2 tool is the Air Command and Control System (ACCS), currently under procurement by the NATO Communications and Information Agency, with the same functionalities as ICC. If ACCS, or any other future system is adopted, it will face the same limitations and challenges as ICC: compatibility when using or embedding AI in existing software.

The key question in a big organization like NATO is: When implementing AI in AirC2, how do you do it right? NATO should establish parameters, guidelines, and priorities for incorporating automation that concisely address these 'how to do it right' concerns. Assessing AI's capabilities, defining the task and work, and looking for non-obvious use cases can be of great help.[8]

There are other challenges which must be mentioned. Software modifications are costly and very time-consuming due to the development, testing, evaluation, implementation, and more. Not all nations use ICC or ACCS, so burden-sharing must be discussed in parallel. Even the composition of the software will have to be discussed, such as political or legal considerations, national interests, and what needs to be included.

The application of AI in ETEE and AirC2 will require more standardization and cooperation between nations and HQs. If not, a possible proliferation of systems and applications could prevent smooth and coordinated operations by all NATO Allies.

Finally, AI-driven systems and programs are very powerful. This also means that in the case of compromise or cyberattack, the consequences could vary from considerable to catastrophic. Robust protection of all AirC2-related systems and programs will be required, and systems and processes must be developed so trained and knowledgeable workers can always pick up the process.

Conclusions

Improving the capabilities of AI algorithms is necessary for mission commanders to keep pace with the increasing velocity and complexity of warfare. For the future battlefield, there will be a need to develop agile and adaptive AI-support tools that are faster, better and cheaper than the existing ones, under the primary assumption that the future flow of information and speed of operation will likely exceed the capabilities

of the current human staff if the C2 processes remain largely manual.[9] Decision speed, accuracy, and efficiency will become increasingly difficult if AirC2 and ETEE are limited by human inputs and reasoning since the amount of data to be processed and considered will only increase in quantity and complexity.

The answer to the question, 'Do we really need AI in AirC2 and ETEE?' is undoubtedly 'Yes'. However, as discussed in previous paragraphs, we must keep in mind the implications and consequences we face. Can we deal with the associated challenges and limitations? Are we asking AI and automation to accomplish the correct tasks in the correct way?

Not that AI can be integrated into AirC2 and ETEE in the blink of an eye, but if NATO wants to be ahead of the game, an incremental approach to incorporate AI over time is a must. ●

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The Case for Fourth-Generation Fighters in NATO

Why Mixed Fighter Fleets Matter

By Colonel Will Barksdale, US Air Force, JAPCC

Introduction

NATO has enthusiastically embraced the procurement of the F-35 Lighting II, and for good reason. The aircraft's incredible capabilities contribute significantly towards deterring NATO's security threats. However, with all the emphasis on the F-35, it is easy to forget that it will not be universally owned and operated throughout the Alliance. Instead, far more third- and fourth-generation fighters of multiple varieties will

remain throughout NATO for the foreseeable future. Approximately 650 F-35s, procured by 14 NATO nations, will be in service on the European continent by 2030, which is 20 % of the Alliance's roughly 3,300 total fighter inventory.[1,2] While the F-35's arrival will greatly expand NATO's deterrence posture and combat capability, the Alliance's third- and fourth-generation fighters will remain the bulk of NATO's fighter presence. This third-, fourth-, and fifth-generation mix reduces vulnerabilities to exploitation, enables fighter integration, provides mass and economy of force, and allows each nation to meaningfully contribute to the Alliance's common defence. As NATO nations procure hundreds of fifth-generation aircraft, NATO must recognize the advantages of sustaining and modernizing its fleet of third- and fourth-generation fighters.

Variety Mitigates Vulnerabilities

No weapon system is perfect, and adversaries actively exploit imperfections to gain advantages on the battlefield. Defending against exploitation begins with proper design and continues with the correct application of defensive measures. One defensive measure NATO possesses organically is deliberately fielding multiple different types of fighters. By doing so, NATO presents a dilemma to adversaries forcing them to prioritize on which fighters to spend limited resources to develop countermeasures. Despite thorough security measures, at some point a breach of any given weapon system may occur, so Alliance members are wise to diversify their fighter fleet to minimize potential impacts to combat capability.

A United States Air Force F-35 and F-16 conduct integration training.

Diversified fleets decrease the probability that the vulnerability in any given weapon system will be identified and exploited. In turn, this increases the odds the Alliance will be able to deter aggression and, if necessary, defend its territory. Admittedly, a greater number of fighter types will increase the probability that a fighter type is exploited, but it will decrease the impact of that exploitation in terms of overall combat capability; assuming the exploitation is limited to only one type.

[...] *'NATO must recognize the advantages of sustaining and modernizing its fleet of third- and fourth-generation fighters.'*

In addition to risks from adversary actions, supply chain and platform risks are also important to consider. Fighters are complex machines made from many discreet and unique parts, each necessary for the full functioning of the aircraft. An internationally manufactured aeroplane, such as the F-35, is particularly vulnerable to supply chain interruptions. Given the prohibitive expense of carrying a large inventory of spare parts, nations are exposed to supply chain fragility. Even if the impact is limited to only one or two parts, the fleet, as a whole, can see negative impacts to mission capability rates if there is a disruption to the supply chain. While a diversified fighter portfolio has an overall increased reliance on logistics, the impact of supply chain interruption for any given part is reduced. Thus, diversification increases the collective mission capability of NATO's fighter fleet as a whole. Platform risks, such as a safety stand down, can ground an entire fleet overnight. This issue may arise from the discovery of a defective batch of parts or an accident that exposes a previously unknown flaw, necessitating procedural or mechanical adjustments to guarantee flight safety. Due to the fact that parts from one type of fighter are rarely interchangeable with another type, having a diverse range of fighters helps to minimize risks for the Alliance.

Fighter Integration

Integrating multiple fighter generations creates an operating environment that maximizes each fighter's strengths while minimizing its weaknesses. For example, a package of four F-35s and four Eurofighters creates a symbiotic relationship that renders each formation more lethal while simultaneously less vulnerable. First, the formation can prioritize using the fuel and weapons of the Eurofighters as much as possible, increasing the on-station time of the F-35s. Next, the F-35s are less likely to be detected because enemy radars are focused on the much larger radar signature of the Eurofighter formation. Further, the Eurofighters maintain increased situational awareness by communicating with the F-35 formation resulting in reduced chances of adversaries approaching the Eurofighters undetected. Finally, each fighter uses a different sensor suite, which mitigates the effects of battlespace jamming and other adversary actions in the electromagnetic spectrum. The results of multi-generation fighter integration, when executed properly, greatly increase the lethality of all formations while minimizing their vulnerabilities, resulting in greatly increased deadliness versus enemy aircraft.

Mass

While 650 F-35s on the European continent is a significant amount of firepower, they alone do not provide the necessary mass to ensure NATO security. NATO now possesses a 2,500 km border with Russia. By way of example, if all 650 F-35s could be airborne simultaneously, they would theoretically be spaced every 4 km, or 2 nm. Realistically, however, perhaps only 25 % of the inventory could be airborne simultaneously, stretching the distance between each fighter to 16 km, or 8 nm. That leaves no defence in depth, and even a small break in that line of fighters could be disastrous for defended assets beyond. Alternatively, by massing the fifth-generation assets in sectors saturated with enemy area denial systems and utilizing third- and fourth-generation fighters to fill in the gaps, they can obtain a much denser and more layered defensive counter-air posture.

The ability to have more fighters airborne, supported with decoys, chaff, and electronic attack, saturates the airspace, creating tracking, engagement, and Weapons Resource Management (WRM) dilemmas for an adversary. Because all contacts could be a threat, adversaries are forced to engage as many as possible without necessarily knowing what fighter type they are targeting, or if the target is even a fighter at all. This can lead to expending tremendous weapons stocks for very little gain. Additionally, the ability to mass fighter forces allows commanders to offensively mass firepower against priority objectives, increasing the probability of achieving the desired effects. Massed firepower also reduces risk to the force package through increased mutual support, self-defence posture, and stand-in situational awareness.

Economy of Force

Economy of force seeks to appropriately allocate forces towards an objective, eliminate waste, minimize the risk to assets, and increase overall theatre lethality and efficiency. Using a 20 mm strafe to stop a freight train is futile; the weapon (20 mm) is not appropriately matched to the target (freight train). Conversely, attacking a mud hut with a 2,000 lb munition will certainly destroy the hut, but at excessive direct and opportunity cost, and with a significant increase in collateral damage potential. Similarly, fifth-generation fighters are enormously capable and can conduct many different mission sets; NATO must ask itself which missions fifth-generation fighters are best suited for, not which missions fifth-generation fighters *can* be used for.

[...] *'Losing a third- or fourth-generation fighter on a routine mission is still agonizing, but not nearly as excruciating as losing an F-35 because the opportunity cost is not nearly as high.'*

Take, for example, Close Air Support (CAS) in a permissive environment-easily considered a lower-threat mission. An F-35 can certainly accomplish this, but its

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This 'Elephant Walk' at Anderson Air Base, Guam embodies a multi-generational mix of aircraft and capabilities.

relatively small payload and high operating costs make it less well-suited than many other fourth-generation fighters, such as the Gripen or F-16, both of which carry more munitions at substantially lower cost. Therefore, it is better to utilize one of these fourth-generation fighters in the CAS mission than to expend unnecessary flying hours on F-35 airframes or to divert them from higher-threat missions where its inherent attributes are needed.

Also, consider the cost of losing an F-35 during such a routine mission; such a loss would be a windfall for the adversary by creating an enormous exploitation opportunity. Additionally, the loss of an F-35 to a routine mission represents an opportunity cost that cannot be ignored because it removes the possibility to use that jet on a high-end mission. Losing a third- or fourth-generation fighter on a routine mission is still agonizing, but not nearly as excruciating as losing an F-35 because the opportunity cost is not nearly as high. Conversely, using a fourth-generation fighter to penetrate overlapping surface-to-air missile sites, engage multiple adversary fighters, and deliver ordnance on multiple targets would create an extreme risk to force for an earlier generation aircraft. In this case, it is far better to use the more expensive flying hours of the fifth-generation fighters and expect the majority to survive rather than the cheaper flying hours of the fourth-generation fighters with a low survival rate. By maintaining a robust multi-generational fighter force, NATO gives itself a larger toolkit, allowing it optionality to pair the right jet to the right task, and in doing so, achieve economy of force.

All Nations' Budgets Contribute

Since the F-35's acquisition and operating costs are significantly higher than fourth-generation fighters, each member nation can contribute to the multi-generational fighter composition of the Alliance based on their diverse national requirements and capabilities. This diversity manifests in many ways, but one important variation is in the defence budgets among member states, whose Gross Domestic Products (GDP) vary from $7.4B (Montenegro) to $27.3T (USA).[3,4] It is, therefore, not fiscally possible for all nations to field similar forces. Instead, NATO defines its overall requirements and nations elect to fulfil those requirements according to their available funds and national interests. In this way, while nations with larger economies may procure expensive equipment such as F-35s, those

nations with smaller GDPs can still meaningfully contribute to the Alliance by sustaining, modernizing, and adding to their third- and fourth-generation fighter fleets. No contribution is too big, and no contribution is too small; NATO's only firm requirement is that each nation spends at least 2 % of its GDP on defence.[5]

Conclusion

The F-35 represents an enormous gain in capability for NATO; however, for reasons of diversity, fighter integration, mass, economy of force, and budgetary constraints, it is unrealistic and undesirable to replace all legacy fighters. Logically, NATO is unable to procure one-for-one replacements, Alliance-wide, of all legacy fighters – nor should it want to. The risk reduction of a mixed fighter fleet more than justifies multiple different types of fighters. Further, NATO needs its existing legacy fighters to achieve the appropriate levels of mass and economy of force. Finally, the beauty of NATO is that nations can contribute broadly toward the Alliance, and members with smaller defence budgets can contribute in a tangible way by procuring and modernizing existing fourth-generation fighter platforms. By employing the combination of third-, fourth-, and fifth-generation fighters, NATO will maximize its capability to deter aggression and, if necessary, defeat any threat to NATO territory. In this way, NATO leverages its inherent strengths and mitigates its weaknesses when it utilizes an integrated, multi-generational fighter fleet. ●

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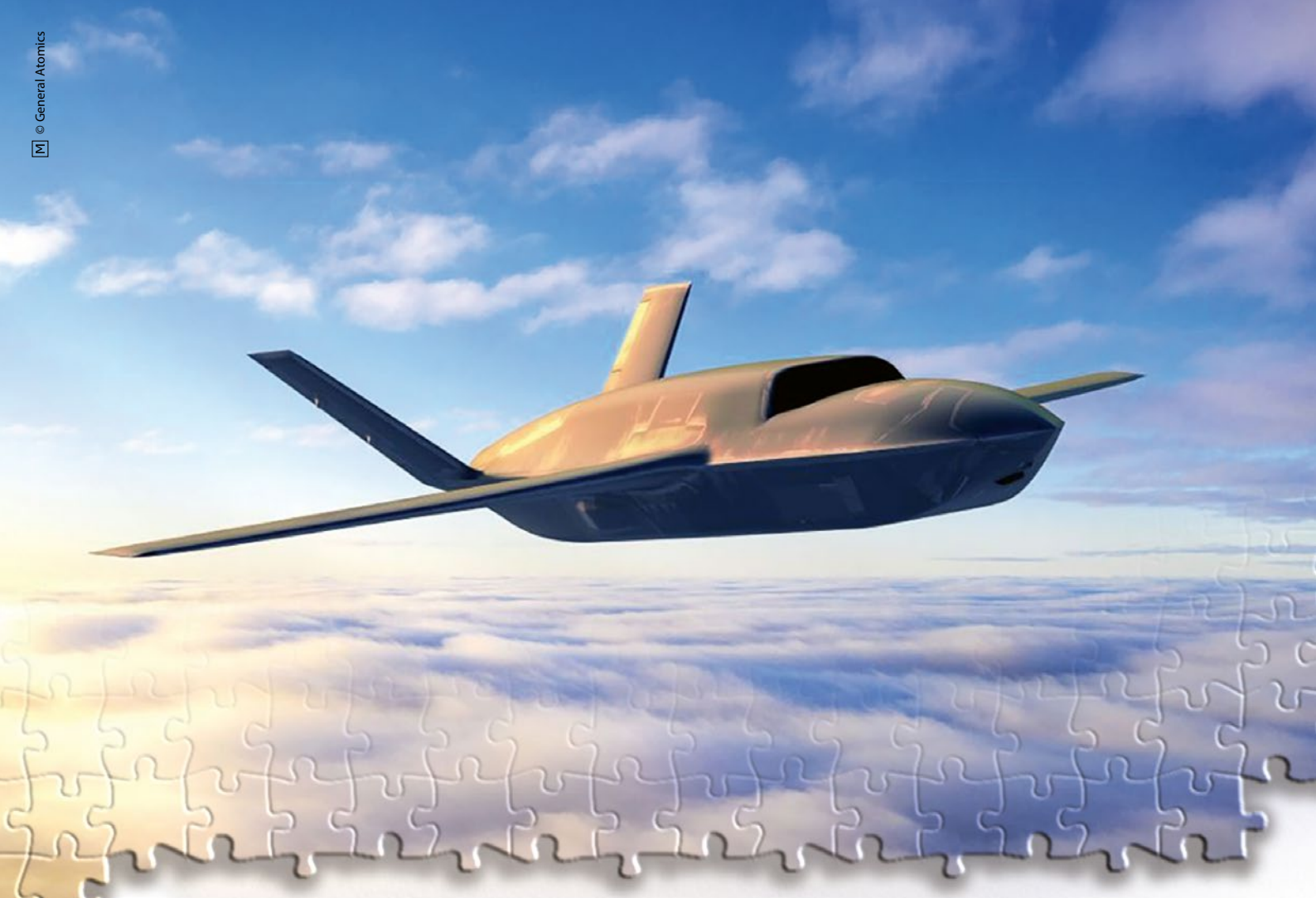


The Missing Pieces of NATO's Autonomous Collaborative Platform Strategy

By Colonel Kevin Anderson, US Air Force, JAPCC

Introduction

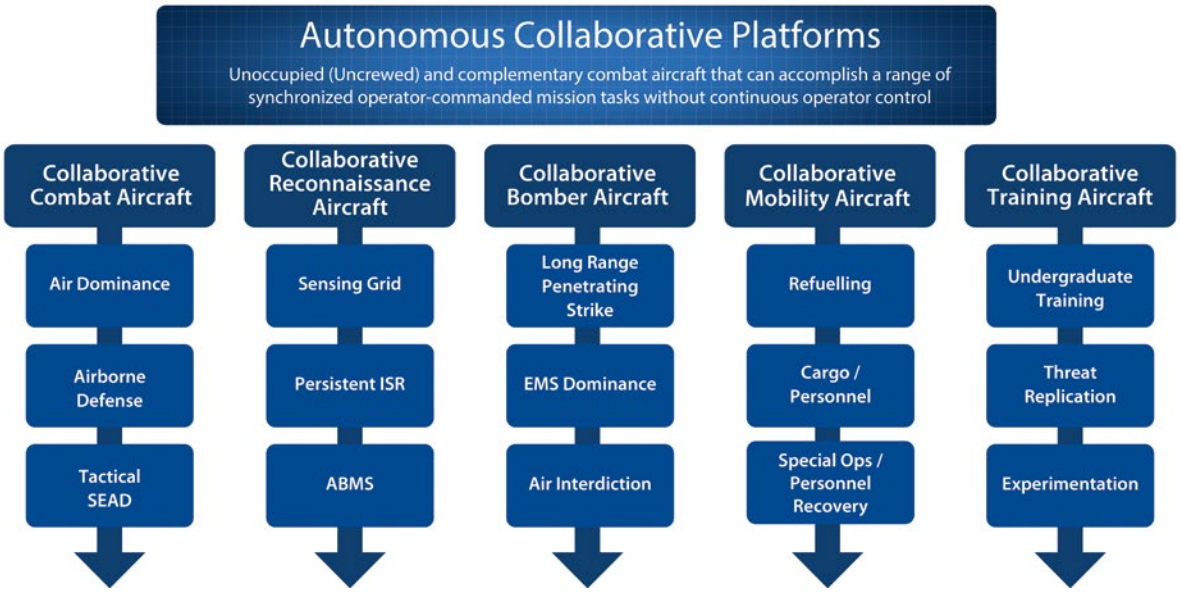
In May 2024, the Secretary of the US Air Force, Frank Kendall, took a groundbreaking flight aboard a modified F-16 (X-62A VISTA), while it was controlled exclusively by autonomous, artificial intelligence (AI)-enabled software. As the Secretary sat in the front seat, the AI-controlled aircraft flew several tactical engagements against a piloted fighter, performing complex calculations to safely and efficiently fly a close-range dogfight against its manned opponent.[1]

Secretary Kendall's flight was an important milestone for an ongoing human-machine collaboration programme called Air Combat Evolution (ACE), which is led by the Defense Advanced Research Projects Agency (DARPA).[2] However, it was more than just a technology demonstration. Instead, it symbolized a much broader paradigm shift in air combat worldwide: the emergence of a new class of autonomous aircraft capable of receiving and executing human commands without continuous operator control. These aircraft are known as Autonomous

Secretary of the US Air Force, Frank Kendall, aboard the X-62A VISTA on an autonomous air-to-air mission, 2 May 2024.

Collaborative Platforms (ACP).[3] The purpose of this article is to describe these systems, highlight their ongoing development, and underscore the work that must be done to prepare for the arrival of this emerging technology.

The term ACP refers to a new category of Unmanned Combat Air Vehicle (UCAV) which uses AI technology to translate human intent, ranging from specific commands to general objectives, into autonomous actions. The spectrum of autonomy can vary depending on the mission, and may range from a highly collaborative 'loyal wingman' working directly with another fighter, to a fully autonomous platform which receives infrequent mission updates from a human. Their diverse roles span five categories of missions, including Collaborative Combat Aircraft (CCA), Collaborative Reconnaissance Aircraft (CRA),



While often viewed in the narrower context of CCAs, ACPs might also accomplish diverse missions ranging from reconnaissance to training roles.

Anduril's YFQ-44A (top), along with General Atomics' YFQ-42A (bottom), won contracts in 2024 for the USAF's CCA Increment I testing.

Collaborative Bomber Aircraft (CBA), Collaborative Mobility Aircraft (CMA) and Collaborative Training Aircraft (CTA). The most well-known category of ACPs are CCAs, which are designed to fight in the vicinity of piloted fighters to enhance lethality and survivability on high-risk missions.[4]

Worldwide ACP development is expected to grow rapidly this year, as nations and industry partners begin teaming up to build initial ACP prototypes. Among European NATO members, two nascent initiatives are gathering momentum: the first involving the United Kingdom, Italy, and Japan, with partners BAE, Leonardo, and Mitsubishi; and the second, involving France, Germany, and Spain, with partners Airbus, Dassault, and Indra Sistemas.[5,6] In the United States, the US Air Force (USAF) is already quite far along in its ACP programmes, and is moving quickly to procure up to 1000 CCAs as a crucial pillar of what it calls its Next Generation Air Dominance (NGAD) family of systems. In 2024, the USAF awarded contracts to Anduril and General Atomics to compete in Increment I prototype testing, and it plans to spend $9 billion on future ACP designs by 2029, with a goal of achieving initial operational capability (IOC) by 2030.[7] While the above-mentioned programmes are the most well-known, several other developments are also taking place in Sweden, Türkiye, South Korea, Japan, Australia, Russia, and China.[8]

ACPs: Pacific-Specific?

The rapid technological advancements and diverse applications of ACPs suggest that these platforms will play a transformative role in next-generation air power. This belief is quite strong within military and aerospace communities, where analyses conducted by the US, Australia, and the UK suggest that ACPs will address several challenges in the Indo-Pacific region, including the vast geography, sophisticated anti-access/area-denial (A2/AD) environment, advanced threats, and unfavourable force ratios expected in that theatre.[9] Furthermore, a recent CCA study from the Mitchell Institute for Aerospace Studies took the research further. By conducting wargames and tabletop exercises, they helped postulate the specific types and quantities of CCAs needed in an Indo-Pacific conflict.[10] While the study focused primarily on combat use cases, its findings emphasize the broad operational potential of ACPs in the Indo-Pacific, and highlight the importance of allied cooperation in tailoring these systems to regional needs.

Although much of the latest research is China-focused, it is essential to recognize that ACPs originated as a response to challenges posed by both China and Russia. Their development gained momentum during the creation of the US's 'Third Offset' strategy, an initiative developed from 2014 to 2018 to counter the rapid military advancements of pacing competitors by leveraging advancements in AI, human-machine teaming, and drone warfare.[11] Within this context, the strategy envisioned ACPs as a means to maintain a competitive edge in both the Indo-Pacific and European theatres, and their diverse capabilities can be tailored to the needs of each region.

Missing Pieces

While the Indo-Pacific has received significant analytical attention, the European theatre's ACP potential remains underexplored. If NATO intends to leverage this technology for deterrence and defence, it must make a deliberate effort to bridge several gaps. This section highlights the work that must be done by NATO members, industry partners, warfare centres, and academic institutions to address the following missing pieces:

1. ***NATO-Centric Operational Analyses:*** Analyse NATO's existing and future capability gaps to determine whether and how ACPs might contribute to future force designs.

2. ***Design Integration:*** Align research, development, testing, fielding, and training efforts across NATO members to ensure interoperability.

3. ***Streamline Capability Development:*** Expedite design requirements and procurement processes for ACPs and other emerging technologies.

4. ***Ethical and Legal Foundations:*** Establish robust, quantifiable frameworks to build confidence in autonomous and collaborative systems in warfare.

Proactively addressing these missing pieces will ensure that future designs will meet NATO's defence and deterrence requirements, operate cohesively, arrive on time, and perform within appropriate legal and ethical boundaries.

Piece 1: NATO-Centric Operational Analyses

To harness the potential of ACPs, NATO must conduct operational analyses tailored to its unique strategic environment. These studies will enable a deeper understanding of how ACPs might enhance NATO's current force designs, particularly in areas where traditional platforms face significant capacity or capability gaps. Since the USA has already conducted extensive studies on the Indo-Pacific, NATO should prioritize the European theatre and its surrounding areas of responsibility (AORs), emphasizing the Baltic, Arctic, Mediterranean, North Africa, the Middle East, and the Red Sea. By exploring the use of ACPs in these diverse, operationally demanding areas, NATO can better define the requirements which most effectively address its security concerns.

The European theatre's ACP potential remains underexplored. If NATO intends to leverage this technology for deterrence and defence, it must make a deliberate effort to bridge several gaps.

The potential mission sets for ACPs are extensive. While typical concepts of operation tend to highlight the offensive potential of the CCA class of systems, the CRA class could prove indispensable for NATO by conducting reconnaissance in austere areas or within contested environments. For instance, given their ability to operate autonomously for extended periods, CRAs could conduct air, land, and maritime surveillance along NATO's eastern flank, the Arctic, and the Red Sea. Similarly, during a high-threat conflict against a peer adversary, other CRA variants could perform risky reconnaissance missions inside A2/AD bubbles, providing real-time intelligence to find and fix dynamic targets. Upon target detection, the CRA would notify the pilot of a manned fighter, who could then

A non-proprietary communications architecture will enable cross-domain interoperability. One example is the USAF's Open Mission Systems/Universal Command and Control Interface (OMS/UCI), currently used throughout its ACP programmes.

send an updated mission task to a nearby CCA, perhaps directing it to attack or to conduct suppression of enemy air defence (SEAD) to support the fighter. Such employment concepts can reduce risks to manned platforms, cut kill chain timelines, and increase overall mission success rates.

To identify these and other practical use cases, NATO should employ various methodologies, including wargaming, simulations, and scenario-based modelling. Wargames, such as those conducted by the Mitchell Institute, have already demonstrated the value of CCAs in complex Indo-Pacific environments. NATO members can replicate and expand these studies by incorporating region-specific parameters, such as the A2/AD environments posed by Russia's integrated air defence System (IADS) in Kaliningrad, the vast intelligence, surveillance, and reconnaissance (ISR) requirements of the Arctic and High North, and by examining other ACP variants in extended deterrence operations in the Middle East and beyond.

As part of the NATO-centric analyses, complementary studies should also explore other emerging, and potentially alternative, systems that are achieving IOC over the next decade, such as hypersonic weapons, one-way attack (OWA) drones, and improved cruise missiles. These analyses must be done simultaneously to help articulate the procurement trade-offs of each system. This effort must occur as soon as possible since the results will inform research and development (R&D) priorities and will influence upcoming budget cycles.

Piece 2: Design Integration

Next, while NATO members have the capability to create diverse ACP designs, proper integration must take place to maximize the interoperability of these assets across the Alliance. To achieve adequate integration, standardization, and interoperability between ACPs and manned fleets, NATO and its defence partners must proactively establish and share foundational architecture, including communication and network standards, technical and operational interoperability standards, and cross-servicing agreements.

The ongoing F-35 procurement among 14 NATO members provides an example of such coordination and interoperability. The programme unites diverse stakeholders and achieves multinational interoperability by establishing common security classifications,

standardized technical agreements, and shared logistics infrastructure.[12] Applying similar collaboration principles to ACPs will mitigate risks and enhance operational effectiveness.

Currently, the highest priority task is to ensure that NATO uses a common communication architecture between surface-based C2 nodes, fourth- and fifth-generation aircraft, and ACPs. Doing so requires consensus across the Alliance, making this the highest priority for NATO's future ACP interoperability.

Organizations such as the NATO Standardization Office (NSO), NATO's Science and Technology Organization (STO), Allied Command Transformation (ACT), and the Joint Capability Group Unmanned Aircraft Systems (JCGUAS) play essential roles in fostering collaboration. Therefore, it is important for stakeholders to collaborate with these organizations to quickly accomplish ongoing interoperability initiatives, including the NSO's Military Committee Joint Standardization Board (MCJSB), STO's Applied Vehicle Technology (AVT) panel and the JCGUAS' Autonomy Task Force.[13]

Piece 3: Streamlining Capability Development

Next, to keep pace with rapidly advancing technology, NATO must streamline the development and fielding of ACPs through stronger collaboration between members and defence industry partners. However, industry officials have highlighted two main obstacles: First, NATO's planning process often lags behind real-world advancements by several years, and second, there is a need for NATO to support agile development and prototyping for ACPs and other emerging capabilities.[14]

One reason for these challenges is the complexity of aligning the national priorities and economic interests of 32 member states. The current method of defining requirements while retaining Alliance cohesion is the NATO Defence Planning Process (NDPP), which begins its next four-year cycle in 2026. While the NDPP is a useful methodology for long-term and steady-state requirements, unfortunately, its multi-year timeline means that NATO might finish defining its ACP requirements while other countries are already achieving IOC.[15]

Instead, NATO must create a more responsive process to advance new technologies from idea to prototype. One option is to broaden or refine the roles of currently existing entities, including the Defence Innovation Accelerator for the North Atlantic (DIANA) and ACT's NATO Innovation Hub. DIANA currently focuses on long-term innovation, harnessing academia and think tanks to generate ideas and to promote future capabilities on 10- to 20-year timelines.[16] In contrast, ACT plays an important role in promoting near-term

ACPs will compete with hypersonic weapons (above), cruise missiles, and one-way attack drones (OWA). More research is required to help make tough procurement choices in the future.

innovation, and its Innovation Hub is a useful forum for collaboration on projects at a higher technology readiness level (TRL) than DIANA.[17]

Currently, the highest priority task is to ensure that NATO uses a common communication architecture between surface-based C2 nodes, fourth- and fifth-generation aircraft, and ACPs.

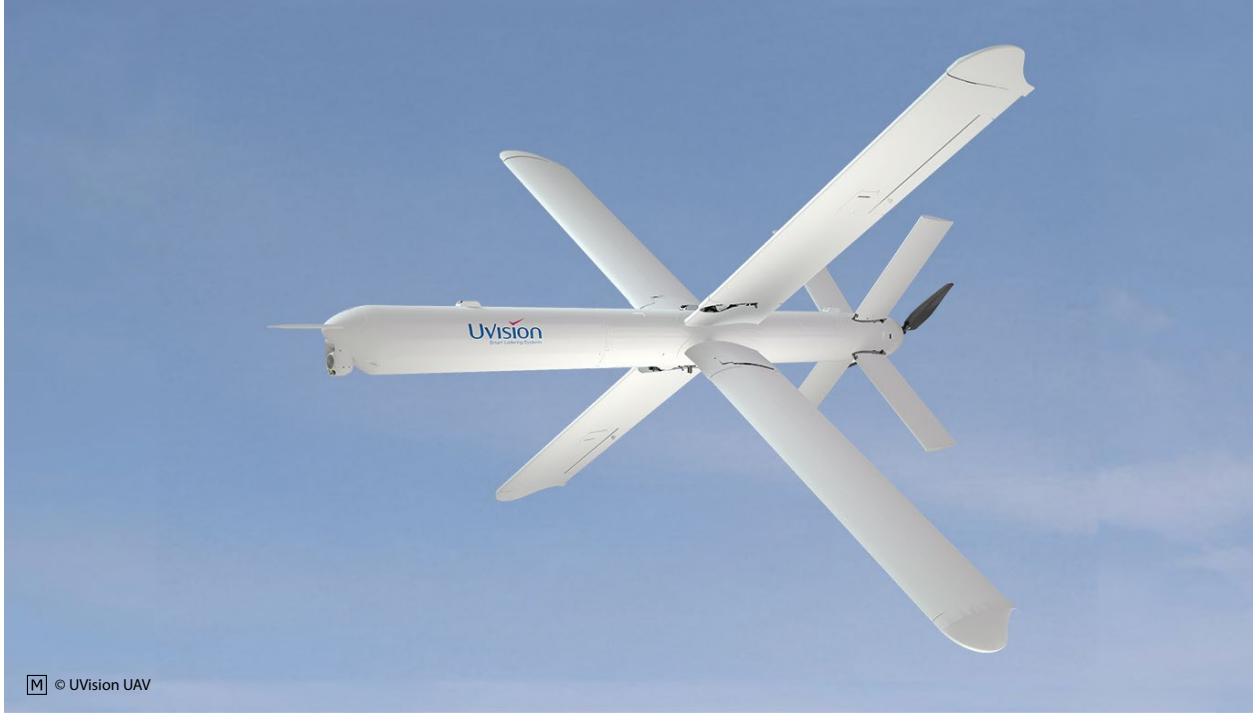
However, neither of these organizations has a mandate to guide a complete innovation cycle from start to finish. As a solution, ACT or DIANA could create new Rapid Capability Accelerator (RCA) teams authorized and funded to design, prototype, and experiment with a specific emerging technology on an aggressive timeline. Each 10- to 15-member RCA team would comprise military operators, defence procurement experts, industry experts, and technical specialists dedicated to converting a new technology into a viable prototype. Such teams could also collaborate with both NATO and non-NATO countries to fast-track operational requirements on timescales measured in one to two years rather than decades.

Changes to the development process must be implemented quickly, as NATO risks falling behind in emerging defence capabilities. By developing a faster, more proactive approach to R&D projects, NATO can more effectively define and communicate its emerging requirements and enable industry to move quickly toward technical solutions.

Piece 4: Ethical and Legal Foundations

A recent Royal Air Force strategy document concludes that 'the uncrewed systems world is rapidly and inexorably advancing towards the use of Autonomous Collaborative Platforms.'[18] This trend appears indisputable, yet it raises important ethical and legal considerations which NATO must address. Currently, most literature focuses on the human-machine teaming and semi-autonomous capabilities of these platforms, wherein an ACP makes non-lethal mission decisions while a 'human on the loop' (HOTL, or HOnL) provides authority for any attacks. However, the next step is clear: NATO must prepare for the arrival of 'human out of the loop' (HOOTL, or HOutL) warfare.

Luckily, NATO has proactively addressed the complexities of lethal autonomy in warfare. The December 2023 'NATO Autonomy Guidelines for Practitioners' provides a common lexicon and a practical list of



Further research is needed to better understand the trade-offs between ACPs and simpler, expendable weapons like one-way attack (OWA) drones (above).

considerations as platforms increase autonomy levels.[19] Additionally, JAPCC's White Paper, 'Future Unmanned System Technologies – Legal and Ethical Implications of Increasing Automation', also addresses practical concerns such as specific legal requirements applicable to Law of Armed Conflict (LOAC) adherence.[20] The JCGUAS Autonomy Task Force also meets regularly to establish a transparent, ethical framework for the technology.

The next step for NATO and the defence industry is to instil trust and confidence in AI's ethical and legal adherence, by converting qualitative legal and moral constraints into specific, measurable AI parameters. A new initiative at DARPA, called ASIMOV, addresses this challenge directly, explaining, 'The rapid development and impending ubiquity of autonomy and AI technologies across both civilian and military applications require a robust and ***quantitative*** framework to measure and evaluate not only the technical but, perhaps more importantly, the ethical ability of autonomous systems to follow human expectations.'[21]

At first glance, quantifying ethical and legal constraints seems impossible. However, NATO rules of engagement (ROE) already include quantifiable parameters which are applicable to AI-enabled ACPs, including geographic safe zones, sensitive target lists, safe-distance charts, and collateral damage estimates (CDE). Such codified rules are prerequisites for testing and evaluation, which is an essential step to building confidence and trust in an autonomous system.[22]

Establishing strong ethical and legal foundations is crucial for the successful integration of ACPs into NATO's defence strategy. By proactively addressing these issues, NATO can ensure its use of autonomous systems aligns with its values.

Conclusion

Upon landing from his F-16 flight, Secretary Kendall stated, 'In the not-too-distant future, there will be two types of Air Forces – those who incorporate this technology into their aircraft and those who do not and fall victim to those who do.'[23] The rapid development of ACPs presents tremendous opportunities and complex challenges for NATO. To succeed, NATO members, industry leaders, and military institutions must proactively and quickly prepare for their arrival. Achieving this will require a NATO-focused approach which addresses current operational gaps, interoperability standards, procurement processes, and legal-ethical foundations. By tackling these shortcomings, NATO will ensure that all pieces are in place to build a cohesive ACP strategy. ●

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Navigating the Digital Battlefield

Understanding Cyber Electromagnetic Activities in Warfare

By Lieutenant Colonel Athanasios Sdrakas, GRC Air Force, JAPCC

Introduction

On the modern battlefield, military forces face a complex environment where success depends on controlling geographic domains such as land, air, sea, and space while exploiting non-physical operational areas like cyberspace, the electromagnetic spectrum (EMS), and information operations (IO). As multi-domain integration advances, cyberspace and electronic warfare have become closely linked, and the fusing of the two operational areas is now commonly called Cyber-Electromagnetic Activities, or CEMA. CEMA is 'the synchronization and coordination of cyber and electromagnetic activities to deliver operational advantage, thereby enabling freedom of movement while simultaneously denying and degrading adversaries' use of the same.[1] Military leaders must be knowledgeable of CEMA and implement CEMA at all levels – strategic, operational, and tactical – to achieve success on the battlefield.

A recent exercise in March 2023 at Schofield Barracks, Hawaii, exemplifies this new operational reality. During an Operational Readiness Assessment, soldiers from the US Army's recently activated 11th Cyber Battalion demonstrated cutting-edge CEMA tactics. Operating under the 780th Military Intelligence Brigade and Army Cyber Command, the battalion delivered close-range cyber effects using radio-frequency (RF) weapons, electronic warfare (EW), and IO Tactics, Techniques, and Procedures (TTP).

During the exercise, the cyber battalion, comprised of four companies with over 300 personnel, divided into five Expeditionary CEMA Teams (ECTs) and demonstrated proficiency in using air- and ground-launched drones, stand-in jammers, and other cyber and EW tools to achieve effects against enemy positions. They gained access to enemy networks and communications, including tactical surface-to-air missile (SAM) systems, which were then infiltrated and disrupted using non-kinetic effects. This event marks a significant step forward in the Army's approach to integrating CEMA with traditional warfare tactics, and emphasises the importance of close-range, decentralized CEMA operations in future combat scenarios.[2]

Origins of CEMA (2009 to Present)

The US Army formally introduced CEMA in 2009 as an organizational initiative to improve the planning and coordination of non-kinetic operations. By 2011, CEMA was incorporated into several Army Field Manuals, and by 2015, experimental units such as the CEMA Support for Corps and Below (CSCB) and the 915th Cyber Warfare Battalion were established.[3] In October 2022, the 11th Cyber Battalion was activated to further enhance the Army's ability to conduct defensive and offensive cyber operations, reflecting a continued commitment to advancing CEMA TTPs. These units were designed to improve the integration of battlefield cyber and EW capabilities.

The US Department of Defense (DOD) has long understood the importance of cyberspace and the EMS for the armed forces. Field Manual 3-38, published in 2014, provides the necessary information for the armed forces to conduct CEMA and model the operational environment. FM 3-38 was superseded in April 2017 with FM 3-12, titled 'Cyberspace and Electronic Warfare Operations'. This updated manual outlines tactics and procedures to enhance the coordination and integration of Army cyberspace and electronic warfare operations to support unified land and joint military operations.

NATO's Role in CEMA Initiatives

Alongside the USA, NATO has integrated CEMA into its operational framework. NATO has been vigilant in the cyber domain since at least 2007, following an eye-opening cyber attack on Estonia that targeted government, financial, and media systems, leading NATO to outline its first Cyber Defence Policy in 2008. The 2010 NATO Summit in Lisbon acknowledged that cyber attacks could threaten Euro-Atlantic security, and in 2011, NATO codified its cyber defence policy. 2012 marked another milestone when the NATO Defence Planning Process (NDPP) first integrated cyber defence. In 2016, NATO declared cyberspace a domain of operations and executed a Cyber Defence Pledge. NATO has also established critical centres such as the Cooperative Cyber Defence Centre of Excellence (CCDCOE) in 2018 in Estonia, which offers training and research to bolster cyber capabilities, the Joint Electronic Warfare Core Staff (JEWCS), which provides advanced EW training and equipment, and the Virtual Cyber Incident Support Capability in 2023. In 2024, NATO took a significant step forward by inaugurating the Integrated Cyber Defence Centre to centralize and enhance its cyber defence efforts. This centre fosters collaboration among Allies, streamlining threat detection and response and developing advanced cyber tools and techniques. These milestones reflect NATO's sustained commitment to evolving its cyber capabilities in response to emerging threats.[4]

To further promote CEMA, NATO collaborates with member nations to align strategies and integrate technologies that enhance military advantage. The UK set up its Land Cyber Electromagnetic Activity Programme in July 2020, which delivers defensive

Year	Event/Milestone
2007	Russian hackers launched a cyber attack on Estonia, targeting government, financial, and media systems, highlighting cyber vulnerabilities.
2008	NATO outlines its first Cyber Defence Policy.
2010	Lisbon Summit acknowledges cyber attacks as a threat to Euro-Atlantic security.
2011	NATO formalizes its cyber defence policy.
2012	The NATO Defence Planning Process (NDPP) first integrates cyber defence.
2016	NATO declares cyberspace a domain of operations and enacts the Cyber Defence Pledge.
2018	NATO establishes the Cooperative Cyber Defence Centre of Excellence (CCDCOE) in Estonia for training and research.
2023	NATO creates the Virtual Cyber Incident Support Capability to improve response to cyber incidents.
2024	NATO inaugurates the Integrated Cyber Defence Centre to centralize and enhance cyber defence efforts.

A brief overview of various cyber-related events pertaining to the Alliance.

and offensive cyber and electromagnetic activity, electronic countermeasures, and EW and signals intelligence capabilities while integrating people within these CEMA capabilities.[5] Additionally, NATO conducts integrated exercises such as 'Cyber Coalition', held annually since 2008, which brings together NATO Allies and Partners to strengthen the Alliance's ability to deter, defend, and counter threats in and through cyberspace.[6] However, while NATO has been hard at work promoting CEMA within the Alliance, the case studies below highlight the rapid changes and advancements occurring globally in this critical domain.

Case Study 1: Recent Crisis Between Israel and Hezbollah

The conflict between Israel and Hezbollah demonstrates the advanced integration of CEMA in modern hybrid warfare. Israel coordinated cyber attacks and electronic jamming to disrupt Hezbollah's radar and communication networks, creating tactical advantages for precision airstrikes. Leveraging AI-driven data analytics, Israel merged cyber intelligence and EMS surveillance to enable real-time decision-making, enhancing operational effectiveness. Additionally, Israeli Unmanned Aerial Vehicles (UAV) utilized secure communication links and frequency-hopping technologies to evade jamming attempts while conducting surveillance and delivering electronic payloads. A recent operation against Hezbollah in Lebanon involved Israel's secretive 'Unit 8200' which embedded explosives in 5,000 pagers, killing 12 and injuring thousands of operatives.[7]

Meanwhile, since its founding in 1982, Hezbollah has served as a critical tool for Iran to project power beyond traditional military means, especially in asymmetric and hybrid warfare. Hezbollah's cyber arm, acting as an extension of Iran's Revolutionary Guard Corps (IRGC), has evolved into a significant force capable of conducting information warfare campaigns. Platforms, such as Hezbollah's Al-Manar TV, amplify anti-Western and anti-Israeli narratives, while Hezbollah's cyber operations target adversaries and spread disinformation such as exaggerated casualty reports of Israeli forces designed to undermine

US Army soldiers coordinate cyber and electronic warfare strategies during a field exercise, showcasing the critical role of integrated CEMA teams in modern combat operations.

Israel's public confidence. The 2006 Lebanon War between Hezbollah and Israel marked a turning point, highlighting Hezbollah's success in psychological warfare and media manipulation. During this conflict, Hezbollah's information campaigns helped it secure symbolic victories, using platforms like Al-Manar to portray itself as a regional resistance leader. Iran's investment in cyber capabilities, particularly after the Stuxnet attack on its nuclear programme in 2010, accelerated Hezbollah's cyber development.

Between 2013 and 2015, Iranian cybersecurity spending increased significantly, leading to the creation of Hezbollah's Cyber Army (HCA). The HCA conducts cyberespionage, sabotage, and disinformation campaigns, with operations such as the *Volatile Cedar* campaign targeting Israeli and Western networks to undermine trust in the targeted institutions, degrade operational capabilities, and amplify psychological pressure on adversaries. By integrating local networks and expertise, Iran and Hezbollah jointly conduct cyber-influence operations, from disinformation campaigns to training regional proxies, demonstrating how nonstate actors can wield substantial soft power with state support. Their efforts included disrupting GPS signals, hacking civilian infrastructure, and spreading disinformation to create public anxiety.[8] Overall, Hezbollah employed cyber intrusions and EMS spoofing to undermine Israeli security and amplify psychological operations.

Both Israel and Hezbollah integrated CEMA to maximize tactical and strategic outcomes, with Israel achieving aerial and operational superiority and Hezbollah focusing on asymmetrical disruption. This conflict highlights the increasing importance of integrating cyber and EMS capabilities in warfare, where technology shapes battlefield dynamics and influences civilian perceptions and the psychological dimensions of conflict.

Case Study 2: CEMA in the Russia-Ukraine Conflict

Russia has long embraced asymmetric warfare; its military doctrine prioritizes the initial preparation stages of a conflict, leveraging non-kinetic and asymmetric

A soldier supports CEMA operations, utilizing electronic warfare systems for signal interception, jamming, and battlefield communication dominance

capabilities to achieve early tactical advantages over its opponents.[9] This includes CEMA operations, as observed in the 2008 Georgia conflict and the 2014 annexation of Crimea, where cyber attacks and electronic jamming were employed to disrupt communications.

Additionally, Russia has made significant breakthroughs in CEMA in their ongoing war in Ukraine. At the onset of the conflict, a cyber attack attributed to Russian hackers targeted Viasat, a communications provider used by Ukrainian forces, disrupting command and control systems across Ukraine, creating difficulty for Ukraine's defence. Russia disrupts battlefield coordination, delays decision-making, and degrades Ukraine's ability to direct forces in real-time by targeting Ukraine's command and control (C2) systems through cyber attacks and EW. Furthermore, Russian artillery can exploit gaps, striking with greater precision the Ukrainian units. For instance, jamming communications and GPS signals hampers real-time targeting data, making it harder for Ukrainian units to direct counter-battery fire or reposition effectively. Despite initially lagging their Ukrainian target, Russian forces have demonstrated high integration between cyber capabilities and physical operations, particularly leveraging UAVs for real-time surveillance, identifying enemy positions and providing data to their artillery. By combining drone reconnaissance with cyber attacks, Russian units have improved their ability to strike targets quickly and accurately, reducing the time between detection and engagement. In one case, Russian forces reportedly employed advanced GPS jamming techniques in Donbas, disrupting Ukrainian drone operations and communications-impacting Ukraine's situational awareness and coordination.[10]

Close-range jammers, such as the Russian Krasukha-4 systems, designed to neutralize airborne electronics, have become a crucial asset in the Russian military's operations in Ukraine. This includes ground-based jamming of UAVs, radar-guided missiles, and other radar-dependent airborne platforms. These jammers have substantially degraded platforms like the M777 Howitzer's models, such as the Bayraktar TB2, resulting in missed targets and reduced strike effectiveness.[11]

Significant CEMA innovations have also been made on the Ukrainian side, where Ukraine has adapted to

A US Army Soldier from the Expeditionary Firing Crew, Alpha Company, 11th Cyber Battalion, conducts field operations.

its opponent by deploying agile, small-scale drones capable of conducting electronic reconnaissance and precision strikes. Ukrainian forces have also excelled in integrating commercial off-the-shelf technology into their operations. For instance, Ukraine's Sky Fortress systems uses smartphones to create mesh networks for audio drone detection, which exemplifies the effective repurposing of consumer technology for defence use. Additionally, Ukraine has utilized commercially available drones equipped with jamming modules to counter Russian UAV and disrupt Russian communications.[12] Similarly, the adoption of Starlink has provided resilient communication capabilities critical for command, control, and coordination, especially in regions with compromised infrastructure. Lastly, adaptations to electronic warfare and deployment of fibre-optics-guided drones resistant to radio frequency jamming highlight the dynamic response to contested electromagnetic environments.

Case Study 3: China's CEMA Development

China's CEMA strategy focuses on *'systems confrontation'* and *'systems destruction warfare'*. This involves coordinating kinetic and non-kinetic operations to degrade an adversary's communication and information systems. China leverages cyberspace and the EMS to disrupt and fragment adversaries' system-of-systems, aiming to gain informational and decision-making superiority. The People's Liberation Army (PLA) views CEMA as essential to integrating and enabling kinetic operations in physical domains while also serving as a key platform for influence operations within the broader scope of information warfare. Central to this approach is China's 'integrated network electronic warfare' strategy, which combines cyber attacks, EW, and precision kinetic strikes on critical nodes within the command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) networks.[13]

The PLA plays a key role in cyber espionage, exemplified by campaigns like Advanced Persistent Threat (APT) 10, which has targeted multinational corporations and government entities to steal intellectual property and sensitive data, providing strategic and technological advantages to China.[14] Additionally, through offensive cyber operations (OCO), the PLA breached the US Office of Personnel Management (OPM) in 2015, compromising the personal data of millions of federal employees, enabling potential exploitation and psychological operations.[15] Both efforts highlight China's integrated approach to leveraging cyber capabilities for strategic gain and to disrup adversaries.

Recommendations

NATO must modernize frameworks to increase its CEMA capabilities in the evolving operational environment. Advancements in simulation technologies, realistic testing environments, and updated doctrinal guidance must be incorporated by NATO. These initiatives must align with the rapid technological evolution and the complexities of contemporary warfare, ensuring that military personnel remain proficient and adaptable.

A critical component of this strategy involves enhancing simulation platforms and the integrating artificial intelligence (AI) and machine learning tools. Existing systems, such as One Semi-Automated Force (OneSAF), should be upgraded to include dynamic Electronic Targeting Folders (ETFs), real-time adversary network modelling, and simulations replicating modern intelligence-gathering environments, including social media and network mapping. Incorporating AI-driven tools can simulate adaptive adversarial behaviours, increasing the realism and rigour of training exercises. Furthermore, interactive decision-making tools can improve operators' ability to perform under time-sensitive conditions, fostering effective decision-making in high-pressure scenarios.

Realistic testing and training environments are urgently needed to complement advancements in simulation. Establishing dedicated physical and/or virtual CEMA ranges for NATO and Allied forces is essential. These ranges should replicate modern EW and cyber operational systems, allowing personnel to test offensive and defensive capabilities under realistic conditions. These ranges can facilitate comprehensive assessments of force readiness while uncovering gaps in interoperability and capability.

Military doctrine and TTPs must be updated frequently to reflect emerging technologies and lessons learned from current conflicts, such as the one in Ukraine. The rapid evolution of technology necessitates an agile approach to doctrinal and procedural development, with accelerated revision cycles to ensure alignment with contemporary threats and opportunities. Furthermore, a sustained emphasis on interoperability is essential for synchronizing across joint and Allied forces during multinational operations. Interoperability should extend beyond technical compatibility to include procedural and operational coherence, ensuring seamless collaboration in complex operational environments.

Collaboration with private industry, academic institutions, and research organizations is another vital element of CEMA capability development. Such partnerships can provide access to cutting-edge innovations, enhance training methodologies, and enable military organizations to stay at the forefront of technological advancements. Insights from real-world conflicts, such as integrating cyber and electromagnetic tactics observed in Ukraine, should inform training and capability development efforts. By leveraging these partnerships and lessons learned, military organizations can remain agile and adaptive in the face of evolving threats.

Enhancing CEMA capabilities requires a holistic approach prioritizing upgraded training, realistic testing environments, agile doctrinal development, and collaborative partnerships. By integrating advanced simulation technologies, establishing CEMA testing ranges, and fostering joint interoperability, militaries can prepare their forces to navigate the dynamic challenges of modern warfare. These efforts must be underpinned by continuous investment in

personnel proficiency, leveraging innovative tools and iterative learning processes to maximize the strategic potential of CEMA.[16]

Conclusion

As the modern battlefield advances, military forces must evolve by mastering physical and non-physical domains. The CEMA concept underscores the need to synchronize cyber and electromagnetic operations with the physical domains to gain strategic and tactical advantages while simultaneously mitigating vulnerabilities. This integration demands technical and procedural interoperability among various forces and agencies to ensure seamless information exchange and coordination. By implementing the recommendations in this paper, NATO can secure its collective defence across the full spectrum of modern warfare. ●

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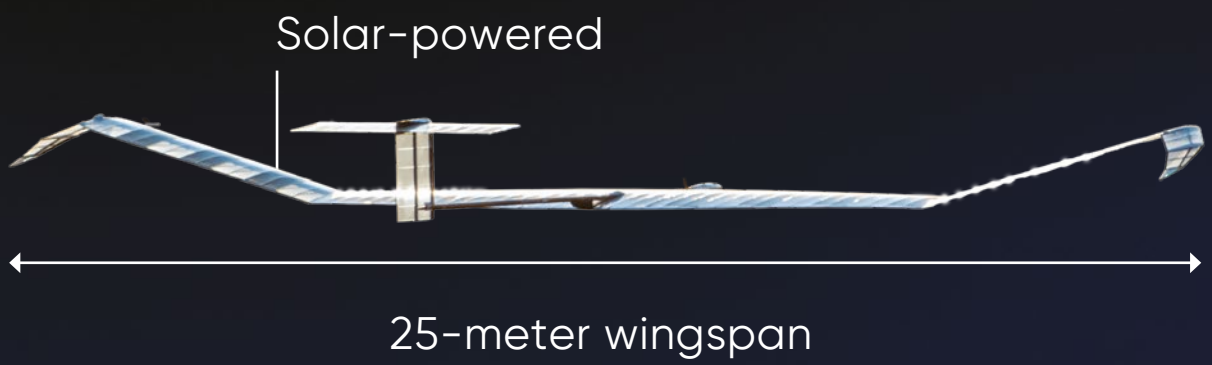

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High Above the High North

Resilient Satellite Communications for the Arctic

By Major Luke Stensberg, US Space Force, JAPCC

> *'I believe that in the future, whoever holds Alaska will hold the world.'*
>
> Billy Mitchell, US military aviation pioneer

The Strategic Importance of the Arctic

Alaska may appear isolated on a map, but it is actually the closest US state to northern Norway. In fact, cargo planes from Anchorage, Alaska can reach 90% of the industrial world in under 10 hours.[1] This strategic location is a major reason why Billy Mitchell testified to the US Congress in 1935, foreshadowing the strategic importance of the Arctic, or High North. Viewing the world from a polar perspective, as US Army-Alaska does, clarifies its proximity to the rest of the northern hemisphere more intuitively.[2] According to US Army-Alaska, this geospatial reality underscores one reason why Russia commonly encroaches NATO nations' airspace in the Arctic, a desolate, yet strategically key, region.

Besides the Arctic's key airspace with proximity to most of the industrial world, climate change is leading to other geopolitical ramifications. Melting ice in the Arctic has paved way to new economic opportunities. As new shipping lanes emerge, claims are intensifying over the region's oil and mineral resources.[3] According to a high-ranking official within NATO,

The Svalbard Satellite Station serves more satellites than any other facility in the world, thanks to its high northern location which maximizes visibility of passing satellites.

anxieties are rising in the Arctic and 'High North, low tension' is no longer the mantra as competitors ramp up military presence in the Arctic.[4] For example, in September 2024, Russia conducted a major naval and air exercise named Ocean 24, part of which included deploying two nuclear submarines under the northern polar icecap. China shares Arctic ambitions as they joined Russia not only in Ocean 24, but also in joint patrols while also conducting their own icebreaker missions.[5] NATO Allies have responded with their own Arctic exercises, increased patrolling, and protection of freedom of navigation and undersea communications links. Also, NATO's two most recent accessions to the Alliance, Finland and Sweden, add territory to defend in the High North.

The Arctic and the Space Domain

The Arctic also plays a vital role for military and commercial space operations. Kongsberg Satellite Services (KSAT) is a commercial provider that operates the world's largest satellite ground station from Svalbard, an archipelago halfway between Norway and the North Pole. The station, like others in the region, capitalizes on its northern latitude to maximize line of sight with satellites passing overhead in heavily inclined orbits. Besides space infrastructure designed for satellite tracking, telemetry, and control (TT&C), there is also American strategic early warning infrastructure at bases such as Pituffik Space Base (formerly known as Thule Air Base) in Greenland. The

Icebreakers are special-purpose ships designed to navigate through ice-covered waters, opening up passageways for other ships.

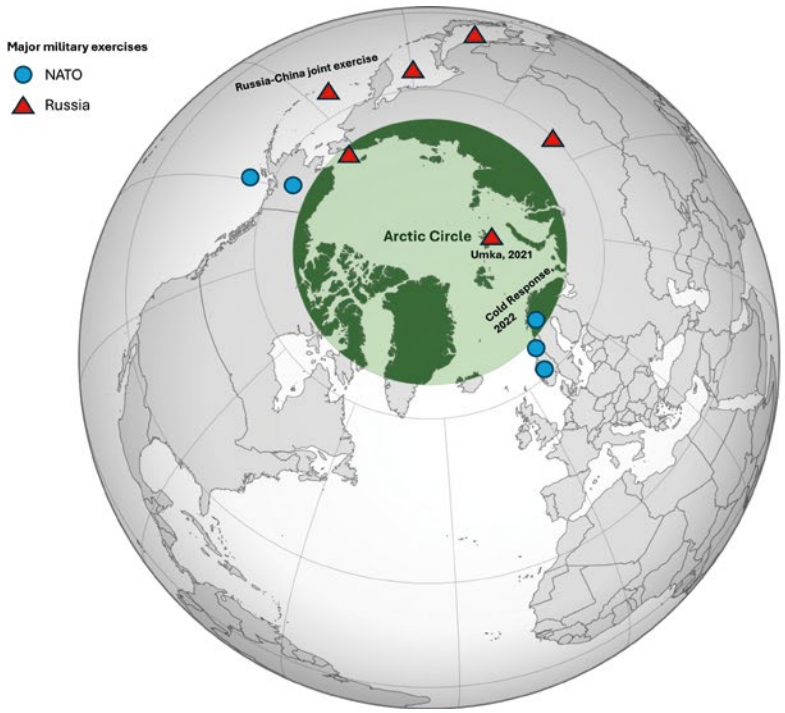
US placed ballistic missile early warning infrastructure there during the Cold War due to its location roughly halfway between Moscow and New York. Radars at sites like Pituffik can monitor for missile threats while also detecting and tracking objects in orbit. Since 2005, Russia has re-opened Soviet-era military bases in the Arctic,[6] to include its own corresponding radar complexes.[7] Their re-militarization coincides with strategic messaging from Foreign Minister Sergei Lavrov that Russia will defend its interests in the Arctic, both diplomatically and militarily.[8] Likewise, Chinese space activities in the region have been expanding, as written about in detail in the JAPCC's Journal Edition 30.[9]

Now with seven NATO Allies holding territory in the Arctic Circle, the Alliance must be prepared to defend its interests as well; however, doing so will come with new challenges. The Arctic's harsh climate and vast, sparsely populated terrain have discouraged nations from investing in the typical infrastructure found near larger population centres. Much of today's Satellite Communications (SATCOM) cannot adequately cover such northern latitudes. This means that, as one of many examples, a remotely piloted aircraft that typically operates near the Mediterranean may not be able to maintain the same SATCOM links from the High North.

One key nuance that operational planners, Allied defence procurement organizations, and NATO interoperability efforts must account for is the line of sight limitations of certain SATCOM architectures in providing coverage above (or below) of roughly 65 degrees north (or south) latitude.[10] This is largely due to the current reliance on SATCOM from Geostationary Orbit (GEO) because it offers relatively stationary orientation from the Earth's perspective. But there are trade-offs associated with SATCOM from GEO that are now becoming more relevant.

Falling Short in the High North

Satellites in GEO have been the backbone of SATCOM for decades because of the convenience for ground equipment to maintain connectivity, and the widespread coverage offered by their high altitude. Positioned far above the Earth's equator, one GEO satellite can offer coverage for approximately one-third of the Earth, theoretically allowing for only a few satellites to provide global coverage. The precise altitude is chosen because it is the narrow sweet spot to park a satellite above the equator. As long as it is in a circular orbit, the satellite will orbit with the same angular velocity as the Earth's rotation, thereby remaining stationary relative to any vantage point from Earth.



Ⓜ Globe: © Heraldry, Isochrone/Wikipedia.org, CC BY 3.0; Overlay: © JAPCC

Arctic nations have been increasingly carrying out military exercises in the region, showcasing escalating tensions.

The fixed orientation between any ground station or user and the satellite itself offers a stable and relatively straightforward architecture. GEO SATCOM does have signal time delays, known as latency, due to the great distance (35,786 km), but the benefits of GEO-based SATCOM have historically outweighed that inherent drawback.

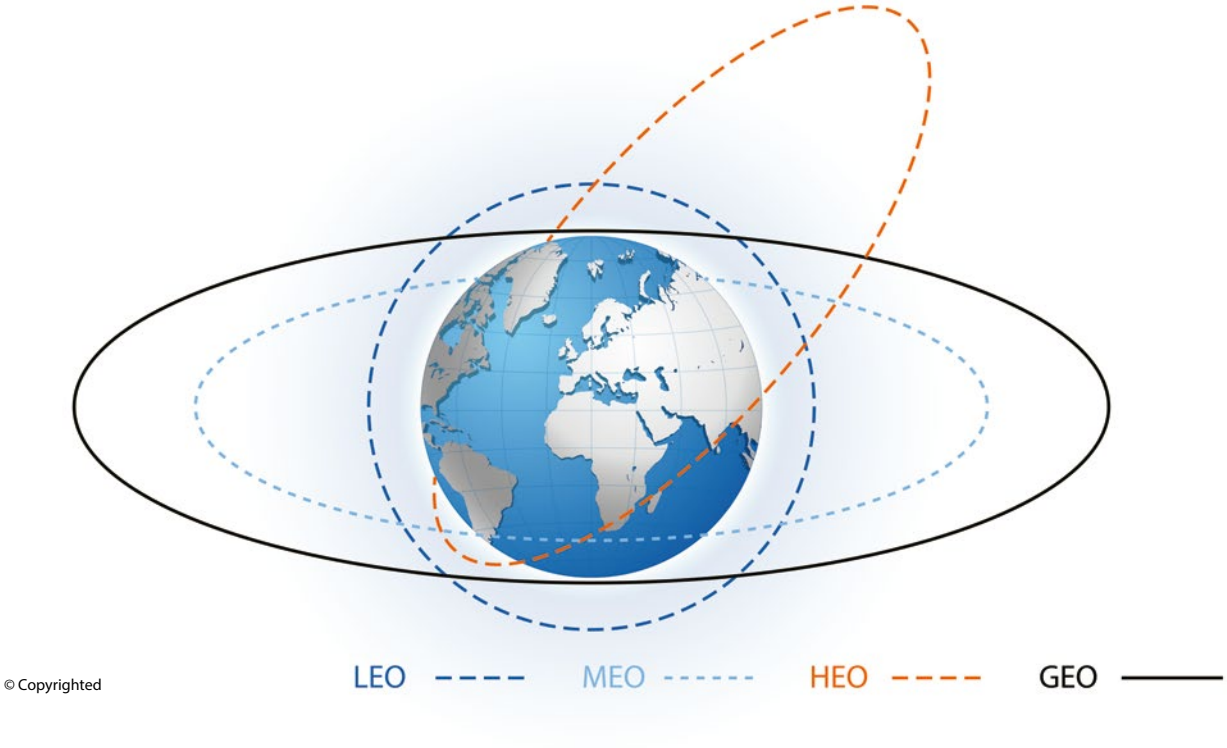
The limitations of today's SATCOM in the Arctic stem from not anticipating the Arctic's growing importance. A GEO satellite must be over the equator to remain in a fixed vantage point with respect to Earth. That geometry makes coverage of the polar regions difficult because a SATCOM user would have to orient their antenna to a very low elevation angle above the horizon. Even if the user can achieve line of sight with the satellite, this difficult angle could sacrifice the link's reliability because the signal would have to fight through more atmospheric conditions, weather, and physical obstructions. While the Mobile User Objective System (MUOS) in GEO has reportedly provided coverage as far north as 74 degrees, that stretches the limits of a system not designed to deliver SATCOM that far north.[11]

Inclining GEO to reach higher latitudes would fundamentally alter the orbit to become a Geosynchronous Orbit (GSO). GEO and GSO both operate at the same altitude and complete one orbit per day, but the orbital tilt of GSO removes the benefit of staying consistently fixed over one point on Earth. If overlaid on a map, GSO ground tracks look like figure-eights, spending half the day over the northern hemisphere, and half in the southern. Therefore, embracing GSO would require multiple satellites for continuous coverage and eliminate the benefits of stationary satellites that is offered by GEO. Given the dilemma, NATO must look beyond GEO and GSO for SATCOM that can deliberately cover the Arctic.

Going Low to Cover High?

There are three other orbit types to consider for SATCOM coverage in the High North: Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Highly Elliptical Orbit (HEO). Each have their advantages and disadvantages, yet each has precedent in covering high latitudes for services other than SATCOM. Additionally, there are efforts underway for each to bring SATCOM to each orbit type. Each will be covered below:

The proliferation of LEO satellite constellations in recent years has been driven by commercial mega-constellations such as the UK's OneWeb and SpaceX's Starlink, which now consists of over 7,000 satellites, approaching half of all satellites ever launched.[12] Reduced launch



A visual representation of the four major orbit types.

costs, smaller and cheaper components, and cost-sharing programmes are three factors fuelling the growth. These large constellations can offer worldwide coverage because LEO satellites are typically launched into highly inclined orbits, often tilted vertically so much that they consistently pass over the polar regions. Then the Earth rotates beneath the satellites to spread the coverage east-west over all lines of longitude. Furthermore, satellites in LEO offer lower latency than GEO due to their altitudes ranging only up to 2,000 km, thereby improving signal quality. Private industry and government agencies have long benefitted from LEO for remote sensing missions such as imagery collection and weather, but historically less so for SATCOM. Achieving seamless, worldwide SATCOM coverage from LEO requires at least 40–80 satellites for bare minimum coverage, and up to hundreds for practical usage.[13] There has already been good precedent from companies like Iridium, but recent developments in the space industry are offering even more robust opportunities for SATCOM from LEO. SpaceX's Starlink, along with their more secure and government-tailored variant Starshield, have demonstrated LEO SATCOM's potential, such as recently enabling C2 for Ukrainian forces.[14]

Orbit Type	Altitude	Latency	Global Coverage Requirement	Polar Coverage
LEO	200–2,000 km	Low	40–80 satellites bare minimum, ideally hundreds	Yes
MEO	2,000–20,000 km	Medium	10–20 satellites minimum, ideally 2–3x more	Limited now, but possible
HEO (Molniya)	~40,000 km at apogee; ~600 km at perigee	High at apogee	N/A; 2 satellites for Arctic coverage	Yes
GEO, GSO	35,786 km	High	3 satellites	No

A Brief Comparison of Orbit Types.

MEO, ranging from LEO's upper boundary to 20,000 km, offers a compromise between LEO and GEO both in terms of the number of satellites required and latency. While satellites have orbited in MEO for decades, they have mostly been part of Global Navigation Satellite Systems (GNSS) that offer positioning, navigation, and timing (PNT) services, such as the US Space Force's GPS, the European Space Agency's Galileo, Russia's GLONASS, and China's BeiDou. One example of MEO SATCOM is the Luxembourgish company SES's O3b mPOWER, which orbits at 8,000 km. They view this as a Goldilocks zone – not too high, not too low. Their chosen altitude reduces latency from GEO's ~500 milliseconds to ~150 milliseconds, and only requires a fraction of the satellites required for worldwide coverage from LEO.[15] SES has provided MEO-based SATCOM for over ten years; however, as a profit-driven company, its satellites in orbit cover between 50 degrees north and south, which in fairness is enough to provide service to 96 % of the global population.[16] There are plans to 'eventually' reach any point on Earth as the company adds to the constellation.[17]

HEO differs from LEO, MEO, and GEO in that the orbit's shape must be elongated. A satellite in HEO will reach its apogee – the farthest and slowest point in its orbit – and then whip back around the Earth at LEO altitudes and much higher speeds. Due to those difference in velocities, HEO satellites will dwell near their apogee for much longer than their perigees. The Soviets' Molniya orbit from the 1960s is credited as the first HEO and is still used today. Satellites in Molniya orbits have long dwell times at their 40,000 km apogees, alternating equally between coverage of ~63 degrees north over North America, then rapidly orbiting to re-emerge again at ~63 degrees north over Russia.[18] The Soviets designed this orbit to maximize consistent coverage of the polar regions between the US and Soviet Union for missile warning, communications, surveillance, and weather purposes. The Arctic Satellite Broadband Mission (ASBM) is a two-satellite HEO constellation with US Space Force, Space Norway, and Viasat payloads onboard. It is an example of the cost-effective hosted payload model, also known as piggybacking or hitchhiking (see 'Hosted Satellite Payloads' in JAPCC's Journal Edition 38 for more information).[19] Each satellite moves relatively slowly at their apogees above the Arctic for ten hours of their sixteen-hour orbits. Then, as one satellite descends out of view, the other ascends, taking its place. With only two satellites, ASBM provides uninterrupted coverage of the Arctic because of HEO's long dwell times near apogee.

Way Forward

There are efforts underway to improve Allied SATCOM in the Arctic. As previously mentioned, ASBM is deliberately designed to provide SATCOM to Norwegian, US, and Allied forces operating in the High North. Additionally, in October 2024, 13 Allies initialized a multinational proposal, NORTHLINK, to explore the development of secure, reliable, and resilient SATCOM in the Arctic.

In the near term, NATO can seek interoperability with ASBM by requesting capacity in conjunction with the NORTHLINK initiative, of which the US and Norway are each members. HEO SATCOM can begin to address the current overreliance on GEO; however, NATO should continue to design a unified Arctic SATCOM framework under NORTHLINK that leverages multiple orbit types and providers to maximize availability across the Alliance. If conflict arises in the Arctic, adversaries will try to disrupt Allied space services. NATO can promote resilience in a contested space environment by augmenting HEO SATCOM with redundant SATCOM from LEO or MEO, or vice versa. Disrupting LEO or MEO SATCOM is more complicated for an adversary, due to the distribution of SATCOM across many, harder-to-target satellites, instead of one fixed high-valued target in GEO. The value proposition of a diversified SATCOM architecture extends its benefits beyond just the Arctic, as it would add worldwide resilience in lower latitudes too.

Over the past decade, many SATCOM providers like SpaceX and OneWeb have heavily invested into LEO constellations, demonstrating proof of concept for support to NATO operations. However, if NATO looks to incorporate SATCOM from MEO, it will likely need to provide explicit requirements to industry. The commercial space industry is profit-driven. Without a clear demand-signal, Arctic SATCOM will remain a lower priority for industry, as seen by O3b mPOWER's standard

SATCOM terminals like the Starlink terminal depicted use phased array antennas to steer their links without mechanical movement, maintaining connection with satellites orbiting overhead in LEO.

services only covering up to 50 degrees north. If the Alliance desires SATCOM from MEO, NATO should formalize long-term service contracts soon to drive industry investment into high-latitude coverage.

There is unfortunate precedent of the military deploying an advanced capability on orbit that ground forces struggle to access for years due to outdated and incompatible user equipment. One notable example is military code-capable (M-code) GPS satellites which became operational in 2005. Two decades later, many ground units still cannot harness M-code due to the units' legacy GPS receivers which are incompatible with the modernized GPS M-code signal.[20] A similar situation could emerge regarding SATCOM in that units may have to procure new physical hardware to maintain interoperability. Unlike the GPS M-code example, it would not likely be due to microelectronics required to receive the unique signal type, but rather antennas that can track satellites that quickly pass overhead.

Augmenting SATCOM from GEO to other orbits will likely require terrestrial units to upgrade their user terminals to have steerable, phased array antennas. Unlike GEO SATCOM, which remains fixed in one location from Earth's perspective, LEO, MEO, and HEO satellites are all constantly in motion relative to the user. Therefore, it is impractical to rely on mechanically steered antenna dishes to track the satellites. A phased array antenna, like those used for Starlink, uses many small antennas to electronically steer the link without moving parts. These instead rely on automated phase shifting of the electronic signal. As NORTHLINK and other SATCOM efforts move forward, procurement efforts will have to simultaneously dedicate focus to the corresponding user equipment to ensure interoperability. That may require procurement organizations outside of NORHTLINK to initiate their own acquisition processes in parallel.

Conclusion

As General Mitchell's testimony to Congress predicted almost a century ago, the Arctic has grown in strategic importance. Therefore, NATO must prioritize Arctic readiness by modernizing its SATCOM architecture to ensure resilient C2 in the High North. As NATO's competitors invest heavily in Arctic military capabilities, the Alliance must ensure it is not outpaced in the region. NATO should embrace multi-orbit SATCOM to ensure reliable C2 in the Arctic across the continuum of competition. ●

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Adapting Air and Missile Defence Training and Doctrine for Hypersonics and Drones

Many Changes Are Needed to Defend NATO Against Emerging Threats

By Lieutenant Colonel Kim Vogt, DEU Air Force, JAPCC

Introduction

The rapidly evolving landscape of contemporary warfare has introduced new challenges to Integrated Air and Missile Defence (IAMD) and fundamentally altered the dynamics of defence and deterrence within NATO. Emerging threats, such as Unmanned Aircraft Systems (UAS), commercial drones, and hypersonic weapons exploit existing technical and doctrinal gaps in our aerial defences, posing significant risk to current air defence strategies.

Unmanned platforms, ranging from advanced military-grade UAS to simple commercial-off-the-shelf (COTS) drones repurposed as airborne improvised explosive devices (IEDs), have been used effectively in recent

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Russian Mig-31 carrying Kinzhal hypersonic ballistic missile.

conflicts, including the 2008 Russo-Georgian War and the ongoing war in Ukraine. Adversaries are challenging traditional air defence strategies by exploiting vulnerabilities in sensor coverage, target tracking, command and control (C2), and magazine depth. For instance, Russia's Shahed-136 UAS has demonstrated the ability to conduct long-range precision strikes while evading detection, especially in the early phases of flight.[1] Ukraine's air defence forces have struggled to detect and track these small UAS (sUAS).

Similarly, Russia has employed *Kinzhal* hypersonic weapons to target critical infrastructure and civilian assets, forcing Ukrainian forces to reallocate limited defence resources to counter this dangerous threat. This article examines the impact of these emerging threats on IAMD, and explains how adaptation in training and education (T&E) and doctrine can mitigate the risks posed by these new weapons.

Gaps in Current Training and Education for Air Defenders

The rapid integration of UAS and hypersonic weapons into adversaries' arsenals has exposed training deficiencies among Western air defenders. Traditional training programmes have not sufficiently prepared personnel to identify and classify low, slow, and small (LSS) drones, limiting defenders' ability to respond effectively.

Additionally, hypersonic weapons, travelling at speeds exceeding Mach 5, present a qualitatively different challenge compared to UAS, LSS, and more traditional supersonic threats. Their high velocity, manoeuvrability, and variable flight paths render existing detection and interception systems less effective. For instance, Hypersonic Glide Vehicles (HGVs) and Hypersonic Cruise Missiles (HCMs) can avoid radar detection by selecting circuitous or off-axis routing which bypasses known tracking sites. Additionally, their variable altitudes and thermal signatures can reduce detection windows and hinder ground and space-based tracking capabilities, thereby reducing response times for defenders.[2] The Russian employment of the Kinzhal missile in Ukraine marks a pivotal moment in the operational use of hypersonic technology, demonstrating the ability to strike targets with minimal warning. This capability presents a significant challenge to NATO's IAMD posture, and further highlights gaps in T&E.

Small Unmanned Aerial Systems create challenges for the current IAMD systems.

Enhancing NATO's IAMD Training and Education

Air defenders require specialised training to address emerging threats, focusing on both technical proficiency and cognitive skills.

First, technical proficiency is essential, as personnel must deepen their knowledge in areas such as electronic warfare (EW), cyber defence, and advanced sensor technology. This includes understanding electronic attack and protection measures, mastering the use of cyber defence mechanisms to safeguard critical C2 systems, and becoming proficient with advanced sensors capable of detecting and tracking elusive threats like hypersonic missiles, sophisticated military-grade UAS, and COTS drones. Expanding weapon system-specific knowledge at the tactical level provides defenders with a crucial information advantage.

Secondly, cognitive skills are crucial for air defenders operating under the intense pressures of modern warfare. Hypersonic weapons' extreme speed and unpredictability significantly compress decision-making timelines, leaving little room for hesitation or error. The same time constraint is true for LSS UAS, which are often detected late. Training programmes must, therefore, enhance decision-making under stress, improve situational awareness, and develop rapid information-processing skills. Techniques such as high-intensity simulations, real-time strategy exercises, and cognitive resilience training can help personnel make swift, accurate decisions in rapidly evolving threat scenarios. Strengthening these cognitive skills ensures air defenders are better prepared for contemporary warfare.

After maximizing the individual capabilities, organizational training enhancements can further strengthen NATO's air defence posture. Several recommendations should be addressed to improve training against hypersonic and UAS threats:

1. **Incorporating Realistic Threat Simulations:** Advanced simulators for hypersonic weapons and UAS would allow defenders to experience and respond to these threats effectively. Joint exercises with allies can foster best practices, information sharing, and collaborative readiness.

2. **Enhancing Intelligence Sharing:** Strengthening intelligence sharing among western nations is crucial to staying ahead of emerging threats. Platforms such as the Battlefield Information Collection and Exploitation System (BICES) enable seamless information exchange among NATO members, while multinational intelligence cells dedicated to emerging threats ensure that training programmes remain informed by updated intelligence.

3. **Training to Interoperability:** Cross-service and cross-domain integration is essential for a cohesive defence strategy; training air defenders in cyber and space operations enhances their understanding of modern warfare's interconnected domains. Joint training with international partners strengthens collective readiness, with multinational exercises like NATO's ***Joint Warrior*** and the ***Technical Interoperability Exercise (TIE)*** events improve coordination and interoperability, as well as operational cohesion among allies and partners.

Continuous Curriculum Improvements

Training programmes must continually evolve based on operational feedback to ensure air defenders are prepared for emerging threats. The NATO Counter-UAS Working Group plays an important role in these efforts, overseeing the development of courses such as the C-UAS Fundamentals Training (led by the Joint Air Power Competence Centre), C-UAS Operators Training, C-UAS Planners Course, and C-UAS Senior Leadership Seminars. These courses, set to begin in 2025, will serve a valuable role in educating personnel at all levels with an iterative, skills-based training approach. However, at present there are no similar courses dedicated to hypersonic threats. By incorporating both hypersonics and C-UAS into T&E initiatives, NATO will enhance readiness and resilience against these threats.

Doctrinal Changes

Hypersonic and drone threats require improvements to current air defence doctrine due to their unprecedented speed, manoeuvrability, and detection difficulties. Addressing these challenges demands doctrinal improvements to four main areas: threat detection, C2, interoperability, and innovation:

1. **Improving Threat Detection:** Detecting hypersonic threats requires investments in over-the-horizon radar, space-based sensors, and infrared tracking technologies, among other improvements. Refining doctrine in this area can support the national procurement processes of NATO nations and inform changes to the NATO Defence Planning Process (NDPP).

2. **Integrated, AI-Assisted C2:** Compressed timelines associated with hypersonic and drone threats necessitate streamlined decision-making processes. Artificial Intelligence (AI) and machine learning can rapidly process vast amount of data and may enable commanders to make informed decisions in real-time. Pre-defined response protocols may also lead to swift, autonomous countermeasures against threats. However, overcoming ethical and legal obstacles will be a key challenge, and NATO doctrine can lay the foundation for the responsible use of AI in C2 systems.

3. **Interoperability Across Domains:** A cohesive network must integrate air, space, and cyber capabilities. Space-based sensors can detect a hypersonic launch, air-based platforms can track its trajectory, and cyber capabilities can disrupt its guidance systems. Strengthening collaboration in these domains will therefore ensure that different nations' personnel and systems can work together seamlessly. This collective approach strengthens individual national defences and presents a unified front that can deter potential adversaries, but it must first be codified in NATO doctrine.

4. **Innovation and Adaptability:** Military doctrines must evolve rapidly to anticipate future advancement in tactics and technology, including emerging countermeasures like directed energy weapons and advanced interception platforms. This fast-paced adaptation requires continuous research, development, and adaptive training to keep air defenders ahead of emerging threats.

In essence, countering hypersonic and drone threats demands a forward-thinking approach which uses doctrinal evolution to drive technological advancements in the air defence realm. By enhancing detection capabilities, streamlining command and control, fostering interoperability, and promoting innovation within NATO and partners around the globe, air defence forces can adapt to the complexities of these weapons and strengthen their overall defence posture.

NATO's IAMD capability will require improvements in early warning and detection. Doctrinal updates must first create a demand signal for change.

Case Studies: Adaptation by NATO Allies

NATO Allies are implementing new training programmes, integrating advanced technologies, and developing innovative tactics to counter hypersonic and UAS threats:

The German Air Force has recently incorporated hypersonic threat trajectories into its training simulations, enabling personnel to practice detection and interception in realistic scenarios. Regular intelligence briefings update threat assessments, while collaborative workshops with defence agencies drive innovation in counter-hypersonic strategies. Limited access to detailed threat data remains a challenge, highlighting the need for improved intelligence-sharing mechanisms within NATO frameworks, such as the BICES network.[3]

The Netherlands' Defence Ground-based Air Defence Command (DGLC) addresses emerging IAMD threats through advanced courses such as the Patriot Advanced Capability (PAC) course and Weapon Instructor Courses (WIC). They partner with scientists and knowledge institutes to stay ahead of technological developments, ensuring that lessons learned from recent conflicts, including Ukraine, are integrated into their national training programmes. The Dutch Army also employs passive defence measures such as mobility and decoys to complicate adversary targeting and ensure survivability.[4]

The Russia-Ukraine war has demonstrated numerous practical and innovative tactics, including EW to jam enemy UAS, 'SAMbush' tactics against glide bombs and low-flying munitions, and rapid tactics, techniques, and procedures (TTP) adaptation to counter new threats. Ukraine's ability to adjust TTP in real time underscores the importance of agility and a robust feedback loop across frontline operators and command structures.[5]

Australia has also emphasized emerging technologies in training and operations. Their forces highlight the importance of decentralized command structures, allowing lower echelons to make rapid decisions in dynamic threat environments. Additionally, interagency cooperation strengthens readiness across military branches and civilian agencies.[6]

These adaptations highlight the importance of innovation, flexibility, and continuous learning in countering hypersonic and UAS threats. By incorporating real-world insights and unconventional tactics into training and operations, NATO Allies can refine their IAMD capabilities to address the complexities of modern warfare.

Conclusion

Adapting training, education, and doctrine is imperative for defending against hypersonic and UAS threats. Adversaries identify and exploit vulnerabilities in technology, training, and doctrine making proactive adaptation essential. To stay ahead, air defenders must evolve their TTP in an iterative manner, making their systems and tactics more resilient, unpredictable, and effective against emerging threats. This requires a holistic approach that combines doctrinal changes, rigorous training, realistic exercises, and information sharing across NATO members.

Incorporating advanced technologies such as AI for real-time threat assessment, machine learning for predictive analytics, and automated response systems enables defenders to address threats faster and more accurately. This aids human operators where they are not available or lack the necessary reaction time future conflicts demand. Adaptability in tactics is equally important, allowing air defenders to adjust to enemy methods in real-time – whether this means employing electronic warfare against drones, using dispersed radar to counteract hypersonics, or coordinating cyber assets to disrupt adversary command networks. By fostering a culture of innovation and adaptability within the IAMD community, NATO can close technological and doctrinal gaps and ensure the security of NATO airspace.

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Supporting NATO Deterrence in the Baltic States through Host Nation Support

A Logistical Perspective

By Lieutenant Colonel Francesco Facchi, ITA Air Force, JAPCC

"'Prospicere in pace oportet quod bellum iuvet' – 'Prepare in peace what you may need for war.' This timeless Latin adage has never been more relevant. Russia's invasion of Ukraine has reshaped Europe's security landscape, making NATO's deterrence strategy a critical pillar of stability.

Nowhere is this urgency more pronounced than on the Alliance's Eastern Flank. Estonia, Latvia, and Lithuania stand on the front lines of NATO's defence, their proximity to Russia making them both strategic assets and potential flashpoints. As tensions rise, ensuring these nations can support and sustain Allied forces is no longer just a logistical concern–it is a strategic necessity. Host Nation Support (HNS) is the backbone of NATO's deterrence efforts, as it enables

rapid troop deployment, sustained operations, and creates the resilience needed to defend the Baltics against emerging threats.

This article explains what HNS is, describes why it is crucial for NATO's defence posture, and recommends improvement areas for Alliance members to strengthen the HNS capabilities.

Understanding Host Nation Support

The ability for NATO to deploy and sustain Allied forces depends on host nation support. Defined in AJP 4.3 as 'civil and military assistance rendered in peace, crisis, or war' by a host nation (HN) to Alliance forces, HNS ensures that Allied troops can operate effectively while minimizing the logistic strain on sending nations (SN).[1] HNS plays a crucial role in four key areas:

1. **Logistics:** Managing transportation networks, supply chains, storage areas, and maintenance procedures to ensure resources are readily available.
2. **Infrastructure:** Developing and maintaining roads, railways, airports, seaports, and energy systems to support incoming supplies and military operations.
3. **Force Deployment:** Facilitating Reception, Staging, Onward Movement, and Integration (RSOMI) of position troops and equipment quickly and efficiently.
4. **Security:** Implementing physical and cybersecurity measures to protect Allied forces and associated communication networks

Effective HNS is a force multiplier that strengthens national defence. This is especially true for smaller nations like the Baltic States, who, by pre-positioning supplies, enabling rapid mobility of reinforcements, and enhancing logistical interoperability, enable NATO forces to quickly defend against an attack.[2]

A prime example of HNS in action is NATO's Baltic Air Policing mission, where Allied Quick Reaction Alert (QRA) aircraft rotate through Lithuania and Estonia to safeguard NATO nations' airspace.[3] In addition to the air policing mission, NATO bolsters regional security with rotational forces and NATO Force Integration

Italian Air Force Eurofighters in Lithuania as part of the NATO Baltic Air Policing mission.

Units (NFIUs).[4] The war in Ukraine has reinforced the urgency of these deterrence forces, and underscored the importance of robust HNS arrangements to ensure swift deployments and sustainment operations in this vulnerable region.

Effective HNS requires joint responsibility by both the host nation and sending nations. HNs must prepare infrastructure and streamline their logistic procedures, while SNs must train for interoperability and mitigate bureaucratic or technological hurdles. A strong, adaptable HNS system is vital to NATO's defence posture, but effective HNS must be proactively accomplished and cannot wait until times of crisis.[5]

Geographic Challenges and Infrastructure Requirements in the Baltics

The Baltic States face unique geographic and logistical challenges that complicate NATO's reinforcement and warfighting capability in a crisis. The Suwalki Gap, a narrow 65-kilometre land corridor connecting the Baltic States to the rest of NATO, is a dangerous bottleneck between Belarus and the Russian heavily militarized exclave of Kaliningrad. This is the only way to get from Poland and Central Europe to the Baltic states by road or rail. If Russian forces were to cut off this corridor, the Baltic States could be quickly isolated from NATO reinforcements, underscoring the importance of robust and pre-emptive HNS.[6]

From a logistical perspective, effective defence of the Baltics requires proactive infrastructure modernization in three key areas:

1. **Transport Networks:** Secure and modern road and rail systems are essential for rapidly deploying troops and equipment. These routes must be resilient to disruption and capable of handling high-volume military movements.
2. **Air and Seaport Facilities:** Upgraded ports and airfields provide redundant entry points for the Baltics, especially if land routes are compromised. Facilities must be large enough to handle simultaneous troop and equipment arrivals, and must be protected from modern air and sea threats such as small unmanned aerial systems and unmanned surface vehicles (UAS/USV).
3. **Strategic Storage Facilities:** Regional supply depots reduce reliance on resupply lines during a crisis, ensuring access to resources even if lines of communication are disrupted.[5]

These infrastructure improvements directly support NATO's RSOMI process in case of a crisis, especially in the early phases when a HN must rapidly receive

forces into the theatre, prepare them for deployment, and integrate them into defensive plans.

Recent Steadfast Defender 2024-series exercises, which focus on multinational operational readiness in the Baltics, have demonstrated the importance of well-prepared infrastructure for deploying NATO's Very High Readiness Joint Task Force (VJTF) to the Baltic region. Key lessons included:

- Pre-coordination requirements between host nation and NATO forces;
- Early infrastructure preparation by Baltic States;
- Effective movement control systems and tracking;
- Strong host nation security of SN forces.

Additionally, these exercises provided valuable HNS lessons concerning effective command and control (C2), including the value of NFIUs as a crucial link between national forces and NATO reinforcements. These small headquarters, composed of HN and SN personnel, coordinate operations, assess logistics challenges, and allocate reinforcements. Their success relies on strong civil-military cooperation, proactive Memorandums of Understanding, deliberate planning, and continued joint exercises.

To sustain a credible deterrence posture, NATO must continue leveraging local infrastructure, reducing logistical burdens, and strengthening its military relationships across the Suwalki gap and the broader Eastern Flank. Without HNS, and associated proactive measures from both HNs and SNs, NATO's ability to defend its Baltic Allies could be severely compromised.

Host Nation Support to Agile Combat Employment

NATO's deterrence strategy for the Baltic States relies on interoperability between HNs and SNs, and this is especially true with Agile Combat Employment (ACE). ACE is a proactive and reactive manoeuvre strategy designed to increase survivability and sustain combat operations by disrupting enemy kill chains. One mechanism for this is the dispersed basing strategy, whereby forces operate across multiple dispersed locations, including civilian airfields and highways. Additionally, ACE strives to reduce reliance on large bases by using minimal logistics footprints, and it uses distributed C2 networks to complicate enemy targeting.[7]

The Baltic geography makes ACE a particularly valuable strategy, permitting NATO to sustain air operations even under contested conditions. However, the scheme of manoeuvre presents unique C2 and civilian-military cooperation challenges. As military forces spread out and continually relocate throughout the AOR, effective HNS must adapt to the increasingly dynamic pace of operations, and much consideration must therefore be given to communicating, tracking, and resupplying dispersed forces in a combat scenario.

Technological Integration Supporting Logistics

In modern warfare, logistics is not just an operational necessity but a strategic linchpin. For NATO, particularly in the Baltic States, ensuring a resilient and digitally integrated multinational logistics framework is vital. This need has only grown in urgency as the Alliance seeks to enhance its deterrence posture and maintain operational readiness against evolving threats.

Effective HNS requires joint responsibility by both the host nation and sending nations. HNs must prepare infrastructure and streamline their logistic procedures, while SNs must train for interoperability and mitigate bureaucratic or technological hurdles. A strong, adaptable HNS system is vital to NATO's defence posture, but effective HNS must be proactively accomplished and cannot wait until times of crisis.

Beyond the traditional focus on physical infrastructure, modern military operations require advanced technological systems to facilitate the rapid and coordinated movement of forces and supplies. NATO's logistical solution is called the Recognised Logistics Picture (RLP) – a shared digital framework that provides a comprehensive understanding of logistics requirements, capabilities, and movements across all NATO participants.

The Logistics Functional Area Service (LOGFAS) serves as the primary tool for achieving the RLP, enabling information exchange across national and organizational boundaries. LOGFAS is not a standalone system, but a suite of integrated digital tools designed to enhance logistics planning, coordination, and execution.[8] It provides real-time asset tracking, automated planning capabilities, supply forecasting, and bottleneck identification, all of which are essential for ensuring uninterrupted operational effectiveness.

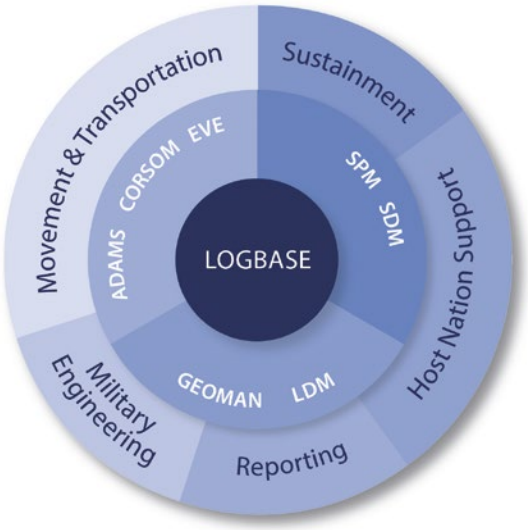
Despite its strategic value, the implementation of LOGFAS within the Baltic States remains uneven, with some national logistics systems only partially integrated into the broader NATO framework. This fragmentation creates potential gaps in logistics visibility and coordination, hampering the full realization of the RLP. To address these challenges, achieving comprehensive LOGFAS adoption across all HNS contributors is an urgent priority.

NFIUs collaborate with host nations to map out logistical networks, transportation routes, and essential infrastructure, enabling NATO's high-readiness forces to deploy rapidly and operate cohesively.

Digital Integration as a Force Multiplier

LOGFAS serves as a key enabler for NATO's Allied Reaction Forces (ARF) deployment, providing commanders with the necessary data to manage resources efficiently across national boundaries. Tools within LOGFAS, such as Effective Visible Execution (EVE), allow real-time mission tracking, ensuring that logistics movements align with operational requirements. Another important tool, CORSOM (Coalition Reception, Staging, Onward Movement), enhances force deployment coordination, offering visibility into scheduled movements and potential bottlenecks that could hinder rapid reinforcement.

While LOGFAS underpins NATO's digital logistics infrastructure, another system–the HNS Capability Planning Catalogue (HNS CAPCAT)–complements it by cataloguing available host nation resources, including facilities, transportation capabilities, and supply chains. CAPCAT provides standardized documentation of



LOGFAS Modules

national capabilities, ensuring that logistics planners can quickly identify suitable infrastructure for military operations. However, CAPCAT alone does not guarantee availability–actual support commitments must be formalized through Technical Arrangements (TAs) and Implementation Agreements (IAs).

Despite significant progress in negotiating and implementing these accords, gaps remain in certain areas that could impact NATO's ability to respond rapidly to crises. Ensuring the full operationalization and maintenance of HNS agreements remains a key priority, particularly given the geographical constraints and security threats in the Baltic region. By strengthening digital logistics integration, NATO can transform potential vulnerabilities into strategic advantages, reinforcing its deterrence posture and ensuring the rapid deployment of forces when necessary.

Enhancing NATO's HNS Framework: Five Strategic Priorities

To fully leverage HNS capabilities and bolster NATO's ability to defend the Baltic States against potential aggression, five concrete logistics actions must be accomplished by HNs and SNs:

1. **Strengthen Transportation Infrastructure:** While digital integration enhances logistical efficiency, physical infrastructure remains the backbone of military mobility. Current transportation networks in the Baltic region require modernization to support rapid force deployment and sustainment operations. Examples include:
   a. Upgrading key corridors linking seaports to inland staging areas and cross-border pathways.
   b. Modernizing railways and integrating NATO standard gauge with legacy Russian rail lines, thereby eliminating track gauge incompatibility.
   c. Reinforcing bridges and roads to accommodate heavy military vehicles, including main battle tanks and artillery systems.
   d. Establishing redundant transport routes to ensure resilience and facilitate ACE operations.

2. **Improve Interoperability Through Standardization and Training:** HN and SN interoperability remains a challenge, and operational success hinges on procedural standardization and personnel readiness. Examples include:
   a. Conducting large multinational logistics exercises to stress-test HNS systems and identify vulnerabilities before real-world crises.
   b. Reinforcing civil-military coordination to enhance preparedness for scenarios involving large-scale troop movements and civilian support in military logistics.
   c. Expediting border-crossing procedures for NATO forces to eliminate bureaucratic delays during crisis response.
   d. Establishing multinational logistics units to efficiently manage infrastructure and resources.
   e. Standardizing documents like STANAG 3430, which outlines interoperability procedures ranging from refuelling to rearming and maintaining each other's aircraft.

3. **Strengthen Physical and Digital Security Against Hybrid Threats:** As potential adversaries enhance their hybrid warfare capabilities, NATO's logistics infrastructure must be fortified against both physical and cyber threats. Examples include:
   a. Hardening critical infrastructure, such as fuel storage and communication nodes.
   b. Enhancing resilient digital networks to ensure operational security.

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Advancing and strengthening interoperability through cross-servicing training is vital for Allied operations.

c. Establishing multiple C2 nodes to provide redundancy.
d. Conducting regular cybersecurity exercises to test NATO's ability to defend logistics networks against cyber threats.

4. **Preposition Supplies for Rapid Reinforcement:** The Suwalki gap highlights the need for pre-positioned supplies to ensure rapid reinforcement. Examples include:
   a. Building storage facilities across the Baltic region to mitigate the risk of single-point failures.
   b. Pre-positioning medical supplies and facilities to provide immediate treatment for casualties during the initial phases of conflict.
   c. Distributing fuel reserves to support ACE operations and reduce reliance on Air-to-Air Refuelling (AAR).
   d. Stockpiling spare parts and repair to sustain prolonged operations.

5. **Leverage Emerging Technologies for Smart Logistics Management:** To enhance resilience, NATO must expedite logistics-based digital transformation, such as:
   a. Integrating LOGFAS across all Baltic HNS providers.
   b. Documenting all logistics capabilities in CAPCAT to ensure accurate planning.
   c. Future-proofing logistics networks by incorporating AI-driven forecasting, autonomous resupply systems, and blockchain technology.

Conclusion: Winning Through Host Nation Support

Host Nation Support (HNS) is the backbone of NATO's ability to deter and, if necessary, win a war in the Baltic region. Without a resilient and technologically advanced logistics network, even the most capable forces risk delays, disruption, and vulnerability.

To ensure operational success, NATO and its Baltic Allies must focus on five areas: infrastructure, interoperability, security, prepositioning, and technology. Upgrading transportation infrastructure–including reinforced bridges, standardized railways, and redundant supply routes–prevents bottlenecks and ensures rapid reinforcement. Fully integrating digital logistics systems like LOGFAS ensures real-time coordination of multinational logistics, while cybersecurity protections safeguard operational continuity. Frequent, large-scale exercises stress-test NATO's logistical readiness under combat conditions, ensuring HNS functions effectively when it matters most. Finally, emerging technologies promise to streamline HNS.

Victory in modern warfare depends not just on combat capability but on sustaining that capability in prolonged conflict. By strengthening HNS in these five areas, NATO ensures that forces in the Baltic region remain supplied, mobile, and combat-ready–turning logistics from a vulnerability into a decisive advantage. ●

Logistics and prepositioning ensure that materiel is swiftly made available at a deployed location.

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NATO Needs an Extended Footprint in East Central Europe

The Case for Ostrava

By Glen E. Howard, President, The Saratoga Foundation

Introduction

Since the beginning of the Cold War, NATO's extended military presence has been broadly located in Northwestern Europe. Much of its military logistical infrastructure is located in the English tidal range, consisting of European coastal areas such as Rotterdam, Antwerp, and Kiel. For most of its 75 years of existence, the tidewater areas served as NATO's principal hubs for its military infrastructure and reinforcement nodes in the event of a conflict with the USSR whereby the Fulda gap military scenario for Soviet forces overrunning Western Europe from East Germany significantly affected NATO's planning and defensive strategy.

Over time, the end result of NATO's strategy led to an over-concentration of resources and infrastructure into one geographic section of Northwestern Europe. Consequently, the bulk of NATO infrastructure and its administrative posture became located in Belgium, such as the Supreme Headquarters Allied Powers Europe (SHAPE), which is also intermixed with the vast European Union bureaucracy in Brussels. This in turn has tainted NATO strategic thinking over threat perceptions arising in the East where many of the new frontline member states shared far deeper concerns over the Russian threat than those in the tidewater regions.

Since the Russian invasion and occupation of Crimea in 2014, and more recently after its offensive into Ukraine in February 2022, the United States has sought to shore up NATO's military infrastructure in Eastern Europe to keep pace with developments to improve its mobility and defend its eastern approaches by investing $8 billion of its financial resources through the European Reassurance Initiative (now known as the European Deterrence Initiative or EDI). Enhanced runways and storage facilities were hallmarks of this programme.

As a result of its investment, NATO is slowly altering its posture toward the East after realizing that the roads and infrastructure required to fight a war in Central and Eastern Europe, namely in Poland and the Baltic states, and even in Romania, sorely lacked the infrastructure among its eastern member states to adequately project power to the East. While Ulm and parts of the Rhine were the centerpiece for NATO staging areas, just as they were during the time of Napoleon, the Atlantic Alliance has only incrementally expanded its logistical and aerial footprint to improve its ability to counter the threat to NATO's new European borderlands.

Airfield Name	Country	Key Observations
Ostrava Leos Janacek Airport (LKMT)	Czech Republic	A regional hub with moderate capacity, well positioned to serve the industrial heartland of the Czech Republic and neighbouring regions.
Katowice Airport (EPKT)	Poland	In Poland represents a larger hub with higher capacity, catering to a more extensive catchment area.
Brno-Tuřany Airport (LKTB)	Czech Republic	It serves as an important logistical hub for southern Czechia.
Kosice International Airport (LZKZ)	Slovakia	It's proximity to the border with Hungary and Ukraine adds to it's logistical and potential strategic significance.
Budapest Ferenc Liszt International Airport	Hungary	Is a major international airport with significantly greater capacity and connectivity.

Key Airfields in Eastern/Southeastern Europe: Contextualizing Ostrava or A comparative overview of critical airfields with assessments based on runway length, MOG (Maximum on Ground) capacity, daily throughput, and proximity to strategic locations.

Despite these efforts, there is a vested interest within NATO to keep its vast administrative apparatus located in the tidal regions in Western Europe, which simply defies military sense. Together, the 'tidewater' dimension of NATO's geography has tainted the strategic thinking of NATO policymakers, creating a major gap in 'center field' to use an American baseball term between the hub of NATO in the coastal tidal range and the actual Russian threat emanating several thousand miles to the East in and around the Black Sea. This has created a major disconnect in perceptions and outlook within NATO as the Eastern European countries regard themselves as part of the frontline against Russian expansionism.

The United States has sought to narrow the gap between the 'tidewater' and the 'frontline states', by investing in its military infrastructure in Eastern Europe to enhance its mobility since 2016 through the EDI. During this time, NATO sought to improve its warfighting capabilities to deal with a conflict emanating from its two flanks - the Baltic and Black Seas, or what some experts refer to as the two Bs. On the far eastern end of that flank the US has established a new 'Ramstein in the East' at the Mihail Kogalniceau (MK) airbase in Romania. While MK has provided NATO with an adequate platform to fend off Russian intrusions from the Black Sea, it is nearly 2,300 km from its command structures, such as NATO Allied Joint Forces Command at Brunssum The Netherlands and the Romanian theatre in the Black Sea, a vast aerial arch that stretches across a region once part of the former Austro-Hungarian empire. In between are what former Secretary of Defense Donald Rumsfeld described as the 'Lily Pads' to describe the wide swath of Eurasia and the former Soviet Union consisting of former Soviet airfields that the United States could utilize in a future conflict.

Unfortunately, NATO's footprint in the Carpathian-dominated East is light in the points in between the 'old' and 'new' Ramsteins. What is needed is perhaps a mini Ramstein located somewhere in between, and the civilian airfield at Ostrava, CZE could be part of that solution. Ostrava could help ensure access to the Eastern flank despite any military or political challenges.

Runway Length	Approx. MOG.	Approx. Daily Throughput	Key Proximity
2,450	15–20	50–70	Industrail centers, major cities (Prague, Vienna)
2,495	20–25	70–90	Industrial Silesia region, major cities (Warsaw, Krakow)
2,500	12–15	40–50	Industrail centers, major cities (Vienna, Budapest)
2,450	10–15	30–40	Eastern Slovakia, Hungarian border
3,500	30–40	100–120	Hungarian capital, central European hub

For example, Germany's AfD party is opposed to German support for Ukraine and has questioned German membership in NATO and could undercut Ramstein as the major aerial hub in Europe.

Fresh thinking is required in the minds of NATO planners over how to reinforce its presence in the East in the areas between Europe's tidewater and the Black Sea. When airpower strategists think about the areas in between the tidewater and the Black Sea, few Western experts think about the importance of Czechia and its strategic location.

Fresh thinking is required in the minds of NATO planners over how to reinforce its presence in the East in the areas between Europe's tidewater and the Black Sea.

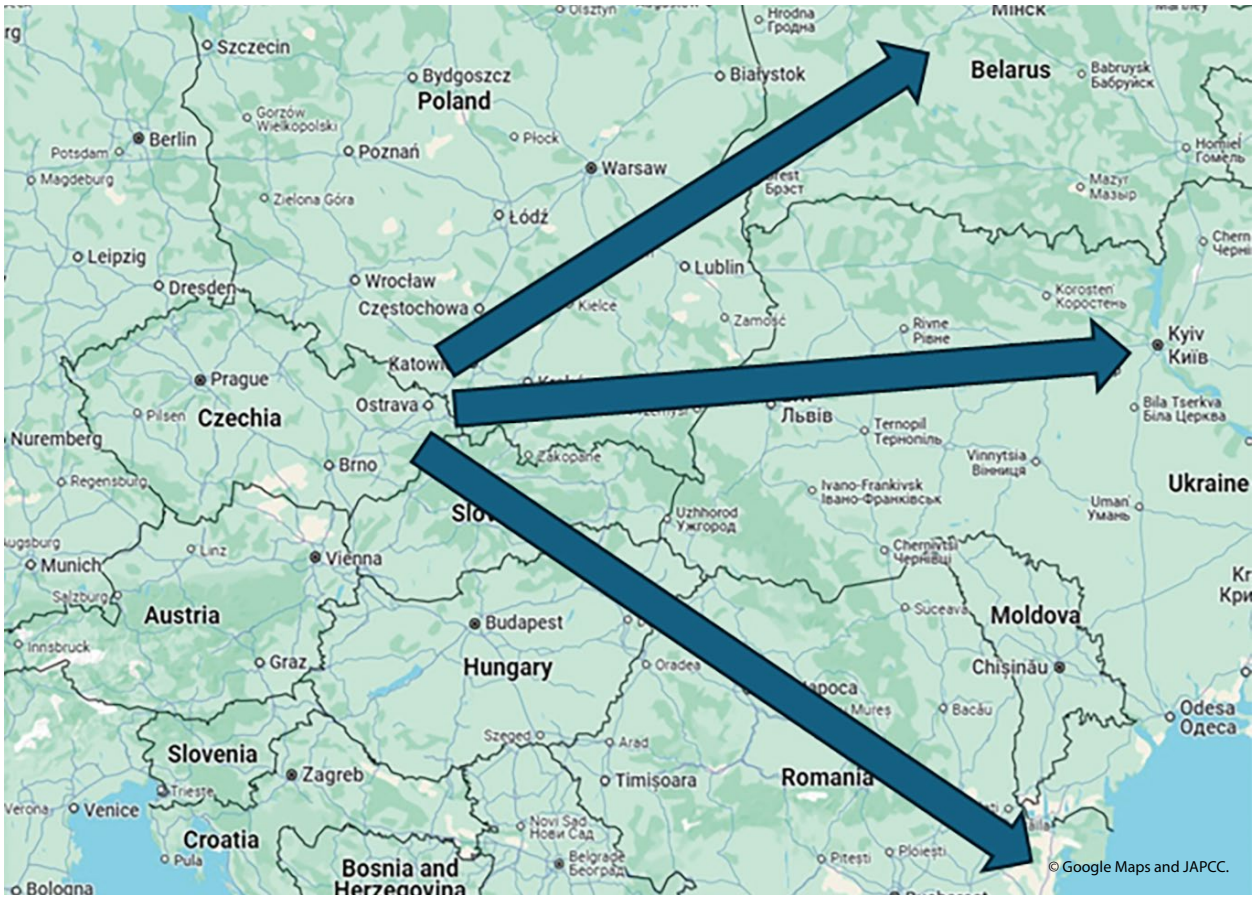
Led by President Petr Pavel, Czechia is making major investments in military rearmament after years of neglect. It is modernizing 50 percent of its military and spent $7.5 billion to purchase two squadrons of F35 fighters. While Čáslav airbase will be the home for two of Czechia's recently acquired F35 squadrons, the civilian airfield at Ostrava deserves closer attention as a new forward base for NATO airpower given its proximity to Ukraine and its rail connections on an east-west, north-south axis with the rest of Eastern Europe.

Ostrava: A NATO Window on the Carpathians?

Situated in Moravia and the gateway to Silesia, the former steel town of Ostrava represents one of a handful of airfields in Eastern Europe that is capable of handling B52H Stratfortresses. As the 'Pittsburgh of Czechia,' Ostrava is strategically located at the confluence of four rivers (Odra, Opava, Ostavice, Lučina) and is well positioned geographically to project NATO beyond the Carpathians.

As an example of its prominence, Ostrava's annual air show has risen to become one of the largest in Europe. Since being launched in 2001, the NATO Days air show in Ostrava has become the 'Farnborough of Eastern Europe,' and attracts several hundred thousand visitors from Czechia and surrounding countries each year.

In 2015, attendance reached an all-time record of 225,000 visitors, elevating it as one of the largest



Ostrava's strategic location at the crossroads of Europe underscores its vital logistical and military significance.

European air shows in terms of attendance. The NATO days in Ostrava air show is also one of NATO's largest public diplomacy events organized in Europe. In 2023, the air show attracted approximately, 183,000 spectators. The air show involved the participation of several NATO member nations, including the United States Air Force, which dispatched B52 Stratofortress aircraft to participate in the air show – an unmistakable diplomatic statement of the US's interest in the strategic importance of the airfield. The civilian-operated airfield at Ostrava has one of the longest runways in the Czech Republic and certainly ranks as one of the top airfields east of Ramstein. While the airfield is operated by a civilian company, the Czech Ministry of Defense has the ability to use the airfield and is working on an arrangement to gain greater access to Ostrava for military purposes.

By developing Ostrava, US strategists could reshape NATO's aerial footprint in the foothills of the wider Carpathians by offering American airpower a new operational axis toward Ukraine and become a 'mini-Ramstein of Central Europe' that would complement Poland's growing airpower capabilities to forge a new aerial centre of gravity over East Central Europe that NATO currently lacks.

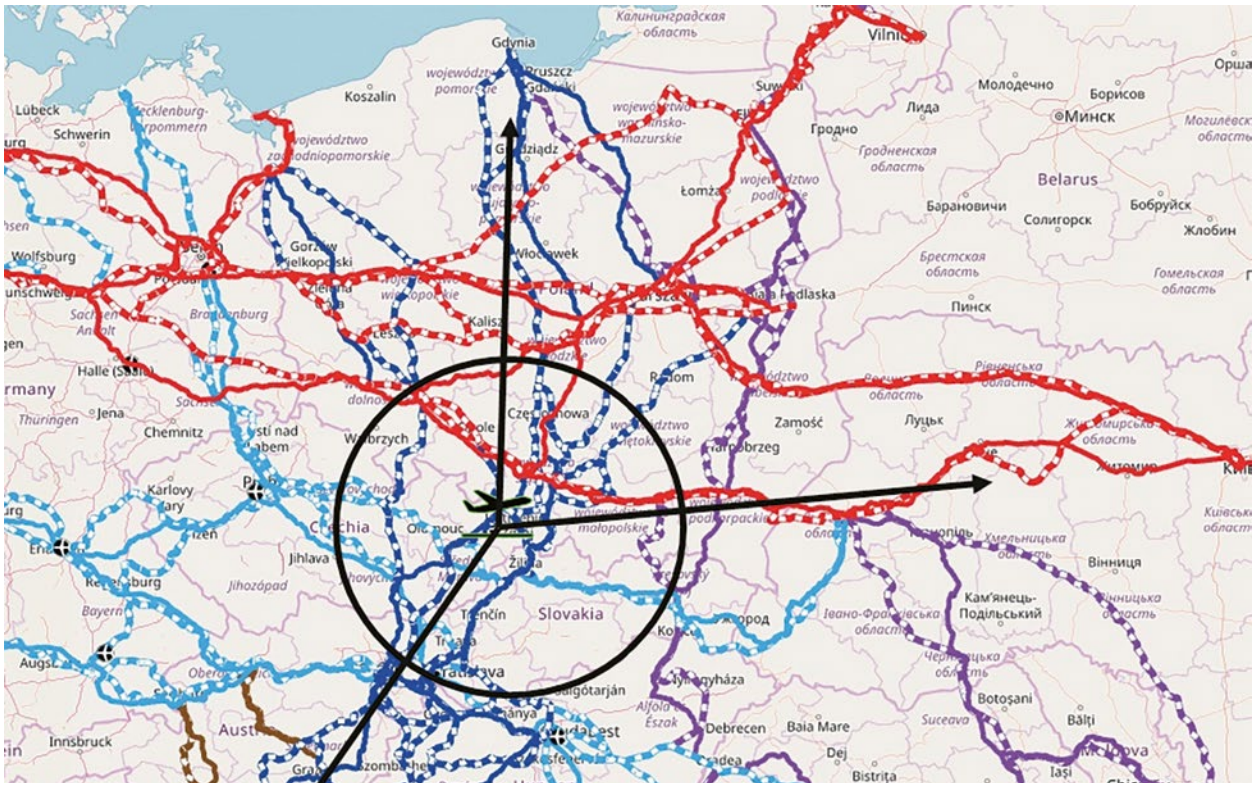
Ostrava is more than a civilian airport at the base of the Carpathian Mountains. It is also a key strategic road, air, and railway hub of two key European transport corridors as part of the Trans-European Transport Network (TEN-T). Two of those strategic transport corridors are interconnected with Ostrava, the Baltic Sea-Adriatic, and the Rhine-Danube corridors. Due to its unique location, Ostrava offers a commanding geographic location that enhances NATO mobility in an East-West direction and is well situated to help position NATO to counter a threat from either Belarus, Western and Central Ukraine and elsewhere from across the Eurasian steppe.

NATO Days in Ostrava: Europe's premier air show and a powerful display of allied unity.

Lastly, another strategic dividend to using Ostrava is it would complement the existing but overtaxed NATO logistical node through Rzeszów in southern Poland. One of the new strategic realities of the war in Ukraine and how it has revolutionized NATO's eastern flank is the emergence of Rzeszów as a key ground-based Line of Communication (LOC) to Ukraine via eastern Poland where an estimated 95 percent of all NATO arms deliveries to Ukraine pass. Often referred to as the 'gateway to Ukraine', Rzeszów and its airport, Jasionka, operate as both a civilian and a military rail and airport hub due to the city's proximity to the Ukrainian battlefront. In the past three years Rzeszów has emerged as a key NATO supply line for munitions and other critically needed materiel being sent to Kyiv as part of the NATO assistance effort. Rzeszów offers important strategic significance due to its road and rail connections and greatly facilitates NATO logistical efforts to assist Ukraine's war efforts.

Lviv, for example, is 50 kilometres from the Ukrainian border. In the past three years, the once quiet Rzeszów-Jasionka airport has become a key weapons hub for Ukraine but its airfield has limited capability to handle the large amounts of supplies destined for Ukraine that transit through it. Moreover, concern over Russia targeting Rzeszów-Jasionka has prompted German Defense Minister Pistorius to order the deployment of a German Patriot battery to protect the supply hub. In short, NATO should avoid putting all its 'logistical eggs' into one basket and should diversify its defensive posture in East Central Europe.

By upping its aerial footprint at Ostrava, NATO accomplishes several objectives at once. It not only reduces the flying distance between Joint Force Command (JFC) Brunssum and JFC Naples to the frontlines of Ukraine, but it could also strategically and economically integrate precarious NATO frontline



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Ostrava is a vital strategic hub connecting road, air, and rail routes within the Trans-European Transport Network.

member states, such as Slovakia, and Hungary, into the Alliance's planning.

Ostrava deserves closer attention as a new forward base for NATO airpower given its proximity to Ukraine and its rail connections on an east-west, north-south axis with the rest of Eastern Europe.

Such a development could dampen their overly friendly ties with Moscow as a larger NATO presence at nearby Ostrava generates economic benefits to the surrounding regional economy. Whereas JFC Brunssum has been called the balcony of Europe, Ostrava could become NATO's front door to the Carpathians and, by extension, provide NATO with a new window into Ukraine and diversify from its dependence on Rzeszów as its only logistical hub in the region and lessen its dependence on central Poland.

Conceptually, Ostrava could become a new symbol of NATO's commitment to its Eastern Europe members by deepening its presence in the wider Carpathians as the war in Ukraine creates new NATO logistical corridors eastward toward Ukraine and Belarus. In addition, it also would help strengthen NATO's political and economic influence over neighbouring Slovakia.

Politically, it would remind European policymakers that the US is not wedded to its old tidal infrastructure in Western Europe but is prepared to embrace a new common-sense approach to deal with its threats from the East. Creating a new airbase at Ostrava would also demonstrate that NATO is prepared 'to balance one foot with another' as it extends its aerial footprint further to the East to ward off Russian encroachment and improve its defensive posture toward Russia while simultaneously enhancing the security of Ukraine.

Perhaps more importantly, by creating an aerial bridgehead at Ostrava, the United States could reward Czech President Petr Pavel for his commitment

to reach NATO's two percent defence spending threshold and his determination to modernize his military, including his $7.5 billion investment to purchase American-made F35s. For the first time in 18 years, Czechia in 2025 reached the two percent threshold for yearly defence spending and will maintain this as a minimum level after passing a national law to ensure that the country's defence spending never drops below two percent. Rewarding Czechia's investments also signals to American allies in Western Europe that the United States is prepared to reward its Eastern European allies for their commitment to defend the Alliance while scaling down its presence in some countries to a shell of their former self and reconstitute this presence if needed.

Finally, the economic payoff for Czechia's investment in Ostrava would result in a major boost to the local economy which has experienced a downturn in recent years. The Dutch economy around JFC Brunssum, for example, has benefited immensely from the NATO presence and generates over $131 million annually for the local community. Diversifying NATO's logistical hubs is wise as the United States adjusts its strategic footprint more to 'center field' than the tidewater regions of Western Europe and solidifies support along three strategic axes in what is known as the Silesian belt comprising southern Poland, Czechia, and Slovakia.

It is time for NATO and US policymakers to think more contextually about how to use what Czechia can offer through its strategic location in East Central Europe and as a window into Ukraine. Developing an air base at Ostrava would also build upon Czechia's existing and well-established logistical rail network to reconfigure NATO's eastern flank to face the threat emanating from eastern Ukraine and the Black Sea. ●

ABOUT THE AUTHOR

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President, The Saratoga Foundation

Glen E. Howard is the President and Chairman of The Saratoga Foundation. He previously served for over 20+ years as the President of The Jamestown Foundation, a research and analysis organization focusing on Eurasia. During that time, he extensively interacted with prominent leaders, experts, and national strategists across Eurasia from the Baltic to Central Asia. An expert on Eurasia and Russia, Mr. Howard published over a dozen books on Eurasia and is the recent editor of Black Sea Battleground: The Road to Ukraine, and Russia's Military Strategy and Doctrine.

He has written extensively on Russia and Eurasia and published articles in the Financial Times, the Hill, and the Wall Street Journal. Mr. Howard received a Master's degree from the University of Kansas in 1988 in Soviet & East European Studies and is a 1984 graduate of Oklahoma State University.

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The JAPCC Conference 2024 brought together military leaders, subject-matter experts, and industry representatives from more than 30 nations, providing a platform to explore NATO's strategic approaches to evolving global power structures, emerging technologies, and cooperative defence efforts.

Challenges and Opportunities for Air and Space Power in an Evolving Security Environment

Review of the JAPCC Conference 2024

Introduction

The JAPCC Conference 2024, conducted under Chatham House rules, gathered military leaders, experts, and industry representatives from over 30 nations and offered a forum to discuss NATO's strategic responses to shifting global power dynamics, technological advancements, and collaborative defence initiatives.

Keynote 1: Addressing the Complexity of Modern Defence Environments

This session explored the complexities NATO faces in today's dynamic global environment. Key points:

Autonomous Systems and AI: The development of AI and autonomy is both a transformative opportunity and a risk. These technologies offer NATO unprecedented control, precision, and operational flexibility, but they also heighten the risk of adversaries using similar systems without constraint to undermine NATO's defence strategies.

Multi-Domain Resilience: Building resilience across all domains is a crucial goal for NATO. Adversaries are likely to target through domains simultaneously, aiming to create cascading disruptions. This comprehensive approach requires NATO to integrate defences, increase interoperability, and ensure that different domains support one another.

Geopolitical Threats: The increasing aggressiveness of certain state actors, particularly Russia and China, and the unpredictable threats posed by non-state actors, are persistent concerns. These actors are advancing their capabilities in cyber and electronic warfare considerably, and NATO must be prepared to respond.

Keynote 2: Enhancing NATO's Technological Agility and Strategic Position

This session examined how NATO can enhance its technological agility to improve defence readiness and support strategic objectives through rapid technological integration and an agile development approach. Key points:

Technological Integration and Interoperability: To maintain a strategic edge, NATO must quickly integrate cutting-edge technologies across all levels of defence. Ensuring interoperability of new technologies within NATO forces allows for smoother, faster responses to crises and operations.

Civil-Military Partnerships: Closer civil-military collaboration is a way for NATO to leverage the fast-paced innovation occurring within the private sector. Civilian companies can drive rapid advancements in defence-related technology, providing NATO with essential tools for modern warfare.

Multi-Domain Operations as a Force Multiplier: A multi-domain approach is essential to enhancing NATO's strategic position. By aligning military, political, and civilian capabilities, NATO can amplify its strategic impact, making it better equipped to respond to both traditional and non-traditional threats.

Panel 1: Navigating the Ripple Effects of Shifting Power Dynamics

This panel described the challenge of navigating the ripple effects of shifting global power dynamics. As the global security dynamic changes, the panel discussed how NATO will adapt to those evolving relationships, new conflicts, and emerging technologies.

The Indo-Pacific Area. Entrenched strategic competition has become the primary feature of the Indo-Pacific security environment. Today we are seeing not just military, but political, economic, technological, and ideological strategic competition. It is a competition for strategic advantage waged in the grey zone of peace and war, where China is pursuing a multi-pronged strategy towards global pre-eminence.

Current and Potential Future NATO Security Landscape Challenges.

A strong European pillar of NATO makes the Alliance more robust, resilient, and sustainable in political terms because it enables future USA administrations to remain committed to Europe at a level sustainable with respect to their own electorate. In Europe, Italy, Germany, and many other European countries would support the concept of a strong European pillar in NATO rather than other concepts favouring EU strategic autonomy. The panel identified three main challenges:

Lt Gen Thorsten Poschwatta, Executive Director of the JAPCC, delivers the opening address at the JAPCC Conference 2024.

1. Geography: If there is an engagement in the Pacific, it automatically has implications on the USA's global focus. As NATO's largest ally, there will be force posture implications in Europe.

2. Second and third order effects: If Russian 'fire' is seen in the Baltic Region, nowhere else in NATO sees the 'smoke'. This relates to the distance between the front lines in the east and the recognition that the capitals, including Brussels, do not recognize the significant difference in proximity and perception.

3. Lines of Communications (LOCs): NATO has extremely long LOCs from the harbours in the West to any potential front line in the East. The establishment of the JSEC, in Ulm, is intended to establish rules and mechanisms that allow the transfer of logistics through the European Union with ease.

Oversight of the Air Domain in a Land-Centric Russia-Ukraine Conflict. A key takeaway is that the air domain has been neglected during Russia's war against Ukraine. Whilst all conflicts are different, the oversight of air superiority as a prerequisite for a successful campaign is striking. Both side's inability to establish air superiority or conduct an integrated air campaign leaves a potentially decisive arrow in the quiver.

The Information Domain

The panel further discussed whether the information domain ought to be broken out into a sixth domain of warfare.

Panel 2: Battlefield Evolution – The Role of Joint Air and Space Power in Contemporary Conflict

This panel discussed momentum and development in the space domain, confirming that space is a warfighting domain and a battleground for the future. Key points included:

The Operational Focus, Divided into three Parts:

1. **Connectivity.** There is an increasing demand for resilient, reliable, and secure connectivity in the battlespace. Commercial satellite constellations are a great opportunity and could be a force multiplier, but also a potential vulnerability.

Panel 1 discussed how shifting power dynamics are reshaping the world and creating far-reaching ripple effects.

2. **The EM Spectrum.** Gaining and maintaining superiority in the EM spectrum still has some problems in phasing EM spectrum activities into campaign design; thankfully, militaries' understanding is growing due to an increased emphasis on the EM spectrum.

3. **A2/AD.** Better and more sophisticated exercise scenario designs, which consider EM threats, coupled with BMs and cruise missiles are necessary steps in the years long process of educating NATO personnel on C-A2/AD activities.

Countering A2/AD and IAMD: A2/AD and IAMD are two critical areas where NATO needs to maintain superiority to guarantee freedom of manoeuvre. Panellists shared insights into NATO's evolving strategies and the specific challenges presented by A2/AD environments.

Developing Multi-Domain Solutions: As adversaries increase their control over certain domains, particularly through A2/AD systems, NATO must respond with multi-domain solutions to neutralize these threats.

Layered Missile Defence: Panellists emphasized the need for ISR capabilities to support overlapping missile defence systems, which would allow NATO to detect and respond to threats more effectively.

Importance of Interoperability and Data Sharing: Effective missile defence relies on smooth communication and data-sharing among allies. This requires NATO to overcome challenges related to data security and to establish secure, reliable networks for information exchange.

Panel 3: Contested Air Superiority in the Age of Drones and Missiles

This panel examined the growing threats posed by drones and missiles, which increasingly challenge NATO's ability to maintain air superiority. Key points included:

Adaptable Air Defence Solutions. Panellists discussed the need for NATO to adopt adaptable and agile air defence strategies. As drones and missiles become more sophisticated, NATO's air defence must evolve to respond effectively to these threats.

Decentralized Command and Control: In a fast-changing battlefield, decentralizing command and

control functions can improve response times and operational flexibility. Such an approach is vital in highly contested airspaces.

Importance of Joint Exercises and Interoperability: NATO's preparedness relies on continuous training and joint exercises, which maintains cohesion and readiness across diverse national defence systems.

Readiness: Readiness is something that is deeply ingrained and is not something that is invented or improvised; it is in our culture. It has been improved on and practiced for 70 years and it enables NATO's military profession.

Revisiting Drone Doctrine: The current use of drones in conflict leaves a lasting impact and forces us to reevaluate how we look at doctrine, approach a problem, and solve it. NATO's air defence TTPs must be sound because NATO does not have the magazine depth to waste resources on inefficient shot doctrine.

Panel 4: Industry's Role in Advancing NATO's Technological Superiority

The final panel addressed how industry can support NATO in maintaining its technological edge, focusing on rapid integration of emerging capabilities. Key topics included:

Emerging Technologies for Defence: Industry representatives discussed the impact of emerging technologies like AI, quantum computing, and autonomous systems on defence capabilities.

Dual-Use Technologies: Dual-use technologies were identified as cost-effective solutions that NATO could leverage due to the potential for greater investment in technology that benefits both sectors.

Scalability in Defence Contracts: Panelists advocated for scalable defence contracts to meet NATO's fluctuating security demands. Industry leaders suggested that flexible contracts could help NATO respond more swiftly to emerging threats.

Future Drone Warfare

There are four main takeaways regarding future drone warfare:

1. **Masking.** Ukraine has done so well partly due to masking i.e. using cover where units cannot be spotted by drones and by maintaining silent comms, to include mobile phones.

2. **Understand that AI is not something to be feared.** Nobody can predict an AI-powered drone or what it will do which raises concerns of weapons safety. However, our adversaries do not operate under that safety culture, placing them at a potential advantage. If doctrine cannot be changed to allow soldiers to work with AI-powered weapons, the lessons could be painfully learned in the next conflict.

3. **Swarm Officers.** NATO should establish swarm officers at the company level. When a soldier is assigned ISR duties, all they should do is ISR, control drones, and feed information into the intelligence hub to alleviate cognitive loads off of the Commander.

4. **Mass.** China currently has 70% of the world's commercial drone manufacturing capacity. It is paramount to have knowledgeable workers in industry that can surge capacity to deliver drones that are smaller and cheaper, at scale, and at pace.

Conclusion

In summary, the JAPCC Conference 2024 underscored the importance of technological agility, strategic partnerships, and a unified approach to address the evolving global security landscape. Join us next year for the 2025 JAPCC Conference. More information can be found in the advertisement within this journal, or by visiting our website www.japcc.org/conference. ●

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In 2025, the Joint Air and Space Power Conference will move to the Grugahalle, not far from our traditional venue.

2025 Conference: A New Era Begins

In the past three years, the JAPCC has reached its maximum capacity for both participants and exhibitors. The previous conference even exceeded attendee limits due to high demand. To accommodate the growing audience, the 2025 conference will take place at the Grugahalle, a larger and more versatile venue that provides new opportunities for participants, sponsors, and exhibitors.

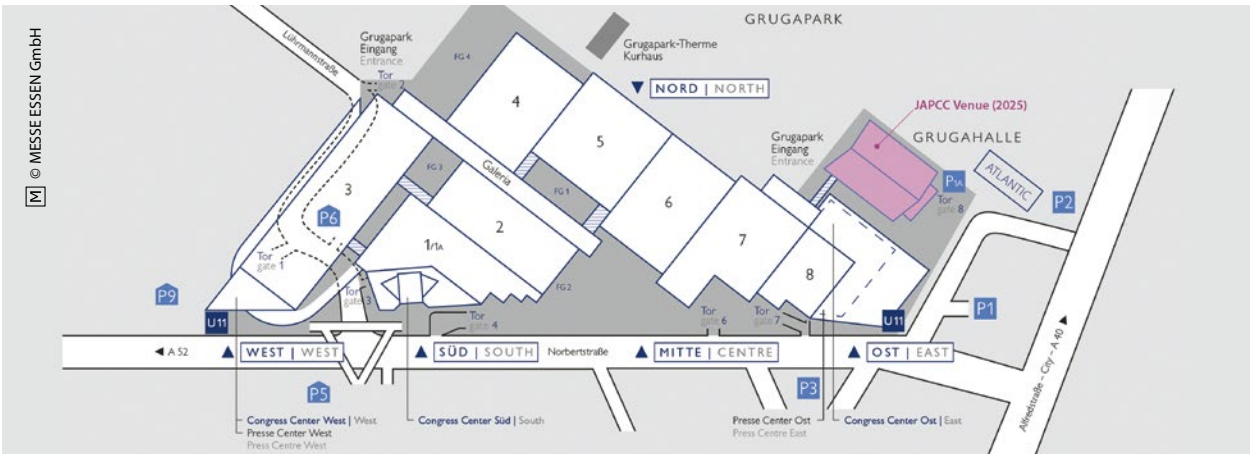
The 2025 conference will showcase a significantly expanded exhibition area, featuring larger and more accessible exhibitor booths and private meeting rooms located on the same floor as the main conference sessions. This setup will ensure seamless engagement between exhibitors and attendees during networking breaks, enhancing the overall experience for all involved.

Experience the Excitement of a New Venue: The Grugahalle offers a modern and spacious setting that caters to JAPCC's expanding audience, all while maintaining the high-quality experience that you have come to expect.

Enhanced Exhibition Experience: Exhibitor booths have been significantly enlarged, allowing for the showcasing of comprehensive solutions and interactive demonstrations that will captivate you.

Unparalleled Networking Opportunities: Interact with other senior leaders and experts as they delve into the future of joint air and space power, offering valuable insights and perspectives.

Don't miss out on this exceptional opportunity to be a part of this event in 2025 – where innovation, collaboration, and excellence converge.



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Strengthening NATO Air and Space Power through Collaboration

11th Joint Air and Space Power Network Meeting

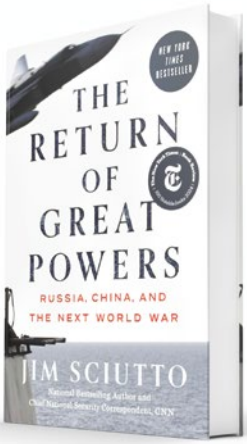
In recent years, the geopolitical landscape has been marked by significant challenges, such as the Russian war against Ukraine, multiple crises in the Middle East, and increasing strategic competition. These events have led to a noticeable shift in NATO's defence thinking and strategy. As a result, the rapid evolution and adaptability of Joint Air and Space Power (JASP) is more critical than ever and relies heavily on the collective commitment and collaboration of NATO nations and associated entities. The annual Joint Air and Space Power Network (JASPN) meeting, organized by the JAPCC, serves as a platform for sharing information, engaging in collaborative discussions, and fostering synergy between multinational organizations within the JASP community.

The 11th JASPN meeting took place from 19th to 20th November, 2024, at the JAPCC's home base in Kalkar. Colonel Vito Cracas, the Assistant Director of the JAPCC, chaired the meeting, which brought together representatives from 12 distinguished entities, including the Allied Air Command, the Competence Centre for Surface Based Air and Missile Defence, the European Air Group, the European Air Transport Command, the European Defence Agency, the European Union Military Staff, the Movement Coordination Centre Europe, the NATO HQ International Military Staff, the NATO HQ International Staff, the NATO Science & Technology Organization, the Supreme Allied Command Transformation, and the Joint Air Power Competence Centre.

Over the course of two days, participants discussed their programmes of work, shared experiences, and engaged in productive conversations to address current challenges and opportunities to advance JASP for NATO. The roundtable and breakout discussions underscored the importance of collaboration and networking. Insights gained and knowledge shared during the meeting have paved the way for potential collaborations and efforts to avoid duplication of effort.

The JAPCC extends its sincere gratitude to all participants for their valuable contributions, which were instrumental in the success of the event. A meeting summary, including presentations, recordings, and a collaboration matrix with points of contact, has been shared with all attendees for reference.

Looking ahead, the JAPCC is excited to build on this momentum and strengthen partnerships at the next JASPN meeting in November 2025. Multinational organizations, such as those mentioned above, are encouraged to contact us at contact@japcc.org if interested in participating. ●

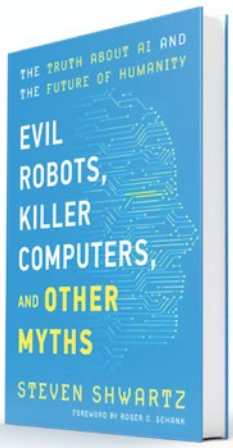


The Return of Great Powers: Russia, China, and the Next World War

Following the collapse of the Soviet Union, many believed the world had entered an era of lasting peace, known as 'The End of History'. It was believed that after the Cold War, the risk of major peer-to-peer conflicts would diminish, giving rise to more limited forms of warfare. However, by February 2022, that optimism had faded. During a live CNN broadcast, author Jim Sciutto not only refuted the end of history, but asserted that history was in fact repeating, with the world experiencing a crisis moment akin to 1939. Sciutto examines the resurgence of multipolar geopolitical rivalries, particularly the threats posed by Russia and China. He explores how Russia has destabilized European security, while China's increasing hostility in the Pacific also challenges the existing global order.

Sciutto delves deeply into the rise of China and Russia, emerging technological trends, and risks to the current global order as the world navigates great power competition. With unique access as CNN's chief national security correspondent, Sciutto supports his comprehensive analysis with first-hand research including interviews with world leaders. This book thoroughly examines the strategic dilemmas facing NATO today, offering compelling arguments on the role of Western leadership in the years to come. ●

By Jim Sciutto; Dutton, 2024
Reviewed by Major Luke Stensberg, US SF, JAPCC



Evil Robots, Killer Computers, and Other Myths

Steven Shwartz's Evil Robots, Killer Computers, and Other Myths is an accessible and engaging exploration of artificial intelligence (AI) designed for a broad audience. Drawing on his extensive AI background, Shwartz demystifies common misconceptions in the field, explaining what AI is, and how modern AI systems, such as semi-autonomous vehicles, function. He argues that all modern AI (at least until the book was published) fall under the category of 'Narrow AI' –systems which outperform humans in specific, limited tasks but lack general intelligence. He argues that AI is a tool which cannot think or make decisions like humans, as it lacks real-world understanding. Thus, he concludes that fears of robots taking over the world are exaggerated.

However, one limitation of the book, written in 2021, is its perspective on the future of AI. While Shwartz mentions large language models (LLMs) in his book, he fails to anticipate the rapid advancements that have since reshaped this field. Despite this shortcoming, Evil Robots, Killer Computers, and Other Myths is a valuable read, particularly for those trying to separate fact from fiction, showing the rapid ecolution of AI technology, often in ways that are hard to predict, even for experts. ●

By Steven Shwartz; Fast Company Press, 2021
Reviewed by Colonel Antonios Chochtoulas, GRC Air Force, JAPCC

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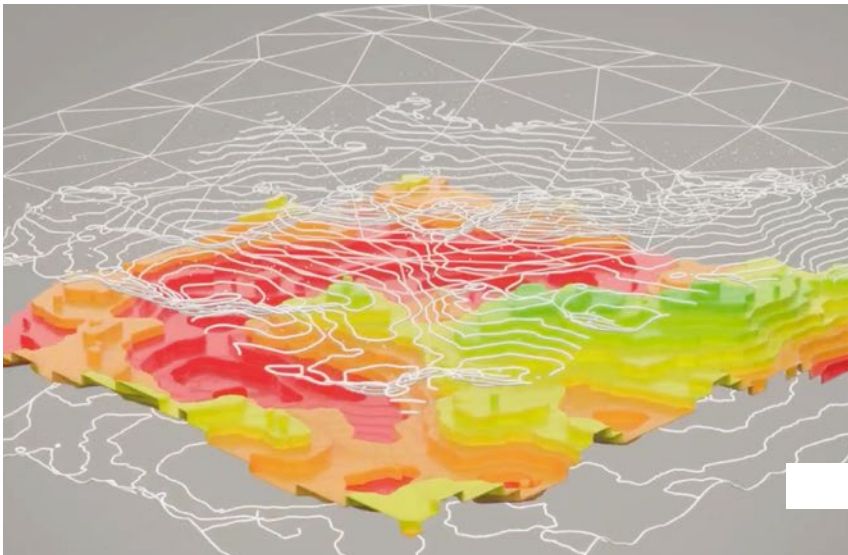


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